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EIFFEL: Energy Initiative for Future Engineer Leaders

Energy Initiative

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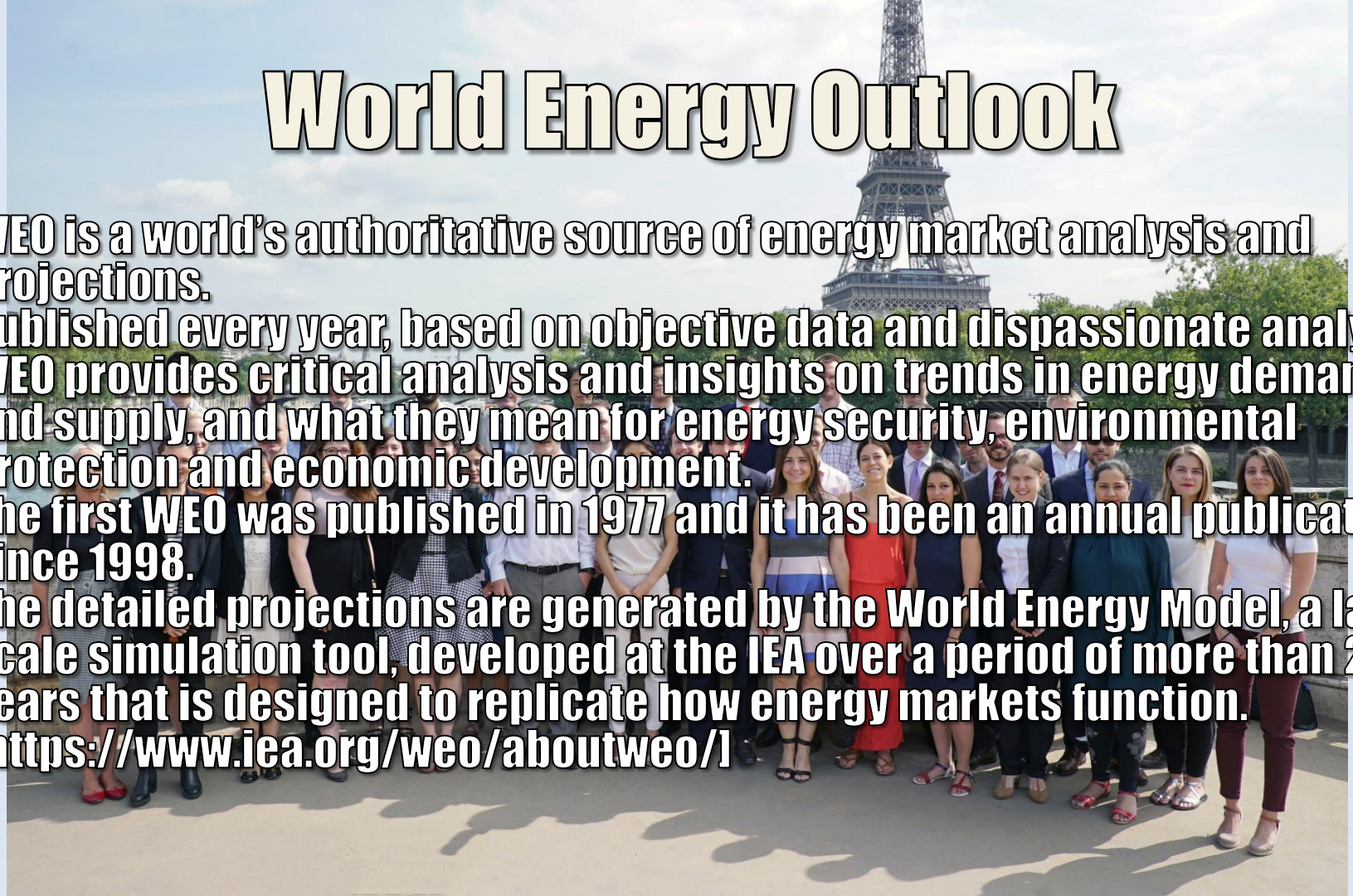
World Energy Forum

- WEF is a platform for energy leadership, providing a transnational platform for world leaders and experts to facilitate sustainable solutions to global energy issues.
- WEF represents the interests of business and governments of every size and region to promote strategic relationships and translate ideas into a global marketplace.
- Access to modern energy services and water are essential for economic, social and human development worldwide.
- WEF's campaign of "energy for all" leads in the areas of policy, technology and finance to enhance the global economy, create a sustainable future, and deliver the hopes and aspirations of all nations and peoples. [http://www.worldeforum.org/]

World Energy Outlook



- WEO is a world's authoritative source of energy market analysis and projections.
- Published every year, based on objective data and dispassionate analysis, WEO provides critical analysis and insights on trends in energy demand and supply, and what they mean for energy security, environmental protection and economic development.
- The first WEO was published in 1977 and it has been an annual publication since 1998.
- The detailed projections are generated by the World Energy Model, a large scale simulation tool, developed at the IEA over a period of more than 20 years that is designed to replicate how energy markets function. [https://www.iea.org/weo/aboutweo/]

Global Shifts in Energy System

- Four large-scale shifts in the global energy system set the scene for the World Energy Outlook 2017: the rapid deployment and falling costs of clean energy technologies, the growing electrification of energy, the shift to a more services-oriented economy and a cleaner energy mix in China, and the resilience of shale gas and tight oil in the U.S.
- These shifts come at a time when traditional distinctions between energy producers and consumers are being blurred and a new group of major developing countries, led by India, moves towards center stage.
- How these developments play out and interact is the story of this year's Outlook. [https://www.iea.org/weo2017/]

World Energy Outlook 2017

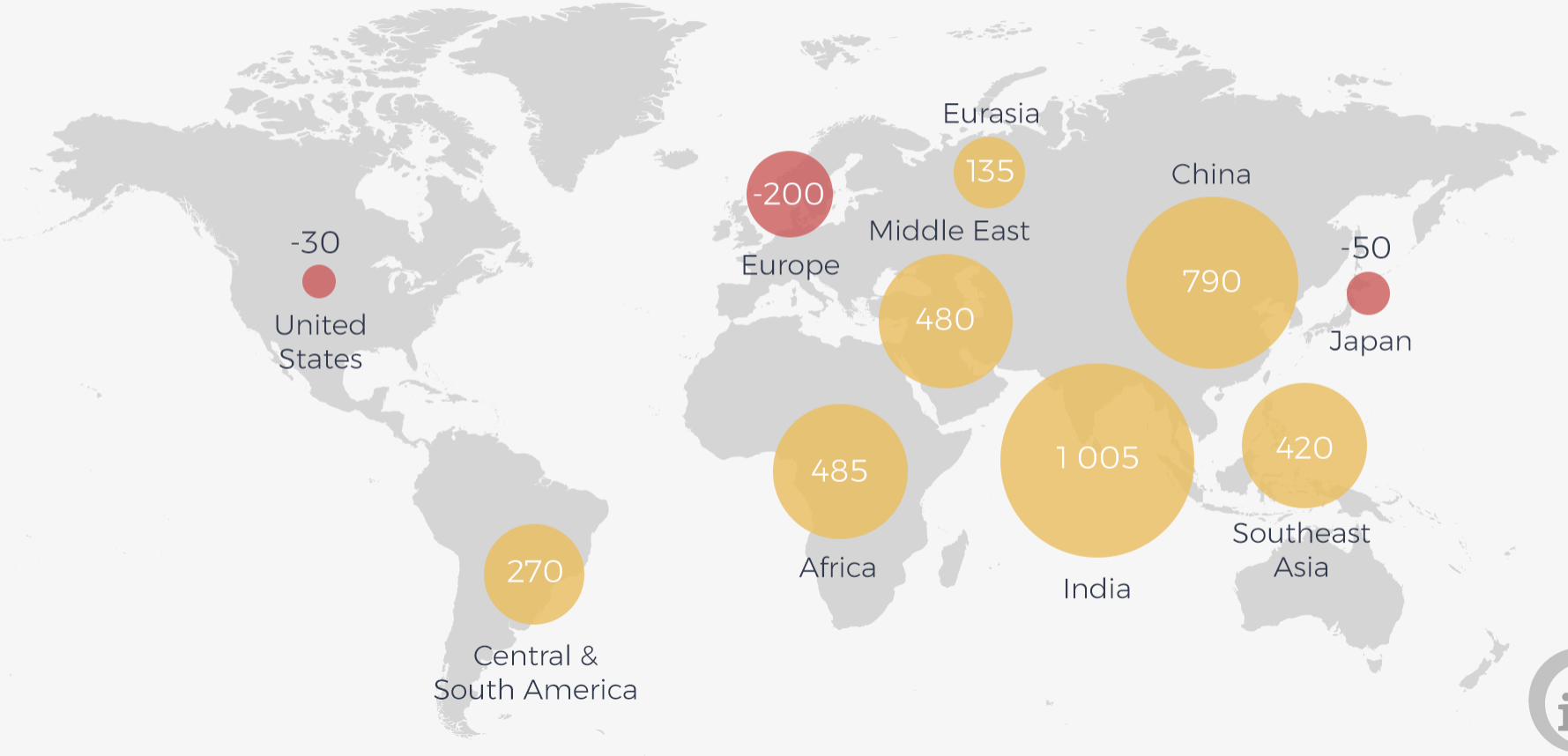
London, 14 November 2017

Growing Energy Demand

- In the New Policies Scenario, global energy needs rise more slowly than in the past but still expand by 30% between today and 2040.
- This is the equivalent of adding another China and India to today's global demand.
- A global economy growing at an average rate of 3.4% per year, a population that expands from 7.4 billion today to more than 9 billion in 2040, and a process of urbanization that adds a city the size of Shanghai to the world's urban population every four months are key forces that underpin the projections.
- The largest contribution to demand growth – almost 30% – comes from India, whose share of global energy use rises to 11% by 2040 (still well below its 18% share in the anticipated global population). [https://www.iea.org/weo2017/]

Change in primary energy demand, 2016-40 (Mtoe)

World Energy Outlook 2017



Renewables Up, Coal Out

- Compared with the past 25 years, the way that the world meets its growing energy needs changes dramatically in the New Policies Scenario, with the lead now taken by natural gas, by the rapid rise of renewables and by energy efficiency.
- Improvements in efficiency play a huge role in taking the strain off the supply side: without them, the projected rise in final energy use would more than double.
- Renewable sources of energy meet 40% of the increase in primary demand and their explosive growth in the power sector marks the end of the boom years for coal.
- Since 2000, coal fired power generation capacity has grown by nearly 900 GW but net additions from today to 2040 are only 400 GW and many of these are plants already under construction. [https://www.iea.org/weo2017/]

Oil, Gas & Nuclear

- In the absence of large-scale carbon capture and storage, global coal consumption flatlines.
- Oil demand continues to grow to 2040, albeit at a steadily decreasing pace.
- Natural gas use rises by 45% to 2040; with more limited room to expand in the power sector, industrial demand becomes the largest area for growth.
- The outlook for nuclear power has dimmed since last year's Outlook, but China continues to lead a gradual rise in output, overtaking the U.S. by 2030 to become the largest producer of nuclear based electricity. [https://www.iea.org/weo2017/]

Bright Future for Renewables

- Renewables capture two-thirds of global investment in power plants to 2040 as they become, for many countries, the least-cost source of new generation.
- Rapid deployment of solar photovoltaics, led by China and India, helps solar become the largest source of low-carbon capacity by 2040, by which time the share of all renewables in total power generation reaches 40%.
- In the European Union, renewables account for 80% of new capacity and wind power becomes the leading source of electricity soon after 2030, due to strong growth both onshore and offshore.
- Growth in renewables is not confined to the power sector.
- The direct use of renewables to provide heat and mobility worldwide also doubles, albeit from a low base. [https://www.iea.org/weo2017/]

The Future Is Electrifying…

- Electricity is the rising force among worldwide end-uses of energy, making up 40% of the rise in final consumption to 2040 – the same share of growth that oil took for the last twenty-five years.
- Industrial electric motor systems account for one-third of the increase in power demand in the New Policies Scenario. Rising incomes mean that many millions of households add electrical appliances with an increasing share of “smart” connected devices and install cooling systems.
- Electricity makes inroads in supplying heat and mobility, alongside growth in its traditional domains, allowing its share of final consumption to rise to nearly a quarter.
- The increasing use of digital technologies across the economy improves efficiency. [https://www.iea.org/weo2017/]

When China Changes,

- China is entering a new phase in its development.
- The president's call for an "energy revolution", the "fight against pollution" and the transition towards a more services based economic model is moving the energy sector in a new direction - with the emphasis in energy policy now firmly on electricity, natural gas and cleaner, high efficiency and digital technologies.
- Demand growth slowed markedly from an average of 8% per year from 2000 to 2012 to less than 2% per year since 2012, and in the New Policies Scenario it slows further to an average of 1% per year to 2040.
- Energy efficiency regulation explains a large part of this slowdown.
- Without new efficiency measures, end use consumption in 2040 would be 40% higher. [https://www.iea.org/weo2017/]

Everything Changes…

- China's choices will play a huge role in determining global trends, and could spark a faster clean energy transition.
- The scale of China's clean energy deployment, technology exports and outward investment makes it a key determinant of momentum behind the low carbon transition: one third of the world's new wind power and solar PV is installed in China in the New Policies Scenario, and China also accounts for more than 40% of global investment in electric vehicles.
- China provides a quarter of the projected rise in global gas demand and its projected imports of 280 billion cubic metres in 2040 are second only to those of the European Union, making China a linchpin of global gas trade.
- China overtakes the U.S. as the largest oil consumer around 2030, and its net imports reach 13 million barrels per day in 2040. But stringent fuel-efficiency measures for cars and trucks. [https://www.iea.org/weo2017/]

The U.S. Shale Gas Revolution

- A remarkable ability to unlock new resources cost effectively pushes combined U.S. oil and gas output to a level 50% higher than any other country has ever managed; already a net exporter of gas, the U.S. becomes a net exporter of oil in the late 2020s.
- The 8 mb/d rise in U.S. tight oil output from 2010 to 2025 would match the highest sustained period of oil output growth by a single country in the history of oil markets.
- A 630 bcm increase in U.S. shale gas production over the 15 years from 2008 would comfortably exceed the previous record for gas.
- Expansion on this scale is having wide-ranging impacts within North America, fuelling major investments in petrochemicals and other energy-intensive industries.
- It is also reordering international trade flows and challenging incumbent suppliers and business models. [https://www.iea.org/weo2017/]

The Era of Oil is Not Over Yet

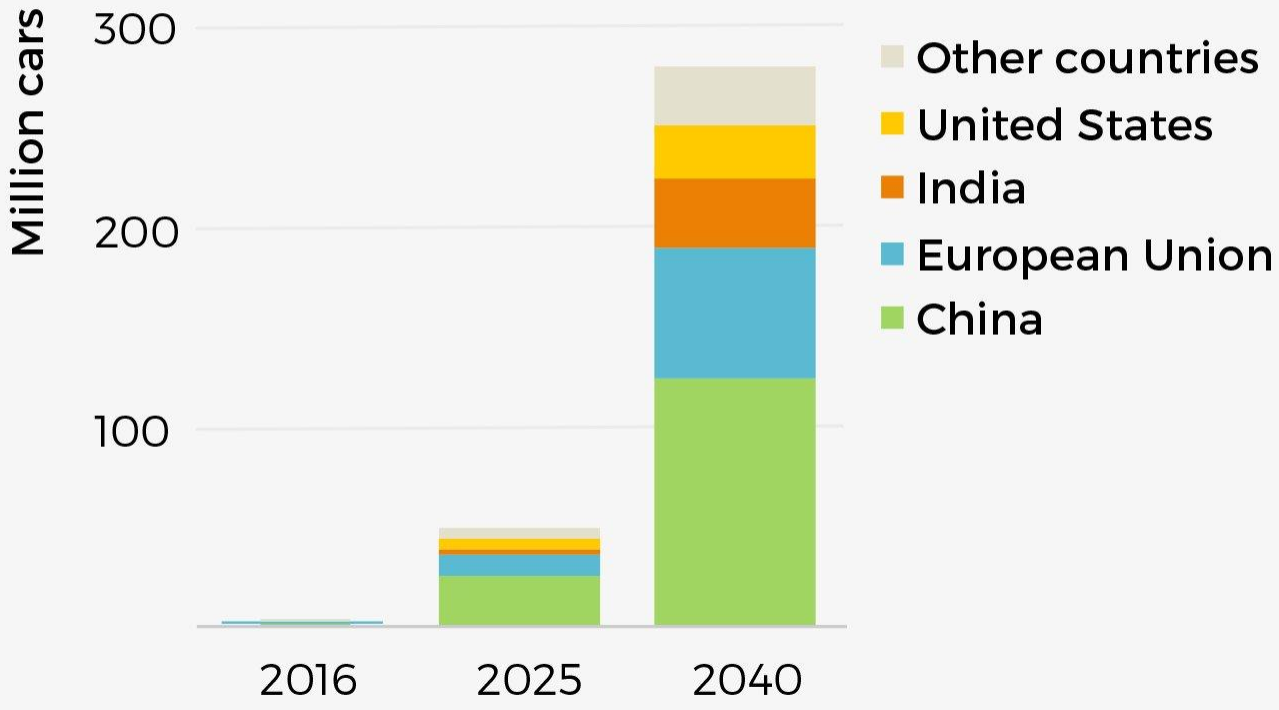
- With the U.S. accounting for 80% of the increase in global oil supply to 2025 and maintaining near-term downward pressure on prices, the world's consumers are not yet ready to say goodbye to the era of oil.
- Up until the mid-2020s demand growth remains robust in the New Policies Scenario, but slows markedly thereafter as greater efficiency and fuel switching bring down oil use for passenger vehicles even though the global car fleet doubles from today to reach 2 billion by 2040.
- Powerful impetus from other sectors is enough to keep oil demand on a rising trajectory to 105 mb/d by 2040.
- Oil use to produce petrochemicals is the largest source of growth, closely followed by rising consumption for trucks.
- Fuel efficiency policies cover 80% of global car sales today, but only 50% of global truck sales, for aviation and for shipping. [https://www.iea.org/weo2017/]

Electric Cars

- Even greater upside for U.S. tight oil and a more rapid switch to electric cars would keep oil prices lower for longer. We explore this possibility in a Low Oil Price Case, in which a doubling of the estimate for tight oil resources, to more than 200 billion barrels, boosts U.S. supply and more widespread application of digital technologies helps to keep a lid on upstream costs around the globe.
- Extra policy and infrastructure support pushes a much more rapid expansion in the global electric car fleet, which approaches 900 million cars by 2040. Along with a favourable assumption about the ability of the main oil-producing regions to weather the storm of lower hydrocarbon revenues, this is enough to keep prices within a $50-70/barrel range to 2040. However, it is not sufficient to trigger a major turnaround in global oil use. [https://www.iea.org/weo2017/]

Electric car fleet, 2016-2040

World Energy Outlook 2017



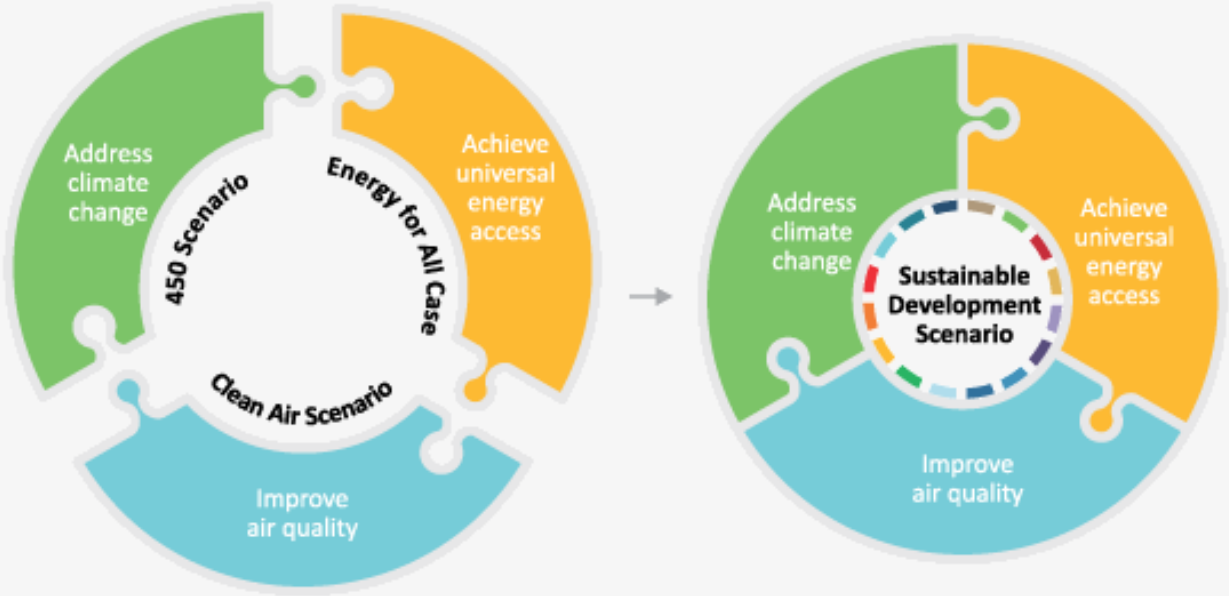
Greenhouse Gas Emissions

- Despite their recent flattening, global energy related CO_2 emissions increase slightly to 2040.
- This outcome is far from enough to avoid severe impacts of climate change, but there are a few positive signs.
- Projected 2040 emissions in the New Policies Scenario are lower by 600 million tonnes than in last year's Outlook (35.7 Gt v. 36.3 Gt).
- In China, CO_2 emissions are projected to plateau at 9.2 Gt (only slightly above current levels) by 2030 before starting to fall back.
- Worldwide emissions from the power sector are limited to a 5% increase between now and 2040, even though electricity demand grows by 60% and global GDP by 125%. However, the speed of change in the power sector is not matched elsewhere: CO_2emissions from oil use in transport almost catch up with those from coal fired power plants by 2040, and there is also a 20% rise in emissions from industry. [https://www.iea.org/weo2017/]

Sustainable Development

- The Sustainable Development Scenario offers an integrated way to achieve a range of energy related goals crucial for sustainable economic development: climate stabilisation, cleaner air and universal access to modern energy, while also reducing energy security risks.
- This scenario starts from a set of desired outcomes and considers what would be necessary to deliver them.
- Central to these outcomes is the achievement of an early peak in CO_2 emissions and a subsequent rapid decline, consistent with the Paris Agreement.
- Universal access to electricity and clean cooking can be reached without making this task any more challenging.
- n a Faster Transition Scenario, how policies could push an even more rapid and steeper decline in CO_2 emissions and limit climate risks further. [https://www.iea.org/weo2017/]

Connecting individual policy targets in the Sustainable Development Scenario



An integrated scenario

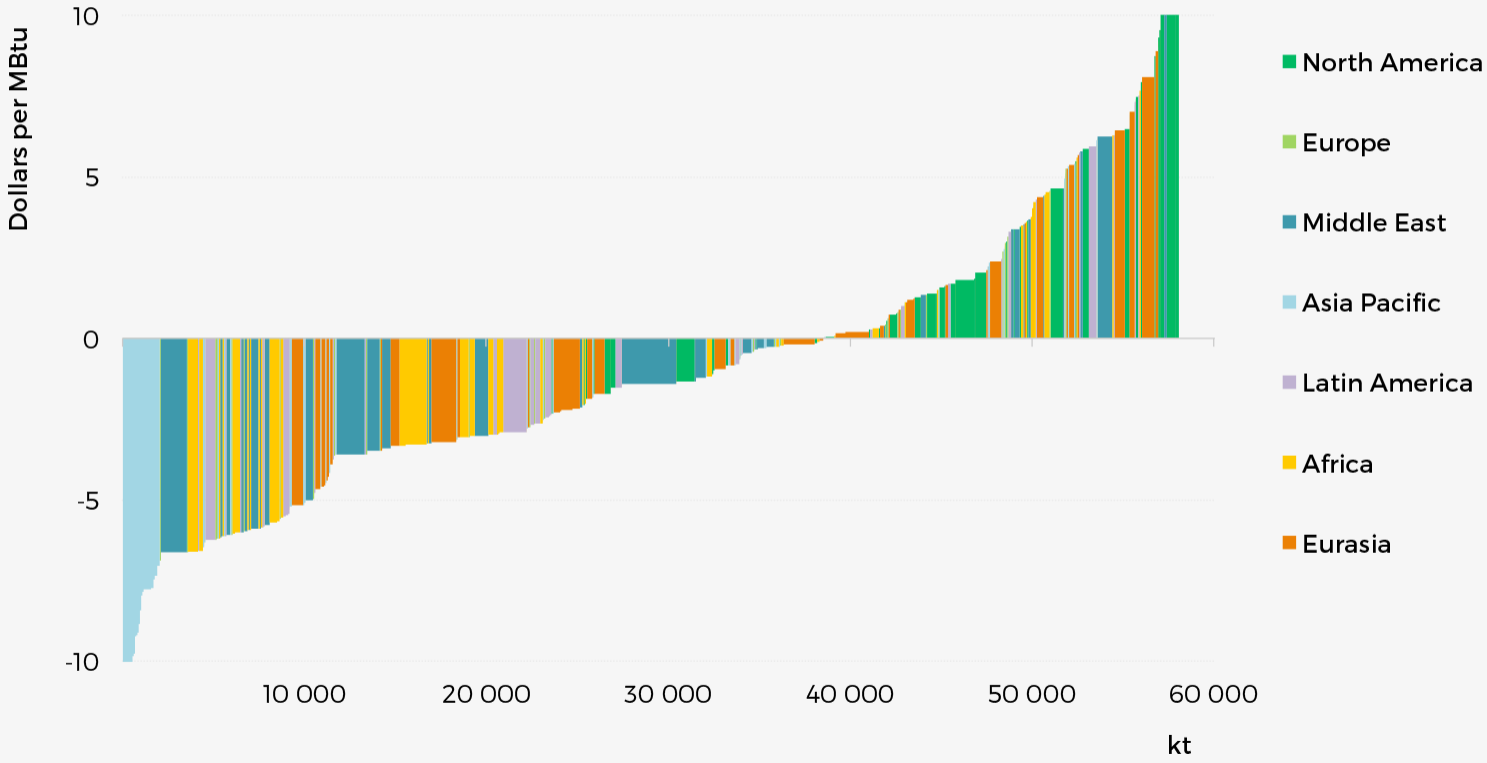
[https://www.iea.org/weo2017/]

Clean Energy Transitions

- As oil and coal fall back and renewables ramp up strongly, natural gas becomes the largest single fuel in the global mix in the Sustainable Development Scenario.
- Securing clear climate benefits from gas use depends on credible action to minimise leaks of methane – a potent greenhouse gas – to the atmosphere.
- Consumption of natural gas rises by nearly 20% to 2030 in the Sustainable Development Scenario and remains broadly at this level to 2040.
- The contribution of gas varies widely across regions, between sectors and over time in this scenario. In energy systems heavily reliant on coal (as in China and India), where renewable alternatives are less readily available (notably in some industrial sectors), or where seasonal flexibility is required to integrate high shares of variable renewables, gas plays an important role. [https://www.iea.org/weo2017/]

Marginal abatement cost curve for oil & gas related methane emissions, 2015

IEA analysis



Source: IEA methane emissions model developed in collaboration with ICF

Annual Energy Outlook 2017

with projections to 2050

eia Independent Statistics & Analysis
U.S. Energy Information Administration

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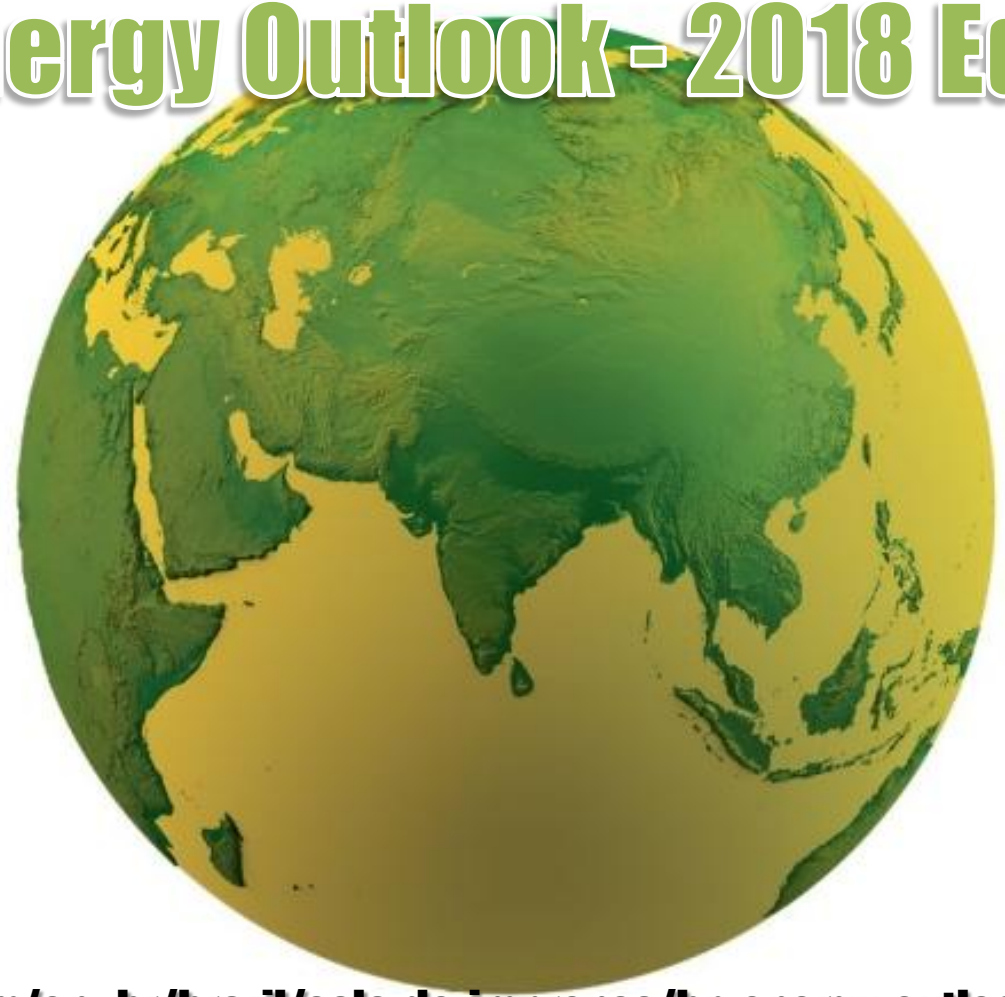
BP Energy Outlook - 2018 Edition



[https://www.bp.com/en_br/brazil/sala-de-imprensa/bp-energy-outlook-2017-edition.html]