



International
Energy Agency

Secure • Sustainable • Together

Special Report

WORLD ENERGY INVESTMENT OUTLOOK

EXECUTIVE SUMMARY

INTERNATIONAL ENERGY AGENCY

The International Energy Agency (IEA), an autonomous agency, was established in November 1974. Its primary mandate was – and is – two-fold: to promote energy security amongst its member countries through collective response to physical disruptions in oil supply, and provide authoritative research and analysis on ways to ensure reliable, affordable and clean energy for its 29 member countries and beyond. The IEA carries out a comprehensive programme of energy co-operation among its member countries, each of which is obliged to hold oil stocks equivalent to 90 days of its net imports. The Agency's aims include the following objectives:

- Secure member countries' access to reliable and ample supplies of all forms of energy; in particular, through maintaining effective emergency response capabilities in case of oil supply disruptions.
- Promote sustainable energy policies that spur economic growth and environmental protection in a global context – particularly in terms of reducing greenhouse-gas emissions that contribute to climate change.
 - Improve transparency of international markets through collection and analysis of energy data.
 - Support global collaboration on energy technology to secure future energy supplies and mitigate their environmental impact, including through improved energy efficiency and development and deployment of low-carbon technologies.
 - Find solutions to global energy challenges through engagement and dialogue with non-member countries, industry, international organisations and other stakeholders.

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The European Commission also participates in the work of the IEA.

More than \$1 600 billion was invested in 2013 to provide the world's consumers with energy, a figure that has more than doubled in real terms since 2000; and a further \$130 billion to improve energy efficiency. A full picture of global energy investment trends – compiled for the first time in this special report – underlines the growing role played by renewable sources of energy, in which annual investment increased from \$60 billion in 2000 to a high point approaching \$300 billion in 2011, before falling back since to \$250 billion. The largest share of current investment, more than \$1 100 billion per year, is related to the extraction and transport of fossil fuels, oil refining and the construction of fossil fuel-fired power plants.

Over the period to 2035, the investment required each year to supply the world's energy needs rises steadily towards \$2 000 billion, while annual spending on energy efficiency increases to \$550 billion. This amounts to a cumulative global investment bill of more than \$48 trillion, consisting of around \$40 trillion in energy supply and the remainder in energy efficiency. The main components of energy supply investment are the \$23 trillion in fossil fuel extraction, transport and oil refining; almost \$10 trillion in power generation, of which low-carbon technologies – renewables (\$6 trillion) and nuclear (\$1 trillion)¹ – account for almost three-quarters, and a further \$7 trillion in transmission and distribution. Nearly two-thirds of this investment takes place in emerging economies, with the focus for investment moving beyond China to other parts of Asia, Africa and Latin America; but ageing infrastructure and climate policies create large requirements also across the OECD.

Less than half of the \$40 trillion investment in energy supply goes to meet growth in demand, the larger share is required to offset declining production from existing oil and gas fields and to replace power plants and other assets that reach the end of their productive life. Compensating for output declines absorbs more than 80% of upstream oil and gas spending. Replacing power plants that are retired triggers almost 60% of investment in electricity generation in OECD countries, although a much smaller share in emerging economies. These declines and retirements set a major re-investment challenge for policymakers and the industry, but they also represent a real opportunity to change the nature of the energy system by switching fuels or deploying more efficient technologies.

Of the \$8 trillion investment in energy efficiency to 2035, 90% is spent in the transport and buildings sectors, reflecting policy ambitions and remaining efficiency potentials. The European Union, North America and China together account for two-thirds of the total, reflecting the size of their car markets and the vehicle efficiency standards in place or planned; efforts in the European Union and in North America to improve the efficiency of electrical appliances and the buildings stock; and China's priority to upgrade the efficiency of its industry. In other emerging economies, the lack of targeted policies and access to finance, as well as the persistence in some countries of fossil-fuel subsidies, pose serious obstacles to investments in energy efficiency.

1. Nuclear power will be covered in detail in this year's *World Energy Outlook*, published in November 2014.

Decisions to commit capital to the energy sector are increasingly shaped by government policy measures and incentives, rather than by signals coming from competitive markets.

In many countries, governments have direct influence over energy sector investment, for example, through retained ownership of more than 70% of global oil and gas reserves or control of nearly half of the world's power generation capacity, via state-owned companies. Some governments, notably in the OECD, stepped back from direct influence when opening energy markets to competition, but many have now stepped back in, typically to promote the deployment of low-carbon sources of electricity. In the oil sector, reliance on countries with more restrictive terms of access to their resources is set to grow, as output from North America plateaus and then falls back from the mid-2020s onwards. In the electricity sector, administrative signals or regulated rates of return have become, by far, the most important drivers for investment: the share of investment in competitive parts of electricity markets has fallen from about one-third of the global total ten years ago to around 10% today. With current market designs, of the \$16 trillion required in the power sector to 2035, investment in competitive parts of electricity markets would account for less than \$1 trillion.

Private sector participation is essential to meet energy investment needs in full, but mobilising private investors and capital will require a concerted effort to reduce political and regulatory uncertainties.

Even where states and state-owned companies take direct responsibility for energy investment, pressures on public funds and the need for new technology and expertise create room for greater private involvement. Yet conditions are often not conducive: the requirement for energy supply investment grows most quickly outside the OECD and outside China, in some cases in countries that have a higher incidence of political instability, weaker institutions and less robust legal frameworks. Throughout the world, policymakers, though they may recognise investors' need for long-term policy consistency, are subject to various and sometimes conflicting pressures: demands for stronger action on climate change, but a backlash against the cost of subsidies to renewables; calls for lower energy prices, but public opposition of varying intensities to many new energy-supply projects. Against this backdrop, there is a risk that policymakers fail to provide clear and consistent signals to investors, with particular impacts on low-carbon technologies that depend, for the moment, on policy support.

New types of investors in the energy sector are emerging, but the supply of long-term finance on suitable terms is still far from guaranteed.

Much of the dynamism in energy markets is coming from smaller market players or new entrants: the expansion of shale gas and tight oil production in North America has been driven by multiple, entrepreneurial companies; emerging state and private companies are taking an increasing share of investment in many non-OECD countries; and the expansion of distributed renewable energy capacities and of energy efficiency initiatives is turning more small businesses and households into energy investors. These players tend to share a reliance on external sources of financing. Even for efficiency projects, which we estimate are almost 60% self-financed today, the required scaling up of efforts is likely to depend on greater recourse to debt or equity. Outside North America (where external financing is more readily available), there is a need to unlock new sources of finance, via growth of bond, securitisation and equity markets and, potentially, by tapping into the large funds held by institutional

investors, such as pension funds and insurers. This would help to diminish undue reliance on the relatively short maturity of loans available from the banking sector, which may themselves be further constrained by new capital adequacy requirements in the wake of the financial crisis.

Investment in natural gas supply rises almost everywhere, but meeting long-term growth in oil demand becomes steadily more reliant on investment in the Middle East.

Upstream oil and gas spending rises by a quarter to more than \$850 billion per year by 2035, with gas accounting for most of the increase. North America has been at the centre of the surge in global investment in recent years and this remains the region with the largest overall oil and gas investment requirement to 2035. But, in the case of oil, the focus for meeting incremental demand shifts towards the main conventional resource-holders in the Middle East as the rise in non-OPEC supply starts to run out of steam in the 2020s. The prospects for a timely increase in oil investment in the Middle East are uncertain: there are competing government priorities for spending, as well as political, security and logistical hurdles that could constrain production. If investment fails to pick up in time – a case considered in this report – the resulting shortfall in supply would create tighter and more volatile oil markets, with prices that are \$15 per barrel higher on average in 2025. Importers of fossil fuels rely for secure supply on the adequacy of investment in resource-rich countries; the investment needed to supply India and China with imported oil and gas over the period to 2035 is more than \$2 trillion, a level that helps to explain the push by their national oil companies to secure investment opportunities abroad.

Investment in liquefied natural gas (LNG) facilities creates new links between markets and improves the security of gas supply; but high costs of gas transportation may dampen the hopes of LNG buyers in Europe and Asia for much cheaper gas supplies.

More than \$700 billion invested in LNG over the period to 2035 accelerates the integration of regional gas markets, with exports from the United States playing a prominent role in stimulating some convergence between gas prices, which vary widely today. However, the expectation that a surge in new LNG supplies will totally transform gas markets needs to be tempered by recognition of the high capital cost of LNG infrastructure, with transportation typically accounting for at least half of the cost of gas delivered over long distances. Europe's near-term perspective for expanding LNG purchases is constrained by the need to outbid Asian consumers for available gas.

The investment required to maintain the reliability of Europe's electricity system is unlikely to materialise with the current design of power markets.

Europe requires more than \$2 trillion in power sector investment to 2035 and, alongside vigorous continued expansion in low-carbon generation, around 100 GW of new thermal capacity needs to be added already in the decade to 2025. Despite public and political concern about high prices to end-users, the wholesale price for electricity is too low at present, by more than 20%, to incentivise the investment required in new thermal plants. If this situation persists, the reliability of European electricity supply will be put at risk. Part of the solution involves higher revenues to thermal generators, but this potentially means higher prices to consumers, underlining the difficulties facing European policymakers as they seek to make simultaneous progress towards ensuring energy security, environment sustainability and

economic competitiveness. Nonetheless, there is scope for a policy framework to combine a continued commitment to decarbonisation with lower import bills, while containing the impact on end-user prices.

For many emerging economies, keeping up with booming electricity demand is a huge investment challenge, and current investment trends provide some warning signs for the adequacy of power supply. We focus on India, where – despite achieving a doubling of power generation capacity since 2000 – current electricity output falls short of meeting demand. The incentives to invest in filling this gap are dimmed by high transmission and distribution losses and low end-user tariffs, which mean that many utilities are struggling to recover their costs. If network losses were 15%, rather than today's 27%, an increase of only 5% in average end-user tariffs would have allowed for full cost recovery. More than \$1.5 trillion is required in power sector investment to 2035. New coal-fired power plants are projected to dominate future investment in generation capacity in India, as in many other parts of Asia: this is the main driver for the \$1 trillion in global coal-supply investment over the period to 2035.

The investment path that we trace in this report falls well short of reaching climate stabilisation goals, as today's policies and market signals are not strong enough to switch investment to low-carbon sources and energy efficiency at the necessary scale and speed: a breakthrough at the Paris UN climate conference in 2015 is vital to open up a different investment landscape. We estimate that \$53 trillion in cumulative investment in energy supply and in energy efficiency is required over the period to 2035 in order to get the world onto a 2 °C emissions path. Investment of \$14 trillion in efficiency helps to lower energy consumption by almost 15% in 2035, compared with our main scenario. The \$39.4 trillion of energy supply investment remains at a comparable level to our main scenario, but unit investment costs are higher as investment shifts away from fossil fuels (where investment is almost 20% lower on average and coal is hit hardest) and towards the power sector. Around \$300 billion in fossil fuel investments is left stranded by stronger climate policies. A lack of clarity over policy would increase the risk of investments becoming stranded, although carbon capture and storage provides an increasingly important hedge for fossil-fuel assets against the possibility of under-utilisation or early retirement.

Consistent and credible policies and innovative financing vehicles can provide the bridge to a low-carbon energy system. By 2035, investment in low-carbon energy supply rises to almost \$900 billion and spending on energy efficiency exceeds \$1 trillion, double the respective amounts seen in 2035 in our main scenario. Dependable policy signals are essential to ensure that these investments offer a sufficiently attractive risk-adjusted return. Getting prices right is essential, both by phasing out existing distortions, in the form of fossil-fuel subsidies, and through carbon pricing. On the financing side, there is still much work to do to marry the available instruments with the specificities of low-carbon energy projects, notably their dispersed, diverse and small-scale nature. It will take time, realism and determination to harness the skills of the financial world to the ambition to reach climate change targets.

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WORLD ENERGY INVESTMENT OUTLOOK

Questions about the reliability, affordability and sustainability of our energy future often boil down to questions about investment. But are investors ready to commit capital in a fast-changing energy world? This special report in the *World Energy Outlook* series takes up this question in a full and comprehensive update of the energy investment picture to 2035 – a first full update since the 2003 *World Energy Investment Outlook*. With benchmark data on past investment trends and updated projections for investment at regional and global level, the report provides insights into:

- The structure of ownership and models for financing investment in different parts of the energy sector.
- The continued importance of oil investment in the Middle East to meet demand, and the consequences of delay in such investment.
- The dynamics and costs of LNG investment and how this can shape the future of global gas supply.
- Where investment in the power sector might fall short of what is required, with important findings on the reliability of electricity supply in Europe and in India.
- The outlook for investment in low-carbon technologies, including renewables, and energy efficiency and the barriers to their realisation.
- How global investment and financing requirements change if governments take stronger action to address climate change.

For more information, and the free download of the report, please visit:

www.worldenergyoutlook.org/investment