SFERS
San Francisco Employees' Retirement System

City and County of San Francisco
Employees' Retirement System

# RETIREMENT BOARD CALENDAR SHEET
## Retirement Board Meeting of August 9, 2017

**To:** The Retirement Board

**From:** Jay Huish
Executive Director

William J. Coaker, Jr. – CFA, MBA
Chief Investment Officer

**Date:** August 9, 2017

**Re:** Discussion and Possible Action related to Complete Divestiture of Fossil Fuel Holdings in Carbon Underground 200 (CU200) Companies in the SFERS Public Markets Portfolio within 180 Days

**Background:**

At the May 17, 2017 Retirement Board meeting, Commissioner Makras requested the Board President calendar a motion to prudently divest, within a 180-day period, from all fossil fuel holdings in Carbon Underground 200 (CU 200) companies in the SFERS public markets portfolio. In June 2017, NEPC, the Retirement Board's general investment consultant, was requested to prepare an analysis of the impact of complete divestment of fossil fuel holdings from the SFERS public markets portfolio. Retirement staff has had the opportunity to review NEPC's analysis and has prepared its own recommendation related to the proposed motion to completely divest from public market fossil fuel holdings in SFERS Trust.

SFERS' Public Market Holdings in Fossil Fuel Companies

As of March 31, 2017, SFERS held $473 million of securities in the CU200 companies, $442 million in equities and $31 million in fixed income securities, excluding fixed income commingled fund holdings. The total equity exposure to CU200 companies is approximately 4% of total public equities. $416.3 million of these CU200 public equity holdings are in separately-managed equity accounts making this proposed divestment by far the largest in scope of any previous divestment actions taken by the Retirement Board (e.g. tobacco divestment - $25 million). NEPC's analysis demonstrates how the size of the proposed investment restrictions impacts the amount by which a restricted portfolio will suffer from reduced expected return or higher expected risk.

History of the Retirement Board Actions related to the 2013 Board of Supervisor's Resolution asking the Board to Divest from the Carbon Underground 200 Fossil Fuel Companies:

At the May 8, 2013 Retirement Board meeting, the Board received Supervisor Avalos' letter urging the Retirement Board to consider Board of Supervisors (BOS) Resolution #126-13 asking the Board to divest from the Carbon Underground 200 fossil fuel companies under the Retirement Board's *Social Investment Policy and Procedures*.

At the October 9, 2013 Retirement Board meeting, the Board considered BOS Resolution #126-13 and voted to direct staff to prepare an analysis and report regarding Level I and Level II engagement of fossil fuel companies under the Retirement Board's *Social Investment Policy and Procedures*.

At the February 19, 2014 special Retirement Board meeting, staff presented its analysis and report regarding a Level I and Level II engagement of fossil fuel companies under the Retirement Board's *Social Investment Policy and Procedures* and the Board approved a Level I (active proxy voting) engagement of the fossil fuel companies.

At the April 9, 2014 Retirement Board meeting, staff presented its report on SFERS' 2014 proxy season votes related to fossil fuels and greenhouse gas issues. Staff provided monthly 2014 proxy season vote updates to the Board at its regular meetings in May and June related to fossil fuels and greenhouse gas issues.

At a special Retirement Board meeting on June 18, 2014, the Retirement Board received various educational presentations, organized through Supervisor Avalos' office, on issues related to investment in fossil fuel companies, including the impact of divestment.

At the March 11, 2015 Retirement Board meeting, staff presented its analysis and report regarding Level II engagement of fossil fuel companies under the Retirement Board's *Social Investment Policy and Procedures* and the Board approved a Level II (active corporate engagement) engagement of fossil fuel companies. The Board also directed staff to bring an analysis and report on possible investment in a passive ex-fossil fuels index fund.

At the April 8, 2015 Retirement Board meeting, staff presented its preliminary analysis and report regarding possible investment in a passive ex-fossil fuels index fund and the Board directed staff to complete its due diligence and bring a recommendation to the Board at a later date. The Board also approved creation of a standing Environmental, Social and Governance (ESG) Committee to review and define the Board's values and policies related to ESG issues.

At the May and June 2015 Retirement Board meetings, staff provided monthly 2015 proxy season vote updates to the Board related to fossil fuels and greenhouse gas issues.

At the July 8, 2015 Retirement Board meeting, staff presented its analysis and recommendation regarding investment in a passive ex-fossil fuels index fund and the Board approved staff's recommendation to invest $100 million in a passive ex-fossil fuels index fund – this $100 million investment in MSCI USA Ex-Fossil Fuels index was completed in January 2016. The Board also approved amending its existing proxy voting policy by adopting the *Policy on Environmental-related Shareholder Proposals* which created a first-level screen for support for resolutions that provides additional information related to environmental issues; that require corporate actions beyond reporting of

environmental issues; and that establish special corporate committees to address broad corporate policies related to environmental issues.

At the December 9, 2015 Retirement Board meeting, staff presented information to the Board related to SB-185: Public Divestiture of Thermal Coal Companies that was signed by Governor Brown on October 8, 2015 which when fully implemented will prohibit both CalPERS and CalSTRS from owning publicly issued stock, corporate bonds or other debt instruments issued by a company that generates 50% or more of its revenue from the mining of thermal coal. Staff reported on SFERS' holdings in companies that have coal mining operations that could be potentially fall under the SB-185 restriction. Staff identified a total of 8 holdings with a market value of $21.1 million as of December 2015. The list provided to the Board included holdings that would not fit under the restrictions imposed by SB-185, namely, global mining firms - BHP Billiton, Rio Tinto, Vale and Glencore – which have multiple lines of business and for which thermal coal mining represents less than 10% of the firms' revenues.

At its December 9, 2015 meeting, the Board approved the divestment from thermal coal companies and the reinvestment of the proceeds in renewables and directed staff to prepare an implementation plan for implementing the divestment from thermal coal companies.

At the May and June 2016 Retirement Board meetings, staff provided monthly 2016 proxy season vote updates to the Board related to fossil fuels and greenhouse gas issues (INCR sponsored resolutions).

At the July 13, 2016 Retirement Board meeting, staff presented its analysis and recommendation for implementing the Board's December 9, 2015 determination to divest from its thermal coal holdings. The Retirement Board referred this item to the ESG Committee for consideration and possible recommendation for action to the full Retirement Board.

Staff's analysis and recommendation for divestment of SFERS' thermal coal holdings was presented to the ESG Committee at its September 14, 2016 committee meeting as a discussion item and continued to its next meeting. It was brought back to the ESG Committee for its action on the staff recommendation on April 19, 2017. The ESG Committee voted to forward staff's recommendation to the full Board with the committee's recommendation to approve staff's recommendation to divest from certain, but not all, thermal coal companies held in the public markets portfolio of the SFERS Trust.

At the May 17, 2017 Retirement Board meeting, the Retirement Board approved staff's recommendation to divest from certain, but not all, thermal coal companies held in the public markets portfolio of the SFERS Trust and to impose Level III investment restrictions on nine thermal coal companies.

At the June 14, 2017 Retirement Board meeting, the Retirement Board approved becoming a signatory to the Principles for Responsible Investment (PRI).

## SFERS ENVIRONMENTAL, SOCIAL AND GOVERNANCE VALUES STATEMENT

As a significant institutional investor with a very long-term investment horizon and expected life, SFERS' success is linked to global economic growth and prosperity. Actions and activities that detract from the likelihood and potential of global growth are not in the long-term interests of the Fund. SFERS considers environmental, social and governance (ESG) factors in its investment process because they can influence both risk and return. ESG issues impact the sustainability, value and performance of SFERS' investments. The relevance of particular ESG issues may differ and vary in degree across companies, sectors, regions, asset classes and over time. Accordingly, consistent with the Retirement Board and staff's fiduciary responsibilities to act in the best interests of the members, retirees and beneficiaries of the Retirement System and with SFERS' role as a prudent long-term investor:

1) Retirement Staff will incorporate relevant ESG issues in SFERS' investment analyses and decision-making processes;

2) Retirement Staff will vote SFERS' US shareholder proxies and will maintain an active corporate governance program for SFERS' publicly traded equity investments with due consideration to ESG issues;

3) Investment recommendations in all asset classes will include information on and consideration of the manager's ESG policies and practices, focusing on the risks and standards relevant to the investment under consideration;

4) SFERS will seek appropriate disclosure on ESG issues by the entities in which it invests; and

5) SFERS will promote acceptance and implementation of its ESG values within the investment industry.

## SFERS Environmental, Social and Governance Investment Policy and Procedures

The SFERS *Environmental, Social and Governance Investment Policies and Procedures* (attached Exhibit A) provide that adequate recognition must be given to the environmental, social and governance consequences of corporate actions and investment decisions to achieve maximum long term investment return from Trust assets. But the policy recognizes that in no event may the policy take precedent over the fiduciary responsibility of producing investment returns for the exclusive benefit of the members and beneficiaries. Environmental, social and governance concerns addressed through the policy will follow the order of action outlined in the policy except where the Board determines that action contemplated in an earlier step has been initiated prior to consideration of action under the policy and found to be ineffective or non-relevant.

The *SFERS Environmental, Social and Governance Investment Policies and Procedures* outline three levels of action that the Board can direct staff to implement to engage companies on environmental, social and governance issues of concern:

Level I – Shareholder Voting: SFERS' shareholder voting rights will be exercised reflecting specific Board environmental, social and governance investment considerations and directions or by authorization

under procedures which reflect the Retirement Board's directions on environmental, social and corporate governance issues.

Level II – Promoting Social Rights and Interests: SFERS will proactively promote environmental, social and governance interests individually or in concert with other shareholders to assure proper recognition of environmental, social and governance interests with the goal of influencing corporate activities or policies. Activities at this level may include direct communication with the company and/or initiation of shareholder resolutions, individually or in concert with other shareholders.

Level III – Investment Restrictions: In the event that Level I and Level II engagement has not provided the Board's desired results and alternatives to the restricted holdings are available which do not compromise investment return and risk, the Board may direct staff to restrict investment activities in specific areas to promote the interest of the SFERS Trust members and beneficiaries. Under Level III engagement, staff would provide directions to the investment managers that could include restricting purchase of additional shares of the targeted securities and directing the managers to research alternative securities to replace the targeted holdings that would provide comparable investment return with comparable risk.

## Fiduciary Duty to SFERS Members and Beneficiaries

California Constitution Article XVI Section 17 provides that Retirement Board members "shall discharge their duties with respect to the system solely in the interest of, and for the exclusive purposes of, providing benefits to participants and their beneficiaries, minimizing employer contributions thereto, and defraying reasonable expenses of administering the system. A Retirement Board's duty to its participants and their beneficiaries shall take precedence over any other duty." CA Constitution, Art. XVI, §17(b). Further, Board "members shall diversify investments of the system so as to minimize the risk of loss and to maximize the rate of return, unless under the circumstances it is clearly not prudent to do so." CA Constitution, Art. XVI, §17(d). See also San Francisco Charter §12.100, §12.103. These duties require the Board to weigh potential risks and returns, choosing an investment mix most likely to fulfill the System's obligations to ensure it provides the promised benefits to its members and beneficiaries.

The Retirement Board and SFERS staff are also required to invest the SFERS Trust "with the care, skill, prudence and diligence under the circumstances then prevailing that a prudent person acting in a like capacity and familiar with these matters would use in the conduct of an enterprise of a like character and with like aims." California Constitution, Art. XVI, §17(c). The prudence requirements are generally satisfied if, in the analysis, the Retirement Board and staff are guided principally by economic and business factors. Whether an investment benefits a social goal may be a secondary consideration.

The Employee Retirement Income Security Act of 1974 ("ERISA") contains similar provisions and, in that context, the Department of Labor ("DOL") has issued guidance relating to fiduciary implications of certain socially responsible investments. The DOL has stated that ERISA fiduciaries may never subordinate the economic interests of the plan when making investment decisions. Fiduciaries risk violating the exclusive purpose rule if they attempt to exercise their fiduciary authority in an attempt to further legislative, regulatory or public policy issues. At the same time, a recent DOL Interpretive Bulletin issued in October 2015 (IB 2015-1) confirms the DOL's consistent view that fiduciaries may take

considerations associated with economically targeted investment (investments selected for the economic benefits they create apart from their investment return to the employee benefit plan), including ESG factors, into account as "tie-breakers" when investments are otherwise equal with respect to return and risk over the appropriate time horizon. (*See* IB 2015-1, p. 6.)

In addition, an "important purpose" of IB 2015-1 is to clarify that ESG factors "may have a direct relationship to the economic value of [a] plan's investment." (Emphasis added.) When they do, these factors are more than just collateral considerations or tie-breakers, but rather are "proper components of the fiduciary's primary analysis of the economic merits of competing investment choices...." (IB 2015-1, p. 6.)

In discharging investment duties, it is the DOL's view that fiduciaries must, among other things, consider the role of the particular investment in the plan's investment portfolio, taking into account factors such as diversification, liquidity, and risk/return characteristics. Because every investment necessarily causes a plan to forgo other investment opportunities, fiduciaries also must consider expected return on alternative investments with similar risks available to the plan. This does not preclude consideration of collateral benefits, such as favoring an investment that supports a particular policy or objective, when evaluating a particular investment opportunity.

Fiduciaries are prohibited from subordinating the interests of the participants and beneficiaries in their retirement income to unrelated objectives. A decision to make an investment, or to designate an investment alternative, may not be influenced by non-economic factors unless the investment ultimately chosen, when judged solely on the basis of its economic value, would be equal to, or superior to, available alternative investments. The DOL also suggests that when fiduciaries rely on non-economic factors, they should maintain written records demonstrating their quantitative and qualitative analyses in order to prove the alternatives were of equal value.

These DOL rules apply directly only to plans that are subject to ERISA. SFERS, as a governmental plan, is not subject to ERISA. However, because the ERISA provisions are similar to the language in the California Constitution and the Charter, the views of the DOL may be looked to for guidance on fiduciary obligations.

On January 15, 2016, the City Attorney's Office prepared the attached *Summary of Recent DOL Guidance regarding "Economically Targeted Investments"* (Exhibit B) which was distributed to the Retirement Board.

## Staff Recommendation

Retirement staff concurs with NEPC's conclusion that divestment from Carbon Underground 200 fossil fuel companies will materially reduce the potential risk-adjusted return from the SFERS public markets portfolio. Further, Retirement staff believes that attempting complete divestment from these holdings within a 180-day period would exacerbate the potential losses associated with divestment.

While Retirement staff is keenly aware and concerned with the negative impact that climate change is having on our environment as well as the potential negative impact on fossil fuel holdings in the SFERS portfolio, Retirement staff recommends that the most recent actions taken by the Retirement Board; namely, divestment from certain thermal coal companies (worst of the worst polluters) and becoming a signatory of the Principles for Responsible Investment, are more effective ways for the Retirement Board to address the climate risk in the SFERS investment program under the Board's *Environmental, Social and Governance Investment Policies and Procedures*. We recognize that SFERS' divestment from fossil fuel holdings will not reduce carbon emissions - it simply changes ownership of these securities. With divestment, SFERS will forfeit its standing as a shareholder to engage these fossil fuel companies to transition their business plans to a low carbon economy in line with the Paris Agreement. Reducing the impact of carbon emissions from fossil fuels requires consumers, governments and businesses to reduce their consumption of fossil fuels or world governments legislating a reduction in the use of fossil fuels. (see SFERS CIO Bill Coaker's commentary – Exhibit C)

**Retirement staff recommends against approving the motion to divest of fossil fuel holdings in Carbon Underground 200 (CU200) companies in the SFERS Public Markets Portfolio within 180 days. As an alternative to divestment, Retirement staff recommends that the Board consider a strategy of *positive investment actions* to address the climate risk within the SFERS investment program as detailed in the NEPC analysis.** A Board vote against the motion to divest would mean that the Retirement System would continue to engage fossil fuel companies (except the restricted thermal coal companies) at Level II – Active Engagement of the Board's *Environmental, Social and Governance Investment Policies and Procedures*. Retirement staff has specific recommendations for positive action engagement strategies for the Board's consideration in the last section of this memo.

Rationale for Supporting NEPC's Recommendation

After careful review of NEPC's Fossil Fuel Divestment Commentary, Retirement staff supports NEPC's conclusion that divestment from CU 200 fossil fuel companies will materially reduce the potential risk-adjusted return in the public market portfolio of the SFERS Trust. We concur with each of NEPC's stated conclusions:

- Divestment reduces expected risk-adjusted performance by decreasing portfolio diversification;
- Divestment reduces expected performance in high inflation periods;
- Divestment implies that SFERS is better positioned to assess the impact of the Stranded Assets thesis on the value of Carbon Tracker 200 companies than collective market perspective as reflected in prevailing prices;
- Divestment reduces the opportunity set for our active managers to earn excess returns;
- Divestment incurs additional transaction costs that would be borne by the Retirement System, without prospect for offsetting incremental performance during the next investment cycle; and

- Divestment has not been adopted broadly by US public pension systems for many of the same reasons detailed above.

**Positive Action Engagement Strategies**

As described in NEPC's analysis, positive action engagement strategies could include engaging with corporations, integrating environmental risks into investment processes and pursuing sustainable investments. Retirement staff believes that this approach is consistent with the principles of investment theory and at the same time extremely relevant to investor concerns regarding climate change.

Corporate Engagement: SFERS has joined Ceres and its Investor Network on Climate Risk (INCR), a leading organization of over 100 US institutional investors representing more than $13 trillion in assets, that advocates for sustainability leadership regarding issues of climate change and carbon asset risk. In addition, SFERS has applied to become a signatory to Principles for Responsible Investment (PRI), the largest global investor network dedicated to responsible investment, with more than 1700 institutional investor and service provider signatories worldwide representing over $63 trillion in assets under management – over half of the world's investment assets. SFERS is also a member of the Council of Institutional Investors (CII), a leading corporate governance advocacy group with voting membership of more than 125 public, union and corporate employee benefit plans, endowments and foundations with combined assets that exceed $3 trillion. These affiliations provide SFERS with frequent opportunities to join other investors in active engagement with companies and regulatory agencies on issues related to climate risk.

At the Ceres conference earlier this year, CalPERS introduced a new engagement initiative – Global Climate 100 – a global alliance between investors to engage "Systemically Important Carbon Emitters" on strategies to transition their business plans toward achieving the Paris Agreement target to hold average global warming to below 2 degrees which entails emissions reductions of 80% by 2050. (See Exhibit E) CalPERS investment staff identified 100 companies in 20 countries in their investment portfolio that account for half of their public equity portfolio's carbon emissions. The Global Climate 100 initiative's objective is for the top carbon emitting companies to align their business models with the low carbon transition. In identifying the 100 companies that will be targeted by this initiative, CalPERS went beyond fossil fuel producers and included leading consumers of fossil fuel by industry sector, including consumer non-durable, energy minerals, industrial services, non-energy minerals, process industries, producer manufacturing, transportation and utilities sectors. Kirsten Spalding, Interim Director, California Office, Ceres, will be available at the Board meeting to provide the Board with additional information related to Ceres and the Global Climate 100 initiative.

Retirement staff will continue to pursue information related to the Global Climate 100 initiative and take steps to join the initiative when it is launched later this year.

Integrating Climate Change Risk into our Investment Process

Retirement staff will be amending the Board's *Investment Policy Statement* in accordance with the Board's recently-adopted *ESG Values Statement* and *Environmental, Social and Governance Investment Policies and Procedures* to integrate consideration of ESG issues, including climate change risk, into the

System's investment process. The amended *Investment Policy Statement* will be presented to the Board for its consideration and approval later this year.

Sustainability Investments

Retirement staff will continue its research into sustainability investments that address climate change investment concerns. As NEPC points out in their analysis, CalPERS and CalSTRS have pursued investment opportunities that have a positive environment impact. Retirement staff believes that continued research and due diligence in sustainability investments is complementary to the Retirement Board's engagement of fossil fuel companies at Level II of the Board's *Environmental, Social and Governance Investment Policies and Procedures*.

Exhibits:
Exhibit A - *SFERS Environmental, Social and Governance Investment Policies and Procedures*
Exhibit B – *Summary of Recent DOL Guidance regarding "Economically Targeted Investments"* from Katherine Hobin Porter, Deputy City Attorney, dated January 15, 2016
Exhibit C – *Additional Commentary on Fossil Fuel Divestment* by SFERS CIO William J. Coaker, Jr., dated August 9, 2017

# Exhibit A

CITY AND COUNTY OF SAN FRANCISCO
EMPLOYEES' RETIREMENT SYSTEM
RETIREMENT BOARD POLICY

## SFERS ENVIRONMENTAL, SOCIAL, AND GOVERNANCE INVESTMENT POLICIES AND PROCEDURES

### SFERS ENVIRONMENTAL, SOCIAL AND GOVERNANCE VALUES STATEMENT

As a significant institutional investor with a very long-term investment horizon and expected life, SFERS' success is linked to global economic growth and prosperity. Actions and activities that detract from the likelihood and potential of global growth are not in the long-term interests of the Fund. SFERS considers environmental, social and governance (ESG) factors in its investment process because they do influence both risk and return. ESG issues impact the sustainability, value and performance of SFERS' investments. The relevance of particular ESG issues may differ and vary in degree across companies, sectors, regions, asset classes and over time. Accordingly, consistent with the Retirement Board and staff's fiduciary responsibilities to act in the best interests of the members, retirees and beneficiaries of the Retirement System and with SFERS' role as a prudent long-term investor:

1) Retirement Staff will incorporate relevant ESG issues in SFERS' investment analyses and decision-making processes;

2) Retirement Staff will vote SFERS' US shareholder proxies and will maintain an active corporate governance program for SFERS' publicly traded equity investments with due consideration to ESG issues;

3) Investment recommendations in all asset classes will include information on and consideration of the manager's ESG policies and practices, weighing and balancing both qualitative and quantitative risks and standards relevant to the investment under consideration;

4) SFERS will seek appropriate disclosure on ESG issues by the entities in which it invests; and

5) SFERS will promote acceptance and implementation of its ESG values within the investment industry.

### SFERS ENVIRONMENTAL, SOCIAL, AND GOVERNANCE INVESTMENT PROCEDURES

Since it is necessary for adequate recognition to be given to the environmental, social and governance consequences of corporate actions and security and portfolio investment decisions to achieve maximum long term investment returns from Retirement System assets, and since the individual decisions of Staff, Managers, Consultants, and other System fiduciaries have to be made within a framework that reflects the particular environmental, social or governance situation and concerns of the participants and the Retirement System, the following procedures shall be followed when investing, managing, or reviewing Retirement System assets. Environmental, social and governance concerns to be addressed through investment policy shall follow the order of action as outlined in I, II, and III except where the Board has determined that action contemplated in an earlier

step has been initiated prior to the adoption of these policies and found to be ineffective or non-relevant. In no event shall these policies take precedent over the fiduciary responsibility of producing investment returns for the exclusive benefit of the members, retirees and beneficiaries of the Retirement System.

I. Shareholder Voting

The ownership of equity interests in many corporations as an investment of Retirement System assets includes the right to vote on the initiation, approval, or denial of major company policies and actions. These voting rights shall be exercised in accordance to Retirement Board proxy voting policies and in consideration of environmental, social and governance issues identified by the Retirement Board and Retirement Staff.

A. Issues likely to come before shareholders in a proxy "season" will be reviewed by Retirement Staff and the SFERS proxy consultant prior to the "season" to ensure that the Retirement Board's policies, including this policy, address all issues that will be considered during the proxy season.

B. New and non-standard corporate proposals will be specifically reviewed by Retirement Staff and the SFERS proxy consultant , with Retirement Staff developing and recommending an appropriate proxy voting policy for such proposals to be approved by the Retirement Board.

C. Determination of the environmental, social and governance concerns that should be addressed through exercise of voting rights and subsequent implementation of the balance of these procedures will be made by the Retirement Board in full consideration of its responsibilities as fiduciaries of the Retirement System and only after Retirement Staff's review and analysis of the investment and environmental, social or governance implications. Additional information from investment managers and other outside sources will be sought when necessary.

II. Actively Promoting Environmental, Social Governance Interests – Direct Engagement

Generally, the ownership of equity interests, and to some extent of fixed income interests, in many corporations provides an opportunity to act individually or in concert with other shareholders to assure proper recognition of environmental, social and governance interests.

A. Shareholder resolutions may be initiated upon review by Retirement Staff of previous shareholder votes, discussion with the corporation, and Retirement Board determination that the proposed resolution is a reasonable vehicle to influence corporate activities.

B. Other interested shareholders may be actively sought to express common concerns, join in resolutions, and solicit proxy votes.

C. Alternative investment opportunities that meet the goals and objectives of this policy and benefit the members, retirees and beneficiaries may be considered provided that expected investment returns are at least equivalent to available alternatives of similar risk.

III. Investment Restrictions

When environmental, social and governance concerns have not been or cannot be addressed adequately through exercise of shareholder voting rights, direct engagement of the investment manager, promotion of shareholder initiatives, or investment in alternative opportunities, it may be necessary to restrict Retirement System investment activities in specific areas to promote the interests of the members, retirees and beneficiaries. In general, investment restrictions will be adopted in accordance with the following considerations:

A. Investment restrictions will be consistent with the Retirement Board's fiduciary duties and responsibilities, including the Department of Labor's requirements with respect to consideration of ESG factors when making investment decisions.

B. Recognizing that substantial investment flexibility is necessary to maximize returns at an acceptable level of risk, investment restrictions will be adopted only when Retirement Board actions detailed in Levels I and II above have not been or, as determined by the Retirement Board, would not be successful and alternatives to the restricted securities that address the environmental, social and governance issues detailed in this policy are available which do not compromise potential long-term investment return.

C. Investment restrictions will be applied at the lowest possible investment level, either specific issuers or securities, to protect against adverse investment effects, implementation risks and facilitate amendment in response to corporate action or changes in investment, environmental, social or governance climate.

D. Investment restrictions will be analyzed periodically for environmental, social, governance and financial consequences and amended or repealed as appropriate.

E. Investment restrictions will be applied only upon specific decision of the Retirement Board based on available information as evaluated by Retirement Staff and consultants, and after full consideration of its fiduciary duty, as well as the investment risks and ramifications.

## RETIREMENT BOARD ACTIONS TAKEN UNDER THE ENVIRONMENTAL, SOCIAL AND GOVERNANCE INVESTMENT POLICIES

Since its adoption by the Retirement Board on September 27, 1988, the Retirement Board has taken the following actions under its Environmental, Social and Governance Investment Policies (previously known as Social Investment Policies:

| Engagement | Level | Dated adopted by Retirement Board |
|---|---|---|
| 1. Corporate activities of companies whose securities are owned by the System shall be conducted in compliance with all applicable laws and regulations. | Level I - Shareholder Voting | September 27, 1988 |
| 2. Employment Standards<br>Active measures shall be taken to assure that the corporation meets fair employment standards including non-discrimination in hiring, transfer, pay and promotion, decent working facilities and conditions, and the recognition of all legal employee rights of organization and political expression. | Level I - Shareholder Voting | September 27, 1988 |
| 3. Community Relations<br>The relationship of the corporation to the communities in which it operates shall be maintained as a good corporate citizen through observing proper environmental standards, supporting the local economic, social and cultural climate, conducting acquisitions and reorganizations to minimize adverse effects and not discriminate in making loans or writing insurance. | Level I - Shareholder Voting | September 27, 1988 |
| 4. Corporate Governance and Internal Affairs<br>The Bylaws of the corporation shall be maintained to permit full expression of shareholder voting rights in corporate affairs and to prevent entrenchment of management. Executive compensation shall be fair and reasonable. Reports and data shall be made available to shareholders concerning social issues to the extent possible without jeopardizing business interests. | Level I - Shareholder Voting | September 27, 1988 |

| Engagement | Level | Dated adopted by Retirement Board |
|---|---|---|
| 5. MacBride Principles<br>The corporation shall affirm and adhere to the MacBride Principles concerning operations in Northern Ireland. | Level I - Shareholder Voting | February 25, 1992 |
| 6. Tobacco Divestment<br>Due to the existing litigation, proposed legislation and probable governmental restrictions relating to the tobacco industry, the System will not invest in the equity and fixed income securities of companies manufacturing tobacco products. | Level III – Investment Restrictions | October 3, 1998 |
| 7. Sudan Investments<br>The Retirement Board directed staff to engage in constructive dialogue with companies doing business in Sudan because the U.S. Congress and the State Department have found the Sudanese Government to be complicit in genocide in the Darfur region. | Level II – Direct Engagement | June 13, 2006 |
| 8. Carbon Tracker 200 Companies<br>The Retirement Board directed staff to engage the SFERS public portfolio companies which are listed on the Carbon Tracker 200 list at Level I due to their role in climate risk activities. | Level II – Direct Engagement | March 11, 2015 |
| 9. Firearms and Ammunition Manufacturers and Retailers<br>The Retirement Board directed staff to restrict investment in certain manufacturers of firearms and ammunition and retail companies which are active in the sale of firearms and ammunition. | Level III – Investment Restrictions | October 12, 2016 |

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| 10. Thermal Coal Companies<br><br>The Retirement Board directed staff to restrict investment in 9 thermal coal companies | Level III – Investment Restrictions | May 17, 2017 |

# Exhibit B

CITY AND COUNTY OF SAN FRANCISCO

DENNIS J. HERRERA
City Attorney

OFFICE OF THE CITY ATTORNEY

KATHARINE HOBIN PORTER
Deputy City Attorney

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# MEMORANDUM

TO: Jay Huish
Executive Director

FROM: Katharine Hobin Porter
Deputy City Attorney

DATE: January 15, 2016

RE: Summary of Recent DOL Guidance regarding "Economically Targeted Investments"

From time to time, the San Francisco City and County Employees' Retirement System ("SFERS") considers potential investments and investment policies based on socially responsible or other similar investing principles and the question is whether those principles are consistent with SFERS' fiduciary duties in administering the plan. In October 2015 the U.S. Department of Labor ("DOL") issued Interpretive Bulletin 2015-1 ("IB 2015-1"), a copy of which is attached to this memorandum. In IB 2015-1 the DOL updates its guidance on the fiduciary duty under the Employee Retirement Income Security Act of 1974, as amended ("ERISA") for decisions to invest plan assets in "economically targeted investments" ("ETIs"). Although SFERS is not covered by ERISA, laws, rules and regulations under ERISA often serve as a model or best practice for non-ERISA pension plans. In this memorandum, we summarize the DOL's guidance to fiduciaries in IB 2015-1, which SFERS could look to as it may consider proposals to invest in ETIs.

Provides definition of ETIs.

As defined in IB 2015-1, ETIs are "investments selected for the economic benefits they create apart from their investment return to the employee benefit plan." (IB 2015-1, p. 9.) In IB 2015-1 the DOL recognizes the term has wide application and that there is no uniform meaning or terminology to capture this concept, and other terms such as "socially responsible investing," "sustainable and responsible investing," "environments, social and governance investing," and "impact investing" are all used in connection with investments selected because of the collateral economic or social benefits they may advance, in addition to their investment returns.

IB 2015-1 replaces the 2008 guidance, and restates the 1994 guidance.

The DOL had previously addressed ETI investment issues with Interpretive Bulletins in 1994 and 2008. In IB 2015-1, the DOL expressed concern that the 2008 guidance had "unduly discouraged" fiduciaries from considering ETIs and environmental, social and governance ("ESG") factors. In the 2008 Interpretive Bulletin the DOL had noted that fiduciaries should contemporaneously document their economic analysis of ETIs to show that the investments were equal. IB 2015-1 clarifies that no special or additional documentation is required for ETIs or

**MEMORANDUM**



consideration of ESG factors. But fiduciaries still should maintain records sufficient to demonstrate their compliance with fiduciary standards. (*See* IB 2015-1, p. 5, p. 7.)

Restates the basic fiduciary rule and identifies two scenarios in which plan fiduciaries may take ETI considerations into account in making investment decisions.

In IB 2015-1 the DOL recognizes the basic fiduciary rule under ERISA: a fiduciary must act prudently and solely in the interest of the plan and its members and beneficiaries. In making an investment or engaging in an investment course of action, fiduciaries must give appropriate consideration to relevant facts and circumstances, for example, diversification, liquidity, risk and return, and alternative investments with similar risk and return profiles. A fiduciary must not subordinate the interests of the plan and its members to unrelated objectives, or sacrifice the economic interests of a plan to promote collateral benefits. The focus of plan fiduciaries on a plan's financial returns and risks to members and beneficiaries must be paramount. "Under ERISA, the plan trustee or other investing fiduciary may not use plan assets to promote environmental, social, governance or other public policy causes at the expense of the financial interests of the plan's participants and beneficiaries. Fiduciaries may not accept lower expected returns or take greater risks in order to secure collateral benefits." (IB 2015-1, p. 3.)

At the same time, in IB 2015-1 the DOL confirms its consistent view that fiduciaries may take considerations associated with ETIs, including ESG factors, into account as "tie-breakers" when investments are otherwise equal with respect to return and risk over the appropriate time horizon. (*See* IB 2015-1, p. 6.)

Also, an "important purpose" of IB 2015-1 is to clarify that ESG factors "may have a direct relationship to the economic value of [a] plan's investment." (IB 2015-1, p. 7, emphasis added.) When they do, these factors are more than just collateral considerations or tie-breakers, but rather are "proper components of the fiduciary's primary analysis of the economic merits of competing investment choices...." (IB 2015-1, p. 6.) "Fiduciaries need not treat commercially reasonable investments as inherently suspect or in need of special scrutiny merely because they take into consideration [ESG] or other such factors." (IB 2015-1, p. 6.)

In summary, IB 2015-1 provides that the "fiduciary standards applicable to ETIs are no different than the standards applicable to plan investments generally." (IB 2015-1, p. 10.) And fiduciaries must continue to rigorously review and evaluate all potential investment options – including ETIs.

# Exhibit C

SFERS
San Francisco Employees' Retirement System

City and County of San Francisco
Employees' Retirement System

Date: July 12, 2017

To: The Retirement Board

Through: Jay Huish
Executive Director

From: William J. Coaker Jr. – CFA, CFP, MBA
Chief Investment Officer

Subject: SFERS CIO Commentary on the Motion before the Board to Divest of Fossil Fuel Holdings in SFERS Public Markets Securities and to do so within 180 days

## Overview

At the May 17, 2017 Board meeting, Commissioner Victor Makras requested a motion that SFERS divest all of its fossil fuel holdings in its public markets securities and do so within 180 days.

Staff is very concerned that carbon emissions are causing global warming with long-term catastrophic impact. However, for numerous reasons, Staff does not support the motion to divest.

One reason Staff does not support the motion is because divestment does not reduce carbon emissions. We think actions that reduce carbon emissions should be pursued and implemented. But divestment simply changes ownership; it does not reduce carbon emissions. Carbon emissions are reduced either by people consuming fewer fossil fuels or by government requiring it.

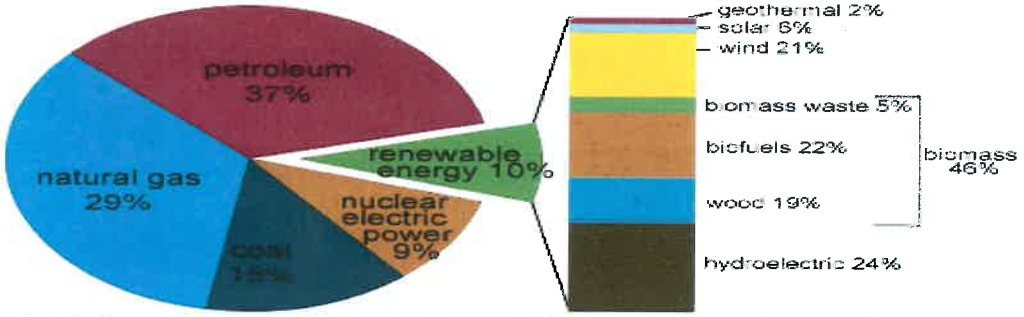
An Appendix with numerous attachments is included. The attachments provide the Board with additional information relevant to this motion.

## Global Energy Statistics

In the U.S., approximately 81 percent of energy comes from fossil fuels, with 9 percent from nuclear power and 10 percent from renewables.

# U.S. energy consumption by energy source, 2016

Total = 97.4 quadrillion British thermal units (Btu)



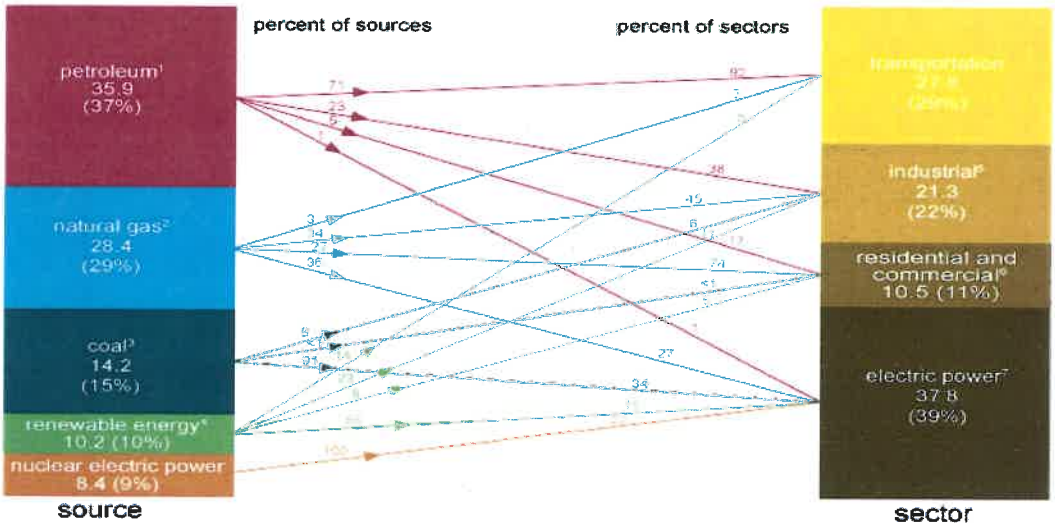

Note: Sum of components may not equal 100% because of independent rounding.

Source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 1.3 and 10.1, April 2017, preliminary data

eia

## U.S. primary energy consumption by source and sector, 2016

Total = 97.4 quadrillion British thermal units (Btu)




[1] Does not include biofuels that have been blended with petroleum—biofuels are included in "Renewable Energy."
[2] Excludes supplemental gaseous fuels.
[3] Includes -0.02 quadrillion Btu of coal coke net imports.
[4] Conventional hydroelectric power, geothermal, solar, wind, and biomass.
[5] Includes industrial combined-heat-and-power (CHP) and industrial electricity-only plants.
[6] Includes commercial combined-heat-and-power (CHP) and commercial electricity-only plants.
[7] Electricity-only and combined-heat-and-power (CHP) plants whose primary business is to sell electricity, or electricity and heat, to the public. Includes 0.24 quadrillion Btu of electricity net imports not shown under "Source."

Notes: • Primary energy is energy in the form that it is accounted for in a statistical energy balance, before any transformation to secondary or tertiary forms of energy occurs (for example, coal before it is used to generate electricity). • The source total may not equal the sector total because of differences in the heat contents of total, end-use, and electric power sector consumption of natural gas. • Data are preliminary. • Values are derived from source data prior to rounding. • Sum of components may not equal total due to independent rounding.

Sources: U.S. Energy Information Administration, *Monthly Energy Review* (April 2017), Tables 1.3, 1.4a, 1.4b, and 2.1–2.6

**World Energy Consumption Statistics**

| | --------- Fossil Fuels ---------- | | | Non-Renewable Non-Fossil Fuel | ----- Renewables ------ | | Carbon Dioxide |
|---|---|---|---|---|---|---|---|
| Year | Coal | Oil | Natural Gas | Nuclear Energy | Hydro-Electricity | Other Renewables | Emissions |
| 2006 | 3,292 | 85,728 | 2,851 | 635 | 688 | 93 | 29,430 |
| 2007 | 3,480 | 87,087 | 2,967 | 622 | 698 | 107 | 30,482 |
| 2008 | 3,528 | 86,578 | 3,045 | 620 | 739 | 123 | 30,800 |
| 2009 | 3,476 | 85,700 | 2,966 | 614 | 737 | 144 | 30,145 |
| 2010 | 3,636 | 88,765 | 3,188 | 626 | 779 | 170 | 31,528 |
| 2011 | 3,807 | 89,790 | 3,246 | 600 | 792 | 204 | 32,413 |
| 2012 | 3,817 | 90,563 | 3,323 | 559 | 832 | 239 | 32,740 |
| 2013 | 3,887 | 92,049 | 3,384 | 564 | 859 | 281 | 33,226 |
| 2014 | 3,889 | 93,109 | 3,401 | 575 | 879 | 317 | 33,342 |
| 2015 | 3,765 | 95,008 | 3,480 | 583 | 883 | 367 | 33,204 |
| 2016 | 3,732 | 96,558 | 3,543 | 592 | 910 | 420 | 33,432 |
| 2016 v. 2013 | -4.0% | 4.9% | 4.7% | 5.0% | 5.9% | 49.5% | 0.6% |
| 2016 v. 2006 | 13.4% | 12.6% | 24.3% | -6.8% | 32.3% | 351.6% | 13.6% |

Oil measured in thousands of barrels a day
Coal, Natural Gas and Nuclear Energy measured in million tons oil equivalent
Natural gas measured in millions tons oil equivalent
Hydroelectricity and Other Renewables measured in terawatt hours.
Carbon Dioxide Emissions - See Page 47 of BP Statistical Review of World Energy June 2017

Note: The 3-year increase in carbon dioxide emissions of 0.6% from 2014-2016 is the lowest three year increase since 1981-83.

| Energy Consumption by Source | | --------- 2015 ------- | | ---------- 2016 ---------- | | |
|---|---|---|---|---|---|---|
| | | Million Tons | % Total | Million Tons | % Change | % Total |
| Oil | Fossil Fuel | 4341 | 33.1% | 4418 | 1.8% | 33.3% |
| Natural Gas | Fossil Fuel | 3147 | 24.0% | 3204 | 1.8% | 24.1% |
| Coal | Fossil Fuel | 3785 | 28.9% | 3732 | -1.4% | 28.1% |
| Nuclear Energy | Non-Renewable | 583 | 4.4% | 592 | 1.5% | 4.5% |
| Hydroelectricity | Renewable | 883 | 6.7% | 910 | 3.1% | 6.9% |
| Other Renewables | Renewable | 367 | 2.8% | 420 | 14.4% | 3.2% |
| Totals | | 13106 | 100.0% | 13276 | 1.3% | 100.0% |

Energy consumption increased by 1.3% in 2016. Renewables increased from 9.5% to 10.1%. Coal fell from 28.9% to 28.1% while oil, natural gas, and nuclear energy all rose slightly.

The following chart shows the energy sector's over- or under-performance by calendar year to the S&P 500. The energy sector outperformed the S&P 500 in 26 of the past 43 1/2 years from 1974 to June 2017. From 1974 to June 2017, energy has lagged the S&P 500 by 0.3 percent annualized.

However, until its recent dramatic underperformance, from 1974 to 2013 the energy sector outperformed the index by

| Calander Year Returns | | | |
|---|---|---|---|
| Year | S&P Energy | S&P 500 | Over/Under |
| 1974 | -24.3% | -26.5% | 2.2% |
| 1975 | 24.0% | 37.2% | -13.2% |
| 1976 | 35.1% | 23.9% | 11.2% |
| 1977 | -1.9% | -7.2% | 5.3% |
| 1978 | 11.8% | 6.6% | 5.2% |
| 1979 | 45.5% | 18.6% | 26.9% |
| 1980 | 74.5% | 32.5% | 42.0% |
| 1981 | -23.6% | -4.9% | -18.7% |
| 1982 | -12.3% | 21.6% | -33.8% |
| 1983 | 25.9% | 22.6% | 3.3% |
| 1984 | 8.1% | 6.3% | 1.8% |
| 1985 | 18.5% | 31.7% | -13.2% |
| 1986 | 17.0% | 18.7% | -1.7% |
| 1987 | 8.8% | 5.3% | 3.5% |
| 1988 | 21.4% | 16.6% | 4.8% |
| 1989 | 40.4% | 31.7% | 8.7% |
| 1990 | 3.6% | -3.1% | 6.7% |
| 1991 | 5.3% | 30.5% | -25.2% |
| 1992 | 2.3% | 7.6% | -5.3% |
| 1993 | 12.8% | 10.1% | 2.7% |
| 1994 | 2.6% | 1.3% | 1.3% |
| 1995 | 30.4% | 37.6% | -7.2% |

| Calander Year Returns | | | |
|---|---|---|---|
| Year | S&P Energy | S&P 500 | Over/Under |
| 1996 | 25.8% | 23.0% | 2.8% |
| 1997 | 24.8% | 33.4% | -8.6% |
| 1998 | 2.5% | 28.6% | -26.1% |
| 1999 | 15.0% | 21.0% | -6.0% |
| 2000 | 20.0% | -9.1% | 29.1% |
| 2001 | -10.9% | -11.9% | 1.0% |
| 2002 | -16.2% | -22.1% | 5.9% |
| 2003 | 26.2% | 28.7% | -2.5% |
| 2004 | 31.3% | 10.9% | 20.4% |
| 2005 | 31.4% | 4.9% | 26.5% |
| 2006 | 24.3% | 15.8% | 8.5% |
| 2007 | 34.4% | 5.5% | 28.9% |
| 2008 | -35.6% | -37.0% | 1.4% |
| 2009 | 14.1% | 26.5% | -12.4% |
| 2010 | 20.5% | 15.1% | 5.4% |
| 2011 | 4.7% | 2.1% | 2.6% |
| 2012 | 4.6% | 16.0% | -11.4% |
| 2013 | 25.1% | 32.4% | -7.3% |
| 2014 | -7.8% | 13.7% | -21.5% |
| 2015 | -21.1% | 1.4% | -22.5% |
| 2016 | 27.4% | 12.0% | 15.4% |
| YTD 6/201 | -12.6% | 11.6% | -24.2% |

| Annualized Returns 12/2016 | | | |
|---|---|---|---|
| | S&P Energy | S&P 500 | Over/Under |
| 5 Yr 2012-2016 | 3.9% | 14.7% | -10.7% |
| 10 Yrs 2007-2016 | 4.2% | 6.9% | -2.7% |
| 20 Yrs 1997-2016 | 8.8% | 7.7% | 1.1% |
| 30 Yrs 1987-2016 | 3.9% | 4.1% | -0.3% |
| 40 Yrs 1977-2016 | 11.2% | 10.8% | 0.3% |
| 43 Yrs 1974-2016 | 6.3% | 6.6% | -0.3% |

**Renewable ETF Performance in Public Markets**

| Symbol | Strategy | AUM $m | 5 yr | 10 yr | Std Dev | Small Co's |
|---|---|---|---|---|---|---|
| GEX | Alternative Energy | 78 | 15.3 | -7.1 | 18.6 | 42 |
| QCLN | Clean Energy | 69 | 14.9 | -2.8 | 21.2 | 58 |
| TAN | Solar Energy | 280 | 5.2 | | 38.2 | 80 |
| ICLN | Clean Energy | 89 | 6.8 | | 20.4 | 42 |
| | | | | | | |
| MSCI ACWI | Global Equity | | 10.5 | 3.5 | 10.8 | 10 |
| VFINX | S&P 500 | | 14.5 | 6.8 | 9.6 | 9 |
| | | | | | | |
| SPYX | S&P 500 Fossil Free | 152 | N/A | N/A | N/A | |
| EFAX | EAFE Fossil Free | 34 | N/A | N/A | N/A | |
| EMAX | EM Fossil Free | 15 | N/A | N/A | N/A | |

## Fossil Fuels Make Modern Life Possible

### Key Takeaways

- Fossil fuels make modern life possible.
- We use fossil fuels all the time, often in ways that are not evident to us.

People use fossil fuels all the time, often in ways that are not evident to us. This section describes how people use fossil fuels in our everyday lives.

### Pre-Industrial Age

People living in the pre-industrial age faced enormous hardships conducting basic tasks in their daily lives. People built their homes from wood. Wood, crop residues, and animal oils were the fuels used for cooking, heating, and lighting. If fossil fuels had not replaced wood as a primary source of fuel, the amount of wood needed in today's U.S. economy would require constant re-harvesting a forest equal to two-thirds of the United States.

In the Pre-Industrial age, humankind worked exhaustive manual labor for our energy needs, including food, transportation and fueling our homes. Prior to fossil fuels, in addition to life being very hard, it was also much shorter, and much less healthy, as compared to today.

### The Industrial Society

Harnessing fossil fuels during the Industrial Revolution powered the U.S. economy and substantially improved the quality of life for humankind. Rapid economic growth in the Industrial Revolution and subsequent decades would not have been made possible without fossil fuels. Steamships and steam-powered railroads transported people and goods across long distances. Kerosene replaced whale oil as a cleaner burning and more reliable fuel for lamps. The explosive growth of the automobile and later the airline industry made modern travel possible. Previously, people were anchored to where they lived and what travel that did take place was slow and exhausting.

Fossil fuels have provided enormous benefits to human life. They have vastly improved the quality of life for several billion people. Next are examples of how people use fossil fuels in our daily lives.

### Transportation

Fossil fuels have made modern possible transportation. They have allowed cars, trucks, tractors, and airplanes to replace hard labor. This reduced work injuries and physical exhaustion. Refined petroleum products reduced the use of wild resources from whales (used for perfumes), trees (used for lumber and firewood), birds (used for feathers), and other wildlife (used for ivory and furs). Fossil fuels also enabled access to fresh food which was produced elsewhere.

Advances in transportation made possible by fossil fuels via cars, trucks, and planes, has greatly enhanced the quality of life in how people work and live. These changes enabled people to move from the farms to the cities, travel across town, as well as across the country and the world. These advancements also enabled people to enjoy travel, vacation, and their daily lives on a scale that is transformational compared to all other periods in human history.

Perhaps surprising, despite enhanced federal standards for fuel usage and taxpayer subsidies for research and development of alternative energy, transportation is still nearly 95 percent powered from fossil fuels.

### Medicines and Cleanliness

Soap and toothpaste are made from fossil fuel oils, both of which have boosted human health and life longevity. Fossil fuels are used in medicines, they sterilize medical instruments, they make clean hospitals possible, and ambulances and medivac hospitals also use fossil fuels.

When people became free from hard labor, our creative minds were allowed to explore. New medicines were created, many of which use fossil fuels. Prior to fossil fuels, life expectancy was about 25. Now life expectancy in the developed world is about 75, three times higher as before fossil fuels.

### Power our Homes

Prior to fossil fuels, homes were powered by firewood, which produced carbon monoxide and dangerous chemicals. Now, fossil fuels are used to build our homes, and make and power our mobile phones, tablets and laptops. They also power our televisions, refrigerators, stoves, ovens, microwaves, cooking materials, lamps, washing machines, dryers, and vacuum cleaners.

### Entertainment

Basketballs and footballs and other sports equipment are made of synthetic rubber, which is a fossil fuel. The electricity used to transmit sporting events to our televisions and laptops use fossil fuels. The transportation we use to attend sports, theater, and other events are more than 90 percent powered by fossil fuels. The stadiums, parking lots, and roads we use to attend sporting events are constructed using steel and cement, both of which are fossil fuels.

### Clothes and Shoes

Until the 19$^{th}$ century, the majority of clothes, shoes, and other textiles were produced from living nature like fibers from cotton or wool from animals. Clothes and shoes are now widely produced by synthetic fibers, which are derived from fossil fuels. The widespread use of synthetic fibers also made clothes and shoes more affordable for the masses, while also improving their durability.

## Plastics

Plastics are used in water bottles, medical bottles, food containers, grocery sacks, medical tubing, children's toys, packaging, insulation, and much more. Each of these is a large industry. Plastics are manufactured from hydrocarbon gas liquids and natural gas. More than 400 billion cubic feet of natural gas are used annually in the U.S. alone to make plastic materials.

## Agriculture

Societies with inadequate or unsafe food supplies have high infant and maternal mortality and low life expectancies as well as poor health and malnutrition. Fossil fuels have enabled humans to vastly improve food production and safety.

In the last 60 years global population has more than doubled, from 3 billion to more than 7 billion people, while the amount of farmland declined. Even so, enormous advances in the availability, convenience, and safety of food have been achieved, made possible by the use of diesel and natural gas to power farm equipment as well as chemicals including fertilizers and pesticides.

Fertilizers and pesticides enhance soil fertility, protect against pests, block weeds, and have substantially improved crop productivity and the availability and safety of food consumption. Harvesting, crop tilling, and weed control require heavy machinery, which depends on distillate fuel. All of these methods of enhancing food production and safety – including farm equipment, fertilizers, and pesticides – are made or powered by fossil fuels.

The agriculture industry also transports food from farms to cities, states, and even countries. This is made possible by the use of trucks, trains, and airplanes that are fueled by fossil fuels.

Prior to advances in transportation, people had to produce their own food and purchase other foods at stores whose supply was dependent solely on nearby production. Safe food packaging and refrigerated vehicles are also used to transport food. Safe packaging and modern transportation are made possible by fossil fuels.

## Electricity

Electricity turns our lives from dark to light, and powers our mobile phones, computers, heaters, air conditioners, cooking appliances, refrigerators, home and business appliances, and much more.

Approximately 67 percent of the electricity we use is generated by fossil fuels. Of that total, coal and natural gas are about 33 percent each, and petroleum accounts for 1 percent. Nuclear power accounts for 20 percent, and, despite decades of research and development, federal and state mandates, and taxpayer subsidies, renewables still provide just 13 percent of our electrical power.

**Partial List of Products Made from Oil**

Thousands of products are made from fossil fuels. The list below includes only about 140 every day products made from oil. There are approximately 95 million barrels of oil that are used daily. One 42-gallon barrel of oil creates 19.4 gallons of gasoline. The remaining 22.6 gallons in a barrel of oil are used to make products such as those listed below.

| | | | |
|---|---|---|---|
| Ammonia | Diesel fuel | Insecticides | Shoe Polish |
| Anesthetics | Dishes | Life Jackets | Shoes |
| Antifreeze | Dishwasher parts | Linings | Shower Curtains |
| Antihistamines | Dresses | Linoleum | Skis |
| Antiseptics | Drinking Cups | Lipstick | Soap |
| Artificial limbs | Dyes | Luggage | Soft Contact lenses |
| Artificial Turf | Electric Blankets | Model Cars | Solvents |
| Aspirin | Electrician's Tape | Mops | Speakers |
| Awnings | Enamel | Motor Oil | Sports Car Bodies |
| Balloons | Eyeglasses | Motorcycle Helmet | Sun Glasses |
| Ballpoint Pens | Fan Belts | Movie film | Surf Boards |
| Bandages | Faucet Washers | Nail Polish | Sweaters |
| Basketballs | Fertilizers | Nylon Rope | Synthetic Rubber |
| Bicycle Tires | Fishing Boots | Oil Filters | Telephones |
| Boats | Fishing Rods | Paint | Tennis Rackets |
| Cameras | Floor Wax | Paint Brushes | Tents |
| Candles | Folding Doors | Paint Rollers | Tires |
| Car Battery Cases | Food Preservatives | Parachutes | Toilet Seats |
| Car Enamel | Football Cleats | Percolators | Tool Boxes |
| Cassettes | Football Helmets | Perfumes | Tool Racks |
| Caulking | Footballs | Petroleum Jelly | Toothbrushes |
| CD Player | Gasoline | Pillows | Toothpaste |
| CD's & DVD's | Glycerin | Plastic Wood | Transparent Tape |
| Clothes | Golf Bags | Purses | Trash Bags |
| Cold cream | Golf Balls | Putty | TV Cabinets |
| Combs | Guitar Strings | Refrigerant | Umbrellas |
| Cortisone | Hair Coloring | Refrigerators | Upholstery |
| Crayons | Hair Curlers | Roller Skates | Vaporizers |
| Curtains | Hand Lotion | Roofing | Vitamin Capsules |
| Dashboards | Heart Valves | Rubber Cement | Water Pipes |
| Denture Adhesive | House Paint | Rubbing Alcohol | Wheels |
| Dentures | Ice Chests | Safety Glasses | Yarn |
| Deodorant | Ice Cube Trays | Shag Rugs | |
| Detergents | Ink | Shampoo | |
| Dice | Insect Repellent | Shaving Cream | |

**Partial List of Products Made from Coal**

Below is a list of products made from coal. Coal is used to make steel, concrete, and insulation, as well as batteries, fertilizers, paint, pens, and plastics.

| | | |
|---|---|---|
| Abrasives | Golf Balls | Plastic |
| Baking Powder | Insulation | Rubber Bands |
| Batteries | Paint | Steel |
| Chalk | Paper Clips | Tray |
| Concrete | Perfumes | |
| Fertilizer | Pens | |

**Partial List of Products Made from Natural Gas**

| | | |
|---|---|---|
| Allergy Medicine | Fertilizer | Parachutes |
| Artificial Limps | Footballs | Perfume |
| Bandages | Golf Balls | Pipes |
| Camera Monitors | Guitar Strings | Refrigerators |
| Cameras | Helmets | Safety Glasses |
| Cellphones | Insect Repellent | Tires |
| Cleats | Insecticides | Tires |
| Cortisone | Life Vests | Tool Racks |
| Crayons | Lipstick | Toothpaste |
| Dentures | Paintbrush | Vitamin Capsules |

Despite greater use of renewable energy sources, worldwide fossil fuel usage has never been higher than it is today. Since the end of the Global Financial Crisis, from 2010 to 2016, usage of fossil fuels has increased seven straight years.

## Transition to Electric Vehicles

**Key Takeaways**

- Electric vehicles still total less than 1 percent of new car sales and only 0.15 percent of vehicles on the road.
- Adoption of electric vehicles has been slow, but they are projected to grow more than 60 percent annually over the next four years and more than 25 percent annually over the next two decades.
- Even so, EV's are projected to be only 25-35 percent of new vehicle sales in 2040.

People have been predicting that electric vehicles will replace gas powered transportation for many decades. It hasn't happened for several reasons: the cost of EV's, the lack of a grid to power them,

the limited distance electric vehicles can travel before needing to be recharged, the time required for recharging, limited battery storage capabilities, and lower vehicle performance.

**Recent Developments**

-Price and Performance

Over the past 5 years, battery power has improved. Regarding performance, some electric vehicles can now get to 60 mph faster than a gas-powered sedan. The price of electric vehicles has also declined. Tesla's base model EV costs $35,000 and the base model Chevy Bolt is $37,500. However, including usual add-ons that people want, as well as sales taxes and registration, the all-in cost appears to still be around $55,000.

-Battery Charging

Time to charge an EV takes as little as 30 minutes to as much as 12 hours, depending on the size of the battery and the speed of the charging point. For short distance driving, charging an EV will be similar to how we charge our mobile phones: we'll do so at home, often while we sleep. That still leaves a problem with long distance traveling. Public and workplace charging points are increasingly available. However, a 7kW public charging point provides just 30 miles of driving for every one hour of charge, or a 7-hour charge needed to drive 200 miles.

In May 2017 Tesla announced an upgrade that reduced charging time from 30 minutes to 20. Even 20 minutes is too long for EV's to be widely used for long distance travel. Tesla also stated they may eventually be able to fully charge an EV in 5 to 10 minutes, but added that "It's not going to happen in a year from now. It's going to be (technologically) hard."

-EV's Currently on the Road

EV sales have averaged 32 percent annualized growth the past four years. However, in 2015 EV's still were only 0.86% of all new vehicles sold, and still total only 0.15% of all vehicles on the road.

-EV sales appear to still be dependent on tax subsidies

EV sales still appear to be dependent on government subsidies for consumers to buy them. In Hong Kong, in March 2017 Tesla sold nearly 3,000 electric vehicles, the last month subsidies were available. The subsidies reduced the cost from about $130,000 to $75,000. When the subsidies ended, the next month Tesla did not sell a single electric vehicle in Hong Kong. In Denmark, sales of EV's plunged 70 percent when government subsidies were ended.

-The Middle Class mostly cannot afford EV's

Critics of subsidies for EV's note that they enable wealthy people to buy an expensive vehicle at a significant discount. They also point out that, even after-tax credits, it's still very expensive for

most people to buy an EV. That's because a base model costs at least $35,000, and after sales tax, registration, and with usual features, a fully equipped EV still costs around $55,000.

**Forecast for adoption of EV's**

-Market Forecasts

Currently, there are 1.1 billion cars on the road. In 2040, there are expected to be 2 billion vehicles on the road. By that year, EV's are projected to total 35 percent of new car sales and 25 percent of all cars on the road, or 500 million EV's on the road in 2040. But it also means there are expected to be 1.5 billion gas powered vehicles in 2040, or nearly 400 million more than today.

The International Energy Agency (IEA) forecast that EV's will total just 1 percent of vehicle sales in 2020, while the Deutsche Bank forecast is 11 percent. The average of seven forecasts we reviewed is that 5.4 percent of sales in year 2020 will be EV's, or 62 percent annualized growth over the next four years. But it would still represent just 1 in nearly 20 vehicles sold.

Bloomberg New Energy Finance and the IEA both predict that EV's and hybrids could represent 35 percent of light-vehicle sales by 2040. That means the projected Cumulative Annual Growth Rate (CAGR) for EV sales is 28 percent annualized from 2017 to 2040.

## The Negative Impact of Fossil Fuels

**Key Takeaways**

- Evidence indicates that global warming is intensifying.
- The warmest 17 years on record have occurred since 1998.
- The 2014 report from the IPCC was more worrisome than their 2007 report.
- The IPCC states that the Long-Term impact of not reducing the use of fossil fuels is catastrophic.

For all of the enormous improvements in the quality of life that fossil fuels have brought, they also have a major negative side effect. Fossil fuels put carbons in the atmosphere, and the vast majority of scientists think this leads to global warming. Some of the effects of global warming include:

- Changes in precipitation. Projections are for more winter and spring precipitation in the Northern United States and less for the Southwest.

- More droughts and heat waves. Droughts in the Southwest and heat waves everywhere are expected to become more intense. Summer temperatures are forecast to rise, and exacerbate heat waves in the west and central U.S. By year 2100, one-in-20-year extreme heat days are expected to occur every two or three years.

- Hurricanes will become stronger and more intense. The intensity and frequency of large hurricanes are projected to continue to increase, displacing many people, reducing property values, increasing the cost of emergencies, and causing more injuries and fatalities.

- Sea levels will rise by 1 to 4 feet by year 2100. Global sea levels have risen about 8 inches since recordkeeping began in 1880, but the pace is expected to accelerate. In the next several decades, storm surges and high tides could cause additional flooding in many regions.

- Long-term Forecast is for Catastrophic Impact. As described next, the Intergovernmental Panel on Climate Change (IPCC) forecasts that the long-term impact of global warming will be catastrophic and irreversible. Already, the 17 warmest years since records began in 1880 have occurred since 1998.

**The Intergovernmental Panel on Climate Change**

The following are five key takeaways from a report published by the Intergovernmental Panel on Climate Change titled "Climate Change 2014 Impacts, Adaptation, and Vulnerability."

1) Evidence that Humans are Causing Climate Change is Stronger

The IPCC states that human influence is "extremely likely" as the dominant cause of global warming over the last several decades. This represents stronger language than the term "very likely" that was used in their 2007 report.

2) The Forecast for year 2100 is ... Challenging

The 2014 report states that "warming by the end of the 21st century will lead to high to very high risk of severe, widespread, and irreversible impacts globally." Their 2007 report did not include such language. Types of irreversible impact include the extinction of plants or animals and ocean tides rising to catastrophic levels from which there is no return. Note: Carbon dioxide stays in the atmosphere for about 100 years.

3) Climate Change is Happening Now

The report concludes that climate change is happening now, as evidenced by rising sea levels, shrinking glaciers, decreasing snow and ice cover, warmer oceans, and more frequent and intense heat waves, rainstorms, and snowstorms.

4) What's Needed Now is ... Politics

Mr. David Victor from the University of San Diego and an author of the working group report stated that "Every time the IPCC (issues a report), we have a crisper more worrisome set of messages about trends in emissions and impacts of climate change, and then you don't see much connection

between the (report) and what governments actually do." Later he states that "Essentially, everything that needs to be done to move the needle is political (meaning, legislation and enforcement.)"

5) But There's Still Paris

The Paris Agreement gave hope that governments worldwide would make agreements that would reduce carbon emissions. Arguments persisted between developed and undeveloped countries, because the developed world wants to maintain their comfortable lifestyles while undeveloped nations want to improve their living standards. However, several agreements were reached. First, average global temperatures should not be allowed to rise more than 3.6 degrees Fahrenheit above Pre-Industrial levels. Temperatures have already risen by 2.0 degrees Fahrenheit. Second, each country submitted its own goals for curbing heat-trapping emissions. The pledges were agreed to by 197 countries.

The U.S. set a target for reducing carbon emissions by 2025 at 26 to 28 percent below 2005 levels. The journal Nature Climate Change stated in 2014 that the U.S. was on track to reach 80 percent of that goal.

### Developments Since the IPCC Report

Since the IPCC released their 2014 report, two developments have taken place. First, in 2017 President Trump announced that the United States was pulling out of the Paris Agreement. Second, over the past three years carbon emissions have increased by only 0.3 percent annualized, or less than $1/10^{th}$ the rate of growth from 2000 to 2009, even as global GDP rose by 10 percent.

## Carbon Emissions: Recent Developments

### Key Takeaways

- Global carbon emissions have increased by only 0.3 percent annualized the past three years.
- In the U.S. carbon emissions have declined by 1.4 percent annualized from 2005 to 2016, a total reduction of 15.5 percent.
- Carbon emissions in the U.S. declined by 15.6 percent since 2005, and are at the same level as they were in 1992, even as GDP grew by 80 percent and the population grew by 40 percent.
- Alternatives and natural gas have increased sharply while the use of coal has declined.
- Earlier this year the Executive Director of the IEA stated ""These three straight years of flat emissions in a growing global economy signal an emerging trend and that is certainly a cause for optimism, even if it is too early to say that global emissions have definitely peaked."

### Growth in Carbon Emissions Has Declined Sharply

The International Energy Agency (IEA) reported that global carbon dioxide emissions in 2016 were essentially flat for the third straight year, even as global economic growth was 3.1 percent. In

2014, global carbon emissions grew by 0.7 percent, were flat in 2015, and edged up by 0.2 percent in 2016. The recent trend is a significant slowdown from the annual rate of 3.5 percent in carbon emission growth from 2000 to 2009. The 3-year growth in carbon emissions of less than 1 percent from 2014-16 was the slowest rate of growth since 1981-83.

In the U.S., carbon dioxide emissions fell by 3 percent in 2016, while the economy grew by 1.6 percent. The decline in carbon emissions in the U.S. was driven by strong growth in shale gas supplies, growth in renewable power, and a significant decline in coal. The U.S. has reduced carbon emissions by 15.6 percent since 2005. Emissions in the U.S. in 2016 are now at their lowest level since 1992, even as the economy grew by 80 percent and the population grew by 40 percent.

In 2016, worldwide coal demand fell, led by an 11 percent decline in the U.S. In China, emissions edged up just 1 percent, even as their economy grew by 6.7 percent. There were several reasons for China's modest increase of emissions in 2016: increased use of renewables, nuclear and natural gas, a switch from coal to gas in the industrial sector, five new nuclear power plants which increased nuclear output by 25 percent, and a decline in their use of coal. In Europe, emissions were flat, as demand for gas rose by 8 percent and use of coal fell by 10 percent.

From 2010 to 2015, energy from renewable sources grew by 15.2 percent annually, while natural gas rose by 1.7 percent, and use of oil and coal rose by 1.1 percent annually. In 2016, the use of coal on a global basis declined, replaced by increases in renewables and natural gas.

Dr. Fatih Birol, Executive Director of the International Energy Agency, stated "These three straight years of flat emissions in a growing global economy signal an emerging trend and that is certainly a cause for optimism, even if it is too early to say that global emissions have definitely peaked."

## Carbon Emissions: Future Forecasts

### Key Takeaways

- Global carbon emissions are expected to grow at 1/3$^{rd}$ their rate of growth from 2000-2009.
- Carbon emissions in the U.S. are projected to decline from 2017 to 2040 by 0.2 percent annually.
- Increased use of alternatives and natural gas, declining use of coal, adoption of electric vehicles, and technological improvements are expected to keep the growth of carbon emissions 2/3rds lower than in the previous decade.

### Forecast is that Carbon Emissions Will Grow Only 1/3$^{rd}$ the Rate of the Past 20 Years

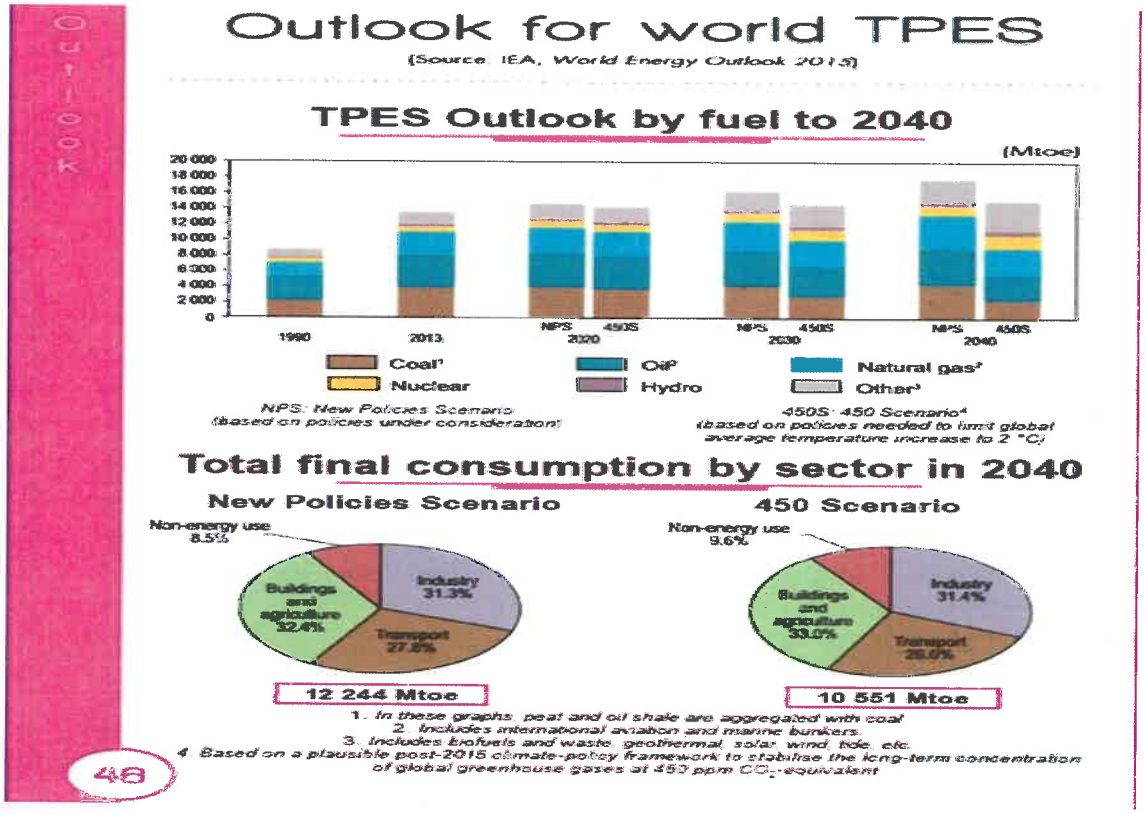
From 2017 to 2035, global GDP is expected to increase by 80 percent, or 3.4 percent annualized, led by growth in emerging market countries. Growth in undeveloped countries is expected to lift 2 billion people out of poverty. Rising global prosperity is expected to drive increased energy demand, but energy demand is expected to rise by only 30 percent, or nearly 2/3rds less than the rate of economic growth.

Why is energy consumption expected to rise only 30 percent over the next 19 years while global GDP increases by 80 percent? First, the fuel mix will continue to adjust, as it has in recent years, with half of energy growth being produced by renewables. Renewables will be by far the fastest growing energy source due to improvements in technology, increased supply, and more competitive pricing. Second, among fossil fuel sources, natural gas will grow the fastest. Third, oil demand will grow over the next 20 years, but the pace of demand will slow as use of electric vehicles increases. Fourth, global coal consumption is set to peak.

Fossil fuels currently comprise about 84 percent of current energy consumption. Oil consumption totals about 32 percent, coal roughly 29 percent, and natural gas about 23 percent, for a total of 84 percent. Nuclear power totals 5 percent, while alternatives are about 11 percent.

In year 2035, fossil fuels are expected to comprise about 78 percent of energy consumption. However, changes in the mix of sources will be more beneficial than the decline from 84 to 78 percent suggests. Oil consumption is expected to fall from 32 to 29 percent, coal will fall from 29 to 24 percent, and natural gas will rise from 23 to 25 percent. Nuclear power is expected to stay essentially the same, rising from 5 to 6 percent, while renewables experience the strongest growth, rising from 11 to 15 percent of total energy consumption.

Below is a chart summarizing TPES' forecast for energy consumption, based on current and potential energy policies:



In short, carbon emissions are expected to grow by less than 1/3rd the rate of the past 20 years, due to gains in energy efficiency and the changing mix of energy use between alternatives, natural gas, oil, and coal. In the U.S., the Energy Information Agency forecasts that domestic carbon emissions continue to decline, but at a slower rate, of 0.2 percent annually from 2017 to 2040.

For all of the recent and forecasted improvements, carbon emissions are still projected to rise, highlighting the need for further action. But as we noted earlier, divestment does not reduce carbon emissions. Consumer behavior and government regulations and enforcement do that.

## Challenges to Reducing Carbon Emissions

### Demand

The first problem toward reducing the use of fossil fuels is demand. The products that fossil fuel companies make are in enormous demand. Another problem is that it's not a local or national issue. The problem is global use of fossil fuels.

### 85 percent of fossil fuel growth will come from emerging countries, not from the west

The second problem with reducing demand for fossil fuels is that, even if people in advanced countries were to reduce their consumption, the use of fossil fuels is poised to increase. That's because 85 percent of the future growth in the use of fossil fuels is expected to come from developing countries.

### Lack of renewables on a scale that meets demand

The third problem with reducing fossil fuels is that there is not a substitute in the form of renewables available that meets the enormous demand for products made from fossil fuels.

Despite several decades of research and development, wind and solar total only about 1.5 percent of energy consumption. Battery power and storage has recently improved, but they still have a long way to go, and we need a much larger infrastructure grid of battery power for EV's to become widely used. Carbon capture and storage seeks to capture and store carbons underground, but the technology is still in its infancy. Nuclear power is available in large volume and it is not a fossil fuel, but it is also controversial.

### Consumer Sentiment

Gallup reports that Americans who are worried "a great deal" about climate change is at a three-decade high, but it's still just 45 percent. Just 42 percent of Americans think that climate change will pose a serious threat in their lifetimes. An Associated Press-NORC-University of Chicago poll reports that just 38 percent of Americans are extremely or very worried about it.

The AP-NORC-University of Chicago poll also found that Americans are willing to pay for reducing carbon emissions, but only a little. That poll also found that only 54 percent of Americans supported President Obama's rules to cut pollution from coal power plants, and, when the question also included that thousands of jobs would be lost, that support fell to 45 percent.

**Lack of Government Regulations That Require Reduced Carbon Emissions**

Legislation by governments across many nations that sets standards is the only action with certainty that will reduce carbon emissions. But that's going to be hugely difficult, because use of fossil fuels is worldwide. Ultimately, as Mr. David Victor from the University of San Diego and a member of the working group that prepared the 2014 IPCC report stated, the solution to global warming is going to have to be governments enacting legislation that requires it.

The following is an excerpt from the Energy Realities blog which highlights why renewables have not been widely adopted yet, and what needs to be done for greater use of renewables:

**Facilitating renewables**

When it comes to renewable energy, there are two basic problems: supply and transport. Unlike traditional nuclear or coal power plants, which deliver predictable, steady streams of electricity to houses and factories, wind, solar and hydro power depend on weather, which can be fickle and unpredictable. That means supplies can dip too low at crucial times or soar too high, sending excess electricity into a carefully calibrated power grid.

And renewable energy supplies are often located far from the cities and factories where electricity is needed most. The wind whistling across the wide-open plains of just three U.S. states – North Dakota, Kansas, and Texas – could power the entire nation. But without massive investments in new high-voltage power lines to move electricity from the Great Plains to the heavily populated coasts, windmills are useless.

The problem is that our electrical grids are relics, dating back a century. In the U.S., power supplies are still local affairs, supplying nearby cities or at best patching into rickety local networks that cover a few states. In Europe, the picture is further complicated by national borders, which require reconciling the competing and conflicting regulations of dozens of different countries.

If renewable energy sources are going to be a part of our electricity supply, the grid needs a wholesale overhaul. While discussions about the smart grid often focus on smart meters in private homes and other micro-fixes, the most important investments will be massive, on the scale of the interstate highway system that changed the face of America a half century ago.

Planners are focusing on making power grids larger and more interconnected, to make sure that excess power can be moved where it's needed easily and efficiently. That's important because larger networks equal more stable energy supplies – and a higher percentage of renewables.

"If you have a large area, the wind is always blowing somewhere," says Paul Wilczek of the European Wind Energy Association. "If we're able to combine wind farms over a large area, output is pretty flat."

As it stands, Europe's grid can't manage it all – and isn't yet ready for the thousands of windmills nine countries plan to install in the stormy North Sea, let alone pie-in-the-sky plans like filling the Sahara with solar panels.

**Getting it done**

Big decisions need to be made now if we have any intention of getting improved grids in place in the next decade. In Europe, regulators hope to add more than 25,000 miles of power lines — a quarter of them long-distance, high-voltage wires to move electricity from coastal regions deep inland – by 2020. It's a tremendous task. "Short term in grid planning is not really short," Wilczek says. "This is infrastructure that's going to be there for 50 years, so you don't put it in fast."

Like a river, electricity flows indiscriminately whether or not customers are using their power at any given moment. Right now, anything that's not used is simply wasted, making up-to-the-second data provided by smart meters valuable to energy companies looking to fine-tune their output.

And in the long term, a steady energy supply will also require ways to store energy produced during off-peak hours, when supply is high but demand is low. Pilot projects to smooth out supply and demand using smart meters, batteries, water pumps, hydrogen fuel cells and even warehouses full of frozen fish are already in place. Electric cars, like the Nissan Leaf or Chevy Volt, are another way to store energy, by charging the car batteries using electricity produced during off-peak hours.

Improving the world's electricity infrastructure isn't sexy, but it's vital. When the lights still go at the flick of a switch half a century from now, we'll be glad we took the leap.

## Why Divestment Could Make Sense

### 1 – Divestment by Many Others Could Pressure the Value of Our Fossil Fuel Holdings Lower

Divestment of fossil fuels by institutional investors is reported to be about $5 trillion, which doubled over the past year. The amount that these institutions have actually divested, however, cannot be determined. One reason why divestment now could make sense is if other investors divest that could cause the value of our holdings to decline.

**Staff's Assessment**

Divestment without a decline in the use of products made from fossil fuels would make those holdings cheaper, and thus better investment value. Also, many people are not aware that the U.S. has reduced carbon dioxide emissions by 15.6 percent since 2005. Many people are also not aware that growth in carbon emissions has slowed to $1/10^{th}$ its level in the previous decade.

### 2 – If the Use of Renewables Proves to be Faster than Projected and the Use of All Sources of Fossil Fuels Declines

Consensus expectations is that, while renewable energy will experience strong growth, the use of fossil fuels will also continue to grow, just at a slower pace compared to renewables. Divestment

now can make sense if the future adoption of renewables proves to be faster than expected and the use of products made from all sources of fossil fuels actually declines.

### Capacity and Pricing of Renewables Are Improving

Recently the capacity of renewable technologies has improved. Wind capacity in the U.S. grew by 8 to 13 percent each year from 2014 to 2016, and solar capacity is growing even faster. The prices for wind and solar have also declined.

Shell and BP estimate that energy use will increase by 1.4 percent annually through 2040. Actual increases have been more like 1.0 percent. The IEA, Shell, BP, Exxon and Mobile estimate that solar and wind will grow between 5.0 to 9.5 percent annually through 2040, while actual recent increases have been 8.0 to 13.0 percent. They also estimate that other non-fossil fuels (nuclear, biomass, and hydroelectric) will grow between 1.4 and 1.9 percent annually, while their actual increases have been about 2.3 percent. Finally, they all estimate that fossil fuels will grow 0.7 percent annually, while in recent years their rate of increase has been about 0.3 percent per year.

In other words, recent increases in renewable capacity have been higher than future forecasts. If renewables can maintain their recent gains, then analysts today would be underestimating their future use. Also, recent increases on the use of fossil fuels have been lower than future forecasts. But only the use of coal has declined. Use of oil has edged up a bit, and use of natural gas has increased significantly.

### Staff's Assessment

Staff anticipates that the use of renewables will surprise to the upside. If demand for renewables proves to be greater than consensus, then growth in the use of fossil fuels could be lower. But even if the latter happens, we still expect use of fossil fuels will grow, just that they may grow less than expected. We also think that demand for energy will surprise to the upside, as economic advancement in China, India, and Africa lift 2 billion people out of poverty over the next two decades. But we are optimistic that a majority of any increase in energy demand will be supplied by alternatives and natural gas and not from coal.

Also, focusing on fossil fuels misses the vital importance that what matters is the amount of carbon dioxide that is released into the atmosphere, and all fossil fuels do not emit the same amount of carbon dioxide.

## Rationale for Staff's Recommendation Not to Divest of Fossil Fuels

### Key Takeaways

- Staff is very concerned about global warming and its potential for long-term catastrophic impact.
- However, for many reasons, as noted below, Staff does not support divestment.

**1 - Divestment does not reduce fossil fuels**

This cannot be emphasized enough: divestment does not reduce fossil fuels. Staff is concerned that fossil fuels are causing global warming. However, divestment does not reduce the amount of fossil fuels; it simply changes ownership. Reducing fossil fuels requires:

- Consumers, government, and businesses to reduce their use of fossil fuels, or:
- Government legislation that requires consumers and business to reduce the use of fossil fuels.

Divestment also does not harm or punish companies that produce fossil fuels. What harms producers of fossil fuels is when consumers reduce the use of products made from fossil fuels, or when governments require it.

**2 – What is important is limiting the growth in carbon emissions: changing the mix of fossil fuels plus greater use of renewables will accomplish that**

Action should be on reducing carbon emissions, not fossil fuels because not all fossil fuels emit the same amount of carbon dioxide.

The key to reducing global warming is limiting the growth of carbon emissions. Changing the mix of fossil fuels can do that. Coal emits about 33 percent more carbon dioxide than gasoline, and about 100 percent more than natural gas.

Coal should be phased out and replaced by renewables when its supply exists and otherwise by natural gas, which is in abundant supply. The good news is that changing the mix to reduce the use of coal and increase the use of alternatives and natural gas is already underway. At the same time, more needs to be done and humankind needs to be smarter about its energy consumption.

**3 – Lack of a substitute to fossil fuels that meets the large demand for energy**

The enormous use of fossil fuels without an alternative to fossil fuels that meets the scale of demand is one reason why staff does not support divestment.

**4 – Use of fossil fuels are expected to grow for at least the next several decades**

Fossil fuels worldwide account for approximately 84 percent of our energy usage. In 2040, energy produced from fossil fuels is still expected to be 78 percent. While the percentage is expected to decline, due to consumption growth the use of fossil fuels is expected to continue to grow over the next two decades. But increasing use of fossil fuels does automatically mean that carbon emissions rise to catastrophic levels. Changing the mix of fossil fuels used and being more aware of how we consume energy would reduce carbon emissions even as the use of fossil fuels increase.

**5 – Technological Advancements Usually Exceed Expectations**

In 2014 the IEA stated that the supply of oil, liquid hydrocarbons, and biofuels is expected to meet global demand for liquid fuels for at least the next 25 years. Their forecast contradicts the views of some analysts that supply will peak and then decline. Finally, the IEA projects that global reserves will likely increase, not decline, as new technologies increase production.

Over the past 25 years, global GDP doubled, but total energy consumption rose by just 30 percent. Doomsday forecast of peak oil and the world running out of food and energy have been proven wrong for decades. That's because advances in technology have repeatedly proven predictions of peak supply to be incorrect.

**6 – Not a single public plan has actually divested; no investment consultant to a U.S. public pension plan has recommended divestment**

There are no U.S. public pension plans that have voted to divest of all of their fossil fuels. The few that have taken action have approved limited divestment or no divestment at all. As noted earlier, recently the City of Seattle and the State of Vermont took up motions to divest of fossil fuels. They voted not to divest. No investment consultant to a U.S. public pension plan has recommended divestment of fossil fuels.

**7 – The Principles for Responsible Investing (PRI) does not recommend divestment: PRI recommends becoming a more active owner**

The PRI does not recommend divestment of fossil fuels. The PRI signatory list includes 350 asset owners, 1,176 investment managers, and 222 service providers. Earlier this year the Retirement Board approved SFERS becoming a member of the PRI.

**8 – Being an active owner to promote change has value**

Being an active owner enables SFERS to help shape how a company uses its resources. Attached are several articles highlighting recent investments by oil and gas companies into alternative energy. The actions of concerned owners appear to be having a positive effect on fossil fuel companies, resulting in their increased investments in renewable energy.

**9 – Forecast is for rising oil prices and rising use of natural gas, making investments in oil and gas companies potentially profitable**

The U.S. Energy Information Agency forecasts from 2017 to 2040 an ongoing transition from coal to natural gas, potentially making our investments in the latter profitable. They project oil prices will be $109 a barrel in 2040, from roughly $50 today, a projected increase of 118 percent. They also expect global demand for oil will be about 20 percent higher than today. Higher expected prices, rising demand, and technological advancements, make our investments in oil companies potentially profitable. Lastly, many oil firms are transitioning to become energy companies.

**10 – Use of alternative energy will rise, but the winners could include existing oil, gas, or utility companies entering the alternative energy space**

Large sums of research and development into alternative energy are being made by utilities, oil and gas companies, governments, and philanthropists. Venture capitalists are also making investments in new sources of energy.

While technological progress will be made and the use of alternatives will rise, nobody knows who the winners will be. They could include companies that have not been formed yet or current alternative energy companies. But the winners could also include existing oil, gas, and utility companies. In the attachments are examples of companies in one industry that entered new markets and were successful in their new industries.

**11 – SFERS divested of tobacco stocks, which have significantly outperformed and reduced our returns**

Even if the use of fossil fuels were in decline, that does not mean their investment returns would be poor. Tobacco stocks are an example. Smoking among adults in the U.S. has declined from 25 percent in 1997 to about 15 percent today. SFERS Board approved divestment of tobacco stocks in May 1998, just over 19 years ago.

| | YTD | 1 Year | 3 Years | 5 Years | 10 Years | 15 Years | 20 Years | 25 Years | Beta |
|---|---|---|---|---|---|---|---|---|---|
| S&P 500 Tobacco | 21.1% | 17.4% | 22.2% | 16.8% | 17.2% | 18.8% | 15.3% | 15.5% | 0.62 |
| S&P 500 | 9.3% | 17.9% | 9.6% | 14.6% | 7.2% | 8.3% | 7.2% | 9.6% | 1.00 |
| Over (Under) Performance | 11.8% | -0.5% | 12.6% | 2.2% | 10.0% | 10.5% | 8.1% | 5.9% | |

- Over the past 15 years tobacco stocks have outperformed the S&P 500 by 10.0% annualized, 17.2% versus 7.2%;
- Over the past 20 years tobacco stocks have outperformed the S&P 500 by 8.1% annualized, 15.3% versus 8.1%.
- The beta of tobacco stocks to the S&P 500 has been just 0.62, meaning they have had 38 percent less systematic risk than the index;
- The correlation of tobacco stocks to every other sector has been low, as noted in the following attachments, and has had a correlation to the S&P 500 of just 0.38, the lowest of all 11 sectors in the index.
- By eliminating our exposure to a low correlated sector such as tobacco, we increased the volatility of our portfolio.
- By eliminating our exposure to a higher returning sector such as tobacco, we reduce the returns of our portfolio.

**12 – Energy has significant diversification benefits, and until its recent dramatic underperformance, from 1974 to 2013 energy outperformed the S&P 500**

Energy has dramatically underperformed the S&P 500 for the past 3 ½ years, but from 1974 to 2013 energy outperformed the S&P 500 in 26 out of 40 years and outpaced the S&P 500 by 0.3% annualized, 11.2% to 10.8% (rounded) per year.

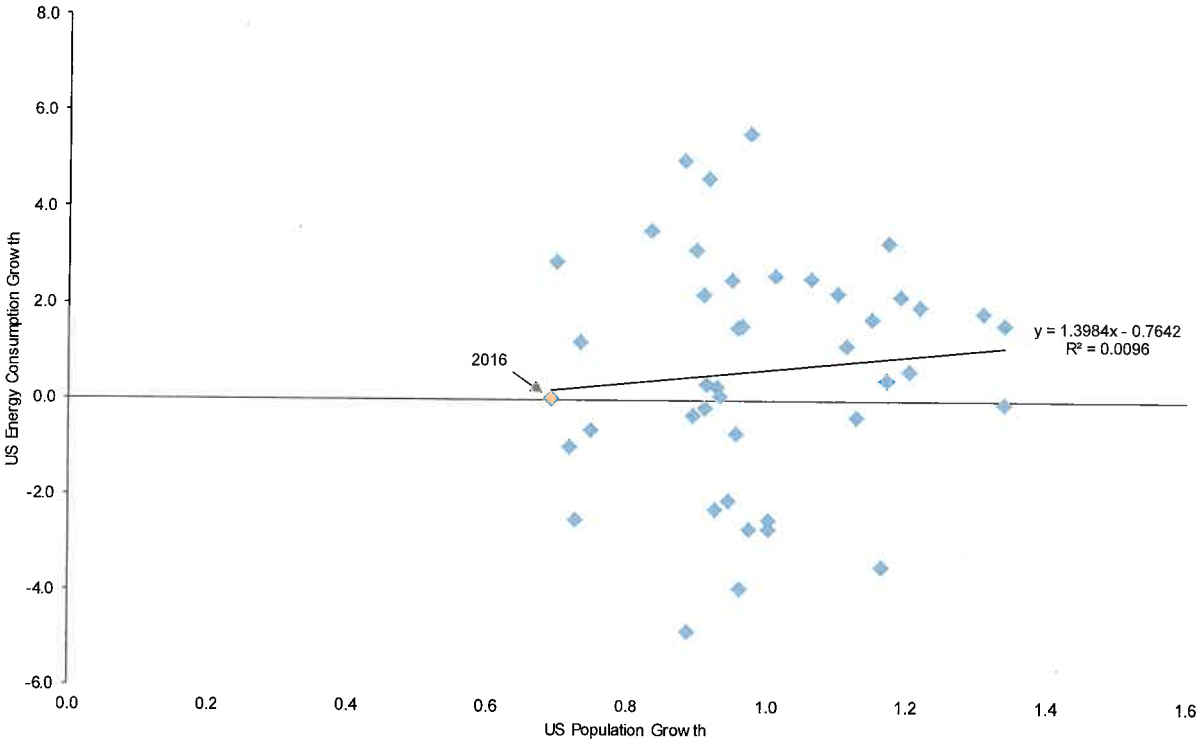
The beta of the energy sector to the S&P 500 is just 0.78, meaning energy has 22 percent less systematic exposure than the index.

The correlation of the energy sector to the S&P 500 is just 0.61, the second lowest of the 11 sectors in the index, behind only tobacco. Further, the energy sector's highest correlation to any of the 11 sectors in the index is just 0.64.

## 13 - Inflation Protection

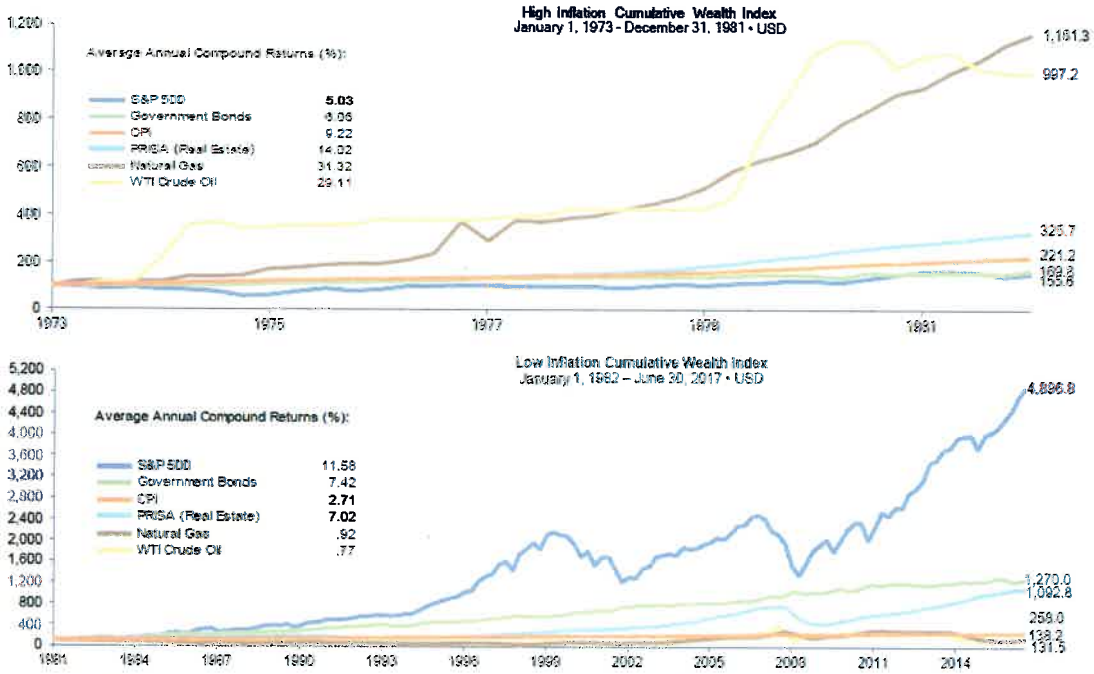
As shown in the following charts, stocks have earned about 11.5 percent annualized returns when inflation has been low. In low inflation, energy has about broken even. However, when Inflation has been high, stocks have armed about 5.0 percent annualized, while energy has soared about 30.0 percent annualized. Another reason why Staff does not support divestment is because energy has significantly outperformed stocks, bonds and real estate when inflation has been high.

**US Energy Consumption Growth vs. Population Growth**
1974 to 2016 • Percent (%)




Sources: US EIA, US BEA
Notes: Growth of average annual US total consumption energy use as reported by the EIA vs. growth the average US population as reported by the Bureau of Economic Affairs.

**Oil & Gas Performance During High and Low Inflation Periods**




Sources: Barclays, Oil & Gas Journal Energy Database, Prudential Real Estate Investors, Standard & Poor's, US Department of Labor - Bureau of Labor Statistics, and The Wall Street Journal. Data for PRISA (Real Estate) are through Q1 2017.

299s

## Summary

• Growth in carbon emissions has averaged 0.3 percent annually the past three years, less than 1/10$^{th}$ their rate of growth of 3.5 percent annualized from 2000 to 2009.

• The U.S. has reduced its carbon dioxide emissions by 15.6 percent since 2005. Carbon emissions in the U.S. today are at their lowest level since 1992.

• In China carbon emissions rose by just 1.0 percent in 2016, even as their economy grew 6.7 percent.

• Changes in the mix of fossil fuels – meaning, less use of coal and more use of natural gas - plus strong growth in use of renewables has driven the slowdown in the growth of carbon emissions.

• Demand for energy is expected to increase by 30 percent over the next two decades.

• Most of the future increase in energy is expected to come from renewables, natural gas, and technological improvements.

• The Paris Agreement included 197 countries. Nations agreed that temperatures should not be permitted to rise more than 3.6 degrees Fahrenheit above Pre-Industrial levels. Since the Pre-

Industrial age temperatures have risen 2.0 degrees. The U.S. agreed to reduce its carbon emissions by 26 to 28 percent by 2030 from its 2005 levels. Thus far the U.S. has reduced its carbon emissions by 15.6 percent since 2005. Carbon emissions in the U.S. today are the same as in 1992.

• Staff is encouraged by the reduction in carbon emissions in the U.S. and by the significant slowdown in carbon emissions growth globally the past three years. We are encouraged that growth in carbon emissions in China has been just 1.0 percent, in Europe it has been flat, and in the U.S. it is declining. We are also encouraged by the strong growth in renewables and the changing mix among fossil fuels from coal to natural gas as the latter burns half the carbon emissions as coal.

• Staff thinks that energy use in the future could surprise to the upside, led by economic development in emerging markets. If energy demand proves higher than consensus, that would be very good for the human impact, as 2 billion people could be lifted out of poverty.

• Staff also thinks that use of renewables could surprise to the upside, as supply improves and prices decline.

• All that said, more certainly still needs to be done to reduce and eventually eliminate the growth of carbon emissions. But as we stated in the beginning, divestment does not reduce carbon emissions. Carbon emissions are reduced by choices people make or by government requiring it.

**Attachments:**

1 – Statistical Data October 1989 to June 2017 on the Energy and Tobacco Sectors and the S&P 500
2 – Cross-Correlation Matrix October 1989 to June 2017
3 – BP Statistical Review of World Energy June 2017
4 – Can Alternative Energy Effectively Replace Fossil Fuels?
5 – The Energy Debate: Renewable Energy Cannot Replace Fossil Fuels?
6 – Large Corporations Are Driving America's Renewable Energy Boom. And They're Just Getting Started – Greentech Media
7 – Global Oil Majors Are Poised for a Resurgence in Solar and Wind – Greentech Media

# 1 – Statistical Data October 1989 to June 2017 on the Energy and Tobacco Sectors and the S&P 500

# Custom Table

## October 1989 - June 2017: Summary Statistics

| | Return | Cumulative Return | Standard Deviation | Sharpe Ratio | Maximum Drawdown | Pain Ratio | Excess Return vs. Market | Tracking Error vs. Market | Information Ratio vs. Market | Up Capture vs. Market | Down Capture vs. Market | Alpha vs. Market | Beta vs. Market |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S&P 500 Tobacco (Industry) | 16.36% | 6605.75% | 23.55% | 0.57 | -59.71% | 1.51 | 6.81% | 22.45% | 0.30 | 79.81% | 36.78% | 12.33% | 0.62 |
| S&P 500 Energy (Industry) | 9.46% | 1126.95% | 18.22% | 0.36 | -49.03% | 0.68 | -0.10% | 14.73% | -0.01 | 84.54% | 82.73% | 2.78% | 0.78 |
| S&P 500 | 9.56% | 1158.52% | 14.28% | 0.46 | -50.95% | 0.74 | 0.00% | 0.00% | 0.00 | 100.00% | 100.00% | 0.00% | 1.00 |

# 2 – Cross-Correlation Matrix October 1989 to June 2017

# Correlation Matrix: Returns vs. S&P 500

October 1989 - June 2017

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1) S&P 500 Financials (Sector) | 1.00 | | | | | | | | | | | |
| 2) S&P 500 Information Technology (Sector) | 0.52 | 1.00 | | | | | | | | | | |
| 3) S&P 500 Health Care (Sector) | 0.58 | 0.39 | 1.00 | | | | | | | | | |
| 4) S&P 500 Industrials (Sector) | 0.80 | 0.66 | 0.56 | 1.00 | | | | | | | | |
| 5) S&P 500 Energy (Sector) | 0.48 | 0.36 | 0.35 | 0.58 | 1.00 | | | | | | | |
| 6) S&P 500 Consumer Discretionary (Sector) | 0.78 | 0.71 | 0.52 | 0.85 | 0.43 | 1.00 | | | | | | |
| 7) S&P 500 Consumer Staples (Sector) | 0.58 | 0.30 | 0.69 | 0.58 | 0.35 | 0.56 | 1.00 | | | | | |
| 8) S&P 500 Tobacco (Industry) | 0.30 | 0.18 | 0.39 | 0.33 | 0.26 | 0.27 | 0.64 | 1.00 | | | | |
| 9) S&P 500 Telecommunication Services (Sector) | 0.43 | 0.48 | 0.40 | 0.49 | 0.33 | 0.52 | 0.41 | 0.27 | 1.00 | | | |
| 10) S&P 500 Utilities (Sector) | 0.34 | 0.15 | 0.37 | 0.37 | 0.45 | 0.26 | 0.45 | 0.36 | 0.35 | 1.00 | | |
| 11) S&P 500 Materials (Sector) | 0.68 | 0.54 | 0.45 | 0.83 | 0.64 | 0.74 | 0.48 | 0.28 | 0.39 | 0.29 | 1.00 | |
| 12) S&P 500 | 0.84 | 0.80 | 0.68 | 0.90 | 0.61 | 0.89 | 0.65 | 0.38 | 0.63 | 0.42 | 0.79 | 1.00 |

# 3 – BP Statistical Review of World Energy June 2017

# BP Statistical Review of World Energy June 2017

bp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66th edition

For 66 years, the *BP Statistical Review of World Energy* has provided high-quality objective and globally consistent data on world energy markets. The review is one of the most widely respected and authoritative publications in the field of energy economics, used for reference by the media, academia, world governments and energy companies. A new edition is published every June.

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# Group chief executive's introduction

Welcome to BP's *Statistical Review of World Energy*. This is the 66th edition of the Statistical Review and the data and analysis it contains provide a window onto another fascinating year in the world of energy.

Global energy markets are in transition. Rapid growth and improving prosperity mean growth in energy demand is increasingly coming from developing economies, particularly within Asia, rather than from traditional markets in the OECD. The relentless drive to improve energy efficiency is causing global energy consumption overall to decelerate. And, of course, the energy mix is shifting towards cleaner, lower carbon fuels, driven by environmental needs and technological advances. BP will play its part in meeting this dual challenge of supplying the energy the world needs to grow and prosper, while also reducing carbon emissions.

As well as the increasing pull of this long-term transition, energy markets last year also had to respond to a series of shorter-run factors, most notably in the oil market which continued to adjust to the excess supply that has weighed on prices over the past three years. To understand this mix of short and long-run factors and what they might imply for the future, we need timely and reliable data. That is where the Statistical Review comes in, providing accurate global data to inform discussion, debate and decision making.

Looking at the picture overall, energy consumption grew slowly again in 2016 – the third consecutive year in which demand has grown by 1% or less – much weaker than the rates of growth we had become used to over the previous 10 years or so. Moreover, the weak growth in energy demand, combined with a continuing shift towards lower carbon fuels, meant global carbon emissions from energy consumption were estimated to have been essentially flat in 2016 for a third consecutive year – a substantial improvement relative to past trends.

From a global level, much of this improvement can be traced back to the pronounced changes in the pace and pattern of economic growth and energy consumption within China. The extent to which these changes will persist as China moves to a more sustainable pattern of growth and how much will unwind as the marked weakness in some of China's most energy-intensive sectors eases is uncertain. We need to keep up our focus and efforts on reducing carbon emissions. BP supports the aims set out in the COP21 meetings in Paris and is committed to playing its part in helping to achieve them.

In terms of individual fuels, 2016 was a year of adjustment for the oil market, with low prices fuelling demand growth and weighing on production, particularly US tight oil which fell back substantially. As a result, the oil market moved broadly into balance in the second half of the year, albeit with inventories remaining at elevated levels. Towards the end of last year, OPEC together with 10 non-OPEC producers announced an agreement to cut output in order to speed up the pace at which oil stocks adjust to more normal levels. The price responsiveness of US tight oil and the actions of OPEC dominated oil markets in 2016 and look set to continue to do so over the next few years.

The weak price environment in 2016 was also felt in the natural gas market, where global production was essentially flat. This is the weakest growth in gas output for 34 years, other than in the immediate aftermath of the financial crisis. Even so, exports of liquefied natural gas (LNG) increased strongly, as a number of major LNG projects in Australia came onstream. The growth spurt in LNG supplies expected over the next few years is likely to have a major influence on global gas markets, leading to greater integration of markets across the globe and a move towards more flexible, competitive markets.

The influence of the energy transition was particularly marked in the contrasting fortunes of coal and renewable energy. Coal consumption fell sharply for the second consecutive year, with its share within primary energy falling to its lowest level since 2004. Indeed, coal production and consumption in the UK completed an entire cycle, falling back to levels last seen almost 200 years ago around the time of the Industrial Revolution, with the UK power sector recording its first ever coal-free day in April of this year. In contrast, renewable energy globally led by wind and solar power grew strongly, helped by continuing technological advances. Although the share of renewable energy within total energy remains small, at around 4%, it accounted for almost a third of the increase in primary energy last year.

Our industry has faced some significant challenges in recent years. There are signs in last year's data that markets are adjusting and some of the near-term pressures may gradually ease. But as we know from history, one set of challenges is likely to be replaced by another, as we learn to operate in ever-changing markets and to harness the opportunities afforded by the transition to a lower carbon environment. That will require understanding and judgement, both of which rely on the kind of robust data and analysis provided by the Statistical Review. I hope you find it a useful resource for your own discussions and deliberations.

Let me conclude by thanking BP's economics team and all those who helped us prepare this Review. The Review relies on the willingness of governments around the world to contribute their official data. Thank you for your continuing co-operation and transparency.

**Bob Dudley**
Group chief executive
June 2017

# 2016 at a glance

## Growth in global primary energy consumption remained low in 2016; and the fuel mix shifted away from coal towards lower carbon fuels.

Aerial view of Shanghai highway in China at night. Shanghai has an expansive grade-separated highway and expressway network consisting of 16 municipal express roads, 10 provincial-level expressways and eight national-level expressways.

### Energy developments

- Global primary energy consumption increased by just 1% in 2016, following growth of 0.9% in 2015 and 1% in 2014. This compares with the 10-year average of 1.8% a year.
- As was the case in 2015, growth was below average in all regions except Europe & Eurasia. All fuels except oil and nuclear power grew at below-average rates.
- Energy consumption in China grew by just 1.3% in 2016. Growth during 2015 and 2016 was the lowest over a two-year period since 1997-98. Despite this, China remained the world's largest growth market for energy for a 16th consecutive year.

### Carbon emissions

- Emissions of $CO_2$ from energy consumption increased by only 0.1% in 2016. During 2014-16, average emissions growth has been the lowest over any three-year period since 1981-83.

### Oil

- The Dated Brent oil price averaged $43.73 per barrel in 2016, down from $52.39 per barrel in 2015 and its lowest (nominal) annual level since 2004.
- Oil remained the world's leading fuel, accounting for a third of global energy consumption. Oil gained global market share for the second year in a row, following 15 years of declines from 1999 to 2014.
- Global oil consumption growth averaged 1.6 million barrels per day (Mb/d), or 1.6%, above its 10-year average (1.2%) for the second successive year. China (400,000 b/d) and India (330,000 b/d) provided the largest increments.
- Global oil production in contrast, rose by only 0.4 Mb/d, the slowest growth since 2013.
- Production in the Middle East rose by 1.7 Mb/d, driven by growth in Iran (700,000 b/d) Iraq (400,000 b/d) and Saudi Arabia (400,000 b/d).
- Production outside the Middle East fell by 1.3 Mb/d, with the largest declines in the US (-400,000 b/d), China (-310,000 b/d) and Nigeria (-280,000 b/d).
- Refinery throughput growth slowed from 1.8 Mb/d in 2015 to 0.6 Mb/d last year. Refining capacity grew by only 440,000 b/d, versus 10-year average growth of 1 Mb/d, causing refinery utilization to rise.

### Natural gas

- World natural gas consumption grew by 63 billion cubic metres (bcm) or 1.5%, slower than the 10-year average of 2.3%.
- EU gas consumption rose sharply by 30 bcm, or 7.1% – the fastest growth since 2010. Russia saw the largest drop in consumption of any country (-12 bcm).
- Global natural gas production increased by only 21 bcm, or 0.3%. Declining production in North America (-21 bcm) partially offset strong growth from Australia (19 bcm) and Iran (13 bcm).
- Gas trade grew by 4.8%, helped by 6.2% growth in LNG imports/exports.
- Most of the net growth in LNG exports came from Australia (19 bcm out of 21). US LNG exports rose from 0.7 bcm in 2015 to 4.4 bcm in 2016.

### Coal

- Global coal consumption fell by 53 million tonnes of oil equivalent (mtoe), or 1.7%, the second successive annual decline.
- The largest declines in coal consumption were seen in the US (-33 mtoe, an 8.8% fall) and China (-26 mtoe, -1.6%). Coal consumption in the UK more than halved (down 52.5%, or 12 mtoe) to its lowest level in our records.
- Coal's share of global primary energy consumption fell to 28.1%, the lowest share since 2004.
- World coal production fell by 6.2%, or 231 mtoe, the largest decline on record. China's production fell by 7.9% or 140 mtoe, also a record decline. US production fell by 19% or 85 mtoe.

### Renewables, hydro & nuclear energy

- Renewable power (excluding hydro) grew by 14.1% in 2016, below the 10-year average, but the largest increment on record (53 mtoe).
- Wind provided more than half of renewables growth, while solar energy contributed almost a third despite accounting for only 18% of the total.
- Asia Pacific overtook Europe & Eurasia as the largest producing region of renewable power. China overtook the US to be the largest single renewables producer.
- Global nuclear power generation increased by 1.3% in 2016, or 9.3 mtoe. China accounted for all of the net growth, expanding by 24.5%. China's increment (9.6 mtoe) was the largest of any country since 2004.
- Hydroelectric power generation rose by 2.8% in 2016, (27.1 mtoe). China (10.9 mtoe) and the US (3.5 mtoe) provided the largest increments. Venezuela experienced the largest decline (-3.2 mtoe).

**+1.0%**

Growth of global primary energy consumption, well below the 10-year average of 1.8%.

# Group chief economist's analysis

## Energy in 2016: short-run adjustments and long-run transition.

Stability and energy markets don't go together – booms and busts; rebounds and reversals are the norm.

But the movements and volatility seen last year were particularly interesting since energy markets were buffeted by two separate forces: the continued adjustment to the short-run cyclical shocks that have rocked energy markets in recent years, particularly the oil market; and the growing gravitational pull of the longer-run energy transition that is under way.

In recent years the nature of the cyclical adjustments has been increasingly affected by the longer-run transition that is shaping global energy markets. On the demand side: the shift in the centre of gravity to fast-growing developing economies, led by China and India; together with a slowing in overall energy growth as it is used ever more efficiently. And on the supply side, the secular movement towards cleaner, lower carbon energy sources, led by renewable energy, driven by technological advances and environmental needs.

2016 was a year of both short-run adjustments and long-run transition, and this year's Statistical Review shines a light on both influences.

+1.3%

Growth of primary energy consumption in China, a quarter of its 10-year average.

### Key features of 2016

Primary energy grew by just 1% (171 mtoe) in 2016, almost half the average rate seen over the previous 10 years.

Some of this weakness reflected short-run factors: global GDP grew by just 3% last year, its slowest rate since 2002 – other than at the time of the financial crisis – driven in part by a slowdown in industrial production, the most energy-intensive sector of the economy.

But the weakness is also indicative of the longer-run trend towards slower energy growth driven by gains in energy efficiency.

This is the third consecutive year in which energy consumption has grown by 1% or less, with energy intensity – the average amount of energy needed to produce a unit of GDP – falling at historically unprecedented rates.

Growth in energy consumption was again driven by the developing economies. China (1.3%, 47 mtoe) and India (5.4%, 39 mtoe) led the way, contributing almost identical increments, and together accounting for around half of the increase in global demand.

But these similar contributions disguise sharply contrasting trends. India's energy consumption grew at a similar rate to the recent past, underpinned by solid economic growth. In contrast, China's energy consumption grew at less than a quarter of the rate seen over the previous 10 years.

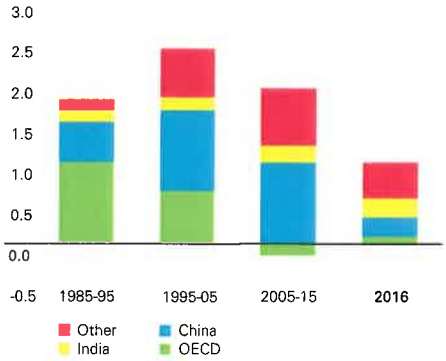
This brake in China's energy consumption partly reflects the gradual slowing in economic growth, but it has been greatly compounded by pronounced weakness in China's most energy-intensive sectors, particularly iron, steel and cement, which together account for around a quarter of China's total energy consumption.

Some of the weakness in these sectors, which drove China's rapid growth and industrialization over much of the past 15 years, reflects the structural rebalancing of the economy towards more consumer and service facing sectors.

But the scale of the slowdown – with output in iron, steel and cement below 2014 levels – suggests that some bounce-back is perhaps likely.

**Energy consumption growth**

Contributions to annual growth, %




Short-run adjustments and long-run transition.

The story in terms of individual fuels also reflects a mix of these two forces.

Renewable energy (including biofuels) (12%, 55 mtoe) was again the fastest growing energy source, accounting for almost a third of the increase in primary energy, despite having a share of only 4%. That said, oil (1.5%, 75 mtoe) actually provided the largest contribution to growth, with the low level of oil prices boosting demand.

Natural gas (1.5%, 57 mtoe) grew at the same rate as oil, although for gas this was considerably slower than its 10-year average.

Perhaps the most striking feature across the different fuels was the continuing rapid descent of coal, with consumption (-1.7%, -53 mtoe) falling sharply for the second consecutive year and the share of coal within primary energy declining to its lowest level since 2004.

The turnaround in the fortunes of coal over the past few years is stark: it is only four years ago that coal was the largest source of energy demand growth. There may be further ups and downs in the fortunes of coal over coming years, but the weakness in recent years does seem to signal a fairly decisive break from the past.

The Beijing central business district is the primary area of finance, media, and business services in Beijing, China.

## Oil

Two years ago, 2015 was a year of thwarted adjustment for oil: strong growth in OPEC production outweighed the responses of both demand and non-OPEC production to lower prices.

In contrast, 2016 was a year of adjustment for the oil market, with oil demand again increasing robustly and production growing by less than a quarter (0.4 Mb/d) of that seen in 2015.

Global oil demand grew by 1.6 Mb/d last year. As in 2015, this strength was almost entirely due to oil importers, with both India (0.3 Mb/d) and Europe (0.3 Mb/d) posting unusually strong increases. Although, growth in China (0.4 Mb/d) and the US (0.1 Mb/d) was more subdued.

As in 2015, the strength in oil demand was most pronounced in consumer-led fuels, such as gasoline, buoyed by low prices. In contrast, diesel demand, which was more exposed to the industrial slowdown, including in the US and China, declined for the first time since 2009.

The weakness on the supply side was driven by non-OPEC production which fell by 0.8 Mb/d, its largest decline for almost 25 years. This fall was led by US tight oil, whose production fell 0.3 Mb/d, a swing of almost 1 Mb/d relative to growth in 2015. China also experienced its largest ever decline in oil production (-0.3 Mb/d).

In contrast, OPEC production recorded another year of solid growth (1.2 Mb/d), with Iran (0.7 Mb/d), Iraq (0.4 Mb/d) and Saudi Arabia (0.4 Mb/d) more than accounting for the increase. Iran's production and its share of OPEC output are now both back around pre-sanction levels.

The combination of strong demand and weak supply was sufficient to move the oil market broadly back into balance by the middle of the year.

But this was not before inventories had increased even further from their already excessive levels, such that the level of OECD inventories by the end of 2016 was around 300 Mbbls above their five-year average.

The drama and intrigue that has characterized oil markets since the price collapse in 2014 have been dominated by two principal actors: US tight oil and OPEC. What have we learnt about the behaviour of both during this cycle?

Consider first US tight oil, which didn't exist during the last oil price cycle, and so we are learning about it in real time.

Perhaps the most important thing is that there is no such thing as the behaviour of 'US tight oil': the Permian is very different to Eagle Ford which is different to Bakken. So beware generalizations.

Notwithstanding that, the short-cycle nature of fracking meant activity related to US tight oil did respond far more quickly to price signals than conventional oil and, in so doing, dampened price volatility. Rigs started to fall around four to six months after oil prices peaked in June 2014 and picked up even more quickly – within three or four months – once prices started to turn at the beginning of last year.

And this lower activity fed through into slower output growth. In the first half of 2015 – so less than a year after the peak in oil prices – tight oil production grew by just 0.1 Mb/d, compared with over 0.5 Mb/d in the same period a year earlier – a swing in annualized terms of 0.8 Mb/d. Similarly, US tight oil has grown solidly in the first half of this year, following the trough in prices in the spring of 2016.

The final point to note about US tight oil is that productivity continued to rise rapidly through the cycle, with new well production per rig increasing by around 40% per year in both 2015 and 2016. Despite rigs in the Permian falling by over 75%, output continued to grow. Put differently, a rig operating in the Permian today is equivalent to more than three rigs at the end of 2014.

So that is the backstory on one of the principal actors, what about the other: OPEC?

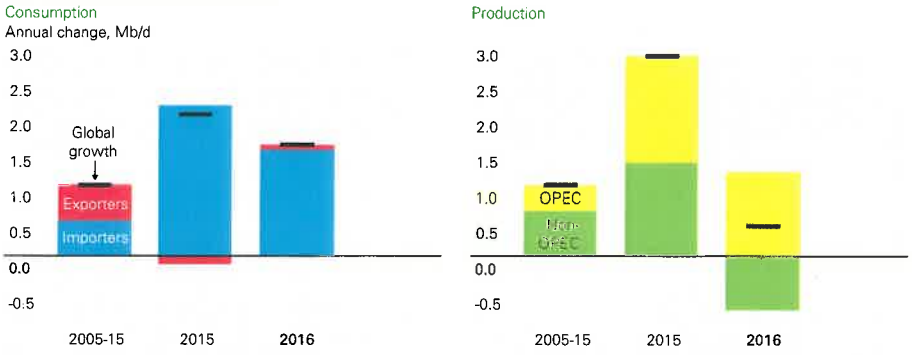
As with many great characters in literature, OPEC took some decisive actions which caught many observers by surprise and dramatically changed the course of events. First, by not cutting production in November 2014, triggering a collapse in prices, and then last November agreeing, along with 10 non-OPEC producers, to a production cut totalling 1.8 Mb/d.

How should we think about these actions?

For me, the clearest explanation of these actions was given by HE Khalid Al-Falih, the Saudi Arabian minister for energy, industry and mineral resources at CERAWeek in March. To quote minister Al-Falih:

"OPEC remains an important catalyst to the stability and sustainability of the market…. but history has also demonstrated that intervention in response to structural shifts is largely ineffective… that's why Saudi Arabia does not support OPEC intervening to alleviate the impacts of long-term structural imbalances, as opposed to addressing short-term aberrations…."

**Oil market in 2015 and 2016**




-0.8 Mb/d

Decline in non-OPEC oil production.

On board BP's Thunder Horse platform in the Gulf of Mexico, USA.

To unpack this a bit: OPEC's power stems from its ability to shift oil production from one period to another. As such, it has the ability to smooth through the effects of temporary shocks to the oil market, lowering or raising production until the shock subsides.

But its ability to respond to permanent shocks is far more limited: shifting supply from one period to another makes little difference if the underlying shock persists. Consider, for example, the unsuccessful attempts by OPEC to support the oil market in the first half of the 1980s as new structural sources of production from the North Sea and Alaska came onstream.

The underlying source of the supply imbalance that emerged in 2014 was the growth of US tight oil. To use the Minister's words, this was not a short-term aberration; it was the emergence of a new source of intra-marginal supply.

In contrast, the focus now is on increasing the pace at which the huge overhang of oil stocks is drawn down to more normal levels. This is exactly the type of temporary adjustment in which OPEC intervention can be effective – reducing supply until stocks have adjusted.

So perhaps like all the best stories, the actions of the main characters make perfect sense when seen in the right context. OPEC remains a central force, able to manage and stabilize the oil market, but the nature of that power means it is effective for short-term aberrations, not structural shifts.

Finally for oil, what has all this meant for prices?

The persistent supply imbalance and growing inventory levels caused prices to fall towards the end of 2015 and into 2016. Prices stabilized through the middle of the year as the market moved into balance and inventories levelled off, before firming somewhat towards the end of the year in the wake of the OPEC/non-OPEC agreement. Dated Brent averaged $44 per barrel in 2016, down from $52 in 2015, its lowest (nominal) average since 2004. So far, this year, prices have averaged about $53 as the OPEC cuts have started to take effect, albeit partially offset by the strong recovery in US tight oil.

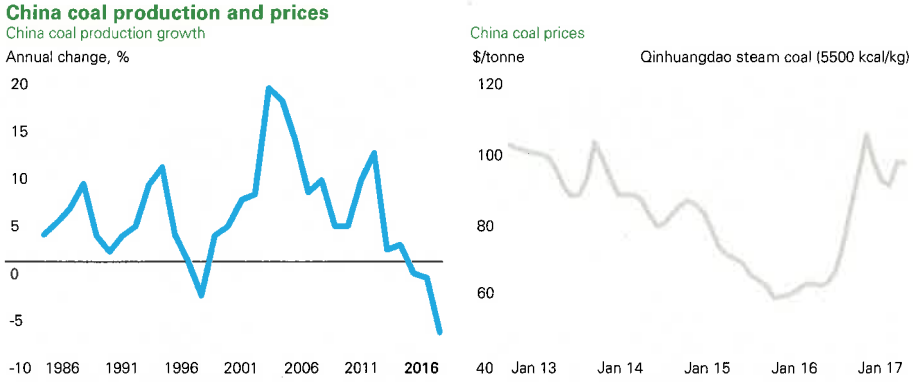
## Refining

Back in 2015, refiners responded to near-record high margins by increasing refinery throughput by 1.8 Mb/d, triple its 10-year average.

That led to a build-up of product inventories that dampened margins in 2016, causing refineries to reduce the growth in crude runs to just 0.6 Mb/d.

After strong growth in 2015, European refiners reduced runs by 0.2 Mb/d, while runs in Mexico, Venezuela and Brazil fell by a combined 0.4 Mb/d due to multiple refinery shutdowns.

**China coal production and prices**




Refining capacity expanded by just 0.4 Mb/d, less than half its 10-year average. This was the second successive year of weak growth in refining capacity, much of which can be attributed to actions by China to limit the build-up of domestic spare refining capacity.

## Coal

The fortunes of coal appear to have taken a decisive break from the past. This shift largely reflects structural factors: the increasing availability and competitiveness of natural gas and renewables, combined with government and societal pressure to shift towards cleaner, lower carbon fuels.

These long-term forces in turn have given rise to near-term tensions and dynamics. This was particularly the case in China, which at the beginning of the year introduced a series of measures to reduce the scale of excess capacity in the domestic coal sector and improve the productivity and profitability of the remaining mines.

These measures were focused on reducing capacity amongst the smallest, least productive mines and encouraging greater consolidation. In addition, the government further constrained production by restricting coal mines to operate for a maximum of 276 days, down from 330 days. The impact of these measures was dramatic: domestic coal production fell sharply and prices jumped sharply higher. For 2016 as a whole, Chinese coal production fell by 7.9% (-140 mtoe), by far the largest decline on record, and through the year the price of steam coal increased by over 60%. Coal consumption also declined (-1.6%, -26 mtoe) for the third consecutive year, although by less than production, with China resuming its position as the world's largest importer of coal.

The events in China spilled over into global coal markets, with world prices taking their cue from China. This rise in global coal prices further depressed global coal demand, particularly in power sector around the globe, with natural gas and renewable energy the main beneficiaries. Global coal consumption fell by 53 mtoe (-1.7%) and global production by a whopping 231 mtoe (-6.2%), with US production registering a second consecutive substantial fall (-19.0%, -85 mtoe).

A particularly striking example of this long-run movement away from coal was here in the UK, where the hike in global coal prices was amplified by the increase in the UK's Carbon Price Floor in 2015. As a result, the UK's relationship with coal almost completed an entire cycle: with the UK's last three underground coal mines closing,

Surface coal mine in England.

**$44/bbl**

Price of Dated Brent crude oil.

consumption falling back to where it was roughly 200 years ago around the time of the industrial revolution, and the UK power sector recording its first-ever coal-free day in April of this year.

## Natural gas

Global consumption increased by 1.5% (63 bcm), quite a bit weaker than its 10-year average (2.3%); while global gas production was essentially flat (0.3%, 21 bcm), the weakest growth in gas output for 34 years, other than in the immediate aftermath of the financial crisis.

This sub-par growth went hand-in-hand with falling gas prices – Henry Hub prices were 5% lower than in 2015, European and Asian gas markers were down 20-30% as prices continued to adjust to increased LNG supplies.

Much of the lacklustre performance can be traced back to the US, particularly on the supply side where falls in gas (and oil) prices caused US gas production (-17 bcm, -2.5%) to fall for the first time since the US shale gas revolution started in earnest in the mid-2000s.

Outside of the US, on the demand side, gas consumption in Europe rose strongly (6%, 28 bcm) helped by both the increasing competitiveness of gas relative to coal and weakness in European nuclear and renewable energy.

The Middle East (3.5%, 19 bcm) and China (16 bcm, 7.7%) both also recorded strong increases aided by improving infrastructure and availability of gas. The largest falls were in Russia (-12 bcm, -3.2%) and Brazil (-5 bcm, -12.5%) both of which benefited from strong increases in hydropower.

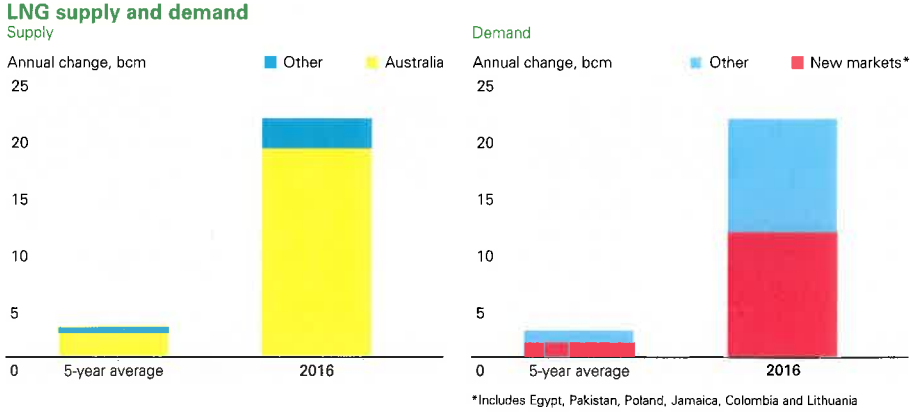
On the supply side, Australian production (19 bcm, 25.2%) was the standout performer as several new LNG facilities came onstream.

Looking at the growing market for LNG, although China continued to provide the main source of growth, it's striking that the increasing availability of supplies has prompted a number of new countries, including Egypt, Pakistan and Poland, to enter the market in the last year or two. These new entrants were helped by the increased flexibility afforded by plentiful supplies of FSRUs (floating storage and regasification units).

2016 was the first year of the growth spurt we expect to see in LNG, with global supplies set to increase by around a further 30% by 2020. That is equivalent to a new LNG train coming onstream every two-to-three months for the next four years – quite astonishing growth.

As the importance of LNG trade grows, global gas markets are likely to evolve quite materially.

**LNG supply and demand**




*Includes Egypt, Pakistan, Poland, Jamaica, Colombia and Lithuania

Alongside increasing market integration, we are likely to see a shift towards a more flexible style of trading, supported by a deeper, more competitive market structure. Indeed, this shift is already apparent, with a move towards smaller and shorter contracts and an increase in the proportion of LNG trade which is not contracted and is freely traded.

A particularly interesting market in the context of the growing LNG supplies is Europe.

On the one hand, Europe's large and increasing need for imported gas, combined with its relatively central location amongst several major LNG suppliers, means Europe is often highlighted as a natural growth market for LNG. On the other hand, Europe's access to plentiful supplies of pipeline gas, particularly from Russia, means LNG imports are likely to face stiff competition.

In terms of this battle of competing supplies, Round 1 went to pipeline gas.

Europe's gas imports increased markedly last year, reflecting the strong increase in demand, together with weakness in the domestic production of natural gas. But virtually the entire rise in European imports was met by pipeline gas, from a combination of Algerian and Russian supplies, with imports of LNG barely increasing.

The economic incentives in this battle of competing supplies are clear: just as with OPEC's response to the emergence of US tight oil, Russia has a strong incentive to compete to maintain its market share in the face of growing competition from LNG supplies.

But this competitive process is complicated by possible concerns about Europe being overly dependent on a single source of supply and the energy security issues this might raise. The interesting question is whether the growth of global LNG trade, by fostering a more globally-integrated gas market, with the optionality of being able to turn to LNG should the need arise, might mitigate those concerns.

Europe doesn't need to consume large amounts of LNG imports in 'normal' times, but it has the option of doing so if the need arises.

## Non-fossil fuels

The leading light of the energy transition is, of course, renewable power which continued to grow rapidly last year, led by wind (15.6%, 131 TWh) and solar (29.6%,77 TWh). Although the share of renewable power within primary energy edged up only slightly to 3.2%, its strong growth meant it accounted for over 30% of the increase in primary energy.

The Trans-Anatolian Natural Gas Pipeline in Turkey, a central part of the Southern Gas Corridor pipeline system.

**25.2%**

Increase in Australian natural gas production as new LNG facilities came onstream.

China continued to dominate renewables growth, contributing over 40% of global growth – more than the entire OECD – and surpassing the US to become the largest producer of renewable power.

One noticeable weak spot last year was the EU, where renewable power barely grew as load factors fell back from unusually high levels in 2015. This is a reminder of the variability that weather conditions can inject into renewable generation from year to year. For example, the decline in Denmark's wind power last year was almost 5% of its total power generation.

Although wind continued to provide the lion's share of the increase in renewable power, solar is catching up fast.

The right-hand chart considers the 67 countries that are separately tracked in the Statistical Review and records the share of those countries that, in any given year, produced a material amount of different energies. It took around 20 years for the share of countries producing a sizeable amount of wind power to increase from 15% to 75%; solar achieved the same degree of diffusion in less than half that time. In sharp contrast, nuclear energy plateaued at less than half the number of countries.

These different rates of diffusion reflect the different characteristics of the technologies: the more modular nature of solar power, together with its steeper learning curve has allowed it to spread more quickly.

Moreover, the fact that the transfer of wind and solar technology is not subject to onerous security restrictions has helped their rapid diffusion relative to nuclear power.

In terms of other non-fossil fuels: China provided the main source of world growth for both hydro (2.8%, 120 TWh) and nuclear (1.3%, 41 TWh) power. Growth in China's hydro power has slowed sharply in recent years from the rapid rates of expansion that characterized the first part of the 2000s. In contrast, China's nuclear programme is just beginning to ramp up: it brought on five new reactors last year – the largest ever annual increase in China's nuclear history – and has more than 20 reactors currently under construction.

## Carbon emissions

Turning finally to carbon emissions. The good news is that carbon emissions were essentially flat in 2016. This is the third consecutive year in which we have seen little or no growth in carbon emissions – in sharp contrast to the 10 years before that, in which emissions grew by almost 2.5% per year. Some of this slowdown reflects weaker GDP growth, but the majority reflects faster declines in the carbon intensity of GDP – the average amount of carbon emitted per unit of GDP – driven by accelerating improvements in both energy efficiency and the fuel mix.

The key question this raises is whether the experience of the past three years signals a decisive break from the past and a significant step towards the goals of Paris or was it largely driven by cyclical factors which are likely to unwind over time?

Long-run transition or short-run adjustment?

Looking at the factors driving this improvement, the key difference is China. China's carbon emissions are estimated to have actually fallen over the past two years, after growing by more than 75% in the previous 10 years.

As mentioned earlier in the context of the slowdown in China's energy consumption, there are good reasons for thinking that some of this improvement in China's carbon emissions reflects structural factors that are likely to persist: slower economic growth; a shift in the composition of growth towards less energy-intensive sectors, and a movement away from coal. But some probably reflects cyclical factors, particularly the contractions in some of China's most energy-intensive sectors, which are unlikely to keep being repeated and may well unwind in future years.

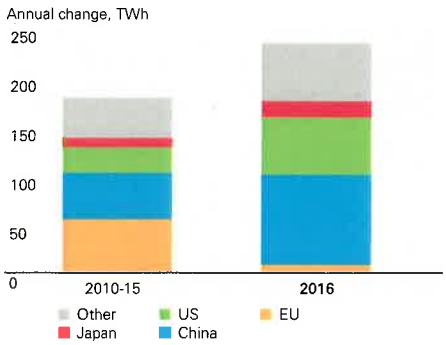
The juxtaposition of short-run adjustments and long-run transition is likely to be a feature of energy markets for many years to come.

**Spencer Dale**
Group chief economist
June 2017

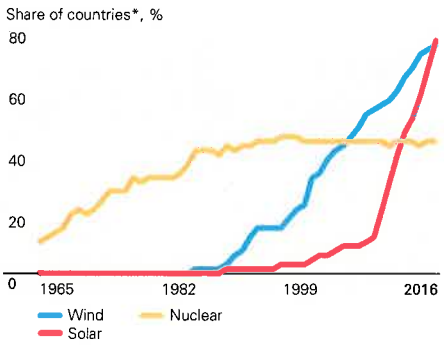
This is a shortened version of the presentation given at the launch of BP's Statistical Review of World Energy in London on 13 June 2017.

**Growth and diffusion of renewables**

Growth by country




Diffusion of power technologies




*The proportion of the 67 countries that are individually listed in the Statistical Review with power generation of at least 50 GWh from the specified technology.

Aerial view of a field of solar panels in Italy.

## In detail

Additional information – including historical time series for the fuels reported in this review; further detail on renewable forms of energy; oil consumption by product – together with the full version of Spencer Dale's presentation is available at *bp.com/statisticalreview*

**Acknowledgements**
We would like to express our sincere gratitude to the many contacts worldwide who provide the publicly available data for this publication, and to the researchers at the Centre for Energy Economics Research and Policy, Heriot-Watt University who assist in the data compilation.

# 1 Primary energy

## Consumption*

| Million tonnes oil equivalent | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Growth rate per annum 2016 | Growth rate per annum 2005-15 | Share 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| US | 2331.6 | 2370.2 | 2318.8 | 2205.1 | 2284.1 | 2264.5 | 2209.3 | 2270.6 | 2296.5 | 2275.9 | **2272.7** | -0.4% | -0.3% | 17.1% |
| Canada | 319.5 | 325.4 | 326.0 | 310.5 | 315.5 | 327.6 | 326.5 | 336.1 | 334.3 | 327.7 | **329.7** | 0.3% | 0.2% | 2.5% |
| Mexico | 172.9 | 170.8 | 174.3 | 174.1 | 178.3 | 186.5 | 188.5 | 189.1 | 190.4 | 188.8 | **186.5** | -1.5% | 1.2% | 1.4% |
| Total North America | 2824.1 | 2866.5 | 2819.2 | 2689.7 | 2777.8 | 2778.6 | 2724.3 | 2795.9 | 2821.2 | 2792.4 | **2788.9** | -0.4% | -0.2% | 21.0% |
| Argentina | 72.5 | 75.6 | 76.8 | 74.8 | 79.7 | 81.4 | 83.4 | 86.5 | 86.7 | 88.7 | **88.9** | -0.1% | 2.5% | 0.7% |
| Brazil | 216.8 | 231.8 | 243.9 | 243.0 | 267.6 | 279.7 | 284.8 | 296.8 | 304.9 | 302.6 | **297.8** | -1.8% | 3.7% | 2.2% |
| Chile | 30.6 | 31.5 | 31.2 | 30.9 | 30.4 | 33.7 | 34.1 | 34.4 | 35.4 | 35.9 | **36.8** | 2.0% | 2.4% | 0.3% |
| Colombia | 30.7 | 30.8 | 34.0 | 32.0 | 34.2 | 35.7 | 38.4 | 38.2 | 40.3 | 41.0 | **41.1** | ◆ | 4.2% | 0.3% |
| Ecuador | 10.3 | 11.0 | 11.7 | 11.5 | 12.7 | 13.5 | 14.3 | 14.7 | 15.5 | 15.5 | **15.3** | -1.3% | 4.7% | 0.1% |
| Peru | 13.8 | 15.1 | 16.4 | 16.7 | 18.5 | 20.3 | 21.2 | 21.7 | 22.4 | 23.7 | **25.3** | 6.3% | 5.7% | 0.2% |
| Trinidad & Tobago | 20.9 | 21.8 | 21.4 | 22.1 | 23.1 | 23.1 | 22.0 | 22.4 | 21.9 | 21.6 | **19.4** | -10.7% | 2.8% | 0.1% |
| Venezuela | 78.5 | 81.2 | 84.4 | 82.9 | 80.7 | 80.3 | 84.1 | 83.3 | 78.1 | 78.8 | **74.6** | -5.5% | 1.1% | 0.6% |
| Other S. & Cent. America | 93.8 | 95.1 | 93.4 | 92.2 | 94.8 | 97.8 | 98.7 | 98.7 | 98.9 | 102.6 | **106.2** | 3.3% | 1.2% | 0.8% |
| Total S. & Cent. America | 567.8 | 593.9 | 613.2 | 606.0 | 641.7 | 665.4 | 680.9 | 696.7 | 704.1 | 710.4 | **705.3** | -1.0% | 2.8% | 5.3% |
| Austria | 35.8 | 35.0 | 35.7 | 34.6 | 35.9 | 33.8 | 35.4 | 35.1 | 33.8 | 33.9 | **35.1** | 3.3% | -0.6% | 0.3% |
| Azerbaijan | 13.6 | 12.3 | 12.3 | 10.9 | 10.7 | 11.9 | 12.3 | 12.6 | 13.2 | 14.5 | **14.5** | -0.4% | 0.5% | 0.1% |
| Belarus | 26.3 | 25.7 | 25.9 | 24.4 | 25.9 | 25.9 | 27.9 | 24.7 | 25.5 | 22.4 | **23.7** | 5.4% | -1.0% | 0.2% |
| Belgium | 65.0 | 65.6 | 66.6 | 61.7 | 65.8 | 61.0 | 58.7 | 60.0 | 55.8 | 56.9 | **61.7** | 8.1% | -1.3% | 0.5% |
| Bulgaria | 20.1 | 19.6 | 19.5 | 17.1 | 17.8 | 19.1 | 18.1 | 16.7 | 17.9 | 19.0 | **18.1** | -5.2% | -0.3% | 0.1% |
| Czech Republic | 45.1 | 44.9 | 43.6 | 41.2 | 43.2 | 42.4 | 41.9 | 41.8 | 40.2 | 40.2 | **39.9** | -1.0% | -0.9% | 0.3% |
| Denmark | 21.6 | 20.5 | 19.8 | 18.5 | 19.5 | 18.4 | 17.1 | 17.9 | 17.4 | 16.9 | **17.1** | 1.1% | -1.5% | 0.1% |
| Finland | 32.2 | 32.2 | 31.1 | 28.9 | 31.6 | 29.1 | 28.1 | 27.7 | 26.7 | 26.7 | **27.1** | 1.4% | -1.2% | 0.2% |
| France | 261.2 | 257.5 | 259.1 | 245.4 | 253.4 | 244.7 | 244.8 | 247.2 | 237.6 | 239.4 | **235.9** | -1.7% | -0.9% | 1.8% |
| Germany | 341.3 | 327.2 | 330.7 | 310.2 | 323.6 | 312.1 | 316.4 | 325.5 | 312.1 | 317.8 | **322.5** | 1.2% | -0.4% | 2.4% |
| Greece | 34.3 | 34.6 | 33.5 | 32.7 | 31.5 | 30.7 | 29.3 | 27.9 | 26.3 | 26.4 | **25.9** | -2.2% | -2.2% | 0.2% |
| Hungary | 25.7 | 25.3 | 25.0 | 22.9 | 23.5 | 22.6 | 21.1 | 20.1 | 20.0 | 21.2 | **21.9** | 3.2% | -2.0% | 0.2% |
| Ireland | 16.2 | 16.7 | 16.6 | 15.2 | 15.2 | 14.1 | 14.0 | 13.7 | 13.7 | 14.5 | **15.2** | 4.1% | -0.9% | 0.1% |
| Italy | 184.9 | 181.0 | 179.2 | 167.1 | 172.2 | 168.5 | 162.2 | 155.7 | 146.9 | 149.9 | **151.3** | 0.7% | -2.1% | 1.1% |
| Kazakhstan | 47.4 | 52.7 | 55.0 | 49.2 | 53.1 | 58.6 | 59.4 | 60.2 | 66.4 | 62.7 | **63.0** | 0.3% | 3.5% | 0.5% |
| Lithuania | 7.6 | 8.3 | 8.2 | 7.6 | 5.6 | 5.8 | 5.8 | 5.4 | 5.2 | 5.4 | **5.5** | 0.9% | -3.7% | ◆ |
| Netherlands | 95.3 | 95.0 | 92.9 | 91.8 | 96.1 | 91.5 | 88.1 | 85.9 | 80.9 | 82.1 | **84.5** | 2.6% | -1.6% | 0.6% |
| Norway | 42.3 | 45.7 | 46.7 | 43.6 | 41.9 | 43.0 | 47.8 | 45.0 | 46.4 | 47.2 | **48.6** | 2.7% | 0.3% | 0.4% |
| Poland | 94.1 | 93.7 | 95.4 | 92.0 | 98.2 | 98.7 | 95.7 | 96.0 | 92.4 | 93.4 | **96.7** | 3.2% | 0.3% | 0.7% |
| Portugal | 25.1 | 25.2 | 24.2 | 24.4 | 25.6 | 24.5 | 22.4 | 24.5 | 24.6 | 24.6 | **26.0** | 5.5% | -0.3% | 0.2% |
| Romania | 39.6 | 38.6 | 39.0 | 33.5 | 33.8 | 34.7 | 34.0 | 31.5 | 32.5 | 32.6 | **33.1** | 1.2% | -1.8% | 0.2% |
| Russian Federation | 676.1 | 680.5 | 683.5 | 648.0 | 673.3 | 694.9 | 695.2 | 686.8 | 689.2 | 681.7 | **673.9** | -1.4% | 0.5% | 5.1% |
| Slovakia | 18.4 | 17.3 | 17.9 | 16.3 | 17.4 | 16.8 | 16.2 | 16.8 | 15.5 | 15.7 | **15.9** | 1.4% | -1.9% | 0.1% |
| Spain | 154.1 | 158.0 | 153.7 | 142.8 | 146.2 | 143.1 | 142.4 | 134.2 | 132.2 | 134.4 | **135.0** | 0.2% | -1.2% | 1.0% |
| Sweden | 52.0 | 53.1 | 52.8 | 48.1 | 51.8 | 51.3 | 54.5 | 51.3 | 51.4 | 52.9 | **52.2** | -1.7% | -0.5% | 0.4% |
| Switzerland | 28.7 | 28.4 | 29.4 | 29.4 | 28.7 | 27.2 | 28.8 | 29.7 | 28.5 | 27.9 | **26.4** | -5.5% | 0.2% | 0.2% |
| Turkey | 95.8 | 102.8 | 103.3 | 104.3 | 111.0 | 114.9 | 120.1 | 118.5 | 122.6 | 131.9 | **137.9** | 4.2% | 4.4% | 1.0% |
| Turkmenistan | 21.4 | 24.2 | 24.5 | 22.7 | 25.9 | 27.0 | 29.7 | 26.8 | 29.5 | 33.1 | **33.2** | 0.2% | 5.4% | 0.3% |
| Ukraine | 137.7 | 134.4 | 132.9 | 112.9 | 121.0 | 125.7 | 122.6 | 114.7 | 101.2 | 83.9 | **87.0** | 3.4% | -4.7% | 0.7% |
| United Kingdom | 226.3 | 219.7 | 216.4 | 205.2 | 210.5 | 198.8 | 202.1 | 200.9 | 188.6 | 190.9 | **188.1** | -1.7% | -1.8% | 1.4% |
| Uzbekistan | 45.7 | 48.4 | 52.0 | 43.3 | 43.8 | 49.7 | 49.2 | 48.7 | 50.5 | 51.7 | **52.7** | 1.5% | 1.1% | 0.4% |
| Other Europe & Eurasia | 92.8 | 93.8 | 95.6 | 93.7 | 99.0 | 97.3 | 95.0 | 97.0 | 93.6 | 94.8 | **97.6** | 2.6% | 0.6% | 0.7% |
| Total Europe & Eurasia | 3023.5 | 3017.7 | 3022.2 | 2839.8 | 2952.6 | 2937.9 | 2936.3 | 2900.6 | 2838.3 | 2846.6 | **2867.1** | 0.4% | -0.4% | 21.6% |
| Iran | 194.2 | 208.2 | 215.9 | 223.5 | 224.6 | 234.6 | 235.2 | 246.0 | 261.9 | 262.8 | **270.7** | 2.7% | 4.0% | 2.0% |
| Israel | 21.7 | 22.8 | 23.3 | 22.3 | 23.8 | 24.3 | 25.2 | 25.2 | 24.5 | 26.0 | **26.4** | 1.5% | 1.9% | 0.2% |
| Kuwait | 28.9 | 28.8 | 30.5 | 31.6 | 34.0 | 35.4 | 41.0 | 39.5 | 37.6 | 41.5 | **41.7** | 0.3% | 3.1% | 0.3% |
| Qatar | 21.9 | 26.4 | 23.6 | 24.8 | 33.3 | 25.7 | 29.3 | 43.4 | 42.5 | 50.2 | **49.2** | -2.3% | 9.5% | 0.4% |
| Saudi Arabia | 164.5 | 171.4 | 186.9 | 196.5 | 216.1 | 222.2 | 235.7 | 237.4 | 252.1 | 260.8 | **266.5** | 1.9% | 5.1% | 2.0% |
| United Arab Emirates | 66.2 | 73.1 | 84.0 | 82.6 | 86.2 | 91.5 | 95.8 | 97.2 | 99.5 | 108.6 | **113.8** | 4.5% | 5.6% | 0.9% |
| Other Middle East | 94.8 | 94.8 | 103.5 | 109.0 | 116.2 | 116.6 | 118.7 | 123.6 | 121.9 | 124.7 | **126.8** | 1.4% | 2.9% | 1.0% |
| Total Middle East | 592.2 | 625.6 | 667.6 | 690.3 | 734.2 | 750.3 | 780.8 | 812.4 | 840.0 | 874.6 | **895.1** | 2.1% | 4.5% | 6.7% |
| Algeria | 33.8 | 35.6 | 37.7 | 39.9 | 38.9 | 41.3 | 45.1 | 47.8 | 51.6 | 55.1 | **55.1** | -0.3% | 5.4% | 0.4% |
| Egypt | 65.4 | 69.6 | 73.6 | 76.5 | 80.7 | 82.1 | 86.5 | 85.7 | 85.4 | 86.7 | **91.0** | 4.7% | 3.4% | 0.7% |
| South Africa | 113.2 | 115.4 | 124.4 | 124.3 | 125.3 | 123.6 | 121.9 | 123.6 | 125.2 | 120.1 | **122.3** | 1.5% | 0.8% | 0.9% |
| Other Africa | 122.3 | 127.4 | 133.8 | 132.7 | 144.1 | 141.1 | 149.3 | 158.3 | 165.6 | 171.7 | **171.8** | -0.2% | 3.5% | 1.3% |
| Total Africa | 334.8 | 347.9 | 369.5 | 373.4 | 388.9 | 388.0 | 402.9 | 415.4 | 427.9 | 433.5 | **440.1** | 1.2% | 2.8% | 3.3% |
| Australia | 123.4 | 125.1 | 127.4 | 127.4 | 126.1 | 131.7 | 130.3 | 131.2 | 132.6 | 138.5 | **138.0** | -0.6% | 1.8% | 1.0% |
| Bangladesh | 18.0 | 18.8 | 19.9 | 21.9 | 22.9 | 24.3 | 26.5 | 27.0 | 28.2 | 31.3 | **32.4** | 3.2% | 6.3% | 0.2% |
| China | 1974.7 | 2147.8 | 2229.0 | 2328.1 | 2491.1 | 2690.3 | 2797.4 | 2905.3 | 2970.6 | 3005.9 | **3053.0** | 1.3% | 5.3% | 23.0% |
| China Hong Kong SAR | 24.7 | 26.3 | 24.6 | 26.8 | 27.5 | 28.1 | 27.0 | 27.8 | 27.1 | 27.9 | **28.6** | 2.3% | 1.8% | 0.2% |
| India | 414.0 | 450.2 | 475.7 | 513.2 | 537.1 | 568.7 | 598.3 | 621.5 | 663.6 | 685.1 | **723.9** | 5.4% | 5.7% | 5.5% |
| Indonesia | 123.9 | 132.9 | 131.3 | 136.0 | 149.3 | 162.8 | 170.5 | 174.2 | 162.9 | 164.8 | **175.0** | 5.9% | 3.0% | 1.3% |
| Japan | 520.4 | 516.0 | 509.3 | 467.2 | 496.0 | 470.4 | 467.7 | 464.0 | 452.3 | 445.8 | **445.3** | -0.4% | -1.6% | 3.4% |
| Malaysia | 69.4 | 72.9 | 76.3 | 73.6 | 72.4 | 79.8 | 83.2 | 89.2 | 91.5 | 93.8 | **99.5** | 5.7% | 3.3% | 0.7% |
| New Zealand | 19.0 | 19.0 | 19.2 | 19.1 | 19.7 | 19.6 | 19.7 | 19.9 | 20.9 | 21.0 | **21.4** | 1.8% | 1.1% | 0.2% |
| Pakistan | 64.9 | 68.7 | 69.2 | 70.1 | 70.5 | 70.6 | 71.4 | 71.7 | 73.5 | 77.1 | **83.2** | 7.6% | 2.3% | 0.6% |
| Philippines | 25.6 | 26.7 | 27.6 | 28.0 | 28.8 | 29.5 | 30.5 | 32.5 | 34.4 | 37.7 | **42.1** | 11.3% | 3.6% | 0.3% |
| Singapore | 52.3 | 56.1 | 59.8 | 64.3 | 69.0 | 71.7 | 72.0 | 74.1 | 76.2 | 81.0 | **84.1** | 3.5% | 5.5% | 0.6% |
| South Korea | 222.9 | 231.9 | 236.4 | 237.3 | 255.0 | 268.9 | 271.8 | 272.2 | 274.9 | 280.2 | **286.2** | 1.9% | 2.4% | 2.2% |
| Taiwan | 105.6 | 110.3 | 104.2 | 102.4 | 108.6 | 108.7 | 108.4 | 109.9 | 112.1 | 111.1 | **112.1** | 0.6% | 0.7% | 0.8% |
| Thailand | 87.2 | 92.1 | 93.3 | 95.9 | 102.4 | 106.4 | 113.7 | 115.7 | 119.1 | 121.8 | **123.8** | 1.4% | 3.5% | 0.9% |
| Vietnam | 28.1 | 30.6 | 38.2 | 39.3 | 44.3 | 50.3 | 52.5 | 54.8 | 59.8 | 63.7 | **64.8** | 1.5% | 7.5% | 0.5% |
| Other Asia Pacific | 50.1 | 49.3 | 50.7 | 51.4 | 53.9 | 53.3 | 54.3 | 54.1 | 57.5 | 60.7 | **66.3** | 8.9% | 2.4% | 0.5% |
| Total Asia Pacific | 3924.3 | 4175.0 | 4292.1 | 4402.2 | 4674.7 | 4935.1 | 5095.5 | 5245.0 | 5357.2 | 5447.4 | **5579.7** | 2.1% | 3.9% | 42.0% |
| **Total World** | **11266.7** | **11626.6** | **11783.8** | **11601.5** | **12170.0** | **12455.3** | **12620.7** | **12866.0** | **12988.8** | **13105.0** | **13276.3** | **1.0%** | **1.8%** | **100.0%** |
| of which: OECD | 5677.4 | 5713.2 | 5662.2 | 5391.6 | 5593.8 | 5536.3 | 5481.8 | 5540.4 | 5497.6 | 5505.5 | **5529.1** | 0.2% | -0.3% | 41.6% |
| Non-OECD | 5589.3 | 5913.4 | 6121.7 | 6209.9 | 6576.2 | 6919.0 | 7138.9 | 7325.6 | 7491.3 | 7599.5 | **7747.2** | 1.7% | 3.7% | 58.4% |
| European Union | 1830.2 | 1804.2 | 1796.7 | 1691.3 | 1754.5 | 1695.9 | 1681.2 | 1669.3 | 1605.0 | 1626.7 | **1642.0** | 0.7% | -1.1% | 12.4% |
| CIS | 983.6 | 994.6 | 1002.1 | 926.8 | 969.5 | 1010.6 | 1014.6 | 991.9 | 993.2 | 967.4 | **965.6** | -0.5% | 0.2% | 7.3% |

*In this review, primary energy comprises commercially-traded fuels, including modern renewables used to generate electricity.
◆Less than 0.05%.
**Notes:** Oil consumption is measured in million tonnes; other fuels in million tonnes of oil equivalent.
**Growth rates are adjusted for leap years.**

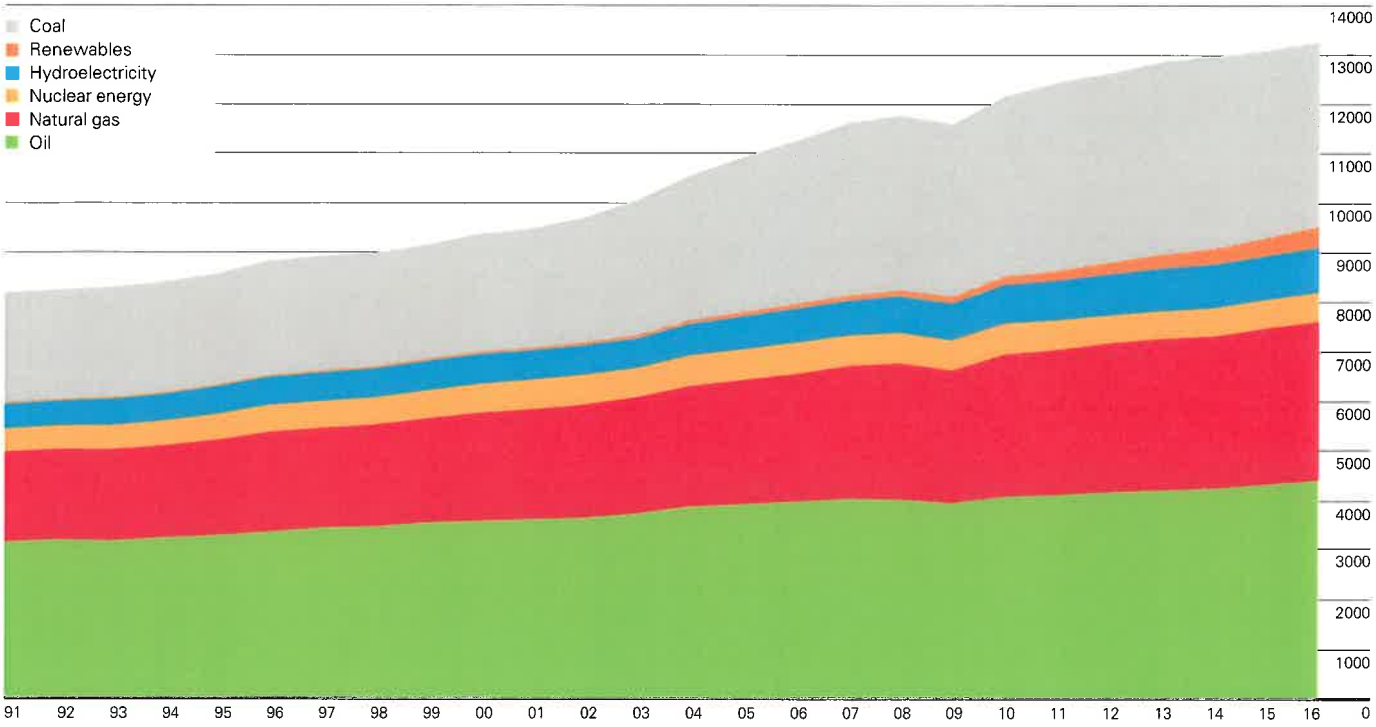
## Primary energy: Consumption by fuel*

| Million tonnes oil equivalent | 2015 Oil | Natural gas | Coal | Nuclear energy | Hydro-electricity | Renew-ables | Total | 2016 Oil | Natural gas | Coal | Nuclear energy | Hydro-electricity | Renew-ables | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| US | 856.5 | 710.5 | 391.8 | 189.9 | 55.8 | 71.5 | 2275.9 | 863.1 | 716.3 | 358.4 | 191.8 | 59.2 | 83.8 | **2272.7** |
| Canada | 99.1 | 92.2 | 19.6 | 22.8 | 85.4 | 8.5 | 327.7 | 100.9 | 89.9 | 18.7 | 23.2 | 87.8 | 9.2 | **329.7** |
| Mexico | 84.4 | 78.4 | 12.7 | 2.6 | 7.0 | 3.7 | 188.8 | 82.8 | 80.6 | 9.8 | 2.4 | 6.8 | 4.1 | **186.5** |
| Total North America | 1040.0 | 881.2 | 424.2 | 215.3 | 148.2 | 83.6 | 2792.4 | 1046.9 | 886.8 | 386.9 | 217.4 | 153.9 | 97.1 | **2788.9** |
| Argentina | 32.2 | 43.4 | 1.4 | 1.6 | 9.6 | 0.6 | 88.7 | 31.9 | 44.6 | 1.1 | 1.9 | 8.7 | 0.7 | **88.9** |
| Brazil | 146.6 | 37.5 | 17.7 | 3.3 | 81.4 | 16.0 | 302.6 | 138.8 | 32.9 | 16.5 | 3.6 | 86.9 | 19.0 | **297.8** |
| Chile | 17.6 | 3.7 | 7.3 | – | 5.4 | 1.9 | 35.9 | 17.8 | 4.1 | 8.2 | – | 4.4 | 2.3 | **36.8** |
| Colombia | 15.6 | 9.6 | 5.3 | – | 10.1 | 0.4 | 41.0 | 15.9 | 9.5 | 4.6 | – | 10.6 | 0.5 | **41.1** |
| Ecuador | 11.8 | 0.6 | – | – | 3.0 | 0.1 | 15.5 | 11.0 | 0.6 | – | – | 3.5 | 0.1 | **15.3** |
| Peru | 10.7 | 6.4 | 0.8 | – | 5.4 | 0.4 | 23.7 | 11.4 | 7.1 | 0.8 | – | 5.4 | 0.6 | **25.3** |
| Trinidad & Tobago | 2.2 | 19.4 | – | – | – | † | 21.6 | 2.2 | 17.2 | – | – | – | † | **19.4** |
| Venezuela | 30.2 | 31.1 | 0.2 | – | 17.3 | † | 78.8 | 28.7 | 32.0 | 0.1 | – | 13.9 | † | **74.6** |
| Other S. & Cent. America | 67.5 | 6.6 | 3.2 | – | 20.8 | 4.5 | 102.6 | 68.5 | 6.7 | 3.4 | – | 22.5 | 5.1 | **106.2** |
| Total S. & Cent. America | 334.4 | 158.3 | 35.9 | 5.0 | 152.9 | 24.0 | 710.4 | 326.2 | 154.7 | 34.7 | 5.5 | 156.0 | 28.2 | **705.3** |
| Austria | 12.5 | 7.5 | 3.2 | – | 8.4 | 2.3 | 33.9 | 12.7 | 7.9 | 3.2 | – | 9.0 | 2.4 | **35.1** |
| Azerbaijan | 4.5 | 9.6 | † | – | 0.4 | † | 14.5 | 4.6 | 9.4 | † | – | 0.4 | † | **14.5** |
| Belarus | 7.7 | 14.0 | 0.7 | – | † | † | 22.4 | 7.5 | 15.3 | 0.8 | – | † | 0.1 | **23.7** |
| Belgium | 31.0 | 13.6 | 3.2 | 5.9 | 0.1 | 3.2 | 56.9 | 31.8 | 13.9 | 3.0 | 9.8 | 0.1 | 3.2 | **61.7** |
| Bulgaria | 4.4 | 2.6 | 6.6 | 3.5 | 1.3 | 0.7 | 19.0 | 4.5 | 2.7 | 5.7 | 3.6 | 0.9 | 0.7 | **18.1** |
| Czech Republic | 8.9 | 6.5 | 16.6 | 6.1 | 0.4 | 1.7 | 40.2 | 8.4 | 7.0 | 16.9 | 5.5 | 0.5 | 1.7 | **39.9** |
| Denmark | 8.0 | 2.8 | 1.7 | – | † | 4.3 | 16.9 | 8.0 | 2.9 | 2.1 | – | † | 4.1 | **17.1** |
| Finland | 8.7 | 2.0 | 3.8 | 5.3 | 3.8 | 3.1 | 26.7 | 9.0 | 1.8 | 4.1 | 5.3 | 3.6 | 3.4 | **27.1** |
| France | 76.8 | 35.1 | 8.4 | 99.0 | 12.3 | 7.9 | 239.4 | 76.4 | 38.3 | 8.3 | 91.2 | 13.5 | 8.2 | **235.9** |
| Germany | 110.0 | 66.2 | 78.5 | 20.8 | 4.3 | 38.1 | 317.8 | 113.0 | 72.4 | 75.3 | 19.1 | 4.8 | 37.9 | **322.5** |
| Greece | 14.9 | 2.5 | 5.6 | – | 1.4 | 2.0 | 26.4 | 15.4 | 2.6 | 4.7 | – | 1.2 | 2.1 | **25.9** |
| Hungary | 7.0 | 7.5 | 2.4 | 3.6 | 0.1 | 0.7 | 21.2 | 7.1 | 8.0 | 2.3 | 3.6 | 0.1 | 0.8 | **21.9** |
| Ireland | 6.8 | 3.8 | 2.2 | – | 0.2 | 1.6 | 14.5 | 7.0 | 4.3 | 2.2 | – | 0.2 | 1.5 | **15.2** |
| Italy | 57.6 | 55.3 | 12.3 | – | 10.3 | 14.3 | 149.9 | 58.1 | 58.1 | 10.9 | – | 9.3 | 15.0 | **151.3** |
| Kazakhstan | 13.2 | 11.6 | 35.8 | – | 2.1 | † | 62.7 | 13.2 | 12.0 | 35.6 | – | 2.1 | 0.1 | **63.0** |
| Lithuania | 2.8 | 2.1 | 0.2 | – | 0.1 | 0.3 | 5.4 | 3.0 | 1.8 | 0.2 | – | 0.1 | 0.4 | **5.5** |
| Netherlands | 38.7 | 28.3 | 11.0 | 0.9 | † | 3.1 | 82.1 | 39.9 | 30.2 | 10.3 | 0.9 | † | 3.1 | **84.5** |
| Norway | 10.3 | 4.4 | 0.8 | – | 31.1 | 0.6 | 47.2 | 10.4 | 4.4 | 0.8 | – | 32.4 | 0.5 | **48.6** |
| Poland | 24.9 | 14.7 | 48.7 | – | 0.4 | 4.7 | 93.4 | 27.2 | 15.6 | 48.8 | – | 0.5 | 4.6 | **96.7** |
| Portugal | 11.5 | 4.3 | 3.3 | – | 2.0 | 3.6 | 24.6 | 11.2 | 4.6 | 2.9 | – | 3.6 | 3.7 | **26.0** |
| Romania | 9.2 | 9.0 | 5.9 | 2.6 | 3.8 | 2.2 | 32.6 | 9.5 | 9.5 | 5.4 | 2.6 | 4.1 | 2.0 | **33.1** |
| Russian Federation | 144.2 | 362.5 | 92.2 | 44.2 | 38.5 | 0.2 | 681.7 | 148.0 | 351.8 | 87.3 | 44.5 | 42.2 | 0.2 | **673.9** |
| Slovakia | 3.7 | 3.9 | 3.3 | 3.4 | 0.9 | 0.5 | 15.7 | 4.0 | 4.0 | 3.1 | 3.3 | 1.0 | 0.5 | **15.9** |
| Spain | 61.2 | 24.6 | 13.7 | 13.0 | 6.3 | 15.6 | 134.4 | 62.5 | 25.2 | 10.4 | 13.3 | 8.1 | 15.5 | **135.0** |
| Sweden | 14.1 | 0.8 | 2.1 | 12.8 | 17.0 | 6.1 | 52.9 | 14.7 | 0.8 | 2.2 | 14.2 | 14.1 | 6.1 | **52.2** |
| Switzerland | 10.7 | 2.6 | 0.1 | 5.3 | 8.5 | 0.7 | 27.9 | 10.2 | 2.7 | 0.1 | 4.8 | 7.8 | 0.8 | **26.4** |
| Turkey | 38.9 | 39.2 | 34.7 | – | 15.2 | 3.9 | 131.9 | 41.2 | 37.9 | 38.4 | – | 15.2 | 5.2 | **137.9** |
| Turkmenistan | 6.6 | 26.5 | – | – | – | † | 33.1 | 6.7 | 26.6 | – | – | – | † | **33.2** |
| Ukraine | 9.2 | 25.9 | 27.3 | 19.8 | 1.2 | 0.4 | 83.9 | 9.1 | 26.1 | 31.5 | 18.3 | 1.6 | 0.3 | **87.0** |
| United Kingdom | 71.8 | 61.3 | 23.0 | 15.9 | 1.4 | 17.5 | 190.9 | 73.1 | 69.0 | 11.0 | 16.2 | 1.2 | 17.5 | **188.1** |
| Uzbekistan | 2.7 | 45.2 | 1.1 | – | 2.7 | † | 51.7 | 2.8 | 46.2 | 1.0 | – | 2.7 | † | **52.7** |
| Other Europe & Eurasia | 33.3 | 13.6 | 23.0 | 1.9 | 20.7 | 2.3 | 94.8 | 34.5 | 13.9 | 23.0 | 1.8 | 21.7 | 2.5 | **97.6** |
| Total Europe & Eurasia | 865.9 | 909.2 | 471.3 | 263.9 | 194.7 | 141.6 | 2846.6 | 884.6 | 926.9 | 451.6 | 258.2 | 201.8 | 144.0 | **2867.1** |
| Iran | 84.5 | 171.7 | 1.6 | 0.8 | 4.1 | 0.1 | 262.8 | 83.8 | 180.7 | 1.7 | 1.4 | 2.9 | 0.1 | **270.7** |
| Israel | 11.4 | 7.6 | 6.7 | – | † | 0.3 | 26.0 | 11.6 | 8.7 | 5.7 | – | † | 0.4 | **26.4** |
| Kuwait | 22.3 | 19.2 | – | – | – | † | 41.5 | 22.0 | 19.7 | – | – | – | † | **41.7** |
| Qatar | 10.7 | 39.5 | – | – | – | † | 50.2 | 11.7 | 37.5 | – | – | – | † | **49.2** |
| Saudi Arabia | 166.6 | 94.0 | 0.1 | – | – | † | 260.8 | 167.9 | 98.4 | 0.1 | – | – | † | **266.5** |
| United Arab Emirates | 40.9 | 66.4 | 1.3 | – | – | 0.1 | 108.6 | 43.5 | 69.0 | 1.3 | – | – | 0.1 | **113.8** |
| Other Middle East | 76.5 | 45.9 | 0.5 | – | 1.8 | 0.1 | 124.7 | 77.3 | 47.1 | 0.5 | – | 1.8 | 0.2 | **126.8** |
| Total Middle East | 412.8 | 444.3 | 10.2 | 0.8 | 5.9 | 0.5 | 874.6 | 417.8 | 461.1 | 9.3 | 1.4 | 4.7 | 0.7 | **895.1** |
| Algeria | 19.5 | 35.5 | 0.1 | – | † | † | 55.1 | 18.9 | 36.0 | 0.1 | – | † | 0.1 | **55.1** |
| Egypt | 39.6 | 43.0 | 0.4 | – | 3.2 | 0.4 | 86.7 | 40.6 | 46.1 | 0.4 | – | 3.2 | 0.6 | **91.0** |
| South Africa | 27.9 | 4.6 | 83.4 | 2.8 | 0.2 | 1.4 | 120.1 | 26.9 | 4.6 | 85.1 | 3.6 | 0.2 | 1.8 | **122.3** |
| Other Africa | 95.1 | 39.2 | 11.4 | – | 23.5 | 2.4 | 171.7 | 98.9 | 37.6 | 10.3 | – | 22.4 | 2.6 | **171.8** |
| Total Africa | 182.1 | 122.2 | 95.3 | 2.8 | 26.9 | 4.2 | 433.5 | 185.4 | 124.3 | 95.9 | 3.6 | 25.8 | 5.0 | **440.1** |
| Australia | 47.9 | 38.6 | 44.1 | – | 3.2 | 4.8 | 138.5 | 47.8 | 37.0 | 43.8 | – | 4.0 | 5.4 | **138.0** |
| Bangladesh | 6.2 | 24.2 | 0.7 | – | 0.2 | † | 31.3 | 6.6 | 24.8 | 0.8 | – | 0.2 | † | **32.4** |
| China | 561.8 | 175.3 | 1913.6 | 38.6 | 252.2 | 64.4 | 3005.9 | 578.7 | 189.3 | 1887.6 | 48.2 | 263.1 | 86.1 | **3053.0** |
| China Hong Kong SAR | 18.3 | 2.9 | 6.7 | – | – | † | 27.9 | 18.9 | 3.0 | 6.7 | – | – | † | **28.6** |
| India | 195.8 | 41.2 | 396.6 | 8.7 | 30.2 | 12.7 | 685.1 | 212.7 | 45.1 | 411.9 | 8.6 | 29.1 | 16.5 | **723.9** |
| Indonesia | 71.8 | 36.4 | 51.2 | – | 3.1 | 2.4 | 164.8 | 72.6 | 33.9 | 62.7 | – | 3.3 | 2.6 | **175.0** |
| Japan | 189.0 | 102.1 | 119.9 | 1.0 | 19.0 | 14.8 | 445.8 | 184.3 | 100.1 | 119.9 | 4.0 | 18.1 | 18.8 | **445.3** |
| Malaysia | 35.5 | 37.6 | 16.9 | – | 3.5 | 0.3 | 93.8 | 36.3 | 38.7 | 19.9 | – | 4.2 | 0.3 | **99.5** |
| New Zealand | 7.5 | 4.0 | 1.4 | – | 5.6 | 2.4 | 21.0 | 7.7 | 4.2 | 1.2 | – | 5.9 | 2.4 | **21.4** |
| Pakistan | 24.6 | 39.2 | 4.7 | 1.1 | 7.3 | 0.3 | 77.1 | 27.5 | 40.9 | 5.4 | 1.3 | 7.7 | 0.4 | **83.2** |
| Philippines | 18.3 | 3.0 | 11.6 | – | 2.0 | 2.8 | 37.7 | 19.9 | 3.4 | 13.5 | – | 2.1 | 3.1 | **42.1** |
| Singapore | 69.4 | 11.0 | 0.4 | – | – | 0.2 | 81.0 | 72.2 | 11.3 | 0.4 | – | – | 0.2 | **84.1** |
| South Korea | 113.8 | 39.3 | 85.5 | 37.3 | 0.5 | 3.9 | 280.2 | 122.1 | 40.9 | 81.6 | 36.7 | 0.6 | 4.3 | **286.2** |
| Taiwan | 46.5 | 16.5 | 37.8 | 8.3 | 1.0 | 1.0 | 111.1 | 46.7 | 17.2 | 38.6 | 7.2 | 1.5 | 1.0 | **112.1** |
| Thailand | 57.3 | 43.8 | 17.6 | – | 0.9 | 2.3 | 121.8 | 59.0 | 43.5 | 17.7 | – | 0.8 | 2.8 | **123.8** |
| Vietnam | 18.8 | 9.6 | 22.3 | – | 12.9 | † | 63.7 | 20.1 | 9.6 | 21.3 | – | 13.7 | 0.1 | **64.8** |
| Other Asia Pacific | 23.2 | 7.0 | 16.9 | – | 13.3 | 0.3 | 60.7 | 24.4 | 7.2 | 20.6 | – | 13.8 | 0.3 | **66.3** |
| Total Asia Pacific | 1505.8 | 631.6 | 2747.7 | 95.0 | 354.7 | 112.7 | 5447.4 | 1557.3 | 650.3 | 2753.6 | 105.9 | 368.1 | 144.5 | **5579.7** |
| **Total World** | **4341.0** | **3146.7** | **3784.7** | **582.7** | **883.2** | **366.7** | **13105.0** | **4418.2** | **3204.1** | **3732.0** | **592.1** | **910.3** | **419.6** | **13276.3** |
| of which: OECD | 2062.4 | 1464.9 | 972.7 | 446.7 | 309.9 | 248.9 | 5505.5 | 2086.8 | 1495.2 | 913.3 | 446.8 | 316.8 | 270.1 | **5529.1** |
| Non-OECD | 2278.5 | 1681.8 | 2812.0 | 136.0 | 573.4 | 117.8 | 7599.5 | 2331.4 | 1708.9 | 2818.7 | 145.2 | 593.4 | 149.5 | **7747.2** |
| European Union | 600.6 | 359.2 | 261.1 | 194.0 | 77.2 | 134.6 | 1626.7 | 613.3 | 385.9 | 238.4 | 190.0 | 78.7 | 135.6 | **1642.0** |
| CIS | 191.6 | 499.8 | 158.9 | 64.7 | 51.7 | 0.6 | 967.4 | 195.5 | 492.0 | 157.9 | 63.3 | 56.2 | 0.7 | **965.6** |

*In this review, primary energy comprises commercially-traded fuels, including modern renewables used to generate electricity.
†Less than 0.05.
**Note:** Oil consumption is measured in million tonnes; other fuels in million tonnes of oil equivalent.

## World consumption

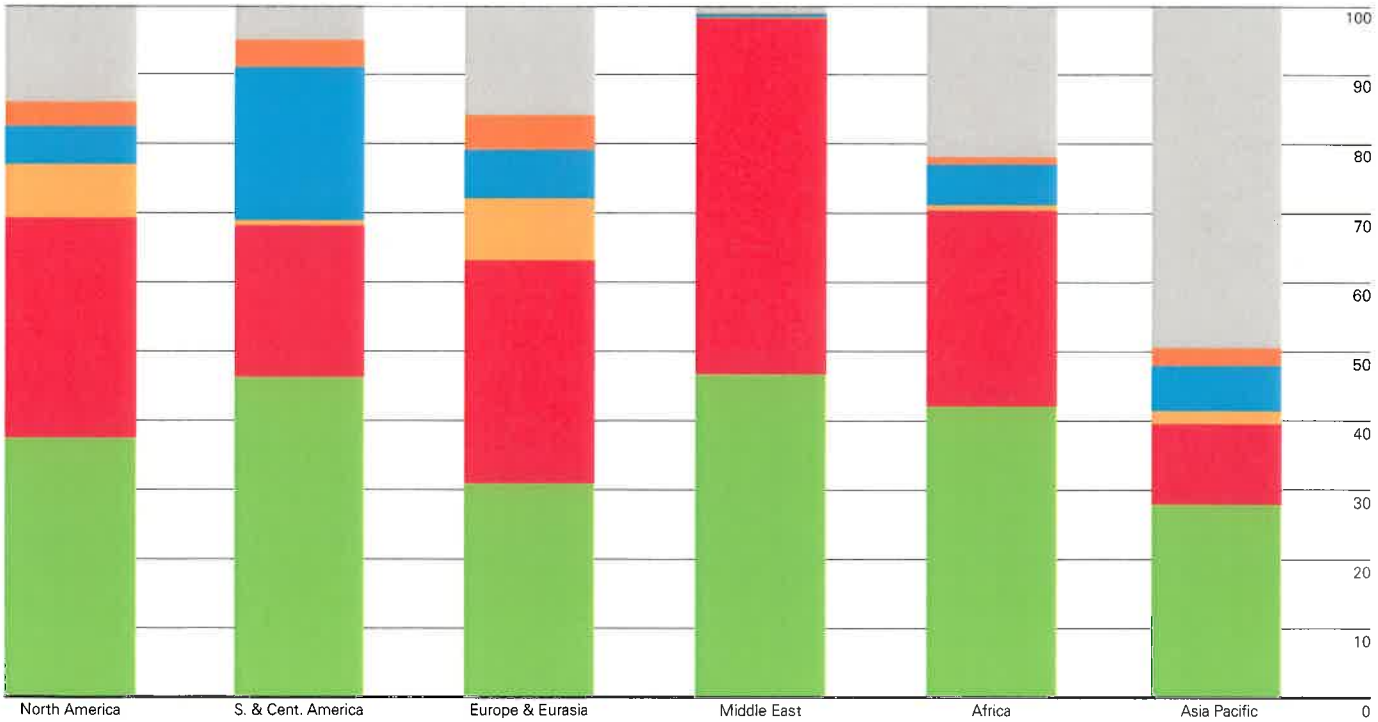
Million tonnes oil equivalent




World primary energy consumption grew by 1.0% in 2016, well below the 10-year average of 1.8% and the third consecutive year at or below 1%. As was the case in 2015, growth was below average in all regions except Europe & Eurasia. All fuels except oil and nuclear power grew at below-average rates. Oil provided the largest increment to energy consumption at 77 million tonnes of oil equivalent (mtoe), followed by natural gas (57 mtoe) and renewable power (53 mtoe).

## Regional consumption by fuel 2016

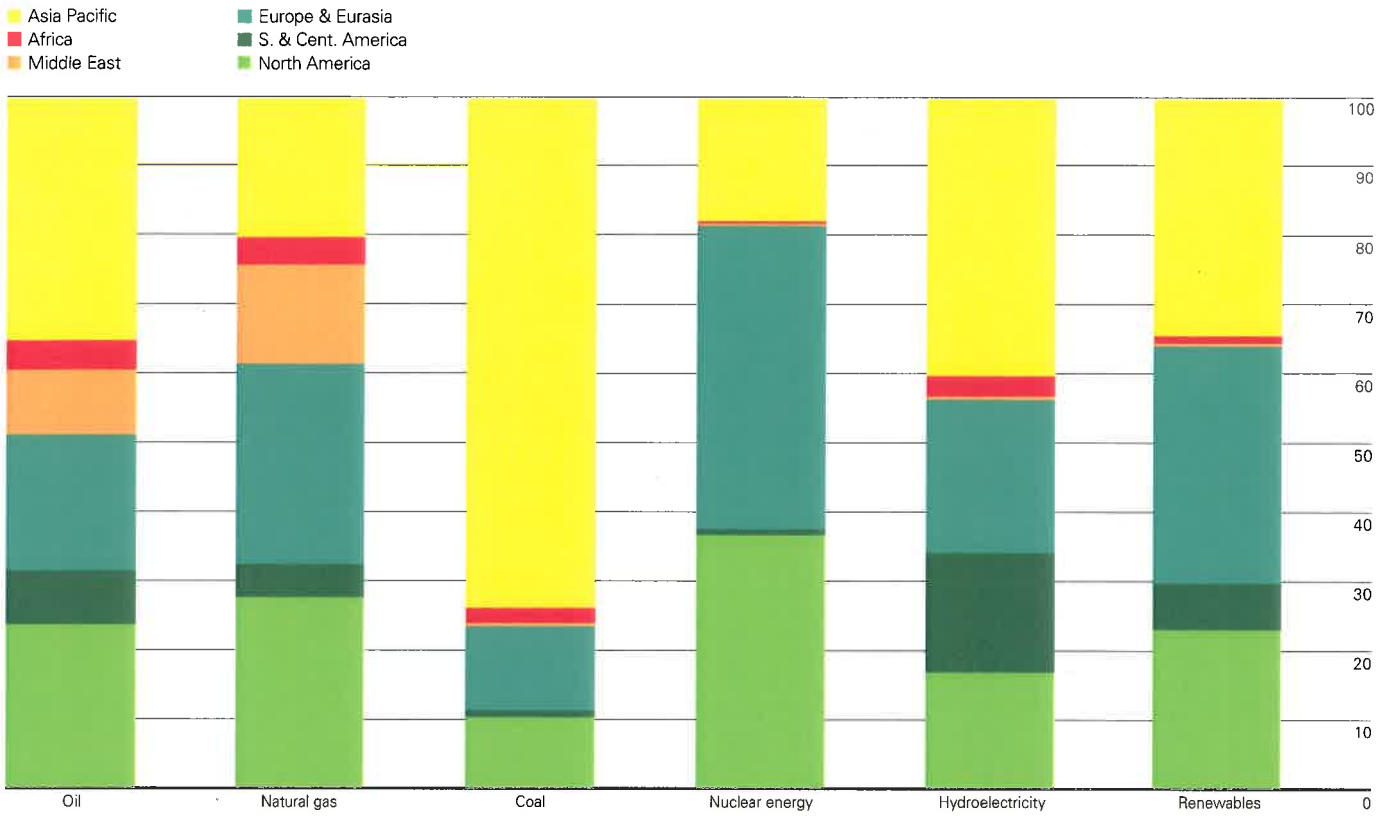
Percentage




Oil remains the dominant fuel in Africa and the Americas, while natural gas dominates in Europe & Eurasia and the Middle East. Coal is the dominant fuel in the Asia Pacific region, accounting for 49% of regional energy consumption. In 2016, coal's share of primary energy fell to its lowest level in our data series in North America, Europe & Eurasia and Africa.

## Fuel consumption by region 2016

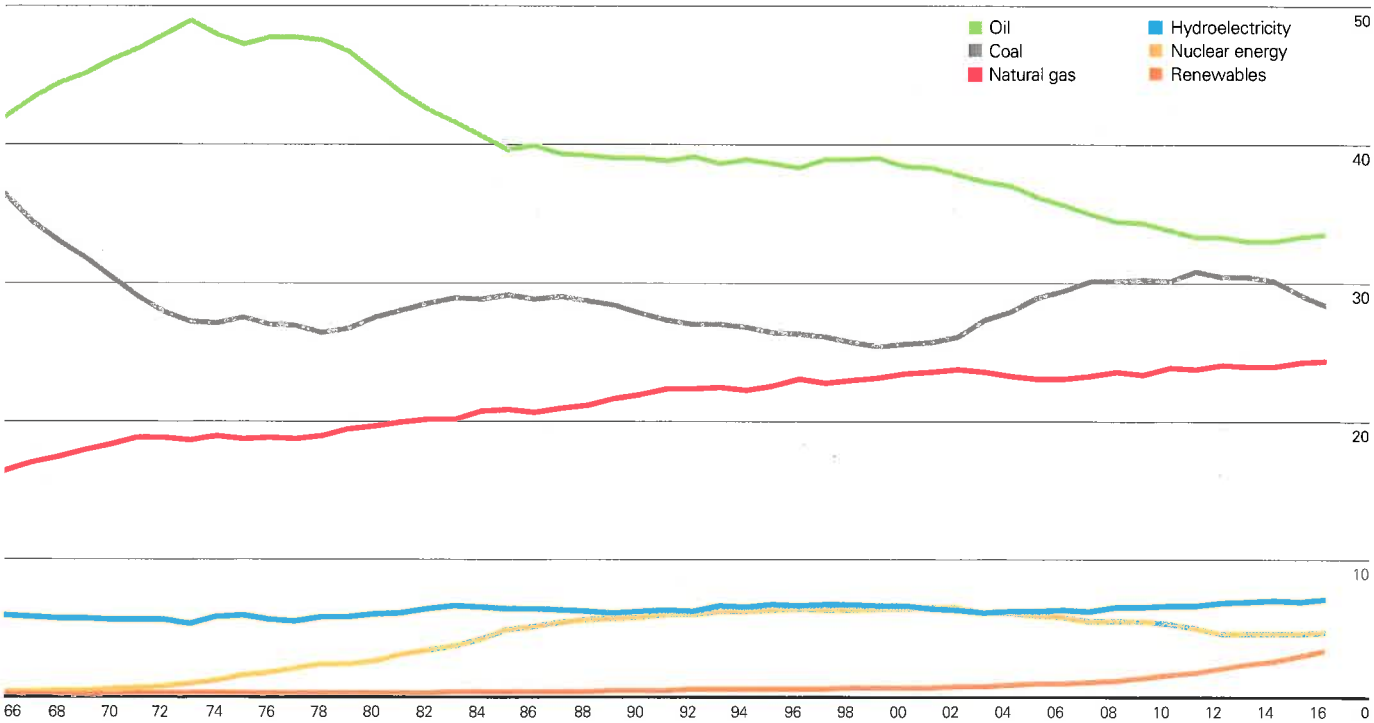
Percentage




Asia is the leading consumer of oil, coal, hydroelectricity and for the first time in 2016, the leading consumer of renewables in power generation, overtaking Europe & Eurasia. Europe & Eurasia remains the leading consumer of natural gas and nuclear power. Asia dominates global coal consumption, accounting for almost three quarters of global consumption (73.8%).

## Shares of global primary energy consumption

Percentage




Oil remains the world's dominant fuel, making up roughly a third of all energy consumed. In 2016 oil gained global market share for the second year in a row, following 15 years of declines from 1999 to 2014. Coal's market share fell to 28.1%, the lowest level since 2004. Renewables in power generation accounted for a record 3.2% of global primary energy consumption.

# Oil

## Total proved reserves

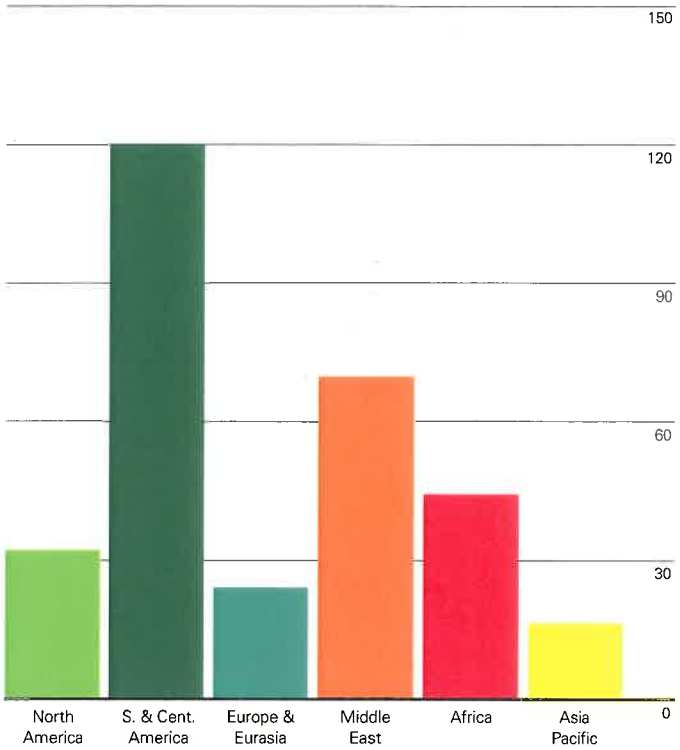
| | At end 1996 Thousand million barrels | At end 2006 Thousand million barrels | At end 2015 Thousand million barrels | At end 2016 Thousand million barrels | At end 2016 Thousand million tonnes | At end 2016 Share of total | At end 2016 R/P ratio |
|---|---|---|---|---|---|---|---|
| US | 29.8 | 29.4 | 48.0 | **48.0** | **5.8** | 2.8% | 10.6 |
| Canada | 48.9 | 179.4 | 171.5 | **171.5** | **27.6** | 10.0% | 105.1 |
| Mexico | 48.5 | 12.8 | 8.0 | **8.0** | **1.1** | 0.5% | 8.9 |
| Total North America | 127.3 | 221.7 | 227.5 | 227.5 | 34.5 | 13.3% | 32.3 |
| Argentina | 2.6 | 2.6 | 2.4 | **2.4** | **0.3** | 0.1% | 10.6 |
| Brazil | 6.7 | 12.2 | 13.0 | **12.6** | **1.8** | 0.7% | 13.3 |
| Colombia | 2.8 | 1.5 | 2.3 | **2.0** | **0.3** | 0.1% | 5.9 |
| Ecuador | 3.5 | 4.5 | 8.0 | **8.0** | **1.2** | 0.5% | 40.1 |
| Peru | 0.8 | 1.1 | 1.2 | **1.2** | **0.1** | 0.1% | 24.0 |
| Trinidad & Tobago | 0.7 | 0.8 | 0.7 | **0.2** | † | • | 6.9 |
| Venezuela | 72.7 | 87.3 | 300.9 | **300.9** | **47.0** | 17.6% | 341.1 |
| Other S. & Cent. America | 1.0 | 0.8 | 0.5 | **0.5** | **0.1** | • | 10.3 |
| Total S. & Cent. America | 90.7 | 110.8 | 329.0 | 327.9 | 50.8 | 19.2% | 119.9 |
| Azerbaijan | 1.2 | 7.0 | 7.0 | **7.0** | **1.0** | 0.4% | 23.1 |
| Denmark | 0.9 | 1.2 | 0.5 | **0.4** | **0.1** | • | 8.5 |
| Italy | 0.8 | 0.5 | 0.6 | **0.5** | **0.1** | • | 18.8 |
| Kazakhstan | 5.3 | 9.0 | 30.0 | **30.0** | **3.9** | 1.8% | 49.0 |
| Norway | 11.7 | 8.5 | 8.0 | **7.6** | **0.9** | 0.4% | 10.4 |
| Romania | 1.0 | 0.5 | 0.6 | **0.6** | **0.1** | • | 20.7 |
| Russian Federation | 113.6 | 104.0 | 102.4 | **109.5** | **15.0** | 6.4% | 26.6 |
| Turkmenistan | 0.5 | 0.6 | 0.6 | **0.6** | **0.1** | • | 6.3 |
| United Kingdom | 5.0 | 3.6 | 2.5 | **2.5** | **0.3** | 0.1% | 6.9 |
| Uzbekistan | 0.6 | 0.6 | 0.6 | **0.6** | **0.1** | • | 29.3 |
| Other Europe & Eurasia | 2.4 | 2.2 | 2.1 | **2.1** | **0.3** | 0.1% | 15.6 |
| Total Europe & Eurasia | 142.8 | 137.6 | 154.9 | 161.5 | 21.8 | 9.5% | 24.9 |
| Iran | 92.6 | 138.4 | 158.4 | **158.4** | **21.8** | 9.3% | 94.1 |
| Iraq | 112.0 | 115.0 | 142.5 | **153.0** | **20.6** | 9.0% | 93.6 |
| Kuwait | 96.5 | 101.5 | 101.5 | **101.5** | **14.0** | 5.9% | 88.0 |
| Oman | 5.3 | 5.6 | 5.3 | **5.4** | **0.7** | 0.3% | 14.6 |
| Qatar | 3.7 | 27.4 | 25.2 | **25.2** | **2.6** | 1.5% | 36.3 |
| Saudi Arabia | 261.4 | 264.3 | 266.6 | **266.5** | **36.6** | 15.6% | 59.0 |
| Syria | 2.5 | 3.0 | 2.5 | **2.5** | **0.3** | 0.1% | 273.2 |
| United Arab Emirates | 97.8 | 97.8 | 97.8 | **97.8** | **13.0** | 5.7% | 65.6 |
| Yemen | 2.0 | 2.8 | 3.0 | **3.0** | **0.4** | 0.2% | * |
| Other Middle East | 0.2 | 0.1 | 0.2 | **0.2** | † | • | 2.6 |
| Total Middle East | 674.9 | 755.9 | 903.0 | 813.5 | 110.1 | 47.7% | 69.9 |
| Algeria | 10.8 | 12.3 | 12.2 | **12.2** | **1.5** | 0.7% | 21.1 |
| Angola | 3.7 | 9.0 | 11.8 | **11.6** | **1.6** | 0.7% | 17.5 |
| Chad | – | 1.5 | 1.5 | **1.5** | **0.2** | 0.1% | 56.1 |
| Republic of Congo | 1.6 | 1.6 | 1.6 | **1.6** | **0.2** | 0.1% | 18.4 |
| Egypt | 3.8 | 3.7 | 3.5 | **3.5** | **0.5** | 0.2% | 13.7 |
| Equatorial Guinea | 0.6 | 1.8 | 1.1 | **1.1** | **0.1** | 0.1% | 10.7 |
| Gabon | 2.8 | 2.2 | 2.0 | **2.0** | **0.3** | 0.1% | 24.1 |
| Libya | 29.5 | 41.5 | 48.4 | **48.4** | **6.3** | 2.8% | 310.1 |
| Nigeria | 20.8 | 37.2 | 37.1 | **37.1** | **5.0** | 2.2% | 49.3 |
| South Sudan | n/a | n/a | 3.5 | **3.5** | **0.5** | 0.2% | 80.9 |
| Sudan | 0.3 | 5.0 | 1.5 | **1.5** | **0.2** | 0.1% | 39.6 |
| Tunisia | 0.3 | 0.6 | 0.4 | **0.4** | **0.1** | • | 18.4 |
| Other Africa | 0.7 | 0.7 | 3.7 | **3.7** | **0.5** | 0.2% | 43.2 |
| Total Africa | 74.9 | 116.9 | 128.3 | 128.0 | 16.9 | 7.5% | 44.3 |
| Australia | 3.8 | 3.5 | 4.0 | **4.0** | **0.4** | 0.2% | 30.3 |
| Brunei | 1.1 | 1.2 | 1.1 | **1.1** | **0.1** | 0.1% | 24.9 |
| China | 16.4 | 20.2 | 25.7 | **25.7** | **3.5** | 1.5% | 17.5 |
| India | 5.5 | 5.7 | 4.8 | **4.7** | **0.6** | 0.3% | 14.9 |
| Indonesia | 4.7 | 4.4 | 3.6 | **3.3** | **0.5** | 0.2% | 10.3 |
| Malaysia | 5.0 | 5.4 | 3.6 | **3.6** | **0.5** | 0.2% | 14.0 |
| Thailand | 0.2 | 0.5 | 0.4 | **0.4** | † | • | 2.3 |
| Vietnam | 0.9 | 3.3 | 4.4 | **4.4** | **0.6** | 0.3% | 36.2 |
| Other Asia Pacific | 1.3 | 1.4 | 1.3 | **1.3** | **0.2** | 0.1% | 12.5 |
| Total Asia Pacific | 39.0 | 45.5 | 48.8 | 48.4 | 6.4 | 2.8% | 16.5 |
| **Total World** | **1148.8** | **1388.3** | **1691.5** | **1706.7** | **240.7** | **100.0%** | **50.6** |
| of which: OECD | 151.0 | 240.2 | 244.5 | **244.0** | **36.6** | 14.3% | 28.8 |
| Non-OECD | 997.8 | 1148.1 | 1447.0 | **1462.7** | **204.1** | 85.7% | 57.9 |
| OPEC | 805.0 | 936.1 | 1210.3 | **1220.5** | **171.2** | 71.5% | 84.7 |
| Non-OPEC | 343.8 | 452.2 | 481.1 | **486.2** | **69.6** | 28.5% | 25.2 |
| European Union# | 8.7 | 6.6 | 5.2 | **5.1** | **0.7** | 0.3% | 9.3 |
| CIS | 121.9 | 121.9 | 141.1 | **148.2** | **20.1** | 8.7% | 28.6 |
| Canadian oil sands: Total | 42.1 | 173.1 | 165.3 | **165.3** | **26.9** | | |
| of which: Under active development | 4.2 | 21.0 | 24.0 | **24.0** | **3.9** | | |
| Venezuela: Orinoco Belt | – | 7.6 | 222.3 | **222.3** | **35.7** | | |

*More than 500 years.
†Less than 0.05.
•Less than 0.05%.
n/a not available.
#Excludes Estonia and Latvia in 2006.

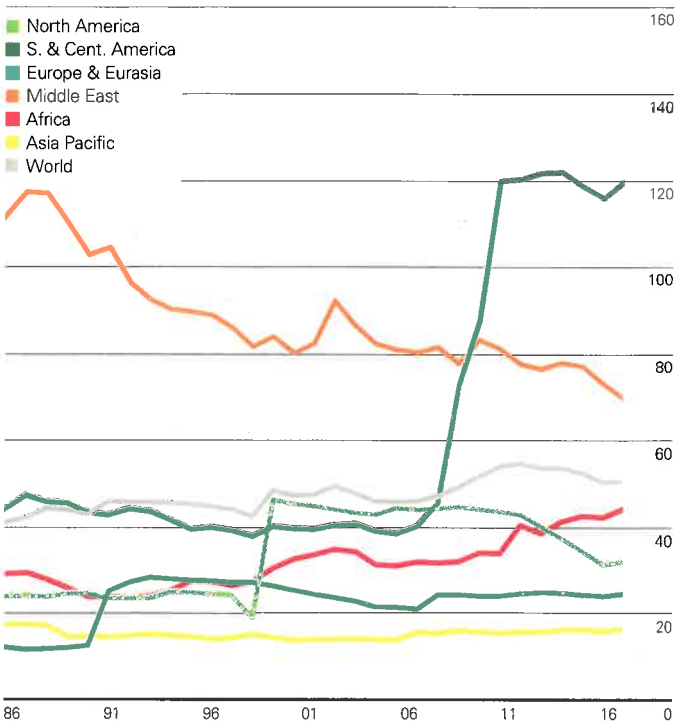
**Notes: Total proved reserves of oil** – Generally taken to be those quantities that geological and engineering information indicates with reasonable certainty can be recovered in the future from known reservoirs under existing economic and operating conditions. The data series for total proved oil does not necessarily meet the definitions, guidelines and practices used for determining proved reserves at company level, for instance as published by the US Securities and Exchange Commission, nor does it necessarily represent BP's view of proved reserves by country.
**Reserves-to-production (R/P) ratio** – If the reserves remaining at the end of any year are divided by the production in that year, the result is the length of time that those remaining reserves would last if production were to continue at that rate.
**Source of data** – The estimates in this table have been compiled using a combination of primary official sources, third-party data from the OPEC Secretariat, World Oil, Oil & Gas Journal and independent estimates of Russian reserves based on official data and Chinese reserves based on information in the public domain.
Canadian oil sands 'under active development' are an official estimate. Venezuelan Orinoco Belt reserves are based on the OPEC Secretariat and government announcements.
**Reserves include gas condensate and natural gas liquids (NGLs) as well as crude oil.**
**Shares of total and R/P ratios are calculated using thousand million barrels figures.**

## Reserves-to-production (R/P) ratios

2016 by region



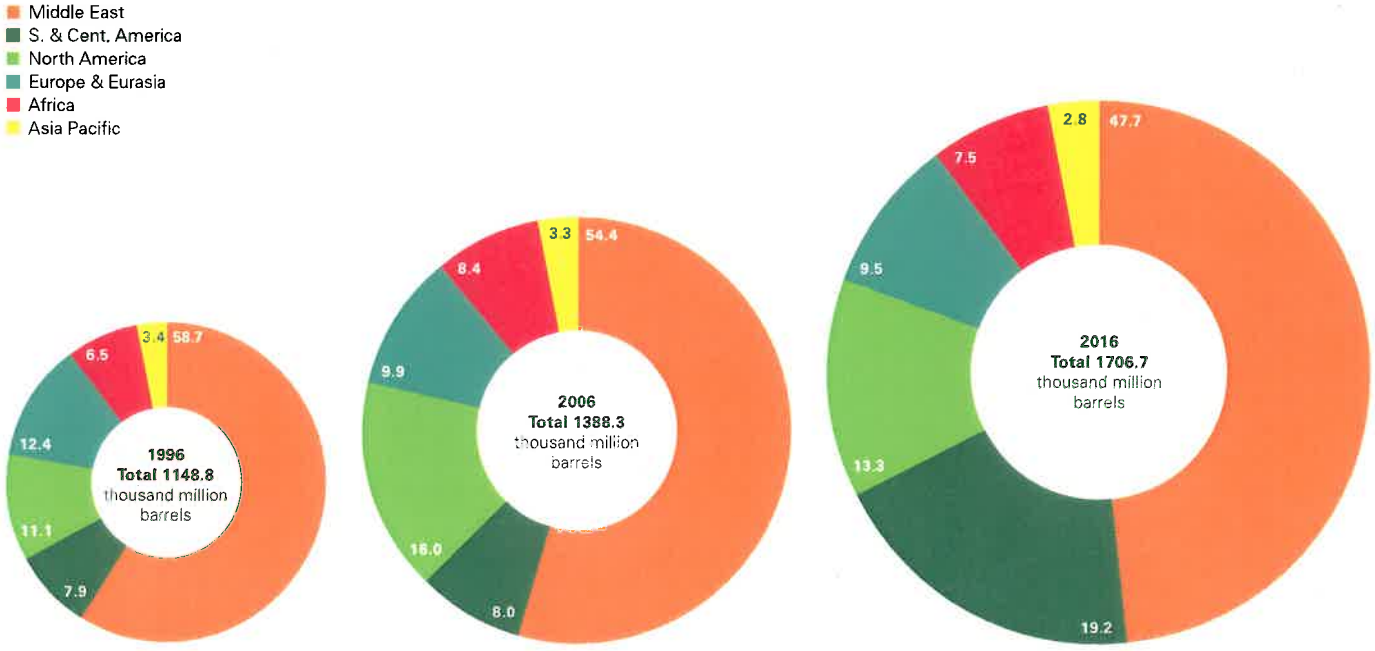

History




Global proved oil reserves in 2016 rose by 15 billion barrels (0.9%) to 1707 billion barrels, which would be sufficient to meet 50.6 years of global production at 2016 levels. The increase came largely from Iraq (10 billion barrels) and Russia (7 billion barrels), with small declines (<1 billion barrels) spread across a number of countries and regions. OPEC countries currently hold 71.5% of global proved reserves.
N.B. lags in reporting official data mean that 2016 figures for many countries are not yet available.

## Distribution of proved reserves in 1996, 2006 and 2016

Percentage



## Oil: Production in thousands of barrels per day*

| Thousand barrels daily | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Growth rate per annum 2016 | Growth rate per annum 2005-15 | Share 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| US | 6825 | 6860 | 6784 | 7263 | 7549 | 7862 | 8894 | 10073 | 11779 | 12757 | **12354** | -3.2% | 6.3% | 13.4% |
| Canada | 3208 | 3290 | 3207 | 3202 | 3332 | 3515 | 3740 | 4000 | 4271 | 4389 | **4460** | 1.6% | 3.7% | 4.8% |
| Mexico | 3689 | 3479 | 3165 | 2978 | 2959 | 2940 | 2911 | 2875 | 2784 | 2587 | **2456** | -5.1% | -3.7% | 2.7% |
| Total North America | 13722 | 13628 | 13156 | 13443 | 13841 | 14317 | 15545 | 16948 | 18833 | 19733 | **19270** | -2.3% | 3.7% | 20.8% |
| Argentina | 852 | 815 | 803 | 729 | 715 | 660 | 664 | 655 | 641 | 641 | **619** | -3.3% | -2.7% | 0.7% |
| Brazil | 1806 | 1831 | 1897 | 2029 | 2137 | 2179 | 2145 | 2110 | 2341 | 2525 | **2605** | 3.2% | 4.0% | 2.8% |
| Colombia | 529 | 531 | 588 | 671 | 786 | 915 | 944 | 1004 | 990 | 1006 | **924** | -8.1% | 6.7% | 1.0% |
| Ecuador | 538 | 513 | 507 | 488 | 488 | 501 | 505 | 527 | 557 | 543 | **545** | 0.4% | 0.2% | 0.6% |
| Peru | 118 | 117 | 122 | 147 | 158 | 153 | 154 | 167 | 169 | 145 | **135** | -6.6% | 2.6% | 0.1% |
| Trinidad & Tobago | 177 | 154 | 152 | 151 | 145 | 137 | 117 | 115 | 114 | 109 | **96** | -11.2% | -4.4% | 0.1% |
| Venezuela | 3340 | 3233 | 3222 | 3042 | 2842 | 2755 | 2704 | 2680 | 2692 | 2644 | **2410** | -8.9% | -2.2% | 2.6% |
| Other S. & Cent. America | 138 | 139 | 138 | 129 | 134 | 137 | 143 | 148 | 154 | 149 | **138** | -7.5% | 0.3% | 0.2% |
| Total S. & Cent. America | 7498 | 7334 | 7430 | 7384 | 7404 | 7436 | 7376 | 7407 | 7659 | 7761 | **7474** | -3.7% | 0.6% | 8.1% |
| Azerbaijan | 646 | 856 | 895 | 1014 | 1023 | 919 | 872 | 877 | 849 | 840 | **826** | -1.6% | 6.6% | 0.9% |
| Denmark | 346 | 311 | 287 | 265 | 249 | 225 | 204 | 178 | 167 | 158 | **142** | -10.2% | -8.4% | 0.2% |
| Italy | 120 | 122 | 108 | 95 | 106 | 110 | 112 | 116 | 121 | 115 | **79** | -31.3% | -1.0% | 0.1% |
| Kazakhstan | 1370 | 1415 | 1485 | 1609 | 1676 | 1684 | 1664 | 1737 | 1710 | 1695 | **1672** | -1.4% | 2.7% | 1.8% |
| Norway | 2772 | 2551 | 2466 | 2349 | 2136 | 2040 | 1917 | 1838 | 1889 | 1948 | **1995** | 2.4% | -4.1% | 2.2% |
| Romania | 105 | 100 | 99 | 94 | 90 | 89 | 83 | 86 | 84 | 83 | **79** | -5.0% | -3.1% | 0.1% |
| Russian Federation | 9819 | 10044 | 9951 | 10140 | 10367 | 10519 | 10642 | 10780 | 10838 | 10981 | **11227** | 2.2% | 1.4% | 12.2% |
| Turkmenistan | 187 | 199 | 211 | 214 | 220 | 220 | 229 | 240 | 249 | 261 | **261** | ◆ | 3.1% | 0.3% |
| United Kingdom | 1659 | 1651 | 1549 | 1469 | 1356 | 1112 | 946 | 864 | 852 | 963 | **1013** | 5.1% | -6.2% | 1.1% |
| Uzbekistan | 114 | 104 | 102 | 95 | 78 | 77 | 68 | 61 | 59 | 57 | **55** | -3.1% | -6.7% | 0.1% |
| Other Europe & Eurasia | 445 | 442 | 420 | 409 | 394 | 394 | 390 | 397 | 388 | 379 | **367** | -3.0% | -1.8% | 0.4% |
| Total Europe & Eurasia | 17582 | 17795 | 17674 | 17754 | 17694 | 17367 | 17127 | 17174 | 17266 | 17419 | **17716** | 1.4% | ◆ | 19.2% |
| Iran | 4293 | 4359 | 4421 | 4292 | 4417 | 4465 | 3819 | 3615 | 3725 | 3897 | **4600** | 18.0% | -0.8% | 5.0% |
| Iraq | 1999 | 2143 | 2428 | 2452 | 2490 | 2801 | 3116 | 3141 | 3285 | 4031 | **4465** | 10.8% | 8.2% | 4.8% |
| Kuwait | 2735 | 2660 | 2784 | 2498 | 2560 | 2913 | 3169 | 3129 | 3101 | 3068 | **3151** | 2.7% | 1.4% | 3.4% |
| Oman | 738 | 710 | 757 | 813 | 865 | 885 | 918 | 942 | 943 | 981 | **1004** | 2.4% | 2.4% | 1.1% |
| Qatar | 1241 | 1267 | 1438 | 1421 | 1638 | 1834 | 1931 | 1906 | 1886 | 1890 | **1899** | 0.5% | 5.1% | 2.1% |
| Saudi Arabia | 10671 | 10268 | 10663 | 9663 | 10075 | 11144 | 11635 | 11393 | 11505 | 11986 | **12349** | 3.0% | 0.9% | 13.4% |
| Syria | 421 | 404 | 406 | 401 | 385 | 353 | 171 | 59 | 33 | 27 | **25** | -7.4% | -24.5% | ◆ |
| United Arab Emirates | 3098 | 3002 | 3027 | 2725 | 2895 | 3320 | 3401 | 3627 | 3674 | 3928 | **4073** | 3.7% | 3.0% | 4.4% |
| Yemen | 387 | 341 | 315 | 307 | 306 | 219 | 174 | 193 | 147 | 44 | **16** | -62.7% | -20.3% | ◆ |
| Other Middle East | 182 | 194 | 193 | 192 | 192 | 201 | 184 | 209 | 214 | 213 | **205** | -3.8% | 1.4% | 0.2% |
| Total Middle East | 25765 | 25348 | 26430 | 24765 | 25822 | 28130 | 28518 | 28213 | 28515 | 30085 | **31789** | 5.7% | 1.6% | 34.5% |
| Algeria | 1979 | 1992 | 1969 | 1775 | 1689 | 1642 | 1537 | 1485 | 1589 | 1558 | **1579** | 1.4% | -2.4% | 1.7% |
| Angola | 1432 | 1699 | 1916 | 1804 | 1863 | 1726 | 1784 | 1799 | 1712 | 1826 | **1807** | -1.1% | 3.6% | 2.0% |
| Chad | 153 | 144 | 127 | 118 | 122 | 114 | 101 | 83 | 82 | 73 | **73** | 0.6% | -8.3% | 0.1% |
| Republic of Congo | 278 | 224 | 237 | 276 | 314 | 301 | 281 | 250 | 266 | 257 | **238** | -7.6% | 0.4% | 0.3% |
| Egypt | 679 | 698 | 715 | 730 | 725 | 714 | 715 | 710 | 714 | 726 | **691** | -4.8% | 0.8% | 0.8% |
| Equatorial Guinea | 342 | 350 | 347 | 307 | 274 | 252 | 272 | 267 | 281 | 289 | **280** | -3.1% | -2.1% | 0.3% |
| Gabon | 242 | 246 | 240 | 241 | 249 | 251 | 253 | 232 | 232 | 230 | **227** | -1.1% | -1.6% | 0.2% |
| Libya | 1815 | 1820 | 1820 | 1651 | 1658 | 479 | 1510 | 988 | 498 | 432 | **426** | -1.4% | -13.0% | 0.5% |
| Nigeria | 2433 | 2314 | 2109 | 2185 | 2471 | 2408 | 2370 | 2270 | 2347 | 2329 | **2053** | -11.9% | -0.8% | 2.2% |
| South Sudan | n/a | n/a | n/a | n/a | n/a | n/a | 31 | 100 | 155 | 148 | **118** | -20.0% | n/a | 0.1% |
| Sudan | 356 | 483 | 457 | 475 | 462 | 291 | 103 | 118 | 120 | 109 | **104** | -5.0% | -9.4% | 0.1% |
| Tunisia | 77 | 106 | 98 | 93 | 85 | 78 | 84 | 78 | 73 | 65 | **63** | -3.3% | -2.0% | 0.1% |
| Other Africa | 227 | 191 | 184 | 181 | 152 | 209 | 205 | 231 | 236 | 255 | **233** | -8.7% | 3.7% | 0.3% |
| Total Africa | 10014 | 10266 | 10218 | 9829 | 10565 | 8804 | 9247 | 8612 | 8307 | 8297 | **7892** | -4.9% | -1.7% | 8.6% |
| Australia | 532 | 549 | 538 | 507 | 548 | 483 | 479 | 407 | 436 | 393 | **359** | -8.7% | -3.6% | 0.4% |
| Brunei | 221 | 194 | 175 | 168 | 172 | 165 | 159 | 135 | 126 | 127 | **121** | -4.6% | -4.7% | 0.1% |
| China | 3711 | 3742 | 3814 | 3805 | 4077 | 4074 | 4155 | 4216 | 4246 | 4309 | **3999** | -7.2% | 1.7% | 4.3% |
| India | 760 | 768 | 803 | 816 | 882 | 916 | 906 | 906 | 887 | 876 | **856** | -2.3% | 1.7% | 0.9% |
| Indonesia | 1018 | 972 | 1006 | 994 | 1003 | 952 | 918 | 882 | 852 | 841 | **881** | 4.8% | -2.6% | 1.0% |
| Malaysia | 713 | 742 | 741 | 701 | 717 | 650 | 654 | 621 | 645 | 699 | **705** | 0.9% | -0.8% | 0.8% |
| Thailand | 326 | 343 | 360 | 374 | 389 | 419 | 458 | 452 | 450 | 468 | **479** | 2.5% | 4.5% | 0.5% |
| Vietnam | 354 | 334 | 309 | 341 | 322 | 326 | 357 | 361 | 373 | 362 | **333** | -8.1% | -0.7% | 0.4% |
| Other Asia Pacific | 304 | 319 | 340 | 330 | 315 | 299 | 287 | 272 | 291 | 295 | **278** | -5.9% | 0.4% | 0.3% |
| Total Asia Pacific | 7938 | 7962 | 8086 | 8038 | 8426 | 8285 | 8372 | 8252 | 8307 | 8369 | **8010** | -4.3% | 0.5% | 8.7% |
| **Total World** | **82519** | **82334** | **82894** | **81222** | **83251** | **84026** | **86183** | **86606** | **88826** | **91704** | **92150** | **0.5%** | **1.1%** | **100.0%** |
| of which: OECD | 19447 | 19131 | 18425 | 18432 | 18527 | 18574 | 19482 | 20635 | 22588 | 23596 | **23122** | -2.0% | 1.7% | 25.1% |
| Non-OECD | 63072 | 63203 | 64469 | 62790 | 64724 | 65452 | 66701 | 65971 | 66238 | 68108 | **69028** | 1.4% | 0.9% | 74.9% |
| OPEC | 35574 | 35269 | 36303 | 33997 | 35086 | 35988 | 37480 | 36561 | 36573 | 38133 | **39358** | 3.2% | 0.8% | 42.7% |
| Non-OPEC | 46945 | 47065 | 46591 | 47225 | 48166 | 48038 | 48703 | 50045 | 52254 | 53572 | **52792** | -1.5% | 1.4% | 57.3% |
| European Union | 2464 | 2418 | 2258 | 2119 | 1981 | 1720 | 1526 | 1434 | 1412 | 1506 | **1488** | -1.2% | -5.7% | 1.6% |
| CIS | 12281 | 12761 | 12783 | 13215 | 13496 | 13544 | 13597 | 13810 | 13810 | 13932 | **14141** | 1.5% | 1.7% | 15.3% |

*Includes crude oil, shale oil, oil sands and NGLs (natural gas liquids – the liquid content of natural gas where this is recovered separately). Excludes liquid fuels from other sources such as biomass and derivatives of coal and natural gas.
◆Less than 0.05%.
n/a not available.
**Note: Annual changes and shares of total are calculated using thousand barrels daily figures.**

## Oil: Consumption in thousands of barrels per day*

| Thousand barrels daily | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Growth rate per annum 2016 | Growth rate per annum 2005-15 | Share 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| US | 20687 | 20680 | 19490 | 18771 | 19180 | 18882 | 18490 | 18961 | 19106 | 19531 | **19631** | 0.5% | -0.6% | 20.3% |
| Canada | 2275 | 2342 | 2295 | 2173 | 2305 | 2380 | 2340 | 2383 | 2372 | 2299 | **2343** | 1.9% | 0.1% | 2.4% |
| Mexico | 2019 | 2067 | 2054 | 1996 | 2014 | 2043 | 2063 | 2020 | 1943 | 1923 | **1869** | -2.8% | -0.5% | 1.9% |
| Total North America | 24982 | 25089 | 23840 | 22940 | 23499 | 23305 | 22894 | 23364 | 23421 | 23753 | **23843** | 0.4% | -0.6% | 24.7% |
| Argentina | 474 | 528 | 540 | 532 | 594 | 609 | 636 | 683 | 674 | 692 | **687** | -0.7% | 4.4% | 0.7% |
| Brazil | 2155 | 2313 | 2485 | 2502 | 2721 | 2839 | 2901 | 3110 | 3239 | 3170 | **3018** | -4.8% | 4.1% | 3.1% |
| Chile | 293 | 377 | 390 | 383 | 343 | 371 | 376 | 362 | 371 | 376 | **378** | 0.6% | 3.5% | 0.4% |
| Colombia | 237 | 234 | 251 | 232 | 258 | 277 | 297 | 298 | 316 | 333 | **340** | 2.3% | 3.5% | 0.4% |
| Ecuador | 180 | 183 | 188 | 191 | 220 | 226 | 233 | 247 | 260 | 254 | **239** | -5.9% | 4.2% | 0.2% |
| Peru | 147 | 153 | 172 | 178 | 189 | 208 | 213 | 227 | 225 | 240 | **256** | 6.9% | 4.7% | 0.3% |
| Trinidad & Tobago | 38 | 43 | 45 | 44 | 45 | 42 | 40 | 45 | 42 | 45 | **44** | -3.9% | 2.8% | ◆ |
| Venezuela | 668 | 640 | 716 | 726 | 725 | 737 | 792 | 782 | 719 | 648 | **611** | -5.7% | 0.7% | 0.6% |
| Other S. & Cent. America | 1363 | 1361 | 1313 | 1306 | 1330 | 1357 | 1339 | 1319 | 1324 | 1381 | **1402** | 1.5% | 0.3% | 1.5% |
| Total S. & Cent. America | 5554 | 5631 | 5100 | 5094 | 5424 | 5666 | 5826 | 7073 | 7171 | 7129 | **6976** | -2.3% | 2.9% | 7.2% |
| Austria | 291 | 276 | 274 | 264 | 276 | 262 | 259 | 264 | 259 | 259 | **263** | 1.5% | -1.0% | 0.3% |
| Azerbaijan | 96 | 91 | 74 | 73 | 71 | 89 | 92 | 101 | 99 | 99 | **99** | -0.2% | -0.7% | 0.1% |
| Belarus | 176 | 162 | 159 | 182 | 150 | 175 | 211 | 145 | 165 | 156 | **152** | -2.2% | 0.3% | 0.2% |
| Belgium | 685 | 700 | 731 | 654 | 678 | 637 | 622 | 636 | 635 | 666 | **675** | 1.4% | -0.3% | 0.7% |
| Bulgaria | 105 | 103 | 102 | 91 | 81 | 79 | 82 | 76 | 82 | 92 | **96** | 4.0% | -1.1% | 0.1% |
| Czech Republic | 207 | 205 | 209 | 204 | 195 | 193 | 192 | 184 | 195 | 189 | **178** | -6.0% | -1.0% | 0.2% |
| Denmark | 190 | 191 | 188 | 169 | 171 | 168 | 158 | 158 | 160 | 164 | **164** | 0.5% | -1.3% | 0.2% |
| Finland | 223 | 226 | 223 | 212 | 222 | 204 | 193 | 191 | 183 | 184 | **189** | 2.6% | -2.2% | 0.2% |
| France | 1942 | 1911 | 1889 | 1822 | 1763 | 1730 | 1676 | 1664 | 1616 | 1616 | **1602** | -0.9% | -1.8% | 1.7% |
| Germany | 2609 | 2380 | 2502 | 2409 | 2445 | 2369 | 2356 | 2408 | 2348 | 2340 | **2394** | 2.3% | -1.0% | 2.5% |
| Greece | 434 | 435 | 414 | 398 | 369 | 348 | 312 | 295 | 294 | 306 | **313** | 2.5% | -2.9% | 0.3% |
| Hungary | 168 | 168 | 164 | 154 | 146 | 139 | 129 | 129 | 144 | 153 | **154** | 0.9% | -0.3% | 0.2% |
| Ireland | 191 | 195 | 187 | 166 | 158 | 143 | 135 | 137 | 136 | 142 | **147** | 2.9% | -2.9% | 0.2% |
| Italy | 1791 | 1740 | 1661 | 1563 | 1532 | 1475 | 1346 | 1260 | 1184 | 1222 | **1232** | 0.9% | -3.8% | 1.3% |
| Kazakhstan | 221 | 242 | 241 | 199 | 211 | 244 | 245 | 260 | 265 | 289 | **287** | -0.6% | 4.1% | 0.3% |
| Lithuania | 58 | 58 | 63 | 54 | 55 | 53 | 55 | 53 | 53 | 57 | **61** | 6.5% | ◆ | 0.1% |
| Netherlands | 1047 | 1065 | 991 | 971 | 977 | 971 | 926 | 898 | 866 | 835 | **851** | 1.9% | -2.2% | 0.9% |
| Norway | 229 | 237 | 228 | 237 | 235 | 239 | 235 | 243 | 232 | 238 | **242** | 1.7% | 0.6% | 0.3% |
| Poland | 512 | 531 | 549 | 549 | 576 | 574 | 553 | 520 | 521 | 541 | **589** | 8.8% | 1.1% | 0.6% |
| Portugal | 302 | 307 | 291 | 273 | 271 | 255 | 230 | 239 | 238 | 245 | **236** | -3.5% | -3.1% | 0.2% |
| Romania | 214 | 218 | 216 | 195 | 184 | 191 | 191 | 174 | 187 | 191 | **197** | 3.2% | -1.3% | 0.2% |
| Russian Federation | 2762 | 2780 | 2861 | 2775 | 2878 | 3074 | 3119 | 3135 | 3299 | 3137 | **3203** | 2.1% | 1.7% | 3.3% |
| Slovakia | 72 | 76 | 82 | 79 | 82 | 81 | 74 | 75 | 71 | 77 | **83** | 8.5% | -0.4% | 0.1% |
| Spain | 1592 | 1613 | 1558 | 1473 | 1446 | 1378 | 1291 | 1195 | 1191 | 1237 | **1268** | 2.5% | -2.5% | 1.3% |
| Sweden | 358 | 357 | 350 | 323 | 336 | 312 | 309 | 306 | 308 | 300 | **313** | 4.3% | -1.7% | 0.3% |
| Switzerland | 266 | 241 | 256 | 260 | 242 | 235 | 238 | 249 | 224 | 228 | **216** | -5.2% | -1.3% | 0.2% |
| Turkey | 681 | 695 | 686 | 709 | 694 | 673 | 680 | 718 | 741 | 839 | **886** | 5.7% | 2.5% | 0.9% |
| Turkmenistan | 105 | 111 | 114 | 106 | 118 | 125 | 129 | 137 | 143 | 147 | **148** | 0.8% | 3.0% | 0.2% |
| Ukraine | 308 | 308 | 299 | 282 | 267 | 278 | 267 | 257 | 222 | 198 | **195** | -1.1% | -3.9% | 0.2% |
| United Kingdom | 1813 | 1752 | 1720 | 1646 | 1623 | 1590 | 1533 | 1518 | 1511 | 1565 | **1597** | 2.1% | -1.5% | 1.7% |
| Uzbekistan | 103 | 94 | 93 | 89 | 76 | 71 | 63 | 60 | 57 | 57 | **58** | 0.8% | -5.7% | 0.1% |
| Other Europe & Eurasia | 699 | 730 | 737 | 720 | 714 | 710 | 692 | 683 | 660 | 683 | **705** | 3.2% | -0.1% | 0.7% |
| Total Europe & Eurasia | 20452 | 20702 | 20110 | 19080 | 19244 | 19064 | 18594 | 18370 | 18287 | 18480 | **18793** | 1.9% | 0.9% | 19.5% |
| Iran | 1851 | 1879 | 1954 | 1950 | 1817 | 1844 | 1854 | 2014 | 1961 | 1850 | **1848** | -0.1% | 0.9% | 1.9% |
| Israel | 248 | 262 | 254 | 232 | 241 | 254 | 295 | 247 | 231 | 247 | **251** | 1.9% | -0.4% | 0.3% |
| Kuwait | 378 | 383 | 406 | 455 | 470 | 464 | 541 | 512 | 480 | 506 | **499** | -1.3% | 2.1% | 0.5% |
| Qatar | 137 | 148 | 177 | 173 | 191 | 246 | 257 | 287 | 293 | 316 | **339** | 7.5% | 11.2% | 0.4% |
| Saudi Arabia | 2274 | 2407 | 2622 | 2914 | 3218 | 3295 | 3462 | 3470 | 3726 | 3868 | **3906** | 1.0% | 5.8% | 4.0% |
| United Arab Emirates | 539 | 576 | 603 | 595 | 643 | 721 | 765 | 774 | 860 | 926 | **987** | 6.7% | 6.3% | 1.0% |
| Other Middle East | 1299 | 1294 | 1402 | 1461 | 1522 | 1558 | 1586 | 1646 | 1631 | 1588 | **1600** | 0.7% | 1.8% | 1.7% |
| Total Middle East | 6726 | 6949 | 7418 | 7779 | 8102 | 8382 | 8760 | 8950 | 9180 | 9300 | **9431** | 1.4% | 3.6% | 9.8% |
| Algeria | 258 | 286 | 309 | 327 | 327 | 350 | 370 | 387 | 390 | 425 | **412** | -3.1% | 5.5% | 0.4% |
| Egypt | 601 | 642 | 686 | 725 | 766 | 720 | 747 | 756 | 806 | 830 | **853** | 2.8% | 3.0% | 0.9% |
| South Africa | 528 | 539 | 511 | 507 | 539 | 542 | 554 | 569 | 564 | 583 | **560** | -3.9% | 1.2% | 0.6% |
| Other Africa | 1526 | 1575 | 1697 | 1758 | 1852 | 1781 | 1900 | 2007 | 2012 | 2028 | **2111** | 4.1% | 2.9% | 2.2% |
| Total Africa | 2912 | 3042 | 3203 | 3316 | 3483 | 3393 | 3571 | 3720 | 3771 | 3866 | **3937** | 1.8% | 2.9% | 4.1% |
| Australia | 936 | 935 | 944 | 950 | 957 | 1006 | 1036 | 1046 | 1045 | 1039 | **1036** | -0.3% | 1.8% | 1.1% |
| Bangladesh | 81 | 76 | 77 | 72 | 80 | 104 | 110 | 107 | 116 | 124 | **131** | 5.6% | 4.5% | 0.1% |
| China | 7432 | 7808 | 7941 | 8278 | 9436 | 9796 | 10230 | 10734 | 11209 | 11986 | **12381** | 3.3% | 5.7% | 12.8% |
| China Hong Kong SAR | 309 | 329 | 298 | 339 | 359 | 361 | 344 | 352 | 336 | 368 | **380** | 3.4% | 2.5% | 0.4% |
| India | 2737 | 2941 | 3077 | 3237 | 3319 | 3488 | 3685 | 3727 | 3849 | 4164 | **4489** | 7.8% | 4.8% | 4.6% |
| Indonesia | 1244 | 1318 | 1287 | 1317 | 1411 | 1589 | 1625 | 1639 | 1663 | 1592 | **1615** | 1.4% | 2.0% | 1.7% |
| Japan | 5174 | 5013 | 4846 | 4387 | 4442 | 4442 | 4702 | 4516 | 4303 | 4139 | **4037** | -2.5% | -2.5% | 4.2% |
| Malaysia | 660 | 701 | 672 | 679 | 690 | 726 | 760 | 803 | 802 | 814 | **829** | 1.9% | 2.5% | 0.9% |
| New Zealand | 152 | 154 | 154 | 148 | 150 | 150 | 148 | 151 | 154 | 160 | **164** | 2.3% | 0.6% | 0.2% |
| Pakistan | 354 | 384 | 389 | 415 | 411 | 414 | 402 | 442 | 458 | 505 | **566** | 12.0% | 5.0% | 0.6% |
| Philippines | 283 | 295 | 283 | 300 | 313 | 298 | 309 | 322 | 347 | 398 | **434** | 9.0% | 2.4% | 0.4% |
| Singapore | 848 | 921 | 973 | 1049 | 1157 | 1208 | 1202 | 1225 | 1268 | 1336 | **1382** | 3.4% | 5.3% | 1.4% |
| South Korea | 2320 | 2399 | 2308 | 2339 | 2370 | 2394 | 2458 | 2455 | 2454 | 2577 | **2763** | 7.2% | 1.1% | 2.9% |
| Taiwan | 1051 | 1110 | 1005 | 1020 | 1045 | 983 | 983 | 1010 | 1032 | 1040 | **1046** | 0.6% | -0.1% | 1.1% |
| Thailand | 996 | 1030 | 1018 | 1065 | 1122 | 1185 | 1250 | 1298 | 1311 | 1355 | **1382** | 2.0% | 2.9% | 1.4% |
| Vietnam | 254 | 283 | 300 | 313 | 337 | 366 | 369 | 371 | 389 | 407 | **431** | 6.0% | 4.7% | 0.4% |
| Other Asia Pacific | 322 | 350 | 333 | 355 | 369 | 409 | 416 | 435 | 458 | 491 | **512** | 4.3% | 4.6% | 0.5% |
| Total Asia Pacific | 25152 | 26047 | 25907 | 26262 | 27969 | 28920 | 30031 | 30636 | 31195 | 32334 | **33577** | 3.9% | 2.8% | 34.8% |
| **Total World** | **85777** | **87161** | **86578** | **85691** | **88722** | **89729** | **90675** | **92114** | **93025** | **95003** | **96558** | **1.6%** | **1.2%** | **100.0%** |
| of which: OECD | 49874 | 49697 | 48059 | 46068 | 46596 | 46054 | 45512 | 45583 | 45184 | 45785 | **46217** | 0.9% | -0.9% | 47.9% |
| Non-OECD | 35903 | 37464 | 38519 | 39623 | 42126 | 43676 | 45163 | 46531 | 47840 | 49218 | **50341** | 2.3% | 3.6% | 52.1% |
| European Union | 15165 | 14878 | 14737 | 14023 | 13942 | 13499 | 12955 | 12702 | 12500 | 12707 | **12942** | 1.8% | -1.7% | 13.4% |
| CIS | 3819 | 3845 | 3901 | 3770 | 3835 | 4120 | 4205 | 4177 | 4326 | 4161 | **4223** | 1.5% | 1.3% | 4.4% |

*Inland demand plus international aviation and marine bunkers and refinery fuel and loss. Consumption of biogasoline (such as ethanol), biodiesel and derivatives of coal and natural gas are also included.

◆Less than 0.05%.

**Notes:** Differences between these world consumption figures and world production statistics are accounted for by stock changes, consumption of non-petroleum additives and substitute fuels, and unavoidable disparities in the definition, measurement or conversion of oil supply and demand data.

**Annual changes and shares of total are calculated using thousand barrels daily figures.**

## Oil: Production in million tonnes*

| Million tonnes | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Growth rate per annum 2016 | Growth rate per annum 2005-15 | Share 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| US | 304.5 | 305.1 | 302.3 | 322.4 | 332.7 | 344.9 | 393.2 | 446.9 | 522.7 | 565.1 | **543.0** | -4.2% | 6.2% | 12.4% |
| Canada | 150.6 | 155.3 | 152.9 | 152.8 | 160.3 | 169.8 | 182.6 | 195.1 | 209.4 | 215.6 | **218.2** | 0.9% | 4.2% | 5.0% |
| Mexico | 182.5 | 172.2 | 156.9 | 146.7 | 145.6 | 144.5 | 143.9 | 141.8 | 137.1 | 127.5 | **121.4** | -5.1% | -3.7% | 2.8% |
| Total North America | 637.6 | 632.6 | 612.0 | 621.9 | 638.6 | 659.2 | 719.8 | 783.8 | 869.2 | 908.3 | **882.6** | -3.1% | 3.6% | 20.1% |
| Argentina | 39.5 | 38.3 | 37.8 | 34.0 | 33.3 | 30.9 | 31.1 | 30.5 | 29.9 | 29.8 | **28.8** | -3.7% | -2.8% | 0.7% |
| Brazil | 94.0 | 95.4 | 99.1 | 106.0 | 111.6 | 114.0 | 112.4 | 110.2 | 122.5 | 132.2 | **136.7** | 3.1% | 4.0% | 3.1% |
| Colombia | 27.9 | 28.0 | 31.1 | 35.3 | 41.4 | 48.2 | 49.9 | 52.9 | 52.2 | 53.0 | **48.8** | -8.1% | 6.7% | 1.1% |
| Ecuador | 28.8 | 27.5 | 27.2 | 26.1 | 26.1 | 26.8 | 27.1 | 28.2 | 29.8 | 29.1 | **29.3** | 0.4% | 0.2% | 0.7% |
| Peru | 5.5 | 5.5 | 5.7 | 6.5 | 7.0 | 6.7 | 6.7 | 7.1 | 7.3 | 6.2 | **5.6** | -10.4% | 1.6% | 0.1% |
| Trinidad & Tobago | 8.3 | 7.1 | 7.0 | 6.8 | 6.2 | 5.9 | 5.2 | 5.1 | 5.1 | 4.8 | **4.3** | -10.5% | -5.0% | 0.1% |
| Venezuela | 171.2 | 165.5 | 165.6 | 156.0 | 145.8 | 141.5 | 139.3 | 137.8 | 138.5 | 135.9 | **124.1** | -9.0% | -2.2% | 2.8% |
| Other S. & Cent. America | 7.0 | 7.1 | 7.1 | 6.6 | 6.9 | 7.0 | 7.3 | 7.5 | 7.7 | 7.5 | **7.0** | -7.5% | 0.2% | 0.2% |
| Total S. & Cent. America | 382.2 | 374.3 | 380.5 | 377.3 | 378.4 | 381.1 | 378.9 | 379.2 | 392.9 | 398.6 | **384.5** | -3.6% | 0.6% | 8.0% |
| Azerbaijan | 32.3 | 42.6 | 44.5 | 50.4 | 50.8 | 45.6 | 43.4 | 43.5 | 42.1 | 41.6 | **41.0** | -1.7% | 6.5% | 0.9% |
| Denmark | 16.8 | 15.2 | 14.0 | 12.9 | 12.2 | 10.9 | 10.0 | 8.7 | 8.1 | 7.7 | **6.9** | -10.2% | -8.4% | 0.2% |
| Italy | 5.8 | 5.9 | 5.2 | 4.6 | 5.1 | 5.3 | 5.4 | 5.6 | 5.8 | 5.5 | **3.8** | -31.4% | -1.0% | 0.1% |
| Kazakhstan | 65.1 | 67.2 | 70.7 | 76.5 | 79.7 | 80.1 | 79.3 | 82.3 | 81.1 | 80.2 | **79.3** | -1.4% | 2.7% | 1.8% |
| Norway | 129.0 | 118.6 | 114.8 | 108.7 | 98.8 | 93.8 | 87.3 | 83.2 | 85.3 | 88.0 | **90.4** | 2.4% | -4.4% | 2.1% |
| Romania | 5.0 | 4.7 | 4.7 | 4.5 | 4.3 | 4.2 | 4.0 | 4.1 | 4.1 | 4.0 | **3.8** | -5.3% | -3.0% | 0.1% |
| Russian Federation | 485.6 | 496.8 | 493.7 | 500.8 | 511.8 | 518.8 | 526.2 | 531.1 | 534.1 | 540.7 | **554.3** | 2.2% | 1.3% | 12.6% |
| Turkmenistan | 9.2 | 9.8 | 10.4 | 10.5 | 10.8 | 10.8 | 11.2 | 11.7 | 12.1 | 12.7 | **12.7** | -0.4% | 3.0% | 0.3% |
| United Kingdom | 76.9 | 76.9 | 72.0 | 68.3 | 63.2 | 52.1 | 44.7 | 40.7 | 40.0 | 45.4 | **47.5** | 4.4% | -6.1% | 1.1% |
| Uzbekistan | 5.4 | 4.9 | 4.8 | 4.5 | 3.6 | 3.6 | 3.2 | 2.9 | 2.8 | 2.7 | **2.6** | -3.3% | -6.9% | 0.1% |
| Other Europe & Eurasia | 21.7 | 21.6 | 20.6 | 19.9 | 19.2 | 19.2 | 19.2 | 19.6 | 19.2 | 18.8 | **18.2** | -3.3% | -1.6% | 0.4% |
| Total Europe & Eurasia | 852.9 | 864.2 | 855.4 | 861.6 | 869.5 | 844.5 | 833.6 | 833.3 | 834.7 | 847.3 | **860.6** | 1.2% | ◆ | 19.5% |
| Iran | 210.7 | 213.3 | 215.6 | 207.4 | 211.7 | 212.7 | 180.7 | 169.8 | 174.2 | 181.6 | **216.4** | 18.9% | -1.3% | 4.9% |
| Iraq | 98.0 | 105.1 | 119.3 | 119.9 | 121.5 | 136.7 | 152.5 | 153.2 | 160.3 | 197.0 | **218.9** | 10.8% | 8.2% | 5.0% |
| Kuwait | 133.7 | 129.9 | 136.1 | 120.9 | 123.3 | 140.8 | 153.9 | 151.3 | 150.1 | 148.2 | **152.7** | 2.8% | 1.3% | 3.5% |
| Oman | 36.2 | 34.8 | 37.1 | 39.7 | 42.2 | 43.2 | 45.0 | 46.1 | 46.2 | 48.0 | **49.3** | 2.4% | 2.4% | 1.1% |
| Qatar | 56.8 | 57.6 | 64.7 | 62.6 | 71.1 | 78.0 | 82.2 | 80.3 | 79.4 | 79.1 | **79.4** | 0.1% | 4.2% | 1.8% |
| Saudi Arabia | 508.9 | 488.9 | 509.9 | 456.7 | 473.8 | 525.9 | 549.8 | 538.4 | 543.4 | 567.8 | **585.7** | 2.9% | 0.9% | 13.4% |
| Syria | 20.3 | 19.5 | 19.6 | 19.3 | 18.5 | 16.9 | 8.1 | 2.7 | 1.5 | 1.2 | **1.1** | -8.3% | -25.1% | ◆ |
| United Arab Emirates | 144.3 | 139.6 | 141.4 | 126.2 | 133.3 | 151.3 | 154.8 | 165.1 | 166.2 | 176.2 | **182.4** | 3.2% | 2.6% | 4.2% |
| Yemen | 18.1 | 15.9 | 14.8 | 14.3 | 14.3 | 10.1 | 8.0 | 8.9 | 6.7 | 2.0 | **0.8** | -60.8% | -20.5% | ◆ |
| Other Middle East | 8.9 | 9.5 | 9.5 | 9.4 | 9.4 | 9.9 | 9.0 | 10.3 | 10.5 | 10.5 | **10.1** | -3.9% | 1.5% | 0.2% |
| Total Middle East | 1236.0 | 1214.1 | 1267.8 | 1176.6 | 1219.2 | 1325.8 | 1344.0 | 1326.1 | 1338.7 | 1411.6 | **1496.9** | 5.8% | 1.4% | 34.2% |
| Algeria | 86.2 | 86.5 | 85.6 | 77.2 | 73.8 | 71.7 | 67.2 | 64.8 | 68.8 | 67.2 | **68.5** | 1.6% | -2.5% | 1.6% |
| Angola | 69.6 | 82.5 | 93.5 | 87.6 | 90.5 | 83.8 | 86.9 | 87.3 | 83.0 | 88.7 | **87.9** | -1.2% | 3.5% | 2.0% |
| Chad | 8.0 | 7.5 | 6.7 | 6.2 | 6.4 | 6.0 | 5.3 | 4.4 | 4.3 | 3.8 | **3.8** | 0.6% | -8.3% | 0.1% |
| Republic of Congo | 14.2 | 11.5 | 12.2 | 14.1 | 16.0 | 15.3 | 14.3 | 12.6 | 13.4 | 12.9 | **11.9** | -7.8% | 0.3% | 0.3% |
| Egypt | 33.2 | 33.8 | 34.7 | 35.3 | 35.0 | 34.6 | 34.7 | 34.4 | 35.1 | 35.4 | **33.8** | -4.8% | 0.7% | 0.8% |
| Equatorial Guinea | 15.6 | 15.9 | 16.1 | 14.2 | 12.6 | 11.6 | 12.7 | 12.4 | 13.1 | 13.5 | **13.1** | -3.3% | -1.9% | 0.3% |
| Gabon | 12.1 | 12.3 | 12.0 | 12.0 | 12.4 | 12.5 | 12.7 | 11.6 | 11.6 | 11.5 | **11.4** | -1.1% | -1.6% | 0.3% |
| Libya | 85.3 | 85.4 | 85.6 | 77.4 | 77.8 | 22.5 | 71.2 | 46.5 | 23.4 | 20.3 | **20.0** | -1.5% | -13.0% | 0.5% |
| Nigeria | 118.5 | 112.4 | 102.6 | 105.3 | 119.1 | 115.9 | 114.4 | 109.2 | 112.8 | 112.0 | **98.8** | -12.1% | -1.0% | 2.3% |
| South Sudan | n/a | n/a | n/a | n/a | n/a | n/a | 1.5 | 4.9 | 7.7 | 7.3 | **5.8** | -20.0% | n/a | 0.1% |
| Sudan | 17.5 | 23.8 | 22.6 | 23.4 | 22.8 | 14.3 | 5.1 | 5.8 | 5.9 | 5.4 | **5.1** | -5.0% | -9.4% | 0.1% |
| Tunisia | 3.6 | 5.0 | 4.6 | 4.3 | 4.0 | 3.7 | 3.9 | 3.6 | 3.4 | 3.0 | **2.9** | -3.8% | -2.1% | 0.1% |
| Other Africa | 11.4 | 9.6 | 9.2 | 9.1 | 7.6 | 10.3 | 10.2 | 11.5 | 11.7 | 12.6 | **11.6** | -8.6% | 3.7% | 0.3% |
| Total Africa | 475.1 | 486.1 | 485.3 | 466.1 | 478.2 | 402.3 | 440.1 | 408.9 | 384.2 | 392.7 | **374.8** | -5.1% | -1.7% | 8.6% |
| Australia | 23.5 | 24.5 | 24.1 | 22.4 | 24.5 | 21.5 | 21.4 | 17.8 | 19.1 | 17.4 | **15.5** | -11.1% | -3.7% | 0.4% |
| Brunei | 10.8 | 9.5 | 8.6 | 8.3 | 8.5 | 8.1 | 7.8 | 6.6 | 6.2 | 6.2 | **5.9** | -4.7% | -4.8% | 0.1% |
| China | 184.8 | 186.3 | 190.4 | 189.5 | 203.0 | 202.9 | 207.5 | 210.0 | 211.4 | 214.6 | **199.7** | -7.2% | 1.7% | 4.6% |
| India | 36.0 | 36.4 | 37.8 | 38.0 | 41.3 | 42.9 | 42.5 | 42.5 | 41.6 | 41.2 | **40.2** | -2.6% | 1.7% | 0.9% |
| Indonesia | 50.2 | 47.8 | 49.4 | 48.4 | 48.6 | 46.3 | 44.6 | 42.7 | 41.2 | 40.7 | **43.0** | 5.2% | -2.7% | 1.0% |
| Malaysia | 32.7 | 33.8 | 34.0 | 32.2 | 32.6 | 29.4 | 29.8 | 28.5 | 29.7 | 32.3 | **32.7** | 0.9% | -0.7% | 0.7% |
| Thailand | 12.6 | 13.2 | 14.0 | 14.5 | 14.9 | 15.4 | 16.6 | 16.5 | 16.2 | 17.0 | **17.6** | 3.2% | 4.0% | 0.4% |
| Vietnam | 17.2 | 16.3 | 15.2 | 16.7 | 15.6 | 15.8 | 17.3 | 17.4 | 18.1 | 17.4 | **16.0** | -8.5% | -0.8% | 0.4% |
| Other Asia Pacific | 13.1 | 13.9 | 14.9 | 14.4 | 13.8 | 13.0 | 12.6 | 12.0 | 13.0 | 13.2 | **12.4** | -6.2% | 0.7% | 0.3% |
| Total Asia Pacific | 381.0 | 381.8 | 388.4 | 384.3 | 402.7 | 395.2 | 400.2 | 393.9 | 396.5 | 408.0 | **383.0** | -4.8% | 0.4% | 8.7% |
| **Total World** | **3964.8** | **3953.2** | **3989.6** | **3867.8** | **3976.5** | **4007.9** | **4116.4** | **4125.3** | **4226.2** | **4359.5** | **4382.4** | **0.3%** | **1.0%** | **100.0%** |
| of which: OECD | 904.3 | 889.3 | 857.9 | 853.7 | 856.7 | 857.0 | 902.1 | 953.8 | 1041.9 | 1086.4 | **1060.0** | -2.7% | 1.6% | 24.2% |
| Non-OECD | 3060.5 | 3064.0 | 3131.7 | 3034.2 | 3119.9 | 3150.9 | 3214.4 | 3171.5 | 3184.3 | 3273.0 | **3322.4** | 1.2% | 0.8% | 75.8% |
| OPEC | 1711.9 | 1694.1 | 1747.0 | 1623.6 | 1668.0 | 1707.6 | 1780.0 | 1732.0 | 1730.1 | 1803.2 | **1864.2** | 3.1% | 0.6% | 42.5% |
| Non-OPEC | 2252.9 | 2259.1 | 2242.6 | 2264.3 | 2308.6 | 2300.3 | 2336.4 | 2393.3 | 2496.1 | 2556.2 | **2518.2** | -1.8% | 1.3% | 57.5% |
| European Union | 116.1 | 114.2 | 106.6 | 100.0 | 93.6 | 81.7 | 73.0 | 68.5 | 67.3 | 71.9 | **70.8** | -1.8% | -5.5% | 1.6% |
| CIS | 604.4 | 628.0 | 630.6 | 649.2 | 662.8 | 664.7 | 668.8 | 676.8 | 677.1 | 682.5 | **694.5** | 1.5% | 1.6% | 15.8% |

*Includes crude oil, shale oil, oil sands and NGLs (natural gas liquids – the liquid content of natural gas where this is recovered separately). Excludes liquid fuels from other sources such as biomass and derivatives of coal and natural gas.
◆Less than 0.05%.
n/a not available.
**Notes: Annual changes and shares of total are calculated using million tonnes figures.**
**Growth rates are adjusted for leap years.**

## Oil: Consumption in million tonnes*

| Million tonnes | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Growth rate per annum 2016 | Growth rate per annum 2005-15 | Share 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| US | 930.7 | 928.8 | 875.4 | 833.2 | 850.1 | 834.9 | 817.0 | 832.1 | 838.1 | 856.5 | **863.1** | 0.5% | -0.9% | 19.5% |
| Canada | 98.7 | 101.7 | 100.6 | 94.4 | 101.0 | 104.2 | 102.3 | 103.5 | 103.1 | 99.1 | **100.9** | 1.5% | ◆ | 2.3% |
| Mexico | 89.7 | 92.0 | 91.6 | 88.5 | 88.6 | 90.3 | 92.3 | 89.8 | 85.4 | 84.4 | **82.8** | -2.1% | -0.7% | 1.9% |
| Total North America | 1119.1 | 1122.5 | 1067.6 | 1016.1 | 1039.7 | 1029.5 | 1011.6 | 1025.4 | 1026.6 | 1040.0 | **1046.9** | 0.4% | -0.8% | 23.7% |
| Argentina | 21.8 | 24.2 | 24.9 | 24.3 | 28.1 | 28.3 | 29.6 | 31.9 | 31.3 | 32.2 | **31.9** | -1.1% | 4.5% | 0.7% |
| Brazil | 100.0 | 107.5 | 116.2 | 117.0 | 126.8 | 131.9 | 134.3 | 144.2 | 150.6 | 146.6 | **138.8** | -5.6% | 4.0% | 3.1% |
| Chile | 13.9 | 17.9 | 18.6 | 18.2 | 16.0 | 17.6 | 17.5 | 16.8 | 17.4 | 17.6 | **17.8** | 0.4% | 3.5% | 0.4% |
| Colombia | 10.9 | 10.7 | 11.7 | 10.7 | 11.9 | 12.8 | 13.9 | 13.9 | 14.8 | 15.6 | **15.9** | 2.0% | 3.7% | 0.4% |
| Ecuador | 8.3 | 8.5 | 8.7 | 8.9 | 10.3 | 10.5 | 10.9 | 11.6 | 12.2 | 11.8 | **11.0** | -6.6% | 4.1% | 0.2% |
| Peru | 6.9 | 7.1 | 8.0 | 8.2 | 8.6 | 9.5 | 9.6 | 10.1 | 10.0 | 10.7 | **11.4** | 6.8% | 4.1% | 0.3% |
| Trinidad & Tobago | 1.8 | 2.1 | 2.2 | 2.1 | 2.2 | 2.1 | 2.0 | 2.3 | 2.1 | 2.2 | **2.2** | -4.3% | 2.9% | ◆ |
| Venezuela | 31.5 | 29.7 | 33.8 | 34.2 | 34.1 | 34.6 | 37.2 | 36.7 | 33.6 | 30.2 | **28.7** | -5.3% | 0.7% | 0.6% |
| Other S. & Cent. America | 68.1 | 67.8 | 65.5 | 64.5 | 65.5 | 66.9 | 66.1 | 64.5 | 64.7 | 67.5 | **68.5** | 1.2% | 0.1% | 1.6% |
| Total S. & Cent. America | 263.2 | 275.4 | 289.6 | 288.1 | 303.6 | 314.0 | 321.0 | 332.0 | 336.5 | 334.4 | **326.2** | -2.7% | 2.8% | 7.4% |
| Austria | 14.2 | 13.4 | 13.4 | 12.8 | 13.4 | 12.7 | 12.5 | 12.7 | 12.5 | 12.5 | **12.7** | 1.3% | -1.2% | 0.3% |
| Azerbaijan | 4.8 | 4.5 | 3.6 | 3.3 | 3.2 | 4.0 | 4.2 | 4.5 | 4.4 | 4.5 | **4.6** | 1.5% | -1.7% | 0.1% |
| Belarus | 8.8 | 8.0 | 7.9 | 9.3 | 7.5 | 8.6 | 10.4 | 7.1 | 8.1 | 7.7 | **7.5** | -2.5% | 0.2% | 0.2% |
| Belgium | 33.8 | 34.6 | 36.0 | 31.5 | 32.7 | 30.5 | 29.6 | 30.1 | 29.7 | 31.0 | **31.8** | 2.3% | -0.8% | 0.7% |
| Bulgaria | 5.0 | 4.8 | 4.8 | 4.3 | 3.9 | 3.8 | 3.9 | 3.6 | 3.9 | 4.4 | **4.5** | 2.9% | -1.0% | 0.1% |
| Czech Republic | 9.8 | 9.7 | 9.9 | 9.7 | 9.2 | 9.0 | 9.0 | 8.5 | 9.1 | 8.9 | **8.4** | -6.2% | -1.1% | 0.2% |
| Denmark | 9.4 | 9.4 | 9.3 | 8.3 | 8.4 | 8.3 | 7.8 | 7.7 | 7.8 | 8.0 | **8.0** | 0.3% | -1.4% | 0.2% |
| Finland | 10.7 | 10.8 | 10.7 | 10.1 | 10.6 | 9.7 | 9.1 | 9.0 | 8.6 | 8.7 | **9.0** | 2.6% | -2.4% | 0.2% |
| France | 93.0 | 91.4 | 90.8 | 87.5 | 84.5 | 83.0 | 80.3 | 79.3 | 76.9 | 76.8 | **76.4** | -0.8% | -1.9% | 1.7% |
| Germany | 123.6 | 112.5 | 118.9 | 113.9 | 115.4 | 112.0 | 111.4 | 113.4 | 110.4 | 110.0 | **113.0** | 2.4% | -1.1% | 2.6% |
| Greece | 21.3 | 21.4 | 20.4 | 19.5 | 18.1 | 17.0 | 15.3 | 14.5 | 14.4 | 14.9 | **15.4** | 2.8% | -3.0% | 0.3% |
| Hungary | 7.8 | 7.7 | 7.5 | 7.1 | 6.7 | 6.4 | 5.9 | 5.9 | 6.6 | 7.0 | **7.1** | 1.3% | -0.5% | 0.2% |
| Ireland | 9.3 | 9.4 | 9.0 | 8.0 | 7.6 | 6.8 | 6.5 | 6.5 | 6.5 | 6.8 | **7.0** | 3.0% | -3.1% | 0.2% |
| Italy | 86.7 | 84.0 | 80.4 | 75.1 | 73.1 | 70.5 | 64.2 | 59.4 | 55.8 | 57.6 | **58.1** | 0.5% | -4.0% | 1.3% |
| Kazakhstan | 10.7 | 11.6 | 11.5 | 9.3 | 9.9 | 11.5 | 11.5 | 12.1 | 12.3 | 13.2 | **13.2** | -0.2% | 3.5% | 0.3% |
| Lithuania | 2.8 | 2.8 | 3.1 | 2.6 | 2.7 | 2.6 | 2.7 | 2.6 | 2.6 | 2.8 | **3.0** | 6.7% | 0.1% | 0.1% |
| Netherlands | 50.8 | 50.7 | 47.3 | 45.9 | 45.9 | 46.1 | 43.7 | 41.4 | 39.6 | 38.7 | **39.9** | 2.8% | -2.5% | 0.9% |
| Norway | 10.5 | 10.7 | 10.4 | 10.7 | 10.8 | 10.6 | 10.5 | 10.8 | 10.2 | 10.3 | **10.4** | 0.7% | 0.2% | 0.2% |
| Poland | 23.3 | 24.2 | 25.3 | 25.3 | 26.7 | 26.6 | 25.7 | 23.8 | 23.9 | 24.9 | **27.2** | 8.8% | 1.1% | 0.6% |
| Portugal | 14.6 | 14.7 | 14.1 | 13.2 | 13.0 | 12.1 | 11.0 | 11.3 | 11.1 | 11.5 | **11.2** | -3.2% | -3.5% | 0.3% |
| Romania | 10.3 | 10.3 | 10.4 | 9.2 | 8.8 | 9.1 | 9.2 | 8.4 | 9.0 | 9.2 | **9.5** | 3.4% | -1.4% | 0.2% |
| Russian Federation | 130.4 | 130.0 | 133.6 | 128.2 | 133.3 | 142.2 | 144.6 | 144.3 | 152.3 | 144.2 | **148.0** | 2.4% | 1.4% | 3.3% |
| Slovakia | 3.4 | 3.6 | 3.9 | 3.7 | 3.9 | 3.9 | 3.6 | 3.6 | 3.4 | 3.7 | **4.0** | 8.6% | -0.4% | 0.1% |
| Spain | 79.3 | 80.3 | 78.0 | 73.5 | 72.1 | 68.8 | 64.7 | 59.3 | 59.0 | 61.2 | **62.5** | 1.8% | -2.6% | 1.4% |
| Sweden | 17.3 | 16.9 | 16.7 | 15.5 | 16.2 | 14.8 | 14.6 | 14.4 | 14.5 | 14.1 | **14.7** | 3.7% | -1.9% | 0.3% |
| Switzerland | 12.6 | 11.3 | 12.1 | 12.3 | 11.4 | 11.0 | 11.2 | 11.8 | 10.6 | 10.7 | **10.2** | -5.4% | -1.3% | 0.2% |
| Turkey | 32.1 | 32.6 | 32.1 | 32.6 | 31.8 | 31.1 | 31.6 | 33.5 | 34.3 | 38.9 | **41.2** | 5.6% | 2.4% | 0.9% |
| Turkmenistan | 4.8 | 5.1 | 5.2 | 5.0 | 5.5 | 5.8 | 6.0 | 6.2 | 6.5 | 6.6 | **6.7** | 0.8% | 2.9% | 0.2% |
| Ukraine | 14.2 | 14.4 | 14.2 | 13.5 | 12.6 | 13.1 | 12.5 | 11.9 | 10.3 | 9.2 | **9.1** | -0.9% | -3.9% | 0.2% |
| United Kingdom | 83.2 | 80.7 | 79.5 | 75.8 | 74.9 | 73.6 | 71.4 | 70.3 | 69.8 | 71.8 | **73.1** | 1.7% | -1.5% | 1.7% |
| Uzbekistan | 5.1 | 4.7 | 4.6 | 4.3 | 3.6 | 3.4 | 3.0 | 2.9 | 2.7 | 2.7 | **2.8** | 0.7% | -6.1% | 0.1% |
| Other Europe & Eurasia | 34.7 | 36.2 | 36.5 | 35.6 | 35.3 | 35.0 | 34.1 | 33.4 | 32.2 | 33.3 | **34.5** | 3.2% | -0.2% | 0.8% |
| Total Europe & Eurasia | 978.0 | 962.6 | 960.8 | 918.5 | 912.3 | 903.7 | 882.1 | 884.3 | 868.8 | 865.9 | **884.6** | 1.8% | -1.1% | 20.9% |
| Iran | 87.7 | 89.6 | 93.1 | 92.2 | 83.6 | 84.7 | 85.7 | 93.6 | 90.4 | 84.5 | **83.8** | -1.1% | 0.5% | 1.9% |
| Israel | 11.7 | 12.3 | 12.0 | 10.8 | 11.2 | 11.8 | 13.9 | 11.5 | 10.6 | 11.4 | **11.6** | 1.9% | -0.7% | 0.3% |
| Kuwait | 17.7 | 17.9 | 19.0 | 20.4 | 20.9 | 20.4 | 24.4 | 22.7 | 21.0 | 22.3 | **22.0** | -1.5% | 1.3% | 0.5% |
| Qatar | 4.6 | 5.2 | 6.3 | 6.0 | 6.5 | 8.0 | 8.2 | 9.3 | 9.7 | 10.7 | **11.7** | 9.2% | 11.6% | 0.3% |
| Saudi Arabia | 98.4 | 104.4 | 114.4 | 125.9 | 137.1 | 139.1 | 146.2 | 147.3 | 159.8 | 166.6 | **167.9** | 0.5% | 5.9% | 3.8% |
| United Arab Emirates | 26.9 | 28.7 | 30.2 | 28.9 | 30.7 | 33.2 | 35.0 | 35.5 | 38.6 | 40.9 | **43.5** | 6.1% | 5.0% | 1.0% |
| Other Middle East | 62.0 | 61.6 | 67.2 | 70.1 | 73.1 | 74.4 | 76.0 | 78.8 | 78.2 | 76.5 | **77.3** | 0.8% | 1.9% | 1.7% |
| Total Middle East | 308.1 | 319.6 | 342.1 | 354.4 | 363.1 | 371.7 | 389.5 | 398.6 | 408.4 | 412.8 | **417.8** | 0.9% | 3.3% | 9.5% |
| Algeria | 11.5 | 12.9 | 14.0 | 14.9 | 14.8 | 15.8 | 16.8 | 17.6 | 17.7 | 19.5 | **18.9** | -3.2% | 5.8% | 0.4% |
| Egypt | 28.7 | 30.6 | 32.6 | 34.4 | 36.3 | 33.7 | 35.3 | 35.8 | 38.3 | 39.6 | **40.6** | 2.3% | 2.9% | 0.9% |
| South Africa | 25.3 | 25.8 | 24.4 | 24.1 | 25.6 | 25.7 | 26.5 | 27.3 | 27.0 | 27.9 | **26.9** | -3.6% | 1.2% | 0.6% |
| Other Africa | 72.7 | 74.8 | 80.6 | 83.2 | 87.7 | 84.2 | 90.0 | 94.8 | 94.5 | 95.1 | **98.9** | 3.7% | 2.8% | 2.2% |
| Total Africa | 138.1 | 144.1 | 151.7 | 156.6 | 164.5 | 159.1 | 168.6 | 175.4 | 177.5 | 182.1 | **185.4** | 1.5% | 2.8% | 4.2% |
| Australia | 42.9 | 42.5 | 43.2 | 43.5 | 43.7 | 46.3 | 47.9 | 48.2 | 48.1 | 47.9 | **47.8** | -0.3% | 1.9% | 1.1% |
| Bangladesh | 3.9 | 3.7 | 3.8 | 3.5 | 3.9 | 5.1 | 5.4 | 5.3 | 5.8 | 6.2 | **6.6** | 6.0% | 4.8% | 0.1% |
| China | 353.1 | 370.7 | 378.1 | 392.8 | 448.5 | 465.1 | 487.1 | 508.1 | 528.0 | 561.8 | **578.7** | 2.7% | 5.5% | 13.1% |
| China Hong Kong SAR | 15.2 | 16.4 | 14.8 | 16.9 | 17.8 | 18.0 | 17.2 | 17.6 | 16.6 | 18.3 | **18.9** | 3.2% | 2.7% | 0.4% |
| India | 128.3 | 138.1 | 144.7 | 152.6 | 155.4 | 163.0 | 173.6 | 175.3 | 180.8 | 195.8 | **212.7** | 8.3% | 4.9% | 4.8% |
| Indonesia | 58.5 | 61.8 | 60.1 | 60.8 | 64.7 | 73.1 | 74.4 | 74.5 | 75.3 | 71.8 | **72.6** | 0.8% | 1.6% | 1.6% |
| Japan | 238.0 | 230.9 | 224.8 | 200.3 | 202.7 | 203.7 | 217.7 | 207.4 | 197.0 | 189.0 | **184.3** | -2.8% | -2.6% | 4.2% |
| Malaysia | 28.9 | 30.8 | 29.5 | 29.2 | 29.3 | 31.5 | 32.9 | 34.9 | 34.9 | 35.5 | **36.3** | 1.8% | 2.4% | 0.8% |
| New Zealand | 7.1 | 7.1 | 7.2 | 6.9 | 7.0 | 7.0 | 7.0 | 7.1 | 7.2 | 7.5 | **7.7** | 1.8% | 0.7% | 0.2% |
| Pakistan | 17.6 | 19.1 | 19.4 | 20.7 | 20.5 | 20.7 | 20.0 | 21.9 | 22.6 | 24.6 | **27.5** | 11.4% | 4.9% | 0.6% |
| Philippines | 13.3 | 13.8 | 13.3 | 14.0 | 14.6 | 13.8 | 14.4 | 14.9 | 16.1 | 18.3 | **19.9** | 8.5% | 2.1% | 0.5% |
| Singapore | 44.5 | 48.3 | 51.4 | 55.5 | 60.9 | 63.7 | 63.4 | 64.2 | 65.8 | 69.4 | **72.2** | 3.7% | 5.3% | 1.6% |
| South Korea | 104.7 | 107.6 | 103.1 | 103.7 | 105.0 | 105.8 | 108.8 | 108.3 | 107.9 | 113.8 | **122.1** | 7.1% | 0.8% | 2.8% |
| Taiwan | 49.1 | 51.1 | 45.9 | 46.1 | 47.2 | 44.5 | 44.6 | 45.1 | 46.1 | 46.5 | **46.7** | 0.1% | -0.6% | 1.1% |
| Thailand | 44.2 | 45.5 | 44.4 | 45.9 | 47.7 | 49.7 | 52.3 | 54.5 | 55.0 | 57.3 | **59.0** | 2.6% | 2.2% | 1.3% |
| Vietnam | 12.0 | 13.3 | 14.1 | 14.6 | 15.6 | 16.9 | 17.1 | 17.3 | 18.0 | 18.8 | **20.1** | 6.2% | 4.4% | 0.5% |
| Other Asia Pacific | 15.5 | 16.8 | 16.0 | 16.9 | 17.5 | 19.4 | 19.7 | 20.6 | 21.7 | 23.2 | **24.4** | 4.6% | 4.4% | 0.6% |
| Total Asia Pacific | 1176.7 | 1217.6 | 1213.8 | 1223.9 | 1302.2 | 1347.4 | 1403.4 | 1435.2 | 1447.0 | 1506.5 | **1557.3** | 3.1% | 2.7% | 35.2% |
| **Total World** | 3984.2 | 4041.9 | 4025.3 | 3955.7 | 4085.4 | 4125.7 | 4176.2 | 4220.9 | 4254.8 | 4341.0 | **4418.2** | 1.5% | 1.0% | 100.0% |
| of which: OECD | 2291.7 | 2278.9 | 2210.1 | 2098.9 | 2118.9 | 2093.8 | 2071.7 | 2059.3 | 2036.7 | 2062.4 | **2086.8** | 0.9% | -1.1% | 47.2% |
| Non-OECD | 1692.5 | 1763.0 | 1815.2 | 1856.7 | 1966.5 | 2032.0 | 2104.5 | 2161.6 | 2218.1 | 2278.5 | **2331.4** | 2.0% | 3.4% | 52.8% |
| European Union | 727.3 | 711.8 | 707.7 | 670.1 | 665.0 | 644.5 | 618.8 | 601.7 | 590.8 | 600.6 | **613.3** | 1.8% | -1.9% | 13.9% |
| CIS | 181.1 | 181.0 | 183.4 | 175.9 | 178.6 | 191.7 | 195.9 | 192.7 | 200.0 | 191.6 | **195.5** | 1.8% | 1.0% | 4.4% |

*Inland demand plus international aviation and marine bunkers and refinery fuel and loss. Consumption of biogasoline (such as ethanol), biodiesel and derivatives of coal and natural gas are also included.

◆Less than 0.05%.

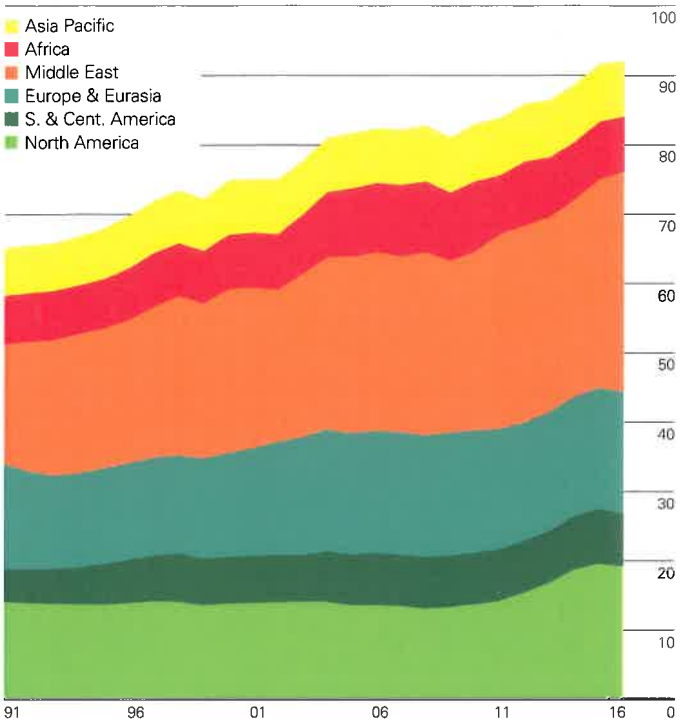
**Notes:** Differences between these world consumption figures and world production statistics are accounted for by stock changes, consumption of non-petroleum additives and substitute fuels, and unavoidable disparities in the definition, measurement or conversion of oil supply and demand data.

**Annual changes and shares of total are calculated using million tonnes figures.**

**Growth rates are adjusted for leap years.**

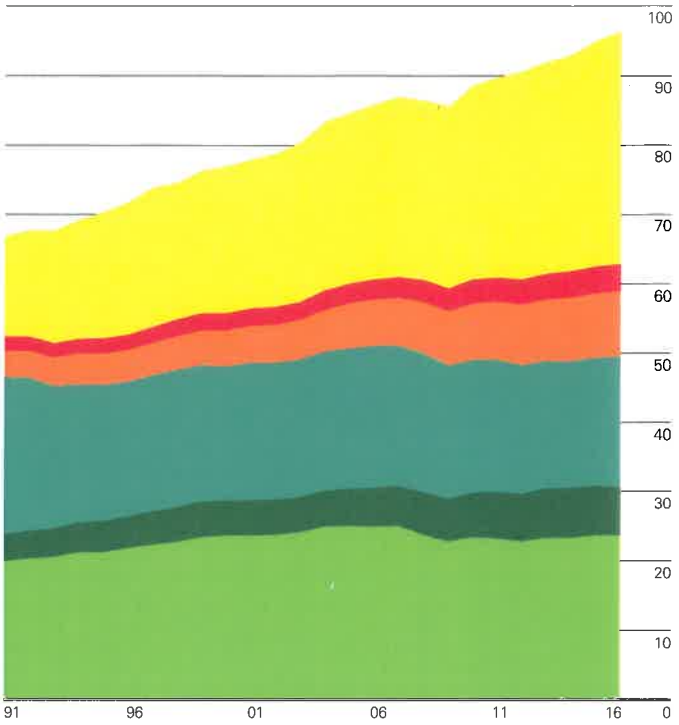
## Oil: Production by region

Million barrels daily




## Oil: Consumption by region

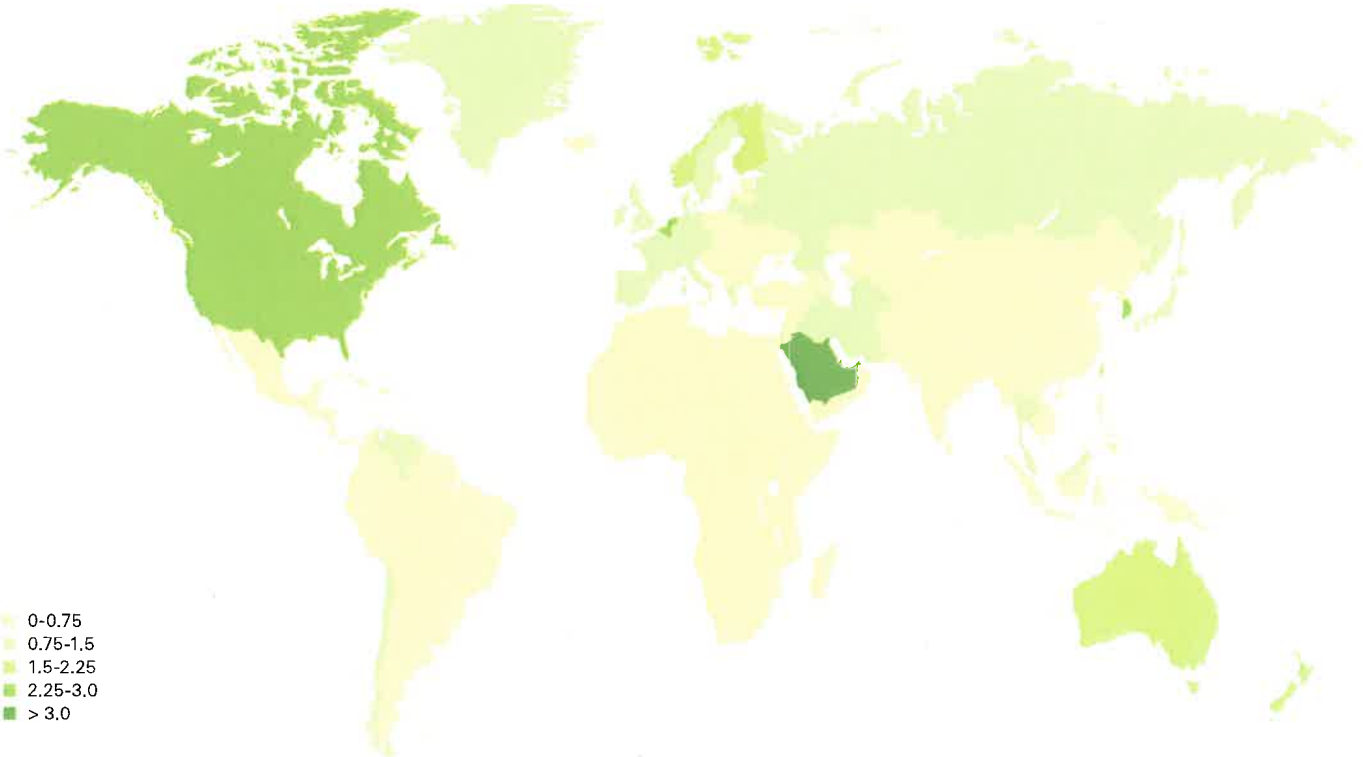
Million barrels daily




World oil production grew by only 0.4 million b/d in 2016, the slowest growth since 2013. Production in the Middle East rose by 1.7 million b/d, driven by Iran, Iraq and Saudi Arabia, but this was largely offset by declines in North America, Africa, Asia Pacific and South & Central America. Global oil consumption growth averaged 1.6 million b/d, above the 10-year average of 1 million b/d for the second successive year as a result of stronger than usual growth in the OECD. However, China (400,000 b/d) and India (330,000 b/d) still provided the largest contributions to growth.

## Oil: Consumption per capita 2016

Tonnes



## Oil: Regional consumption – by product group

| Thousand barrels daily | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | Growth rate per annum 2016 | 2016 | 2005-15 | Share 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North America | | | | | | | | | | | | | | |
| Light distillates | 11131 | 11200 | 10859 | 10839 | 10950 | 10697 | 10572 | 10778 | 10841 | 11088 | **11312** | 2.0% | 0.1% | 47.4% |
| Middle distillates | 7297 | 7318 | 6934 | 6281 | 6567 | 6694 | 6409 | 6519 | 6801 | 6812 | **6750** | -0.9% | -0.6% | 28.3% |
| Fuel oil | 1055 | 1081 | 941 | 801 | 810 | 745 | 662 | 576 | 447 | 419 | **505** | 20.5% | -11.3% | 2.1% |
| Others | 5499 | 5490 | 5106 | 5019 | 5172 | 5169 | 5251 | 5492 | 5332 | 5435 | **5276** | -2.9% | ◆ | 22.1% |
| Total North America | 24982 | 25089 | 23840 | 22940 | 23499 | 23305 | 22894 | 23364 | 23421 | 23753 | **23843** | 0.4% | -0.6% | 100.0% |
| of which: US | | | | | | | | | | | | | | |
| Light distillates | 9599 | 9597 | 9253 | 9257 | 9263 | 9022 | 8932 | 9125 | 9164 | 9413 | **9556** | 1.5% | -0.1% | 48.7% |
| Middle distillates | 6226 | 6199 | 5801 | 5241 | 5464 | 5518 | 5278 | 5371 | 5632 | 5657 | **5594** | -1.1% | -0.9% | 28.5% |
| Fuel oil | 683 | 718 | 609 | 508 | 532 | 459 | 367 | 317 | 256 | 258 | **356** | 37.8% | -11.9% | 1.8% |
| Others | 4178 | 4166 | 3827 | 3766 | 3921 | 3883 | 3913 | 4147 | 4054 | 4203 | **4125** | -1.8% | 0.1% | 21.0% |
| Total US | 20687 | 20680 | 19490 | 18771 | 19180 | 18882 | 18490 | 18061 | 19106 | 19631 | **19631** | 0.5% | -0.6% | 100.0% |
| S. & Cent. America | | | | | | | | | | | | | | |
| Light distillates | 1512 | 1613 | 1690 | 1795 | 1890 | 1969 | 2019 | 2118 | 2178 | 2231 | **2214** | -0.7% | 4.1% | 31.7% |
| Middle distillates | 1946 | 2144 | 2196 | 2168 | 2392 | 2513 | 2635 | 2760 | 2774 | 2749 | **2696** | -2.0% | 3.7% | 38.6% |
| Fuel oil | 813 | 813 | 831 | 789 | 763 | 741 | 740 | 715 | 734 | 730 | **663** | -9.2% | -0.7% | 9.5% |
| Others | 1284 | 1262 | 1384 | 1341 | 1379 | 1443 | 1432 | 1481 | 1484 | 1429 | **1403** | -1.8% | 1.9% | 20.1% |
| Total S. & Cent. America | 5554 | 5831 | 6100 | 6094 | 6424 | 6666 | 6826 | 7073 | 7171 | 7139 | **6976** | 2.3% | 2.9% | 100.0% |
| Europe & Eurasia | | | | | | | | | | | | | | |
| Light distillates | 4922 | 4936 | 4763 | 4658 | 4661 | 4448 | 4325 | 4272 | 4208 | 4143 | **4144** | ◆ | -1.9% | 22.1% |
| Middle distillates | 8920 | 8898 | 9165 | 8768 | 8970 | 8954 | 8839 | 8859 | 8787 | 9071 | **9269** | 2.2% | 0.5% | 49.3% |
| Fuel oil | 2304 | 2062 | 1973 | 1794 | 1655 | 1631 | 1499 | 1387 | 1369 | 1235 | **1306** | 5.7% | -6.0% | 7.0% |
| Others | 4306 | 4306 | 4209 | 4079 | 3958 | 4031 | 3932 | 3852 | 3924 | 4000 | **4074** | 1.8% | -0.6% | 21.7% |
| Total Europe & Eurasia | 20452 | 20202 | 20110 | 19300 | 19244 | 19063 | 18594 | 18370 | 18287 | 18450 | **18793** | 1.9% | 0.9% | 100.0% |
| of which: CIS | | | | | | | | | | | | | | |
| Light distillates | 1106 | 1172 | 1233 | 1211 | 1267 | 1273 | 1300 | 1338 | 1329 | 1327 | **1314** | -1.0% | 2.3% | 31.1% |
| Middle distillates | 1151 | 1219 | 1286 | 1168 | 1273 | 1387 | 1395 | 1379 | 1343 | 1278 | **1303** | 1.9% | 1.6% | 30.8% |
| Fuel oil | 558 | 424 | 397 | 379 | 350 | 373 | 361 | 369 | 435 | 347 | **370** | 6.8% | -3.6% | 8.8% |
| Others | 1004 | 1031 | 985 | 1011 | 944 | 1087 | 1149 | 1090 | 1219 | 1209 | **1236** | 2.3% | 1.9% | 29.3% |
| Total CIS | 3819 | 3845 | 3901 | 3770 | 3835 | 4120 | 4205 | 4177 | 4326 | 4161 | **4223** | 1.5% | 1.2% | 100.0% |
| of which: European Union | | | | | | | | | | | | | | |
| Light distillates | 3551 | 3516 | 3300 | 3190 | 3153 | 2952 | 2812 | 2719 | 2674 | 2602 | **2608** | 0.2% | -3.4% | 20.2% |
| Middle distillates | 7112 | 6990 | 7153 | 6883 | 6983 | 6840 | 6696 | 6674 | 6618 | 6875 | **7020** | 2.1% | -0.1% | 54.2% |
| Fuel oil | 1564 | 1473 | 1428 | 1276 | 1193 | 1148 | 1028 | 909 | 839 | 797 | **848** | 6.4% | -6.6% | 6.5% |
| Others | 2938 | 2898 | 2856 | 2674 | 2612 | 2559 | 2419 | 2400 | 2370 | 2432 | **2466** | 1.4% | -1.8% | 19.1% |
| Total European Union | 15165 | 14878 | 14737 | 14023 | 13942 | 13499 | 12955 | 12702 | 12500 | 12707 | **12942** | 1.8% | -1.7% | 100.0% |
| Middle East | | | | | | | | | | | | | | |
| Light distillates | 1485 | 1479 | 1592 | 1633 | 1681 | 1758 | 1839 | 1908 | 1944 | 2009 | **2053** | 2.2% | 3.6% | 21.8% |
| Middle distillates | 2114 | 2272 | 2315 | 2403 | 2412 | 2537 | 2656 | 2753 | 2749 | 2672 | **2661** | -0.4% | 2.9% | 28.2% |
| Fuel oil | 1534 | 1581 | 1746 | 1901 | 1939 | 1972 | 2042 | 2080 | 2211 | 2235 | **2192** | -1.9% | 3.9% | 23.2% |
| Others | 1592 | 1617 | 1765 | 1841 | 2070 | 2115 | 2223 | 2209 | 2276 | 2384 | **2525** | 5.9% | 4.2% | 26.8% |
| Total Middle East | 6726 | 6949 | 7418 | 7779 | 8102 | 8382 | 8760 | 8950 | 9180 | 9300 | **9431** | 1.4% | 3.6% | 100.0% |
| Africa | | | | | | | | | | | | | | |
| Light distillates | 686 | 703 | 760 | 799 | 835 | 815 | 867 | 883 | 902 | 954 | **1038** | 8.9% | 3.1% | 26.4% |
| Middle distillates | 1297 | 1379 | 1461 | 1507 | 1613 | 1615 | 1680 | 1805 | 1846 | 1872 | **1843** | -1.6% | 4.2% | 46.8% |
| Fuel oil | 423 | 425 | 436 | 446 | 460 | 394 | 440 | 438 | 437 | 431 | **421** | -2.3% | -0.5% | 10.7% |
| Others | 506 | 535 | 546 | 563 | 576 | 568 | 583 | 595 | 586 | 609 | **634** | 4.1% | 1.9% | 16.1% |
| Total Africa | 2912 | 3042 | 3203 | 3316 | 3483 | 3393 | 3571 | 3720 | 3771 | 3866 | **3937** | 1.8% | 2.9% | 100.0% |
| Asia Pacific | | | | | | | | | | | | | | |
| Light distillates | 7021 | 7401 | 7453 | 7685 | 8320 | 8526 | 8944 | 9449 | 9759 | 10519 | **10955** | 4.2% | 4.5% | 32.6% |
| Middle distillates | 9110 | 9304 | 9389 | 9390 | 9917 | 10345 | 10788 | 10991 | 11085 | 11368 | **11414** | 0.4% | 2.3% | 34.0% |
| Fuel oil | 3528 | 3583 | 3361 | 3046 | 3045 | 3112 | 3216 | 2987 | 2828 | 2808 | **2898** | 3.2% | -2.0% | 8.6% |
| Others | 5493 | 5760 | 5704 | 6141 | 6688 | 6937 | 7083 | 7209 | 7523 | 7799 | **8310** | 6.5% | 3.9% | 24.7% |
| Total Asia Pacific | 25152 | 26047 | 25907 | 26262 | 27969 | 28920 | 30031 | 30636 | 31196 | 32494 | **33577** | 3.3% | 2.8% | 100.0% |
| of which: China | | | | | | | | | | | | | | |
| Light distillates | 1713 | 1846 | 1975 | 2046 | 2406 | 2593 | 2776 | 3105 | 3324 | 3768 | **4035** | 7.1% | 9.5% | 32.6% |
| Middle distillates | 2682 | 2859 | 3078 | 3127 | 3452 | 3667 | 3963 | 4068 | 4114 | 4220 | **4046** | -4.1% | 5.3% | 32.7% |
| Fuel oil | 954 | 906 | 724 | 662 | 666 | 588 | 560 | 564 | 592 | 591 | **617** | 4.4% | -4.1% | 5.0% |
| Others | 2083 | 2198 | 2164 | 2443 | 2912 | 2948 | 2932 | 2998 | 3179 | 3408 | **3683** | 8.1% | 5.6% | 29.7% |
| Total China | 7432 | 7808 | 7941 | 8278 | 9436 | 9796 | 10230 | 10734 | 11209 | 11988 | **12381** | 5.3% | 5.7% | 100.0% |
| of which: Japan | | | | | | | | | | | | | | |
| Light distillates | 1758 | 1731 | 1614 | 1634 | 1696 | 1635 | 1614 | 1631 | 1575 | 1610 | **1560** | -3.1% | -1.0% | 38.6% |
| Middle distillates | 1760 | 1621 | 1502 | 1381 | 1391 | 1343 | 1361 | 1345 | 1319 | 1281 | **1291** | 0.8% | -3.8% | 32.0% |
| Fuel oil | 657 | 657 | 707 | 450 | 442 | 577 | 824 | 646 | 532 | 433 | **368** | -14.9% | -4.4% | 9.1% |
| Others | 999 | 1005 | 1024 | 922 | 913 | 887 | 903 | 895 | 876 | 816 | **817** | 0.2% | -2.2% | 20.3% |
| Total Japan | 5174 | 5013 | 4846 | 4387 | 4442 | 4442 | 4702 | 4616 | 4303 | 4139 | **4037** | -2.5% | -2.5% | 100.0% |
| World | | | | | | | | | | | | | | |
| Light distillates | 26756 | 27331 | 27116 | 27409 | 28337 | 28213 | 28565 | 29408 | 29831 | 30943 | **31718** | 2.5% | 1.6% | 32.8% |
| Middle distillates | 30684 | 31315 | 31460 | 30519 | 31871 | 32658 | 33007 | 33686 | 34041 | 34545 | **34632** | 0.3% | 1.4% | 35.9% |
| Fuel oil | 9658 | 9545 | 9289 | 8778 | 8672 | 8595 | 8598 | 8182 | 8027 | 7858 | **7986** | 1.6% | -2.3% | 8.3% |
| Others | 18679 | 18971 | 18713 | 18985 | 19842 | 20264 | 20505 | 20837 | 21125 | 21656 | **22223** | 2.6% | 1.7% | 23.0% |
| Total World | 85777 | 87161 | 86578 | 85691 | 88722 | 89729 | 90675 | 92114 | 93025 | 95003 | **96558** | 1.6% | 1.2% | 100.0% |
| OECD | | | | | | | | | | | | | | |
| Light distillates | 18000 | 18102 | 17381 | 17354 | 17528 | 17062 | 16864 | 16998 | 16988 | 17264 | **17506** | 1.4% | -0.4% | 37.9% |
| Middle distillates | 17771 | 17631 | 17310 | 16231 | 16654 | 16651 | 16323 | 16466 | 16685 | 17067 | **17223** | 0.9% | -0.3% | 37.3% |
| Fuel oil | 3785 | 3697 | 3492 | 2894 | 2767 | 2772 | 2822 | 2424 | 2071 | 1905 | **2005** | 5.2% | -7.6% | 4.3% |
| Others | 10318 | 10267 | 9876 | 9590 | 9646 | 9569 | 9502 | 9696 | 9441 | 9548 | **9484** | -0.7% | -0.6% | 20.5% |
| Total OECD | 49874 | 49697 | 48059 | 46068 | 46596 | 46054 | 45512 | 45583 | 45181 | 45785 | **46217** | 0.9% | -0.9% | 100.0% |
| Non-OECD | | | | | | | | | | | | | | |
| Light distillates | 8756 | 9228 | 9736 | 10056 | 10809 | 11150 | 11701 | 12411 | 12843 | 13679 | **14212** | 3.9% | 5.0% | 28.2% |
| Middle distillates | 12913 | 13684 | 14150 | 14288 | 15216 | 16007 | 16684 | 17220 | 17356 | 17478 | **17409** | -0.4% | 3.4% | 34.6% |
| Fuel oil | 5873 | 5849 | 5796 | 5884 | 5905 | 5823 | 5776 | 5759 | 5957 | 5953 | **5981** | 0.5% | 0.4% | 11.9% |
| Others | 8361 | 8704 | 8837 | 9395 | 10196 | 10696 | 11002 | 11142 | 11685 | 12108 | **12739** | 5.2% | 4.1% | 25.3% |
| Total Non-OECD | 35903 | 37464 | 38519 | 39623 | 42126 | 43676 | 45163 | 46531 | 47840 | 49218 | **50341** | 2.3% | 3.4% | 100.0% |

◆Less than 0.05%.

**Notes:** 'Light distillates' consists of aviation and motor gasolines and light distillate feedstock (LDF).
'Middle distillates' consists of jet and heating kerosenes, and gas and diesel oils (including marine bunkers).
'Fuel oil' includes marine bunkers and crude oil used directly as fuel.
'Others' consists of refinery gas, liquefied petroleum gas (LPG), solvents, petroleum coke, lubricants, bitumen, wax, other refined products and refinery fuel and loss.

**Annual changes and shares of total are calculated using thousand barrels daily figures**

An extended breakdown of oil consumption by product group is available at *bp.com/statisticalreview*

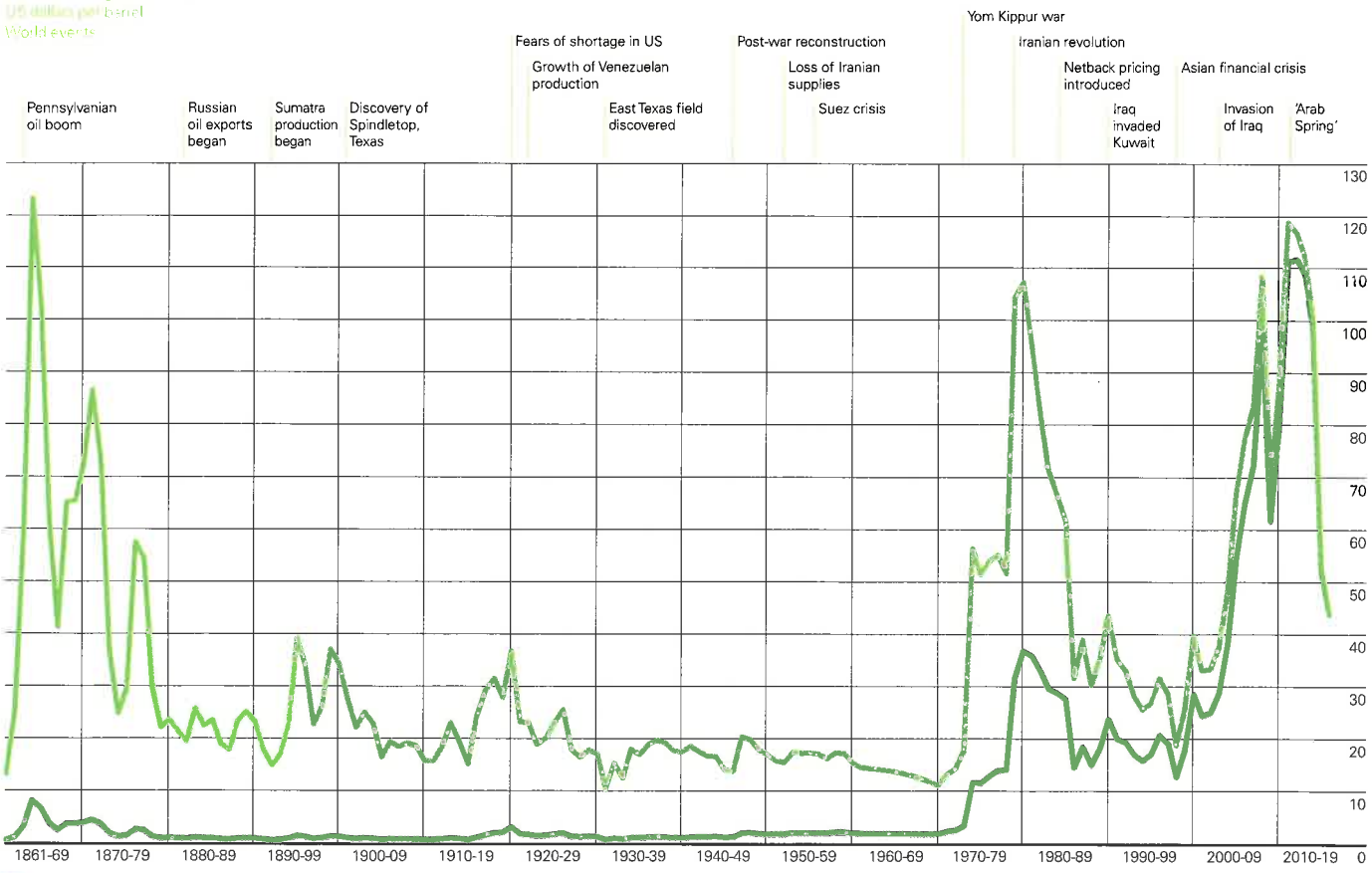
## Spot crude prices

| US dollars per barrel | Dubai $/bbl* | Brent $/bbl† | Nigerian Forcados $/bbl | West Texas Intermediate $/bbl‡ |
|---|---|---|---|---|
| 1981 | 34.32 | 35.93 | 36.18 | 36.08 |
| 1982 | 31.80 | 32.97 | 33.29 | 33.65 |
| 1983 | 28.78 | 29.55 | 29.54 | 30.30 |
| 1984 | 28.06 | 28.78 | 28.14 | 29.39 |
| 1985 | 27.53 | 27.56 | 27.75 | 27.98 |
| 1986 | 13.10 | 14.43 | 14.46 | 15.10 |
| 1987 | 16.95 | 18.44 | 18.39 | 19.18 |
| 1988 | 13.27 | 14.92 | 15.00 | 15.97 |
| 1989 | 15.62 | 18.23 | 18.30 | 19.68 |
| 1990 | 20.45 | 23.73 | 23.85 | 24.50 |
| 1991 | 16.63 | 20.00 | 20.11 | 21.54 |
| 1992 | 17.17 | 19.32 | 19.61 | 20.57 |
| 1993 | 14.93 | 16.97 | 17.41 | 18.45 |
| 1994 | 14.74 | 15.82 | 16.25 | 17.21 |
| 1995 | 16.10 | 17.02 | 17.26 | 18.42 |
| 1996 | 18.52 | 20.67 | 21.16 | 22.16 |
| 1997 | 18.23 | 19.09 | 19.33 | 20.61 |
| 1998 | 12.21 | 12.72 | 12.62 | 14.39 |
| 1999 | 17.25 | 17.97 | 18.00 | 19.31 |
| 2000 | 26.20 | 28.50 | 28.42 | 30.37 |
| 2001 | 22.81 | 24.44 | 24.23 | 25.93 |
| 2002 | 23.74 | 25.02 | 25.04 | 26.16 |
| 2003 | 26.78 | 28.83 | 28.66 | 31.07 |
| 2004 | 33.64 | 38.27 | 38.13 | 41.49 |
| 2005 | 49.35 | 54.52 | 55.69 | 56.59 |
| 2006 | 61.50 | 65.14 | 67.07 | 66.02 |
| 2007 | 68.19 | 72.39 | 74.48 | 72.20 |
| 2008 | 94.34 | 97.26 | 101.43 | 100.06 |
| 2009 | 61.39 | 61.67 | 63.35 | 61.92 |
| 2010 | 78.06 | 79.50 | 81.05 | 79.45 |
| 2011 | 106.18 | 111.26 | 113.65 | 95.04 |
| 2012 | 109.08 | 111.67 | 114.21 | 94.13 |
| 2013 | 105.47 | 108.66 | 111.95 | 97.99 |
| 2014 | 97.07 | 98.95 | 101.35 | 93.28 |
| 2015 | 51.20 | 52.39 | 54.41 | 48.71 |
| 2016 | 41.19 | 43.73 | 44.54 | 43.34 |

*1981-1985 Arabian Light, 1986-2016 Dubai dated.
†1981-1983 Forties, 1984-2016 Brent dated.
‡1981-1983 Posted WTI prices, 1984-2016 Spot WTI (Cushing) prices.

Source: Platts.

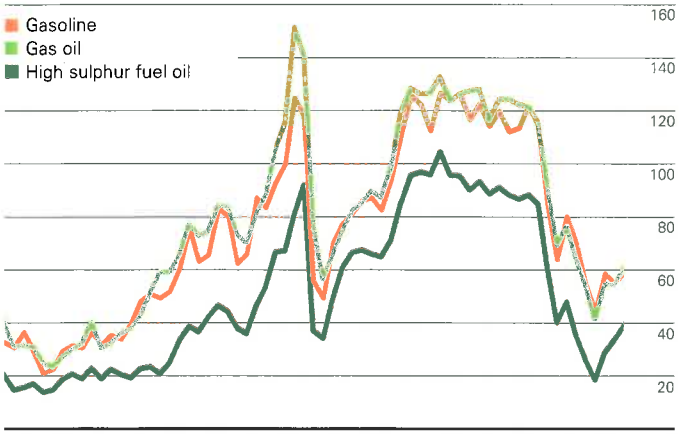
## Crude oil prices 1861-2016




■ $ 2016 (deflated using the Consumer Price Index for the US)
■ $ money of the day

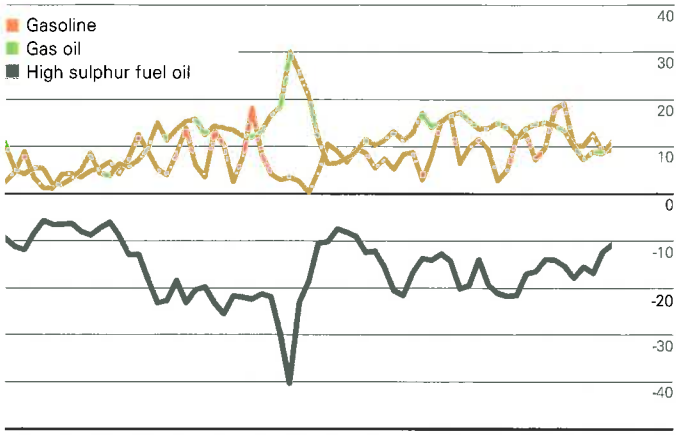
1861-1944 US average.
1945-1983 Arabian Light posted at Ras Tanura.
1984-2016 Brent dated.

## Oil product prices (Rotterdam)




Source: Platts.

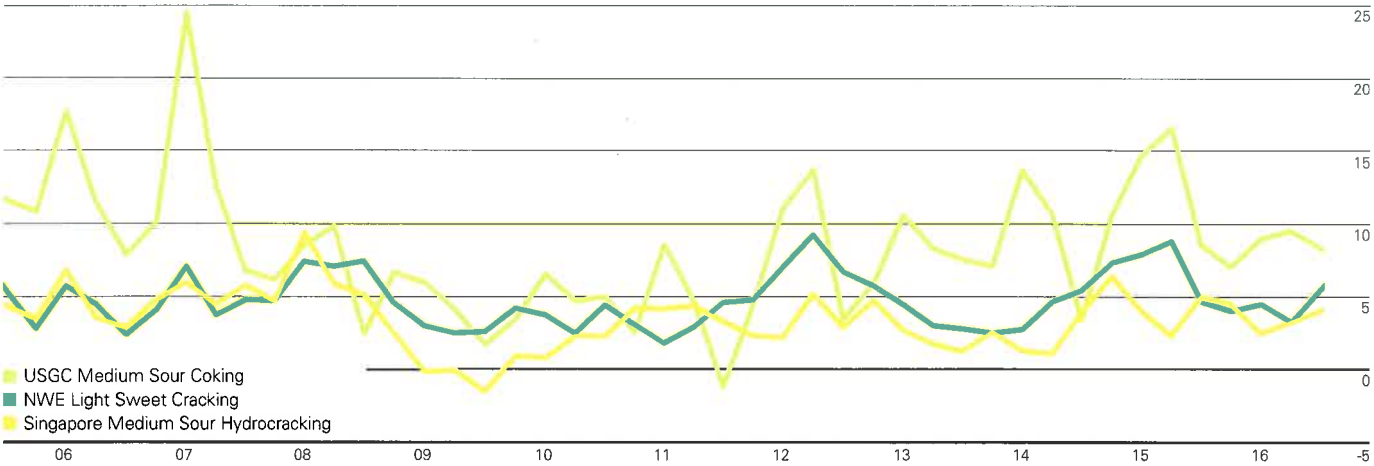
## Product differentials to crude (Rotterdam products minus Dated Brent)




Source: Platts.

## Regional refining margins

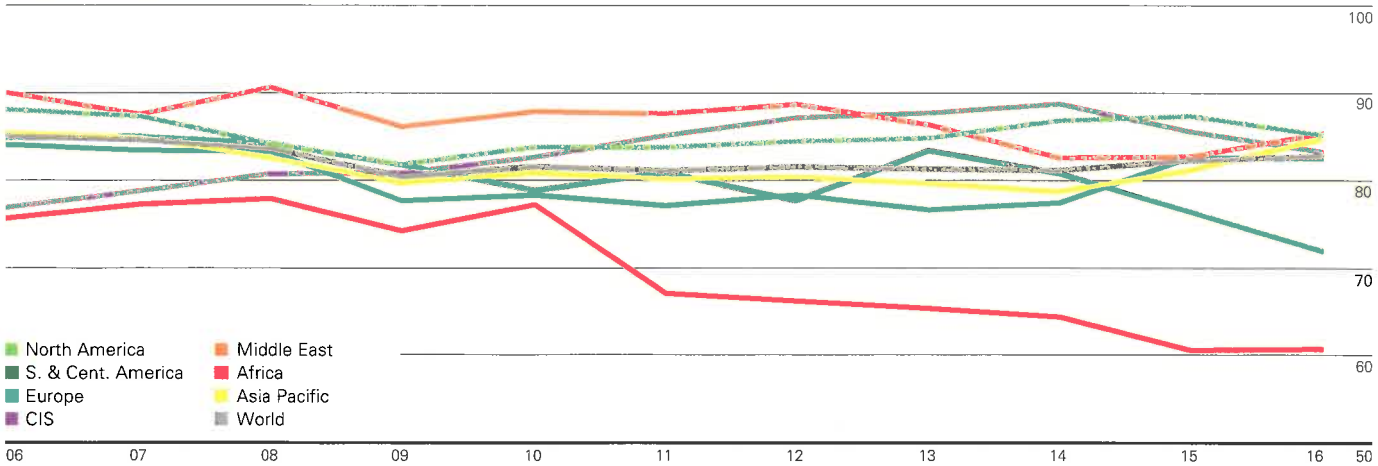
US dollars per barrel




**Note:** The refining margins presented are benchmark margins for three major global refining centres: US Gulf Coast (USGC), North West Europe (NWE – Rotterdam) and Singapore. In each case they are based on a single crude oil appropriate for that region and have optimized product yields based on a generic refinery configuration (cracking, hydrocracking or coking), again appropriate for that region. The margins are on a semi-variable basis, i.e. the margin after all variable costs and fixed energy costs.

## Refinery utilization

Percentage based on average annual capacity




Refinery throughput growth slowed to 0.6 million b/d in 2016, with crude runs falling in Mexico (-130,000 b/d), South & Central America (-210,000 b/d) and Europe & Eurasia (-300,000 b/d). Global refinery capacity increased by only 0.4 million b/d, well below 10-year average growth (1 million b/d) for the second year in a row as Chinese capacity declined. Global refinery utilisation rose from 82.4% in 2015 to 82.9% in 2016. Utilisation in South & Central America fell to 72% – the lowest since 1987.

## Oil: Refinery throughput

| Thousand barrels daily* | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Growth rate per annum 2016 | Growth rate per annum 2005-15 | Share 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| US | 15242 | 15156 | 14648 | 14336 | 14724 | 14806 | 14999 | 15312 | 15848 | 16188 | **16202** | 0.1% | 0.6% | 20.1% |
| Canada | 1788 | 1849 | 1781 | 1731 | 1774 | 1680 | 1751 | 1719 | 1640 | 1635 | **1594** | -2.5% | -1.2% | 2.0% |
| Mexico | 1270 | 1261 | 1295 | 1184 | 1184 | 1166 | 1199 | 1224 | 1155 | 1064 | **933** | -12.3% | -1.9% | 1.2% |
| Total North America | 18300 | 18266 | 17724 | 17251 | 17682 | 17652 | 17949 | 18255 | 18643 | 18887 | **18729** | -0.9% | 0.1% | 23.2% |
| Argentina | 568 | 600 | 578 | 532 | 531 | 516 | 530 | 527 | 526 | 536 | **511** | -4.7% | ◆ | 0.6% |
| Brazil | 1708 | 1741 | 1760 | 1781 | 1787 | 1813 | 1889 | 2035 | 2085 | 1972 | **1831** | -7.2% | 1.5% | 2.3% |
| Chile | 217 | 201 | 204 | 192 | 159 | 173 | 164 | 174 | 174 | 165 | **163** | -1.0% | -2.3% | 0.2% |
| Colombia | 315 | 313 | 313 | 302 | 300 | 306 | 305 | 284 | 247 | 244 | **339** | 39.0% | -2.0% | 0.4% |
| Curacao | 205 | 209 | 197 | 183 | 64 | 164 | 165 | 170 | 189 | 178 | **173** | -2.6% | -1.9% | 0.2% |
| Ecuador | 152 | 150 | 155 | 156 | 137 | 156 | 152 | 141 | 125 | 121 | **150** | 24.5% | -2.2% | 0.2% |
| Peru | 172 | 177 | 177 | 192 | 195 | 189 | 189 | 183 | 185 | 182 | **185** | 1.6% | 0.1% | 0.2% |
| Trinidad & Tobago | 152 | 154 | 150 | 152 | 126 | 137 | 107 | 132 | 105 | 125 | **148** | 18.2% | -2.7% | 0.2% |
| Venezuela | 1022 | 1004 | 1010 | 961 | 969 | 991 | 936 | 952 | 920 | 863 | **698** | -19.2% | -1.6% | 0.9% |
| Other S. & Cent. America | 957 | 972 | 967 | 809 | 709 | 720 | 335 | 301 | 295 | 316 | **291** | -7.7% | -10.9% | 0.4% |
| Total S. & Cent. America | 5468 | 5522 | 5511 | 5258 | 4972 | 5165 | 4771 | 4899 | 4851 | 4702 | **4490** | -4.5% | -1.5% | 5.6% |
| Austria | 172 | 174 | 176 | 169 | 158 | 168 | 170 | 174 | 173 | 179 | **164** | -8.3% | 0.1% | 0.2% |
| Azerbaijan | 150 | 150 | 147 | 121 | 124 | 127 | 124 | 132 | 135 | 130 | **117** | -9.8% | -1.3% | 0.1% |
| Belarus | 427 | 429 | 427 | 434 | 330 | 411 | 434 | 425 | 448 | 462 | **392** | -15.1% | 1.5% | 0.5% |
| Belgium | 631 | 662 | 675 | 629 | 668 | 598 | 634 | 555 | 645 | 644 | **640** | -0.5% | ◆ | 0.8% |
| Bulgaria | 143 | 143 | 143 | 125 | 110 | 102 | 118 | 113 | 104 | 121 | **125** | 3.4% | -0.2% | 0.2% |
| Czech Republic | 158 | 149 | 165 | 148 | 159 | 143 | 145 | 134 | 151 | 145 | **109** | -25.1% | -0.7% | 0.1% |
| Denmark | 159 | 157 | 156 | 157 | 146 | 137 | 153 | 144 | 139 | 147 | **140** | -4.9% | -0.5% | 0.2% |
| Finland | 208 | 218 | 222 | 220 | 211 | 225 | 215 | 227 | 225 | 197 | **226** | 14.6% | -0.2% | 0.3% |
| France | 1655 | 1654 | 1676 | 1449 | 1314 | 1313 | 1138 | 1117 | 1096 | 1152 | **1111** | -3.5% | -3.9% | 1.4% |
| Germany | 2245 | 2193 | 2151 | 2026 | 1915 | 1876 | 1901 | 1857 | 1833 | 1875 | **1887** | 0.6% | -2.0% | 2.3% |
| Greece | 379 | 385 | 360 | 346 | 393 | 331 | 410 | 399 | 416 | 436 | **464** | 6.6% | 1.5% | 0.6% |
| Hungary | 139 | 142 | 140 | 127 | 128 | 132 | 122 | 120 | 131 | 130 | **133** | 2.3% | -0.8% | 0.2% |
| Ireland | 63 | 67 | 62 | 55 | 60 | 59 | 61 | 57 | 55 | 68 | **64** | -4.9% | 0.2% | 0.1% |
| Italy | 1847 | 1863 | 1741 | 1614 | 1673 | 1570 | 1475 | 1259 | 1198 | 1347 | **1300** | -3.5% | -3.3% | 1.6% |
| Kazakhstan | 225 | 229 | 236 | 235 | 257 | 326 | 331 | 341 | 361 | 342 | **339** | -1.1% | 4.6% | 0.4% |
| Lithuania | 168 | 118 | 195 | 174 | 190 | 189 | 181 | 192 | 160 | 170 | **185** | 8.4% | -0.9% | 0.2% |
| Netherlands | 1226 | 1204 | 1160 | 1143 | 1189 | 1144 | 1144 | 1044 | 1067 | 1138 | **1147** | 0.8% | -1.0% | 1.4% |
| Norway | 307 | 305 | 279 | 278 | 259 | 289 | 287 | 292 | 274 | 293 | **230** | -21.6% | 0.2% | 0.3% |
| Poland | 396 | 402 | 417 | 408 | 458 | 482 | 505 | 488 | 486 | 532 | **517** | -2.9% | 3.5% | 0.6% |
| Portugal | 265 | 247 | 241 | 209 | 227 | 206 | 221 | 239 | 217 | 278 | **273** | -1.8% | 0.5% | 0.3% |
| Romania | 266 | 280 | 282 | 247 | 217 | 194 | 182 | 189 | 194 | 208 | **228** | 9.9% | -2.9% | 0.3% |
| Russian Federation | 4423 | 4597 | 4742 | 4765 | 5018 | 5185 | 5438 | 5636 | 5926 | 5773 | **5709** | -1.1% | 3.3% | 7.1% |
| Slovakia | 113 | 120 | 117 | 114 | 110 | 120 | 108 | 116 | 105 | 119 | **116** | -2.9% | 0.9% | 0.1% |
| Spain | 1210 | 1159 | 1174 | 1057 | 1060 | 1051 | 1186 | 1168 | 1185 | 1304 | **1303** | ◆ | 0.9% | 1.6% |
| Sweden | 415 | 369 | 413 | 394 | 406 | 374 | 417 | 332 | 380 | 401 | **395** | -1.6% | -0.3% | 0.5% |
| Switzerland | 109 | 94 | 101 | 95 | 90 | 87 | 68 | 97 | 98 | 56 | **59** | 4.3% | -5.2% | 0.1% |
| Turkey | 530 | 518 | 490 | 375 | 392 | 394 | 398 | 421 | 406 | 526 | **532** | 1.3% | 0.1% | 0.7% |
| Turkmenistan | 137 | 144 | 149 | 152 | 170 | 165 | 157 | 160 | 163 | 157 | **153** | -2.8% | 1.1% | 0.2% |
| Ukraine | 289 | 279 | 243 | 255 | 249 | 206 | 108 | 85 | 69 | 64 | **65** | 0.9% | -16.1% | 0.1% |
| United Kingdom | 1533 | 1528 | 1533 | 1440 | 1395 | 1433 | 1348 | 1197 | 1125 | 1118 | **1069** | -4.3% | -3.6% | 1.3% |
| Uzbekistan | 105 | 95 | 93 | 88 | 73 | 69 | 62 | 58 | 62 | 63 | **70** | 11.5% | -5.0% | 0.1% |
| Other Europe & Eurasia | 189 | 199 | 184 | 201 | 186 | 160 | 134 | 140 | 132 | 148 | **158** | 6.6% | -3.2% | 0.2% |
| Total Europe & Eurasia | 20284 | 20273 | 20291 | 19256 | 19335 | 19269 | 19376 | 18908 | 19158 | 19724 | **19420** | -1.5% | -0.2% | 24.1% |
| Iran | 1674 | 1719 | 1779 | 1826 | 1829 | 1873 | 1932 | 1999 | 1932 | 1867 | **1891** | 1.3% | 1.4% | 2.3% |
| Iraq | 468 | 447 | 476 | 417 | 520 | 543 | 579 | 598 | 487 | 409 | **440** | 7.6% | -1.4% | 0.5% |
| Israel | 202 | 189 | 215 | 220 | 226 | 218 | 219 | 238 | 245 | 250 | **232** | -7.4% | 2.3% | 0.3% |
| Kuwait | 898 | 923 | 906 | 869 | 892 | 852 | 916 | 873 | 879 | 913 | **830** | -9.2% | 0.6% | 1.0% |
| Qatar | 130 | 149 | 145 | 158 | 294 | 278 | 292 | 270 | 261 | 253 | **280** | 10.8% | 8.2% | 0.3% |
| Saudi Arabia | 1992 | 1936 | 2018 | 1928 | 1922 | 1884 | 1953 | 1876 | 2201 | 2479 | **2750** | 11.0% | 2.2% | 3.4% |
| United Arab Emirates | 592 | 529 | 493 | 492 | 571 | 635 | 638 | 650 | 659 | 929 | **1000** | 7.6% | 4.4% | 1.2% |
| Other Middle East | 743 | 721 | 868 | 840 | 809 | 805 | 719 | 685 | 671 | 629 | **605** | -3.8% | -2.1% | 0.8% |
| Total Middle East | 6699 | 6615 | 6900 | 6750 | 7063 | 7087 | 7248 | 7189 | 7335 | 7728 | **8028** | 3.9% | 1.5% | 10.0% |
| Algeria | 382 | 391 | 429 | 475 | 548 | 520 | 478 | 492 | 615 | 591 | **584** | -1.1% | 5.2% | 0.7% |
| Egypt | 631 | 653 | 617 | 598 | 580 | 523 | 534 | 523 | 525 | 535 | **508** | -5.0% | -1.7% | 0.6% |
| South Africa | 385 | 388 | 408 | 388 | 384 | 384 | 401 | 411 | 461 | 441 | **477** | 8.1% | -0.3% | 0.6% |
| Other Africa | 948 | 915 | 944 | 842 | 910 | 726 | 797 | 827 | 625 | 532 | **533** | 0.3% | -6.6% | 0.7% |
| Total Africa | 2345 | 2348 | 2398 | 2303 | 2422 | 2154 | 2210 | 2254 | 2226 | 2099 | **2102** | 0.2% | -1.7% | 2.6% |
| Australia | 597 | 614 | 570 | 577 | 606 | 627 | 600 | 588 | 538 | 427 | **433** | 1.5% | -3.4% | 0.5% |
| Bangladesh | 26 | 25 | 25 | 18 | 26 | 27 | 24 | 27 | 24 | 25 | **23** | -10.1% | 1.1% | ◆ |
| China | 6235 | 6594 | 6828 | 7452 | 8408 | 8686 | 9199 | 9599 | 10155 | 10684 | **11023** | 3.2% | 6.2% | 13.7% |
| India | 2860 | 3107 | 3213 | 3641 | 3899 | 4085 | 4302 | 4462 | 4475 | 4561 | **4931** | 8.1% | 5.9% | 6.1% |
| Indonesia | 913 | 904 | 910 | 900 | 853 | 880 | 820 | 822 | 848 | 836 | **885** | 5.8% | -1.6% | 1.1% |
| Japan | 4026 | 3995 | 3946 | 3627 | 3619 | 3410 | 3400 | 3453 | 3289 | 3258 | **3280** | 0.7% | -2.4% | 4.1% |
| Malaysia | 522 | 557 | 560 | 554 | 470 | 516 | 575 | 558 | 553 | 508 | **537** | 5.6% | ◆ | 0.7% |
| New Zealand | 97 | 91 | 99 | 95 | 99 | 108 | 109 | 105 | 101 | 109 | **108** | -1.4% | 1.3% | 0.1% |
| Pakistan | 222 | 238 | 226 | 209 | 190 | 193 | 192 | 223 | 232 | 257 | **242** | -5.7% | 1.1% | 0.3% |
| Philippines | 211 | 206 | 184 | 147 | 181 | 190 | 170 | 158 | 168 | 212 | **216** | 1.7% | 0.3% | 0.3% |
| Singapore | 1155 | 1163 | 1161 | 844 | 979 | 1035 | 1020 | 936 | 871 | 897 | **965** | 7.6% | -2.7% | 1.2% |
| South Korea | 2407 | 2417 | 2365 | 2297 | 2390 | 2533 | 2582 | 2484 | 2516 | 2784 | **2928** | 5.2% | 1.8% | 3.6% |
| Taiwan | 1000 | 992 | 900 | 956 | 876 | 809 | 897 | 847 | 850 | 838 | **861** | 2.7% | -2.2% | 1.1% |
| Thailand | 926 | 922 | 927 | 938 | 963 | 937 | 978 | 1078 | 1029 | 1132 | **1096** | -3.2% | 2.2% | 1.4% |
| Vietnam | 9 | 10 | 10 | 43 | 123 | 124 | 142 | 145 | 125 | 145 | **148** | 2.5% | 32.0% | 0.2% |
| Other Asia Pacific | 104 | 94 | 94 | 98 | 97 | 100 | 89 | 97 | 96 | 92 | **107** | 16.8% | -0.9% | 0.1% |
| Total Asia Pacific | 21310 | 21930 | 22017 | 22396 | 23708 | 24258 | 25098 | 25581 | 25869 | 26765 | **27781** | 3.8% | 2.6% | 34.5% |
| **Total World** | **74406** | **74953** | **74840** | **73207** | **75257** | **75586** | **76653** | **77086** | **78083** | **79905** | **80550** | **0.8%** | **0.8%** | **100.0%** |
| of which: OECD | 39608 | 39384 | 38572 | 36711 | 37191 | 36854 | 37130 | 36733 | 36912 | 37965 | **37752** | -0.6% | -0.5% | 46.9% |
| Non-OECD | 34798 | 35569 | 36269 | 36496 | 38066 | 38732 | 39523 | 40353 | 41171 | 41940 | **42798** | 2.0% | 2.1% | 53.1% |
| European Union | 13485 | 13333 | 13286 | 12345 | 12270 | 11915 | 11895 | 11181 | 11132 | 11766 | **11660** | -0.9% | -1.5% | 14.5% |
| CIS | 5758 | 5926 | 6040 | 6053 | 6224 | 6492 | 6656 | 6840 | 7168 | 6996 | **6849** | -2.1% | 2.3% | 8.5% |

*Atmospheric distillation capacity on a calendar-day basis.
◆Less than 0.05%.

Source: Includes data from ICIS.

## Oil: Refinery capacities

| Thousand barrels daily* | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Growth rate per annum 2016 | Growth rate per annum 2005-15 | Share 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| US | 17443 | 17594 | 17672 | 17584 | 17736 | 17322 | 17824 | 17925 | 17889 | 18315 | **18621** | 1.7% | 0.5% | 19.1% |
| Canada | 1914 | 1907 | 1951 | 1976 | 1913 | 2040 | 2050 | 1965 | 1965 | 1966 | **1967** | ◆ | 0.4% | 2.0% |
| Mexico | 1463 | 1463 | 1463 | 1463 | 1463 | 1606 | 1606 | 1606 | 1522 | 1522 | **1522** | – | 0.4% | 1.6% |
| Total North America | 20821 | 20964 | 21086 | 21023 | 21113 | 20967 | 21479 | 21496 | 21375 | 21803 | **22110** | 1.4% | 0.5% | 22.7% |
| Argentina | 617 | 628 | 628 | 625 | 625 | 625 | 657 | 657 | 657 | 657 | **657** | – | 0.7% | 0.7% |
| Brazil | 1942 | 1961 | 1973 | 1988 | 1988 | 2010 | 2001 | 2093 | 2235 | 2278 | **2289** | 0.5% | 1.6% | 2.3% |
| Chile | 234 | 242 | 242 | 242 | 242 | 250 | 254 | 254 | 258 | 258 | **258** | – | 0.8% | 0.3% |
| Colombia | 324 | 324 | 326 | 336 | 336 | 336 | 336 | 336 | 336 | 421 | **421** | – | 3.1% | 0.4% |
| Curacao | 320 | 320 | 320 | 320 | 320 | 320 | 320 | 320 | 320 | 320 | **320** | – | – | 0.3% |
| Ecuador | 177 | 175 | 175 | 175 | 175 | 175 | 175 | 175 | 175 | 175 | **210** | 19.7% | -0.1% | 0.2% |
| Peru | 223 | 223 | 230 | 252 | 252 | 252 | 252 | 253 | 253 | 253 | **253** | – | 1.3% | 0.3% |
| Trinidad & Tobago | 165 | 165 | 165 | 165 | 165 | 165 | 165 | 165 | 165 | 165 | **165** | – | – | 0.2% |
| Venezuela | 1294 | 1303 | 1303 | 1303 | 1303 | 1303 | 1303 | 1303 | 1303 | 1303 | **1303** | – | 0.1% | 1.3% |
| Other S. & Cent. America | 1150 | 1192 | 1176 | 900 | 901 | 1013 | 356 | 361 | 376 | 384 | **384** | – | -10.3% | 0.4% |
| Total S. & Cent. America | 6446 | 6533 | 6538 | 6306 | 6307 | 6449 | 5819 | 5917 | 6078 | 6214 | **6259** | 0.7% | -0.3% | 6.4% |
| Austria | 201 | 201 | 201 | 201 | 201 | 193 | 193 | 193 | 193 | 193 | **193** | – | -0.4% | 0.2% |
| Azerbaijan | 205 | 205 | 205 | 205 | 205 | 205 | 205 | 205 | 205 | 205 | **205** | – | – | 0.2% |
| Belarus | 460 | 460 | 460 | 460 | 460 | 460 | 460 | 460 | 460 | 460 | **460** | – | – | 0.5% |
| Belgium | 766 | 781 | 786 | 786 | 787 | 788 | 753 | 776 | 776 | 776 | **776** | – | 0.3% | 0.8% |
| Bulgaria | 205 | 175 | 175 | 180 | 195 | 195 | 195 | 195 | 195 | 195 | **195** | – | -0.5% | 0.2% |
| Czech Republic | 193 | 193 | 193 | 193 | 193 | 193 | 178 | 178 | 178 | 178 | **178** | – | -0.8% | 0.2% |
| Denmark | 189 | 189 | 189 | 189 | 189 | 181 | 181 | 181 | 180 | 180 | **180** | – | -0.5% | 0.2% |
| Finland | 261 | 261 | 261 | 261 | 261 | 261 | 261 | 261 | 261 | 261 | **261** | – | – | 0.3% |
| France | 1959 | 1962 | 1971 | 1842 | 1702 | 1610 | 1513 | 1375 | 1375 | 1375 | **1224** | -11.0% | -3.6% | 1.3% |
| Germany | 2390 | 2390 | 2366 | 2362 | 2091 | 2077 | 2097 | 2061 | 2077 | 2049 | **2024** | -1.2% | -1.2% | 2.1% |
| Greece | 425 | 425 | 425 | 425 | 490 | 495 | 498 | 498 | 498 | 498 | **498** | – | 1.8% | 0.5% |
| Hungary | 165 | 165 | 165 | 165 | 165 | 165 | 165 | 165 | 165 | 165 | **165** | – | – | 0.2% |
| Ireland | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | **75** | – | – | 0.1% |
| Italy | 2526 | 2377 | 2396 | 2396 | 2396 | 2276 | 2113 | 1876 | 1915 | 1915 | **1915** | – | -2.7% | 2.0% |
| Kazakhstan | 330 | 330 | 330 | 330 | 330 | 330 | 330 | 350 | 350 | 350 | **350** | – | 0.6% | 0.4% |
| Lithuania | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | **241** | – | – | 0.2% |
| Netherlands | 1274 | 1236 | 1280 | 1280 | 1274 | 1276 | 1274 | 1274 | 1274 | 1293 | **1293** | – | 0.1% | 1.3% |
| Norway | 316 | 316 | 316 | 316 | 316 | 316 | 316 | 316 | 316 | 316 | **316** | – | – | 0.3% |
| Poland | 498 | 493 | 492 | 491 | 560 | 580 | 582 | 582 | 582 | 581 | **581** | – | 1.4% | 0.6% |
| Portugal | 306 | 306 | 306 | 306 | 306 | 306 | 306 | 306 | 306 | 306 | **306** | – | – | 0.3% |
| Romania | 389 | 389 | 358 | 283 | 247 | 229 | 214 | 235 | 228 | 239 | **256** | 7.1% | -4.8% | 0.3% |
| Russian Federation | 5524 | 5481 | 5397 | 5435 | 5573 | 5731 | 5826 | 6245 | 6347 | 6408 | **6418** | 0.2% | 1.7% | 6.6% |
| Slovakia | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | **122** | – | – | 0.1% |
| Spain | 1362 | 1362 | 1362 | 1362 | 1421 | 1542 | 1546 | 1546 | 1546 | 1562 | **1562** | – | 1.3% | 1.6% |
| Sweden | 436 | 436 | 436 | 436 | 436 | 436 | 436 | 436 | 436 | 436 | **436** | – | – | 0.4% |
| Switzerland | 140 | 140 | 140 | 140 | 140 | 140 | 106 | 140 | 140 | 68 | **68** | – | -7.0% | 0.1% |
| Turkey | 613 | 613 | 613 | 613 | 613 | 613 | 613 | 613 | 613 | 613 | **613** | – | – | 0.6% |
| Turkmenistan | 251 | 251 | 251 | 251 | 251 | 251 | 251 | 251 | 251 | 271 | **271** | – | 0.8% | 0.3% |
| Ukraine | 525 | 526 | 566 | 582 | 474 | 474 | 248 | 262 | 248 | 248 | **248** | – | -7.2% | 0.3% |
| United Kingdom | 1836 | 1819 | 1827 | 1757 | 1757 | 1787 | 1526 | 1498 | 1337 | 1337 | **1227** | -8.3% | -3.0% | 1.3% |
| Uzbekistan | 232 | 232 | 232 | 232 | 232 | 232 | 232 | 232 | 232 | 232 | **232** | – | – | 0.2% |
| Other Europe & Eurasia | 411 | 411 | 408 | 430 | 434 | 414 | 436 | 387 | 404 | 413 | **413** | – | -0.4% | 0.4% |
| Total Europe & Eurasia | 24826 | 24645 | 24646 | 24347 | 24139 | 24195 | 23492 | 23836 | 23528 | 23563 | **23304** | -1.1% | -0.5% | 23.9% |
| Iran | 1772 | 1772 | 1805 | 1860 | 1860 | 1860 | 1952 | 1985 | 1985 | 1985 | **1985** | – | 1.6% | 2.0% |
| Iraq | 743 | 738 | 738 | 853 | 914 | 935 | 971 | 823 | 931 | 903 | **919** | 1.8% | 2.2% | 0.9% |
| Israel | 270 | 272 | 275 | 275 | 280 | 292 | 292 | 294 | 301 | 301 | **301** | – | 1.1% | 0.3% |
| Kuwait | 936 | 936 | 936 | 936 | 936 | 936 | 936 | 936 | 936 | 936 | **936** | – | – | 1.0% |
| Qatar | 137 | 137 | 137 | 283 | 283 | 283 | 283 | 283 | 283 | 283 | **429** | 51.6% | 7.5% | 0.4% |
| Saudi Arabia | 2107 | 2107 | 2107 | 2109 | 2109 | 2107 | 2107 | 2507 | 2899 | 2899 | **2899** | – | 3.2% | 3.0% |
| United Arab Emirates | 620 | 625 | 680 | 700 | 700 | 705 | 710 | 710 | 1143 | 1143 | **1143** | – | 6.3% | 1.2% |
| Other Middle East | 957 | 972 | 978 | 978 | 978 | 978 | 978 | 864 | 864 | 864 | **864** | – | 0.3% | 0.9% |
| Total Middle East | 7542 | 7559 | 7656 | 7994 | 8060 | 8036 | 8229 | 8402 | 9342 | 9314 | **9476** | 1.7% | 2.4% | 9.7% |
| Algeria | 443 | 443 | 444 | 554 | 554 | 652 | 652 | 647 | 651 | 651 | **651** | – | 3.9% | 0.7% |
| Egypt | 810 | 810 | 810 | 810 | 810 | 810 | 810 | 810 | 810 | 810 | **810** | – | – | 0.8% |
| South Africa | 520 | 520 | 520 | 520 | 520 | 520 | 520 | 520 | 520 | 520 | **520** | – | – | 0.5% |
| Other Africa | 1262 | 1264 | 1339 | 1199 | 1301 | 1247 | 1453 | 1473 | 1476 | 1476 | **1476** | – | 0.6% | 1.5% |
| Total Africa | 3035 | 3037 | 3113 | 3083 | 3185 | 3229 | 3436 | 3449 | 3457 | 3457 | **3457** | – | 0.9% | 3.5% |
| Australia | 694 | 733 | 734 | 734 | 740 | 742 | 663 | 662 | 536 | 443 | **452** | 2.0% | -4.7% | 0.5% |
| Bangladesh | 36 | 36 | 36 | 39 | 39 | 39 | 40 | 43 | 43 | 43 | **43** | – | 1.8% | ◆ |
| China | 8508 | 8737 | 9670 | 10616 | 11604 | 12296 | 12962 | 13594 | 14534 | 14306 | **14177** | -0.9% | 6.3% | 14.6% |
| India | 2872 | 2983 | 2992 | 3574 | 3703 | 3795 | 4279 | 4319 | 4319 | 4307 | **4620** | 7.3% | 5.3% | 4.7% |
| Indonesia | 1157 | 1147 | 1135 | 1135 | 1141 | 1141 | 1141 | 1152 | 1155 | 1155 | **1155** | – | 0.9% | 1.2% |
| Japan | 4588 | 4650 | 4650 | 4630 | 4291 | 4274 | 4254 | 4123 | 3749 | 3721 | **3600** | -3.2% | -2.0% | 3.7% |
| Malaysia | 528 | 534 | 568 | 572 | 582 | 601 | 606 | 612 | 612 | 612 | **612** | – | 1.6% | 0.6% |
| New Zealand | 102 | 103 | 103 | 136 | 136 | 136 | 136 | 136 | 136 | 136 | **136** | – | 2.9% | 0.1% |
| Pakistan | 271 | 271 | 274 | 273 | 277 | 277 | 275 | 390 | 390 | 392 | **392** | – | 3.9% | 0.4% |
| Philippines | 276 | 270 | 270 | 267 | 264 | 261 | 261 | 270 | 271 | 271 | **271** | – | -0.3% | 0.3% |
| Singapore | 1422 | 1427 | 1427 | 1427 | 1427 | 1427 | 1422 | 1414 | 1514 | 1514 | **1514** | – | 0.6% | 1.6% |
| South Korea | 2633 | 2679 | 2712 | 2746 | 2774 | 2864 | 2878 | 2878 | 3110 | 3110 | **3234** | 4.0% | 1.8% | 3.3% |
| Taiwan | 1140 | 1197 | 1197 | 1197 | 1197 | 1197 | 1197 | 1197 | 1197 | 988 | **988** | – | -1.6% | 1.0% |
| Thailand | 1100 | 1100 | 1165 | 1236 | 1230 | 1230 | 1230 | 1237 | 1252 | 1252 | **1235** | -1.4% | 1.5% | 1.3% |
| Vietnam | 11 | 11 | 11 | 159 | 159 | 159 | 159 | 159 | 159 | 159 | **163** | 2.5% | 30.6% | 0.2% |
| Other Asia Pacific | 212 | 212 | 214 | 219 | 219 | 220 | 220 | 226 | 233 | 233 | **233** | – | 1.0% | 0.2% |
| Total Asia Pacific | 25580 | 26080 | 27108 | 28058 | 29182 | 30059 | 31723 | 32410 | 33210 | 32842 | **32825** | 0.6% | 3.0% | 33.7% |
| **Total World** | **88220** | **88746** | **90096** | **91711** | **92586** | **93596** | **94176** | **95210** | **96990** | **96992** | **97430** | **0.5%** | **1.1%** | **100.0%** |
| of which: OECD | 45396 | 45506 | 45724 | 45503 | 45071 | 44959 | 44810 | 44314 | 43832 | 44073 | **44105** | 0.1% | -0.2% | 45.3% |
| Non-OECD | 42824 | 43240 | 44372 | 46208 | 47514 | 48637 | 49367 | 50896 | 53158 | 52920 | **53325** | 0.8% | 2.5% | 54.7% |
| European Union | 15991 | 15772 | 15800 | 15525 | 15283 | 15201 | 14641 | 14247 | 14134 | 14151 | **13882** | -1.9% | -1.2% | 14.2% |
| CIS | 7537 | 7495 | 7451 | 7505 | 7539 | 7693 | 7562 | 8016 | 8121 | 8211 | **8221** | 0.1% | 1.0% | 8.4% |

*Atmospheric distillation capacity at year end on a calendar-day basis.
◆Less than 0.05%.

Source: Includes data from ICIS.

## Oil: Trade movements

| Thousand barrels daily | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Growth rate per annum 2016 | Growth rate per annum 2005-15 | Share 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Imports** | | | | | | | | | | | | | | |
| US | 13612 | 13632 | 12872 | 11453 | 11689 | 11338 | 10587 | 9859 | 9241 | 9450 | **10056** | 6.4% | -3.5% | 15.4% |
| Europe | 13530 | 14034 | 13885 | 12608 | 12201 | 12272 | 12569 | 12815 | 12855 | 13959 | **14188** | 1.6% | 0.4% | 21.7% |
| China | 3883 | 4172 | 4494 | 5100 | 5886 | 6295 | 6675 | 6978 | 7398 | 8333 | **9216** | 10.6% | 9.3% | 14.1% |
| India | 2613 | 2924 | 3066 | 3491 | 3749 | 3823 | 4168 | 4370 | 4155 | 4357 | **4877** | 11.9% | 6.9% | 7.5% |
| Japan | 5201 | 5032 | 4925 | 4263 | 4567 | 4494 | 4743 | 4637 | 4383 | 4332 | **4179** | -3.5% | -1.9% | 6.4% |
| Rest of World | 15739 | 17598 | 17282 | 17332 | 17143 | 17717 | 17862 | 20085 | 21261 | 22543 | **22939** | 1.8% | 3.9% | 35.0% |
| **Total World** | 54579 | 57392 | 56524 | 54247 | 55234 | 55938 | 56604 | 58744 | 59293 | 62974 | **65454** | 3.9% | 1.7% | 100.0% |
| **Exports** | | | | | | | | | | | | | | |
| US | 1317 | 1439 | 1967 | 1947 | 2154 | 2495 | 2682 | 3563 | 4033 | 4521 | **4723** | 4.5% | 14.9% | 7.2% |
| Canada | 2330 | 2457 | 2498 | 2518 | 2599 | 2798 | 3056 | 3296 | 3536 | 3841 | **3906** | 1.7% | 5.7% | 6.0% |
| Mexico | 2102 | 1975 | 1609 | 1449 | 1539 | 1487 | 1366 | 1347 | 1293 | 1326 | **1400** | 5.6% | -4.3% | 2.1% |
| S. & Cent. America | 3681 | 3570 | 3616 | 3748 | 3568 | 3755 | 3830 | 3790 | 3939 | 4117 | **4170** | 1.3% | 1.6% | 6.4% |
| Europe | 2241 | 2305 | 2086 | 2074 | 1949 | 2106 | 2193 | 2578 | 2512 | 2990 | **3110** | 4.0% | 3.0% | 4.8% |
| Russia | 6792 | 7827 | 7540 | 7257 | 7397 | 7448 | 7457 | 7948 | 7792 | 8455 | **8634** | 2.1% | 2.1% | 13.2% |
| Other CIS | 1312 | 1538 | 1680 | 1790 | 1944 | 2080 | 1848 | 2102 | 2012 | 2024 | **1817** | -10.2% | 6.1% | 2.8% |
| Saudi Arabia | 8307 | 8101 | 8357 | 7276 | 7595 | 8120 | 8468 | 8365 | 7911 | 8017 | **8526** | 6.3% | -0.7% | 13.0% |
| Middle East (ex S. Arabia) | 12527 | 12198 | 12415 | 11744 | 11976 | 12188 | 11742 | 12242 | 12699 | 13446 | **14992** | 11.5% | 1.2% | 22.9% |
| North Africa | 3245 | 3341 | 3268 | 2943 | 2878 | 1951 | 2602 | 2127 | 1743 | 1717 | **1683** | -2.0% | -5.7% | 2.6% |
| West Africa | 4797 | 4961 | 4712 | 4531 | 4755 | 4759 | 4724 | 4590 | 4849 | 4906 | **4486** | -8.6% | 1.1% | 6.9% |
| Asia Pacific (ex Japan) | 4567 | 6004 | 5392 | 5631 | 6226 | 6088 | 6299 | 6307 | 6450 | 7068 | **7514** | 6.3% | 4.8% | 11.5% |
| Rest of World | 1362 | 1675 | 1385 | 1340 | 653 | 663 | 338 | 491 | 524 | 546 | **493** | -9.6% | -9.9% | 0.8% |
| **Total World** | 54579 | 57392 | 56524 | 54247 | 55234 | 55938 | 56604 | 58744 | 59293 | 62974 | 65454 | 3.9% | 1.7% | 100.0% |

**Notes:** Unless otherwise stated, this table shows inter-regional trade based on the regional classification in the table 'Oil trade in 2015 and 2016' (see page 25).
Bunkers are not included as exports.
**Annual changes and shares of total are calculated using thousand barrels daily figures.**

## Oil: Inter-area movements 2016

Crude (million tonnes)

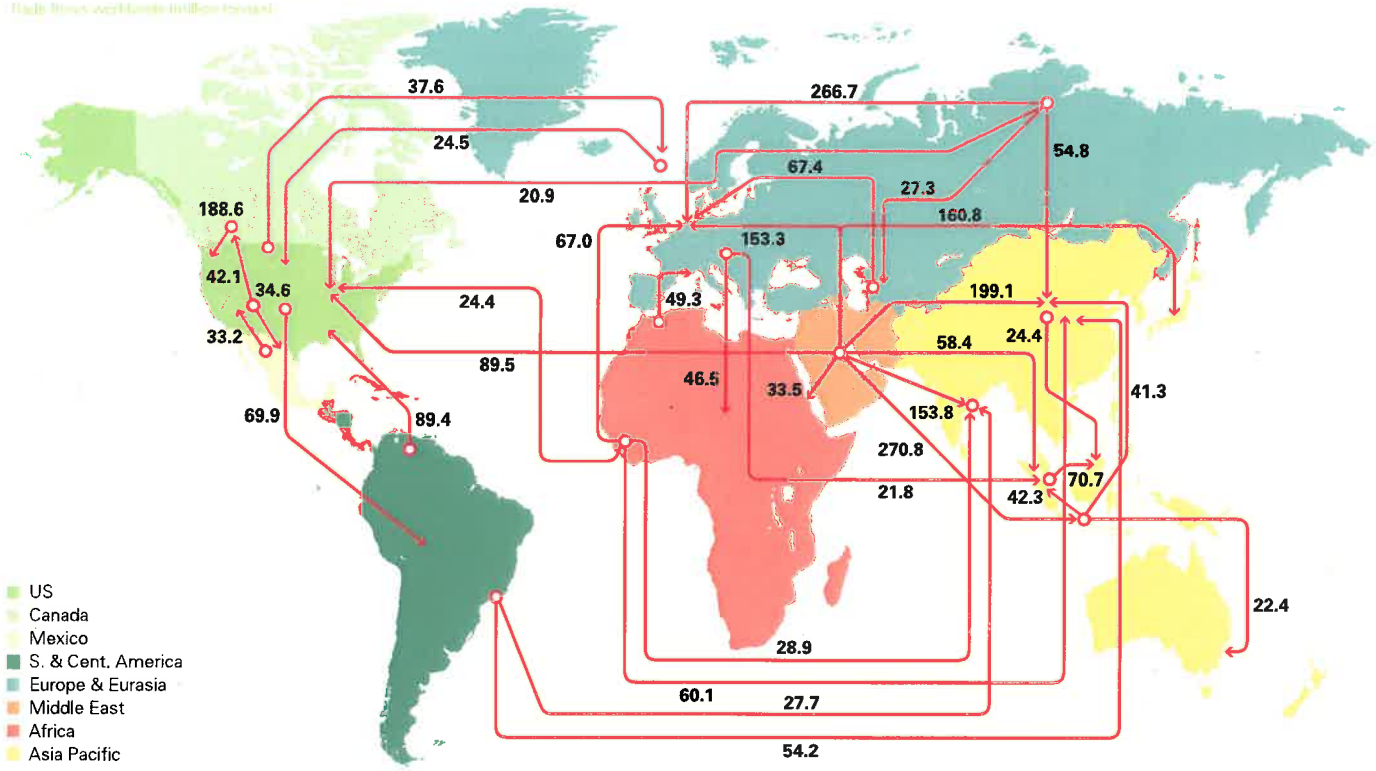
| From \ To | US | Canada | Mexico | S. & Cent. America | Europe | Russia | Other CIS | Middle East | Africa | Australasia | China | India | Japan | Singapore | Other Asia Pacific | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| US | – | 15.0 | – | 3.3 | 4.0 | – | † | 0.3 | 0.1 | † | 0.5 | – | 0.4 | † | 0.7 | **24.4** |
| Canada | 162.6 | – | – | 0.1 | 1.6 | – | – | † | † | † | 0.2 | – | – | – | – | **164.4** |
| Mexico | 29.1 | 0.7 | – | 1.7 | 13.5 | – | – | 0.1 | – | – | 1.0 | 6.2 | 4.6 | – | 3.8 | **60.8** |
| S. & Cent. America | 79.8 | 0.3 | † | – | 12.7 | † | – | – | 0.6 | – | 51.0 | 27.7 | 1.7 | 0.3 | 3.4 | **177.4** |
| Europe | 3.2 | 2.1 | – | 1.2 | – | † | † | 0.5 | 0.7 | † | 5.8 | 1.2 | – | † | 2.9 | **17.6** |
| Russia | 1.9 | – | – | 2.9 | 177.4 | – | 18.2 | 0.4 | † | 0.4 | 52.5 | 0.3 | 10.0 | 0.7 | 9.2 | **274.0** |
| Other CIS | 0.5 | 1.1 | – | – | 61.6 | 0.8 | – | 5.3 | 0.7 | – | 4.2 | 1.3 | 0.4 | – | 5.9 | **81.7** |
| Iraq | 20.9 | – | – | 0.4 | 49.7 | † | – | 3.7 | 1.2 | – | 36.2 | 38.0 | 4.0 | 1.4 | 21.9 | **177.5** |
| Kuwait | 10.4 | † | – | – | 9.6 | – | – | † | 2.6 | – | 16.3 | 10.1 | 11.5 | 6.4 | 36.2 | **103.3** |
| Saudi Arabia | 54.8 | 3.1 | – | 3.3 | 43.0 | – | – | 13.4 | 8.0 | 1.0 | 51.0 | 40.3 | 59.0 | 14.4 | 84.1 | **375.3** |
| UAE | 0.6 | † | – | † | 0.7 | † | – | † | 0.7 | 4.7 | 12.2 | 17.4 | 39.6 | 12.6 | 34.7 | **123.2** |
| Other Middle East | 1.5 | † | – | † | 22.2 | – | † | 0.1 | 0.8 | 1.0 | 68.4 | 30.2 | 30.3 | 7.4 | 41.3 | **203.2** |
| North Africa | 3.6 | 3.4 | – | 1.5 | 38.5 | – | † | 1.1 | † | 0.1 | 1.7 | 3.6 | 0.1 | 0.6 | 3.8 | **58.2** |
| West Africa | 22.2 | 3.5 | – | 10.1 | 64.6 | † | † | † | 10.7 | 1.6 | 59.5 | 28.9 | 0.3 | 0.1 | 15.0 | **216.5** |
| East & S. Africa | – | – | – | – | 0.1 | – | † | † | † | – | 6.7 | † | † | † | † | **6.9** |
| Australasia | 0.2 | – | – | 0.2 | † | – | – | † | † | – | 3.2 | † | 0.4 | 0.5 | 4.9 | **9.4** |
| China | – | – | – | † | † | – | – | † | 0.2 | † | – | – | 1.2 | † | 1.6 | **2.9** |
| India | – | – | – | † | † | – | – | – | † | † | – | – | – | – | † | **†** |
| Japan | – | † | – | † | – | – | – | – | – | † | – | – | – | † | † | **†** |
| Singapore | – | – | – | – | – | – | – | – | – | † | † | † | – | – | 0.1 | **0.1** |
| Other Asia Pacific | 2.1 | † | † | † | † | † | – | 0.1 | † | 11.6 | 12.3 | 7.1 | 4.4 | 3.5 | – | **41.0** |
| **Total imports** | 393.3 | 29.2 | 1 | 24.6 | 499.4 | 0.8 | 18.3 | 25.1 | 26.3 | 20.4 | 382.6 | 212.3 | 168.0 | 48.1 | 269.5 | 2117.8 |

Product (million tonnes)

| From \ To | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| US | – | 27.0 | 34.6 | 66.6 | 33.6 | † | † | 2.3 | 5.6 | 0.5 | 7.2 | 6.7 | 7.7 | 4.3 | 7.0 | **203.1** |
| Canada | 26.0 | – | 0.1 | 0.3 | 2.1 | † | † | † | 0.2 | † | 0.2 | 0.1 | 0.4 | † | 0.1 | **29.4** |
| Mexico | 4.2 | † | – | 1.5 | 0.2 | † | † | † | 0.1 | † | 0.2 | † | – | 2.5 | 0.2 | **8.8** |
| S. & Cent. America | 9.6 | 0.1 | 1.1 | – | 4.8 | † | † | 0.2 | 1.8 | 0.1 | 3.2 | † | 0.2 | 7.9 | 0.6 | **29.6** |
| Europe | 21.4 | 4.0 | 1.7 | 7.0 | – | 0.5 | 2.8 | 15.4 | 45.8 | 0.1 | 4.8 | 0.6 | 0.6 | 21.7 | 5.6 | **132.2** |
| Russia | 18.9 | † | – | 2.2 | 89.3 | – | 9.1 | 4.2 | 2.7 | – | 2.3 | 0.5 | 1.6 | 10.4 | 9.7 | **151.0** |
| Other CIS | 0.7 | † | † | 0.1 | 5.7 | 0.7 | – | † | 0.1 | † | 0.3 | † | † | 0.2 | 0.8 | **8.7** |
| Iraq | 0.2 | – | – | – | 0.1 | – | † | 0.2 | † | – | † | 0.1 | † | 0.5 | 0.3 | **1.5** |
| Kuwait | † | – | – | 0.6 | 2.3 | – | † | 1.1 | 3.0 | † | 1.4 | 0.9 | 2.9 | 2.0 | 10.7 | **25.0** |
| Saudi Arabia | 0.3 | † | – | 0.5 | 12.6 | – | † | 1.3 | 6.4 | † | 2.2 | 7.7 | 2.3 | 5.1 | 9.9 | **48.4** |
| UAE | 0.1 | † | † | 0.7 | 6.8 | † | † | 2.2 | 7.1 | 0.1 | 8.2 | 5.1 | 5.3 | 5.5 | 19.8 | **60.8** |
| Other Middle East | 0.7 | † | † | 0.3 | 6.3 | † | 0.2 | 9.4 | 3.6 | 0.1 | 3.2 | 4.0 | 5.9 | 3.1 | 11.8 | **48.6** |
| North Africa | 6.6 | † | 0.1 | 3.7 | 10.7 | † | † | 0.6 | 0.3 | † | 0.9 | 0.2 | 0.5 | † | 1.2 | **24.8** |
| West Africa | 2.2 | † | † | 0.5 | 2.4 | † | † | † | 0.2 | 0.3 | 0.6 | † | 0.1 | † | 0.9 | **7.3** |
| East & S. Africa | † | † | † | 0.1 | 0.2 | † | † | 0.8 | 0.6 | † | † | † | † | 0.2 | 0.2 | **2.3** |
| Australasia | † | † | † | † | 1.2 | † | † | † | † | – | 0.4 | † | 0.9 | 0.5 | 0.7 | **3.9** |
| China | 1.0 | 0.4 | 0.1 | 3.8 | 2.4 | 0.3 | † | 1.8 | 1.6 | 1.8 | – | 0.9 | 0.4 | 8.6 | 22.8 | **46.0** |
| India | 4.3 | † | † | 0.5 | 13.9 | † | † | 13.9 | 7.1 | 2.5 | 0.4 | – | 1.9 | 7.5 | 9.9 | **61.9** |
| Japan | 1.1 | † | 0.1 | 0.6 | 0.2 | † | † | 0.1 | † | 4.2 | 2.8 | † | – | 2.7 | 2.9 | **14.7** |
| Singapore | 0.9 | † | 0.2 | 0.4 | 2.0 | † | † | 0.7 | 2.4 | 7.0 | 7.0 | 1.4 | 1.2 | – | 70.6 | **93.7** |
| Other Asia Pacific | 6.2 | † | 0.2 | 1.2 | 4.0 | 0.1 | † | 1.0 | 3.7 | 10.9 | 29.1 | 1.6 | 7.0 | 38.7 | – | **103.5** |
| **Total imports** | 104.5 | 31.6 | 38.2 | 90.5 | 200.8 | 1.7 | 12.2 | 55.0 | 92.4 | 27.6 | 74.5 | 30.0 | 35.1 | 121.4 | 185.8 | 1105.2 |

†Less than 0.05.
**Notes:** Bunkers are not included as exports. Intra-area movements (for example, between countries in Europe) are excluded.
Crude imports and exports include condensates.

## Major trade movements 2016




## Oil trade in 2015 and 2016

| | 2015 | | | | 2016 | | | |
|---|---|---|---|---|---|---|---|---|
| Million tonnes | Crude imports | Product imports | Crude exports | Product exports | Crude imports | Product imports | Crude exports | Product exports |
| US | 366.7 | 99.8 | 25.3 | 191.9 | 393.3 | 104.5 | 24.4 | 203.1 |
| Canada | 32.3 | 29.4 | 159.3 | 30.7 | 29.2 | 31.6 | 164.4 | 29.4 |
| Mexico | † | 35.2 | 57.6 | 8.1 | † | 38.2 | 60.8 | 8.8 |
| S. & Cent. America | 27.0 | 88.9 | 173.4 | 30.4 | 24.6 | 90.5 | 177.4 | 29.6 |
| Europe | 499.9 | 187.6 | 11.8 | 131.7 | 499.4 | 200.8 | 17.6 | 132.2 |
| Russia | 2.9 | 2.0 | 261.9 | 152.9 | 0.8 | 1.7 | 274.0 | 151.0 |
| Other CIS | 23.1 | 12.8 | 88.5 | 11.8 | 18.3 | 12.2 | 81.7 | 8.7 |
| Iraq | – | 1.7 | 161.2 | 0.8 | † | 1.2 | 177.5 | 1.5 |
| Kuwait | 0.1 | 0.7 | 96.6 | 26.4 | † | 0.8 | 103.3 | 25.0 |
| Saudi Arabia | † | 7.3 | 359.2 | 38.4 | † | 7.3 | 375.3 | 48.4 |
| United Arab Emirates | 0.4 | 16.4 | 125.4 | 54.2 | 1.2 | 24.4 | 123.2 | 60.8 |
| Other Middle East | 26.2 | 19.3 | 157.5 | 42.4 | 23.9 | 21.4 | 203.2 | 48.6 |
| North Africa | 8.4 | 35.2 | 60.6 | 23.9 | 4.4 | 34.4 | 58.2 | 24.8 |
| West Africa | 0.8 | 31.3 | 236.7 | 7.3 | 0.7 | 32.9 | 216.5 | 7.3 |
| East & S. Africa | 20.0 | 31.3 | 8.8 | 2.7 | 21.2 | 25.1 | 6.9 | 2.3 |
| Australasia | 24.8 | 24.4 | 10.5 | 3.9 | 20.4 | 27.6 | 9.4 | 3.9 |
| China | 336.2 | 75.7 | 1.8 | 36.2 | 382.6 | 74.5 | 2.9 | 46.0 |
| India | 193.3 | 22.8 | 0.2 | 56.6 | 212.3 | 30.0 | † | 61.9 |
| Japan | 168.9 | 44.9 | 0.3 | 14.7 | 168.0 | 39.1 | † | 14.7 |
| Singapore | 45.9 | 125.8 | 0.1 | 87.7 | 48.1 | 121.4 | 0.1 | 93.7 |
| Other Asia Pacific | 259.1 | 164.2 | 39.1 | 104.0 | 269.5 | 185.8 | 41.0 | 103.5 |
| **Total World** | 2035.9 | 1056.7 | 2035.9 | 1056.7 | 2117.8 | 1105.2 | 2117.8 | 1105.2 |
| Thousand barrels daily | | | | | | | | |
| US | 7365 | 2086 | 509 | 4012 | 7877 | 2179 | 489 | 4234 |
| Canada | 649 | 614 | 3200 | 641 | 586 | 659 | 3293 | 613 |
| Mexico | ‡ | 735 | 1157 | 169 | ‡ | 796 | 1217 | 184 |
| S. & Cent. America | 542 | 1858 | 3482 | 636 | 493 | 1887 | 3554 | 617 |
| Europe | 10039 | 3921 | 237 | 2753 | 10001 | 4187 | 353 | 2756 |
| Russia | 58 | 42 | 5259 | 3195 | 15 | 35 | 5487 | 3147 |
| Other CIS | 464 | 268 | 1777 | 247 | 366 | 254 | 1636 | 180 |
| Iraq | – | 35 | 3238 | 17 | ‡ | 24 | 3554 | 30 |
| Kuwait | 2 | 15 | 1939 | 551 | ‡ | 17 | 2069 | 521 |
| Saudi Arabia | ‡ | 153 | 7214 | 803 | ‡ | 152 | 7517 | 1009 |
| United Arab Emirates | 8 | 343 | 2518 | 1133 | 23 | 509 | 2468 | 1268 |
| Other Middle East | 526 | 404 | 3163 | 887 | 480 | 446 | 4069 | 1013 |
| North Africa | 168 | 737 | 1218 | 499 | 88 | 717 | 1165 | 518 |
| West Africa | 17 | 655 | 4753 | 153 | 14 | 686 | 4335 | 151 |
| East & S. Africa | 401 | 653 | 177 | 56 | 425 | 524 | 138 | 49 |
| Australasia | 497 | 509 | 211 | 81 | 408 | 575 | 189 | 81 |
| China | 6751 | 1582 | 36 | 757 | 7663 | 1553 | 58 | 959 |
| India | 3881 | 476 | 3 | 1184 | 4252 | 625 | ‡ | 1291 |
| Japan | 3392 | 939 | 6 | 306 | 3364 | 815 | ‡ | 307 |
| Singapore | 921 | 2630 | 2 | 1834 | 963 | 2531 | 2 | 1954 |
| Other Asia Pacific | 5204 | 3433 | 786 | 2174 | 5397 | 3872 | 822 | 2159 |
| **Total World** | 40885 | 22089 | 40885 | 22089 | 42413 | 23041 | 42413 | 23041 |

†Less than 0.05.
‡Less than 0.5.
**Notes:** Bunkers are not included as exports. Intra-area movements (for example, between countries in Europe) are excluded.
Crude imports and exports include condensates.

# Natural gas

## Total proved reserves

| | At end 1996 Trillion cubic metres | At end 2006 Trillion cubic metres | At end 2015 Trillion cubic metres | At end 2016 Trillion cubic metres | At end 2016 Trillion cubic feet | At end 2016 Share of total | At end 2016 R/P ratio |
|---|---|---|---|---|---|---|---|
| US | 4.7 | 6.0 | 8.7 | **8.7** | **307.7** | 4.7% | 11.6 |
| Canada | 1.9 | 1.6 | 2.2 | **2.2** | **76.7** | 1.2% | 14.3 |
| Mexico | 1.8 | 0.4 | 0.2 | **0.2** | **8.6** | 0.1% | 5.2 |
| Total North America | 8.5 | 8.0 | 11.1 | **11.1** | **393.0** | 6.0% | 11.7 |
| Argentina | 0.6 | 0.4 | 0.4 | **0.4** | **12.4** | 0.2% | 9.2 |
| Bolivia | 0.1 | 0.7 | 0.3 | **0.3** | **9.9** | 0.2% | 14.2 |
| Brazil | 0.2 | 0.3 | 0.4 | **0.4** | **13.1** | 0.2% | 15.8 |
| Colombia | 0.2 | 0.1 | 0.1 | **0.1** | **4.4** | 0.1% | 11.9 |
| Peru | 0.2 | 0.3 | 0.4 | **0.4** | **14.1** | 0.2% | 28.5 |
| Trinidad & Tobago | 0.5 | 0.5 | 0.3 | **0.3** | **10.6** | 0.2% | 8.7 |
| Venezuela | 4.1 | 4.7 | 5.7 | **5.7** | **201.3** | 3.1% | 166.3 |
| Other S. & Cent. America | 0.1 | 0.1 | 0.1 | **0.1** | **2.2** | ◆ | 26.7 |
| Total S. & Cent. America | 6.0 | 7.2 | 7.7 | **7.6** | **268.0** | 4.1% | 42.9 |
| Azerbaijan | n/a | 0.9 | 1.1 | **1.1** | **40.6** | 0.6% | 65.8 |
| Denmark | 0.1 | 0.1 | † | **†** | **0.5** | ◆ | 2.9 |
| Germany | 0.2 | 0.1 | † | **†** | **1.2** | ◆ | 5.3 |
| Italy | 0.3 | 0.1 | † | **†** | **1.2** | ◆ | 6.6 |
| Kazakhstan | n/a | 1.3 | 1.0 | **1.0** | **34.0** | 0.5% | 48.3 |
| Netherlands | 1.6 | 1.2 | 0.7 | **0.7** | **24.6** | 0.4% | 17.4 |
| Norway | 1.5 | 2.3 | 1.9 | **1.8** | **62.3** | 0.9% | 15.1 |
| Poland | 0.1 | 0.1 | 0.1 | **0.1** | **3.2** | ◆ | 23.0 |
| Romania | 0.4 | 0.6 | 0.1 | **0.1** | **3.9** | 0.1% | 12.0 |
| Russian Federation | 30.9 | 31.2 | 32.3 | **32.3** | **1139.6** | 17.3% | 55.7 |
| Turkmenistan | n/a | 2.3 | 17.5 | **17.5** | **617.3** | 9.4% | 261.7 |
| Ukraine | n/a | 0.7 | 0.6 | **0.6** | **20.9** | 0.3% | 33.2 |
| United Kingdom | 0.8 | 0.4 | 0.2 | **0.2** | **7.3** | 0.1% | 5.0 |
| Uzbekistan | n/a | 1.2 | 1.1 | **1.1** | **38.3** | 0.6% | 17.3 |
| Other Europe & Eurasia | 0.2 | 0.2 | 0.2 | **0.2** | **7.2** | 0.1% | 23.2 |
| Total Europe & Eurasia | 39.8 | 42.8 | 56.8 | **56.7** | **2002.0** | 30.4% | 56.3 |
| Bahrain | 0.1 | 0.1 | 0.2 | **0.2** | **5.8** | 0.1% | 10.5 |
| Iran | 23.0 | 26.9 | 33.5 | **33.5** | **1183.0** | 18.0% | 165.5 |
| Iraq | 3.4 | 3.2 | 3.7 | **3.7** | **130.5** | 2.0% | * |
| Israel | † | † | 0.2 | **0.2** | **5.5** | 0.1% | 16.8 |
| Kuwait | 1.5 | 1.8 | 1.8 | **1.8** | **63.0** | 1.0% | 104.2 |
| Oman | 0.6 | 1.0 | 0.7 | **0.7** | **24.9** | 0.4% | 19.9 |
| Qatar | 8.5 | 25.5 | 24.3 | **24.3** | **858.1** | 13.0% | 134.1 |
| Saudi Arabia | 5.7 | 7.1 | 8.4 | **8.4** | **297.6** | 4.5% | 77.0 |
| Syria | 0.2 | 0.3 | 0.3 | **0.3** | **10.1** | 0.2% | 79.1 |
| United Arab Emirates | 5.8 | 6.4 | 6.1 | **6.1** | **215.1** | 3.3% | 98.5 |
| Yemen | 0.3 | 0.3 | 0.3 | **0.3** | **9.4** | 0.1% | 365.8 |
| Other Middle East | † | † | † | **†** | **0.2** | ◆ | 52.6 |
| Total Middle East | 49.2 | 72.6 | 79.4 | **79.4** | **2803.2** | 42.5% | 124.5 |
| Algeria | 3.7 | 4.5 | 4.5 | **4.5** | **159.1** | 2.4% | 49.3 |
| Egypt | 0.8 | 2.0 | 1.8 | **1.8** | **65.2** | 1.0% | 44.1 |
| Libya | 1.3 | 1.4 | 1.5 | **1.5** | **53.1** | 0.8% | 149.2 |
| Nigeria | 3.5 | 5.2 | 5.3 | **5.3** | **186.6** | 2.8% | 117.7 |
| Other Africa | 0.8 | 1.2 | 1.1 | **1.1** | **39.3** | 0.6% | 54.9 |
| Total Africa | 10.2 | 14.4 | 14.2 | **14.3** | **503.3** | 7.6% | 68.4 |
| Australia | 1.3 | 2.3 | 3.5 | **3.5** | **122.6** | 1.9% | 38.1 |
| Bangladesh | 0.3 | 0.4 | 0.2 | **0.2** | **7.3** | 0.1% | 7.5 |
| Brunei | 0.4 | 0.3 | 0.3 | **0.3** | **9.7** | 0.1% | 24.6 |
| China | 1.2 | 1.7 | 4.8 | **5.4** | **189.5** | 2.9% | 38.8 |
| India | 0.6 | 1.1 | 1.3 | **1.2** | **43.3** | 0.7% | 44.4 |
| Indonesia | 2.0 | 2.6 | 2.8 | **2.9** | **101.2** | 1.5% | 41.1 |
| Malaysia | 2.4 | 2.5 | 1.2 | **1.2** | **41.3** | 0.6% | 15.8 |
| Myanmar | 0.3 | 0.5 | 0.5 | **1.2** | **42.0** | 0.6% | 63.0 |
| Pakistan | 0.6 | 0.8 | 0.5 | **0.5** | **16.0** | 0.2% | 10.9 |
| Papua New Guinea | † | † | 0.1 | **0.2** | **7.4** | 0.1% | 20.1 |
| Thailand | 0.2 | 0.3 | 0.2 | **0.2** | **7.3** | 0.1% | 5.4 |
| Vietnam | 0.2 | 0.2 | 0.6 | **0.6** | **21.8** | 0.3% | 57.6 |
| Other Asia Pacific | 0.4 | 0.4 | 0.3 | **0.3** | **9.8** | 0.1% | 13.7 |
| Total Asia Pacific | 9.9 | 13.2 | 16.2 | **17.5** | **619.3** | 9.4% | 30.2 |
| **Total World** | **123.5** | **158.2** | **185.4** | **186.6** | **6588.8** | **100.0%** | **52.5** |
| of which: OECD | 14.7 | 14.9 | 17.9 | **17.8** | **629.1** | 9.5% | 13.9 |
| Non-OECD | 108.9 | 143.3 | 167.5 | **168.8** | **5959.7** | 90.5% | 74.3 |
| European Union | 3.6 | 2.8 | 1.3 | **1.3** | **45.3** | 0.7% | 10.8 |
| CIS | 30.9 | 37.6 | 53.6 | **53.6** | **1891.8** | 28.7% | 70.1 |

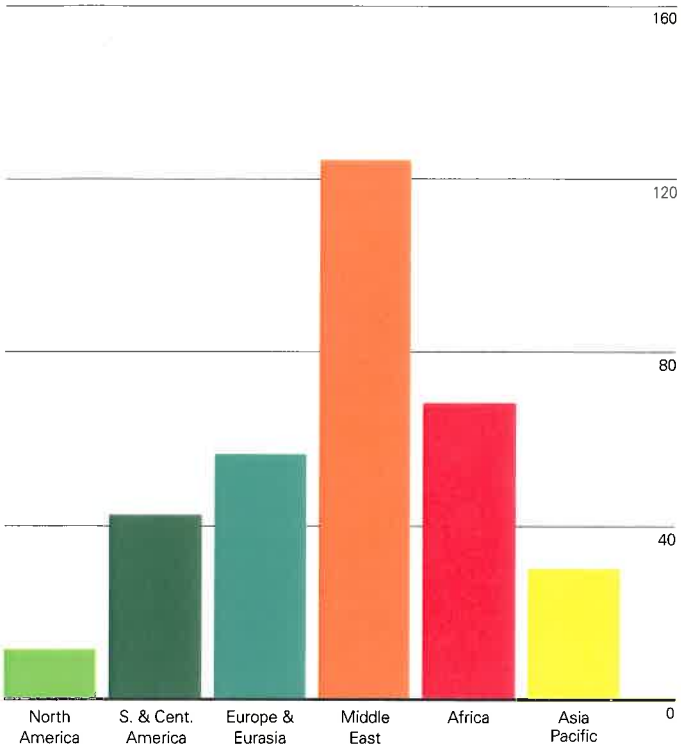
*More than 500 years.
†Less than 0.05.
◆Less than 0.05%.
n/a not available.

**Notes: Total proved reserves of natural gas** – Generally taken to be those quantities that geological and engineering information indicates with reasonable certainty can be recovered in the future from known reservoirs under existing economic and operating conditions. The data series for total proved natural gas reserves does not necessarily meet the definitions, guidelines and practices used for determining proved reserves at a company level, for instance as published by the US Securities and Exchange Commission, nor does it necessarily represent BP's view of proved reserves by country.
**Reserves-to-production (R/P) ratio** – If the reserves remaining at the end of any year are divided by the production in that year, the result is the length of time that those remaining reserves would last if production were to continue at that rate.
**Source of data** – The estimates in this table have been compiled using a combination of primary official sources and third-party data from Cedigaz and the OPEC Secretariat.

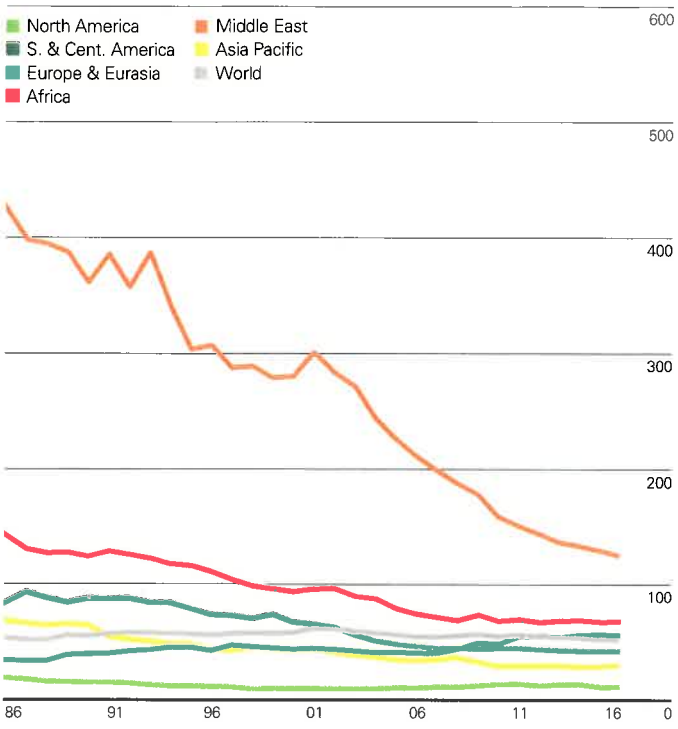
## Reserves-to-production (R/P) ratios

Years

### 2016 by region



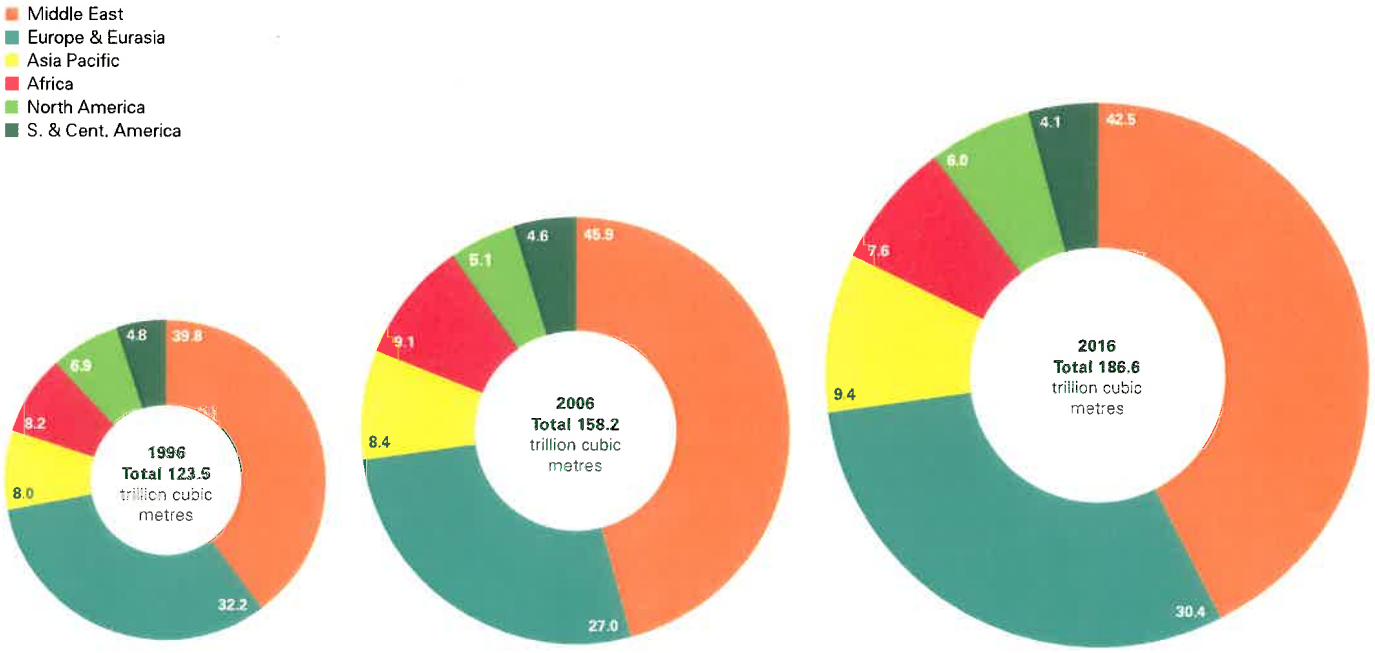

### History




Global proved gas reserves in 2016 rose slightly by 1.2 trillion cubic metres (tcm) or 0.6% to 186.6 tcm. As with oil, this is sufficient to meet more than 50 years of current production (52.5 years). Myanmar (+0.7 tcm) and China (+0.6 tcm) were the main contributors to growth. By region, the Middle East holds the largest proved reserves (79.4 tcm, 42.5% of the global total), while by country, Iran is the largest reserve holder (33.5 tcm, 18% of total).
N.B. Lags in reporting official data mean that 2016 figures for many countries are not yet available.

## Distribution of proved reserves in 1996, 2006 and 2016

Percentage



## Natural gas: Production in billion cubic metres*

| Billion cubic metres | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Growth rate per annum 2016 | Growth rate per annum 2005-15 | Share 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| US | 524.0 | 545.6 | 570.8 | 584.0 | 603.6 | 648.5 | 680.5 | 685.4 | 733.1 | 766.2 | **749.2** | -2.5% | 4.1% | 21.1% |
| Canada | 171.7 | 165.5 | 159.3 | 147.6 | 144.5 | 144.4 | 141.1 | 141.4 | 147.2 | 149.1 | **152.0** | 1.7% | -1.3% | 4.3% |
| Mexico | 57.3 | 53.6 | 53.4 | 59.3 | 57.6 | 58.3 | 57.2 | 58.2 | 57.1 | 54.1 | **47.2** | -13.0% | 0.3% | 1.3% |
| Total North America | 753.0 | 764.6 | 783.5 | 790.9 | 805.7 | 851.2 | 878.9 | 885.0 | 937.3 | 969.4 | **948.4** | -2.4% | 2.8% | 26.7% |
| Argentina | 46.1 | 44.8 | 44.1 | 41.4 | 40.1 | 38.8 | 37.7 | 35.5 | 35.5 | 36.5 | **38.3** | 4.6% | -2.2% | 1.1% |
| Bolivia | 12.9 | 13.8 | 14.3 | 12.3 | 14.2 | 15.6 | 17.8 | 20.3 | 21.0 | 20.3 | **19.7** | -3.0% | 5.3% | 0.6% |
| Brazil | 11.2 | 11.2 | 14.0 | 11.9 | 14.6 | 16.7 | 19.3 | 21.3 | 22.7 | 23.1 | **23.5** | 1.2% | 7.8% | 0.7% |
| Colombia | 7.0 | 7.5 | 9.1 | 10.5 | 11.3 | 11.0 | 12.0 | 12.6 | 11.8 | 11.1 | **10.4** | -6.6% | 5.2% | 0.3% |
| Peru | 1.8 | 2.7 | 3.5 | 3.5 | 7.2 | 11.4 | 11.9 | 12.2 | 12.9 | 12.5 | **14.0** | 11.7% | 23.5% | 0.4% |
| Trinidad & Tobago | 40.1 | 42.2 | 42.0 | 43.6 | 44.8 | 43.1 | 42.7 | 42.8 | 42.1 | 39.6 | **34.5** | -13.2% | 1.8% | 1.0% |
| Venezuela | 31.5 | 36.2 | 32.8 | 31.0 | 30.6 | 27.6 | 29.5 | 28.4 | 28.6 | 32.4 | **34.3** | 5.5% | 1.7% | 1.0% |
| Other S. & Cent. America | 3.6 | 3.6 | 3.5 | 3.4 | 3.4 | 2.8 | 2.7 | 2.4 | 2.3 | 2.5 | **2.4** | -4.6% | -2.7% | 0.1% |
| Total S. & Cent. America | 154.1 | 162.1 | 163.0 | 157.8 | 166.2 | 166.9 | 173.4 | 175.6 | 176.9 | 178.0 | **177.0** | -0.8% | 2.4% | 5.0% |
| Azerbaijan | 6.1 | 9.8 | 14.8 | 14.8 | 15.1 | 14.8 | 15.6 | 16.2 | 17.6 | 17.9 | **17.5** | -3.0% | 13.2% | 0.5% |
| Denmark | 10.4 | 9.2 | 10.0 | 8.4 | 8.2 | 6.6 | 5.7 | 4.8 | 4.6 | 4.6 | **4.5** | -2.2% | -7.9% | 0.1% |
| Germany | 15.6 | 14.3 | 13.0 | 12.2 | 10.6 | 10.0 | 9.0 | 8.2 | 7.7 | 7.2 | **6.6** | -8.2% | -7.6% | 0.2% |
| Italy | 10.1 | 8.8 | 8.4 | 7.3 | 7.6 | 7.7 | 7.8 | 7.0 | 6.5 | 6.2 | **5.3** | -14.8% | -5.7% | 0.1% |
| Kazakhstan | 13.4 | 13.8 | 16.1 | 16.5 | 17.6 | 17.3 | 17.2 | 18.4 | 18.7 | 19.0 | **19.9** | 4.5% | 4.0% | 0.6% |
| Netherlands | 61.5 | 60.5 | 66.5 | 62.7 | 70.5 | 64.1 | 63.8 | 68.6 | 57.9 | 43.3 | **40.2** | -7.6% | -3.6% | 1.1% |
| Norway | 88.7 | 90.3 | 100.1 | 104.4 | 107.3 | 101.3 | 114.7 | 108.7 | 108.8 | 117.2 | **116.6** | -0.7% | 3.2% | 3.3% |
| Poland | 4.3 | 4.3 | 4.1 | 4.1 | 4.1 | 4.3 | 4.3 | 4.2 | 4.1 | 4.1 | **3.9** | -3.8% | -0.5% | 0.1% |
| Romania | 10.6 | 10.3 | 10.0 | 9.9 | 9.6 | 9.6 | 10.0 | 9.6 | 9.7 | 9.8 | **9.2** | -6.5% | -1.0% | 0.3% |
| Russian Federation | 595.2 | 592.0 | 601.7 | 527.7 | 588.9 | 607.0 | 592.3 | 604.7 | 581.7 | 575.1 | **579.4** | 0.5% | -0.1% | 16.3% |
| Turkmenistan | 60.4 | 65.4 | 66.1 | 36.4 | 42.4 | 59.5 | 62.3 | 62.3 | 67.1 | 69.6 | **66.8** | -4.3% | 2.0% | 1.9% |
| Ukraine | 18.7 | 18.7 | 19.0 | 19.3 | 18.5 | 18.7 | 18.6 | 19.3 | 18.2 | 17.9 | **17.8** | -1.1% | -0.3% | 0.5% |
| United Kingdom | 80.0 | 72.1 | 69.6 | 59.7 | 57.1 | 45.2 | 38.9 | 36.5 | 36.8 | 39.6 | **41.0** | 3.3% | -7.7% | 1.2% |
| Uzbekistan | 56.6 | 58.2 | 57.8 | 55.6 | 54.4 | 57.0 | 56.9 | 56.9 | 57.3 | 57.7 | **62.8** | 8.4% | 0.7% | 1.8% |
| Other Europe & Eurasia | 10.7 | 10.0 | 9.4 | 9.2 | 9.3 | 9.2 | 8.3 | 7.2 | 6.4 | 6.2 | **8.7** | 40.3% | -4.8% | 0.2% |
| Total Europe & Eurasia | 1042.2 | 1037.8 | 1066.7 | 947.9 | 1021.1 | 1032.5 | 1025.5 | 1032.7 | 1003.2 | 995.4 | **1000.1** | 0.2% | -0.3% | 28.2% |
| Bahrain | 11.3 | 11.8 | 12.7 | 12.8 | 13.1 | 13.3 | 13.7 | 14.7 | 15.5 | 15.5 | **15.5** | -0.8% | 3.8% | 0.4% |
| Iran | 111.5 | 124.9 | 130.8 | 143.7 | 152.4 | 159.9 | 166.2 | 166.8 | 185.8 | 189.4 | **202.4** | 6.6% | 6.4% | 5.7% |
| Iraq | 1.5 | 1.5 | 1.9 | 1.1 | 1.3 | 0.9 | 0.6 | 1.2 | 0.9 | 1.0 | **1.1** | 12.6% | -3.6% | ◆ |
| Kuwait | 12.4 | 11.3 | 12.7 | 11.5 | 11.7 | 13.5 | 15.5 | 16.3 | 15.0 | 16.9 | **17.1** | 1.0% | 3.2% | 0.5% |
| Oman | 25.8 | 26.1 | 26.0 | 27.0 | 29.3 | 30.9 | 32.2 | 34.8 | 33.3 | 34.7 | **35.4** | 1.7% | 4.6% | 1.0% |
| Qatar | 50.7 | 63.2 | 77.0 | 89.3 | 131.2 | 145.3 | 157.0 | 177.6 | 174.1 | 178.5 | **181.2** | 1.3% | 14.6% | 5.1% |
| Saudi Arabia | 73.5 | 74.4 | 80.4 | 78.5 | 87.7 | 92.3 | 99.3 | 100.0 | 102.4 | 104.5 | **109.4** | 4.4% | 3.9% | 3.1% |
| Syria | 5.6 | 5.4 | 5.3 | 5.9 | 8.1 | 7.1 | 5.8 | 4.8 | 4.4 | 4.1 | **3.6** | -11.6% | -3.0% | 0.1% |
| United Arab Emirates | 48.8 | 50.3 | 50.2 | 48.8 | 51.3 | 52.3 | 54.3 | 54.6 | 54.2 | 60.2 | **61.9** | 2.5% | 2.3% | 1.7% |
| Yemen | – | – | – | 0.7 | 6.0 | 9.0 | 7.3 | 9.9 | 9.3 | 2.7 | **0.7** | -73.4% | – | ◆ |
| Other Middle East | 2.6 | 3.0 | 3.6 | 2.9 | 3.4 | 4.4 | 2.7 | 6.5 | 7.7 | 8.4 | **9.4** | 11.9% | 16.0% | 0.3% |
| Total Middle East | 343.6 | 371.9 | 400.7 | 422.2 | 495.4 | 528.8 | 554.7 | 587.2 | 602.6 | 615.9 | **637.8** | 3.3% | 6.7% | 18.0% |
| Algeria | 84.5 | 84.8 | 85.8 | 79.6 | 80.4 | 82.7 | 81.5 | 82.4 | 83.3 | 84.6 | **91.3** | 7.6% | -0.4% | 2.6% |
| Egypt | 54.7 | 55.7 | 59.0 | 62.7 | 61.3 | 61.4 | 60.9 | 56.1 | 48.8 | 44.3 | **41.8** | -5.7% | 0.4% | 1.2% |
| Libya | 13.2 | 15.3 | 15.9 | 15.9 | 16.8 | 7.9 | 11.1 | 11.6 | 11.3 | 11.8 | **10.1** | -14.7% | 0.4% | 0.3% |
| Nigeria | 29.6 | 36.9 | 36.2 | 26.0 | 37.3 | 40.6 | 43.3 | 36.2 | 45.0 | 50.1 | **44.9** | -10.6% | 7.2% | 1.3% |
| Other Africa | 10.6 | 10.7 | 15.1 | 15.5 | 17.4 | 16.8 | 17.6 | 20.0 | 18.6 | 19.3 | **20.2** | 4.5% | 6.9% | 0.6% |
| Total Africa | 192.6 | 203.4 | 212.0 | 199.7 | 213.2 | 209.4 | 214.4 | 206.3 | 207.1 | 210.0 | **208.3** | -1.1% | 1.7% | 5.9% |
| Australia | 39.2 | 41.2 | 40.4 | 45.9 | 50.4 | 53.2 | 56.9 | 59.0 | 63.6 | 72.6 | **91.2** | 25.2% | 7.0% | 2.6% |
| Bangladesh | 14.9 | 15.9 | 17.0 | 19.5 | 20.0 | 20.3 | 22.2 | 22.8 | 23.9 | 26.9 | **27.5** | 2.2% | 6.9% | 0.8% |
| Brunei | 12.6 | 12.3 | 12.2 | 11.4 | 12.3 | 12.8 | 12.6 | 12.2 | 11.9 | 11.6 | **11.2** | -3.8% | -0.3% | 0.3% |
| China | 60.6 | 71.6 | 83.1 | 88.2 | 99.1 | 109.0 | 111.8 | 122.2 | 131.6 | 136.1 | **138.4** | 1.4% | 10.3% | 3.9% |
| India | 29.3 | 30.1 | 30.5 | 37.6 | 49.3 | 44.5 | 38.9 | 32.1 | 30.5 | 29.3 | **27.6** | -6.0% | -0.1% | 0.8% |
| Indonesia | 74.3 | 71.5 | 73.7 | 76.9 | 85.7 | 81.5 | 77.1 | 76.5 | 75.3 | 75.0 | **69.7** | -7.4% | ◆ | 2.0% |
| Malaysia | 62.7 | 61.5 | 63.8 | 61.1 | 56.2 | 62.2 | 61.5 | 67.3 | 68.4 | 71.2 | **73.8** | 3.4% | 1.1% | 2.1% |
| Myanmar | 12.6 | 13.5 | 12.4 | 11.6 | 12.4 | 12.8 | 12.7 | 13.1 | 16.8 | 19.6 | **18.9** | -3.9% | 4.8% | 0.5% |
| Pakistan | 39.9 | 40.5 | 41.4 | 41.6 | 42.3 | 42.3 | 43.8 | 42.6 | 41.9 | 42.0 | **41.5** | -1.3% | 0.7% | 1.2% |
| Thailand | 24.0 | 25.7 | 28.5 | 30.6 | 35.8 | 36.6 | 41.0 | 41.3 | 41.6 | 39.3 | **38.6** | -2.2% | 5.3% | 1.1% |
| Vietnam | 7.0 | 7.1 | 7.5 | 8.0 | 9.4 | 8.5 | 9.4 | 9.8 | 10.2 | 10.7 | **10.7** | 0.2% | 5.2% | 0.3% |
| Other Asia Pacific | 14.2 | 16.8 | 17.8 | 18.1 | 17.6 | 17.8 | 17.5 | 18.1 | 23.1 | 27.6 | **30.8** | 11.3% | 9.6% | 0.9% |
| Total Asia Pacific | 391.3 | 407.8 | 428.3 | 450.3 | 490.6 | 501.4 | 505.4 | 517.0 | 538.8 | 561.9 | **579.9** | 2.9% | 4.1% | 16.3% |
| **Total World** | **2875.7** | **2947.5** | **3054.2** | **2968.8** | **3192.2** | **3290.2** | **3352.3** | **3403.9** | **3465.9** | **3530.6** | **3551.6** | **0.3%** | **2.4%** | **100.0%** |
| of which: OECD | 1081.3 | 1084.3 | 1115.1 | 1114.1 | 1140.9 | 1162.8 | 1197.2 | 1202.0 | 1247.6 | 1284.5 | **1281.6** | -0.5% | 1.9% | 36.1% |
| Non-OECD | 1795.5 | 1863.2 | 1939.1 | 1854.8 | 2051.3 | 2127.4 | 2155.1 | 2201.9 | 2218.3 | 2246.1 | **2270.0** | 0.8% | 2.8% | 63.9% |
| European Union | 201.9 | 188.1 | 189.8 | 172.2 | 175.8 | 155.3 | 146.6 | 144.8 | 132.5 | 119.8 | **118.2** | -1.6% | -5.5% | 3.3% |
| CIS | 750.6 | 758.2 | 775.6 | 670.4 | 737.1 | 774.7 | 763.0 | 778.1 | 760.9 | 757.6 | **764.3** | 0.6% | 0.4% | 21.5% |

*Excludes gas flared or recycled. Includes natural gas produced for Gas-to-Liquids transformation.

Source: Includes data from Cedigaz.

◆Less than 0.05%.

**Notes:** As far as possible, the data above represents standard cubic metres (measured at 15°C and 1013 mbar); as they are derived directly from tonnes of oil equivalent using an average conversion factor, they do not necessarily equate with gas volumes expressed in specific national terms.

**Annual changes and shares of total are calculated using billion cubic metres figures.**

**Growth rates are adjusted for leap years.**

Natural gas production data expressed in billion cubic feet per day is available at *bp.com/statisticalreview*

## Natural gas: Consumption in billion cubic metres*

| Billion cubic metres | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Growth rate per annum 2016 | Growth rate per annum 2005-15 | Share 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| US | 614.4 | 654.2 | 659.1 | 648.7 | 682.1 | 693.1 | 723.2 | 740.6 | 753.0 | 773.2 | **778.6** | 0.4% | 2.2% | 22.0% |
| Canada | 96.9 | 96.2 | 96.1 | 94.9 | 95.0 | 100.9 | 100.2 | 103.9 | 104.2 | 102.5 | **99.9** | -2.8% | 0.5% | 2.8% |
| Mexico | 66.6 | 63.4 | 66.3 | 72.2 | 72.5 | 76.6 | 79.9 | 83.3 | 86.8 | 87.1 | **89.5** | 2.5% | 3.6% | 2.5% |
| Total North America | 778.0 | 813.8 | 821.5 | 815.9 | 849.6 | 870.6 | 903.3 | 927.8 | 944.1 | 962.8 | **968.0** | 0.3% | 2.1% | 27.3% |
| Argentina | 41.8 | 43.9 | 44.4 | 42.1 | 43.3 | 45.1 | 46.7 | 46.7 | 47.2 | 48.2 | **49.6** | 2.7% | 1.8% | 1.4% |
| Brazil | 20.6 | 21.2 | 24.9 | 20.1 | 26.8 | 26.7 | 31.7 | 37.3 | 39.5 | 41.7 | **36.6** | -12.5% | 7.9% | 1.0% |
| Chile | 7.2 | 4.3 | 2.4 | 2.4 | 4.9 | 5.0 | 4.6 | 4.6 | 3.8 | 4.1 | **4.5** | 11.1% | -6.3% | 0.1% |
| Colombia | 7.0 | 7.4 | 7.6 | 8.7 | 9.1 | 8.8 | 9.8 | 10.0 | 10.9 | 10.7 | **10.6** | -1.6% | 4.8% | 0.3% |
| Ecuador | 0.4 | 0.5 | 0.4 | 0.5 | 0.5 | 0.4 | 0.6 | 0.6 | 0.7 | 0.6 | **0.6** | 1.5% | 6.9% | ◆ |
| Peru | 1.8 | 2.7 | 3.4 | 3.5 | 4.9 | 5.5 | 6.2 | 6.0 | 6.8 | 7.2 | **7.9** | 9.8% | 16.8% | 0.2% |
| Trinidad & Tobago | 21.2 | 21.9 | 21.3 | 22.2 | 23.2 | 23.3 | 22.2 | 22.4 | 22.0 | 21.5 | **19.1** | -11.4% | 2.8% | 0.5% |
| Venezuela | 31.5 | 36.2 | 34.3 | 32.3 | 32.2 | 29.7 | 31.4 | 30.5 | 30.7 | 34.5 | **35.6** | 2.7% | 2.3% | 1.0% |
| Other S. & Cent. America | 4.0 | 4.5 | 4.8 | 5.0 | 5.3 | 5.9 | 6.5 | 7.0 | 7.3 | 7.3 | **7.4** | 1.1% | 8.1% | 0.2% |
| Total S. & Cent. America | 135.5 | 142.6 | 143.4 | 136.7 | 150.2 | 150.5 | 159.6 | 165.2 | 168.9 | 175.8 | **171.9** | -2.5% | 3.6% | 4.9% |
| Austria | 9.3 | 8.8 | 9.4 | 9.2 | 10.0 | 9.4 | 8.9 | 8.6 | 7.9 | 8.3 | **8.7** | 4.4% | -1.7% | 0.2% |
| Azerbaijan | 9.1 | 8.0 | 9.2 | 7.8 | 7.4 | 8.1 | 8.5 | 8.6 | 9.4 | 10.6 | **10.4** | -2.2% | 2.2% | 0.3% |
| Belarus | 18.8 | 18.8 | 19.3 | 16.1 | 19.7 | 18.3 | 18.5 | 18.5 | 18.3 | 15.6 | **17.0** | 9.0% | -1.6% | 0.5% |
| Belgium | 16.7 | 16.6 | 16.5 | 16.8 | 18.9 | 15.8 | 16.0 | 15.8 | 13.8 | 15.1 | **15.4** | 1.8% | -0.8% | 0.4% |
| Bulgaria | 3.2 | 3.2 | 3.2 | 2.3 | 2.6 | 2.9 | 2.7 | 2.6 | 2.6 | 2.9 | **3.0** | 3.9% | -0.8% | 0.1% |
| Czech Republic | 8.4 | 7.9 | 7.9 | 7.4 | 8.5 | 7.7 | 7.6 | 7.7 | 6.9 | 7.2 | **7.8** | 7.9% | -1.7% | 0.2% |
| Denmark | 5.1 | 4.5 | 4.6 | 4.4 | 5.0 | 4.2 | 3.9 | 3.7 | 3.1 | 3.2 | **3.2** | 1.4% | -4.4% | 0.1% |
| Finland | 4.2 | 3.9 | 4.0 | 3.6 | 3.9 | 3.5 | 3.1 | 2.8 | 2.5 | 2.2 | **2.0** | -9.2% | -5.8% | 0.1% |
| France | 44.0 | 42.8 | 44.3 | 42.7 | 47.3 | 41.1 | 42.5 | 43.1 | 36.2 | 38.9 | **42.6** | 9.0% | -1.6% | 1.2% |
| Germany | 87.9 | 84.7 | 85.5 | 80.7 | 84.1 | 77.3 | 77.5 | 81.2 | 70.6 | 73.5 | **80.5** | 9.2% | -1.6% | 2.3% |
| Greece | 3.1 | 3.7 | 3.9 | 3.3 | 3.6 | 4.4 | 4.0 | 3.6 | 2.7 | 2.8 | **2.8** | 0.6% | 0.5% | 0.1% |
| Hungary | 12.7 | 11.9 | 11.7 | 10.2 | 10.9 | 10.4 | 9.3 | 8.7 | 7.8 | 8.3 | **8.9** | 7.0% | -4.7% | 0.3% |
| Ireland | 4.4 | 4.8 | 5.0 | 4.7 | 5.2 | 4.6 | 4.5 | 4.3 | 4.1 | 4.2 | **4.8** | 14.0% | 0.8% | 0.1% |
| Italy | 77.4 | 77.3 | 77.2 | 71.0 | 75.6 | 70.9 | 68.2 | 63.8 | 56.3 | 61.4 | **64.5** | 4.7% | -2.5% | 1.8% |
| Kazakhstan | 7.4 | 9.0 | 8.9 | 8.3 | 8.9 | 10.0 | 10.8 | 11.2 | 12.5 | 12.9 | **13.4** | 3.8% | 6.3% | 0.4% |
| Lithuania | 2.7 | 3.2 | 2.9 | 2.4 | 2.8 | 3.0 | 2.9 | 2.4 | 2.3 | 2.3 | **2.0** | -11.1% | -1.8% | 0.1% |
| Netherlands | 38.0 | 36.9 | 38.5 | 38.9 | 43.6 | 38.1 | 36.0 | 36.5 | 31.8 | 31.5 | **33.6** | 6.4% | -2.3% | 0.9% |
| Norway | 4.4 | 4.3 | 4.3 | 4.1 | 4.1 | 4.4 | 4.4 | 4.4 | 4.7 | 4.8 | **4.9** | 0.4% | 0.8% | 0.1% |
| Poland | 13.7 | 13.8 | 14.9 | 14.4 | 15.5 | 15.7 | 16.6 | 16.6 | 16.3 | 16.3 | **17.3** | 5.7% | 1.9% | 0.5% |
| Portugal | 4.1 | 4.3 | 4.7 | 4.7 | 5.1 | 5.2 | 4.5 | 4.3 | 4.1 | 4.8 | **5.2** | 8.1% | 1.2% | 0.1% |
| Romania | 15.9 | 14.1 | 14.0 | 11.7 | 12.0 | 12.3 | 12.4 | 11.3 | 10.5 | 9.9 | **10.6** | 6.2% | -4.3% | 0.3% |
| Russian Federation | 415.0 | 422.0 | 416.0 | 389.6 | 414.1 | 424.6 | 416.2 | 413.5 | 409.7 | 402.8 | **390.9** | -3.2% | 0.2% | 11.0% |
| Slovakia | 6.0 | 5.7 | 5.7 | 4.9 | 5.6 | 5.2 | 4.9 | 5.3 | 4.2 | 4.3 | **4.4** | 1.6% | -4.1% | 0.1% |
| Spain | 34.7 | 35.3 | 38.8 | 34.7 | 34.6 | 32.1 | 31.7 | 29.0 | 26.3 | 27.3 | **28.0** | 2.0% | -1.9% | 0.8% |
| Sweden | 0.9 | 1.0 | 0.9 | 1.1 | 1.5 | 1.2 | 1.0 | 1.0 | 0.9 | 0.9 | **0.9** | 10.0% | -0.9% | ◆ |
| Switzerland | 2.7 | 2.6 | 2.8 | 2.7 | 3.0 | 2.7 | 2.9 | 3.1 | 2.7 | 2.9 | **3.0** | 4.8% | 0.2% | 0.1% |
| Turkey | 30.5 | 36.1 | 37.5 | 35.7 | 39.0 | 40.9 | 41.4 | 42.0 | 44.6 | 43.6 | **42.1** | -3.7% | 5.0% | 1.2% |
| Turkmenistan | 18.4 | 21.3 | 21.4 | 19.7 | 22.6 | 23.5 | 26.3 | 22.9 | 25.6 | 29.4 | **29.5** | ◆ | 6.2% | 0.8% |
| Ukraine | 67.0 | 63.2 | 60.0 | 46.8 | 52.2 | 53.7 | 49.6 | 43.3 | 36.8 | 28.8 | **29.0** | 0.3% | -8.4% | 0.8% |
| United Kingdom | 90.0 | 91.0 | 93.8 | 87.0 | 94.2 | 78.1 | 73.9 | 73.0 | 66.7 | 68.1 | **76.7** | 12.2% | -3.3% | 2.2% |
| Uzbekistan | 41.9 | 45.9 | 48.7 | 39.9 | 40.8 | 47.6 | 47.2 | 46.8 | 48.8 | 50.2 | **51.4** | 2.0% | 1.6% | 1.4% |
| Other Europe & Eurasia | 17.1 | 17.4 | 16.6 | 14.6 | 16.0 | 16.2 | 16.0 | 14.9 | 14.9 | 15.1 | **15.5** | 2.4% | 1.4% | 0.4% |
| Total Europe & Eurasia | 1114.8 | 1123.8 | 1132.2 | 1041.3 | 1118.4 | 1092.8 | 1074.0 | 1054.4 | 1005.6 | 1010.2 | **1029.9** | 1.7% | -0.8% | 29.1% |
| Iran | 112.0 | 125.5 | 133.2 | 142.7 | 152.9 | 162.2 | 161.5 | 162.9 | 183.7 | 190.8 | **200.8** | 5.0% | 6.4% | 5.7% |
| Israel | 2.3 | 2.7 | 3.8 | 4.2 | 5.3 | 5.0 | 2.6 | 6.9 | 7.6 | 8.4 | **9.7** | 14.5% | 17.8% | 0.3% |
| Kuwait | 12.5 | 12.1 | 12.8 | 12.4 | 14.5 | 16.7 | 18.5 | 18.7 | 18.5 | 21.3 | **21.9** | 2.5% | 5.7% | 0.6% |
| Qatar | 19.2 | 23.5 | 19.3 | 20.8 | 29.8 | 19.6 | 23.4 | 37.9 | 36.4 | 43.9 | **41.7** | -5.4% | 9.0% | 1.2% |
| Saudi Arabia | 73.5 | 74.4 | 80.4 | 78.5 | 87.7 | 92.3 | 99.3 | 100.0 | 102.4 | 104.5 | **109.4** | 4.4% | 3.9% | 3.1% |
| United Arab Emirates | 43.4 | 49.2 | 59.5 | 59.1 | 60.8 | 63.2 | 65.6 | 66.9 | 65.9 | 73.8 | **76.6** | 3.6% | 5.8% | 2.2% |
| Other Middle East | 33.5 | 34.3 | 38.4 | 41.5 | 45.5 | 44.4 | 44.2 | 46.9 | 46.3 | 51.0 | **52.3** | 2.3% | 5.2% | 1.5% |
| Total Middle East | 296.3 | 321.7 | 347.3 | 359.1 | 396.5 | 403.4 | 415.0 | 440.3 | 460.8 | 493.6 | **512.3** | 3.5% | 5.9% | 14.5% |
| Algeria | 23.7 | 24.3 | 25.4 | 27.2 | 26.3 | 27.8 | 31.0 | 33.4 | 37.5 | 39.4 | **40.0** | 1.2% | 5.4% | 1.1% |
| Egypt | 36.5 | 38.4 | 40.8 | 42.5 | 45.1 | 49.6 | 52.6 | 51.4 | 48.0 | 47.8 | **51.3** | 7.0% | 4.2% | 1.4% |
| South Africa | 3.5 | 3.5 | 3.7 | 3.4 | 3.9 | 4.1 | 4.4 | 4.6 | 5.0 | 5.1 | **5.1** | 1.3% | 4.9% | 0.1% |
| Other Africa | 25.9 | 30.5 | 30.8 | 26.4 | 31.1 | 31.7 | 32.6 | 33.8 | 36.6 | 43.5 | **41.7** | -4.4% | 4.9% | 1.2% |
| Total Africa | 89.6 | 96.7 | 100.7 | 99.5 | 106.4 | 113.3 | 120.6 | 123.2 | 127.0 | 135.8 | **138.2** | 1.4% | 4.8% | 3.9% |
| Australia | 25.1 | 28.1 | 27.9 | 29.1 | 31.1 | 33.7 | 33.8 | 35.5 | 38.3 | 42.9 | **41.1** | -4.4% | 6.6% | 1.2% |
| Bangladesh | 14.9 | 15.9 | 17.0 | 19.5 | 20.0 | 20.3 | 22.2 | 22.8 | 23.9 | 26.9 | **27.5** | 2.2% | 6.9% | 0.8% |
| China | 59.3 | 73.0 | 84.1 | 92.6 | 111.2 | 137.1 | 150.9 | 171.9 | 188.4 | 194.8 | **210.3** | 7.7% | 15.0% | 5.9% |
| China Hong Kong SAR | 2.9 | 2.7 | 3.2 | 3.1 | 3.8 | 3.1 | 2.8 | 2.6 | 2.5 | 3.2 | **3.3** | 2.4% | 1.9% | 0.1% |
| India | 37.3 | 40.3 | 41.5 | 50.7 | 60.3 | 61.1 | 56.5 | 49.3 | 48.8 | 45.7 | **50.1** | 9.2% | 2.5% | 1.4% |
| Indonesia | 36.6 | 34.1 | 39.1 | 41.5 | 43.4 | 42.1 | 42.2 | 40.8 | 40.9 | 40.4 | **37.7** | -7.0% | 1.2% | 1.1% |
| Japan | 83.7 | 90.2 | 93.7 | 87.4 | 94.5 | 105.5 | 116.9 | 116.9 | 118.0 | 113.4 | **111.2** | -2.2% | 3.7% | 3.1% |
| Malaysia | 35.3 | 35.5 | 39.2 | 35.4 | 29.6 | 34.8 | 35.5 | 40.3 | 42.2 | 41.8 | **43.0** | 2.7% | 1.8% | 1.2% |
| New Zealand | 3.7 | 4.0 | 3.8 | 4.0 | 4.3 | 3.9 | 4.2 | 4.5 | 4.9 | 4.5 | **4.7** | 4.3% | 2.3% | 0.1% |
| Pakistan | 39.9 | 40.5 | 41.4 | 41.6 | 42.3 | 42.3 | 43.8 | 42.6 | 41.9 | 43.5 | **45.5** | 4.2% | 1.1% | 1.3% |
| Philippines | 3.0 | 3.6 | 3.7 | 3.8 | 3.5 | 3.9 | 3.7 | 3.4 | 3.6 | 3.3 | **3.8** | 14.3% | 0.6% | 0.1% |
| Singapore | 8.6 | 8.6 | 9.2 | 9.7 | 8.8 | 8.7 | 9.4 | 10.5 | 10.9 | 12.2 | **12.5** | 2.5% | 6.5% | 0.4% |
| South Korea | 32.0 | 34.7 | 35.7 | 33.9 | 43.0 | 46.3 | 50.2 | 52.5 | 47.8 | 43.6 | **45.5** | 4.0% | 3.7% | 1.3% |
| Taiwan | 10.1 | 10.7 | 11.6 | 11.4 | 14.1 | 15.5 | 16.3 | 16.3 | 17.2 | 18.4 | **19.1** | 3.6% | 6.9% | 0.5% |
| Thailand | 31.5 | 33.6 | 35.3 | 36.4 | 41.3 | 42.3 | 46.5 | 46.7 | 47.7 | 48.7 | **48.3** | -1.0% | 4.7% | 1.4% |
| Vietnam | 7.0 | 7.1 | 7.5 | 8.0 | 9.4 | 8.5 | 9.4 | 9.8 | 10.2 | 10.7 | **10.7** | 0.2% | 5.2% | 0.3% |
| Other Asia Pacific | 5.5 | 6.0 | 5.8 | 5.3 | 5.8 | 6.3 | 6.2 | 6.4 | 7.2 | 7.8 | **8.0** | 2.7% | 4.0% | 0.2% |
| Total Asia Pacific | 436.5 | 468.7 | 499.8 | 513.3 | 566.4 | 615.4 | 650.5 | 672.9 | 694.4 | 701.8 | **722.5** | 2.7% | 5.6% | 20.4% |
| **Total World** | **2850.6** | **2967.3** | **3044.9** | **2965.9** | **3187.6** | **3245.9** | **3323.1** | **3383.8** | **3400.8** | **3480.1** | **3542.9** | **1.5%** | **2.3%** | **100.0%** |
| of which: OECD | 1433.7 | 1478.8 | 1503.8 | 1461.8 | 1554.8 | 1545.1 | 1580.9 | 1609.5 | 1580.6 | 1611.4 | **1644.1** | 1.7% | 1.2% | 46.4% |
| Non-OECD | 1417.0 | 1488.6 | 1541.1 | 1504.1 | 1632.8 | 1700.8 | 1742.2 | 1774.4 | 1820.2 | 1868.7 | **1898.8** | 1.3% | 3.4% | 53.6% |
| European Union | 490.1 | 483.0 | 494.9 | 462.8 | 497.9 | 449.7 | 438.6 | 431.2 | 383.0 | 399.1 | **428.8** | 7.1% | -2.2% | 12.1% |
| CIS | 582.5 | 593.6 | 589.0 | 533.1 | 570.9 | 591.0 | 582.9 | 569.6 | 566.4 | 555.4 | **546.7** | -1.8% | -0.1% | 15.4% |

*Excludes natural gas converted to liquid fuels but includes derivatives of coal as well as natural gas consumed in Gas-to-Liquids transformation. Source: Includes data from Cedigaz.

◆Less than 0.05%.

**Notes:** As far as possible, the data above represents standard cubic metres (measured at 15°C and 1013 mbar); as they are derived directly from tonnes of oil equivalent using an average conversion factor, they do not necessarily equate with gas volumes expressed in specific national terms.

The difference between these world consumption figures and the world production statistics is due to variations in stocks at storage facilities and liquefaction plants, together with unavoidable disparities in the definition, measurement or conversion of gas supply and demand data.

**Annual changes and shares of total are calculated using billion cubic metres figures.**

**Growth rates are adjusted for leap years.**

Natural gas consumption data expressed in billion cubic feet per day is available at *bp.com/statisticalreview*

## Natural gas: Production in million tonnes oil equivalent*

| Million tonnes oil equivalent | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Growth rate per annum 2016 | Growth rate per annum 2005-15 | Share 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| US | 479.3 | 498.6 | 521.7 | 532.7 | 549.5 | 589.8 | 620.2 | 626.4 | 673.3 | 707.1 | **690.8** | -2.6% | 4.2% | 21.5% |
| Canada | 154.5 | 148.9 | 143.4 | 132.8 | 130.1 | 130.0 | 127.0 | 127.3 | 132.4 | 134.2 | **136.8** | 1.7% | -1.3% | 4.3% |
| Mexico | 51.6 | 48.2 | 48.0 | 53.3 | 51.8 | 52.4 | 51.5 | 52.4 | 51.4 | 48.7 | **42.5** | -13.0% | 0.3% | 1.3% |
| Total North America | 685.4 | 695.7 | 713.2 | 718.9 | 731.4 | 772.2 | 798.7 | 806.1 | 857.1 | 890.0 | **870.1** | -2.5% | 2.9% | 27.1% |
| Argentina | 41.5 | 40.3 | 39.7 | 37.3 | 36.1 | 34.9 | 34.0 | 32.0 | 31.9 | 32.8 | **34.4** | 4.6% | -2.2% | 1.1% |
| Bolivia | 11.6 | 12.4 | 12.9 | 11.1 | 12.8 | 14.0 | 16.0 | 18.3 | 18.9 | 18.2 | **17.8** | -3.0% | 5.3% | 0.6% |
| Brazil | 10.0 | 10.1 | 12.6 | 10.7 | 13.1 | 15.1 | 17.3 | 19.2 | 20.4 | 20.8 | **21.1** | 1.2% | 7.8% | 0.7% |
| Colombia | 6.3 | 6.8 | 8.2 | 9.5 | 10.1 | 9.9 | 10.8 | 11.4 | 10.6 | 10.0 | **9.4** | -6.6% | 5.2% | 0.3% |
| Peru | 1.6 | 2.4 | 3.1 | 3.2 | 6.5 | 10.2 | 10.7 | 11.0 | 11.6 | 11.2 | **12.6** | 11.7% | 23.5% | 0.4% |
| Trinidad & Tobago | 36.1 | 38.0 | 37.8 | 39.3 | 40.3 | 38.8 | 38.4 | 38.6 | 37.9 | 35.7 | **31.0** | -13.2% | 1.8% | 1.0% |
| Venezuela | 28.3 | 32.6 | 29.5 | 27.9 | 27.6 | 24.8 | 26.5 | 25.6 | 25.8 | 29.2 | **30.9** | 5.5% | 1.7% | 1.0% |
| Other S. & Cent. America | 3.2 | 3.3 | 3.1 | 3.1 | 3.1 | 2.5 | 2.4 | 2.2 | 2.1 | 2.2 | **2.1** | -4.6% | -2.7% | 0.1% |
| Total S. & Cent. America | 138.7 | 145.9 | 146.7 | 142.0 | 149.6 | 150.2 | 156.1 | 158.1 | 159.2 | 160.2 | **159.3** | -0.8% | 2.4% | 5.0% |
| Azerbaijan | 5.5 | 8.8 | 13.3 | 13.3 | 13.6 | 13.3 | 14.0 | 14.6 | 15.8 | 16.2 | **15.7** | -3.0% | 13.2% | 0.5% |
| Denmark | 9.3 | 8.3 | 9.0 | 7.5 | 7.3 | 5.9 | 5.2 | 4.3 | 4.1 | 4.1 | **4.0** | -2.2% | -7.9% | 0.1% |
| Germany | 14.1 | 12.9 | 11.7 | 11.0 | 9.6 | 9.0 | 8.1 | 7.4 | 7.0 | 6.5 | **6.0** | -8.2% | -7.6% | 0.2% |
| Italy | 9.1 | 7.9 | 7.6 | 6.6 | 6.9 | 6.9 | 7.0 | 6.3 | 5.9 | 5.5 | **4.7** | -14.8% | -5.7% | 0.1% |
| Kazakhstan | 12.0 | 12.4 | 14.4 | 14.9 | 15.8 | 15.6 | 15.5 | 16.6 | 16.9 | 17.1 | **17.9** | 4.5% | 4.0% | 0.6% |
| Netherlands | 55.4 | 54.4 | 59.9 | 56.4 | 63.4 | 57.7 | 57.4 | 61.8 | 52.1 | 39.0 | **36.1** | -7.6% | -3.6% | 1.1% |
| Norway | 79.8 | 81.3 | 90.1 | 93.9 | 96.5 | 91.1 | 103.3 | 97.9 | 97.9 | 105.4 | **105.0** | -0.7% | 3.2% | 3.3% |
| Poland | 3.9 | 3.9 | 3.7 | 3.7 | 3.7 | 3.8 | 3.9 | 3.8 | 3.7 | 3.7 | **3.6** | -3.8% | -0.5% | 0.1% |
| Romania | 9.6 | 9.2 | 9.0 | 8.9 | 8.6 | 8.7 | 9.0 | 8.6 | 8.8 | 8.8 | **8.2** | -6.5% | -1.0% | 0.3% |
| Russian Federation | 535.6 | 532.8 | 541.5 | 474.9 | 530.0 | 546.3 | 533.0 | 544.2 | 523.6 | 517.6 | **521.5** | 0.5% | -0.1% | 16.2% |
| Turkmenistan | 54.3 | 58.9 | 59.5 | 32.7 | 38.1 | 53.6 | 56.1 | 56.1 | 60.4 | 62.6 | **60.1** | -4.3% | 2.0% | 1.9% |
| Ukraine | 16.9 | 16.9 | 17.1 | 17.3 | 16.7 | 16.9 | 16.7 | 17.3 | 16.4 | 16.1 | **16.0** | -1.1% | -0.3% | 0.5% |
| United Kingdom | 72.0 | 64.9 | 62.7 | 53.7 | 51.4 | 40.7 | 35.0 | 32.8 | 33.1 | 35.6 | **36.9** | 3.3% | -7.7% | 1.1% |
| Uzbekistan | 51.0 | 52.4 | 52.0 | 50.0 | 49.0 | 51.3 | 51.2 | 51.2 | 51.6 | 52.0 | **56.5** | 8.4% | 0.7% | 1.8% |
| Other Europe & Eurasia | 9.7 | 9.0 | 8.5 | 8.2 | 8.4 | 8.3 | 7.5 | 6.5 | 5.7 | 5.6 | **7.9** | 40.3% | -4.8% | 0.2% |
| Total Europe & Eurasia | 938.0 | 934.0 | 960.0 | 853.1 | 919.0 | 929.2 | 923.0 | 929.4 | 902.9 | 895.9 | **900.1** | 0.2% | -0.3% | 28.0% |
| Bahrain | 10.2 | 10.6 | 11.4 | 11.5 | 11.8 | 12.0 | 12.4 | 13.2 | 13.9 | 14.0 | **13.9** | -0.8% | 3.8% | 0.4% |
| Iran | 100.3 | 112.5 | 117.7 | 129.3 | 137.1 | 143.9 | 149.5 | 150.1 | 167.3 | 170.4 | **182.2** | 6.6% | 6.4% | 5.7% |
| Iraq | 1.3 | 1.3 | 1.7 | 1.0 | 1.2 | 0.8 | 0.6 | 1.1 | 0.8 | 0.9 | **1.0** | 12.6% | -3.6% | ◆ |
| Kuwait | 11.2 | 10.1 | 11.4 | 10.3 | 10.6 | 12.2 | 14.0 | 14.7 | 13.5 | 15.2 | **15.4** | 1.0% | 3.2% | 0.5% |
| Oman | 23.2 | 23.5 | 23.4 | 24.3 | 26.4 | 27.8 | 29.0 | 31.3 | 30.0 | 31.3 | **31.9** | 1.7% | 4.6% | 1.0% |
| Qatar | 45.6 | 56.9 | 69.3 | 80.4 | 118.0 | 130.7 | 141.3 | 159.8 | 156.7 | 160.6 | **163.1** | 1.3% | 14.6% | 5.1% |
| Saudi Arabia | 66.1 | 67.0 | 72.4 | 70.6 | 78.9 | 83.0 | 89.4 | 90.0 | 92.1 | 94.0 | **98.4** | 4.4% | 3.9% | 3.1% |
| Syria | 5.1 | 4.9 | 4.8 | 5.3 | 7.2 | 6.4 | 5.2 | 4.3 | 4.0 | 3.7 | **3.2** | -11.6% | -3.0% | 0.1% |
| United Arab Emirates | 43.9 | 45.3 | 45.2 | 44.0 | 46.2 | 47.1 | 48.9 | 49.1 | 48.8 | 54.2 | **55.7** | 2.5% | 2.3% | 1.7% |
| Yemen | – | – | – | 0.7 | 5.4 | 8.1 | 6.5 | 8.9 | 8.4 | 2.5 | **0.7** | -73.4% | – | ◆ |
| Other Middle East | 2.3 | 2.7 | 3.3 | 2.6 | 3.1 | 4.0 | 2.4 | 5.9 | 6.9 | 7.6 | **8.5** | 11.9% | 16.0% | 0.3% |
| Total Middle East | 309.2 | 334.7 | 360.6 | 380.0 | 445.8 | 475.9 | 499.2 | 528.5 | 542.4 | 554.3 | **574.0** | 3.3% | 6.7% | 17.9% |
| Algeria | 76.0 | 76.3 | 77.2 | 71.6 | 72.4 | 74.4 | 73.4 | 74.2 | 75.0 | 76.1 | **82.2** | 7.6% | -0.4% | 2.6% |
| Egypt | 49.2 | 50.1 | 53.1 | 56.4 | 55.2 | 55.3 | 54.8 | 50.5 | 43.9 | 39.8 | **37.6** | -5.7% | 0.4% | 1.2% |
| Libya | 11.9 | 13.8 | 14.3 | 14.3 | 15.1 | 7.1 | 10.0 | 10.5 | 10.2 | 10.6 | **9.1** | -14.7% | 0.4% | 0.3% |
| Nigeria | 26.6 | 33.2 | 32.5 | 23.4 | 33.6 | 36.5 | 39.0 | 32.6 | 40.5 | 45.1 | **40.4** | -10.6% | 7.2% | 1.3% |
| Other Africa | 9.6 | 9.7 | 13.6 | 14.0 | 15.6 | 15.1 | 15.9 | 18.0 | 16.8 | 17.4 | **18.2** | 4.5% | 6.9% | 0.6% |
| Total Africa | 173.3 | 183.1 | 190.8 | 179.7 | 191.9 | 188.4 | 192.9 | 185.7 | 186.3 | 189.0 | **187.5** | -1.1% | 1.7% | 5.8% |
| Australia | 35.3 | 37.1 | 36.4 | 41.3 | 45.4 | 47.9 | 51.2 | 53.1 | 57.3 | 65.4 | **82.0** | 25.2% | 7.0% | 2.6% |
| Bangladesh | 13.4 | 14.3 | 15.3 | 17.5 | 18.0 | 18.3 | 20.0 | 20.5 | 21.5 | 24.2 | **24.8** | 2.2% | 6.9% | 0.8% |
| Brunei | 11.3 | 11.0 | 10.9 | 10.3 | 11.1 | 11.5 | 11.3 | 11.0 | 10.7 | 10.5 | **10.1** | -3.8% | -0.3% | 0.3% |
| China | 54.5 | 64.5 | 74.8 | 79.4 | 89.2 | 98.1 | 100.7 | 110.0 | 118.4 | 122.5 | **124.6** | 1.4% | 10.3% | 3.9% |
| India | 26.4 | 27.1 | 27.5 | 33.8 | 44.3 | 40.1 | 35.0 | 28.9 | 27.5 | 26.4 | **24.9** | -6.0% | -0.1% | 0.8% |
| Indonesia | 66.9 | 64.4 | 66.4 | 69.2 | 77.1 | 73.3 | 69.4 | 68.8 | 67.7 | 67.5 | **62.7** | -7.4% | ◆ | 2.0% |
| Malaysia | 56.4 | 55.4 | 57.4 | 55.0 | 50.6 | 56.0 | 55.4 | 60.5 | 61.5 | 64.1 | **66.5** | 3.4% | 1.1% | 2.1% |
| Myanmar | 11.3 | 12.2 | 11.2 | 10.4 | 11.2 | 11.5 | 11.5 | 11.8 | 15.2 | 17.6 | **17.0** | -3.9% | 4.8% | 0.5% |
| Pakistan | 35.9 | 36.4 | 37.3 | 37.4 | 38.1 | 38.1 | 39.4 | 38.4 | 37.7 | 37.8 | **37.4** | -1.3% | 0.7% | 1.2% |
| Thailand | 21.6 | 23.1 | 25.6 | 27.5 | 32.2 | 32.9 | 36.9 | 37.2 | 37.5 | 35.4 | **34.7** | -2.2% | 5.3% | 1.1% |
| Vietnam | 6.3 | 6.4 | 6.7 | 7.2 | 8.5 | 7.6 | 8.4 | 8.8 | 9.2 | 9.6 | **9.6** | 0.2% | 5.2% | 0.3% |
| Other Asia Pacific | 12.8 | 15.1 | 16.0 | 16.3 | 15.9 | 16.0 | 15.8 | 16.3 | 20.8 | 24.8 | **27.7** | 11.3% | 9.6% | 0.9% |
| Total Asia Pacific | 352.2 | 367.0 | 385.5 | 405.3 | 441.5 | 451.2 | 454.9 | 465.3 | 484.9 | 505.7 | **521.9** | 2.9% | 4.1% | 16.2% |
| **Total World** | **2596.8** | **2660.3** | **2756.7** | **2679.1** | **2879.2** | **2967.3** | **3024.7** | **3073.1** | **3132.8** | **3195.0** | **3212.9** | **0.3%** | **2.5%** | **100.0%** |
| of which: OECD | 980.9 | 983.5 | 1011.5 | 1009.8 | 1033.1 | 1052.7 | 1085.1 | 1091.3 | 1136.3 | 1173.5 | **1169.9** | -0.6% | 1.9% | 36.4% |
| Non-OECD | 1615.9 | 1676.9 | 1745.2 | 1669.3 | 1846.2 | 1914.7 | 1939.6 | 1981.8 | 1996.5 | 2021.5 | **2043.0** | 0.8% | 2.8% | 63.6% |
| European Union | 181.7 | 169.3 | 170.8 | 155.0 | 158.2 | 139.8 | 132.0 | 130.4 | 119.3 | 107.8 | **106.4** | -1.6% | -5.5% | 3.3% |
| CIS | 675.5 | 682.4 | 698.0 | 603.4 | 663.4 | 697.2 | 686.7 | 700.3 | 684.8 | 681.8 | **687.9** | 0.6% | 0.4% | 21.4% |

*Excludes gas flared or recycled. Includes natural gas produced for Gas-to-Liquids transformation.
◆Less than 0.05%.
**Notes: Annual changes and shares of total are calculated using million tonnes oil equivalent figures.**
**Growth rates are adjusted for leap years.**

Source: Includes data from Cedigaz.

## Natural gas: Consumption in million tonnes oil equivalent*

| Million tonnes oil equivalent | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Growth rate per annum 2016 | Growth rate per annum 2005-15 | Share 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| US | 560.4 | 596.3 | 600.8 | 590.1 | 619.3 | 628.8 | 657.4 | 675.5 | 690.0 | 710.5 | **716.3** | 0.5% | 2.3% | 22.4% |
| Canada | 87.3 | 86.6 | 86.5 | 85.4 | 85.5 | 90.8 | 90.2 | 93.5 | 93.8 | 92.2 | **89.9** | -2.8% | 0.5% | 2.8% |
| Mexico | 59.9 | 57.1 | 59.7 | 65.0 | 65.2 | 68.9 | 71.9 | 74.9 | 78.1 | 78.4 | **80.6** | 2.5% | 3.6% | 2.5% |
| Total North America | 707.6 | 739.9 | 747.0 | 740.5 | 770.0 | 788.6 | 819.5 | 843.9 | 862.0 | 881.2 | **886.8** | 0.4% | 2.2% | 27.7% |
| Argentina | 37.6 | 39.5 | 40.0 | 37.9 | 39.0 | 40.6 | 42.1 | 42.1 | 42.5 | 43.4 | **44.6** | 2.7% | 1.8% | 1.4% |
| Brazil | 18.5 | 19.1 | 22.4 | 18.1 | 24.1 | 24.0 | 28.5 | 33.6 | 35.6 | 37.5 | **32.9** | -12.5% | 7.9% | 1.0% |
| Chile | 6.5 | 3.8 | 2.1 | 2.2 | 4.4 | 4.5 | 4.1 | 4.1 | 3.4 | 3.7 | **4.1** | 11.1% | -6.3% | 0.1% |
| Colombia | 6.3 | 6.7 | 6.8 | 7.8 | 8.2 | 8.0 | 8.9 | 9.0 | 9.8 | 9.6 | **9.5** | -1.6% | 4.8% | 0.3% |
| Ecuador | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 0.6 | 0.6 | 0.6 | **0.6** | 1.5% | 6.9% | ◆ |
| Peru | 1.6 | 2.4 | 3.1 | 3.1 | 4.4 | 5.0 | 5.5 | 5.4 | 6.1 | 6.4 | **7.1** | 9.8% | 16.8% | 0.2% |
| Trinidad & Tobago | 19.1 | 19.7 | 19.2 | 19.9 | 20.9 | 21.0 | 20.0 | 20.2 | 19.8 | 19.4 | **17.2** | -11.4% | 2.8% | 0.5% |
| Venezuela | 28.3 | 32.6 | 30.9 | 29.0 | 29.0 | 26.7 | 28.3 | 27.5 | 27.7 | 31.1 | **32.0** | 2.7% | 2.3% | 1.0% |
| Other S. & Cent. America | 3.6 | 4.1 | 4.3 | 4.5 | 4.8 | 5.3 | 5.8 | 6.3 | 6.6 | 6.6 | **6.7** | 1.1% | 8.1% | 0.2% |
| Total S. & Cent. America | 121.9 | 128.4 | 129.1 | 123.0 | 135.2 | 135.4 | 143.6 | 148.7 | 152.0 | 158.3 | **154.7** | -2.5% | 3.6% | 4.8% |
| Austria | 8.4 | 7.9 | 8.5 | 8.2 | 9.0 | 8.4 | 8.1 | 7.7 | 7.1 | 7.5 | **7.9** | 4.4% | -1.7% | 0.2% |
| Azerbaijan | 8.2 | 7.2 | 8.2 | 7.0 | 6.7 | 7.3 | 7.7 | 7.7 | 8.5 | 9.6 | **9.4** | -2.2% | 2.2% | 0.3% |
| Belarus | 16.9 | 16.9 | 17.4 | 14.5 | 17.8 | 16.5 | 16.7 | 16.7 | 16.5 | 14.0 | **15.3** | 9.0% | -1.6% | 0.5% |
| Belgium | 15.0 | 14.9 | 14.8 | 15.1 | 17.0 | 14.2 | 14.4 | 14.2 | 12.4 | 13.6 | **13.9** | 1.8% | -0.8% | 0.4% |
| Bulgaria | 2.9 | 2.9 | 2.9 | 2.1 | 2.3 | 2.6 | 2.5 | 2.4 | 2.4 | 2.6 | **2.7** | 3.9% | -0.8% | 0.1% |
| Czech Republic | 7.6 | 7.1 | 7.1 | 6.7 | 7.6 | 6.9 | 6.9 | 6.9 | 6.2 | 6.5 | **7.0** | 7.9% | -1.7% | 0.2% |
| Denmark | 4.6 | 4.1 | 4.1 | 3.9 | 4.5 | 3.7 | 3.5 | 3.3 | 2.8 | 2.8 | **2.9** | 1.4% | -4.4% | 0.1% |
| Finland | 3.8 | 3.5 | 3.6 | 3.2 | 3.6 | 3.1 | 2.7 | 2.6 | 2.3 | 2.0 | **1.8** | -9.2% | -5.8% | 0.1% |
| France | 39.6 | 38.5 | 39.9 | 38.4 | 42.6 | 37.0 | 38.2 | 38.8 | 32.6 | 35.1 | **38.3** | 9.0% | -1.6% | 1.2% |
| Germany | 79.1 | 76.2 | 77.0 | 72.6 | 75.7 | 69.5 | 69.7 | 73.1 | 63.5 | 66.2 | **72.4** | 9.2% | -1.6% | 2.3% |
| Greece | 2.8 | 3.3 | 3.5 | 2.9 | 3.2 | 4.0 | 3.6 | 3.2 | 2.4 | 2.5 | **2.6** | 0.6% | 0.5% | 0.1% |
| Hungary | 11.5 | 10.7 | 10.6 | 9.2 | 9.8 | 9.4 | 8.4 | 7.8 | 7.0 | 7.5 | **8.0** | 7.0% | -4.7% | 0.3% |
| Ireland | 3.9 | 4.3 | 4.5 | 4.3 | 4.7 | 4.1 | 4.0 | 3.8 | 3.7 | 3.8 | **4.3** | 14.0% | 0.8% | 0.1% |
| Italy | 69.7 | 69.5 | 69.5 | 63.9 | 68.1 | 63.8 | 61.4 | 57.4 | 50.7 | 55.3 | **58.1** | 4.7% | -2.5% | 1.8% |
| Kazakhstan | 6.6 | 8.1 | 8.0 | 7.5 | 8.0 | 9.0 | 9.7 | 10.1 | 11.3 | 11.6 | **12.0** | 3.8% | 6.3% | 0.4% |
| Lithuania | 2.5 | 2.9 | 2.6 | 2.2 | 2.5 | 2.7 | 2.7 | 2.2 | 2.1 | 2.1 | **1.8** | -11.1% | -1.8% | 0.1% |
| Netherlands | 34.2 | 33.2 | 34.6 | 35.0 | 39.2 | 34.3 | 32.4 | 32.8 | 28.6 | 28.3 | **30.2** | 6.4% | -2.3% | 0.9% |
| Norway | 4.0 | 3.8 | 3.9 | 3.7 | 3.7 | 4.0 | 3.9 | 4.0 | 4.2 | 4.4 | **4.4** | 0.4% | 0.8% | 0.1% |
| Poland | 12.4 | 12.4 | 13.5 | 13.0 | 14.0 | 14.1 | 15.0 | 15.0 | 14.6 | 14.7 | **15.6** | 5.7% | 1.9% | 0.5% |
| Portugal | 3.7 | 3.9 | 4.3 | 4.2 | 4.6 | 4.7 | 4.0 | 3.8 | 3.7 | 4.3 | **4.6** | 8.1% | 1.2% | 0.1% |
| Romania | 14.4 | 12.7 | 12.6 | 10.5 | 10.8 | 11.0 | 11.2 | 10.2 | 9.5 | 9.0 | **9.5** | 6.2% | -4.3% | 0.3% |
| Russian Federation | 373.5 | 379.8 | 374.4 | 350.7 | 372.7 | 382.1 | 374.6 | 372.1 | 368.7 | 362.5 | **351.8** | -3.2% | 0.2% | 11.0% |
| Slovakia | 5.4 | 5.1 | 5.2 | 4.4 | 5.0 | 4.6 | 4.4 | 4.8 | 3.8 | 3.9 | **4.0** | 1.6% | -4.1% | 0.1% |
| Spain | 31.2 | 31.8 | 34.9 | 31.2 | 31.1 | 28.9 | 28.6 | 26.1 | 23.7 | 24.6 | **25.2** | 2.0% | -1.9% | 0.8% |
| Sweden | 0.8 | 0.9 | 0.8 | 1.0 | 1.3 | 1.1 | 0.9 | 0.9 | 0.8 | 0.8 | **0.8** | 10.0% | -0.9% | ◆ |
| Switzerland | 2.4 | 2.4 | 2.5 | 2.4 | 2.7 | 2.4 | 2.6 | 2.8 | 2.4 | 2.6 | **2.7** | 4.8% | 0.2% | 0.1% |
| Turkey | 27.4 | 32.5 | 33.8 | 32.1 | 35.1 | 36.8 | 37.3 | 37.8 | 40.1 | 39.2 | **37.9** | -3.7% | 5.0% | 1.2% |
| Turkmenistan | 16.5 | 19.1 | 19.3 | 17.7 | 20.4 | 21.2 | 23.7 | 20.6 | 23.0 | 26.5 | **26.6** | ◆ | 6.2% | 0.8% |
| Ukraine | 60.3 | 56.9 | 54.0 | 42.1 | 47.0 | 48.3 | 44.6 | 38.9 | 33.1 | 25.9 | **26.1** | 0.3% | -8.4% | 0.8% |
| United Kingdom | 81.0 | 81.9 | 84.4 | 78.3 | 84.8 | 70.3 | 66.5 | 65.7 | 60.0 | 61.3 | **69.0** | 12.2% | -3.3% | 2.2% |
| Uzbekistan | 37.7 | 41.3 | 43.8 | 35.9 | 36.8 | 42.9 | 42.5 | 42.2 | 43.9 | 45.2 | **46.2** | 2.0% | 1.6% | 1.4% |
| Other Europe & Eurasia | 15.4 | 15.6 | 14.9 | 13.2 | 14.4 | 14.6 | 14.4 | 13.4 | 13.4 | 13.6 | **13.9** | 2.4% | 1.4% | 0.4% |
| Total Europe & Eurasia | 1003.3 | 1011.4 | 1018.9 | 937.2 | 1006.5 | 983.5 | 966.6 | 949.0 | 905.0 | 909.2 | **926.9** | 1.7% | -0.8% | 28.9% |
| Iran | 100.8 | 113.0 | 119.9 | 128.4 | 137.6 | 146.0 | 145.4 | 146.6 | 165.3 | 171.7 | **180.7** | 5.0% | 6.4% | 5.6% |
| Israel | 2.1 | 2.5 | 3.4 | 3.8 | 4.8 | 4.5 | 2.3 | 6.2 | 6.8 | 7.6 | **8.7** | 14.5% | 17.8% | 0.3% |
| Kuwait | 11.3 | 10.9 | 11.5 | 11.1 | 13.1 | 15.0 | 16.6 | 16.8 | 16.6 | 19.2 | **19.7** | 2.5% | 5.7% | 0.6% |
| Qatar | 17.2 | 21.2 | 17.4 | 18.7 | 26.9 | 17.7 | 21.1 | 34.1 | 32.8 | 39.5 | **37.5** | -5.4% | 9.0% | 1.2% |
| Saudi Arabia | 66.1 | 67.0 | 72.4 | 70.6 | 78.9 | 83.0 | 89.4 | 90.0 | 92.1 | 94.0 | **98.4** | 4.4% | 3.9% | 3.1% |
| United Arab Emirates | 39.0 | 44.3 | 53.5 | 53.2 | 54.7 | 56.9 | 59.0 | 60.2 | 59.3 | 66.4 | **69.0** | 3.6% | 5.8% | 2.2% |
| Other Middle East | 30.2 | 30.8 | 34.6 | 37.4 | 41.0 | 39.9 | 39.8 | 42.2 | 41.7 | 45.9 | **47.1** | 2.3% | 5.2% | 1.5% |
| Total Middle East | 266.7 | 289.6 | 312.5 | 323.2 | 356.9 | 363.0 | 373.5 | 396.3 | 414.7 | 444.3 | **461.1** | 3.5% | 5.9% | 14.4% |
| Algeria | 21.4 | 21.9 | 22.8 | 24.5 | 23.7 | 25.1 | 27.9 | 30.0 | 33.7 | 35.5 | **36.0** | 1.2% | 5.4% | 1.1% |
| Egypt | 32.9 | 34.5 | 36.8 | 38.3 | 40.6 | 44.7 | 47.3 | 46.3 | 43.2 | 43.0 | **46.1** | 7.0% | 4.2% | 1.4% |
| South Africa | 3.1 | 3.1 | 3.4 | 3.0 | 3.5 | 3.7 | 4.0 | 4.1 | 4.5 | 4.6 | **4.6** | 1.3% | 4.9% | 0.1% |
| Other Africa | 23.3 | 27.5 | 27.7 | 23.8 | 28.0 | 28.5 | 29.3 | 30.4 | 32.9 | 39.2 | **37.6** | -4.4% | 4.9% | 1.2% |
| Total Africa | 80.6 | 87.0 | 90.6 | 89.6 | 95.8 | 101.9 | 108.6 | 110.9 | 114.3 | 122.2 | **124.3** | 1.4% | 4.8% | 3.9% |
| Australia | 22.6 | 25.3 | 25.1 | 26.2 | 28.0 | 30.3 | 30.4 | 32.0 | 34.4 | 38.6 | **37.0** | -4.4% | 6.6% | 1.2% |
| Bangladesh | 13.4 | 14.3 | 15.3 | 17.5 | 18.0 | 18.3 | 20.0 | 20.5 | 21.5 | 24.2 | **24.8** | 2.2% | 6.9% | 0.8% |
| China | 53.4 | 65.7 | 75.7 | 83.3 | 100.1 | 123.4 | 135.8 | 154.7 | 169.6 | 175.3 | **189.3** | 7.7% | 15.0% | 5.9% |
| China Hong Kong SAR | 2.6 | 2.5 | 2.9 | 2.8 | 3.4 | 2.7 | 2.5 | 2.4 | 2.3 | 2.9 | **3.0** | 2.4% | 1.9% | 0.1% |
| India | 33.5 | 36.3 | 37.4 | 45.6 | 54.3 | 55.0 | 50.8 | 44.4 | 43.9 | 41.2 | **45.1** | 9.2% | 2.5% | 1.4% |
| Indonesia | 32.9 | 30.7 | 35.2 | 37.3 | 39.1 | 37.9 | 38.0 | 36.7 | 36.8 | 36.4 | **33.9** | -7.0% | 1.2% | 1.1% |
| Japan | 75.4 | 81.2 | 84.4 | 78.7 | 85.1 | 95.0 | 105.2 | 105.2 | 106.2 | 102.1 | **100.1** | -2.2% | 3.7% | 3.1% |
| Malaysia | 31.8 | 31.9 | 35.3 | 31.8 | 26.6 | 31.3 | 31.9 | 36.3 | 38.0 | 37.6 | **38.7** | 2.7% | 1.8% | 1.2% |
| New Zealand | 3.3 | 3.6 | 3.4 | 3.6 | 3.9 | 3.5 | 3.8 | 4.0 | 4.4 | 4.0 | **4.2** | 4.3% | 2.3% | 0.1% |
| Pakistan | 35.9 | 36.4 | 37.3 | 37.4 | 38.1 | 38.1 | 39.4 | 38.4 | 37.7 | 39.2 | **40.9** | 4.2% | 1.1% | 1.3% |
| Philippines | 2.7 | 3.2 | 3.4 | 3.4 | 3.2 | 3.5 | 3.3 | 3.0 | 3.2 | 3.0 | **3.4** | 14.3% | 0.6% | 0.1% |
| Singapore | 7.7 | 7.7 | 8.3 | 8.7 | 7.9 | 7.9 | 8.5 | 9.5 | 9.8 | 11.0 | **11.3** | 2.5% | 6.5% | 0.4% |
| South Korea | 28.8 | 31.2 | 32.1 | 30.5 | 38.7 | 41.7 | 45.2 | 47.3 | 43.0 | 39.3 | **40.9** | 4.0% | 3.7% | 1.3% |
| Taiwan | 9.1 | 9.6 | 10.5 | 10.2 | 12.7 | 14.0 | 14.7 | 14.7 | 15.5 | 16.5 | **17.2** | 3.6% | 6.9% | 0.5% |
| Thailand | 28.4 | 30.2 | 31.8 | 32.8 | 37.2 | 38.1 | 41.8 | 42.0 | 42.9 | 43.8 | **43.5** | -1.0% | 4.7% | 1.4% |
| Vietnam | 6.3 | 6.4 | 6.7 | 7.2 | 8.5 | 7.6 | 8.4 | 8.8 | 9.2 | 9.6 | **9.6** | 0.2% | 5.2% | 0.3% |
| Other Asia Pacific | 4.9 | 5.4 | 5.2 | 4.8 | 5.2 | 5.6 | 5.6 | 5.8 | 6.5 | 7.0 | **7.2** | 2.7% | 4.0% | 0.2% |
| Total Asia Pacific | 392.9 | 421.8 | 449.8 | 462.0 | 509.8 | 553.8 | 585.5 | 605.6 | 624.9 | 631.6 | **650.3** | 2.7% | 5.6% | 20.3% |
| **Total World** | **2573.0** | **2678.1** | **2748.0** | **2675.5** | **2874.2** | **2926.3** | **2997.4** | **3054.4** | **3073.0** | **3146.7** | **3204.1** | **1.5%** | **2.3%** | **100.0%** |
| of which: OECD | 1297.7 | 1338.4 | 1361.0 | 1321.8 | 1404.8 | 1395.6 | 1429.4 | 1457.4 | 1434.8 | 1464.9 | **1495.2** | 1.8% | 1.2% | 46.7% |
| Non-OECD | 1275.3 | 1339.7 | 1387.0 | 1353.7 | 1469.5 | 1530.7 | 1568.0 | 1596.9 | 1638.2 | 1681.8 | **1708.9** | 1.3% | 3.4% | 53.3% |
| European Union | 441.1 | 434.7 | 445.4 | 416.5 | 448.1 | 404.7 | 394.7 | 388.1 | 344.7 | 359.2 | **385.9** | 7.1% | -2.2% | 12.0% |
| CIS | 524.3 | 534.3 | 530.1 | 479.8 | 513.8 | 531.9 | 524.6 | 512.6 | 509.8 | 499.8 | **492.0** | -1.8% | -0.1% | 15.4% |

*Excludes natural gas converted to liquid fuels but includes derivatives of coal as well as natural gas consumed in Gas-to-Liquids transformation. Source: Includes data from Cedigaz.

◆Less than 0.05%.

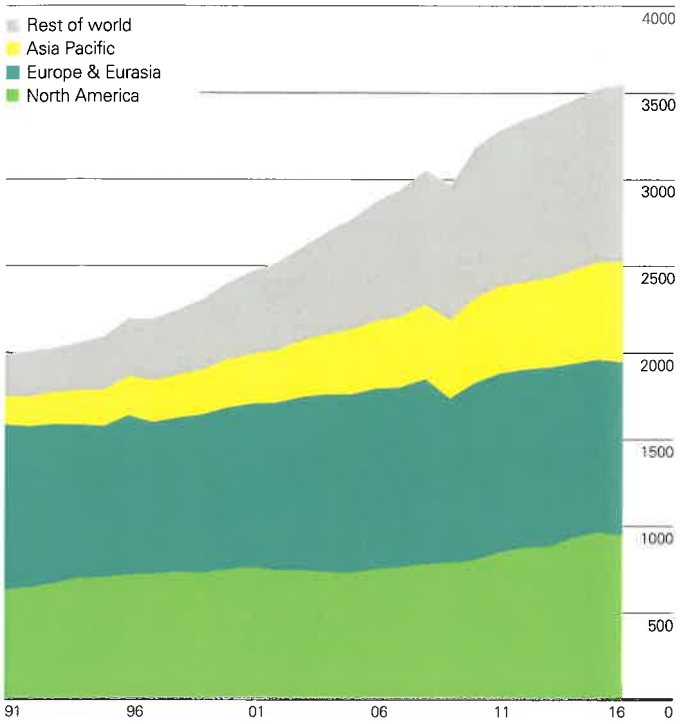
**Notes:** The difference between these world consumption figures and the world production statistics is due to variations in stocks at storage facilities and liquefaction plants, together with unavoidable disparities in the definition, measurement or conversion of gas supply and demand data.

**Annual changes and shares of total are calculated using million tonnes oil equivalent figures.**

**Growth rates are adjusted for leap years.**

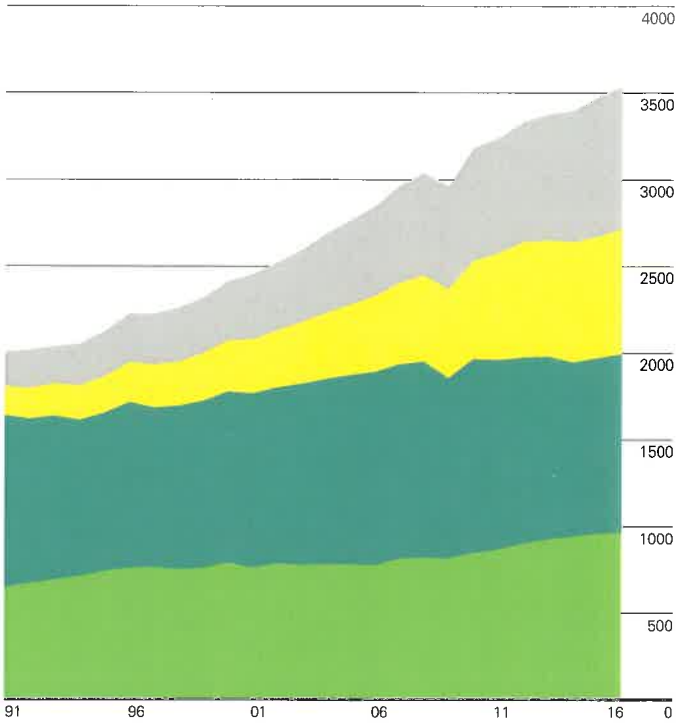
## Natural gas: Production by region

Billion cubic metres




## Natural gas: Consumption by region

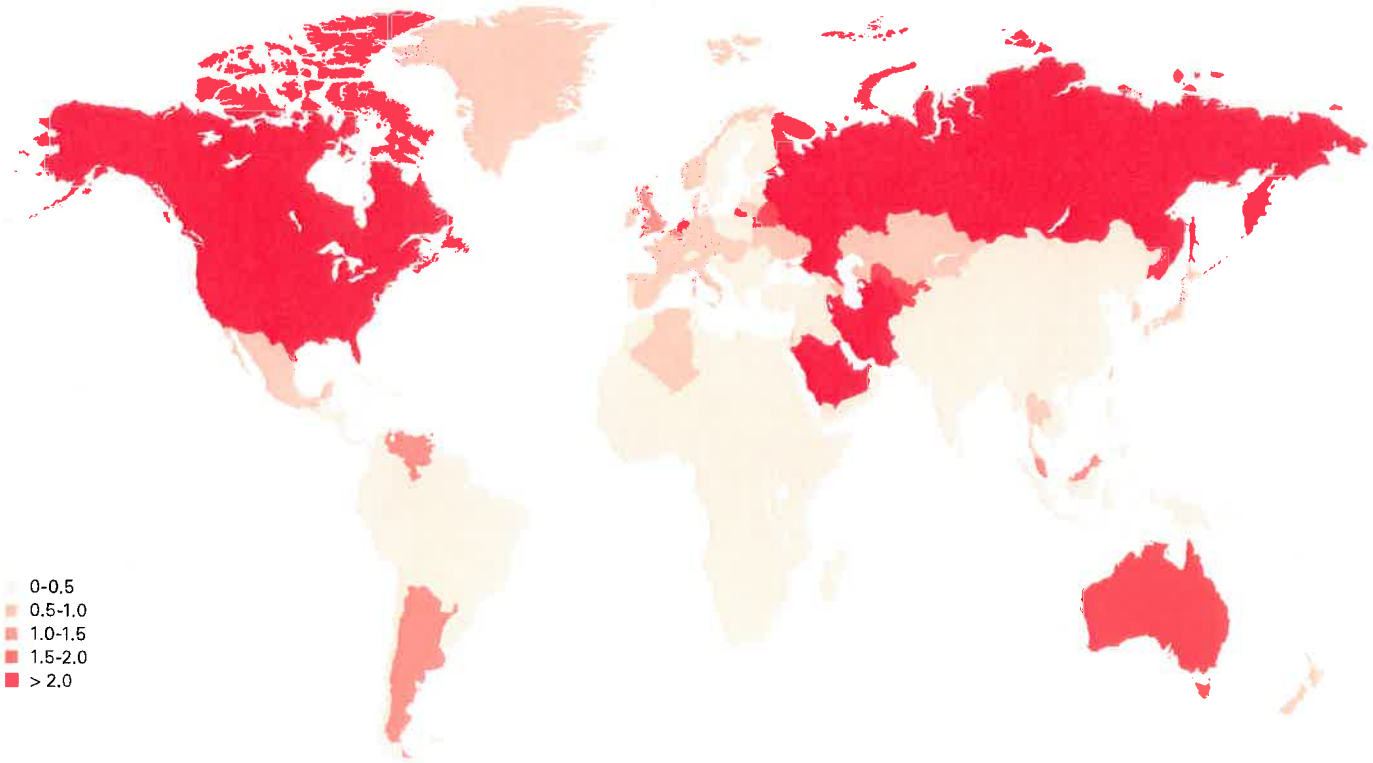
Billion cubic metres




Global natural gas production increased by only 0.3%, or 21 billion cubic metres (bcm) to 3552 bcm. Declining production in North America (-21 bcm) partially offset strong growth from Australia (19 bcm) and Iran (13 bcm). Gas consumption increased by 63 bcm or 1.5% – slower than the 10 year average (2.3%). EU gas consumption rose sharply by 30 bcm, or 7.1% – the fastest growth since 2010. Russia saw the largest drop in consumption of any country (-12 bcm).

## Natural gas: Consumption per capita 2016

Tonnes oil equivalent

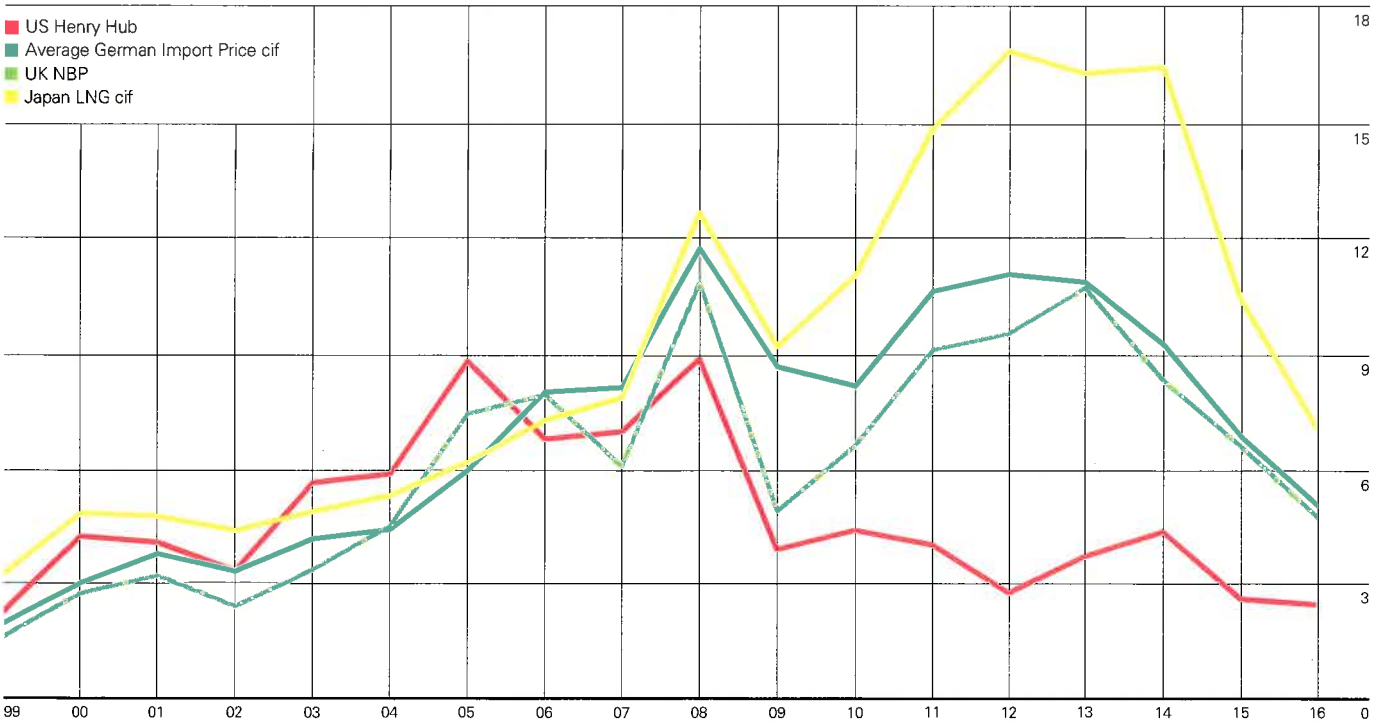


## Prices

| US dollars per million Btu | LNG Japan cif | Natural gas Average German Import Price* | Natural gas UK (Heren NBP Index)† | Natural gas US Henry Hub‡ | Natural gas Canada (Alberta)‡ | Crude oil OECD countries cif |
|---|---|---|---|---|---|---|
| 1986 | 4.10 | 3.93 | – | – | – | 2.57 |
| 1987 | 3.35 | 2.55 | – | – | – | 3.09 |
| 1988 | 3.34 | 2.22 | – | – | – | 2.56 |
| 1989 | 3.28 | 2.00 | – | 1.70 | – | 3.01 |
| 1990 | 3.64 | 2.78 | – | 1.64 | 1.05 | 3.82 |
| 1991 | 3.99 | 3.23 | – | 1.49 | 0.89 | 3.33 |
| 1992 | 3.62 | 2.70 | – | 1.77 | 0.98 | 3.19 |
| 1993 | 3.52 | 2.51 | – | 2.12 | 1.69 | 2.82 |
| 1994 | 3.18 | 2.35 | – | 1.92 | 1.45 | 2.70 |
| 1995 | 3.46 | 2.43 | – | 1.69 | 0.89 | 2.96 |
| 1996 | 3.66 | 2.50 | 1.87 | 2.76 | 1.12 | 3.54 |
| 1997 | 3.91 | 2.66 | 1.96 | 2.53 | 1.36 | 3.29 |
| 1998 | 3.05 | 2.33 | 1.86 | 2.08 | 1.42 | 2.16 |
| 1999 | 3.14 | 1.86 | 1.58 | 2.27 | 2.00 | 2.98 |
| 2000 | 4.72 | 2.91 | 2.71 | 4.23 | 3.75 | 4.83 |
| 2001 | 4.64 | 3.67 | 3.17 | 4.07 | 3.61 | 4.08 |
| 2002 | 4.27 | 3.21 | 2.37 | 3.33 | 2.57 | 4.17 |
| 2003 | 4.77 | 4.06 | 3.33 | 5.63 | 4.83 | 4.89 |
| 2004 | 5.18 | 4.30 | 4.46 | 5.85 | 5.03 | 6.27 |
| 2005 | 6.05 | 5.83 | 7.38 | 8.79 | 7.25 | 8.74 |
| 2006 | 7.14 | 7.87 | 7.87 | 6.76 | 5.83 | 10.66 |
| 2007 | 7.73 | 7.99 | 6.01 | 6.95 | 6.17 | 11.95 |
| 2008 | 12.55 | 11.60 | 10.79 | 8.85 | 7.99 | 16.76 |
| 2009 | 9.06 | 8.53 | 4.85 | 3.89 | 3.38 | 10.41 |
| 2010 | 10.91 | 8.03 | 6.56 | 4.39 | 3.69 | 13.47 |
| 2011 | 14.73 | 10.49 | 9.04 | 4.01 | 3.47 | 18.56 |
| 2012 | 16.75 | 10.93 | 9.46 | 2.76 | 2.27 | 18.82 |
| 2013 | 16.17 | 10.73 | 10.64 | 3.71 | 2.93 | 18.25 |
| 2014 | 16.33 | 9.11 | 8.25 | 4.35 | 3.87 | 16.80 |
| 2015 | 10.31 | 6.72 | 6.53 | 2.60 | 2.01 | 8.77 |
| 2016 | 6.94 | 4.93 | 4.69 | 2.46 | 1.55 | 7.04 |

*Source: 1986-1990 German Federal Statistical Office, 1991-2016 German Federal Office of Economics and Export Control (BAFA).
†Source: ICIS Heren Energy Ltd.
‡Source: Energy Intelligence Group, *Natural Gas Week*.
**Note:** cif = cost+insurance+freight (average prices).

## Prices
$/mmBtu



## Natural gas: Trade movements 2016 by pipeline

Billion cubic metres

| To | From US | Canada | Mexico | Bolivia | Other S. & Cent. America | Netherlands | Norway | United Kingdom | Other Europe | Azerbaijan | Kazakhstan | Russian Federation | Turkmenistan | Uzbekistan | Iran | Qatar | Algeria | Libya | Other Africa | Indonesia | Myanmar | Other Asia Pacific | Total imports |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| US | – | 82.4 | † | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | **82.5** |
| Canada | 21.9 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | **21.9** |
| Mexico | 38.4 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | **38.4** |
| North America | 60.3 | 82.4 | † | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | **142.8** |
| Argentina | – | – | – | 5.8 | 0.4 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | **6.1** |
| Brazil | – | – | – | 10.4 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | **10.4** |
| Other S. & Cent. America | – | – | – | – | 0.3 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | **0.3** |
| S. & Cent. America | – | – | – | 16.1 | 0.7 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | **16.8** |
| Austria | – | – | – | – | – | – | 1.7 | – | – | – | – | 5.6 | – | – | – | – | – | – | – | – | – | – | **7.3** |
| Belgium | – | – | – | – | – | 10.9 | 0.2 | 5.8 | – | – | – | 5.4 | – | – | – | – | – | – | – | – | – | – | **22.2** |
| Czech Republic | – | – | – | – | – | – | 3.3 | – | – | – | – | 4.2 | – | – | – | – | – | – | – | – | – | – | **7.5** |
| Finland | – | – | – | – | – | – | – | – | – | – | – | 2.3 | – | – | – | – | – | – | – | – | – | – | **2.3** |
| France | – | – | – | – | – | 4.6 | 16.6 | – | 0.6 | – | – | 10.5 | – | – | – | – | – | – | – | – | – | – | **32.3** |
| Germany | – | – | – | – | – | 22.9 | 29.7 | – | 0.6 | – | – | 46.0 | – | – | – | – | – | – | – | – | – | – | **99.3** |
| Greece | – | – | – | – | – | – | – | – | 0.6 | – | – | 2.5 | – | – | – | – | – | – | – | – | – | – | **3.1** |
| Hungary | – | – | – | – | – | – | – | – | 2.1 | – | – | 5.1 | – | – | – | – | – | – | – | – | – | – | **7.2** |
| Ireland | – | – | – | – | – | – | – | 2.7 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | **2.7** |
| Italy | – | – | – | – | – | 9.2 | 5.9 | – | – | – | – | 22.7 | – | – | – | – | 17.2 | 4.4 | – | – | – | – | **59.4** |
| Netherlands | – | – | – | – | – | – | 18.6 | 1.6 | 3.1 | – | – | 14.7 | – | – | – | – | – | – | – | – | – | – | **38.0** |
| Poland | – | – | – | – | – | – | – | – | 2.4 | – | – | 10.2 | – | – | – | – | – | – | – | – | – | – | **12.6** |
| Slovakia | – | – | – | – | – | – | – | – | 10.0 | – | – | 3.4 | – | – | – | – | – | – | – | – | – | – | **13.4** |
| Spain | – | – | – | – | – | – | 3.2 | – | † | – | – | – | – | – | – | – | 11.8 | – | – | – | – | – | **15.0** |
| Turkey | – | – | – | – | – | – | – | – | – | 6.5 | – | 23.2 | – | – | 7.7 | – | – | – | – | – | – | – | **37.4** |
| United Kingdom | – | – | – | – | – | 4.1 | 28.7 | – | 1.3 | – | – | – | – | – | – | – | – | – | – | – | – | – | **34.1** |
| Other Europe | – | – | – | – | – | 0.6 | 1.7 | † | 3.6 | 2.1 | – | 10.3 | – | – | – | – | 3.5 | – | – | – | – | – | **21.9** |
| Europe | – | – | – | – | – | 52.3 | 109.8 | 10.0 | 24.4 | 8.6 | – | 166.1 | – | – | 7.7 | – | 32.5 | 4.4 | – | – | – | – | **415.8** |
| Belarus | – | – | – | – | – | – | – | – | – | – | – | 16.6 | – | – | – | – | – | – | – | – | – | – | **16.6** |
| Kazakhstan | – | – | – | – | – | – | – | – | – | – | – | 3.6 | 1.1 | 1.5 | – | – | – | – | – | – | – | – | **6.2** |
| Russian Federation | – | – | – | – | – | – | – | – | – | – | 16.1 | – | – | 5.6 | – | – | – | – | – | – | – | – | **21.7** |
| Ukraine | – | – | – | – | – | – | – | – | 11.1 | – | – | – | – | – | – | – | – | – | – | – | – | – | **11.1** |
| Other CIS | – | – | – | – | – | – | – | – | † | – | – | 4.5 | – | – | 0.7 | – | – | – | – | – | – | – | **5.1** |
| CIS | – | – | – | – | – | – | – | – | 11.1 | – | 16.1 | 24.7 | 1.1 | 7.1 | 0.7 | – | – | – | – | – | – | – | **60.8** |
| Iran | – | – | – | – | – | – | – | – | – | 0.2 | – | – | 6.7 | – | – | – | – | – | – | – | – | – | **6.9** |
| Oman | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 2.1 | – | – | – | – | – | – | **2.1** |
| United Arab Emirates | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 17.9 | – | – | – | – | – | – | **17.9** |
| Middle East | – | – | – | – | – | – | – | – | – | 0.2 | – | – | 6.7 | – | – | 20.0 | – | – | – | – | – | – | **26.9** |
| South Africa | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 4.0 | – | – | – | **4.0** |
| Other Africa | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 4.6 | – | 0.1 | – | – | – | **4.7** |
| Africa | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 4.6 | – | 4.2 | – | – | – | **8.8** |
| Australia | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 8.3 | **8.3** |
| China | – | – | – | – | – | – | – | – | – | – | 0.4 | – | 29.4 | 4.3 | – | – | – | – | – | – | 3.9 | – | **38.0** |
| Malaysia | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 0.6 | – | – | **0.6** |
| Singapore | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 8.2 | – | 1.7 | **9.9** |
| Thailand | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 8.8 | – | **8.8** |
| Asia Pacific | – | – | – | – | – | – | – | – | – | – | 0.4 | – | 29.4 | 4.3 | – | – | – | – | – | 8.8 | 12.7 | 10.0 | **65.6** |
| **Total exports** | **60.3** | **82.4** | † | **16.1** | **0.7** | **52.3** | **109.8** | **10.0** | **35.5** | **8.8** | **16.6** | **190.8** | **37.3** | **11.4** | **8.4** | **20.0** | **37.1** | **4.4** | **4.2** | **8.8** | **12.7** | **10.0** | **737.5** |

†Less than 0.05.

Source: Includes data from CISStat, FGE MENagas service, IHS.

## Natural gas: Trade movements 2016 as liquefied natural gas*

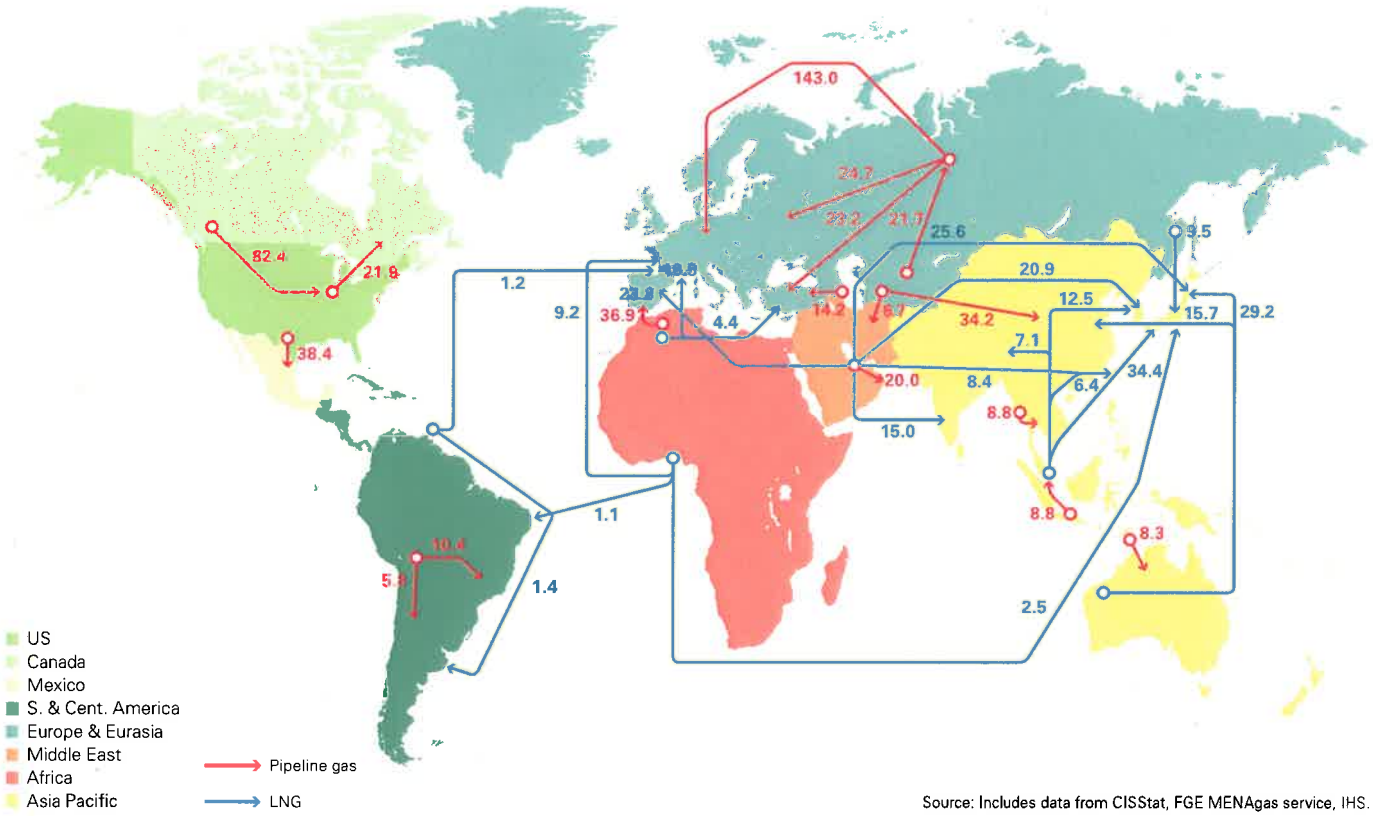
Billion cubic metres

| To | From US* | Brazil | Peru | Trinidad & Tobago | Norway | Other Europe* | Russian Federation | Oman | Qatar | United Arab Emirates | Algeria | Angola | Egypt | Equatorial Guinea | Nigeria | Australia | Brunei | Indonesia | Malaysia | Papua New Guinea | Other Asia Pacific* | Total imports |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| US | – | – | – | 2.3 | 0.1 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | **2.5** |
| Canada | † | – | – | 0.2 | 0.1 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | **0.3** |
| Mexico | 0.7 | 0.1 | 2.9 | 0.5 | – | – | – | – | – | – | 0.1 | – | – | 0.1 | 0.8 | 0.4 | – | 0.3 | – | – | – | **5.9** |
| North America | 0.7 | 0.1 | 2.9 | 3.1 | 0.2 | – | – | – | – | – | 0.1 | – | – | 0.1 | 0.8 | 0.4 | – | 0.3 | – | – | – | **8.7** |
| Argentina | 0.4 | 0.4 | – | 1.4 | 0.5 | 0.3 | – | – | 1.1 | – | 0.2 | † | – | 0.1 | 0.8 | 0.1 | – | – | – | – | – | **5.2** |
| Brazil | 0.2 | – | – | 0.3 | 0.3 | 0.2 | – | – | 0.7 | – | – | 0.1 | – | 0.2 | 1.1 | – | – | – | – | – | – | **3.0** |
| Chile | 0.7 | – | – | 3.2 | 0.2 | 0.1 | – | – | 0.1 | – | – | – | – | 0.1 | – | – | – | – | – | – | – | **4.3** |
| Other S. & Cent. America | 0.1 | – | – | 2.4 | 0.2 | 0.2 | – | – | – | – | – | – | – | 0.1 | 0.1 | – | – | – | – | – | – | **3.0** |
| S. & Cent. America | 1.5 | 0.4 | – | 7.2 | 1.1 | 0.7 | – | – | 1.8 | – | 0.2 | 0.1 | – | 0.4 | 2.0 | 0.1 | – | – | – | – | – | **15.5** |
| Belgium | – | – | – | – | – | 0.1 | – | – | 2.7 | – | † | – | – | – | – | – | – | – | – | – | – | **2.8** |
| France | – | – | 0.2 | – | 0.6 | † | – | – | 0.8 | – | 6.2 | – | – | – | 1.9 | – | – | – | – | – | – | **9.7** |
| Italy | 0.1 | – | 0.1 | – | 0.1 | † | – | – | 5.2 | – | 0.1 | – | – | – | 0.1 | – | – | – | – | – | – | **5.7** |
| Spain | 0.1 | – | 1.7 | 0.6 | 0.7 | † | – | – | 2.5 | – | 2.9 | 0.1 | – | – | 4.5 | – | – | – | – | – | – | **13.2** |
| Turkey | 0.2 | – | – | 0.3 | 0.1 | 0.2 | – | – | 1.0 | – | 4.4 | – | 0.1 | – | 1.4 | – | – | – | – | – | – | **7.7** |
| United Kingdom | – | – | – | 0.1 | 0.2 | 0.1 | – | – | 9.6 | – | 0.4 | – | † | – | † | – | – | – | – | – | – | **10.5** |
| Other Europe & Eurasia | 0.1 | – | – | 0.2 | 2.4 | † | † | – | 1.9 | 0.1 | 0.9 | – | – | – | 1.3 | – | – | – | – | – | – | **6.9** |
| Europe & Eurasia | 0.5 | – | 2.0 | 1.2 | 4.1 | 0.5 | † | – | 23.7 | 0.1 | 14.9 | 0.1 | 0.1 | – | 9.2 | – | – | – | – | – | – | **56.4** |
| Middle East | 0.5 | – | – | 1.1 | 0.2 | 0.9 | – | 1.3 | 4.5 | – | – | 0.1 | 0.2 | 1.2 | 3.2 | 0.9 | – | 0.1 | – | – | – | **14.2** |
| Africa | 0.1 | – | – | 0.5 | 0.3 | 0.9 | – | – | 6.4 | – | – | – | – | 0.1 | 1.4 | 0.4 | – | – | 0.1 | – | 0.1 | **10.2** |
| China | 0.3 | – | 0.3 | 0.2 | 0.2 | † | 0.3 | 0.1 | 6.5 | – | – | – | 0.1 | – | 0.4 | 15.7 | 0.1 | 3.7 | 3.4 | 2.9 | 0.2 | **34.3** |
| India | 0.5 | 0.1 | 0.1 | 0.6 | 0.1 | 0.3 | – | 0.3 | 14.0 | 0.7 | 0.1 | 0.4 | 0.1 | 1.4 | 2.7 | 1.2 | – | – | 0.1 | – | – | **22.5** |
| Japan | – | – | – | 0.1 | – | 0.7 | 9.5 | 3.3 | 15.8 | 6.5 | 0.4 | – | 0.1 | 0.4 | 2.5 | 29.2 | 5.5 | 8.7 | 20.2 | 5.5 | 0.2 | **108.5** |
| Malaysia | – | – | – | 0.1 | – | 0.1 | – | 0.1 | 0.1 | – | – | – | 0.1 | – | – | 0.7 | 0.5 | – | – | – | – | **1.6** |
| Pakistan | – | – | – | 0.2 | – | 0.1 | – | – | 2.9 | – | – | – | – | 0.4 | 0.3 | 0.2 | – | – | – | – | – | **4.0** |
| Singapore | – | – | – | – | – | – | – | – | 0.8 | 0.1 | – | – | 0.1 | 0.2 | – | 1.6 | – | – | 0.1 | – | † | **3.0** |
| South Korea | 0.3 | – | 0.2 | – | 0.1 | 0.1 | 2.4 | 5.3 | 15.6 | – | 0.2 | 0.1 | – | 0.1 | 0.7 | 6.1 | 1.8 | 5.7 | 5.0 | 0.2 | 0.1 | **43.9** |
| Taiwan | – | – | – | 0.1 | 0.1 | – | 1.7 | 0.2 | 8.2 | 0.1 | 0.1 | – | – | 0.1 | 0.6 | 0.3 | 0.4 | 2.6 | 3.3 | 1.8 | – | **19.5** |
| Thailand | – | – | – | – | – | – | – | 0.1 | 4.1 | – | – | – | – | – | – | – | – | – | – | – | – | **4.2** |
| Other Asia Pacific | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 0.1 | – | – | – | **0.1** |
| Asia Pacific | 1.0 | 0.1 | 0.6 | 1.2 | 0.5 | 1.3 | 13.9 | 9.4 | 68.0 | 7.3 | 0.7 | 0.5 | 0.5 | 2.5 | 7.1 | 55.1 | 8.3 | 20.8 | 32.0 | 10.4 | 0.4 | **241.6** |
| **Total exports** | **4.4** | **0.6** | **5.5** | **14.3** | **6.3** | **4.2** | **14.0** | **10.6** | **104.4** | **7.4** | **15.9** | **0.8** | **0.7** | **4.3** | **23.7** | **56.8** | **8.3** | **21.2** | **32.1** | **10.4** | **0.5** | **346.6** |

†Less than 0.05.
*Includes re-exports.

## Major trade movements 2016

Trade flows worldwide (billion cubic metres)




Source: Includes data from CISStat, FGE MENAgas service, IHS.

## Gas trade in 2015 and 2016 in billion cubic metres

| | 2015 | | | | 2016 | | | |
|---|---|---|---|---|---|---|---|---|
| Billion cubic metres | Pipeline imports | LNG imports | Pipeline exports | LNG exports | Pipeline imports | LNG imports | Pipeline exports | LNG exports |
| US | 74.4 | 2.6 | 49.1 | 0.7 | 82.5 | 2.5 | 60.3 | 4.4 |
| Canada | 19.2 | 0.6 | 74.3 | † | 21.9 | 0.3 | 82.4 | † |
| Mexico | 29.9 | 7.3 | † | – | 38.4 | 5.9 | † | – |
| Trinidad and Tobago | – | – | – | 16.9 | – | – | – | 14.3 |
| Other S. & Cent. America | 19.9 | 19.8 | 19.9 | 5.1 | 16.8 | 15.5 | 16.8 | 6.1 |
| France | 31.8 | 6.8 | – | 0.6 | 32.3 | 9.7 | – | 1.5 |
| Germany | 102.3 | – | 32.7 | – | 99.3 | – | 19.3 | – |
| Italy | 55.7 | 5.4 | 0.2 | – | 59.4 | 5.7 | – | – |
| Netherlands | 33.6 | 2.1 | 47.1 | 1.3 | 38.0 | 1.5 | 52.3 | 0.7 |
| Norway | † | – | 109.6 | 5.9 | † | – | 109.8 | 6.3 |
| Spain | 15.2 | 13.1 | 0.5 | 1.8 | 15.0 | 13.2 | 0.6 | 0.2 |
| Turkey | 38.4 | 7.7 | 0.6 | – | 37.4 | 7.7 | 0.6 | – |
| United Kingdom | 29.0 | 13.1 | 13.4 | 0.3 | 34.1 | 10.5 | 10.0 | 0.5 |
| Other Europe | 94.7 | 6.9 | 13.8 | 1.5 | 100.2 | 8.2 | 15.0 | 1.3 |
| Russian Federation | 21.8 | – | 179.1 | 14.0 | 21.7 | – | 190.8 | 14.0 |
| Ukraine | 17.3 | – | – | – | 11.1 | – | – | – |
| Other CIS | 27.0 | – | 72.3 | – | 27.9 | – | 74.0 | – |
| Qatar | – | – | 20.0 | 101.8 | – | – | 20.0 | 104.4 |
| Other Middle East | 29.6 | 10.2 | 8.4 | 18.8 | 26.9 | 14.2 | 8.4 | 18.1 |
| Algeria | – | – | 26.3 | 16.6 | – | – | 37.1 | 15.9 |
| Other Africa | 9.0 | 3.7 | 11.0 | 30.0 | 8.8 | 10.2 | 8.5 | 29.6 |
| Australia | 6.4 | – | – | 38.1 | 8.3 | 0.1 | – | 56.8 |
| China | 33.6 | 25.8 | – | – | 38.0 | 34.3 | – | – |
| Japan | – | 110.7 | – | – | – | 108.5 | – | – |
| Indonesia | – | – | 9.3 | 20.7 | – | – | 8.8 | 21.2 |
| South Korea | – | 43.8 | – | 0.2 | – | 43.9 | – | 0.1 |
| Other Asia Pacific | 20.3 | 46.0 | 21.4 | 51.4 | 19.3 | 54.8 | 22.7 | 51.1 |
| **Total World** | **709.0** | **325.5** | **709.0** | **325.5** | **737.5** | **346.6** | **737.5** | **346.6** |

†Less than 0.05.

Source: Includes data from CISStat, FGE MENAgas service, IHS.

# Coal

## Total proved reserves at end 2016

| Million tonnes | Anthracite and bituminous | Sub-bituminous and lignite | Total | Share of total | R/P ratio |
|---|---|---|---|---|---|
| US | 221400 | 30182 | **251582** | 22.1% | 381 |
| Canada | 4346 | 2236 | **6582** | 0.6% | 109 |
| Mexico | 1160 | 51 | **1211** | 0.1% | 151 |
| Total North America | 226906 | 32469 | **259375** | 22.8% | 356 |
| Brazil | 1547 | 5049 | **6596** | 0.6% | * |
| Colombia | 4881 | – | **4881** | 0.4% | 54 |
| Venezuela | 731 | – | **731** | 0.1% | * |
| Other S. & Cent. America | 1784 | 24 | **1808** | 0.2% | * |
| Total S. & Cent. America | 8943 | 5073 | **14016** | 1.2% | 138 |
| Bulgaria | 192 | 2174 | **2366** | 0.2% | 75 |
| Czech Republic | 1103 | 2573 | **3676** | 0.3% | 80 |
| Germany | 12 | 36200 | **36212** | 3.2% | 206 |
| Greece | – | 2876 | **2876** | 0.3% | 87 |
| Hungary | 276 | 2633 | **2909** | 0.3% | 311 |
| Kazakhstan | 25605 | – | **25605** | 2.2% | 250 |
| Poland | 18700 | 5461 | **24161** | 2.1% | 184 |
| Romania | 11 | 280 | **291** | ◆ | 13 |
| Russian Federation | 69634 | 90730 | **160364** | 14.1% | 417 |
| Serbia | 402 | 7112 | **7514** | 0.7% | 196 |
| Spain | 868 | 319 | **1187** | 0.1% | * |
| Turkey | 378 | 10975 | **11353** | 1.0% | 163 |
| Ukraine | 32039 | 2336 | **34375** | 3.0% | * |
| United Kingdom | 70 | – | **70** | ◆ | 17 |
| Uzbekistan | 1375 | – | **1375** | 0.1% | 355 |
| Other Europe & Eurasia | 2618 | 5172 | **7790** | 0.7% | 201 |
| Total Europe & Eurasia | 153283 | 168841 | **322124** | 28.3% | 284 |
| South Africa | 9893 | – | **9893** | 0.9% | 39 |
| Zimbabwe | 502 | – | **502** | ◆ | 186 |
| Other Africa | 2756 | 66 | **2822** | 0.2% | 276 |
| Middle East | 1203 | – | **1203** | 0.1% | * |
| Total Middle East & Africa | 14354 | 66 | **14420** | 1.3% | 54 |
| Australia | 68310 | 76508 | **144818** | 12.7% | 294 |
| China | 230004 | 14006 | **244010** | 21.4% | 72 |
| India | 89782 | 4987 | **94769** | 8.3% | 137 |
| Indonesia | 17326 | 8247 | **25573** | 2.2% | 59 |
| Japan | 340 | 10 | **350** | ◆ | 261 |
| Mongolia | 1170 | 1350 | **2520** | 0.2% | 66 |
| New Zealand | 825 | 6750 | **7575** | 0.7% | * |
| Pakistan | 207 | 2857 | **3064** | 0.3% | * |
| South Korea | 326 | – | **326** | ◆ | 189 |
| Thailand | – | 1063 | **1063** | 0.1% | 63 |
| Vietnam | 3116 | 244 | **3360** | 0.3% | 85 |
| Other Asia Pacific | 1322 | 646 | **1968** | 0.2% | 29 |
| Total Asia Pacific | 412728 | 116668 | **529396** | 46.5% | 102 |
| **Total World** | **816214** | **323117** | **1139331** | **100.0%** | **153** |
| of which: OECD | 319878 | 177264 | **497142** | 43.6% | 291 |
| Non-OECD | 496336 | 145853 | **642189** | 56.4% | 112 |
| European Union | 21813 | 53006 | **74819** | 6.6% | 162 |
| CIS | 130162 | 93066 | **223228** | 19.6% | 417 |

*More than 500 years.
◆Less than 0.05%.

Source: Includes data from Federal Institute for Geosciences and Natural Resources (BGR) Energy Study 2016.

**Notes: Total proved reserves of coal** – Generally taken to be those quantities that geological and engineering information indicates with reasonable certainty can be recovered in the future from known reservoirs under existing economic and operating conditions. The data series for total proved coal reserves does not necessarily meet the definitions, guidelines and practices used for determining proved reserves at company level, for instance as published by the US Securities and Exchange Commission, nor does it necessarily represent BP's view of proved reserves by country.
**Reserves-to-production (R/P) ratio –** If the reserves remaining at the end of any year are divided by the production in that year, the result is the length of time that those remaining reserves would last if production were to continue at that rate.
**Reserves-to-production (R/P) ratios are calculated excluding other solid fuels in reserves and production.**
**Shares of total and R/P ratios are calculated using million tonnes figures.**

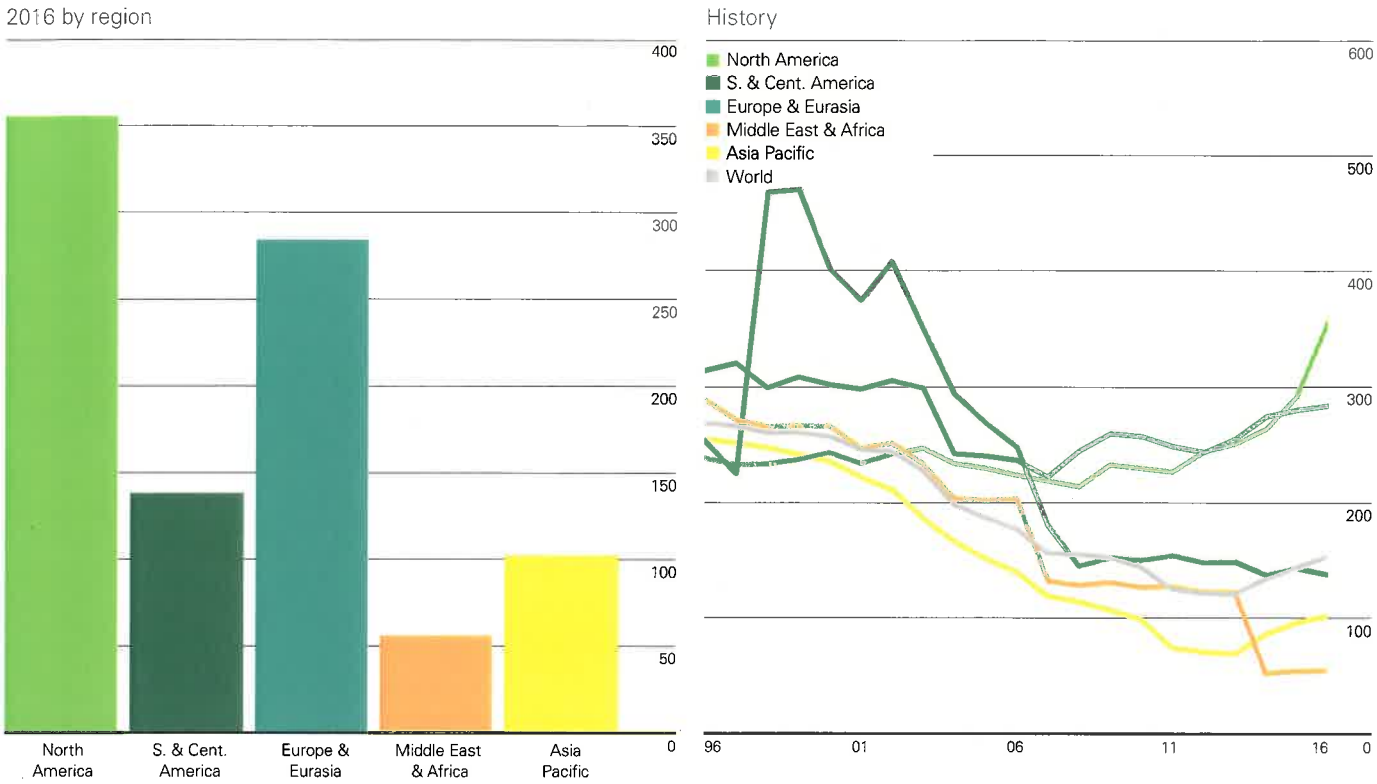
## Prices

| US dollars per tonne | Northwest Europe marker price† | US Central Appalachian coal spot price index‡ | Japan steam spot cif price† | China Qinhuangdao spot price† |
|---|---|---|---|---|
| 1996 | 41.25 | 29.86 | – | – |
| 1997 | 38.92 | 29.76 | – | – |
| 1998 | 32.00 | 31.00 | – | – |
| 1999 | 28.79 | 31.29 | – | – |
| 2000 | 35.99 | 29.90 | – | 27.52 |
| 2001 | 39.03 | 50.15 | 37.69 | 31.78 |
| 2002 | 31.65 | 33.20 | 31.47 | 33.19 |
| 2003 | 43.60 | 38.52 | 39.61 | 31.74 |
| 2004 | 72.08 | 64.90 | 74.22 | 42.76 |
| 2005 | 60.54 | 70.12 | 64.62 | 51.34 |
| 2006 | 64.11 | 62.96 | 65.22 | 53.53 |
| 2007 | 88.79 | 51.16 | 95.59 | 61.23 |
| 2008 | 147.67 | 118.79 | 157.88 | 104.97 |
| 2009 | 70.66 | 68.08 | 83.59 | 87.86 |
| 2010 | 92.50 | 71.63 | 108.47 | 110.08 |
| 2011 | 121.52 | 87.38 | 126.13 | 127.27 |
| 2012 | 92.50 | 72.06 | 100.30 | 111.89 |
| 2013 | 81.69 | 71.39 | 90.07 | 95.42 |
| 2014 | 75.38 | 69.00 | 76.13 | 84.12 |
| 2015 | 56.79 | 53.59 | 60.10 | 67.53 |
| 2016 | 59.87 | 53.56 | 71.66 | 71.35 |

†Source: IHS. Northwest Europe prices for 1996-2000 based on monthly data, 2001-2016 on weekly data. China prices for 2000-2005 based on monthly data, 2006-2016 on weekly data. China basis 5,500 kilocalories per kg NAR CFR. Japan basis = 6,000 kilocalories per kg NAR CIF.
‡Source: Platts. Prices are for Central Appalachian 12,500 BTU, 1.2 SO2 coal, fob. Prices for 1996-2000 are by coal price publication date, 2001-2016 by coal price assessment date.
**Note:** cif = cost+insurance+freight (average prices); cfr = cost and freight; fob = free on board.

## Reserves-to-production (R/P) ratios

Years




World proved coal reserves are currently sufficient to meet 153 years of global production, roughly three times the R/P ratio for oil and gas. By region, Asia Pacific holds the most proved reserves (46.5% of total), with China accounting for 21.4% of the global total. The US remains the largest reserve holder (22.1% of total).

## Distribution of proved reserves in 1996, 2006 and 2016

Percentage

## Coal: Production*

| Million tonnes oil equivalent | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Growth rate per annum 2016 | Growth rate per annum 2005-15 | Share 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| US | 595.1 | 587.7 | 596.7 | 540.8 | 551.2 | 556.1 | 517.8 | 500.9 | 507.7 | 449.3 | **364.8** | -19.0% | -2.5% | 10.0% |
| Canada | 34.8 | 35.7 | 35.6 | 33.1 | 35.4 | 35.5 | 35.6 | 36.4 | 35.6 | 31.9 | **31.4** | -1.8% | -1.0% | 0.9% |
| Mexico | 6.8 | 7.3 | 6.9 | 6.1 | 7.3 | 9.4 | 7.4 | 7.2 | 7.3 | 6.9 | **4.5** | -34.8% | 1.2% | 0.1% |
| Total North America | 636.7 | 630.7 | 639.2 | 580.0 | 594.0 | 600.9 | 560.9 | 544.5 | 550.5 | 488.1 | **400.7** | -18.1% | -2.4% | 11.0% |
| Brazil | 2.6 | 2.7 | 2.9 | 2.3 | 2.3 | 2.4 | 2.9 | 3.7 | 3.4 | 3.5 | **3.5** | – | 2.3% | 0.1% |
| Colombia | 45.7 | 48.2 | 50.7 | 50.2 | 51.3 | 59.2 | 61.5 | 59.0 | 61.1 | 59.0 | **62.5** | 5.5% | 3.7% | 1.7% |
| Venezuela | 5.2 | 5.0 | 3.7 | 2.4 | 1.9 | 1.9 | 1.4 | 0.9 | 0.6 | 0.6 | **0.2** | -66.4% | -19.7% | ◆ |
| Other S. & Cent. America | 0.4 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 1.7 | 2.4 | 1.9 | **1.5** | -18.3% | 16.3% | ◆ |
| Total S. & Cent. America | 53.9 | 56.2 | 57.7 | 55.3 | 55.9 | 63.9 | 66.3 | 65.3 | 67.5 | 64.9 | **67.6** | 3.9% | 2.7% | 1.8% |
| Bulgaria | 4.3 | 4.7 | 4.8 | 4.6 | 4.9 | 6.2 | 5.6 | 4.8 | 5.1 | 5.8 | **5.1** | -12.5% | 3.4% | 0.1% |
| Czech Republic | 23.9 | 23.8 | 22.8 | 20.9 | 20.7 | 20.9 | 20.1 | 17.7 | 16.8 | 16.8 | **16.3** | -3.4% | -3.3% | 0.4% |
| Germany | 53.3 | 54.4 | 50.1 | 46.4 | 45.9 | 46.7 | 47.8 | 45.1 | 44.1 | 42.9 | **39.9** | -7.2% | -2.7% | 1.1% |
| Greece | 8.2 | 8.4 | 8.1 | 8.2 | 7.3 | 7.5 | 8.0 | 6.7 | 6.4 | 5.7 | **4.1** | -28.7% | -4.0% | 0.1% |
| Hungary | 1.8 | 1.8 | 1.7 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.5 | **1.5** | 0.6% | -1.4% | ◆ |
| Kazakhstan | 41.4 | 42.2 | 47.9 | 43.4 | 47.5 | 49.8 | 51.6 | 51.4 | 48.9 | 46.2 | **44.1** | -4.9% | 2.2% | 1.2% |
| Poland | 68.0 | 62.5 | 60.9 | 56.4 | 55.4 | 55.7 | 57.8 | 57.2 | 54.0 | 53.0 | **52.3** | -1.5% | -2.7% | 1.4% |
| Romania | 6.5 | 6.9 | 7.0 | 6.6 | 5.9 | 6.7 | 6.3 | 4.7 | 4.4 | 4.7 | **4.3** | -9.2% | -2.0% | 0.1% |
| Russian Federation | 141.0 | 143.5 | 149.0 | 141.7 | 151.0 | 157.6 | 168.3 | 173.1 | 176.6 | 186.4 | **192.8** | 3.1% | 3.2% | 5.3% |
| Serbia | n/a | 7.2 | 7.5 | 7.4 | 7.2 | 7.8 | 7.3 | 7.7 | 5.7 | 7.2 | **7.4** | 1.4% | – | 0.2% |
| Spain | 6.2 | 5.9 | 4.4 | 3.8 | 3.3 | 2.6 | 2.5 | 1.8 | 1.6 | 1.2 | **0.7** | -43.3% | -15.7% | ◆ |
| Turkey | 13.2 | 14.8 | 16.7 | 17.4 | 17.5 | 17.9 | 17.0 | 15.5 | 16.4 | 12.8 | **15.2** | 18.7% | 1.3% | 0.4% |
| Ukraine | 35.7 | 34.0 | 34.4 | 31.8 | 31.8 | 36.3 | 38.0 | 36.6 | 25.9 | 16.4 | **17.1** | 4.3% | -7.3% | 0.5% |
| United Kingdom | 11.4 | 10.7 | 11.3 | 11.0 | 11.4 | 11.5 | 10.6 | 8.0 | 7.3 | 5.4 | **2.6** | -51.5% | -8.2% | 0.1% |
| Uzbekistan | 0.8 | 1.0 | 0.9 | 1.0 | 1.0 | 1.1 | 1.2 | 1.1 | 1.2 | 1.1 | **1.1** | -1.8% | 2.3% | ◆ |
| Other Europe & Eurasia | 24.8 | 16.3 | 16.5 | 16.6 | 16.9 | 17.1 | 15.6 | 18.0 | 17.0 | 15.3 | **14.9** | -3.1% | -4.0% | 0.4% |
| Total Europe & Eurasia | 440.4 | 438.0 | 443.9 | 418.8 | 429.3 | 446.9 | 459.4 | 450.9 | 433.2 | 422.5 | **419.4** | -1.0% | -0.2% | 11.5% |
| Total Middle East | 1.0 | 1.1 | 1.0 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.6 | 0.7 | **0.7** | – | -3.3% | ◆ |
| South Africa | 138.3 | 138.4 | 141.0 | 139.7 | 144.1 | 143.2 | 146.6 | 145.3 | 148.2 | 142.9 | **142.4** | -0.6% | 0.3% | 3.9% |
| Zimbabwe | 1.4 | 1.3 | 1.0 | 1.1 | 1.7 | 1.7 | 1.0 | 2.0 | 3.7 | 2.8 | **1.7** | -37.9% | 2.6% | ◆ |
| Other Africa | 0.9 | 0.8 | 0.8 | 0.7 | 0.9 | 1.1 | 4.4 | 5.1 | 5.5 | 6.0 | **6.3** | 5.5% | 20.6% | 0.2% |
| Total Africa | 140.5 | 140.5 | 142.7 | 141.5 | 146.8 | 146.0 | 152.0 | 152.3 | 157.5 | 151.7 | **150.5** | -1.0% | 0.7% | 4.1% |
| Australia | 220.4 | 227.0 | 234.2 | 242.5 | 250.6 | 245.1 | 265.9 | 285.8 | 305.7 | 305.8 | **299.3** | -2.4% | 3.6% | 8.2% |
| China | 1328.4 | 1439.3 | 1491.8 | 1537.9 | 1665.3 | 1851.7 | 1873.5 | 1894.6 | 1864.2 | 1825.6 | **1685.7** | -7.9% | 3.9% | 46.1% |
| India | 198.2 | 210.3 | 227.5 | 246.0 | 252.4 | 250.8 | 255.0 | 255.7 | 269.5 | 280.9 | **288.5** | 2.4% | 4.0% | 7.9% |
| Indonesia | 114.2 | 127.8 | 141.6 | 151.0 | 162.1 | 208.2 | 227.4 | 279.7 | 269.9 | 272.0 | **255.7** | -6.2% | 11.7% | 7.0% |
| Japan | 0.7 | 0.8 | 0.7 | 0.7 | 0.5 | 0.7 | 0.7 | 0.7 | 0.7 | 0.6 | **0.7** | 14.2% | 0.5% | ◆ |
| Mongolia | 4.1 | 4.8 | 5.2 | 8.2 | 15.2 | 19.9 | 18.1 | 18.0 | 14.8 | 14.5 | **22.8** | 57.0% | 14.8% | 0.6% |
| New Zealand | 3.6 | 3.0 | 3.0 | 2.8 | 3.3 | 3.1 | 3.0 | 2.8 | 2.5 | 2.0 | **1.7** | -15.4% | -4.8% | ◆ |
| Pakistan | 1.8 | 1.7 | 1.8 | 1.6 | 1.5 | 1.4 | 1.4 | 1.3 | 1.5 | 1.5 | **1.8** | 19.5% | -0.5% | ◆ |
| South Korea | 1.3 | 1.3 | 1.3 | 1.2 | 1.0 | 1.0 | 1.0 | 0.8 | 0.8 | 0.8 | **0.8** | -2.4% | -4.4% | ◆ |
| Thailand | 5.4 | 5.0 | 5.0 | 4.8 | 5.0 | 6.0 | 4.8 | 4.9 | 4.8 | 3.9 | **4.3** | 10.6% | -4.5% | 0.1% |
| Vietnam | 21.7 | 23.8 | 22.3 | 24.7 | 25.1 | 26.1 | 23.6 | 23.0 | 23.0 | 23.2 | **22.0** | -5.4% | 2.0% | 0.6% |
| Other Asia Pacific | 22.4 | 20.6 | 22.0 | 23.5 | 24.7 | 24.9 | 25.3 | 25.1 | 25.7 | 28.6 | **33.9** | 18.3% | 2.6% | 0.9% |
| Total Asia Pacific | 1922.2 | 2065.5 | 2156.2 | 2244.8 | 2406.7 | 2638.8 | 2699.7 | 2792.5 | 2783.1 | 2759.4 | **2617.4** | -5.4% | 4.4% | 71.6% |
| **Total World** | **3194.7** | **3331.9** | **3440.8** | **3441.1** | **3633.3** | **3897.3** | **3938.9** | **4006.1** | **3992.4** | **3887.3** | **3656.4** | **-6.2%** | 2.5% | **100.0%** |
| of which: OECD | 1060.1 | 1055.8 | 1064.6 | 1003.4 | 1023.4 | 1025.5 | 1005.7 | 1000.7 | 1020.9 | 946.6 | **844.8** | -11.0% | -1.0% | 23.1% |
| Non-OECD | 2134.6 | 2276.0 | 2376.3 | 2437.7 | 2609.9 | 2871.8 | 2933.1 | 3005.5 | 2971.4 | 2940.7 | **2811.6** | -4.7% | 3.9% | 76.9% |
| European Union | 193.2 | 187.0 | 178.9 | 167.9 | 165.7 | 168.5 | 168.1 | 157.3 | 150.6 | 144.6 | **133.6** | -7.9% | -3.1% | 3.7% |
| CIS | 219.5 | 221.5 | 233.0 | 218.8 | 232.0 | 245.7 | 260.3 | 263.5 | 254.0 | 251.5 | **256.8** | 1.8% | 1.9% | 7.0% |

*Commercial solid fuels only, i.e. bituminous coal and anthracite (hard coal), lignite and brown (sub-bituminous) coal, and other commercial solid fuels. Includes coal produced for Coal-to-Liquids and Coal-to-Gas transformations.
◆Less than 0.05%.
n/a not available.
**Notes: Annual changes and shares of total are calculated using million tonnes oil equivalent figures.**
**Growth rates are adjusted for leap years.**
Coal production data expressed in million tonnes is available at *bp.com/statisticalreview*

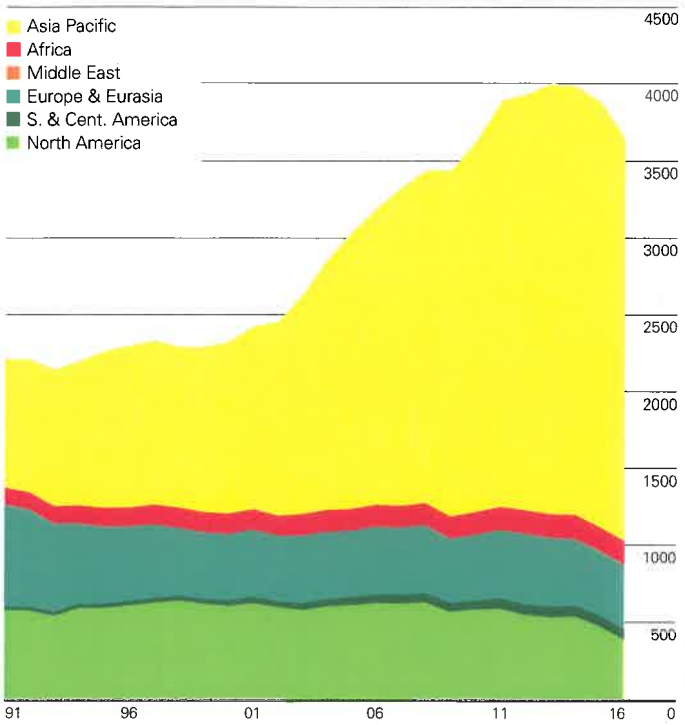
## Coal: Consumption*

| Million tonnes oil equivalent | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | **2016** | Growth rate per annum 2016 | Growth rate per annum 2005-15 | Share 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| US | 565.7 | 573.3 | 564.2 | 496.2 | 525.0 | 495.4 | 437.9 | 454.6 | 453.5 | 391.8 | **358.4** | -8.8% | -3.8% | 9.6% |
| Canada | 29.2 | 30.3 | 29.4 | 23.5 | 24.8 | 21.8 | 21.0 | 20.8 | 19.7 | 19.6 | **18.7** | -5.2% | -4.2% | 0.5% |
| Mexico | 12.3 | 11.3 | 10.1 | 10.3 | 12.7 | 14.7 | 12.8 | 12.7 | 12.7 | 12.7 | **9.8** | -22.9% | 1.0% | 0.3% |
| Total North America | 607.1 | 614.9 | 603.7 | 530.0 | 562.5 | 531.9 | 471.8 | 488.1 | 486.0 | 424.2 | **386.9** | -9.0% | -3.7% | 10.4% |
| Argentina | 1.1 | 1.2 | 1.4 | 1.0 | 1.3 | 1.5 | 1.3 | 1.3 | 1.5 | 1.4 | **1.1** | -22.5% | 1.9% | ◆ |
| Brazil | 12.8 | 13.6 | 13.8 | 11.1 | 14.5 | 15.4 | 15.3 | 16.5 | 17.5 | 17.7 | **16.5** | -6.8% | 3.1% | 0.4% |
| **Chile** | **3.4** | **4.1** | **4.4** | **4.0** | **4.5** | **5.8** | **6.7** | **7.5** | **7.6** | **7.3** | **8.2** | **12.3%** | **10.2%** | **0.2%** |
| Colombia | 3.7 | 3.2 | 4.9 | 4.0 | 4.7 | 3.7 | 4.6 | 5.0 | 5.2 | 5.3 | **4.6** | -14.0% | 14.8% | 0.1% |
| Ecuador | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Peru | 0.8 | 1.0 | 0.9 | 0.8 | 0.8 | 0.8 | 0.9 | 0.9 | 0.9 | 0.8 | **0.8** | – | -1.3% | ◆ |
| Trinidad & Tobago | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Venezuela | 0.2 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | **0.1** | -66.4% | 18.4% | ◆ |
| Other S. & Cent. America | 2.3 | 2.4 | 2.4 | 2.1 | 2.2 | 2.7 | 2.7 | 2.9 | 3.2 | 3.2 | **3.4** | 5.4% | 4.9% | 0.1% |
| Total S. & Cent. America | 24.3 | 25.7 | 28.0 | 23.2 | 28.1 | 30.2 | 31.7 | 34.2 | 36.1 | 35.9 | **34.7** | -3.7% | 5.4% | 0.9% |
| Austria | 4.1 | 3.9 | 3.8 | 2.9 | 3.4 | 3.5 | 3.2 | 3.3 | 3.0 | 3.2 | **3.2** | -2.3% | -2.1% | 0.1% |
| Azerbaijan | † | † | † | † | † | † | † | † | † | † | **†** | – | -19.8% | ◆ |
| Belarus | 0.6 | 0.7 | 0.6 | 0.6 | 0.6 | 0.8 | 0.8 | 0.9 | 0.8 | 0.7 | **0.8** | 16.5% | -0.3% | ◆ |
| Belgium | 5.0 | 4.4 | 4.5 | 3.1 | 3.8 | 3.5 | 3.2 | 3.3 | 3.3 | 3.2 | **3.0** | -6.7% | -4.7% | 0.1% |
| Bulgaria | 7.0 | 7.9 | 7.6 | 6.4 | 6.9 | 8.1 | 6.9 | 5.9 | 6.4 | 6.6 | **5.7** | -13.5% | -0.4% | 0.2% |
| Czech Republic | 21.0 | 21.4 | 19.7 | 17.7 | 18.8 | 18.4 | 17.4 | 17.2 | 16.0 | 16.6 | **16.9** | 1.7% | -2.0% | 0.5% |
| Denmark | 5.6 | 4.7 | 4.1 | 4.0 | 3.8 | 3.2 | 2.5 | 3.2 | 2.6 | 1.7 | **2.1** | 20.8% | -7.3% | 0.1% |
| Finland | 7.4 | 7.0 | 5.3 | 5.4 | 6.8 | 5.5 | 4.5 | 5.0 | 4.5 | 3.8 | **4.1** | 8.0% | -2.2% | 0.1% |
| France | 12.4 | 12.8 | 12.1 | 10.8 | 11.5 | 9.8 | 11.1 | 11.6 | 8.6 | 8.4 | **8.3** | -1.1% | -4.6% | 0.2% |
| Germany | 84.5 | 86.7 | 80.1 | 71.7 | 77.1 | 78.3 | 80.5 | 82.8 | 79.6 | 78.5 | **75.3** | -4.3% | -0.4% | 2.0% |
| Greece | 8.4 | 8.8 | 8.3 | 8.4 | 7.9 | 7.9 | 8.1 | 7.0 | 6.7 | 5.6 | **4.7** | -16.7% | -4.6% | 0.1% |
| Hungary | 3.1 | 3.1 | 3.1 | 2.6 | 2.7 | 2.7 | 2.6 | 2.3 | 2.2 | 2.4 | **2.3** | -3.6% | -2.5% | 0.1% |
| Ireland | 2.4 | 2.3 | 2.3 | 2.0 | 2.0 | 1.9 | 2.3 | 2.0 | 2.0 | 2.2 | **2.2** | -0.7% | -2.0% | 0.1% |
| Italy | 16.7 | 16.3 | 15.8 | 12.4 | 13.7 | 15.4 | 15.7 | 13.5 | 13.1 | 12.3 | **10.9** | -11.9% | -2.9% | 0.3% |
| Kazakhstan | 28.3 | 31.1 | 33.8 | 30.9 | 33.4 | 36.3 | 36.5 | 36.3 | 41.0 | 35.8 | **35.6** | -0.8% | 2.9% | 1.0% |
| Lithuania | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | **0.2** | 4.8% | -0.1% | ◆ |
| Netherlands | 7.7 | 8.4 | 8.0 | 7.5 | 7.5 | 7.5 | 8.2 | 8.2 | 9.1 | 11.0 | **10.3** | -7.0% | 3.1% | 0.3% |
| Norway | 0.6 | 0.7 | 0.7 | 0.6 | 0.8 | 0.8 | 0.8 | 0.8 | 0.9 | 0.8 | **0.8** | -0.1% | 1.3% | ◆ |
| Poland | 57.4 | 55.9 | 55.2 | 51.8 | 55.1 | 55.0 | 51.2 | 53.4 | 49.4 | 48.7 | **48.8** | ◆ | -1.2% | 1.3% |
| Portugal | 3.3 | 2.9 | 2.5 | 2.9 | 1.6 | 2.2 | 2.9 | 2.7 | 2.7 | 3.3 | **2.9** | -11.9% | -0.2% | 0.1% |
| Romania | 9.5 | 10.1 | 9.6 | 7.6 | 7.0 | 8.2 | 7.6 | 5.8 | 5.7 | 5.9 | **5.4** | -8.9% | -3.9% | 0.1% |
| Russian Federation | 97.0 | 93.9 | 100.7 | 92.2 | 90.5 | 94.0 | 98.4 | 90.5 | 87.6 | 92.2 | **87.3** | -5.5% | -0.3% | 2.3% |
| Slovakia | 4.5 | 4.0 | 4.0 | 3.9 | 3.9 | 3.7 | 3.5 | 3.5 | 3.4 | 3.3 | **3.1** | -5.0% | -2.5% | 0.1% |
| Spain | 17.9 | 20.0 | 13.5 | 9.4 | 6.9 | 12.8 | 15.5 | 11.4 | 11.6 | 13.7 | **10.4** | -23.9% | -4.0% | 0.3% |
| Sweden | 2.7 | 2.7 | 2.4 | 1.9 | 2.5 | 2.5 | 2.2 | 2.2 | 2.1 | 2.1 | **2.2** | 6.0% | -2.1% | 0.1% |
| Switzerland | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | **0.1** | – | -1.1% | ◆ |
| Turkey | 26.2 | 29.5 | 29.6 | 30.9 | 31.4 | 33.9 | 36.5 | 31.6 | 36.1 | 34.7 | **38.4** | 10.3% | 4.6% | 1.0% |
| Turkmenistan | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Ukraine | 39.8 | 39.8 | 41.8 | 35.9 | 38.3 | 41.5 | 42.5 | 41.6 | 35.6 | 27.3 | **31.5** | 14.9% | -3.1% | 0.8% |
| United Kingdom | 40.9 | 38.4 | 35.6 | 29.8 | 30.9 | 31.4 | 39.0 | 36.8 | 29.7 | 23.0 | **11.0** | -52.5% | -4.7% | 0.3% |
| Uzbekistan | 0.8 | 1.0 | 1.0 | 1.0 | 0.9 | 1.1 | 1.2 | 1.1 | 1.2 | 1.1 | **1.0** | -10.1% | 1.9% | ◆ |
| Other Europe & Eurasia | 21.0 | 21.2 | 22.2 | 21.3 | 22.5 | 24.6 | 22.9 | 23.8 | 21.9 | 23.0 | **23.0** | -0.1% | 1.1% | 0.6% |
| Total Europe & Eurasia | 536.3 | 540.2 | 528.3 | 475.8 | 492.5 | 514.9 | 528.1 | 508.1 | 487.3 | 471.3 | **451.6** | -4.5% | -0.9% | 12.1% |
| Iran | 1.5 | 1.6 | 1.2 | 1.4 | 1.3 | 1.4 | 1.1 | 1.4 | 1.6 | 1.6 | **1.7** | 4.3% | 0.5% | ◆ |
| Israel | 7.8 | 8.0 | 7.9 | 7.7 | 7.7 | 7.9 | 8.8 | 7.4 | 6.9 | 6.7 | **5.7** | -15.5% | -1.6% | 0.2% |
| Kuwait | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Qatar | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Saudi Arabia | † | 0.1 | 0.1 | † | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | **0.1** | – | 13.5% | ◆ |
| United Arab Emirates | 0.3 | 0.1 | 0.3 | 0.6 | 0.7 | 1.3 | 1.7 | 1.4 | 1.5 | 1.3 | **1.3** | – | 24.1% | ◆ |
| Other Middle East | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 0.4 | 0.6 | 0.5 | 0.7 | 0.5 | **0.5** | ◆ | 13.2% | ◆ |
| Total Middle East | 9.8 | 9.9 | 9.7 | 9.9 | 10.1 | 11.2 | 12.3 | 10.9 | 10.8 | 10.2 | **9.3** | -9.5% | 0.4% | 0.2% |
| Algeria | 0.9 | 0.8 | 0.8 | 0.5 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.1 | **0.1** | – | -13.2% | ◆ |
| Egypt | 0.9 | 0.8 | 0.7 | 0.6 | 0.5 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | **0.4** | 4.3% | -7.0% | ◆ |
| South Africa | 81.5 | 83.7 | 93.3 | 93.8 | 92.8 | 90.5 | 88.3 | 88.6 | 89.8 | 83.4 | **85.1** | 1.8% | 0.4% | 2.3% |
| Other Africa | 7.4 | 6.9 | 6.7 | 6.1 | 6.5 | 7.2 | 7.0 | 8.3 | 11.9 | 11.4 | **10.3** | -10.3% | 3.8% | 0.3% |
| Total Africa | 90.6 | 92.1 | 101.5 | 101.0 | 100.1 | 98.5 | 96.1 | 97.5 | 102.3 | 95.3 | **95.9** | 0.4% | 0.7% | 2.6% |
| Australia | 53.1 | 52.7 | 54.9 | 53.1 | 49.4 | 48.1 | 45.1 | 43.0 | 42.6 | 44.1 | **43.8** | -0.9% | -1.6% | 1.2% |
| Bangladesh | 0.5 | 0.6 | 0.6 | 0.8 | 0.8 | 0.7 | 0.9 | 1.0 | 0.8 | 0.7 | **0.8** | 17.0% | 3.7% | ◆ |
| China | 1454.7 | 1584.2 | 1609.3 | 1685.8 | 1748.9 | 1903.9 | 1927.8 | 1969.1 | 1954.5 | 1913.6 | **1887.6** | -1.6% | 3.7% | 50.6% |
| China Hong Kong SAR | 6.9 | 7.5 | 6.9 | 7.2 | 6.2 | 7.4 | 7.3 | 7.8 | 8.1 | 6.7 | **6.7** | -0.3% | -0.2% | 0.2% |
| India | 219.4 | 240.1 | 259.3 | 280.8 | 290.4 | 304.8 | 330.0 | 352.8 | 387.5 | 396.6 | **411.9** | 3.6% | 6.5% | 11.0% |
| Indonesia | 28.9 | 36.2 | 31.5 | 33.2 | 39.5 | 46.9 | 53.0 | 57.0 | 45.1 | 51.2 | **62.7** | 22.2% | 7.7% | 1.7% |
| Japan | 112.3 | 117.7 | 120.3 | 101.6 | 115.7 | 109.6 | 115.8 | 121.2 | 119.1 | 119.9 | **119.9** | -0.2% | 0.5% | 3.2% |
| Malaysia | 7.3 | 8.8 | 9.8 | 10.6 | 14.8 | 14.8 | 15.9 | 15.1 | 15.4 | 16.9 | **19.9** | 17.6% | 9.4% | 0.5% |
| New Zealand | 2.2 | 1.7 | 2.1 | 1.6 | 1.4 | 1.4 | 1.7 | 1.5 | 1.5 | 1.4 | **1.2** | -15.4% | -4.5% | ◆ |
| Pakistan | 4.0 | 5.4 | 6.0 | 4.9 | 4.6 | 4.0 | 4.0 | 3.2 | 4.7 | 4.7 | **5.4** | 15.1% | 2.2% | 0.1% |
| Philippines | 5.0 | 5.4 | 6.4 | 6.1 | 7.0 | 7.7 | 8.1 | 10.0 | 10.6 | 11.6 | **13.5** | 16.0% | 9.7% | 0.4% |
| Singapore | † | † | † | † | † | † | † | 0.3 | 0.4 | 0.4 | **0.4** | -6.5% | 47.4% | ◆ |
| South Korea | 54.8 | 59.7 | 66.1 | 68.6 | 75.9 | 83.6 | 81.0 | 81.9 | 84.6 | 85.5 | **81.6** | -4.8% | 4.6% | 2.2% |
| Taiwan | 37.0 | 38.8 | 37.0 | 35.2 | 37.6 | 38.9 | 38.0 | 38.6 | 39.0 | 37.8 | **38.6** | 1.7% | 0.7% | 1.0% |
| Thailand | 12.4 | 14.0 | 15.1 | 15.1 | 15.5 | 15.8 | 16.5 | 16.3 | 17.9 | 17.6 | **17.7** | 0.7% | 4.3% | 0.5% |
| Vietnam | 5.3 | 5.8 | 11.4 | 10.7 | 14.0 | 16.5 | 15.0 | 15.8 | 18.9 | 22.3 | **21.3** | -4.4% | 9.5% | 0.6% |
| Other Asia Pacific | 21.9 | 18.8 | 20.6 | 20.9 | 20.4 | 16.5 | 17.2 | 13.8 | 16.0 | 16.9 | **20.6** | 21.3% | -2.3% | 0.6% |
| Total Asia Pacific | 2025.7 | 2197.4 | 2257.3 | 2336.3 | 2442.3 | 2620.6 | 2677.4 | 2748.3 | 2767.0 | 2747.7 | **2753.6** | -0.1% | 3.9% | 73.8% |
| **Total World** | **3293.9** | **3480.2** | **3528.4** | **3476.1** | **3635.6** | **3807.2** | **3817.3** | **3887.0** | **3889.4** | **3784.7** | **3732.0** | **-1.7%** | **1.9%** | **100.0%** |
| of which: OECD | 1177.7 | 1198.4 | 1175.2 | 1051.0 | 1114.8 | 1094.1 | 1047.3 | 1058.4 | 1040.9 | 972.7 | **913.3** | -6.4% | -1.9% | 24.5% |
| Non-OECD | 2116.2 | 2281.7 | 2353.2 | 2425.1 | 2520.8 | 2713.1 | 2770.0 | 2828.5 | 2848.5 | 2812.0 | **2818.7** | ◆ | 3.7% | 75.5% |
| European Union | 327.2 | 328.4 | 303.6 | 267.4 | 280.2 | 288.1 | 294.3 | 288.0 | 268.4 | 261.1 | **238.4** | -8.9% | -1.9% | 6.4% |
| CIS | 167.3 | 167.3 | 179.0 | 161.5 | 164.7 | 174.7 | 180.7 | 171.8 | 167.8 | 158.9 | **157.9** | -0.9% | -0.2% | 4.2% |

*Commercial solid fuels only, i.e. bituminous coal and anthracite (hard coal), lignite and brown (sub-bituminous) coal, and other commercial solid fuels. Excludes coal converted to liquid or gaseous fuels, but includes coal consumed in transformation processes.
†Less than 0.05.
◆Less than 0.05%.
**Notes:** Differences between these world consumption figures and the world production statistics are accounted for by stock changes, and unavoidable disparities in the definition, measurement or conversion of coal supply and demand data.
**Annual changes and shares of total are calculated using million tonnes oil equivalent figures.**
**Growth rates are adjusted for leap years.**

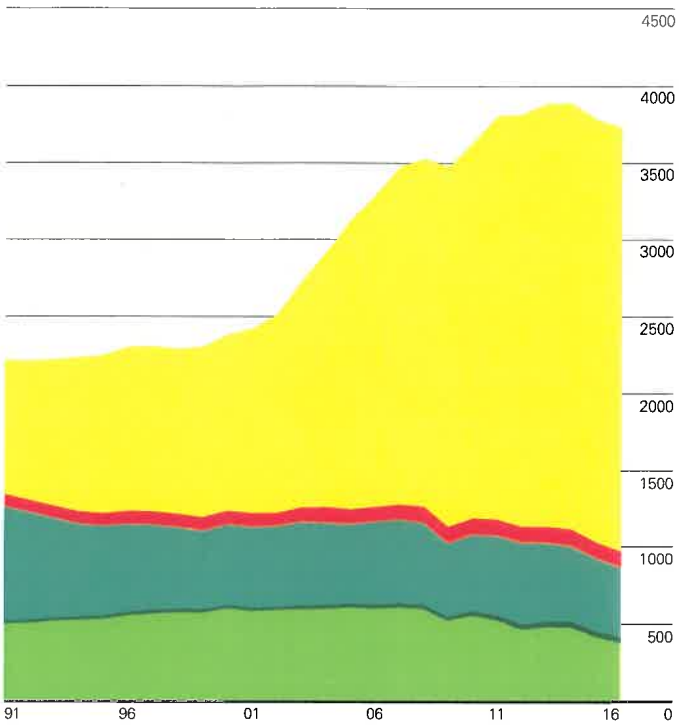
## Coal: Production by region

Million tonnes oil equivalent




## Coal: Consumption by region

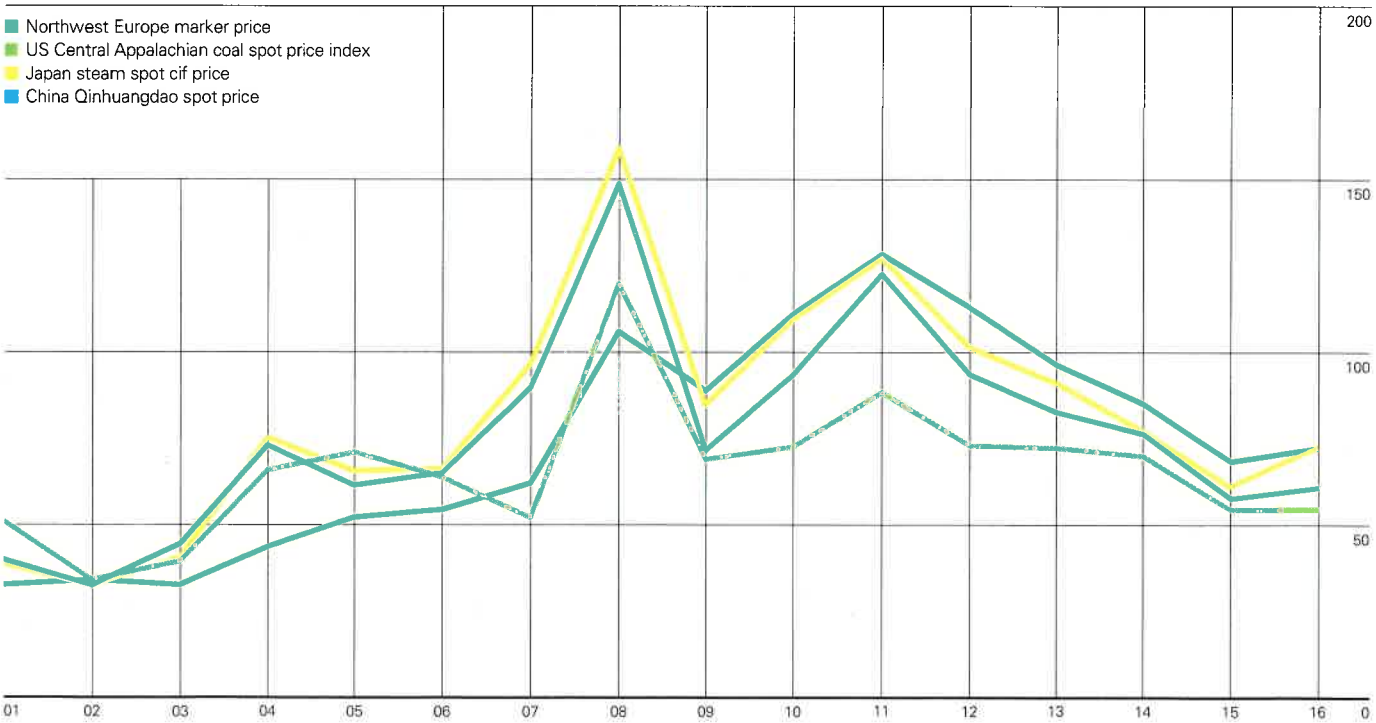
Million tonnes oil equivalent




World coal production fell by 6.2%, or 231 million tonnes of oil equivalent (mtoe) in 2016, the largest decline on record. China's production fell by 7.9% or 140 mtoe – also a record decline – while US production fell by 19% or 85 mtoe. Global coal consumption fell by 1.7%, the second successive decline. The largest decreases were seen in the US (-33 mtoe, an 8.8% fall), China (-26 mtoe, -1.6%) and the United Kingdom (-12 mtoe, -52.5%).

## Coal prices

US dollars per tonne



# Nuclear energy

## Consumption*

| Million tonnes oil equivalent | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | **2016** | Growth rate per annum 2016 | Growth rate per annum 2005-15 | Share 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| US | 187.5 | 192.1 | 192.0 | 190.3 | 192.2 | 188.2 | 183.2 | 187.9 | 189.9 | 189.9 | **191.8** | 0.7% | 0.2% | 32.4% |
| Canada | 22.0 | 21.0 | 21.6 | 20.2 | 20.4 | 21.0 | 21.3 | 23.2 | 24.1 | 22.8 | **23.2** | 1.6% | 1.0% | 3.9% |
| Mexico | 2.5 | 2.4 | 2.2 | 2.4 | 1.3 | 2.3 | 2.0 | 2.7 | 2.2 | 2.6 | **2.4** | -9.0% | 0.7% | 0.4% |
| Total North America | 212.0 | 215.4 | 215.8 | 212.9 | 213.9 | 211.5 | 206.5 | 213.8 | 216.2 | 215.3 | **217.4** | 0.7% | 0.3% | 36.7% |
| Argentina | 1.7 | 1.6 | 1.7 | 1.9 | 1.6 | 1.4 | 1.4 | 1.4 | 1.3 | 1.6 | **1.9** | 17.5% | 0.4% | 0.3% |
| Brazil | 3.1 | 2.8 | 3.2 | 2.9 | 3.3 | 3.5 | 3.6 | 3.5 | 3.5 | 3.3 | **3.6** | 7.5% | 4.1% | 0.6% |
| Chile | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Colombia | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Ecuador | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Peru | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Trinidad & Tobago | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Venezuela | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Other S. & Cent. America | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Total S. & Cent. America | 4.9 | 4.4 | 4.8 | 4.8 | 4.9 | 5.0 | 5.1 | 4.9 | 4.8 | 5.0 | **5.5** | 10.7% | 2.7% | 0.9% |
| Austria | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Azerbaijan | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Belarus | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Belgium | 10.6 | 10.9 | 10.3 | 10.7 | 10.8 | 10.9 | 9.1 | 9.6 | 7.6 | 5.9 | **9.8** | 66.3% | -5.8% | 1.7% |
| Bulgaria | 4.4 | 3.3 | 3.6 | 3.5 | 3.5 | 3.7 | 3.6 | 3.2 | 3.6 | 3.5 | **3.6** | 2.3% | -1.8% | 0.6% |
| Czech Republic | 5.9 | 5.9 | 6.0 | 6.2 | 6.3 | 6.4 | 6.9 | 7.0 | 6.9 | 6.1 | **5.5** | -10.4% | 0.8% | 0.9% |
| Denmark | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Finland | 5.2 | 5.4 | 5.3 | 5.4 | 5.2 | 5.3 | 5.3 | 5.4 | 5.4 | 5.3 | **5.3** | -0.5% | ◆ | 0.9% |
| France | 101.9 | 99.5 | 99.4 | 92.7 | 96.9 | 100.0 | 96.3 | 95.9 | 98.8 | 99.0 | **91.2** | -8.1% | -0.3% | 15.4% |
| Germany | 37.9 | 31.8 | 33.7 | 30.5 | 31.8 | 24.4 | 22.5 | 22.0 | 22.0 | 20.8 | **19.1** | -8.0% | -5.6% | 3.2% |
| Greece | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Hungary | 3.0 | 3.3 | 3.4 | 3.5 | 3.6 | 3.5 | 3.6 | 3.5 | 3.5 | 3.6 | **3.6** | 1.1% | 1.4% | 0.6% |
| Ireland | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Italy | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Kazakhstan | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Lithuania | 2.0 | 2.2 | 2.2 | 2.5 | – | – | – | – | – | – | **–** | – | – | – |
| Netherlands | 0.8 | 1.0 | 0.9 | 1.0 | 0.9 | 0.9 | 0.9 | 0.7 | 0.9 | 0.9 | **0.9** | 0.7% | 0.2% | 0.2% |
| Norway | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Poland | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Portugal | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Romania | 1.3 | 1.7 | 2.5 | 2.7 | 2.6 | 2.7 | 2.6 | 2.6 | 2.6 | 2.6 | **2.6** | -3.3% | 7.7% | 0.4% |
| Russian Federation | 35.4 | 36.2 | 36.9 | 37.0 | 38.5 | 39.2 | 40.2 | 39.1 | 40.9 | 44.2 | **44.5** | 0.3% | 2.8% | 7.5% |
| Slovakia | 4.1 | 3.5 | 3.8 | 3.2 | 3.3 | 3.5 | 3.5 | 3.6 | 3.5 | 3.4 | **3.3** | -2.7% | -1.6% | 0.6% |
| Spain | 13.6 | 12.5 | 13.3 | 11.9 | 14.0 | 13.1 | 13.9 | 12.8 | 13.0 | 13.0 | **13.3** | 2.2% | ◆ | 2.2% |
| Sweden | 15.2 | 15.2 | 14.5 | 11.8 | 13.1 | 13.7 | 14.5 | 15.0 | 14.7 | 12.8 | **14.2** | 11.1% | -2.5% | 2.4% |
| Switzerland | 6.3 | 6.3 | 6.2 | 6.2 | 6.0 | 6.1 | 5.8 | 5.9 | 6.3 | 5.3 | **4.8** | -8.7% | ◆ | 0.8% |
| Turkey | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Turkmenistan | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Ukraine | 20.4 | 20.9 | 20.3 | 18.8 | 20.2 | 20.4 | 20.4 | 18.8 | 20.0 | 19.8 | **18.3** | -7.9% | -0.1% | 3.1% |
| United Kingdom | 17.1 | 14.3 | 11.9 | 15.6 | 14.1 | 15.6 | 15.9 | 16.0 | 14.4 | 15.9 | **16.2** | 1.7% | -1.5% | 2.7% |
| Uzbekistan | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Other Europe & Eurasia | 1.9 | 1.9 | 2.0 | 1.9 | 1.8 | 2.0 | 1.8 | 1.7 | 2.0 | 1.9 | **1.8** | -4.3% | -0.2% | 0.3% |
| Total Europe & Eurasia | 266.7 | 275.7 | 276.2 | 264.8 | 272.7 | 271.4 | 266.6 | 262.9 | 268.1 | 263.9 | **258.2** | -2.4% | -0.8% | 43.6% |
| Iran | – | – | – | – | – | † | 0.3 | 0.9 | 1.0 | 0.8 | **1.4** | 75.3% | – | 0.2% |
| Israel | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Kuwait | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Qatar | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Saudi Arabia | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| United Arab Emirates | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Other Middle East | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Total Middle East | – | – | – | – | – | † | 0.3 | 0.9 | 1.0 | 0.8 | **1.4** | 75.3% | – | 0.2% |
| Algeria | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Egypt | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| South Africa | 2.7 | 2.6 | 2.9 | 2.9 | 2.7 | 3.1 | 2.7 | 3.2 | 3.1 | 2.8 | **3.6** | 29.7% | 0.8% | 0.6% |
| Other Africa | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Total Africa | 2.7 | 2.6 | 2.9 | 2.9 | 2.7 | 3.1 | 2.7 | 3.2 | 3.1 | 2.8 | **3.6** | 29.7% | 0.8% | 0.6% |
| Australia | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Bangladesh | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| China | 12.4 | 14.1 | 15.5 | 15.9 | 16.7 | 19.5 | 22.0 | 25.3 | 30.0 | 38.6 | **48.2** | 24.5% | 12.4% | 8.1% |
| China Hong Kong SAR | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| India | 4.0 | 4.0 | 3.4 | 3.8 | 5.2 | 7.3 | 7.5 | 7.5 | 7.8 | 8.7 | **8.6** | -1.3% | 8.0% | 1.4% |
| Indonesia | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Japan | 69.0 | 63.1 | 57.0 | 65.0 | 66.2 | 36.9 | 4.1 | 3.3 | – | 1.0 | **4.0** | 289.7% | -34.1% | 0.7% |
| Malaysia | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| New Zealand | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Pakistan | 0.6 | 0.6 | 0.4 | 0.6 | 0.5 | 0.9 | 1.2 | 1.2 | 1.1 | 1.1 | **1.3** | 15.1% | 6.2% | 0.2% |
| Philippines | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Singapore | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| South Korea | 33.7 | 32.3 | 34.2 | 33.4 | 33.6 | 35.0 | 34.0 | 31.4 | 35.4 | 37.3 | **36.7** | -1.8% | 1.2% | 6.2% |
| Taiwan | 9.0 | 9.2 | 9.2 | 9.4 | 9.4 | 9.5 | 9.1 | 9.4 | 9.6 | 8.3 | **7.2** | -13.4% | -0.9% | 1.2% |
| Thailand | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Vietnam | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Other Asia Pacific | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Total Asia Pacific | 128.7 | 123.3 | 119.7 | 128.7 | 131.7 | 109.1 | 78.0 | 78.1 | 83.9 | 95.0 | **105.9** | 11.7% | 2.7% | 17.9% |
| **Total World** | **635.0** | **621.5** | **619.5** | **613.6** | **625.9** | **600.1** | **559.2** | **563.9** | **575.0** | **582.7** | **592.1** | **1.3%** | **-0.7%** | **100.0%** |
| of which: OECD | 537.3 | 521.6 | 517.0 | 511.4 | 521.0 | 488.3 | 444.0 | 447.1 | 449.9 | 446.7 | **446.8** | -0.2% | -1.7% | 75.5% |
| Non-OECD | 97.6 | 99.9 | 102.5 | 102.3 | 104.9 | 111.8 | 115.3 | 116.8 | 125.1 | 136.0 | **145.2** | 6.5% | 3.8% | 24.5% |
| European Union | 224.1 | 211.7 | 212.2 | 202.4 | 207.4 | 205.2 | 199.7 | 198.5 | 198.3 | 194.0 | **190.0** | -2.3% | -1.5% | 32.1% |
| CIS | 56.4 | 57.7 | 57.8 | 56.3 | 59.3 | 60.2 | 61.1 | 58.5 | 61.5 | 64.7 | **63.3** | -2.3% | 1.8% | 10.7% |

*Based on gross generation and not accounting for cross-border electricity supply. Converted on the basis of thermal equivalence assuming 38% conversion efficiency in a modern thermal power station.
†Less than 0.05.
◆Less than 0.05%.
**Notes: Growth rates are adjusted for leap years.**
Nuclear energy data expressed in terawatt-hours is available at *bp.com/statisticalreview*

# Hydroelectricity

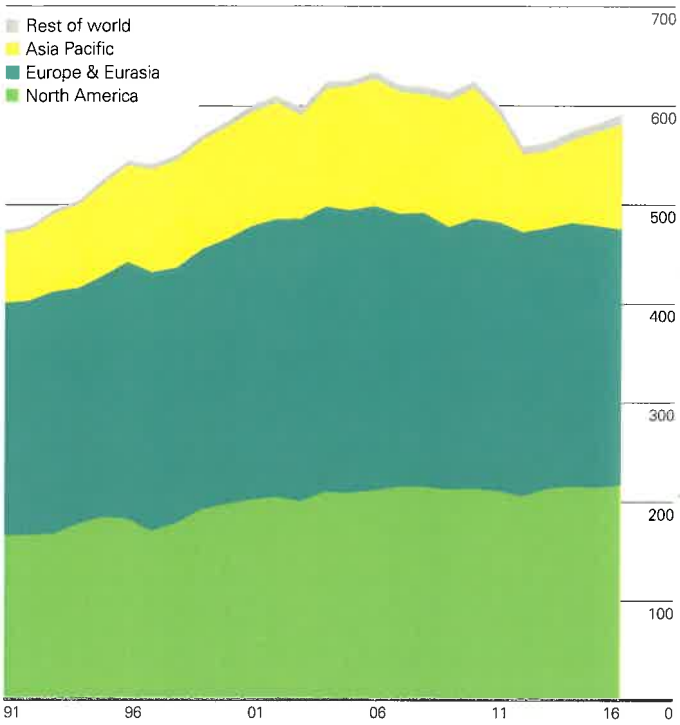
## Consumption*

| Million tonnes oil equivalent | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Growth rate per annum 2016 | Growth rate per annum 2005-15 | Share 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| US | 64.6 | 55.0 | 56.8 | 61.4 | 58.2 | 71.5 | 62.0 | 60.3 | 57.9 | 55.8 | **59.2** | 5.9% | -0.8% | 6.5% |
| Canada | 79.9 | 83.2 | 85.4 | 83.4 | 79.5 | 85.0 | 86.1 | 88.7 | 86.6 | 85.4 | **87.8** | 2.5% | 0.4% | 9.7% |
| Mexico | 6.9 | 6.1 | 8.9 | 6.1 | 8.4 | 8.2 | 7.2 | 6.3 | 8.8 | 7.0 | **6.8** | -3.3% | 1.1% | 0.7% |
| Total North America | 151.4 | 144.3 | 151.1 | 151.0 | 146.2 | 164.8 | 155.3 | 155.3 | 153.2 | 148.2 | **153.9** | 3.5% | • | 16.9% |
| Argentina | 9.9 | 8.6 | 8.5 | 9.3 | 9.2 | 9.0 | 8.4 | 9.3 | 9.3 | 9.6 | **8.7** | -9.4% | 0.7% | 1.0% |
| Brazil | 78.9 | 84.6 | 83.6 | 88.5 | 91.3 | 96.9 | 94.0 | 88.5 | 84.5 | 81.4 | **86.9** | 6.5% | 0.6% | 9.6% |
| Chile | 6.4 | 5.1 | 5.4 | 5.6 | 4.8 | 4.7 | 4.6 | 4.4 | 5.3 | 5.4 | **4.4** | -18.8% | -0.6% | 0.5% |
| Colombia | 9.6 | 10.0 | 10.4 | 9.2 | 9.2 | 11.0 | 10.8 | 10.0 | 10.1 | 10.1 | **10.6** | 5.0% | 1.3% | 1.2% |
| Ecuador | 1.6 | 2.0 | 2.6 | 2.1 | 2.0 | 2.5 | 2.8 | 2.5 | 2.6 | 3.0 | **3.5** | 18.7% | 6.6% | 0.4% |
| Peru | 4.4 | 4.4 | 4.3 | 4.5 | 4.5 | 4.9 | 5.0 | 5.1 | 5.0 | 5.4 | **5.4** | 0.3% | 2.8% | 0.6% |
| Trinidad & Tobago | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Venezuela | 18.4 | 18.8 | 19.6 | 19.4 | 17.3 | 18.8 | 18.5 | 18.9 | 16.7 | 17.3 | **13.9** | -20.0% | -0.1% | 1.5% |
| Other S. & Cent. America | 18.5 | 19.5 | 19.5 | 19.3 | 20.3 | 20.7 | 21.4 | 21.9 | 20.8 | 20.8 | **22.5** | 8.3% | 1.2% | 2.5% |
| Total S. & Cent. America | 147.8 | 153.1 | 154.0 | 157.9 | 158.7 | 168.5 | 165.4 | 160.6 | 154.5 | 152.9 | **156.0** | 1.8% | 0.8% | 17.1% |
| Austria | 8.1 | 8.4 | 8.7 | 9.3 | 8.7 | 7.7 | 9.9 | 9.5 | 9.3 | 8.4 | **9.0** | 6.8% | • | 1.0% |
| Azerbaijan | 0.6 | 0.5 | 0.5 | 0.5 | 0.8 | 0.6 | 0.4 | 0.3 | 0.3 | 0.4 | **0.4** | 19.3% | -5.9% | • |
| Belarus | † | † | † | † | † | † | † | † | † | † | **†** | – | 11.5% | • |
| Belgium | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | † | 0.1 | 0.1 | 0.1 | 0.1 | **0.1** | 22.4% | 1.0% | • |
| Bulgaria | 0.9 | 0.7 | 0.7 | 0.8 | 1.1 | 0.7 | 0.7 | 0.9 | 1.0 | 1.3 | **0.9** | -32.1% | 2.9% | 0.1% |
| Czech Republic | 0.6 | 0.5 | 0.5 | 0.5 | 0.6 | 0.5 | 0.5 | 0.6 | 0.4 | 0.4 | **0.5** | 11.1% | -2.8% | • |
| Denmark | † | † | † | † | † | † | † | † | † | † | **†** | 2.8% | -2.2% | • |
| Finland | 2.6 | 3.2 | 3.9 | 2.9 | 2.9 | 2.8 | 3.8 | 2.9 | 3.0 | 3.8 | **3.6** | -6.1% | 2.1% | 0.4% |
| France | 12.9 | 13.3 | 14.6 | 13.1 | 14.4 | 10.4 | 13.5 | 15.9 | 14.1 | 12.3 | **13.5** | 9.2% | 0.5% | 1.5% |
| Germany | 4.5 | 4.8 | 4.6 | 4.3 | 4.7 | 4.0 | 5.0 | 5.2 | 4.4 | 4.3 | **4.8** | 10.4% | -0.3% | 0.5% |
| Greece | 1.3 | 0.6 | 0.7 | 1.2 | 1.7 | 0.9 | 1.0 | 1.4 | 1.0 | 1.4 | **1.2** | -12.3% | 2.0% | 0.1% |
| Hungary | † | † | † | 0.1 | † | 0.1 | † | † | 0.1 | 0.1 | **0.1** | 11.1% | 1.5% | • |
| Ireland | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.2 | 0.2 | 0.1 | 0.2 | 0.2 | **0.2** | -15.8% | 2.5% | • |
| Italy | 8.4 | 7.4 | 9.4 | 11.1 | 11.6 | 10.4 | 9.5 | 11.9 | 13.2 | 10.3 | **9.3** | -10.2% | 2.4% | 1.0% |
| Kazakhstan | 1.8 | 1.8 | 1.7 | 1.6 | 1.8 | 1.8 | 1.7 | 1.7 | 1.9 | 2.1 | **2.1** | – | 1.7% | 0.2% |
| Lithuania | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | **0.1** | 29.8% | -2.5% | • |
| Netherlands | † | † | † | † | † | † | † | † | † | † | **†** | 16.3% | 0.6% | • |
| Norway | 27.0 | 30.2 | 31.5 | 28.3 | 26.4 | 27.2 | 32.1 | 29.0 | 30.6 | 31.1 | **32.4** | 4.1% | 0.1% | 3.6% |
| Poland | 0.5 | 0.5 | 0.5 | 0.5 | 0.7 | 0.5 | 0.5 | 0.6 | 0.5 | 0.4 | **0.5** | 16.5% | -1.8% | 0.1% |
| Portugal | 2.5 | 2.3 | 1.5 | 1.9 | 3.7 | 2.6 | 1.3 | 3.1 | 3.5 | 2.0 | **3.6** | 81.9% | 6.2% | 0.4% |
| Romania | 4.2 | 3.6 | 3.9 | 3.5 | 4.5 | 3.3 | 2.7 | 3.3 | 4.2 | 3.8 | **4.1** | 7.4% | -1.9% | 0.4% |
| Russian Federation | 39.6 | 40.5 | 37.7 | 39.9 | 38.1 | 37.3 | 37.2 | 40.6 | 39.6 | 38.5 | **42.2** | 9.5% | -0.3% | 4.6% |
| Slovakia | 1.0 | 1.0 | 0.9 | 1.0 | 1.2 | 0.8 | 0.9 | 1.1 | 1.0 | 0.9 | **1.0** | 9.9% | -1.1% | 0.1% |
| Spain | 5.8 | 6.2 | 5.3 | 6.0 | 9.6 | 6.9 | 4.6 | 8.3 | 8.9 | 6.3 | **8.1** | 27.3% | 4.5% | 0.9% |
| Sweden | 13.9 | 15.0 | 15.6 | 14.8 | 15.2 | 15.2 | 17.9 | 13.9 | 14.4 | 17.0 | **14.1** | -17.4% | 0.4% | 1.5% |
| Switzerland | 7.0 | 8.0 | 8.2 | 8.1 | 8.2 | 7.2 | 8.6 | 8.6 | 8.5 | 8.5 | **7.8** | -8.7% | 1.9% | 0.9% |
| Turkey | 10.0 | 8.1 | 7.5 | 8.1 | 11.7 | 11.8 | 13.1 | 13.4 | 9.2 | 15.2 | **15.2** | -0.2% | 5.4% | 1.7% |
| Turkmenistan | † | † | † | † | † | – | – | – | – | – | **–** | – | -100.0% | – |
| Ukraine | 2.9 | 2.3 | 2.6 | 2.7 | 2.9 | 2.4 | 2.4 | 3.1 | 1.9 | 1.2 | **1.6** | 32.2% | -8.0% | 0.2% |
| United Kingdom | 1.0 | 1.1 | 1.2 | 1.2 | 0.8 | 1.3 | 1.2 | 1.1 | 1.3 | 1.4 | **1.2** | -14.9% | 2.5% | 0.1% |
| Uzbekistan | 2.1 | 1.4 | 2.6 | 2.1 | 2.5 | 2.3 | 2.5 | 2.6 | 2.7 | 2.7 | **2.7** | – | 3.2% | 0.3% |
| Other Europe & Eurasia | 19.1 | 17.9 | 18.8 | 20.4 | 23.6 | 19.5 | 19.9 | 22.7 | 21.9 | 20.7 | **21.7** | 4.9% | 0.4% | 2.4% |
| Total Europe & Eurasia | 178.6 | 179.8 | 183.5 | 184.2 | 197.6 | 178.6 | 191.4 | 202.3 | 197.3 | 194.7 | **201.8** | 3.4% | 0.7% | 22.2% |
| Iran | 4.2 | 4.1 | 1.7 | 1.5 | 2.2 | 2.4 | 2.7 | 3.4 | 3.4 | 4.1 | **2.9** | -29.3% | 3.3% | 0.3% |
| Israel | † | † | † | † | † | † | † | † | † | † | **†** | – | -1.5% | • |
| Kuwait | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Qatar | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Saudi Arabia | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| United Arab Emirates | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| Other Middle East | 2.5 | 2.2 | 1.5 | 1.3 | 1.9 | 1.9 | 2.3 | 2.0 | 1.4 | 1.8 | **1.8** | -0.6% | -1.7% | 0.2% |
| Total Middle East | 6.6 | 6.3 | 3.2 | 2.8 | 4.0 | 4.3 | 5.0 | 5.4 | 4.8 | 5.9 | **4.7** | -20.5% | 1.5% | 0.5% |
| Algeria | † | 0.1 | 0.1 | 0.1 | † | 0.1 | 0.1 | † | † | † | **†** | -50.5% | -12.6% | • |
| Egypt | 2.9 | 3.5 | 3.3 | 2.9 | 3.0 | 2.9 | 3.2 | 2.9 | 3.2 | 3.2 | **3.2** | – | 1.0% | 0.3% |
| South Africa | 0.7 | 0.2 | 0.3 | 0.3 | 0.5 | 0.5 | 0.3 | 0.3 | 0.2 | 0.2 | **0.2** | 32.2% | -5.1% | • |
| Other Africa | 18.2 | 17.7 | 18.2 | 19.0 | 21.0 | 20.3 | 22.0 | 23.5 | 24.6 | 23.5 | **22.4** | -5.1% | 3.4% | 2.5% |
| Total Africa | 21.9 | 21.4 | 21.9 | 22.3 | 24.4 | 23.7 | 25.5 | 26.8 | 28.0 | 26.9 | **25.8** | -4.3% | 2.9% | 2.8% |
| Australia | 3.4 | 3.0 | 2.7 | 2.9 | 3.1 | 4.4 | 3.9 | 4.3 | 3.3 | 3.2 | **4.0** | 27.7% | -1.0% | 0.4% |
| Bangladesh | 0.2 | 0.2 | 0.2 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.2 | **0.2** | -1.8% | 1.8% | • |
| China | 98.6 | 109.8 | 144.1 | 139.3 | 161.0 | 155.7 | 195.2 | 205.8 | 237.8 | 252.2 | **263.1** | 4.0% | 10.9% | 28.9% |
| China Hong Kong SAR | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| India | 25.5 | 27.7 | 26.1 | 24.1 | 24.6 | 29.8 | 26.2 | 29.9 | 31.5 | 30.2 | **29.1** | -3.6% | 3.2% | 3.2% |
| Indonesia | 2.2 | 2.6 | 2.6 | 2.6 | 3.9 | 2.8 | 2.9 | 3.8 | 3.4 | 3.1 | **3.3** | 4.8% | 2.5% | 0.4% |
| Japan | 19.9 | 16.9 | 16.8 | 15.6 | 19.7 | 18.3 | 17.2 | 17.7 | 18.1 | 19.0 | **18.1** | -4.9% | 0.8% | 2.0% |
| Malaysia | 1.4 | 1.3 | 1.8 | 1.6 | 1.4 | 1.8 | 2.1 | 2.6 | 3.0 | 3.5 | **4.2** | 19.5% | 9.9% | 0.5% |
| New Zealand | 5.3 | 5.4 | 5.1 | 5.5 | 5.6 | 5.7 | 5.2 | 5.2 | 5.5 | 5.6 | **5.9** | 5.4% | 0.5% | 0.6% |
| Pakistan | 6.8 | 7.2 | 6.1 | 6.4 | 6.7 | 6.9 | 6.7 | 7.0 | 7.2 | 7.3 | **7.7** | 5.2% | 0.5% | 0.8% |
| Philippines | 2.2 | 1.9 | 2.2 | 2.2 | 1.8 | 2.2 | 2.3 | 2.3 | 2.1 | 2.0 | **2.1** | 6.7% | 0.3% | 0.2% |
| Singapore | – | – | – | – | – | – | – | – | – | – | **–** | – | – | – |
| South Korea | 0.8 | 0.8 | 0.7 | 0.6 | 0.8 | 1.0 | 0.9 | 1.0 | 0.6 | 0.5 | **0.6** | 14.1% | -5.2% | 0.1% |
| Taiwan | 0.9 | 1.0 | 1.0 | 0.8 | 0.9 | 0.9 | 1.3 | 1.2 | 1.0 | 1.0 | **1.5** | 46.2% | 1.2% | 0.2% |
| Thailand | 1.8 | 1.8 | 1.6 | 1.6 | 1.2 | 1.8 | 1.9 | 1.2 | 1.2 | 0.9 | **0.8** | -6.0% | -4.0% | 0.1% |
| Vietnam | 4.5 | 5.1 | 5.9 | 6.8 | 6.2 | 9.3 | 11.9 | 12.9 | 13.6 | 12.9 | **13.7** | 5.7% | 13.2% | 1.5% |
| Other Asia Pacific | 7.7 | 8.2 | 8.7 | 8.6 | 10.6 | 11.7 | 11.6 | 13.6 | 13.1 | 13.3 | **13.8** | 3.9% | 6.7% | 1.5% |
| Total Asia Pacific | 181.2 | 192.9 | 225.5 | 218.5 | 247.7 | 252.5 | 289.4 | 308.8 | 341.5 | 354.7 | **368.1** | 3.5% | 8.0% | 40.4% |
| **Total World** | **687.5** | **697.8** | **739.3** | **736.7** | **778.7** | **792.3** | **832.1** | **859.2** | **879.3** | **883.2** | **910.3** | **2.8%** | **2.9%** | **100.0%** |
| of which: OECD | 297.0 | 289.0 | 300.5 | 297.7 | 306.4 | 313.1 | 314.3 | 318.8 | 314.2 | 309.9 | **316.8** | 2.0% | 0.6% | 34.8% |
| Non-OECD | 390.5 | 408.8 | 438.7 | 439.0 | 472.3 | 479.2 | 517.8 | 540.5 | 565.1 | 573.4 | **593.4** | 3.2% | 4.5% | 65.2% |
| European Union | 71.5 | 71.4 | 75.4 | 76.1 | 85.6 | 71.1 | 76.3 | 83.9 | 84.7 | 77.2 | **78.7** | 1.7% | 0.9% | 8.6% |
| CIS | 54.3 | 54.2 | 51.6 | 53.1 | 53.0 | 51.9 | 51.9 | 55.8 | 53.6 | 51.7 | **56.2** | 8.3% | -0.5% | 6.2% |

*Based on gross primary hydroelectric generation and not accounting for cross-border electricity supply. Converted on the basis of thermal equivalence assuming 38% conversion efficiency in a modern thermal power station.
†Less than 0.05.
•Less than 0.05%.
**Notes: Growth rates are adjusted for leap years.**
Hydroelectricity data expressed in terawatt-hours is available at *bp.com/statisticalreview*

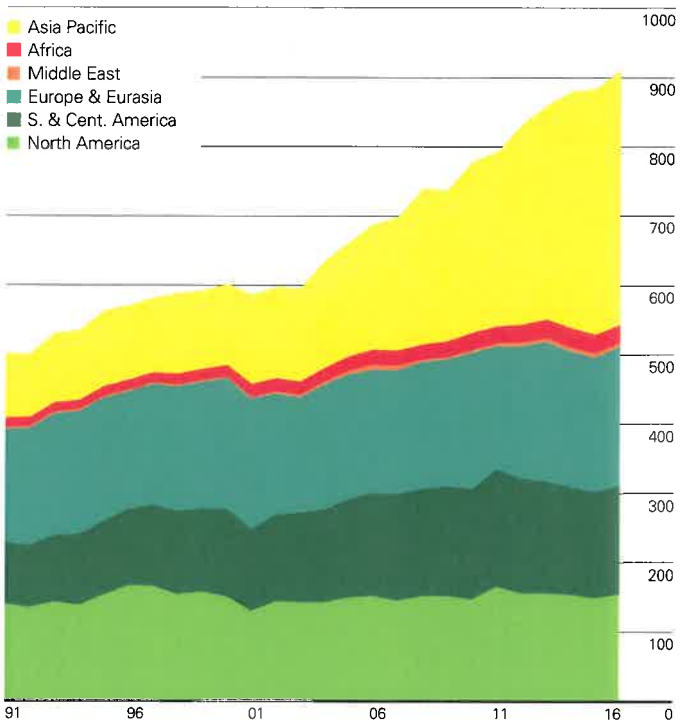
## Nuclear energy consumption by region

Million tonnes oil equivalent




## Hydroelectricity consumption by region

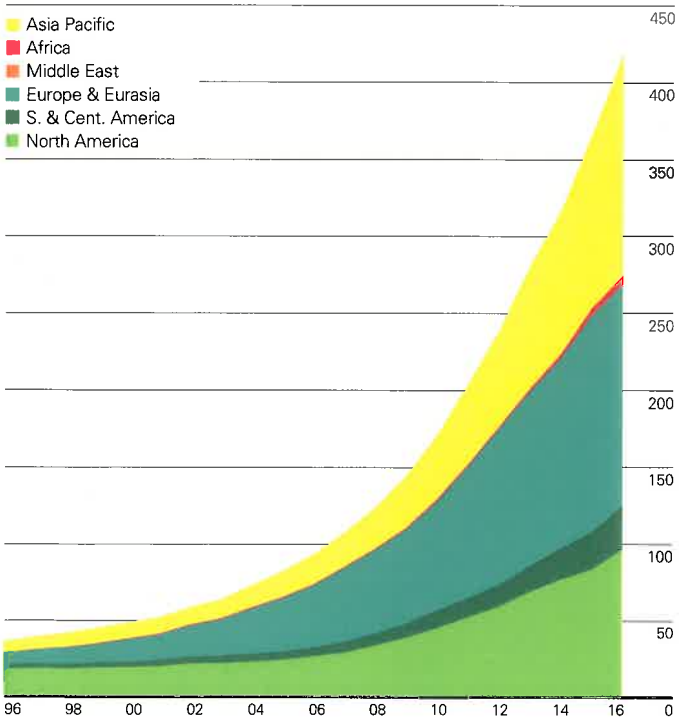
Million tonnes oil equivalent




Global nuclear power generation increased by 1.3% in 2016, or 9.3 million tonnes of oil equivalent (mtoe). China accounted for all of the net growth, expanding by 24.5% (9.6 mtoe). Generation in Japan and Belgium also grew strongly, while France saw a sharp decline (-8.1%, -7.7 mtoe). Hydroelectric power generation rose by 2.8% (27.1 mtoe), slightly below the 10-year average of 2.9%. China (4%, 10.9 mtoe) and Brazil (6.5%, 5.5 mtoe) were the largest contributors to growth.

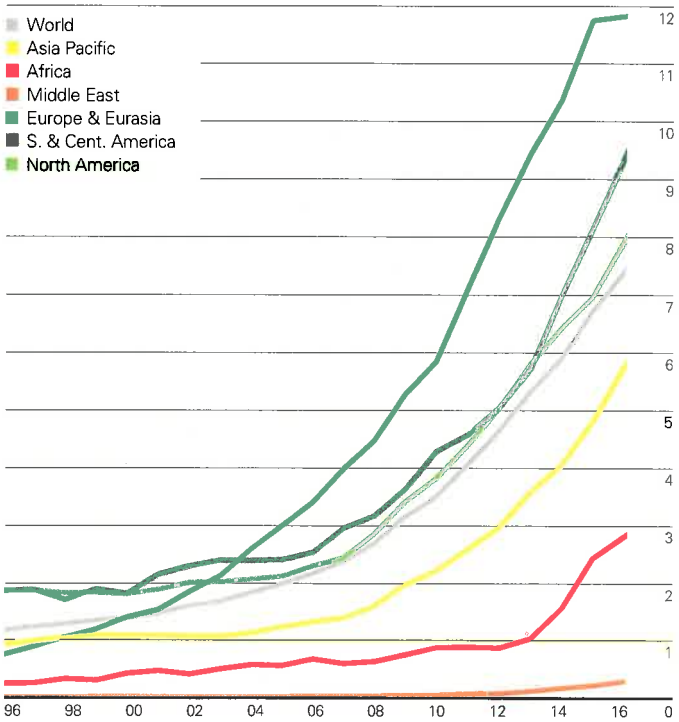
## Other renewables consumption by region

Million tonnes oil equivalent




## Other renewables share of power generation by region

Percentage




Renewable energy in power generation (not including hydro) grew by 14.1% in 2016, slightly below the 10-year average, but the largest increment on record (52.9 mtoe). Wind provided more than half of the growth, while solar energy contributed almost a third despite accounting for only 18% of the total. Asia Pacific contributed 60% of growth, with China overtaking the United States to become the world's largest renewable power producer. Renewable energy accounted for 7.5% of power generation, up from 6.7% in 2015. Europe & Eurasia has the highest share of power from renewables at 11.8%, but its share rose by the smallest increment on record in 2016.

# Renewable energy

## Other renewables consumption*

| Million tonnes oil equivalent | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | Growth rate per annum 2016 | 2016 | 2005-15 | Share 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| US | 22.8 | 24.8 | 29.7 | 33.9 | 39.3 | 45.7 | 51.7 | 60.2 | 67.2 | 71.5 | **83.8** | 16.9% | 13.2% | 20.0% |
| Canada | 2.5 | 2.6 | 2.6 | 3.4 | 4.2 | 4.8 | 5.6 | 6.4 | 7.0 | 8.5 | **9.2** | 8.1% | 13.8% | 2.2% |
| Mexico | 1.7 | 1.9 | 1.8 | 1.8 | 2.0 | 2.0 | 2.3 | 2.6 | 3.1 | 3.7 | **4.1** | 10.4% | 7.2% | 1.0% |
| Total North America | 27.0 | 29.4 | 34.1 | 39.2 | 45.6 | 52.5 | 59.6 | 69.3 | 77.2 | 83.6 | **97.1** | 15.7% | 12.9% | 23.1% |
| Argentina | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 0.5 | 0.6 | 0.6 | 0.8 | 0.6 | **0.7** | 5.0% | 8.4% | 0.2% |
| Brazil | 3.4 | 4.2 | 4.7 | 5.4 | 7.6 | 7.9 | 9.1 | 10.6 | 13.3 | 16.0 | **19.0** | 18.4% | 17.8% | 4.5% |
| Chile | 0.3 | 0.6 | 0.7 | 1.0 | 0.6 | 1.1 | 1.2 | 1.4 | 1.6 | 1.9 | **2.3** | 19.9% | 16.7% | 0.5% |
| Colombia | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | **0.5** | 15.4% | 12.8% | 0.1% |
| Ecuador | † | † | † | † | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | **0.1** | 12.6% | 18.1% | • |
| Peru | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.4 | 0.4 | **0.6** | 29.9% | 18.5% | 0.1% |
| Trinidad & Tobago | † | † | † | † | † | † | † | † | † | † | **†** | – | -14.1% | • |
| Venezuela | – | – | – | – | † | † | † | † | † | † | **†** | – | – | • |
| Other S. & Cent. America | 1.3 | 1.4 | 1.6 | 1.8 | 2.0 | 2.2 | 2.7 | 3.0 | 3.6 | 4.5 | **5.1** | 11.9% | 14.5% | 1.2% |
| Total S. & Cent. America | 5.7 | 6.9 | 7.7 | 9.0 | 11.1 | 12.3 | 14.1 | 16.4 | 20.2 | 24.0 | **28.2** | 17.1% | 16.6% | 6.7% |
| Austria | 1.2 | 1.4 | 1.4 | 1.4 | 1.5 | 1.5 | 1.7 | 1.9 | 2.0 | 2.3 | **2.4** | 6.0% | 10.5% | 0.6% |
| Azerbaijan | – | – | – | † | † | – | – | † | † | † | **†** | 66.3% | – | • |
| Belarus | † | † | † | † | † | † | † | † | † | † | **0.1** | 100.5% | 65.2% | • |
| Belgium | 0.6 | 0.7 | 0.9 | 1.2 | 1.4 | 1.9 | 2.3 | 2.6 | 2.7 | 3.2 | **3.2** | -1.7% | 22.8% | 0.8% |
| Bulgaria | † | † | † | 0.1 | 0.2 | 0.2 | 0.5 | 0.6 | 0.6 | 0.7 | **0.7** | 1.5% | 90.3% | 0.2% |
| Czech Republic | 0.2 | 0.3 | 0.4 | 0.5 | 0.7 | 1.2 | 1.3 | 1.5 | 1.6 | 1.7 | **1.7** | -3.5% | 27.5% | 0.4% |
| Denmark | 2.1 | 2.3 | 2.3 | 2.3 | 2.8 | 3.2 | 3.4 | 3.6 | 4.1 | 4.3 | **4.1** | -5.7% | 6.8% | 1.0% |
| Finland | 2.5 | 2.3 | 2.4 | 2.0 | 2.5 | 2.6 | 2.6 | 2.9 | 2.9 | 3.1 | **3.4** | 8.6% | 3.5% | 0.8% |
| France | 1.4 | 1.9 | 2.3 | 2.8 | 3.4 | 4.4 | 5.5 | 5.8 | 6.5 | 7.9 | **8.2** | 2.9% | 21.8% | 1.9% |
| Germany | 11.7 | 15.2 | 16.5 | 17.2 | 18.9 | 23.8 | 27.2 | 29.0 | 32.1 | 38.1 | **37.9** | -0.9% | 14.7% | 9.0% |
| Greece | 0.4 | 0.5 | 0.6 | 0.6 | 0.7 | 0.9 | 1.3 | 1.8 | 1.7 | 2.0 | **2.1** | 4.7% | 20.2% | 0.5% |
| Hungary | 0.3 | 0.3 | 0.5 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.7 | **0.8** | 15.8% | 6.3% | 0.2% |
| Ireland | 0.4 | 0.5 | 0.6 | 0.7 | 0.7 | 1.1 | 1.0 | 1.1 | 1.3 | 1.6 | **1.5** | -5.8% | 19.0% | 0.4% |
| Italy | 3.5 | 3.8 | 4.1 | 4.6 | 5.8 | 8.4 | 11.4 | 13.4 | 14.1 | 14.3 | **15.0** | 4.3% | 16.4% | 3.6% |
| Kazakhstan | † | † | † | † | † | – | † | † | † | † | **0.1** | 95.1% | – | • |
| Lithuania | † | † | † | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 0.3 | **0.4** | 20.0% | 65.2% | 0.1% |
| Netherlands | 1.8 | 1.7 | 2.1 | 2.4 | 2.5 | 2.8 | 2.8 | 2.7 | 2.6 | 3.1 | **3.1** | 0.8% | 6.3% | 0.7% |
| Norway | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.5 | 0.6 | 0.6 | **0.5** | -14.6% | 12.5% | 0.1% |
| Poland | 0.5 | 0.7 | 1.0 | 1.4 | 1.8 | 2.4 | 3.4 | 3.3 | 4.0 | 4.7 | **4.6** | -1.8% | 28.9% | 1.1% |
| Portugal | 1.1 | 1.4 | 1.8 | 2.3 | 2.8 | 2.8 | 3.1 | 3.6 | 3.6 | 3.6 | **3.7** | 4.4% | 16.2% | 0.9% |
| Romania | † | † | † | † | 0.1 | 0.4 | 0.6 | 1.2 | 1.5 | 2.2 | **2.0** | -6.0% | 109.1% | 0.5% |
| Russian Federation | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | **0.2** | 6.9% | 4.0% | • |
| Slovakia | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.3 | 0.3 | 0.3 | 0.5 | 0.5 | **0.5** | 1.8% | 49.5% | 0.1% |
| Spain | 6.2 | 7.2 | 8.7 | 10.7 | 12.5 | 12.6 | 15.0 | 16.3 | 16.1 | 15.6 | **15.5** | -0.9% | 10.8% | 3.7% |
| Sweden | 2.1 | 2.5 | 2.8 | 3.2 | 3.6 | 4.0 | 4.4 | 4.8 | 5.0 | 6.1 | **6.1** | -0.8% | 12.4% | 1.5% |
| Switzerland | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.5 | 0.5 | 0.6 | 0.7 | **0.8** | 17.6% | 10.3% | 0.2% |
| Turkey | 0.1 | 0.2 | 0.3 | 0.5 | 0.9 | 1.3 | 1.7 | 2.3 | 2.8 | 3.9 | **5.2** | 33.8% | 51.0% | 1.2% |
| Turkmenistan | – | – | – | – | † | † | † | † | † | † | **†** | 27.0% | – | • |
| Ukraine | † | 0.1 | 0.1 | † | 0.1 | 0.1 | 0.2 | 0.3 | 0.4 | 0.4 | **0.3** | -12.4% | 46.9% | 0.1% |
| United Kingdom | 3.1 | 3.3 | 3.8 | 4.5 | 5.0 | 6.5 | 8.1 | 11.0 | 13.3 | 17.5 | **17.5** | -0.1% | 20.4% | 4.2% |
| Uzbekistan | – | – | – | – | – | – | – | † | † | † | **†** | 50.0% | – | • |
| Other Europe & Eurasia | 0.7 | 0.9 | 1.1 | 1.3 | 1.4 | 1.6 | 1.9 | 2.0 | 2.2 | 2.3 | **2.5** | 7.7% | 17.2% | 0.6% |
| Total Europe & Eurasia | 40.4 | 48.1 | 54.4 | 61.2 | 71.0 | 85.7 | 101.5 | 114.1 | 123.8 | 141.6 | **144.0** | 1.5% | 15.0% | 34.3% |
| Iran | † | † | † | 0.1 | † | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | **0.1** | 2.6% | 20.0% | • |
| Israel | † | † | † | † | † | 0.1 | 0.1 | 0.1 | 0.2 | 0.3 | **0.4** | 37.1% | 60.6% | 0.1% |
| Kuwait | – | – | – | – | – | – | – | – | † | † | **†** | 580.0% | – | • |
| Qatar | – | – | – | – | – | – | † | † | † | † | **†** | 10.0% | – | • |
| Saudi Arabia | – | – | – | – | – | † | † | † | † | † | **†** | 14.3% | – | • |
| United Arab Emirates | – | – | – | † | † | † | † | † | 0.1 | 0.1 | **0.1** | 2.6% | – | • |
| Other Middle East | † | † | † | † | † | † | † | † | † | 0.1 | **0.2** | 196.8% | 39.9% | • |
| Total Middle East | † | † | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | **0.7** | 42.0% | 38.4% | 0.2% |
| Algeria | – | – | – | – | † | † | † | † | † | † | **0.1** | 190.2% | – | • |
| Egypt | 0.1 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.3 | 0.3 | 0.3 | 0.4 | **0.6** | 35.5% | 13.3% | 0.1% |
| South Africa | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.6 | 1.4 | **1.8** | 26.3% | 35.3% | 0.4% |
| Other Africa | 0.7 | 0.6 | 0.6 | 0.7 | 0.9 | 0.9 | 1.0 | 1.3 | 1.8 | 2.4 | **2.6** | 9.6% | 16.6% | 0.6% |
| Total Africa | 0.9 | 0.8 | 0.9 | 1.1 | 1.3 | 1.4 | 1.4 | 1.7 | 2.7 | 4.2 | **5.0** | 18.5% | 19.6% | 1.2% |
| Australia | 1.4 | 1.6 | 1.7 | 1.7 | 1.9 | 2.5 | 3.0 | 3.7 | 4.1 | 4.8 | **5.4** | 12.0% | 14.9% | 1.3% |
| Bangladesh | † | † | † | † | † | † | † | † | † | † | **†** | 15.3% | 40.8% | • |
| China | 2.5 | 3.5 | 6.4 | 11.0 | 15.9 | 22.8 | 29.4 | 42.3 | 50.8 | 64.4 | **86.1** | 33.4% | 44.1% | 20.5% |
| China Hong Kong SAR | † | † | † | † | † | † | † | † | † | † | **†** | -0.4% | – | • |
| India | 3.3 | 4.0 | 4.8 | 6.3 | 7.2 | 8.8 | 10.4 | 11.6 | 12.0 | 12.7 | **16.5** | 29.2% | 18.8% | 3.9% |
| Indonesia | 1.5 | 1.6 | 1.9 | 2.1 | 2.1 | 2.2 | 2.2 | 2.2 | 2.3 | 2.4 | **2.6** | 7.1% | 4.7% | 0.6% |
| Japan | 5.8 | 6.2 | 6.1 | 6.1 | 6.7 | 7.0 | 7.7 | 9.3 | 11.8 | 14.8 | **18.8** | 26.7% | 10.0% | 4.5% |
| Malaysia | – | † | † | 0.3 | 0.3 | 0.3 | 0.4 | 0.3 | 0.3 | 0.3 | **0.3** | 21.6% | – | 0.1% |
| New Zealand | 1.0 | 1.1 | 1.3 | 1.6 | 1.8 | 2.0 | 2.0 | 2.0 | 2.3 | 2.4 | **2.4** | -0.2% | 10.0% | 0.6% |
| Pakistan | – | – | – | – | † | † | † | 0.1 | 0.2 | 0.3 | **0.4** | 47.0% | – | 0.1% |
| Philippines | 2.4 | 2.3 | 2.4 | 2.4 | 2.3 | 2.3 | 2.4 | 2.2 | 2.4 | 2.8 | **3.1** | 10.8% | 2.2% | 0.7% |
| Singapore | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | **0.2** | 14.8% | 6.2% | 0.1% |
| South Korea | 0.1 | 0.2 | 0.3 | 0.4 | 1.0 | 1.7 | 2.0 | 2.3 | 3.3 | 3.9 | **4.3** | 9.6% | 45.6% | 1.0% |
| Taiwan | 0.5 | 0.6 | 0.6 | 0.6 | 0.7 | 0.8 | 0.8 | 0.9 | 0.9 | 1.0 | **1.0** | 1.8% | 8.8% | 0.2% |
| Thailand | 0.5 | 0.6 | 0.5 | 0.5 | 0.8 | 0.9 | 1.2 | 1.6 | 2.0 | 2.3 | **2.8** | 24.4% | 18.3% | 0.7% |
| Vietnam | † | † | † | † | † | † | † | † | † | † | **0.1** | 40.5% | 15.9% | • |
| Other Asia Pacific | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | **0.3** | 1.3% | 20.8% | 0.1% |
| Total Asia Pacific | 19.2 | 22.0 | 26.2 | 33.3 | 41.1 | 51.7 | 61.8 | 79.0 | 93.0 | 112.7 | **144.5** | 27.9% | 21.1% | 34.4% |
| **Total World** | **93.2** | **107.2** | **123.4** | **143.9** | **170.1** | **203.6** | **238.5** | **280.7** | **317.3** | **366.7** | **419.6** | **14.1%** | **16.1%** | **100.0%** |
| of which: OECD | 75.9 | 86.9 | 98.2 | 110.8 | 127.9 | 151.5 | 175.2 | 199.4 | 221.0 | 248.9 | **270.1** | 8.2% | 13.9% | 64.4% |
| Non-OECD | 17.3 | 20.3 | 25.1 | 33.0 | 42.2 | 52.1 | 63.4 | 81.3 | 96.3 | 117.8 | **149.5** | 26.6% | 23.4% | 35.6% |
| European Union | 39.1 | 46.3 | 52.4 | 58.9 | 68.2 | 82.3 | 97.4 | 109.1 | 118.0 | 134.6 | **135.6** | 0.5% | 14.8% | 32.3% |
| CIS | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.5 | 0.6 | 0.6 | **0.7** | 7.8% | 19.1% | 0.2% |

*Based on gross generation from renewable sources including wind, geothermal, solar, biomass and waste, and not accounting for cross-border electricity supply. Converted on the basis of thermal equivalence assuming 38% conversion efficiency in a modern thermal power station.
†Less than 0.05.
•Less than 0.05%.
**Notes: Growth rates are adjusted for leap years.**
Other renewables data expressed in terawatt-hours is available at *bp.com/statisticalreview*

## Biofuels production

| Thousand tonnes oil equivalent | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Growth rate per annum 2016 | Growth rate per annum 2005-15 | Share 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| US | 10670 | 14709 | 20934 | 23761 | 28044 | 31184 | 29808 | 31057 | 32890 | 33849 | **35779** | 5.4% | 15.2% | 43.5% |
| Canada | 174 | 503 | 546 | 786 | 809 | 950 | 1017 | 1056 | 1188 | 1142 | **1160** | 1.2% | 22.8% | 1.4% |
| Mexico | – | 5 | 5 | 5 | 14 | 13 | 15 | 58 | 58 | 58 | **58** | – | – | 0.1% |
| Total North America | 10844 | 15216 | 21485 | 24552 | 28866 | 32147 | 30840 | 32171 | 34137 | 35049 | **36997** | 5.3% | 15.4% | 45.0% |
| Argentina | 30 | 173 | 635 | 1055 | 1670 | 2234 | 2295 | 2014 | 2644 | 2038 | **2828** | 38.4% | 71.7% | 3.4% |
| Brazil | 9590 | 12427 | 15486 | 15277 | 16866 | 14403 | 14739 | 17114 | 18005 | 19332 | **18552** | -4.3% | 8.4% | 22.5% |
| Colombia | 144 | 155 | 158 | 320 | 455 | 572 | 627 | 650 | 676 | 693 | **626** | -10.0% | 46.2% | 0.8% |
| Other S. & Cent. America | 513 | 596 | 806 | 634 | 229 | 310 | 300 | 354 | 378 | 379 | **373** | -1.9% | 6.5% | 0.5% |
| Total S. & Cent. America | 10278 | 13351 | 17085 | 17285 | 19220 | 17519 | 17961 | 20131 | 21703 | 22442 | **22378** | -0.6% | 9.8% | 27.2% |
| Austria | 109 | 222 | 269 | 373 | 391 | 390 | 390 | 374 | 329 | 381 | **419** | 9.8% | 18.0% | 0.5% |
| Belgium | 22 | 146 | 282 | 486 | 603 | 664 | 562 | 547 | 574 | 556 | **558** | – | 89.9% | 0.7% |
| Finland | 12 | 54 | 101 | 231 | 301 | 208 | 263 | 330 | 367 | 445 | **446** | – | 51.8% | 0.5% |
| France | 682 | 1153 | 2064 | 2408 | 2353 | 1935 | 2145 | 2306 | 2541 | 2519 | **2226** | -11.9% | 18.5% | 2.7% |
| Germany | 2603 | 3243 | 2805 | 2834 | 3022 | 2967 | 3031 | 2770 | 3460 | 3191 | **3198** | -0.1% | 7.2% | 3.9% |
| Italy | 594 | 448 | 623 | 772 | 678 | 486 | 298 | 457 | 585 | 582 | **583** | – | 5.1% | 0.7% |
| Netherlands | 23 | 82 | 78 | 242 | 391 | 674 | 1276 | 1495 | 1756 | 1675 | **1680** | – | 87.5% | 2.0% |
| Poland | 154 | 103 | 290 | 408 | 439 | 414 | 652 | 697 | 750 | 940 | **898** | -4.6% | 23.2% | 1.1% |
| Portugal | 70 | 162 | 149 | 226 | 284 | 330 | 276 | 274 | 301 | 321 | **298** | -7.5% | 79.7% | 0.4% |
| Spain | 273 | 378 | 384 | 1001 | 1312 | 851 | 620 | 749 | 1030 | 1122 | **1148** | 2.0% | 14.0% | 1.4% |
| Sweden | 91 | 150 | 183 | 254 | 339 | 400 | 491 | 635 | 789 | 222 | **211** | -5.1% | 15.7% | 0.3% |
| United Kingdom | 228 | 374 | 289 | 220 | 304 | 322 | 303 | 517 | 403 | 310 | **351** | 12.8% | 22.4% | 0.4% |
| Other Europe & Eurasia | 407 | 506 | 964 | 1190 | 1187 | 1235 | 1428 | 1351 | 1560 | 1749 | **1761** | 0.4% | 19.2% | 2.1% |
| Total Europe & Eurasia | 5269 | 7021 | 8482 | 10646 | 11604 | 10876 | 11734 | 12503 | 14445 | 14012 | **13777** | -1.9% | 15.6% | 16.7% |
| Total Middle East | – | – | – | – | 5 | 5 | 5 | 5 | 5 | 5 | **5** | – | – | • |
| Total Africa | 9 | 6 | 11 | 18 | 6 | 8 | 23 | 32 | 40 | 40 | **40** | – | 20.5% | • |
| Australia | 59 | 76 | 119 | 174 | 222 | 223 | 239 | 202 | 169 | 157 | **144** | -8.5% | 21.9% | 0.2% |
| China | 925 | 982 | 1194 | 1224 | 1584 | 1970 | 2103 | 2346 | 2609 | 2653 | **2053** | -22.8% | 14.6% | 2.5% |
| India | 146 | 149 | 169 | 77 | 123 | 210 | 229 | 268 | 349 | 410 | **505** | 23.0% | 12.7% | 0.6% |
| Indonesia | 44 | 217 | 530 | 469 | 723 | 1110 | 1397 | 1750 | 2547 | 1354 | **2503** | 84.3% | 65.4% | 3.0% |
| South Korea | 41 | 78 | 146 | 358 | 511 | 309 | 283 | 321 | 337 | 385 | **404** | 4.7% | 45.4% | 0.5% |
| Thailand | 87 | 148 | 525 | 656 | 700 | 765 | 1054 | 1330 | 1490 | 1603 | **1610** | 0.2% | 39.9% | 2.0% |
| Other Asia Pacific | 144 | 227 | 390 | 478 | 443 | 692 | 997 | 1234 | 1873 | 1913 | **1889** | -1.5% | 69.1% | 2.3% |
| Total Asia Pacific | 1446 | 1876 | 3074 | 3435 | 4306 | 5280 | 6300 | 7450 | 9374 | 8476 | **9110** | 7.2% | 25.0% | 11.1% |
| **Total World** | **27848** | **37471** | **50138** | **55936** | **64008** | **65834** | **66863** | **72293** | **79703** | **80024** | **82306** | **2.6%** | **14.1%** | **100.0%** |
| of which: OECD | 16174 | 22281 | 29997 | 35389 | 40889 | 43192 | 42733 | 44808 | 48698 | 49186 | **50900** | 3.2% | 15.5% | 61.8% |
| Non-OECD | 11674 | 15190 | 20141 | 20547 | 23119 | 22642 | 24130 | 27485 | 31005 | 30838 | **31407** | 1.6% | 12.2% | 38.2% |
| European Union | 5214 | 6945 | 8334 | 10461 | 11466 | 10707 | 11593 | 12394 | 14286 | 13820 | **13580** | -2.0% | 15.5% | 16.5% |
| CIS | – | 2 | 7 | 36 | 34 | 28 | 29 | 23 | 25 | 25 | **25** | – | – | • |

•Less than 0.05%.

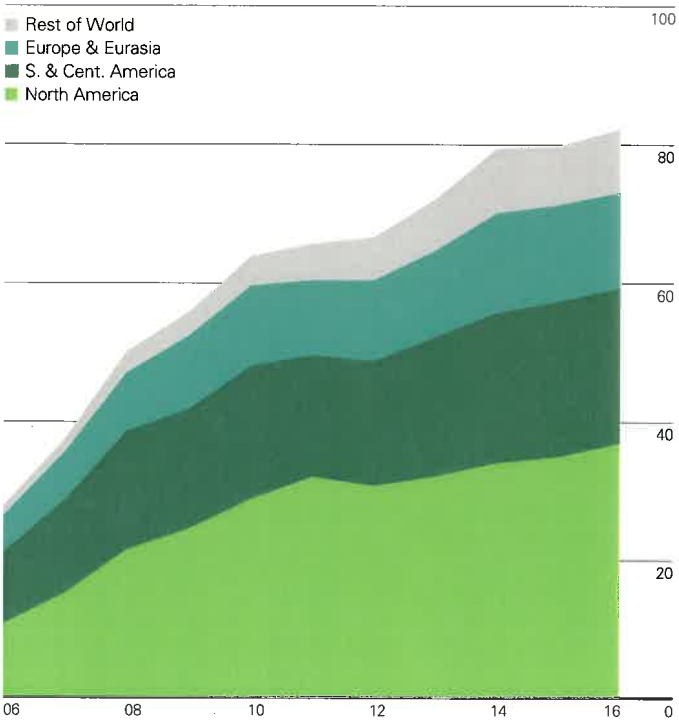
Source: Includes data from F.O. Lichts; US Energy Information Administration.

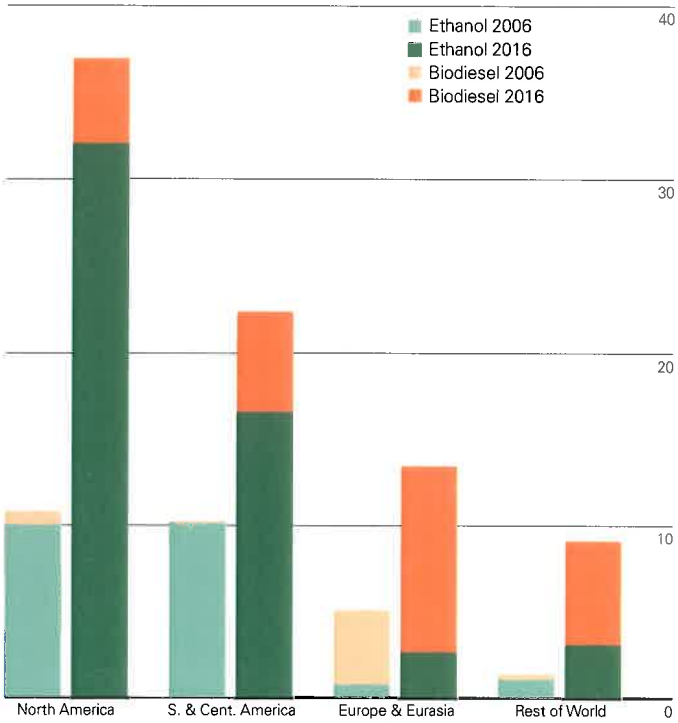
**Notes:** Consumption of fuel ethanol and biodiesel is included in oil consumption tables.

**Annual changes and shares of total are calculated using thousand tonnes a day oil equivalent figures. Growth rates are adjusted for leap years.**

## World biofuels production

Million tonnes oil equivalent




Global biofuels production rose by 2.6% in 2016, well below the 10-year average of 14.1%, but faster than in 2015 (0.4%). The US provided the largest increment (1930 thousand tonnes of oil equivalent, or ktoe). Global ethanol production increased by only 0.7%, partly due to falling production in Brazil. Biodiesel production rose by 6.5% with Indonesia providing more than half of the increment (1149 ktoe).

# Electricity

## Electricity generation*

| Terawatt-hours | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | Growth rate per annum 2016 | 2016 | 2005-15 | Share 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| US | 4331.0 | 4431.8 | 4390.1 | 4206.5 | 4394.3 | 4363.4 | 4310.6 | 4330.3 | 4363.3 | 4348.7 | **4350.8** | -0.2% | 0.1% | 17.5% |
| Canada | 601.5 | 625.6 | 627.7 | 604.2 | 596.7 | 628.6 | 629.0 | 651.2 | 648.6 | 652.3 | **663.0** | 1.4% | 0.6% | 2.7% |
| Mexico | 256.2 | 263.2 | 269.3 | 267.8 | 275.6 | 292.1 | 296.4 | 297.1 | 303.3 | 310.3 | **314.8** | 1.1% | 2.3% | 1.3% |
| Total North America | 5188.7 | 5320.6 | 5287.1 | 5078.4 | 5266.5 | 5284.1 | 5236.0 | 5278.6 | 5315.3 | 5311.3 | **5328.6** | 0.1% | 0.2% | 21.5% |
| Argentina | 112.8 | 115.2 | 129.0 | 129.8 | 132.5 | 129.5 | 136.0 | 139.7 | 141.6 | 145.4 | **146.9** | 0.7% | 2.7% | 0.6% |
| Brazil | 419.4 | 445.1 | 463.1 | 466.2 | 515.8 | 531.8 | 552.5 | 570.8 | 590.5 | 581.5 | **581.7** | -0.2% | 3.7% | 2.3% |
| Chile | 57.6 | 60.1 | 60.9 | 61.0 | 61.6 | 65.0 | 69.7 | 73.0 | 73.6 | 75.4 | **77.5** | 2.4% | 3.3% | 0.3% |
| Colombia | 59.7 | 61.1 | 61.9 | 63.8 | 67.0 | 68.0 | 69.4 | 71.6 | 74.5 | 77.0 | **78.5** | 1.7% | 3.3% | 0.3% |
| Ecuador | 15.1 | 17.3 | 18.6 | 18.3 | 19.5 | 20.5 | 22.8 | 23.3 | 24.3 | 26.0 | **27.1** | 4.1% | 6.8% | 0.1% |
| Peru | 27.4 | 29.9 | 32.5 | 32.9 | 35.9 | 38.8 | 41.0 | 43.3 | 45.5 | 48.3 | **51.5** | 6.3% | 6.6% | 0.2% |
| Trinidad & Tobago | 6.9 | 7.7 | 7.7 | 7.7 | 8.5 | 8.8 | 9.1 | 9.5 | 9.9 | 9.7 | **8.9** | -8.4% | 3.2% | ◆ |
| Venezuela | 110.6 | 113.7 | 119.3 | 124.8 | 116.7 | 122.9 | 127.9 | 127.6 | 110.4 | 127.8 | **115.6** | -9.8% | 2.0% | 0.5% |
| Other S. & Cent. America | 178.6 | 186.8 | 188.2 | 187.9 | 192.1 | 198.4 | 205.4 | 209.6 | 206.6 | 212.9 | **224.6** | 5.2% | 1.9% | 0.9% |
| Total S. & Cent. America | 988.1 | 1037.0 | 1081.2 | 1092.5 | 1149.6 | 1183.7 | 1233.9 | 1268.4 | 1277.0 | 1304.0 | **1312.2** | 0.4% | 3.2% | 5.3% |
| Austria | 64.4 | 64.9 | 66.9 | 69.1 | 71.1 | 65.9 | 72.4 | 68.0 | 65.1 | 64.9 | **67.6** | 3.8% | -0.3% | 0.3% |
| Azerbaijan | 24.5 | 21.8 | 21.6 | 18.9 | 18.7 | 20.3 | 23.0 | 23.4 | 24.7 | 24.7 | **25.0** | 0.9% | 0.8% | 0.1% |
| Belarus | 31.8 | 31.8 | 35.1 | 30.4 | 34.9 | 32.2 | 30.8 | 31.5 | 34.7 | 34.1 | **33.1** | -3.1% | 1.0% | 0.1% |
| Belgium | 85.6 | 88.8 | 84.9 | 91.2 | 95.2 | 90.2 | 82.9 | 83.5 | 72.7 | 70.6 | **86.9** | 22.7% | -2.1% | 0.4% |
| Bulgaria | 45.8 | 43.3 | 45.0 | 43.0 | 46.7 | 50.8 | 47.3 | 43.8 | 47.5 | 49.2 | **45.1** | -8.7% | 1.0% | 0.2% |
| Czech Republic | 84.4 | 88.0 | 83.5 | 82.3 | 85.9 | 87.6 | 87.6 | 87.1 | 86.0 | 83.9 | **83.3** | -1.0% | 0.2% | 0.3% |
| Denmark | 45.6 | 39.3 | 36.6 | 36.4 | 38.9 | 35.2 | 30.7 | 34.7 | 32.2 | 28.9 | **30.3** | 4.4% | -2.2% | 0.1% |
| Finland | 82.3 | 81.2 | 77.4 | 72.1 | 80.7 | 73.5 | 70.4 | 71.2 | 68.1 | 68.6 | **68.6** | -0.3% | -0.3% | 0.3% |
| France | 575.0 | 570.3 | 574.9 | 542.8 | 574.3 | 566.8 | 565.1 | 573.1 | 561.7 | 568.7 | **553.4** | -3.0% | -0.1% | 2.2% |
| Germany | 639.6 | 640.6 | 640.7 | 595.6 | 633.1 | 613.1 | 630.1 | 638.7 | 626.7 | 646.9 | **648.4** | ◆ | 0.4% | 2.6% |
| Greece | 60.8 | 63.5 | 63.7 | 61.4 | 57.4 | 59.4 | 61.0 | 57.2 | 50.5 | 51.9 | **52.5** | 0.9% | -1.4% | 0.2% |
| Hungary | 35.9 | 40.0 | 40.0 | 35.9 | 37.4 | 36.0 | 34.6 | 30.3 | 29.4 | 30.3 | **31.5** | 3.7% | -1.6% | 0.1% |
| Ireland | 27.5 | 28.7 | 30.3 | 28.4 | 28.7 | 27.5 | 27.6 | 26.1 | 26.3 | 28.4 | **30.4** | 6.9% | 0.9% | 0.1% |
| Italy | 314.1 | 313.9 | 319.1 | 292.6 | 302.1 | 302.6 | 299.3 | 289.8 | 279.8 | 283.0 | **286.3** | 0.9% | -0.7% | 1.2% |
| Kazakhstan | 71.7 | 76.6 | 80.3 | 78.7 | 82.6 | 86.6 | 90.6 | 92.6 | 94.6 | 91.6 | **94.5** | 2.8% | 3.0% | 0.4% |
| Lithuania | 12.5 | 14.0 | 14.0 | 15.4 | 5.7 | 4.8 | 5.0 | 4.8 | 4.4 | 4.9 | **4.3** | -13.5% | -10.4% | ◆ |
| Netherlands | 98.8 | 105.2 | 108.2 | 113.5 | 118.2 | 113.0 | 102.5 | 100.9 | 103.4 | 109.6 | **114.7** | 4.3% | 0.9% | 0.5% |
| Norway | 121.4 | 137.2 | 142.1 | 131.8 | 123.6 | 127.6 | 147.7 | 134.0 | 142.0 | 144.5 | **149.5** | 3.2% | 0.5% | 0.6% |
| Poland | 161.7 | 159.3 | 155.3 | 151.7 | 157.7 | 163.5 | 162.1 | 164.6 | 159.1 | 164.9 | **166.6** | 0.7% | 0.5% | 0.7% |
| Portugal | 49.0 | 47.3 | 46.0 | 50.2 | 54.1 | 52.5 | 46.6 | 51.7 | 52.8 | 52.4 | **60.5** | 15.1% | 1.2% | 0.2% |
| Romania | 62.7 | 61.7 | 65.0 | 58.0 | 61.0 | 62.2 | 59.0 | 58.9 | 63.3 | 66.3 | **64.8** | -2.5% | 1.1% | 0.3% |
| Russian Federation | 992.1 | 1018.7 | 1040.0 | 993.1 | 1035.7 | 1050.2 | 1064.1 | 1050.7 | 1058.7 | 1063.4 | **1087.1** | 1.9% | 1.1% | 4.4% |
| Slovakia | 31.2 | 27.9 | 29.3 | 26.1 | 27.7 | 28.1 | 28.4 | 28.6 | 27.3 | 27.2 | **27.5** | 0.7% | -1.4% | 0.1% |
| Spain | 302.9 | 312.2 | 317.9 | 296.3 | 303.0 | 291.8 | 297.6 | 283.6 | 278.8 | 280.5 | **274.4** | -2.4% | -0.5% | 1.1% |
| Sweden | 143.3 | 148.7 | 149.7 | 136.7 | 148.3 | 151.2 | 166.3 | 153.2 | 153.7 | 162.1 | **154.9** | -4.7% | 0.2% | 0.6% |
| Switzerland | 66.8 | 70.9 | 72.0 | 71.5 | 71.2 | 67.6 | 73.1 | 73.5 | 74.9 | 70.9 | **66.3** | -6.8% | 1.3% | 0.3% |
| Turkey | 176.3 | 191.6 | 198.4 | 194.8 | 211.2 | 229.4 | 239.5 | 240.2 | 252.0 | 261.8 | **272.7** | 3.9% | 4.9% | 1.1% |
| Turkmenistan | 13.7 | 14.9 | 15.0 | 16.0 | 16.7 | 17.2 | 17.8 | 18.9 | 20.1 | 21.5 | **22.6** | 4.7% | 5.3% | 0.1% |
| Ukraine | 192.1 | 195.1 | 191.7 | 172.9 | 187.9 | 194.9 | 198.9 | 194.4 | 182.8 | 163.7 | **163.7** | -0.3% | -1.2% | 0.7% |
| United Kingdom | 397.3 | 396.8 | 388.9 | 376.8 | 381.8 | 367.4 | 363.6 | 358.4 | 338.2 | 339.1 | **338.6** | -0.4% | -1.6% | 1.4% |
| Uzbekistan | 49.3 | 49.0 | 50.1 | 50.0 | 51.7 | 52.4 | 52.5 | 54.2 | 55.6 | 57.6 | **58.9** | 1.9% | 1.9% | 0.2% |
| Other Europe & Eurasia | 186.7 | 187.3 | 194.4 | 196.0 | 213.3 | 204.9 | 201.5 | 214.1 | 202.7 | 201.8 | **209.3** | 3.4% | 0.9% | 0.8% |
| Total Europe & Eurasia | 5246.8 | 5330.6 | 5378.1 | 5129.4 | 5356.2 | 5326.4 | 5379.7 | 5335.3 | 5269.3 | 5318.2 | **5373.1** | 0.8% | 0.3% | 21.7% |
| Iran | 184.3 | 196.0 | 206.3 | 215.1 | 226.1 | 235.5 | 247.7 | 254.6 | 274.6 | 281.9 | **286.0** | 1.2% | 5.2% | 1.2% |
| Israel | 51.8 | 55.1 | 55.8 | 55.3 | 58.5 | 59.3 | 63.0 | 61.4 | 61.3 | 65.4 | **67.4** | 2.7% | 2.8% | 0.3% |
| Kuwait | 47.6 | 48.8 | 51.7 | 53.2 | 57.1 | 57.5 | 62.7 | 61.0 | 65.1 | 68.3 | **71.1** | 3.9% | 4.6% | 0.3% |
| Qatar | 15.3 | 19.5 | 21.6 | 24.2 | 28.1 | 30.7 | 34.8 | 34.7 | 38.7 | 41.8 | **42.4** | 0.9% | 11.3% | 0.2% |
| Saudi Arabia | 181.4 | 190.5 | 204.2 | 217.3 | 240.1 | 250.1 | 271.7 | 284.0 | 311.8 | 328.1 | **330.5** | 0.4% | 6.4% | 1.3% |
| United Arab Emirates | 66.8 | 78.8 | 80.5 | 85.7 | 93.9 | 99.1 | 106.2 | 110.0 | 116.5 | 127.4 | **136.8** | 7.1% | 7.7% | 0.6% |
| Other Middle East | 121.1 | 128.5 | 139.6 | 155.3 | 167.6 | 170.8 | 177.2 | 171.1 | 179.1 | 179.4 | **181.5** | 0.9% | 4.8% | 0.7% |
| Total Middle East | 668.4 | 717.2 | 759.8 | 806.1 | 871.4 | 902.9 | 963.2 | 976.7 | 1047.2 | 1092.4 | **1115.7** | 1.9% | 5.7% | 4.5% |
| Algeria | 35.2 | 37.3 | 40.2 | 43.1 | 45.7 | 53.1 | 57.4 | 59.9 | 64.2 | 68.8 | **70.2** | 1.8% | 7.3% | 0.3% |
| Egypt | 110.7 | 119.0 | 127.9 | 133.3 | 143.5 | 148.6 | 161.9 | 164.0 | 170.2 | 180.6 | **187.3** | 3.4% | 5.7% | 0.8% |
| South Africa | 253.8 | 263.5 | 258.3 | 249.6 | 259.6 | 262.5 | 257.9 | 256.1 | 254.7 | 249.7 | **251.9** | 0.6% | 0.2% | 1.0% |
| Other Africa | 188.3 | 189.3 | 194.7 | 200.6 | 219.7 | 218.1 | 242.3 | 262.6 | 275.8 | 276.3 | **272.7** | -1.6% | 4.6% | 1.1% |
| Total Africa | 588.0 | 609.0 | 621.1 | 626.6 | 668.5 | 682.3 | 719.4 | 742.5 | 764.9 | 775.4 | **782.1** | 0.6% | 3.3% | 3.2% |
| Australia | 238.0 | 243.2 | 245.4 | 249.9 | 251.0 | 256.3 | 250.7 | 249.6 | 247.4 | 253.0 | **256.9** | 1.2% | 0.9% | 1.0% |
| Bangladesh | 29.5 | 31.0 | 34.2 | 37.2 | 40.8 | 44.2 | 48.6 | 53.1 | 55.8 | 60.8 | **67.4** | 10.6% | 8.7% | 0.3% |
| China | 2865.7 | 3281.6 | 3495.8 | 3714.7 | 4207.2 | 4713.0 | 4987.6 | 5431.6 | 5649.6 | 5814.6 | **6142.5** | 5.4% | 8.8% | 24.8% |
| China Hong Kong SAR | 38.6 | 38.9 | 38.0 | 38.7 | 38.3 | 39.0 | 38.8 | 39.1 | 39.8 | 38.0 | **38.2** | 0.3% | -0.1% | 0.2% |
| India | 744.1 | 794.8 | 825.8 | 879.7 | 935.3 | 1031.1 | 1088.2 | 1141.4 | 1252.0 | 1308.4 | **1400.8** | 6.8% | 6.4% | 5.6% |
| Indonesia | 133.1 | 142.4 | 149.4 | 156.8 | 169.8 | 183.4 | 200.3 | 216.2 | 228.5 | 234.0 | **248.9** | 6.1% | 6.3% | 1.0% |
| Japan | 1164.3 | 1180.1 | 1183.7 | 1114.0 | 1156.0 | 1104.2 | 1106.9 | 1087.8 | 1062.7 | 1030.1 | **999.6** | -3.2% | -1.1% | 4.0% |
| Malaysia | 100.0 | 103.6 | 106.9 | 111.3 | 120.1 | 120.9 | 127.3 | 138.3 | 143.6 | 144.7 | **156.8** | 8.1% | 4.4% | 0.6% |
| New Zealand | 43.4 | 43.8 | 43.8 | 43.4 | 44.9 | 44.4 | 44.3 | 43.3 | 43.6 | 44.3 | **43.9** | -1.2% | 0.3% | 0.2% |
| Pakistan | 96.1 | 98.1 | 96.2 | 97.1 | 100.3 | 100.3 | 99.3 | 102.2 | 107.2 | 110.2 | **115.4** | 4.5% | 2.0% | 0.5% |
| Philippines | 56.8 | 59.6 | 60.8 | 61.9 | 67.7 | 69.2 | 72.9 | 75.3 | 77.3 | 82.4 | **89.9** | 8.8% | 3.8% | 0.4% |
| Singapore | 39.4 | 41.1 | 41.7 | 41.8 | 45.4 | 46.0 | 46.9 | 48.0 | 49.3 | 50.3 | **51.6** | 2.3% | 2.8% | 0.2% |
| South Korea | 403.0 | 425.4 | 442.6 | 452.4 | 495.0 | 517.6 | 531.2 | 537.2 | 540.4 | 545.5 | **551.2** | 0.8% | 3.4% | 2.2% |
| Taiwan | 235.5 | 243.1 | 238.3 | 230.0 | 247.1 | 252.2 | 250.4 | 252.4 | 260.0 | 258.0 | **264.1** | 2.1% | 1.3% | 1.1% |
| Thailand | 136.8 | 142.5 | 145.4 | 145.9 | 157.6 | 153.3 | 169.0 | 168.6 | 173.8 | 177.8 | **179.7** | 0.8% | 3.1% | 0.7% |
| Vietnam | 57.9 | 64.1 | 71.0 | 80.6 | 91.7 | 101.5 | 115.1 | 124.5 | 142.3 | 159.7 | **175.7** | 9.7% | 11.9% | 0.7% |
| Other Asia Pacific | 69.2 | 71.5 | 74.3 | 72.9 | 81.4 | 86.5 | 87.7 | 92.9 | 97.2 | 102.6 | **122.1** | 18.6% | 4.5% | 0.5% |
| Total Asia Pacific | 6451.7 | 7004.9 | 7293.3 | 7528.4 | 8249.5 | 8863.1 | 9265.1 | 9801.2 | 10170.3 | 10414.3 | **10904.7** | 4.4% | 5.7% | 43.9% |
| **Total World** | **19131.7** | **20019.3** | **20420.6** | **20261.4** | **21561.7** | **22242.4** | **22797.3** | **23402.9** | **23844.0** | **24215.5** | **24816.4** | **2.2%** | **2.8%** | **100.0%** |
| of which: OECD | 10749.8 | 10987.9 | 10992.2 | 10557.5 | 10985.8 | 10930.6 | 10939.9 | 10929.3 | 10875.5 | 10911.5 | **10939.2** | ◆ | 0.2% | 44.1% |
| Non-OECD | 8381.9 | 9031.4 | 9428.4 | 9703.9 | 10576.0 | 11311.9 | 11857.4 | 12473.6 | 12968.5 | 13304.0 | **13877.2** | 4.0% | 5.5% | 55.9% |
| European Union | 3374.4 | 3391.5 | 3393.4 | 3230.7 | 3371.5 | 3300.4 | 3295.7 | 3267.3 | 3185.3 | 3234.3 | **3247.3** | 0.1% | -0.3% | 13.1% |
| CIS | 1418.7 | 1452.1 | 1473.6 | 1399.1 | 1469.6 | 1498.4 | 1523.7 | 1509.0 | 1515.3 | 1499.9 | **1527.8** | 1.6% | 0.9% | 6.2% |

*Based on gross output.
◆Less than 0.05%.
**Note: Growth rates are adjusted for leap years.**

# Carbon

## Carbon dioxide emissions

| Million tonnes of carbon dioxide | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Growth rate per annum 2016 | Growth rate per annum 2005-15 | Share 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| US | 6029.2 | 6132.4 | 5954.1 | 5529.8 | 5754.6 | 5617.3 | 5406.0 | 5544.3 | 5599.9 | 5445.0 | **5350.4** | -2.0% | -1.1% | 16.0% |
| Canada | 556.6 | 567.2 | 565.5 | 525.0 | 544.5 | 550.8 | 536.0 | 548.2 | 545.5 | 531.6 | **527.4** | -1.1% | -0.7% | 1.6% |
| Mexico | 450.5 | 445.5 | 447.9 | 451.6 | 459.7 | 482.1 | 491.8 | 490.0 | 481.6 | 481.4 | **470.3** | -2.6% | 0.9% | 1.4% |
| Total North America | 7036.2 | 7145.1 | 6967.5 | 6506.3 | 6758.9 | 6650.2 | 6433.8 | 6582.4 | 6627.0 | 6458.1 | **6348.0** | -2.0% | -1.0% | 19.0% |
| Argentina | 150.3 | 162.9 | 166.1 | 159.2 | 172.7 | 176.5 | 182.3 | 188.4 | 189.3 | 193.4 | **194.3** | 0.2% | 2.9% | 0.6% |
| Brazil | 336.9 | 351.4 | 374.9 | 352.1 | 400.3 | 426.4 | 447.3 | 486.6 | 508.3 | 491.3 | **458.0** | -7.0% | 4.0% | 1.4% |
| Chile | 64.4 | 75.9 | 77.0 | 73.9 | 75.1 | 85.9 | 88.4 | 90.1 | 90.6 | 91.0 | **95.9** | 5.1% | 4.2% | 0.3% |
| Colombia | 62.1 | 60.8 | 70.5 | 66.3 | 73.7 | 72.2 | 81.1 | 83.1 | 88.7 | 91.1 | **89.0** | -2.6% | 5.8% | 0.3% |
| Ecuador | 26.3 | 26.8 | 27.3 | 27.7 | 31.9 | 32.7 | 34.0 | 36.2 | 38.1 | 37.3 | **35.0** | -6.4% | 4.2% | 0.1% |
| Peru | 27.5 | 31.1 | 34.8 | 34.7 | 38.8 | 42.9 | 44.2 | 45.4 | 46.7 | 49.2 | **53.1** | 7.6% | 5.6% | 0.2% |
| Trinidad & Tobago | 24.8 | 27.5 | 27.8 | 26.5 | 28.3 | 28.3 | 27.6 | 29.0 | 28.3 | 28.4 | **25.8** | -9.4% | 3.7% | 0.1% |
| Venezuela | 161.4 | 165.3 | 173.8 | 171.1 | 171.3 | 166.3 | 177.7 | 175.1 | 166.6 | 164.0 | **161.0** | -2.1% | 1.4% | 0.5% |
| Other S. & Cent. America | 221.4 | 224.7 | 215.9 | 214.9 | 218.2 | 225.0 | 223.6 | 220.3 | 223.4 | 232.1 | **236.1** | 1.4% | 0.8% | 0.7% |
| Total S. & Cent. America | 1075.0 | 1125.6 | 1168.2 | 1126.5 | 1210.3 | 1256.3 | 1306.2 | 1354.8 | 1380.1 | 1377.9 | **1348.2** | -2.1% | 3.1% | 4.0% |
| Austria | 73.7 | 69.8 | 70.3 | 64.4 | 69.7 | 67.0 | 64.3 | 64.5 | 60.1 | 62.2 | **63.2** | 1.3% | -1.9% | 0.2% |
| Azerbaijan | 32.3 | 29.1 | 28.7 | 25.2 | 24.0 | 27.7 | 28.7 | 29.4 | 31.0 | 33.9 | **33.9** | -0.2% | 0.4% | 0.1% |
| Belarus | 58.3 | 57.1 | 59.8 | 57.6 | 60.4 | 57.4 | 58.6 | 59.1 | 57.7 | 50.7 | **53.7** | 5.7% | -1.0% | 0.2% |
| Belgium | 139.8 | 139.4 | 141.3 | 128.3 | 137.3 | 123.0 | 118.6 | 119.3 | 112.0 | 117.6 | **120.2** | 1.9% | -1.6% | 0.4% |
| Bulgaria | 49.2 | 52.5 | 50.3 | 43.2 | 45.0 | 50.4 | 45.3 | 39.9 | 42.5 | 45.5 | **42.9** | -6.0% | -0.6% | 0.1% |
| Czech Republic | 126.1 | 127.0 | 119.8 | 111.0 | 115.1 | 111.3 | 106.7 | 104.9 | 99.0 | 102.3 | **105.2** | 2.5% | -1.9% | 0.3% |
| Denmark | 61.7 | 56.9 | 54.4 | 50.6 | 51.3 | 46.5 | 40.9 | 43.4 | 40.3 | 37.2 | **38.9** | 4.4% | -3.5% | 0.1% |
| Finland | 69.7 | 67.6 | 60.2 | 57.7 | 65.7 | 56.8 | 50.3 | 50.8 | 46.1 | 43.1 | **44.6** | 3.1% | -3.2% | 0.1% |
| France | 378.8 | 369.6 | 370.1 | 355.9 | 360.8 | 335.8 | 336.4 | 337.3 | 304.2 | 309.7 | **316.0** | 1.7% | -2.2% | 0.9% |
| Germany | 840.1 | 807.2 | 806.5 | 751.0 | 779.9 | 761.0 | 770.7 | 795.1 | 749.4 | 751.1 | **760.8** | 1.0% | -0.9% | 2.3% |
| Greece | 105.9 | 109.2 | 104.1 | 100.5 | 93.6 | 93.0 | 88.1 | 79.8 | 76.2 | 73.4 | **70.5** | -4.3% | -3.4% | 0.2% |
| Hungary | 57.2 | 55.6 | 54.5 | 48.2 | 49.0 | 47.7 | 43.7 | 42.3 | 41.6 | 44.4 | **45.8** | 2.8% | -2.5% | 0.1% |
| Ireland | 47.5 | 48.5 | 47.9 | 42.8 | 42.6 | 38.1 | 38.2 | 36.9 | 36.6 | 38.4 | **40.5** | 5.4% | -2.2% | 0.1% |
| Italy | 470.2 | 459.7 | 446.9 | 404.0 | 409.7 | 399.9 | 380.5 | 349.9 | 325.1 | 336.2 | **336.9** | ◆ | -3.3% | 1.0% |
| Kazakhstan | 157.7 | 173.3 | 187.0 | 167.9 | 180.5 | 199.2 | 200.9 | 202.6 | 225.0 | 207.6 | **207.2** | -0.5% | 3.5% | 0.6% |
| Lithuania | 13.3 | 13.0 | 13.2 | 11.9 | 13.1 | 12.2 | 12.3 | 11.6 | 10.9 | 11.3 | **11.6** | 2.0% | -1.3% | ◆ |
| Netherlands | 242.0 | 236.8 | 232.5 | 224.1 | 233.0 | 224.6 | 216.4 | 210.9 | 199.4 | 207.5 | **212.5** | 2.1% | -1.6% | 0.6% |
| Norway | 37.8 | 37.8 | 36.7 | 37.2 | 37.9 | 37.8 | 37.5 | 37.7 | 37.0 | 37.0 | **37.5** | 1.1% | -0.1% | 0.1% |
| Poland | 317.4 | 314.2 | 316.4 | 302.3 | 320.4 | 320.1 | 304.5 | 307.4 | 290.4 | 290.1 | **299.0** | 2.8% | -0.6% | 0.9% |
| Portugal | 61.3 | 59.5 | 57.9 | 57.2 | 51.9 | 51.7 | 50.9 | 49.3 | 49.2 | 53.9 | **52.9** | -2.2% | -2.0% | 0.2% |
| Romania | 98.6 | 96.6 | 94.9 | 79.8 | 77.4 | 83.1 | 81.1 | 69.4 | 69.4 | 69.1 | **69.2** | -0.1% | -3.1% | 0.2% |
| Russian Federation | 1559.0 | 1552.4 | 1578.3 | 1464.1 | 1509.8 | 1572.1 | 1582.2 | 1533.8 | 1542.2 | 1521.9 | **1490.1** | -2.4% | 0.2% | 4.5% |
| Slovakia | 37.2 | 35.1 | 36.3 | 33.5 | 36.0 | 33.8 | 32.2 | 32.9 | 30.0 | 30.1 | **30.7** | 1.7% | -2.4% | 0.1% |
| Spain | 365.1 | 378.6 | 352.4 | 314.6 | 299.0 | 308.3 | 306.5 | 275.3 | 272.8 | 289.4 | **282.4** | -2.7% | -2.5% | 0.8% |
| Sweden | 60.2 | 58.1 | 56.3 | 52.9 | 57.7 | 53.3 | 50.3 | 48.5 | 47.6 | 47.3 | **49.1** | 3.6% | -2.4% | 0.1% |
| Switzerland | 44.1 | 40.2 | 42.9 | 43.5 | 41.2 | 39.3 | 40.6 | 42.7 | 38.0 | 38.9 | **37.5** | -4.0% | -1.1% | 0.1% |
| Turkey | 253.7 | 280.7 | 284.8 | 283.4 | 288.6 | 303.4 | 317.0 | 305.5 | 337.9 | 343.0 | **361.8** | 5.2% | 4.1% | 1.1% |
| Turkmenistan | 54.0 | 60.9 | 61.6 | 57.3 | 65.2 | 67.8 | 74.5 | 67.6 | 74.2 | 82.8 | **83.2** | 0.2% | 5.3% | 0.2% |
| Ukraine | 321.3 | 315.5 | 317.4 | 271.9 | 287.0 | 303.1 | 296.8 | 281.3 | 241.5 | 190.3 | **206.9** | 8.4% | -4.9% | 0.6% |
| United Kingdom | 579.0 | 568.9 | 561.4 | 513.0 | 529.7 | 494.4 | 512.2 | 497.4 | 454.4 | 433.4 | **406.4** | -6.5% | -2.8% | 1.2% |
| Uzbekistan | 106.0 | 114.0 | 116.0 | 97.7 | 97.6 | 111.4 | 109.6 | 108.5 | 112.4 | 115.1 | **117.0** | 1.4% | 0.7% | 0.3% |
| Other Europe & Eurasia | 224.5 | 232.9 | 234.4 | 225.5 | 231.8 | 240.1 | 231.5 | 229.8 | 218.2 | 226.2 | **230.6** | 1.7% | 0.5% | 0.7% |
| Total Europe & Eurasia | 7042.7 | 7017.9 | 6995.1 | 6478.0 | 6681.9 | 6871.2 | 6827.9 | 6464.8 | 6272.5 | 6240.7 | **6258.5** | ◆ | -1.0% | 18.1% |
| Iran | 473.5 | 505.5 | 529.8 | 544.6 | 548.2 | 560.9 | 564.2 | 594.7 | 623.7 | 616.5 | **630.9** | 2.1% | 3.5% | 1.9% |
| Israel | 67.8 | 70.9 | 72.3 | 69.1 | 72.5 | 74.0 | 79.4 | 73.3 | 70.2 | 73.5 | **72.9** | -1.1% | 0.8% | 0.2% |
| Kuwait | 77.9 | 77.1 | 82.2 | 83.5 | 89.4 | 92.5 | 108.6 | 103.7 | 98.3 | 108.3 | **108.6** | -0.1% | 2.7% | 0.3% |
| Qatar | 43.9 | 55.0 | 49.5 | 52.2 | 70.8 | 53.2 | 60.4 | 92.3 | 91.1 | 108.5 | **106.7** | -1.9% | 10.3% | 0.3% |
| Saudi Arabia | 387.9 | 405.9 | 439.0 | 457.2 | 501.5 | 518.4 | 543.7 | 552.9 | 589.0 | 611.7 | **621.8** | 1.4% | 5.2% | 1.9% |
| United Arab Emirates | 175.4 | 192.8 | 220.1 | 214.1 | 222.6 | 234.6 | 245.6 | 249.6 | 254.8 | 275.2 | **288.0** | 4.4% | 5.2% | 0.9% |
| Other Middle East | 251.0 | 252.9 | 277.3 | 294.2 | 311.1 | 312.5 | 319.2 | 333.5 | 331.1 | 333.9 | **338.8** | 1.2% | 3.0% | 1.0% |
| Total Middle East | 1477.4 | 1560.2 | 1670.2 | 1714.9 | 1816.0 | 1846.0 | 1921.0 | 2006.0 | 2058.1 | 2127.5 | **2167.8** | 1.6% | 4.2% | 6.5% |
| Algeria | 84.8 | 89.3 | 94.9 | 100.2 | 98.5 | 105.0 | 113.8 | 120.7 | 127.7 | 136.4 | **136.0** | -0.5% | 5.4% | 0.4% |
| Egypt | 156.7 | 165.9 | 176.5 | 183.4 | 195.5 | 197.0 | 208.4 | 207.1 | 208.8 | 211.4 | **220.6** | 4.1% | 3.4% | 0.7% |
| South Africa | 401.3 | 411.5 | 447.5 | 447.1 | 449.2 | 440.7 | 435.6 | 439.4 | 444.0 | 421.8 | **425.7** | 0.6% | 0.7% | 1.3% |
| Other Africa | 296.8 | 311.4 | 328.7 | 324.8 | 351.0 | 349.4 | 369.2 | 390.9 | 409.9 | 422.9 | **426.6** | 0.6% | 3.5% | 1.3% |
| Total Africa | 938.6 | 978.1 | 1047.6 | 1055.4 | 1094.1 | 1092.1 | 1127.0 | 1158.2 | 1190.4 | 1192.6 | **1209.0** | 1.1% | 2.6% | 3.6% |
| Australia | 393.2 | 397.6 | 408.3 | 404.7 | 395.1 | 404.0 | 397.2 | 393.3 | 398.4 | 413.6 | **408.9** | -1.4% | 1.1% | 1.2% |
| Bangladesh | 40.1 | 42.0 | 45.5 | 50.6 | 53.9 | 58.2 | 63.8 | 65.0 | 68.5 | 75.4 | **78.5** | 3.9% | 7.3% | 0.2% |
| China | 6661.6 | 7223.9 | 7362.3 | 7692.5 | 8118.7 | 8806.7 | 8979.4 | 9218.8 | 9224.1 | 9164.5 | **9123.0** | -0.7% | 4.2% | 27.3% |
| China Hong Kong SAR | 80.6 | 86.2 | 79.9 | 87.1 | 89.2 | 92.7 | 89.3 | 92.1 | 90.1 | 90.9 | **93.1** | 2.1% | 1.8% | 0.3% |
| India | 1257.3 | 1370.7 | 1472.2 | 1601.7 | 1667.2 | 1741.2 | 1853.3 | 1933.1 | 2085.9 | 2157.4 | **2271.1** | 5.0% | 6.0% | 6.8% |
| Indonesia | 360.4 | 388.4 | 378.2 | 390.1 | 429.5 | 481.1 | 510.8 | 523.4 | 477.1 | 492.5 | **531.4** | 7.6% | 3.7% | 1.6% |
| Japan | 1252.2 | 1266.0 | 1273.1 | 1110.2 | 1182.4 | 1192.1 | 1284.4 | 1274.6 | 1240.8 | 1206.6 | **1191.2** | -1.5% | -0.6% | 3.6% |
| Malaysia | 183.3 | 184.3 | 193.1 | 184.7 | 199.8 | 210.5 | 218.6 | 228.9 | 240.1 | 247.6 | **263.8** | 6.3% | 3.3% | 0.8% |
| New Zealand | 37.2 | 36.0 | 37.2 | 34.2 | 34.3 | 33.7 | 35.2 | 34.8 | 35.0 | 35.1 | **35.2** | 0.1% | -0.5% | 0.1% |
| Pakistan | 145.5 | 157.4 | 162.1 | 161.7 | 161.6 | 160.2 | 162.4 | 161.8 | 168.6 | 177.1 | **192.7** | 8.5% | 2.7% | 0.6% |
| Philippines | 68.0 | 72.3 | 74.4 | 75.1 | 80.4 | 81.3 | 83.8 | 92.0 | 98.0 | 107.0 | **119.9** | 11.8% | 4.2% | 0.4% |
| Singapore | 142.2 | 153.1 | 165.2 | 178.6 | 187.1 | 194.4 | 193.8 | 194.8 | 194.7 | 206.5 | **220.9** | 6.7% | 4.8% | 0.7% |
| South Korea | 520.8 | 545.4 | 556.8 | 559.0 | 609.8 | 645.6 | 644.1 | 646.5 | 644.3 | 654.0 | **662.1** | 1.0% | 2.3% | 2.0% |
| Taiwan | 273.9 | 276.3 | 258.9 | 248.1 | 261.3 | 271.4 | 266.1 | 266.2 | 271.8 | 270.3 | **276.2** | 1.9% | 0.1% | 0.8% |
| Thailand | 225.1 | 237.2 | 238.5 | 237.4 | 249.7 | 254.7 | 272.0 | 275.4 | 282.5 | 287.7 | **292.0** | 1.2% | 2.4% | 0.9% |
| Vietnam | 71.8 | 78.6 | 103.7 | 103.1 | 121.9 | 133.7 | 130.5 | 134.8 | 150.4 | 166.9 | **167.0** | -0.2% | 6.8% | 0.5% |
| Other Asia Pacific | 146.0 | 138.7 | 142.5 | 145.4 | 145.2 | 135.6 | 139.3 | 130.8 | 144.3 | 154.1 | **173.3** | 12.1% | 0.9% | 0.5% |
| Total Asia Pacific | 11809.1 | 12059.1 | 12261.8 | 13264.2 | 13987.1 | 14897.2 | 15324.2 | 15666.4 | 15814.5 | 15992.2 | **16100.5** | 0.9% | 3.6% | 48.2% |
| **Total World** | 29430.1 | 30481.9 | 30800.4 | 30145.3 | 31528.4 | 32413.0 | 32740.2 | 33226.1 | 33342.5 | 33303.9 | **33432.0** | 0.1% | 1.6% | 100.0% |
| of which: OECD | 13791.2 | 13911.0 | 13698.5 | 12781.4 | 13250.9 | 13084.9 | 12920.3 | 12979.8 | 12804.1 | 12665.9 | **12574.4** | -1.0% | -0.9% | 37.6% |
| Non-OECD | 15638.9 | 16570.9 | 17101.8 | 17363.9 | 18277.5 | 19328.1 | 19819.9 | 20246.3 | 20538.4 | 20638.0 | **20857.7** | 0.8% | 3.4% | 62.4% |
| European Union | 4285.6 | 4220.4 | 4142.7 | 3835.4 | 3932.5 | 3805.0 | 3738.5 | 3654.7 | 3442.7 | 3477.0 | **3485.1** | ◆ | -2.0% | 10.4% |
| CIS | 2308.7 | 2324.9 | 2373.2 | 2164.8 | 2247.7 | 2362.8 | 2379.3 | 2309.1 | 2312.2 | 2230.6 | **2220.4** | -0.7% | 0.1% | 6.6% |

◆Less than 0.05%.

**Notes:** The carbon emissions above reflect only those through consumption of oil, gas and coal for combustion related activities, and are based on 'Default $CO_2$ Emissions Factors for Combustion' listed by the IPCC in its Guidelines for National Greenhouse Gas Inventories (2006). This does not allow for any carbon that is sequestered, for other sources of carbon emissions, or for emissions of other greenhouse gases. Our data is therefore not comparable to official national emissions data.

**Growth rates are adjusted for leap years.**

# Appendices

## Approximate conversion factors

### Crude oil*

| From | To | | | | |
|---|---|---|---|---|---|
| | tonnes (metric) | kilolitres | barrels | US gallons | tonnes per year |
| | Multiply by | | | | |
| Tonnes (metric) | 1 | 1.165 | 7.33 | 307.86 | – |
| Kilolitres | 0.8581 | 1 | 6.2898 | 264.17 | – |
| Barrels | 0.1364 | 0.159 | 1 | 42 | – |
| US gallons | 0.00325 | 0.0038 | 0.0238 | 1 | – |
| Barrels per day | – | – | – | – | 49.8 |

*Based on worldwide average gravity.

### Products

| | To convert | | | |
|---|---|---|---|---|
| | barrels to tonnes | tonnes to barrels | kilolitres to tonnes | tonnes to kilolitres |
| | Multiply by | | | |
| Liquefied petroleum gas (LPG) | 0.086 | 11.60 | 0.542 | 1.844 |
| Gasoline | 0.120 | 8.35 | 0.753 | 1.328 |
| Kerosene | 0.127 | 7.88 | 0.798 | 1.253 |
| Gas oil/diesel | 0.134 | 7.46 | 0.843 | 1.186 |
| Residual fuel oil | 0.157 | 6.35 | 0.991 | 1.010 |
| Product basket | 0.125 | 7.98 | 0.788 | 1.269 |

### Natural gas (NG) and liquefied natural gas (LNG)

| From | To | | | | | |
|---|---|---|---|---|---|---|
| | billion cubic metres NG | billion cubic feet NG | million tonnes oil equivalent | million tonnes LNG | trillion British thermal units | million barrels oil equivalent |
| | Multiply by | | | | | |
| 1 billion cubic metres NG | 1 | 35.3 | 0.90 | 0.74 | 35.7 | 6.16 |
| 1 billion cubic feet NG | 0.028 | 1 | 0.025 | 0.021 | 1.01 | 0.17 |
| 1 million tonnes oil equivalent | 1.11 | 39.2 | 1 | 0.82 | 39.7 | 6.84 |
| 1 million tonnes LNG | 1.36 | 48.0 | 1.22 | 1 | 48.6 | 8.37 |
| 1 trillion British thermal units | 0.028 | 0.99 | 0.025 | 0.021 | 1 | 0.17 |
| 1 million barrels oil equivalent | 0.16 | 5.74 | 0.15 | 0.12 | 5.80 | 1 |

### Units

| | |
|---|---|
| 1 metric tonne | = 2204.62lb<br>= 1.1023 short tons |
| 1 kilolitre | = 6.2898 barrels<br>= 1 cubic metre |
| 1 kilocalorie (kcal) | = 4.187kJ<br>= 3.968Btu |
| 1 kilojoule (kJ) | = 0.239kcal<br>= 0.948Btu |
| 1 British thermal unit (Btu) | = 0.252kcal<br>= 1.055kJ |
| 1 kilowatt-hour (kWh) | = 860kcal<br>= 3600kJ<br>= 3412Btu |

### Calorific equivalents

One tonne of oil equivalent equals approximately:

| | |
|---|---|
| Heat units | 10 million kilocalories<br>42 gigajoules<br>40 million British thermal units |
| Solid fuels | 1.5 tonnes of hard coal<br>3 tonnes of lignite and sub-bituminous coal |
| Gaseous fuels | See Natural gas and liquefied natural gas table |
| Electricity | 12 megawatt-hours |

One million tonnes of oil or oil equivalent produces about 4400 gigawatt-hours (= 4.4 terawatt-hours) of electricity in a modern power station.

1 barrel of ethanol = 0.58 barrels of oil equivalent
1 barrel of biodiesel = 0.86 barrels of oil equivalent
1 tonne of ethanol = 0.68 tonnes of oil equivalent
1 tonne of biodiesel = 0.88 tonnes of oil equivalent

## Definitions

Statistics published in this review are taken from government sources and published data. No use is made of confidential information obtained by BP in the course of its business.

### Country and geographic groupings

Country and geographic groupings are made purely for statistical purposes and are not intended to imply any judgement about political or economic standings.

**North America**
US (excluding US territories), Canada, Mexico.

**South & Central America**
Caribbean (including Puerto Rico and US Virgin Islands), Central and South America.

**Europe**
European members of the OECD plus Albania, Bosnia-Herzegovina, Bulgaria, Croatia, Cyprus, The former Yugoslav Republic of Macedonia, Georgia, Gibraltar, Latvia, Lithuania, Malta, Montenegro, Romania and Serbia.

**Commonwealth of Independent States (CIS)**
Armenia, Azerbaijan, Belarus, Kazakhstan, Kyrgyzstan, Moldova, Russian Federation, Tajikistan, Turkmenistan, Ukraine, Uzbekistan.

**Europe & Eurasia**
All countries listed above under the headings Europe and CIS.

**Middle East**
Arabian Peninsula, Iran, Iraq, Israel, Jordan, Lebanon, Syria.

**North Africa**
Territories on the north coast of Africa from Egypt to western Sahara.

**West Africa**
Territories on the west coast of Africa from Mauritania to Angola, including Cape Verde, Chad.

**East and Southern Africa**
Territories on the east coast of Africa from Sudan to Republic of South Africa. Also Botswana, Madagascar, Malawi, Namibia, Uganda, Zambia, Zimbabwe.

**Asia Pacific**
Brunei, Cambodia, China, China Hong Kong SAR*, China Macau SAR*, Indonesia, Japan, Laos, Malaysia, Mongolia, North Korea, Philippines, Singapore, South Asia (Afghanistan, Bangladesh, India, Myanmar, Nepal, Pakistan, Sri Lanka), South Korea, Taiwan, Thailand, Vietnam, Australia, New Zealand, Papua New Guinea, Oceania.
*Special Administrative Region.

**Australasia**
Australia, New Zealand.

**OECD members**
Europe: Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, UK.
Other member countries: Australia, Canada, Chile, Israel, Japan, Mexico, New Zealand, South Korea, US.

**OPEC members**
Middle East: Iran, Iraq, Kuwait, Qatar, Saudi Arabia, United Arab Emirates.
North Africa: Algeria, Libya.
West Africa: Angola, Nigeria.
South America: Ecuador, Venezuela.

**European Union members**
Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, UK.

**Non-OECD**
All countries that are not members of the OECD.

### Methodology

The primary energy values of nuclear and hydroelectric power generation, as well as electricity from renewable sources, have been derived by calculating the equivalent amount of fossil fuel required to generate the same volume of electricity in a thermal power station, assuming a conversion efficiency of 38% (the average for OECD thermal power generation).

Fuels used as inputs for conversion technologies (gas-to-liquids, coal-to-liquids and coal-to-gas) are counted as production for the source fuel and the outputs are counted as consumption for the converted fuel.

**Percentages**
Calculated before rounding of actuals.

**Rounding differences**
Because of rounding, some totals may not agree exactly with the sum of their component parts.

**Tonnes**
Metric equivalent of tons.

# More information

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London SW1Y 4PD
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## Acknowledgements

**Data compilation:** Centre for Energy Economics Research and Policy, Heriot-Watt University, *ceerp.hw.ac.uk*

**Design and typesetting:** Whitehouse Associates, London

**Printing:** Pureprint Group Limited, UK ISO 14001, FSC® certified and CarbonNeutral®

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# 4 – Can Alternative Energy Effectively Replace Fossil Fuels?

# Can Alternative Energy Effectively Replace Fossil Fuels?

Last updated on: 2/22/2017 2:55:16 PM PST

Pro & Con Quotes | Readers' Comments (136)

## PRO (yes)

### Pro 1

Richard Heinberg, MA, Senior Fellow at the Post Carbon Institute, stated the following in his Feb. 22, 2016 article titled "100% Renewable Energy: What We Can Do in 10 Years," published by *Yes! Magazine*:

> "It will take at least three decades to completely leave behind fossil fuels. But we can do it...
>
> But the transition will entail costs—not just money and regulation, but also changes in our behavior and expectations. It will probably take at least three or four decades, and will fundamentally change the way we live...
>
> Nearly everyone agrees that the easiest way to kick-start the transition would be to replace coal with solar and wind power for electricity generation...
>
> The collective weight of these challenges and opportunities suggests that a truly all-renewable economy may be very different from the American economy we know today. The renewable economy will likely be slower and more local; it will probably be a conserver economy rather than a

## CON (no)

### Con 1

Robert Lyman, Principal at ENTRANS Policy Research Group, Inc., stated the following in his May 2016 report titled "Why Renewable Energy Cannot Replace Fossil Fuels by 2050," published by Friends of Science:

> "Oil provides 95% of the fuel demands of the transportation sector... Every transport mode – cars, trucks, trains, buses, marine vessels, and aircraft – relies almost entirely on petroleum fuels. Only natural gas liquids and, in recent years as the result of regulated fuel mandates, ethanol - have made small inroads in the dominant share held by oil. Further, on the basis of the projections by all major agencies that analyze energy supply and demand trends to 2035 and 2040, this will continue to be the case for the foreseeable future...
>
> Proponents of the all-renewable future seem to be stuck in a time warp. For them, it is still 2014, oil prices are still close to $130 per barrel, and natural gas and coal prices are surging. In such a world, it may be easier to make the case that renewables will become far more competitive sooner. The reality, of course,

consumer economy. It will also likely feature far less economic inequality."
Feb. 22, 2016 - Richard Heinberg, MA ★★★

## Pro 2

Michael Klare, PhD, Professor of Peace and World Security Studies at Hampshire College, stated the following in his Apr. 22, 2015 article titled "The Age of Wind and Solar Is Closer Than You Think" available at the *Scientific American* website:

"That day will come: the life-changing moment when renewable energy—wind, solar, geothermal and others still in development—replace fossil fuels as the principal source of world energy...
The transition to renewables will be hastened by dramatic improvements in the pricing and performance of such systems. Due to steady increases in the efficiency of wind and solar systems, coupled with the savings achieved through large-scale manufacture, the price of renewables is falling globally...
The transition from fossil fuels to renewable energy will not occur overnight, and it will not escape recurring setbacks. Nevertheless, renewables are likely to replace fossil fuels as the dominant source of electrical power well before mid-century as well as make giant strides in other areas such as transportation."
Apr. 22, 2015 - Michael Klare, PhD ★★★

## Pro 3

is that the decline of international oil prices to the range of $40 per barrel and the dramatic slumps in natural gas and coal prices in many areas (especially North America), has meant that these hydrocarbons are far better placed to compete with alternative energy sources."
May 2016 - Robert Lyman ★

## Con 2

Gary Wolfram, PhD, William E. Simon Professor of Economics and Public Policy at Hillsdale College, stated the following in his May 11, 2016 article "Can We Replace Fossil Fuels by 2030?," available at the Detroit News website:

"Today in the U.S. 33 percent of electricity generation is from coal, 33 percent from natural gas and 20 percent nuclear. While rising steadily, only 13 percent is from renewable energy. The decline in the price of renewable energy is indeed worth noting... However, the price of oil and natural gas has also fallen steeply with the use of horizontal drilling and other new technologies which make it difficult for other fuel sources to compete economically, much less totally capture the market...
There has certainly been improvements in renewable energy sources over the last decade. However, the idea that there will be no need for coal or oil in 15 years is simply not believable."
May 11, 2016 - Gary Wolfram, PhD ★★★

Richard Schiffman, environmental journalist, stated the following in his June 26, 2014 article "Why the Shift to Alternate Energies Continues, Despite Shale Boom," available at reuters.com:

> "However difficult and expensive it may be at the outset to green the U.S. power system, it won't take long before our initial investment begins to pay off in lower electric bills — which are no longer a hostage to global oil prices — and a cleaner environment...
>
> It does cost more to build wind farms and install solar arrays. But once these plants are set up and running, they have lower operation and maintenance costs than conventional power on a yearly basis. No more regular fuel bills and only minimal expenses for upkeep of solar, for example, which has no movable parts that wear out and need to be replaced.
>
> The price argument is also fallacious because we have never paid the real price for the power we use, which includes the cost to the environment and human health of the carbon pollution that fossil-fuel mining and burning generates... We should be supporting technologies that help us to put the brake on destructive climate change, rather than feeding the unsustainable fossil-fuel habit that is driving it."
>
> June 26, 2014 - Richard Schiffman ★

# Pro 4

Alfred W. Crosby, PhD, Professor Emeritus of History, Geography, and American Studies at

# Con 3

Christopher Helman, MS, MA, Senior Editor for *Forbes* Magazine, stated the following in his Apr. 24, 2014 article "Solar Power Is Booming, but Will Never Replace Coal. Here's Why," available at forbes.com:

> "So is the solar revolution finally here? Not quite. Even after a decade of rampant growth solar energy still barely moves the needle in the U.S. energy mix. In fact, solar merely equals the amount of electricity that the nation generates by burning natural gas captured from landfills...
>
> The biggest sources are the old standbys. Oil still reigns supreme at 36 quadrillion Btu, natural gas at 26 quads, nuclear 8. Hydropower and biomass bring up the rear at 2.6 and 2.7 quads. Wind is just 1.5 quads. And coal — the great carbon-belching demon of the global energy mix — its contribution is 19 quads. That's nearly 8 times all the nation's wind and solar generation combined...
>
> For all the talk of 'grid parity' the simple reality is that even combined with far more power generation from natural gas, renewable alternatives will need decades to push out coal. And the irony will be that as demand for coal lessens, it will become cheaper and cheaper, making it even more attractive for the coal-burning power plants that survive the coming cull...
>
> Coal has gotten immensely cleaner over the past generation. And new and better ways will be found to extract energy from coal without sending its dangerous

the University of Texas at Austin, stated the following in a June 19, 2009 email to ProCon.org:

"Alternative sources of energy can become a satisfactory substitute for fossil fuels if we put as much effort and genius in the effort as we did in producing the first atomic bomb. The most satisfactory single alternative would be hydrogen fusion but that quasi-miracle may be beyond our capability. We may discover that wind, solar, biomass, etc., all piled on top of each other, may have to do, but their success may turn out to require an effort that started a generation ago. Essential to any and all success is the realization on our part that we may be able to do anything, which includes fail."

June 19, 2009 - Alfred W. Crosby, PhD ★★★

# Pro 5

Arjun Makhijani, PhD, President of the Institute for Energy and Environmental Research, stated the following in his Aug. 2007 article "Carbon-Free and Nuclear-Free," in *Science for Democratic Action*:

"[A] zero-CO2 U.S. economy can be achieved within the next thirty to fifty years without the use of nuclear power...

The U.S. renewable energy resource base is vast and practically untapped. Available wind energy resources in 12 Midwestern and Rocky Mountain states equal about 2.5 times the entire electricity production of the United States... Solar energy resources on just one percent of the area byproducts into the environment. It's scalable and reliable in ways that renewable energy sources simply aren't. In short, unless we're willing to put up with blackouts that freeze grandma in the winter and melt her in the summer, coal will remain a mainstay of U.S. power generation for decades to come."

Apr. 24, 2014 - Christopher Helman, MS, MA ★

# Con 4

Clive Best, PhD, a former physicist, stated the following on his website in a May 4, 2016 post titled "The Logical Fallacy of Renewable Energy":

"Modern society depends on always available power. If power goes down then society stops. There are no phones, no internet, no ATMs, no refrigeration, no sewage pumps – nothing, and if a large city like London is without power for more than 12 hours rioting and looting would quickly take hold. It is therefore inconceivable not to ensure that we have reliable energy at all times. So an energy plan for the UK must be able to meet demand even on the coldest evening of the year in winter with no wind and no solar. For this reason Renewable energy can never under any realistic scenario meet that target. To imagine that battery prices could fall enough to make wind and solar backup such enormous power demands is simply a delusion."

May 4, 2016 - Clive Best, PhD ★★★

of the United States are about three times as large as wind energy, if production is focused in the high insolation areas [strong sunlight] in the Southwest and West...

With the right combination of technologies, it is likely that even the use of coal can be phased out, along with nuclear electricity. Complete elimination of CO2 could occur as early as 2040. Elimination of nuclear power could also occur in that time frame."

Aug. 2007 - Arjun Makhijani, PhD ★★★

## Pro 6

Patrick Moore, PhD, Chair and Chief Scientist of Greenspirit Strategies Ltd. and former International Director of Greenpeace International, stated the following in a Feb. 18, 2009 email to ProCon.org:

"It all depends on what you mean by 'alternative energy'. Alternative to what? Specifically if nuclear energy is considered 'alternative' (to fossil fuels) then I am in the Pro camp. If nuclear is not considered alternative I am decidedly in the Con camp because I do not believe it is remotely possible to replace fossil fuels with wind, solar, geothermal etc. by themselves. Then there is the question of whether hydroelectricity is 'alternative'. If both hydro and nuclear are not considered alternative then it is doubly impossible to replace fossil fuels with alternatives.

The terms 'renewable', 'sustainable', 'clean', 'green', and 'alternative' tend to be tossed about as if they all mean the same thing when they each have distinct meanings,

## Con 5

Robert L. Hirsch, PhD, Senior Energy Advisor, Management Information Systems Inc. (MISI), stated the following in a Feb. 18, 2009 email to ProCon.org:

"In the next few decades world economies will require hydrocarbon liquids from oil, coal, natural gas, heavy oil, oil sands, and enhanced oil recovery. Sugar cane ethanol is also practical, but volumes will be limited. Other biomass liquids are uncertain. Corn-ethanol is an energy & environmental loser, and cellulosic liquids are not yet practical."

Feb. 18, 2009 - Robert L. Hirsch, PhD ★★★

## Con 6

Tad W. Patzek, PhD, Chairman of the Petroleum and Geosystems Engineering Department at the University of Texas at Austin, and David Pimentel, PhD, Professor Emeritus of Ecology and Evolutionary Biology at Cornell University stated the following in their Mar. 14, 2005 article "Thermodynamics of Energy Production from Biomass," published in *Critical Reviews in Plant Sciences*:

"We want to be very clear: solar cells, wind turbines, and biomass-for-energy plantations can never replace even a small fraction of the highly reliable, 24-hours-a-day, 365-days-a-year, nuclear, fossil, and hydroelectric power stations. Claims to the contrary are popular, but irresponsible."

Mar. 14, 2005 - Tad W. Patzek, PhD ★★★
David Pimentel, PhD ★★★

some of which are less than objective. 'Green', for example, can be a shameless marketing term. 'Clean' is relatively straightforward, meaning there is no pollution involved. Hydroelectric energy is renewable. Nuclear energy is not renewable but it is sustainable."

[**Editor's Note:** The term "alternative energy" has numerous definitions. On this website "alternative energy" refers to any form of energy that is not derived from fossil fuels (oil, coal, or natural gas). Under this definition nuclear energy is an alternative energy even though it is not considered a renewable energy like solar or wind energy. To learn more about the terms alternative energy and renewable energy, please visit our webpage titled What are alternative energies?]

Feb. 18, 2009 - Patrick Moore, PhD ★★★

# Pro 7

Helen Caldicott, MBBS, President of the Nuclear Policy Research Institute, stated the following in her July 25, 2006 article "Fuel Plan Beset by Fossilised Thinking," published in *The Australian*:

"Anyone who has seen Al Gore's extraordinary film An Inconvenient Truth will realise that the world must, urgently, stop burning fossil fuel...

We need politicians with knowledge, energy and courage who will move beyond the fossil fuel and nuclear eras. Is it possible to make that leap with available technology? Yes...

Tidal power, geothermal energy,

# Con 7

Walter Youngquist, PhD, Emeritus Chair of the Department of Geology at the University of Oregon at Portland, stated the following in his Spring 2005 article "Spending Our Great Inheritance; Then What," in *The Social Contract*:

"Ethanol is a net energy loss - it takes 70 percent more energy to produce than is obtained from the product itself. Other biomass resources show, at best, very low net energy recovery...

The two most popularly suggested energy alternatives, wind and solar, suffer because they're undependable, intermittent sources of energy, and the end product is electricity. We have no way to store large amounts of electricity for use when wind and sunshine are not with us. Geothermal and tidal energy are insignificant energy sources in total but can be locally important. Nuclear energy can be a large power source if the safety aspects can be guaranteed (and this may be possible) -- but again, the end product is electricity. There is no battery pack even remotely in sight that would supply the energy needed to effectively power bulldozers, heavy agricultural equipment such as tractors and combines, or 18-wheelers hauling freight cross-country. Can electricity be used to obtain hydrogen as a fuel from water? It can, but hydrogen is difficult to store and dangerous to handle. And there is no energy system now visualized to replace kerosene jet fuel,

cogeneration and biomass combined with conservation are some of the resources yet to be explored...
[F]or the first time in human history, all electricity can be generated by a combination of renewable carbon-free and nuclear-free technologies."
July 25, 2006 - Helen Caldicott, MBBS ★★★

## Pro 8

Greenpeace International stated the following in a Feb. 23, 2009 email to ProCon.org:

"Our position on the question 'Can alternative energy effectively replace fossil fuels?' is clear.
Renewable energy, can and indeed must replace both fossil fuel and nuclear power as quickly as possible if the world is to avoid the catastrophic effects of runaway climate change. Page 12 of the summary report of the 2nd edition of the Energy Revolution contains this statement: 'The amount of energy that can be accessed with current technologies supplies a total of 5.9 times the global demand for energy.' The remainder of the report spells out how we believe the world can set off down the path to a clean energy future, within the current political and economic constraints."
Feb. 23, 2009 - Greenpeace International ★

## Pro 9

Ulf Bossel, PhD, freelance fuel cell consultant, stated the following in his Apr. 7, 2005 article

which propels a Boeing 747 about 600 miles an hour nonstop on the 14-hour trip from New York to Capetown (currently the longest plane flight). We continue to seek the holy grail of energy - fusion - but containing the heat of the sun at 10 million degrees Centigrade is still only a far-off hope."
Spring 2005 - Walter Youngquist, PhD ★★★

## Con 8

ExxonMobil, an international energy corporation, stated the following in its Feb. 2006 study "Tomorrow's Energy: A Perspective on Energy Trends, Greenhouse Gas Emissions and Future Energy Options," available at the Exxon Mobil website:

"Although wind, solar, biofuels and nuclear all compete with fossil fuels as sources of primary energy, their contribution to the world's total energy demand is limited because they are more expensive than fossil fuels – and in the case of nuclear, limited by waste and disposal concerns... While we recognize the risks of climate change we also conclude that the world will continue to demand oil and gas for a majority of its primary energy supplies for many decades to come."
Feb. 2006 - ExxonMobil ★

## Con 9

David B. Barber, MS, Nuclear Engineer at the Idaho National Laboratory, stated the following in his Mar. 24, 2005 article "Nuclear Energy and the Future: The Hydrogen

"Does a Hydrogen Economy Make Sense?," available at www.efcf.com:

> "[H]ydro power, solar energy, wind power, ocean energy or geothermal installations harvest renewable energy in a sustainable way. Add energy obtained from sustainably managed biomass and organic waste to complete the list of renewable energy. After depletion of fossil and uranium deposits energy must come from these sources. There are no other sustainable energy sources that could possibly contribute substantially to the energy needs of mankind...
> Without any question, the energy demand of mankind can be satisfied from renewable sources."
> Apr. 7, 2005 - Ulf Bossel, PhD ★★★

# Pro 10

Joseph Romm, PhD, Senior Fellow at the Center for American Progress (CAP), stated the following in his May 17, 2008 article "Winds of Change," published in *Salon*:

> "[W]ind power is coming of age... Sadly, most wind power manufacturers are no longer American, thanks to decades of funding cuts by conservatives. Still, new wind is poised to be a bigger contributor to U.S. (and global) electricity generation than new nuclear power in the coming decades. As I have written earlier, concentrated solar power could be an even bigger power source, and it can even share power lines with wind.
> That means we can realistically envision an electric grid built around renewables:

Economy or the Electricity Economy?," available at lags.org:

> "The wind doesn't always blow and sunlight isn't always striking every solar panel. Renewable energy desperately needs a very big battery, a load leveler. Without some form of energy storage, renewables are physically limited to less than a twenty percent share of the grid. At twenty percent, renewables are more of a headache than a resource for a grid manager. Electricity storage tools are expensive. Very expensive. Too expensive to justify on their own or at societal scale."
> Mar. 24, 2005 - David B. Barber, MS ★★★

# Con 10

Samuel Bodman, ScD, former US Secretary of Energy, stated the following in his Apr. 22, 2008 article "Developing a Cleaner, Sustainable, and More Energy Secure Future," published in the *Washington Times*:

> "Any comprehensive strategy must recognize that our energy challenges have been decades in the making and certainly won't be resolved overnight. So even as we rightly place a great deal of emphasis on renewable energy and alternative fuels, it is clear that our economy is – and will remain for some time – dependent on fossil energy. We must diversify the available supply of conventional fuels and expand production around the world and here at home– including within a small area of the Arctic National Wildlife Refuge and portions of America's Outer Continental Shelf – in an environmentally

electricity with no greenhouse gas emissions, no fuel cost (and no future price volatility) and no radioactive waste."
May 17, 2008 - Joseph Romm, PhD ★★★

## Pro 11

Al Gore, Jr., Chairman of the Alliance for Climate Protection and former Vice President of the United States, stated the following in his Nov. 9, 2008 article "The Climate for Change," in the *New York Times*:

"Here's what we can do — now: we can make an immediate and large strategic investment to put people to work replacing 19th-century energy technologies that depend on dangerous and expensive carbon-based fuels with 21st-century technologies that use fuel that is free forever: the sun, the wind and the natural heat of the earth...
What follows is a five-part plan to repower America with a commitment to producing 100 percent of our electricity from carbon-free sources within 10 years."
Nov. 9, 2008 - Al Gore, Jr. ★★★

## Pro 12

Robert F. Kennedy Jr., LLM, Chief Prosecuting Attorney for the Hudson Riverkeeper and Chairman of the Water Keeper Alliance, stated the following in his Aug. 25, 2008 article "Obama's Energy Plan Would Create Green Gold Rush," published in the *Los Angeles Times*:

"The United States has far greater domestic energy resources than Iceland or sensitive and efficient manner. Also, we must maintain an adequate liquefied natural gas infrastructure and promote the development of nontraditional fossil fuels like oil shale and oil sands."
Apr. 22, 2008 - Samuel Bodman, ScD ★★★

## Con 11

Colin J. Campbell, PhD, Founder and Honorary Chairman of the Association for the Study of Peak Oil and Gas (ASPO), stated the following in a Feb. 18, 2009 email to ProCon.org:

"The First Half of the Age of Oil comes to an end, being partly responsible for the current financial and economic crisis facing the world. Oil and gas are set to decline during the Second Half of the Age of Oil to near exhaustion by the end of this Century due to natural depletion. Today, renewable energy, including hydro, accounts for no more than about 12% of the world's energy consumption. It is evident that the demand for it will grow greatly in the years ahead, but it is doubted that it can replace fossil fuels as such. Improved efficiency and changed lifestyles are called for to meet the challenges imposed by Nature. The tensions and challenges of the transition threaten to be serious."
Feb. 18, 2009 - Colin J. Campbell, PhD ★★★

## Con 12

Jerry Taylor, Senior Fellow at the Cato Institute, stated the following in his 2007

Sweden. We sit atop the second-largest geothermal resources in the world. The American Midwest is the Saudi Arabia of wind. Solar installations across just 19 percent of the most barren desert land in the Southwest could supply nearly all of our nation's electricity needs even if every American owned an electric car...
For a tiny fraction of the projected cost of the Iraq war, we could completely wean the country from carbon."
Aug. 25, 2008 - Robert F. Kennedy, Jr., LLM ★★★

# Pro 13

David Morris, PhD, Vice President of the Institute for Local Self-Reliance, stated the following in his Aug. 2, 2008 article "Electric Cars Are the Key to Energy Independence," available at the Alternet website:

"Oil generates only 3 percent of our electricity. Therefore a 100 percent renewable electricity system does little to reduce our oil dependency -- unless that electricity is used to substitute for oil in our transportation system...
Converting our electric system fully to renewables would require us to shut down about 80 percent of our current electricity-generating capacity, much of it low-cost, already paid off and capable of generating electricity for another 25 years or more.
Moreover, to reach very high penetration rates of renewable electricity would require that we overcome the principal shortcoming of wind and sunlight: intermittency.

article "Energy," published in *The Concise Encyclopedia of Economics*:

"In a free market, cost dictates energy choices. Fossil fuels, for example, are economically attractive for many applications because the energy available from fossil fuels is highly concentrated, easily transportable, and cheaply extracted. Renewable energies such as wind and solar power, on the other hand, are relatively dispersed, difficult to transport, and costly to harness given the capital costs of facility construction.
Many people recommend accelerated federal subsidies and preferences for renewable energy in order to reduce America's dependence on imported oil. But such recommendations fail to appreciate the fact that energy sources are often difficult to substitute for one another. Until we see major technological advances in electric-powered vehicles and related battery systems, for example, technological breakthroughs in solar or wind power will have little, if any, impact on oil imports. That's because renewable energy is used primarily to generate electricity and cannot be used directly in transportation to replace oil: in 2002, only 2.5 percent of America's total electricity was generated from oil combustion."
2007 - Jerry Taylor ★

# Con 13

Abdullah S. Jum'ah, MBA, President and Chief Executive Officer of Saudi Aramco, stated the following during his Nov. 2007

Powering 100 percent of our transportation system would require about 30 percent of the electricity generated in 2006. With a massive effort, using a combination of solar and wind power, we could generate about that much electricity by 2020."

Aug. 2, 2008 - David Morris, PhD ★★★

# Pro 14

Hosein Shapouri, PhD, Economist at the Office of Energy Policy and New Uses at the United States Department of Agriculture (USDA), stated the following in a Nov. 25, 2008 email to ProCon.org:

"In response to your question, I believe alternative energy could effectively replace fossil fuels."

Nov. 25, 2008 - Hosein Shapouri, PhD ★★★

# Pro 15

Christopher Paine, Director of the Nuclear Program of the Natural Resources Defense Council (NRDC), stated the following during a July 15-17, 2008 online debate titled, "Is Nuclear Power Essential to Addressing Climate Change and Energy Independence?," available at newtalk.org:

"The US has enough potentially recoverable efficiency savings and renewable energy resources - direct solar radiation, indirect solar radiation, wind, geothermal, biomass, small hydro, and wave-tidal energy, to eventually power the entire US economy, essentially indefinitely, without nuclear or coal."

remarks, "Global Oil Resources and the World's Energy Future: A Holistic View," presented at the 20th Congress of the World Energy Council:

"[A]lternative energy sources have some way to go before they can make substantial contributions to the world's future energy mix, given the current state of their development and the various hurdles they still face. We must also remember that many of these alternatives, such as nuclear or renewables, or even conventional sources such as coal, may be able to meet additional demand in power generation and possibly industry but not in transportation, which of course is a key sector of oil utilization.

Alternatives and their contributions to meeting steadily rising energy demand are needed and welcome, and eventually these fuel sources will become a more important component of global energy supplies. But we must be realistic about the pace of their future development, and understand that for the foreseeable future, their significance in the energy supply mix will continue to be limited."

Nov. 2007 - Abdallah S. Jum'ah ★

# Con 14

Clifford J. Wirth, PhD, retired Professor of Energy Policy at the University of New Hampshire, wrote in his July 5, 2008 paper, "Peak Oil: Alternatives, Renewables, and Impacts," available at the Peak Oil Associates website:

July 15-17, 2008 - Christopher Paine ★

# Pro 16

Martha Young, Principal of Nova Amber, LLC, stated the following in a Feb. 19, 2009 email to ProCon.org:

"Yes, a portfolio of alternative energy solutions can and must replace the use of fossil fuels around the globe. Each country has its own collection of assets such as geothermal, wind, hydro and solar to support its energy needs. Being energy independent allows each country to grow its economic base in a sustainable manner without impacting any other country in a race to consume finite resources."

Feb. 19, 2009 - Martha Young ★

# Pro 17

Green America (formerly Co-op America), a non-profit environmental organization, stated the following in its Summer 2005 article "The Promise of the Solar Future," available at its website:

"Gradually shifting toward more efficient technologies and renewable energy sources won't be enough—we must catalyze a massive shift in our energy use within the next decade to stabilize our climate while meeting the world's growing power needs. Since our country accounts for more than 20 percent of world greenhouse gas emissions, it is particularly important that we in the US lead the way.

The good news is that we have the

"The studies reviewed in this report indicate that alternatives cannot provide significant amounts of liquid fuels. Thus it is not feasible to ramp up alternatives to replace oil, even if there are decades to prepare for the occurrence of Peak Oil. There are no significant mitigation options on the supply side regarding the Peak Oil crisis...

Solar power, nuclear energy, and coal are primarily useful for generating electric power, but these energies do not provide liquid fuels needed for transportation or mechanized agriculture, nor do they provide raw materials for manufacturing of 300,000 products, including fertilizer. Electric power from solar, coal, nuclear fission, or nuclear fusion will therefore not solve the nation's energy problems...

Because leaders lack a basic understanding of energy sources, the nation will continue to direct attention toward the hydrogen economy, corn ethanol, wind power, and solar energy – even though the most authoritative sources conclude that these are not solutions for the liquid fuels problems facing the nation."

July 5, 2008 - Clifford J. Wirth, PhD ★★★

# Con 15

J. Robinson West, JD, Chairman and Founder of PFC Energy, stated the following in his July 10, 2008 article "Two Takes: Energy Independence Is Neither Practical nor Attainable," published in *US News & World Report*:

knowledge, technology, and capacity to make the shift to a renewable energy path—it all hinges on growing solar power. Solar energy is essential to a renewable energy future. Even after we achieve all possible energy-efficiency gains and take full advantage of other renewable energy sources, such as wind and geothermal, we'll still need some other way to generate at least 30 percent of our power. (This gap between energy demand and renewable energy supply for all energy, not only electricity, could be as much as 70 percent without aggressive energy efficiency.) That remaining energy must come from solar."
Summer 2005 - Green America (formerly Co-op America) ★

# Pro 18

Physicians for Social Responsibility (PSR) stated the following in their Dec. 23, 2008 article "Green Energy Notes," available at psr.org:

"[E]xisting renewable energy technologies are capable of meeting the entire U.S. need for electricity by the year 2020. Solar energy could produce 100 percent of electricity demanded in the U.S. on .3 percent of the nation's land, while wind power could create 2.6 times the amount of electricity used in the U.S. with turbines in just twelve states.
A change in fuels would also have benefits in the area of transportation. According to the Department of Agriculture, biofuels could make up 37 percent of transportation fuels in the U.S. by 2025. If

"Many politicians want to substitute other domestically produced liquid fuels for oil and assure the public that they are around the corner. They are not.
There is now no liquid fuel that can largely replace oil for transportation. We are stuck because of the scale of the industry and - despite criticism - oil's efficiency...
Politicians pose with gimmicks like hydrogen cars, but they will have little near-term impact. Breakthrough technologies, such as cellulosic ethanol, are theoretically attractive - but don't exist."
July 10, 2008 - J. Robinson West, JD ★★★

# Con 16

The Institute for Energy Research (IER), an energy research organization that promotes free-market solutions to energy problems, stated the following in its article "Energy Overview," available on its website (accessed Jan. 28, 2009):

"America's insatiable appetite for the good things energy delivers could not be satisfied by fossil fuels alone.
Hydroelectric power, a renewable source of energy created by the damming of rapidly-flowing rivers, was introduced in the 1890s, as was nuclear power in the late 1950s. In recent years, other renewable sources of energy – wind, solar, biomass, and geothermal – have entered the fray. However, while the use of renewable fuels is expected to increase in the years to come, their overall contribution to America's energy pool is forecast by the EIA [US Energy Information

combined with the use of fuel-efficient vehicles, this percentage could rise to 75 percent. Further advances in technology, such as the use of hydrogen fuel cells, and an increase in the use of hybrid vehicles would create further benefits."
Dec. 23, 2008 - Physicians for Social Responsibility (PSR) ★

## Pro 19

The Nuclear Information and Resource Service, a non-profit anti-nuclear organization, stated the following in its May 2008 article "False Promises: Debunking the Nuclear Industry Propaganda," available at nirs.org:

"What we need to do is get rid of both of our addictions: carbon and uranium...
There are numerous renewable energy technologies available which could be expanded and many more that have great potential and should be pursued and funded more aggressively...
It has been estimated that the solar energy available in a 100-square-mile area of Nevada could supply the United States with all its electricity needs...
It has been estimated that wind energy has the potential to satisfy the world's electricity needs 40 times over, and could meet all global energy demand five times over."
May 2008 - Nuclear Information and Resource Service ★

Agency] to remain very modest, far behind fossil fuels and nuclear energy. Nuclear power, by contrast, which currently supplies about 20 percent of US electricity, is expected to become a more prominent player as a new generation of power plants go into service in the decades to come."
Jan. 28, 2009 - Institute for Energy Research ★

## Con 17

The World Nuclear Association stated the following in its Nov. 25, 2008 article "World Energy Needs and Nuclear Power," available on its website:

"The renewable energy sources for electricity constitute a diverse group, from wind, solar, tidal and wave energy to hydro, geothermal and biomass-based power generation. Apart from hydro power in the few places where it is very plentiful, none of these is suitable, intrinsically or economically, for large-scale power generation where continuous, reliable supply is needed...
Without nuclear power the world would have to rely almost entirely on fossil fuels, especially coal, to meet electricity demands for base-load electricity production."
Nov. 25, 2008 - World Nuclear Association ★

## Con 18

The United States Carbon Sequestration Council, a non-profit coalition of scientists,

environmentalists, and businessmen supporting the development of CCS technology, stated in its Apr. 2009 publication "Is Carbon Capture & Storage (CCS) Needed? How Can We Make It Happen Sooner?," available at its website:

"Electricity is needed to give us light, to power our appliances, to power our televisions and computers, and to enable all of the work saving gadgets that we own. In order to meet these fundamental needs, we will need ever more energy, especially in the emerging economies of the world. This again translates to a very rapid growth in global energy demand, especially the demand for electricity. In the U.S. alone, electricity demand is expected to double by mid-century...

The large growth in global energy demand can only be met by relying on all of our energy resources. No single energy resource can meet such requirements. If we are to avoid energy shortages, we need to greatly expand our use of fossil fuels, nuclear energy, renewables and conservation."

Apr. 2009 - United States Carbon Sequestration Council ★

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# 5 – The Energy Debate: Renewable Energy Cannot Replace Fossil Fuels?

April 12, 2017

# The energy debate: Renewable energy cann fossil fuels

By Toni Pyke

> *"The fact that oil is a "finite" material is not a problem...Every material is finite. Life is all about taking the theoretically finite but practically limitless materials in nature and creatively turning them into useful resources. The fossil fuel industry does it, the "renewable"—actually, the "unreliable"—energy industry doesn't. End of story."* ***Alex Epstein***

Fossil Fuels (coal, oil, petroleum, and natural gas) are originally formed from plants and animals that lived hundreds of millions of years ago and became buried deep beneath the Earth's surface. These then collectively transformed into the combustible materials that we use today for fuel. The earliest known fossil fuel deposits are from about 500 million years ago, when most of the major groups of animals first appeared on Earth. The later fossil fuels, such as peat or lignite coal (soft coal), began forming from about five million years ago.

Currently, we are (over)dependent on fossil fuels to heat our homes, run our cars, power our offices, industry and manufacturing, and respond to our insatiable desire to power all of our electrical goods. Nearly all of the energy needed to meet our demands – 80 percent of global energy – comes from burning fossil fuels. At the current rate of global energy demands, fossil

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fuels cannot replenish fast enough to meet these growing needs. The (over)consumption of these non-renewable fuels has been linked to the emission of greenhouse gases and pollutants into the atmosphere – the leading cause of global warming and climate change.

In Ireland, for example, our energy consumption from fossil fuels was 89% in 2013. Our highest demand for fossil fuel energy over the last 51 years was experienced during the period of high growth under the 'Celtic Tiger' (2004), where we required 93.39%. The lowest energy consumption value (67.24%) was in 1960, more than half a century ago! Ireland is ranked 46th out of 136 countries in its fossil fuel energy consumption. That's higher than the UK (52nd) and the US (56th)!

For more background to the debate see "5 possible climate scenarios" by the Guardian.

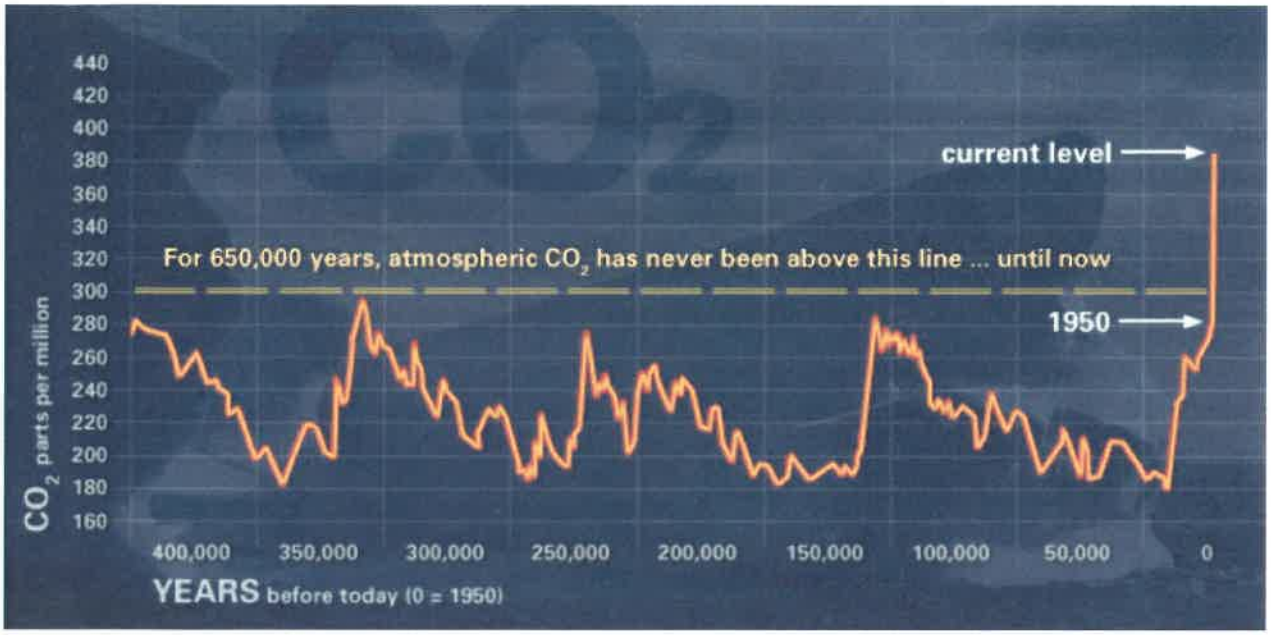
## Renewables

Renewable energy is energy that is derived from natural processes (e.g. sunlight and wind). Solar, wind, geothermal, hydropower, bioenergy and ocean power are sources of renewable energy. Currently, renewables are utilised in the electricity, heating and cooling and transport sectors. Renewable energy, collectively provides only about 7 percent of the world's energy needs. This means that fossil fuels, along with nuclear energy — a non-renewable energy source — are supplying 93% of the world's energy resources. Nuclear energy (a controversial energy source among public opinion) currently provides 6% of the world's energy supplies.

## The issues

*"Models predict that Earth will warm between 2 and 6 degrees Celsius in the next century. When global warming has happened at various times in the past two million years, it has taken the planet about 5,000 years to warm 5 degrees. The predicted rate of warming for the next century is at least 20 times faster. This rate of change is extremely unusual."* – NASA Earth observatory

Burning fossil fuels creates carbon dioxide, the main greenhouse gas emitter that contributes to global warming, which hit its peak in 2012. In the last 30 years, temperatures have risen to the warmest since records began. If we continue to pump greenhouse gases into our environment the average global temperature could increase by 1°C to 4°C by 2100. Even if we changed today to using more renewable resources instead of fossil fuels for example, increases could be between 1 to 2.5°C.




This graph, based on the comparison of atmospheric samples contained in ice cores and more recent direct measurements, provides evidence that atmospheric CO2 has increased since the Industrial Revolution. (Credit: Vostok ice core data/J.R. Petit et al.; NOAA Mauna Loa CO2 record.)

The 20th century saw the most prolific population growth and industrial development, which was and remains totally dependent on the use of fossil fuel for energy.

Estimates for fossil fuel reserves depletion range from between 50-120 years. None of these projections are very appealing for a global community that is so heavily dependent on energy to meet even our basic human needs – needs that keep growing.

Predictions estimate that global energy demand will grow by a third by 2035. Also critical to consider is the more than 1.2 *billion* people around the world who still do not have access – yet – to electricity. As the global population continues to grow – predicted to be nine billion people over the next 50 years – the world's energy demands will increase proportionately.

Scientists maintain that the impact of global warming on the environment is widespread. In the Arctic and Antarctica, warmer temperatures are melting ice, which leads to increases in sea levels and alters the composition of the surrounding sea water. Rising sea levels impacts on settlements, agriculture and fishing both commercially and recreationally. Air pollution is also a direct result of the use of fossil fuels, resulting in smog (see in China and India), and the degradation of human health and plant growth. There is the negative impact on natural ecosystems that result from collecting fossil fuels, particularly coal and oil. There is also the continuing threat of oil spills that devastate ecosystems and the impact of mining on land vitality.

## The future

The discussions around climate change and energy problems today centre around the potential for technical solutions to energy demands that are *cost effective*. So far, the alternative to fossil fuels has been around renewable energy sources, which are expected to play an increasingly vital role in the mix of power generation over the next century. The demands on these alternative energy sources are inordinate – they will need to not only keep up with the increasing population growth, but needs to go beyond these demands by contributing to the replacement of fossil fuel energy production in order to meet future energy needs and consider the natural environment.

However, the argument from governments, oil, coal and natural gas companies is that until renewable energy sources become more viable as major energy providers, the only alternative in meeting the increasing demands for energy from a growing global population that requires more and more energy, is to continue to extract fossil fuel reserves.

# The Debate

## AGREE 1:

**Switching to renewable energy is not as simple as it is being made out to be. Quite the opposite.**

"*It is commonly assumed that greenhouse gas and energy problems can be solved by switching from fossil fuel sources of energy to renewables. However, little attention has been given to exploring the limits to renewable energy. Unfortunately, people working on renewable energy technologies tend not to throw critical light on the difficulties and limits. They typically make enthusiastic claims regarding the potential of their specific technologies.*" (Alex Epstein)

## DISAGREE 1:

**Leaving fossil fuels in the ground is good for everyone**

"*To deliver a 50% probability (which is not exactly reassuring) of no more than 2C of warming this century, the world would have to leave two-thirds of its fossil fuel reserves unexploited. I should point out that reserves are just a small fraction of resources (which means all the minerals in the Earth's crust). The reserve is that proportion of a mineral resource which has been discovered, quantified and is viable to exploit in current conditions: in other words that's good to go.... a third of the world's oil reserves, half its gas reserves and 80% of its coal reserves must be left untouched to avert extremely*

The idea of drawing our energy from sources that are renewable, independent of foreign nations, and do not emit greenhouse gases has powerful appeal. But capturing these resources is expensive, and many are intermittent, which complicates using them on a large scale. Furthermore, it takes time and money to change distribution and consumption of energy, meaning we will be dependent on fossil fuels until we can afford this switch. Finally, bringing new renewable energy technologies to market causes problems both in regard to cost and convenience, meaning a switch from fossil fuels to renewable energy is not a simple task.

*"It would be difficult to find a more taken for granted, unquestioned assumption than that it will be possible to substitute renewable energy sources for fossil fuels, while consumer-capitalist society continues on its merry pursuit of limitless affluence and growth. There is a strong case that this assumption is seriously mistaken."* (Ted Trainer)

*dangerous levels of global warming. 2C is dangerous enough; at present we are on course for around 5C by the time the century ends, with no obvious end in sight beyond 2100."* (George Monbiot, The Guardian, 2015)

*"The major thrust of climate-change claims is that man is destroying the planet. There is much evidence to show that we are the greatest burden that Earth has to bear. To simply rape the earth of all its fossil-fuels would be gross folly."* (Dr. Peter Langdon)

Fossil fuels are not renewable, they can't be made again. Once they are gone, they're gone.

For more on this see renewable energy vs fossil fuels by Energy Quest (USA).

## AGREE 2:

**Renewables cannot provide the required amount of energy to supply demand (Intermittency)**

Solar and wind technology, after 50 years of subsidies, produces less than 1 percent of the world's energy—and, because the sun and wind provide only intermittent energy, continue to require fossil fuel backups.

## DISAGREE 2:

**Renewable energy can meet energy needs in a safe and reliable way**

*"...The key is to have a mix of sources spread over a wide area: solar and wind power, biogas, biomass and geothermal sources. In the future, ocean energy can contribute. Intelligent technologies can track and manage energy use patterns, provide*

The issue of intermittency from solar and wind means that is difficult to get reliable power from either as it is weather dependent – which, particularly in Ireland is unpredictable. This creates a need for energy storage (which is currently not efficient enough to be cost effective) or needs traditional fossil fuels or nuclear power to supplement.

"*As you look at the jagged and woefully insufficient bursts of electricity from solar and wind, remember this: some reliable source of energy needed to do the heavy lifting. In the case of Germany, much of that energy is coal. As Germany has paid tens of billions of dollars to subsidize solar panels and windmills, fossil fuel capacity, especially coal, has not been shut down—it has increased. Why? Because Germans need more energy, and they cannot rely on the renewables.*" (Alex Epstein)

"*It is concluded that although the foregoing figures are not precise or confident, their magnitudes indicate that it will not be possible to meet a 1000 EJ/yr energy target for 2050 from alternative energy sources, within safe greenhouse gas emission levels... . Such a goal could not be achieved without radical change in social, economic, political and cultural systems.*" (Ted Trainer)

Much of the debate around renewables is in reference to the 'present' energy demands, where the anticipated demand for energy in the future is expected to double by 2050. "The crucial question is can renewables meet the future demand for energy in a society that is *flexible power that follows demand through the day, use better storage options and group producers together to form virtual power plants. With all these solutions we can secure the renewable energy future needed. We just need smart grids to put it all together and effectively 'keep the lights on'*". (Greenpeace.org 2014)

"*There's no shortage of renewable energy from the sun, wind and water and even stuff usually thought of as garbage — dead trees, tree branches, yard clippings, left-over crops, sawdust, even livestock manure, can produce electricity and fuels — resources collectively called 'biomass'... The sunlight ... in one day contains more than twice the energy we consume in an entire year. ... Clean energy sources can be harnessed to produce electricity, process heat, fuel and valuable chemicals with less impact on the environment.*" (California Energy Commission 2006)

Continued research has made renewable energy more affordable today than 25 years ago. The cost of wind energy has declined from 40 cents per kilowatt-hour to less than 5 cents. The cost of electricity from the sun, through photovoltaics (literally meaning "light-electricity") has dropped from more than $1/kilowatt-hour in 1980 to nearly 20cents/kilowatt-hour today. And ethanol fuel costs have plummeted from $4 per gallon in the early 1980s to $1.20 today.

The amount of energy used in Irish homes has decreased by 32 per cent since 1990 despite a 50 per cent increase in the average floor area

fiercely and blindly committed to limitless increases in "living standards" and economic output. The absurdity of this commitment is easily shown. If 9 billion people were to rise to the "living standards" we in rich countries will have in 2070 given 3% p.a. economic growth, then total world economic output would be 60 times as great as it is now! It is concluded that the investment cost that would be involved in deriving total world energy supply from renewable sources would be unaffordable. Full dependence on renewable energy can only be done if we move to lifestyles and systems that require only a small fraction of the present rich world per capita energy consumption.
Renewables could provide around of 25% of energy needs in some countries, but much of the generating capacity would have to be duplicated in the form of fossil or nuclear plant for use when there is little sun or wind; and the amount of coal use that will continue to be required would continue to exceed safe greenhouse gas emission limits."
For more on this see Ted Trainer, The Simpler Way

As discussed above, Renewable Energies have limitations, but these are varied based on the type of renewable energy being discussed. Here are the specific limitations of each

**Solar Power:**

– Photovoltaic solar electricity (or PV) is intermittent. Its potential contribution to providing widespread renewable energy is limited without the capacity for very large-scale storage. Even if it became cheaper than of residential properties. Renewable energy last year accounted for 21% of the amount used in the electricity sector, 5.7% of the amount used for heat and 4.9 per cent of that used in transport.

By 2050 almost all of global energy needs can be met with renewable energy share: 41 percent by 2030 and 82 percent by 2050. That would be the global electricity supply-energy used in buildings and industry, would come from renewable energy sources. The transport sector, in particular aviation and shipping, would be the last sector to become fossil fuel free.

Already many countries throughout the world are committing to a future that will be powered by renewables. For example:

– **Germany**, currently generates 25 percent of its electricity from renewables and is aiming for 80 percent by 2050
– **Spain's** top source of electricity in 2013 was wind power, ahead of nuclear, coal and gas. Renewables supplied 42 percent of mainland Spain's electricity in the same year
– In 2012 **China's** wind power generation increased more than generation from coal
– The **Philippines** produces 29 percent of its electricity with renewables, targeting 40 percent by 2020
– **Denmark** is aiming to produce 100 percent of its heat and power with renewable energy by 2035 and all energy by 2050.
– Emerging economies like **South Africa, China and Brazil** are setting the pace for renewable energies. Investments in renewables from these economies was US$112

fossil fuels, its major limitation is that it can't power anything for about 16 hours a day, or in the case of consecutive cloudy days. It can feed surpluses from house roofs etc., into a grid running on coal (although this is expensive), while drawing power from that grid at night. But this only works when a lot of coal or nuclear power plants are running all the time to act as a giant "battery" into which PV can send surpluses.

– Solar thermal plants – need to be located in the Sahara region. While they can store energy as heat to generate and transmit electricity when it is needed, their biggest limitation is the significant transmission losses and the magnitude of the potential of this type of renewable energy is uncertain, and especially doubtful in winter, where output is generally about 20% of summer output. This means that solar thermal systems will need to be located in the world's hottest regions, and will need to supply major demand centres by long transmission lines, and will not be able to make a large contribution in winter.

**Biomass:**

– For very large scale biomass production, each person in the world would need about 2.6 hectares of land growing only biomass to provide for their liquid and gas consumption (in the form of ethanol net, not primary energy amount.) To provide the anticipated 9 billion people on earth by 2060 we would need 24 billion hectares of biomass plantations. The world's total land area is 13 billion hectares, and the total forest, cropland

billion in 2012, which is close to the US$132 billion that developed countries invested.

Emerging economies do not need to go down a path of relying on fossil fuels. Just as many developing countries skipped land lines and went straight to cellular telephones, these countries can leapfrog right to affordable clean energy. Many have already taken advantage of the benefits of renewable energy and recognised the long-term benefits. For example, in Uganda less than 15% of a total population of 38 million people, have access to electricity. The majority of the population is dependent on kerosene or charcoal for their energy and light, both of which are expensive and environmentally damaging. Yet, the population is embracing the potential for clean energy alternatives being promoted within the country.

Intermittency is an issue **at the moment** as the technology is expanding, but it can be managed by thinking about the overall energy system. Over reliance on one renewable technology could result both in massive variability in output over short time periods and in severe risk of big gaps in generation.

The way round this is:

a) a dispersed portfolio of generation connected by a wide grid and
b) clean gas on standby

"*Yes, backup generation ups the overall price, but it's cheaper than having half the planet die of climate-induced starvation*" (Quora.com)

and pasture adds to only about 8 billion hectares, just about all heavily overused already. If we vary the above assumptions there is no possibility of explaining how all people could ever have something like the present rich world liquid fuel consumption from biomass.

For more on this point see The climate change deniers guide to getting rich from fossil fuel divestment, The Guardian (April 2015)

## AGREE 3:

**Renewable energy is not cost effective**

*Renewable energies in their current supply are either not cost effective without heavy government subsidies, use tremendous amounts of land, or they harm the environment in some way. (Quora.com)*

Calculating the cost of electricity from renewable energy sources is quite difficult. It depends on the fuel used, the cost of capital (power plants take years to build and last for decades), how much of the time a plant operates, and whether it generates power at times of peak demand. In measuring the costs economists use "levelised costs"(the net present value of all costs – capital and operating – of a generating unit over its life cycle, divided by the number of megawatt-hours of electricity it is expected to supply). What levelised costing doesn't take into account is the issue of **intermittency** – wind power isn't generated on a calm day, or solar

## DISAGREE 3:

**Fossil Fuel energy costs do not factor in all the 'hidden' costs**

*"Investing in clean energy is not only good for the economic growth, it is good for people. The unfortunate reality is that those in the poorest countries are often the most vulnerable to climate change — whether from rising seas that threaten homes and water supplies or droughts that drive up food prices. This is the human cost of fossil fuels that often goes unmentioned in balance sheets and gross domestic product statistics."*

If the full cost of fossil fuel generation (including climate impact) were included then the costs would be comparable.

*"Typically, the ones who claim that wind and solar will bring trouble to the grid are the old players, who failed to take renewable energy seriously and over-invested in fossil fuel capacities instead. Renewable energy is now*

power at night, resulting in the need for conventional power plants to be kept on standby.

Electricity demand varies during the day in ways that the supply from wind and solar generation may not match, so even if renewable forms of energy have the same levelised cost as conventional ones, the value of the power they produce may be lower.

Another way to measure the costs is through a 'cost-benefit analysis' which looks at the benefits of renewable energy including the value of the fuel that would have been used if coal or gas-fired plants had produced the same amount of electricity and the amount of carbon-dioxide emissions that they avoid. According to this calculation, wind and solar power appear to be far more expensive than if calculated on the basis of levelised costs.

To determine the overall cost or benefit, the cost of the fossil-fuel plants that need to continue to be on stand-by for the intermittency problem, needs to be factored in. For example, solar farms run at only about 15% of capacity, so they can replace even less. Seven solar plants or four wind farms would be needed to produce the same amount of electricity over time as a similar-sized coal-fired plant. And all that extra solar and wind capacity is expensive.

In Europe, rather than seeking to increase the availability of low cost electricity, governments enforce scarcity by manipulating the factors influencing electricity prices such as "*regulatory eating their profits and making their old business models out-of-date" (Greenpeace.de)*

*"Those who argue that wind is expensive and unnecessary are quite simply wrong. Because Ireland has such a good wind energy resource, we can get cheap clean electricity from it. Making comparisons with other countries about wind effectiveness is not always valid. Ireland has a uniquely strong resource. We have one of the lowest support regimes and wind is not raising electricity prices."*(Sustainable Energy Authority of Ireland 2014)

Ireland is highly dependent on imported fossil fuels – for 89 per cent of its energy, spending €6.5 billion per year on imports – just over half of this on transport. In the past five years renewable energy has saved over €1 billion in fossil fuel imports; has reduced $CO_2$ emissions by 12 million tonnes and has not added to consumers' bills. The potential for wind and other provides the opportunity for greater energy independence, reducing carbon footprint, national competiveness leading to greater control over energy prices.

Growing our use of renewable energy is also vital for our national competitiveness, giving us greater control over our energy prices. *"Less reliance on fossil fuels gives us greater certainty on our energy prices, rather than leaving us at the mercy of international commodity price rises. It also helps attract foreign investment, as more global companies seek access to clean energy as part of their location decisions."* (SEAI 2014)

*structures—including taxes and other user fees, investment in renewable energy technologies, and the mix and cost of fuels.*"

In the EU governments interfere with electricity markets, and enforce the use of inferior electricity sources such as wind and solar, resulting in subsidies, taxes, feed-in tariffs, materials and labour, forcing the consumer to pay the ultimate costs. Rather than seeking to increase the availability of low cost electricity, governments enforce scarcity by manipulating the factors influencing electricity prices such as regulatory structures—including taxes and other user fees, investment in renewable energy technologies, and the mix and cost of fuels. In Germany for example, "*taxes and levies account for about half of retail electricity prices, [and] transmission system operators charge residential consumers a renewable energy levy that is used to subsidise certain renewable generation facilities.*" (Alex Epstein) This is in addition to policies which penalise coal and nuclear electricity generators.

The costs of some renewable energy inputs such as Photovoltaic solar panels have halved in price since 2008 and the capital cost of a solar-power plant—of which panels account for slightly under half—fell by 22 percent between 2010 and 2013. In a few sunny places, solar power is providing electricity to the grid as cheaply as conventional coal- or gas-fired power plants.

As the large utilities' fossil and nuclear plants become more expensive and alternatives become cheaper, savvy consumers are looking to decrease their dependence on the utilities' power supply. To cope, the utilities are trying to decouple their increasing costs from the amount of electricity they sell, further increasing the cost advantages of renewables and other alternatives. Renewables, with zero-marginal-costs, helped push down wholesale prices to 8-year lows in 2013.

Most sources of electricity, including coal, natural gas, and nuclear are and have historically been subsidized with both *implicit* and *explicit* subsidies, including the same types of tax credits afforded to wind and solar. For example:

*Explicit* subsidies: Nuclear receives a Production Tax Credit, similar to Wind. Natural Gas gets access to the Oil and Gas Exploration & Development Expensing subsidy.

*Implicit* subsidies through the tax payer for example in the US, subsidises cover the costs of catastrophic insurance for nuclear plants, because there is no way their owners could

afford to clean up after a Fukushima-style disaster. And, of course, the ultimate *implicit* subsidy – the cost of environmental damage due to pollution and CO2 production, for which we all pay and will continue to pay for generations.

Also hidden costs such as bonus payouts to CEOs of the top 5 oil companies estimated at US$1tn (£650bn or €888bn) for fossil fuel exploration and extraction over nine years, reflecting the confidence of top oil companies that demand will remain high for decades to come.

The combined 2014 upstream (Upstream operations deal primarily with the exploration stages of the oil and gas industry, with upstream firms taking the first steps to first locate, test and drill for oil and gas. Later, once reserves are proven, upstream firms will extract any oil and gas from the reserve) capital spending bill for the big five is three and a half times the sum devoted to research and development by the world's five biggest-spending drug firms. It is also equivalent to more than 14% of the combined stock market value of Exxon Mobil, Shell, Chevron, Total and BP.

Currently, renewables are more expensive than fossil fuels. BUT, this is changing rapidly. There are various types of renewables – onshore wind is the most cost competitive and offshore wind is heading that way but will likely remain more expensive; the large scale solar power costs are rapidly reducing, hydro power – marine, tidal stream, dams, run-of-river – are currently more expensive but some

large-scale projects such as the Severn Barrage in the UK are competitive.

Given the interest in the private sector for renewable energy – it must be big business, with giants like Wal-Mart, Google and General Electric that have been increasing in clean energy investments. Billionaire Warrant Buffett recently spent US$5.6 billion for a renewable energy company in Nevada and a US$2.4 billion investment in a wind farm in California. Many oil companies are involved in the development of more reliable renewable energy technologies. Already for example, BP has become one of the world's leading providers of solar energy through its BP Solar division. Dong Energy and EDP have built up balanced energy portfolios which include higher shares of renewables. Their renewable assets are making more profits than their thermal ones.

Fossil fuel companies are benefitting from global subsidies of US$5.3tn (£3.4tn) a year, equivalent to US$10m a minute every day. This subsidy estimated for 2015 is greater than the total health spending of all the world's governments and 6.5% of global GDP. The vast sum is largely due to polluters not paying the costs imposed on governments by the burning of coal, oil and gas. These include the harm caused to local populations by air pollution as well as to people across the globe affected by the floods, droughts and storms being driven by climate change.

"*This very important analysis shatters the myth that fossil fuels are cheap by showing just how huge their real costs are. There is no*

*justification for these enormous subsidies for fossil fuels, which distort markets and damages economies, particularly in poorer countries... A more complete estimate of the costs due to climate change would show the implicit subsidies for fossil fuels are much bigger even than this report suggests.*" (IMF 2015)

The need for subsidies for renewable energy –$120bn a year – would disappear if fossil fuel prices reflected the full cost of their impacts.

## AGREE 4:

**Renewable energy utilises too much land, meaning problems in scalability and storage.**

A problem with solar and wind energy is the sheer scale of land that is required to obtain as much energy as even a small coal fire power plant can produce. Storing renewable energy more effectively and inexpensive energy from wind or solar could become much more viable than they are currently. However right now, no cost effective forms of energy storage exist, and are not foreseen.

The area of productive land required to provide for one Australian is over 7 hectares per person. The US figure is closer to 12 hectares. However, the amount of productive land per person on the planet is about 1.3 hectares and by the time we reach 9 billion it will be close to 0.8 hectares. In other words

## DISAGREE 4:

**Many renewable technologies are scalable, and perceived problems regarding land, noise and animal welfare can be overcome.**

Many renewable technologies are very scalable. The much hyped DeserTec project pointed to a new model for electricity generation for Europe with massive PV arrays in North Africa. Difficult, expensive... but do-able.

All of the scalability problems are surmountable. Doing so requires a new, far more complex, energy system with new technologies and new policy tools.

"*The really fun bit will come when electric vehicles and demand-side-management become a mainstream reality. Finally, we would have the beginnings of a sustainable energy system.*"

Australians have a footprint about 10 times greater than all could share.

*"Renewables are so much less energy dense than conventional generation, meaning so much more land is required. The British economist David McKay estimated that to meet the UK's electricity needs from offshore wind would require 44,000 3MW turbines in a 4km wide band around the entire 3,000km coastline of the country. And if the wind stops, well..."* (Ted Trainer)

The best option is to use electricity to pump water up into dams, then generate with this later. This works well, but the capacity is very limited. World hydro generating capacity is about 7 – 10% of electricity demand, so there would often be times when it could not come anywhere near topping up supply. Hydroelectric power is cost effective and does not suffer from intermittency, but have been linked to impacting on the ecosystems in which they are installed and affecting settlements and livelihoods.

Very large scale production of renewable energy, especially via solar thermal and PV farms located at the most favourable regions, will involve long distance transmission. European supply from solar thermal fields will probably have to be via several thousand kilometre long HVDC (high-voltage, direct current) lines from North Africa and the Middle East. Expected power losses from long distance plus local distribution are predicted to be around 15 percent. This makes it different than coal, natural gas, and nuclear, and in some senses

**Land use**: The land used for renewable energy projects, like wind farms, can still be used for farming and cattle grazing. International experience has shown that livestock are completely unaffected by the presence of wind farms and will often graze right up to the base of wind turbines.

**Noise**: Studies have shown that noise complaints, especially those related to wind farms, are often unrelated to actual noise. In most cases it was found that people were actually opposed to the farms on aesthetic grounds – which would be the same with coal or nuclear plants. It was also found that 'noise' complaints dropped off rapidly when local communities derived income from the renewable energy projects in question.

**Birds and bats**: A common argument against wind farms is that they kill birds and bats. However, if environmental impact assessments are conducted and migratory and local bird population patterns are assessed before construction, this is avoided completely. It is vital that these assessments are made to ensure the safety of birds and bats, as with any development project

worse. It means that it can't supply 100 percent of our needs, and intermittency needs to be factored into any electricity system design. An intelligently designed energy system using very basic "smart grid" technology could support easily up to 25 percent production from intermittent renewables without significant strain on resources.

## AGREE 5:

**Demand is increasing globally**

The total world energy demand is for about 400 *quad*rillion British Thermal Units (BTUs) annually. One 'BTU' is about the energy and heat generated by a match. Oil, coal and natural gas supply about 350 quadrillion BTUs. Oil provides most of this, around 41 percent of the world's total energy supplies (164 quadrillion BTUs). Coal provides 24 percent (96 quadrillion BTUs), and natural gas provides the remaining 22 percent (88 quadrillion BTUs).

By the year 2020, world energy consumption is projected to increase by around 50 percent – an additional 207 quadrillion BTUs. As outlined in previous points, renewable energies would not be able to meet this increasing demand.

## DISAGREE 5:

**Demand is decreasing in significant parts of the world, for example the European Union**

Total and peak electricity demand in the European Union started to slow in the 1990s, and have been falling since 2007 (with the exception of in 2009). Total demand in the EU-27 fell by around 2.5% from 2007 to 2012. Demand also fell in several large national markets: by 7.5% in the UK, 4.3% in Italy, 3.4% in Spain and 3.2% in Germany. In the first 11 months of 2013, demand fell by a further 2.6% in Spain and 3.5% in Italy (where Enel, the country's major electricity producer, reported an even larger drop in its nine-month report); in the first nine months of 2013, demand in Germany fell by1.1 percent.

Europe today has about twice as much installed generation capacity as peak demand would warrant.

## Finally...:

The Clean Air Act of the late 1950s means that today a building stays the same colour as when new. The catalytic converter means that vehicles are cleaner than even thought possible 25 years ago. It prevents sulphurs entering the atmosphere and turns unburnt or half-burnt carbons into CO2. Why? Because CO2 is harmless. More CO2 provides more plant food and is, in effect, greening the planet.

New cars require only half the engine size to produce the same power and twice the mileage. Electric generators that 25 years ago were around 30 per cent efficient are now around 70 per cent efficient. Yet the 'greens' would have us adopt wind generation, solar power or electric cars, none of which can ever approach the efficiency of boiling water to achieve a 600 times expansion and thus power the world as economically as is possible to date. Green policies cause more damage.

In conclusion, it is our responsibility to advance alternative power. However, we should remember that low-cost electricity generation is crucial to the economy. It increases income and employment in all sectors, the purchasing power of the consumer, and makes exports more competitive. Renewable energy certainly can supplement conventional power, and its use will likely continue to steadily grow. Nevertheless, realistically speaking, it can't

## Finally...:

*"Eventually, the degree to which we depend on fossil fuels will have to lessen as the planet's known supplies diminish, the difficulty and cost of tapping remaining reserves increases, and the effect of their continued use on our planet grows more dire. But shifting to new energy sources will take time which we don't have"* (NowIreland)

"The number one way to cut emissions quickly and get back to 350ppm is to stop burning dirty coal as soon as possible. Without coal, we must find a way to make cheap, renewable energy widely available in order to ensure all communities the right to develop cleanly." (350.org 2013)

If we contemplate the finite dimension of our earth and our (over)consumption of our natural environment, the reality of extinction spreads beyond fossil fuels:

**Soil quality**–erosion of topsoil, depleted minerals, added salt

**Fresh water**–depletion of aquifers that only replenish over thousands of years

**Deforestation**–cutting down trees faster than they can regrow

**Ore quality**–depletion of high quality ores, leaving only low quality ores

**Extinction of other species**–as we build more structures and disturb more land, we remove habitat that other species use, or pollute it

entirely replace non-renewable fuels anytime soon.

**Pollution**–many types: CO2, heavy metals, noise, smog, fine particles, radiation, etc.

Arable land per person, as population continues to rise. In light of these 'costs' of fossil fuels, renewable energy is a solid alternative to meet the energy demands of our world.

Photo: Alternative energies by Guerito (2005) CC-BY-NC Via Flickr

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More about our work and the non-profit website consortium

# 6 – Large Corporations Are Driving America's Renewable Energy Boom. And They're Just Getting Started – Greentech Media


MARKETS & POLICY

# Large Corporations Are Driving America's Renewable Energy Boom. And They're Just Getting Started

"But there's still a lot more work to do."

Photo Credit: Julia Pyper

by Julia Pyper (https://www.greentechmedia.com/authors/Julia+Pyper)
January 10, 2017

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Large corporations aren't typically thought of as environmental champions. But these companies now stand to be one of the most powerful advocates for clean energy in the U.S. -- both in Washington, D.C. and in states across the country.

A December report (http://info.aee.net/growth-in-corporate-advanced-energy-demand-market-benefits-report) by Advanced Energy Economy (AEE) found that 71 of the Fortune 100 companies currently have renewable energy or sustainability targets, up from 60 companies just two years ago. Commitments among Fortune 500 companies have held steady over the past two years at 43 percent, or 215 firms.

Of the Fortune 500 companies, AEE reports that 22 have committed to powering all of their operations with renewable energy, including Wal-Mart and General Motors -- the CEOs of which have been selected to join President-elect Donald Trump's business advisory council. A total of 83 companies from around the world have now committed to going 100 percent renewable through the RE100 initiative (http://there100.org/companies). Google announced in December that it will meet its renewable energy target (http://https://www.greentechmedia.com/articles/read/google-will-achieve-100-percent-renewable-energy-in-2017) in 2017.

"We're really encouraged by all the progress that we've made [on renewable energy procurement], but there's a lot of work to do," said Michael Terrell, energy policy lead at Google, in an interview during GreenBiz's Verge conference last fall. "We need to meet the growing needs of our business and our industry, and also help grow the space more generally."

Sustainability targets are good news for states. "Companies are deploying their private capital to finance projects that will bring in new jobs and tax revenue while improving the resource diversity of the grid and in some cases decreasing reliance on imported electricity," according to the AEE paper. "But in many states, there are not clear mechanisms for companies to fulfill their commitment to procure advanced energy."

In a changing political landscape -- with a new Republican administration and Congress that's hostile to climate action (http://www.eenews.net/climatewire/2016/12/09/stories/1060046920) -- corporations stand to play a leading role in advocating for low-carbon energy resources at the national level. Trump recently met with leaders at Apple, Facebook and Google, all of which have set a 100 percent renewable energy target. Trump is also being advised by solar and electric-vehicle champion Elon Musk (https://www.greentechmedia.com/articles/read/will-elon-musk-be-the-champion-cleantech-needs-at-the-white-house), and has spoken with Bill Gates, the co-founder of Microsoft, who recently launched a $1 billion cleantech and climate action fund.

"Sustained and vocal advocacy by corporations that recognize the ecological and economic imperative of an aggressive transition to renewable sources of electricity has never been more important in the United States given the election of Donald Trump, who has promised to roll back climate policies and revive the use of coal," said Gary Cook, senior analyst at Greenpeace, which released a report (http://greenpeace.pr-optout.com/Tracking.aspx?Data=HHL%3d8%2c4898-%3eLCE5946%2f9%26SDG%3c90%3a.&RE=MC&RI=4691280&Preview=False&DistributionActionID=15313&Action=Follow+Link) today on internet brands leading the renewable energy transition.

But while there's a lot of focus on the federal government with Trump taking office, much of the real work in rolling out renewable energy projects in the U.S. takes place at the state level. Progressive companies will be instrumental in helping pioneer state policies to help meet their clean energy procurement targets, and set the stage for other companies to follow suit.

"Corporations have already been a big part of the staggering growth we've seen in renewables over the past few years. In 2015, corporations purchased over 3 gigawatts of large-scale offsite renewable energy," Patrick Flynn, director of sustainability at Salesforce, wrote in an email.

"The problem is that that growth is driven by a handful of large, experienced corporations," he said. "The biggest thing the sector can do to turn that 3 gigawatts into the 60 gigawatts we need to help prevent a global-average temperature rise of 2 degrees (let alone 1.5 degrees) is to lower barriers to entry."

## Early movers aren't enough

Executing corporate renewable energy deals is not easy. Several pioneering companies have made meaningful wind and solar purchases in recent years, but as the number of companies looking to procure clean energy increases, "so too will the urgency to develop clear and replicable pathways for companies to follow through on these commitments across all 50 states," according to the AEE paper.

How easy or hard it is for companies to reach their goals often comes down to policy. While there are still challenges in getting CEOs on board with clean energy investments in the first place, the conversation has evolved to how leading companies can make renewable energy procurement easier for those further down the Fortune 500 list -- or off of the list entirely -- by actively steering policy discussions.

The corporate renewable energy market hardly existed just a few years ago, said Google's Terrell, during last fall's interview. In 2012, there were 100 megawatts of corporate power-purchase agreements, he said. In 2015, there were 3.2 gigawatts -- which represented 21 percent of the 16.4 gigawatts of renewables added to the grid that year. Deployment numbers for 2016 are expected to be even higher.

Companies like Google buy clean energy to meet their sustainability goals, but also to have control of their energy usage, as well as price assurance and the ability to save on their energy bills. But for Terrell, the story isn't just about his company's ability to buy renewables, it's about how to expand the renewable energy market to an increasing number of players -- beyond the leaders that have moved the market forward to date. Opening up traditionally regulated utility markets is a major part of that.

"At Google, I'm proud that we were one of the early movers in this space and really helped to start the market and helped to grow the market," he said. "We're the largest corporate renewable energy purchaser in the world; but if you dig deep, you'll see that there's still an enormous amount of work that needs to be done and it's really only happening in certain areas."

"If you look at the stats on the deals, 91 percent of the deals over the past couple of years have happened in markets that have a deregulated wholesale market and an RTO, and only 9 percent of the deals are happening in traditionally regulated utility markets," Terrell said. "I think that shows that we have a long way to go to provide access to renewables in those markets; and if we can find ways to do that, this market can grow that much more."

Corporations are already taking action. Dozens of companies have joined Rocky Mountain Institute's Business Renewables Center (http://www.businessrenewables.org/), and signed on to the Corporate Renewable Energy Buyers' Principles (http://http://buyersprinciples.org/) -- a combined effort by RMI, the World Wildlife Fund (WWF) and the World Resources Institute (WRI). Utilities are also taking a more active role. In June, Edison Electric Institute, the nation's leading trade association for investor-owned utilities, released a report (http://buyersprinciples.org/resource/utility-buyer-dialogue-insights/) on creating renewable energy opportunities for companies in cooperation with WWF and WRI.

"As large corporate buyers invest in fulfilling their corporate renewable energy goals, state policy and utility planning must also evolve to take advantage of this trend, rather than be challenged by it," according to a report (http://www.ourenergypolicy.org/wp-content/uploads/2016/12/CNEE_Corporate-Procurement.pdf) published in December by the Center for the New Energy Economy. The paper lays out three pathways for factoring corporate renewable energy goals into state energy planning.

A separate report released today by the Retail Industry Leaders Association and the Information Technology Industry Council, ranked all 50 states based on the ease with which companies can procure renewable energy for their operations. Iowa, Illinois, New Jersey, California and Texas were found to be the top five states for clean energy procurement overall. Iowa leads the index ranking primarily because of the opportunity to procure renewable energy through utilities in the state -- which has emerged as a preferred route for many corporate customers.

## How to buy renewable energy

There are several ways in which companies can procure clean energy. One option is to contract with a third party to build a distributed renewable energy project onsite at the customer's premises.

Kaiser Permanente, for instance, is installing 70 megawatts of solar at 85 hospitals in partnership with NRG Energy. Speaking at GreenBiz's Verge conference last fall, Kaiser's Rame Hemstreet said behind-the-meter deals are attractive because they can also reduce a company's transmission and

distribution costs. MGM Resorts has also worked with NRG to build onsite renewable energy projects (pictured above). The drawback is that onsite projects are usually limited in size due to space constraints.

Another option is for companies to purchase a portion of a renewable energy project. Shared or community renewable energy is a subscription-based model that allows multiple customers to share the output of a single nearby offsite project. Puget Sound Energy (http://buyersprinciples.org/wp-content/uploads/Emerging-Green-Tariffs-September-16-Washington-PSE.pdf), for instance, recently won approval to offer this type of program to business customers in its territory starting on January 1, 2017.

Power-purchase agreements are yet another way for companies to procure renewable energy from offsite facilities, this time by contracting directly with third-party power providers. The vast majority of corporate clean energy purchases to date have been made through PPAs, but these agreements are only available in deregulated states.

Customers in regulated states can contract for clean energy through a third party using a virtual PPA (http://http://www.renewablechoice.com/blog-direct-vs-virtual-ppas/), however. In this case, the customer does not contract for power, but instead pays a fixed price for a project's renewable energy credits while the renewable energy output is delivered into wholesale markets. Salesforce, for instance, recently signed two virtual PPAs (http://http://blog.rmi.org/blog_2016_01_27_salesforce_signs_second_major_renewable_energy_deal_ for wind projects, one in Texas and one in West Virginia, for a combined output of 227,000 megawatt-hours per year, which is more than Salesforce's global electricity use in fiscal year 2015.

Virtual PPAs are not exclusive to third parties. Utilities can also make these deals, although Dominion Virginia (in crafting an 80-megawatt deal with Amazon (http://https://www.greentechmedia.com/articles/read/Amazon-and-Dominion-Power-Forge-a-New-Renewable-Energy-Path-in-Virginia)) is the only utility known to have adopted this structure to date.

"Sleeved" PPAs allow companies in regulated markets to contract with an offsite project through their utility -- where the utility shops for the project, takes the power and the passes the cost through to the customer. In these cases, the utility has to create a pathway for the renewable energy transaction through a regulator-approved green tariff program.

*Want to learn more about how deals are structured? Listen to our interview with Emily Williams, the director of energy supply for Altenex, about how the sector is evolving:*




# Various flavors of green tariffs

According to the World Resources Institute (WRI), the number of green tariff programs offered by utilities has doubled from five to 10 over the past year, in response to mounting demand from large customers. Green tariffs offer a competitive, long-term fixed price for generating and delivering renewable energy to a customer, typically bundled with renewable energy credits. The list of utilities offering such arrangements includes Xcel Energy, Rocky Mountain Power, Dominion Virginia and Public Service Company of New Mexico (http://www.bizjournals.com/albuquerque/news/2016/08/17/pnm-gets-go-ahead-on-facebook-energy-plan.html), which took this approach to supply clean energy to Facebook's new data center.

Green tariffs come in a few variations, according to WRI's Letha Tawney (http://www.wri.org/blog/2016/10/green-tariffs-take-us-expand-access-renewable-energy). Tariff programs are one option, where the standard electricity rate customers pay is replaced with the cost of the renewable energy. Riders are another option, where the cost of the renewable energy and a credit for the replaced fossil-fuel power are added on top of a customer's standard rate.

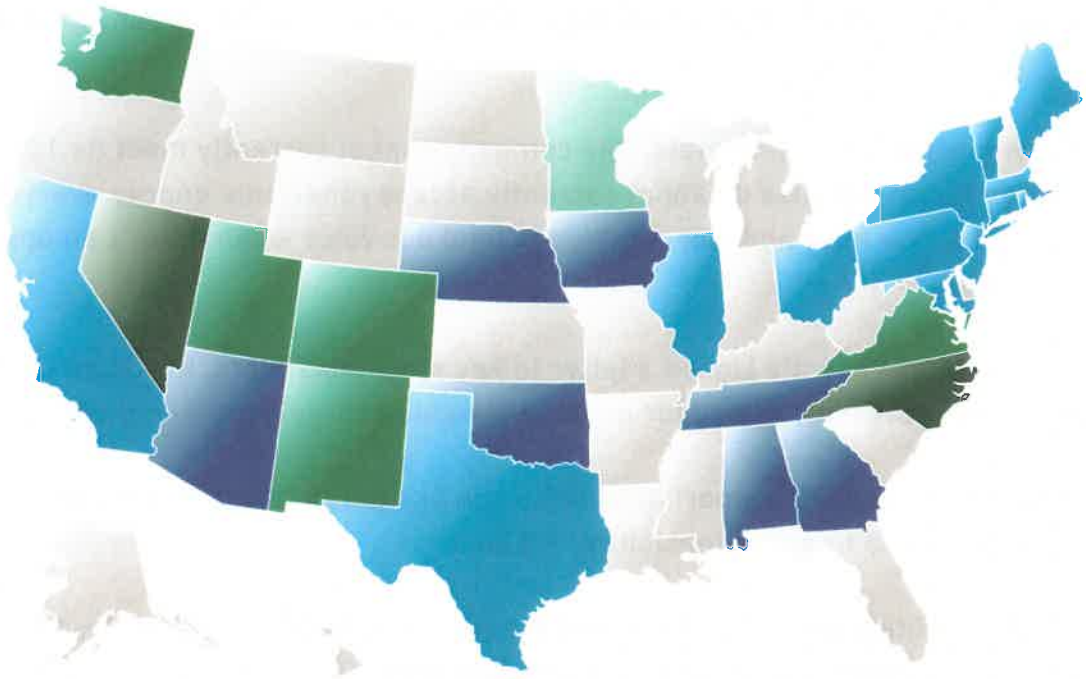
Subscriber programs, like the one offered by Puget Sound, are yet another alternative. In this case, the customer is locked into a long-term contract to purchase a small amount of renewable energy from a large renewable project at a predictable rate.

"It's complicated to get a tariff proposed and approved," said Tawney, in an interview. Large commercial customers have the pull and resources to negotiate these agreements, but not all members of RE100 or companies signed to the Buyers Principles have the bandwidth to take on a policymaking role.

In crafting a green tariff, public utility commissions are particularly interested in making sure the corporate customer is paying its fair share for the clean energy, and non-participating customers are not bearing costs they shouldn't bear. For that reason, green tariff programs vary across the country and are still relatively complex to create.

"But the upside is that once it's approved any company can use it if they fall within defined boundaries," said Tawney. In contrast, traditional PPAs with third parties have to be renegotiated for each new project.

## Where companies can buy renewable energy through the grid




*Source: WRI Corporate Renewable Strategy Map (http://buyersprinciples.org/corporate-re-strategy-map/)*

## "We recognize that utilities are the experts"

Wal-Mart, one of the largest corporate renewable energy buyers in the U.S. today, currently has 370 on-site solar projects. But given the company's ambitious 100 percent renewable energy goal, Mack Wyckoff, senior manager of renewable energy at Wal-Mart, said his team is now focusing more on expanding the offsite renewable energy portfolio.

"We believe in [green tariffs] from a market perspective," Wyckoff said at GTM's Solar Market Insight conference last fall. "A virtual PPA is a work around to get to the product we want and is a model that probably doesn't fit most corporate buyers. [...] [Smaller companies] don't necessarily have the load or creditworthiness to do those deals today. So really one thing leading corporations have to do today is leverage our load and credit into doing a utility deal so that others can come along and do this too."

Salesforce's Flynn echoed this sentiment. The company cannot currently meet its 100 percent renewable energy target because it cannot currently access renewable energy everywhere that Salesforce operates. "We have and will continue to lend our voice when there's an opportunity to change that," he said.

For instance, Salesforce recently signed a letter to key state legislators, the State Corporation Commission, and the governor, asking for more renewable energy purchasing options in Virginia.

"Whenever possible, we look to support local offerings like green tariffs that meet our criteria for environmental impact and financial feasibility," he said.

"We recognize that utilities are the experts, and it's our job to help communicate, as their customers, what we want," Flynn added. "By doing so, we can gain access to clean energy not just for us, but the communities we operate in."

But not all utility-run programs work out well.

## Green tariff gone wrong

In June, the Edison Electric Institute's (EEI) Institute for Electric Innovation released a book (http://www.edisonfoundation.net/iei/Documents/Key_Trends_Driving_Change_Volume_II_FINAL_Web.p chronicling some of the major changes in the electric industry. In one chapter, Jonathan Weisgall, vice president of government relations at Berkshire Hathaway Energy, described how one of his companies, NV Energy, successfully accommodated a large customer's request to go 100 percent renewable.

The data storage company Switch (highlighted in the new Greenpeace report (http://greenpeace.pr-optout.com/Tracking.aspx?Data=HHL%3d8%2c4898-%3eLCE5946%2f9%26SDG%3c90%3a.&RE=MC&RI=4691280&Preview=False&DistributionActionID=15313&Action=Follow+Link)) recently sought to leave NV Energy's service and obtain renewable energy from a third party, invoking a 2001 law that allows companies to buy electricity from other providers to lessen pressure on utilities during an energy crisis. There is no crisis today, but the combination of sustainability goals and dropping technology costs is pushing companies to pursue clean energy options on the competitive market.

Switch filed an application with state utility regulators to change its electricity provider in 2014, but the application was denied in 2015. NV Energy then took action, and the two parties, along with state regulators, negotiated a green rider tariff where the utility would contract for renewable energy from First Solar and Switch would pay the utility a premium for that power.

"The green energy tariff approach that NV Energy used works, and it works for all parties," Weisgall wrote in the EEI case study.

But the story doesn't end there.

In May 2016, MGM Resorts International, Nevada's largest employer, announced it was ending its energy-buying relationship (http://https://www.greentechmedia.com/articles/read/How-MGM-Prepared-Itself-to-Leave-Nevadas-Biggest-Utility) with Nevada Power, a subsidiary of NV Energy. Utility regulators approved the application, but required the hotel and casino company to pay an $87 million exit fee -- which is slightly more than MGM pays for electricity each year -- in order to leave Nevada Power's service. MGM stopped purchasing energy from the utility on October 1, and is now contracting with the independent energy company Tenaska (http://www.tenaska.com/abouttenaska/) to meet its electricity needs.

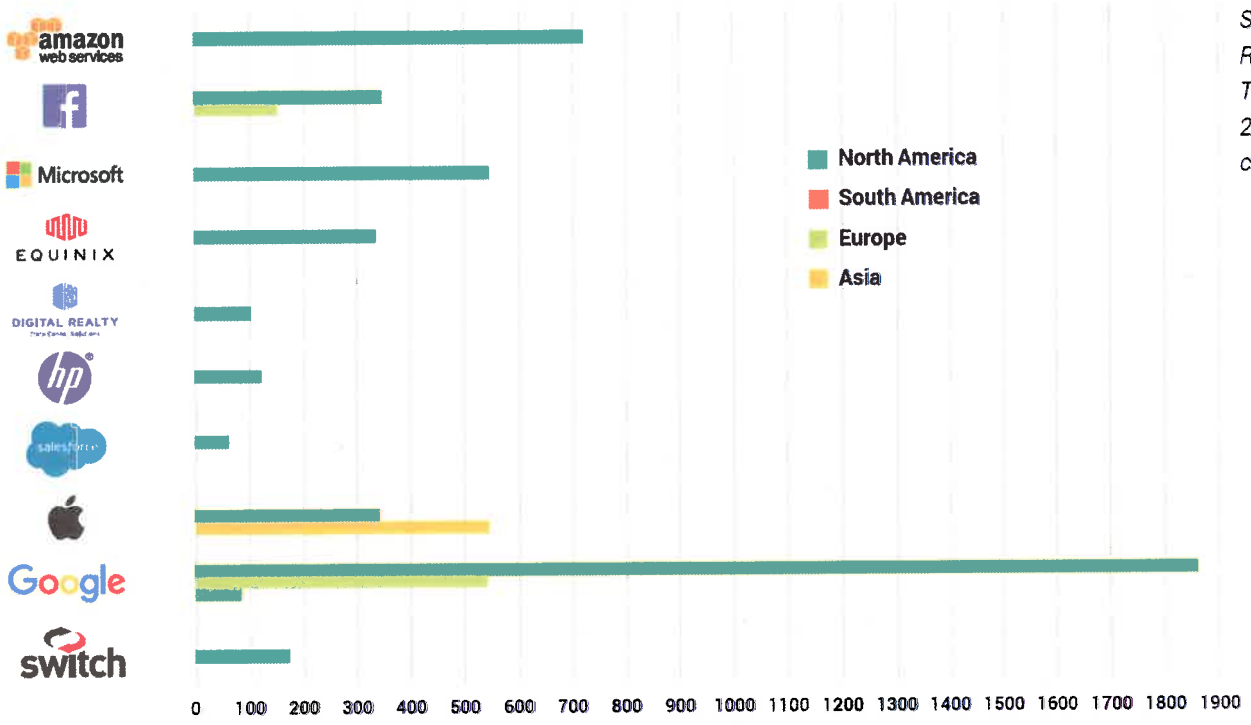
Wynn Resorts, a smaller, but sizable, hotel and casino Las Vegas, also paid a fee to leave Nevada Power and buy electricity on the free market starting October 1, 2016. In late November, Caesars Entertainment also filed to leave NV Energy. (http://www.energymanagertoday.com/caesars-files-to-cut-ties-with-nv-energy-0128777/)

As the gaming companies prepared to cut ties with the NV Energy subsidiary, the Switch deal went sour. Last July, Switch filed a lawsuit (http://lasvegassun.com/news/2016/jul/12/switch-sues-puc-nv-energy-for-30-million-in-damage/) alleging the Public Utilities Commission of Nevada did not treat the company fairly when it denied the application to leave NV Energy in 2015. The suit was launched after a PUC attorney was found to be expressing biased personal opinions (http://www.reviewjournal.com/business/energy/puc-general-counsel-out-after-tweet-under-

pseudonym) about regulatory matters on social media. Switch accuses NV Energy of deceptive trade practices, fraud and negligence among other things. The data storage company is now seeking $30 million in damages and asking again to leave NV Energy and purchase power on the open market.

While praising the Switch deal last year, Weisgall also noted that utilities, even in regulated markets, are not immune to the pressures of competition. "Our monopoly days are coming to an end," he said (https://www.greentechmedia.com/articles/read/the-electric-industry-prepares-for-a-renewable-energy-dominant-grid). "We are in a competitive market, and we have to recognize that as a utility."

## FIGURE: IT Sector Renewable Energy Contracts, 2010-2016




*Source: Click Clean Renewable Energy Tracker (January 2017) www.clickclean.org*

*Source: Clicking Clean: Who Is Winning the Race to Build a Green Internet? (http://greenpeace.pr-optout.com/Tracking.aspx?Data=HHL%3d8%2c4898-%3eLCE5946%2f9%26SDG%3c90%3a.&RE=MC&RI=4691280&Preview=False&DistributionActionID=15313&Action=Follow+Link)*

## Nevada moves to deregulate

Nevada is now on track to become a truly competitive market. In November, voters overwhelmingly approved a ballot initiative to deregulate the state's electricity market. The initiative was supported by several Nevada casinos, Switch, and Tesla, which is building an enormous, renewable-energy-powered battery factory near Reno. The proposal must also pass on the 2018 ballot and will require legislative action in order to become law, but the vote sent a strong signal that deregulation is the direction Nevada's biggest customers want to go.

Cindy Ortega, senior vice president and chief sustainability officer at MGM, said the reason her company is driving market reform comes down to "delivering value to the shareholder and corporation." It's not about environmentalism; it's about the attractive business case for clean energy and removing an intermediary from MGM's energy decisions, she said, during a talk at SXSW Eco in October. MGM is now using its experience to lead on clean energy, both inside and outside of the Silver State.

"We've learned that in the area of energy and environment, we could bring a lot of sensible policy to the state level. So it was a natural outgrowth to start working on the federal level," said Ortega, in an interview. "When a person like me or some of my colleagues at MGM go to the Hill and speak to a congressperson or a senator about the reasons for investing in energy technologies, we carry a lot of credibility, because we've invested in those ourselves at our companies."

"Nevada has the opportunity to be a platform for designing a deregulated system that can be used in other jurisdictions," she added. "And so we'll be a part of that conversation as well."

## Was 2016 a turning point?

The Switch and MGM cases in Nevada have prompted discussions around the country about how utilities and state policymakers can do a better job of serving the needs of their corporate customers. Many companies say they prefer working with their utility because they're considered a trusted energy adviser, and because it's necessary to adopt renewables at a large scale.

In October, WRI released a paper (http://www.wri.org/publication/emerging-green-tariffs-us-regulated-electricity-markets) on emerging green tariffs in regulated electricity markets. The report concluded that traditional utilities can offer renewable energy services that are as attractive as what companies can find in competitive markets or through third-party-financed deals for behind-the-meter projects. Green tariffs may also provide customers with greater flexibility and lower transaction costs, given the level of experience utilities have with integrating generation technologies and aggregating customer demand.

One way to address the issue of shifting costs to non-participating ratepayers, the paper suggests, is for utilities and regulators to "consider justifying some cost-sharing by all customers if those costs lead to system-wide benefits (for example, reduced congestion) or positive externalities (for example, reduced emissions)."

Another problem with utility deals is speed -- or lack thereof. Companies, especially internet brands like Amazon, Google and Facebook, are used to working at a fast pace. Regulated utilities move more slowly. They're built to provide reliability and low-cost energy; they're not built to come up with customized clean energy offerings. In North Carolina, for instance, it took Google three years to complete its first solar deal with Duke Energy. During that same period, the company procured more than 800 megawatts of renewable energy in other parts of the country and around the world.

But 2016 showed significant progress. A lot more green tariff programs were created, and commissioners started approving them more quickly, said Tawney. Still, a lot more work needs to be done -- on green tariffs and other policies -- in order to make corporate renewable energy purchasing mainstream.

"Right now, I think it's about breaking down some of these market barriers and really seeing what we can do to accelerate the uptake, because clearly the demand is there," said Terrell. "You're talking about some of the biggest brand names on the planet putting money and resources behind buying renewables and we need to do what we can to make sure that we can continue that progress."

*Will more corporations go out on their own to procure renewables? And what will that mean for utilities? Listen to our discussion of the consequences on the Energy Gang podcast:*

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# 7 – Global Oil Majors Are Poised for a Resurgence in Solar and Wind – Greentech Media

FOSSIL FUELS

# Global Oil Majors Are Poised for a Resurgence in Solar and Wind

Oil companies have realized that renewables aren't going away—and they want to get in on the action.

by Julia Pyper
(https://www.greentechmedia.com/authors/Jul
June 13, 2017

Wind and solar have reached a point where they're impossible for the world's largest oil and gas companies to ignore. But it's not yet clear how the majors will choose to capitalize on this growing market, having wavered on clean energy in the past.

A new report (https://www.woodmac.com/reports/upstream-oil-and-gas-could-renewables-be-the-majors-next-big-thing-46827370) from Wood Mackenzie examines the threat that renewable energy poses to legacy oil and gas operations, as well as the opportunity for wind and solar to diversify and future-proof fossil-fuel-heavy portfolios.

The global market for wind and solar is currently just 4 percent that of oil and gas; however, renewables are set to grow "much faster than oil demand," the report states. By 2035, annual revenues from wind and solar will represent one-twelfth of the revenues in oil and gas under Wood Mackenzie's base-case scenario. In a carbon-constrained scenario -- which assumes negative growth for coal and oil demand, and positive growth for natural gas and other zero-carbon fuels out to 2035 -- revenues from wind and solar would be much higher.

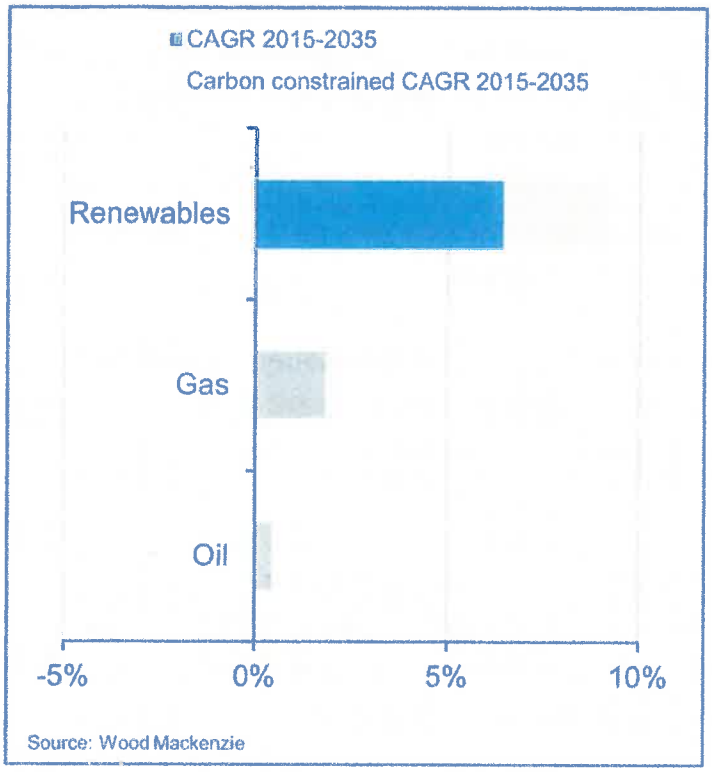
"The majors are faced with a mega trend of cost reductions and continuous growth in renewables that started slow but is gaining momentum," said Valentina Kretschmar, director of corporate research at Wood Mackenzie and co-author of the report. "It's driven by technology innovation that seems absolutely unstoppable right now, and there is a realization among the majors that it's a trend that's not going away -- and that it's a threat to their core business."

Renewables will satisfy only 1 percent of the world's energy needs this year, but even in Wood Mackenzie's base-case scenario, renewables will be the fastest-growing primary energy source worldwide over the next 20 years. The research firm projects average annual growth rates of 6 percent for wind and 11 percent for solar. By 2035, wind and solar will have captured 8 percent and 5 percent of the global power supply, respectively. The total primary energy demand for oil, meanwhile, is forecast to grow just 0.5 percent per year.

In a future with even tighter environmental regulations, Wood Mackenzie projects solar and wind will make up a 23 percent combined share of the global power market by 2035, and 6 percent of the total market for all forms of energy. In this carbon-constrained scenario -- which assumes strong adoption of electric vehicles and highly efficient gas-powered engines, in addition to renewables -- oil demand peaks before 2030 and "subsequently enters a slow decline, putting prices under pressure," the report states.

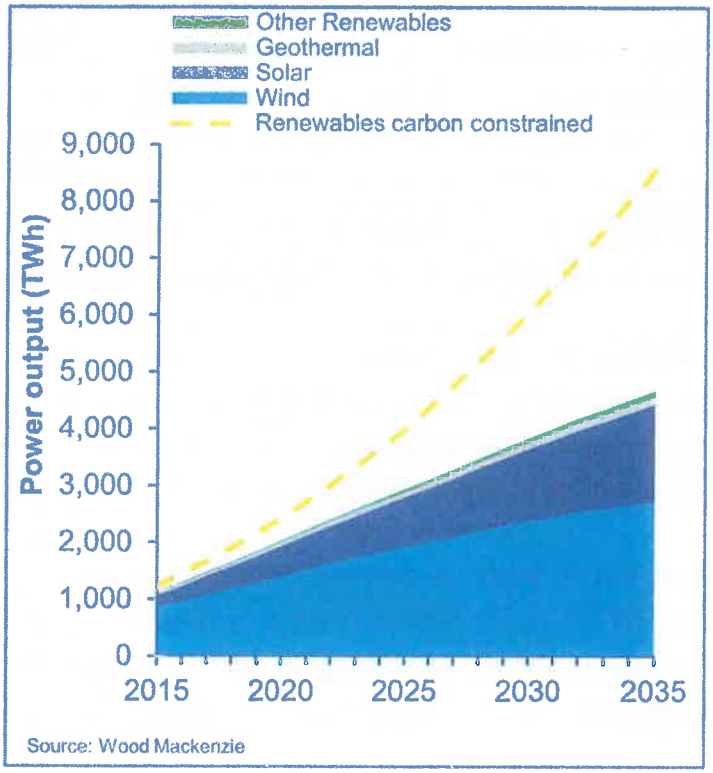
For a sense of scale, Wood Mackenzie projects overall revenues from renewables in 2035 will be nearly three times greater than those from U.S. unconventionals -- the industry's No. 1 growth segment -- under the carbon-constrained scenario. That's a market worth getting into.

**Total primary energy demand growth from 2015 to 2035**




*Carbon constrained scenario is additional growth to base case.*

**Renewables power market growth, 2015 to 2035**




*Carbon constrained scenario is total renewables generation.*

*Source: Wood Mackenzie, "Could renewables be the majors' next big thing?"*

# Not the first renewables rodeo, so what's different?

This isn't the first time big oil companies have considered the business risks and benefits of renewable energy. Over the past few decades, the majors have made meaningful investments in wind, solar and other clean energy resources. But more recently, they backed off.

British Petroleum made its first solar investment in 1981. Then in 2001, BP rebranded itself as "Beyond Petroleum" and changed its logo to a green and yellow sunburst to signify the company's embrace of renewable energy. But the new slogan didn't stick. BP quietly retired the renewables campaign and sold off its solar assets in 2011, following the Deepwater Horizon oil spill. Two years later, BP divested its U.S. wind farm division (http://http://www.ibtimes.co.uk/bp-wind-farm-shell-solar-biofuels-453083) to focus on high-yield oil and gas projects.

Chevron acquired its renewable energy arm in 2000, and went on to develop multiple large-scale solar and geothermal projects. The division was successful. Chevron Energy Solutions doubled its projected profit target in 2013, Bloomberg reports (https://www.bloomberg.com/news/articles/2014-05-29/chevron-dims-the-lights-on-renewable-energy-projects). But because these revenues were so small in the context of Chevron's total earnings, management decided to officially nix the renewables arm (https://www.bloomberg.com/news/articles/2014-09-02/chevron-makes-it-official-with-sale-of-renewable-energy-unit-to-opterra) in August 2014. Chevron said the sale was part of a "strategic focus on supporting Chevron's upstream and downstream businesses."

A few months prior to that, Chevron sold its 48-person business unit that developed renewable power plants and energy efficiency projects for U.S. federal agencies. The oil giant also cut funding (http://www.bloomberg.com/news/2013-04-18/chevron-defies-california-on-carbon-emissions.html) for biofuel projects in 2013.

Royal Dutch Shell suspended (http://www.reuters.com/article/us-shell-renewables-idUSTRE52G4SU20090317) its investments in wind, solar and hydrogen projects in 2009. "They continue to struggle to compete with the other investment opportunities we have in our portfolio," Linda Cook, head of Shell's gas and power unit, said of solar and wind at the time.

But times have changed.

Four years after pulling out of the renewable energy space, Shell released a report that found solar PV could become the leading energy source (http://http://www.businessinsider.com/shell-says-solar-leads-world-by-2100-2013-10) by the end of the century. As a 110-year-old company, it's not unreasonable for Shell to look at projections several decades in the future. In 2016, Shell and Saudi Aramco joined forces (http://www.reuters.com/article/us-oil-climatechange-idUSKBN12X0WA) to launch a renewable energy investment fund. Other oil majors are also reconsidering (https://www.bloomberg.com/news/articles/2017-02-16/bp-weighing-upgrade-of-u-s-wind-turbines-to-compete-with-gas) their wind and solar strategies.

"Things are different now," said Kretschmar. "What's different is the momentum; there's momentum behind the technology, and we've seen renewable energy costs drop dramatically in the last five years. Also, we didn't have the same mental pressure 10 years ago."

In 2015, global leaders banded together at the United Nations climate talks in Paris, with nearly 200 countries agreeing to set national policies to reduce their carbon emissions. President Trump's announcement (https://www.greentechmedia.com/articles/read/the-us-is-leaving-the-paris-climate-agreement-will-cease-all-implementation) earlier this month that the U.S. will withdraw from the Paris Agreement seems to have only galvanized support (https://www.greentechmedia.com/articles/read/the-fallout-from-trumps-paris-dropout) for

climate action in other countries and at other levels of government. In addition to new policies, oil companies are facing pressure to diversify from environmental groups and even some investors. No one wants to be like Kodak (http://http://mashable.com/2012/01/20/kodak-digital-missteps/#QH1eRKXgeiqp) when the digital camera came to market.

"I think the majors have to keep their...finger on the pulse of this fast-growing trend," Kretschmar said. "Talking about [a transition in] 2030 might be too late. They may have to act sooner, because they could risk erosion of their value and balance sheets that enable them to get into a new space."

## A balance between core business and new opportunities

European firms Statoil and Total have arguably been the most proactive on the renewables front among the oil majors. Statoil has made significant investments in offshore wind (https://www.statoil.com/en/what-we-do/new-energy-solutions/our-offshore-wind-projects.html) in Europe -- leveraging its experience in offshore oil drilling -- and will soon expand to the U.S. (https://www.statoil.com/en/news/statoil-wins-offshore-wind-lease-new-york.html) Total, meanwhile, has positioned itself to be a global leader in solar and batteries (http://https://www.greentechmedia.com/articles/read/Oil-Giant-Total-to-Acquire-Battery-Maker-Saft-for-1.1-Billion).

The European companies have tended to be more active in the clean energy space, according Kretschmar. That's likely because these firms are facing greater governmental pressure, and because U.S. firms are benefiting from low-cost unconventional oil and gas production, and don't feel the same sense of urgency to invest in new businesses.

There is a limit to how much it currently makes sense for the oil majors to invest in wind and solar, according to Wood Mackenzie. In order to replicate the 12 percent market share the majors hold in oil and gas, researchers estimate the majors would need to spend $350 billion on solar and wind out to 2035 -- or around a quarter of the $1.5 trillion Wood Mackenzie estimates the majors need to spend to sustain upstream volumes to 2035. In this bullish (and admittedly unlikely) scenario, renewables would increase to just 6.5 percent of the majors' fossil fuel production on an energy-equivalent basis in 20 years' time.

This represents "a disproportionate investment that would have to go into renewables," said Kretschmar. "But there is also an understanding that the cost of renewable energy is coming down, and there are other means of getting into renewables as well." For instance, building a renewables business through M&A could be a more economically effective way of gaining market share in this new space.

The value proposition for wind and solar is also competitive today when compared to some less attractive upstream oil and gas investments. Furthermore, these companies can benefit from the long lives and stable cash flows of clean energy projects that help to support shareholder dividends.

Despite the evidence that wind and solar will be increasingly important to strategic growth, the majors and their investors are still coming to grips with the value proposition and the timing of the transition. "This presents difficult capital allocation choices in the near term," the report states. "The majors will need to strike a balance between sustaining their core oil and gas business while keeping their options open in alternative energy."

The report goes on to note, however, that early movers might be at a competitive advantage in accessing new opportunities.

"Players that are slower to embrace new energy will rely much more on low-cost oil and gas supply to drive future performance," according to Wood Mackenzie analysts. "They could find themselves at a structural disadvantage if there is rapid penetration of renewables into the energy mix and entry costs rise."

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