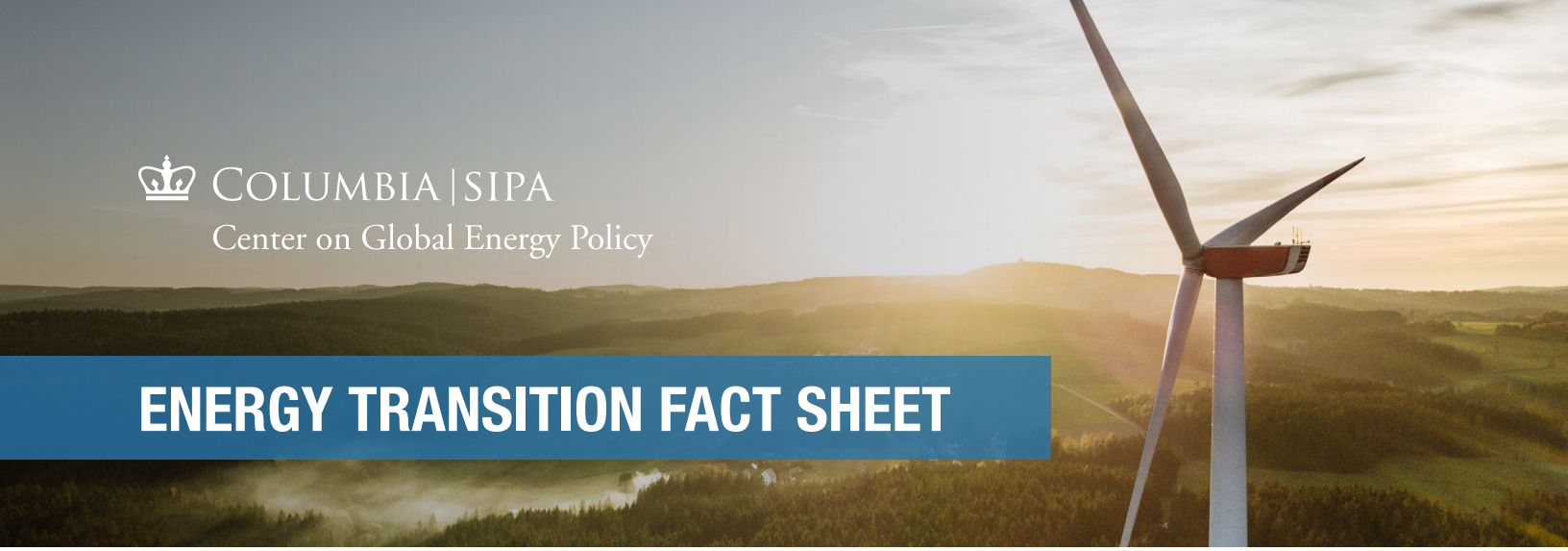


COLUMBIA | SIPA
Center on Global Energy Policy

ENERGY TRANSITION FACT SHEET

The world has embarked on an unprecedented effort to completely transition its energy supply and use to mitigate risks of global climate change. An effective transformation of energy systems globally ideally fosters inclusive economic growth. affordability, security and access to energy as well as decarbonization. While climate action globally continues to increase, the challenges associated with energy transition remain immense and the tangible efforts so far are inadequate.

Climate change poses significant risks

There is broad scientific agreement that earth's climate is changing and that human activity is the major cause. The worst effects of climate change are no mere distant prospects, but have already started to unfold and impact humanity in profound ways.

- The signatories of the 2015 Paris Agreement committed to holding global warming well below 2°C above pre-industrial levels—and to pursue efforts to limit warming to 1.5 °C. By 2018, global average surface temperatures were already more than 1°C above pre-industrial levels
- 2018 was the 4th warmest year since records began, and the past five years were the hottest years ever recorded since 1880.
- The likelihood of extreme heat waves across Western Europe is 10 to 100 times higher than would be without climate change.
- Average sea levels have been rising at a rate of 0.10-0.14 inches per year, roughly twice as fast as the long-term trend since 1880, and accelerating.

Concern over climate change is rising, now a major public, government & corporate focus

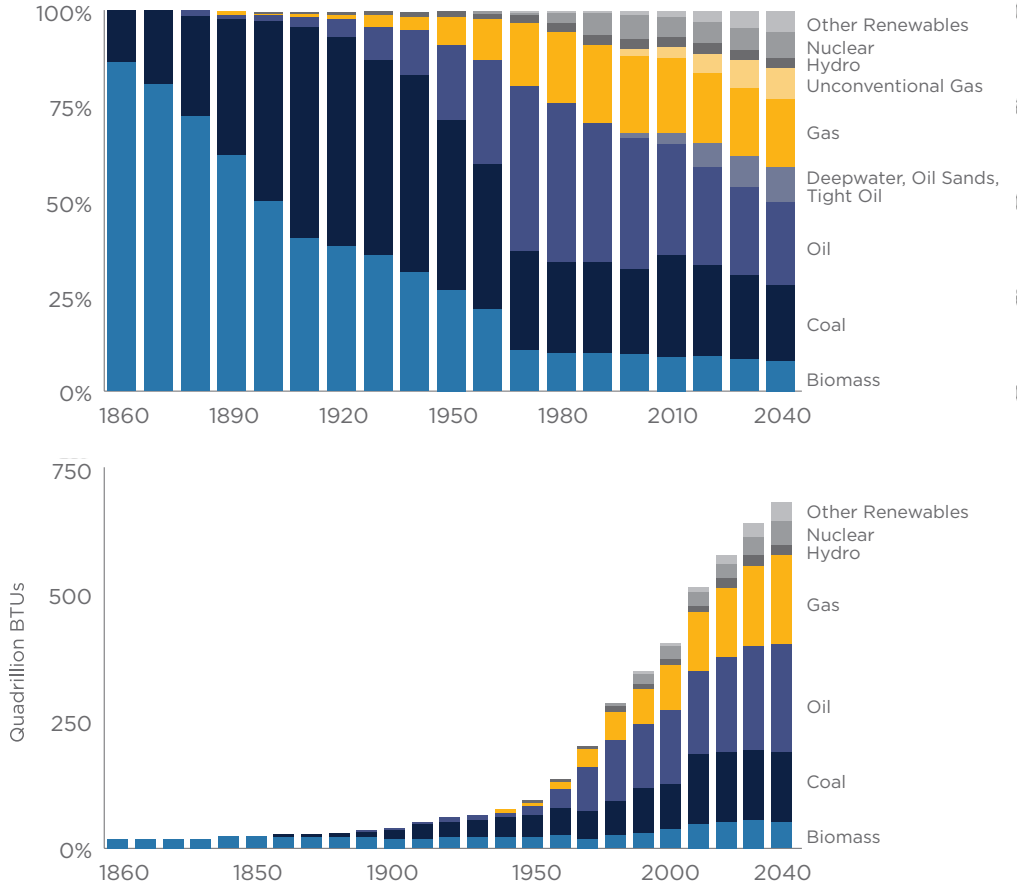
- Recent events like the Paris Agreement in December 2015 and increasingly visible impacts of climate change have propelled climate change forward for policy makers, business leaders and the public alike. Voters, shareholders, religious leaders, and many others increasingly demand forceful action to address the climate challenge. Demographic patterns demonstrate sharply higher concern about climate change with younger generations.
- As of August 2019, 185 countries have ratified the Paris Agreement, including the US, China, and the EU. One-sixth of the global economy (16 countries), 11 states and regions, 21 cities and 34 major companies announced net zero emission targets by 2050, with an addition 4 countries and the European Union considering similar goals.
- Of 24 Democratic presidential candidates, 17 co-sponsored or endorsed the Green New Deal.
- In a survey of 46 global institutional investors with $33 trillion of assets under management, 85% of survey respondents indicated that climate change will be the most prioritized sustainability topic of their corporate engagements in 2019, up by 31 percentage points from 2018 and by 35 percentage points since 2017.
- In 2018, listed US companies faced a record number of 72 climate-related shareholder proposals at annual meetings, up from 17 in 2013.

There are positive signs of progress towards energy transition and decarbonization

Over the last decade, a number of trends indicate that decarbonization in certain sectors could be significant with existing technologies. Strong gains in renewable electricity and the electrification of passenger transport augmented progress in coal-to-gas switching and energy efficiency. All have contributed significantly to slowing emissions growth.

- Since 2010, the unit costs of new wind power and solar PV have fallen by 49% and 85%, respectively. Lithium-ion battery pack prices dropped by 85% between 2010 and 2018.
- Renewables accounted for two-thirds of total power generation investment in 2018, substantially exceeding spending on all fossil fuel-based power generation sources combined. Low-carbon generation, electricity networks, and battery storage accounted for 85% total power sector investment in 2018.
- EV sales increased almost 4-fold since 2015 and reached 2 million units in 2018. The global EV fleet surpassed the 5 million mark in 2018.
- Coal-to-gas switching avoided more than 500 million tons of CO_2 emissions between 2010 and 2018. The IEA estimates that further 1.2 Gt of CO_2 emissions could be abated annually in the short term by switching from coal to existing gas-fired power plants.
- The energy intensity of GDP has continued to improve at an average rate of about 2% annually since 2010.
- As of 2019, 46 national and 28 sub-national jurisdictions implemented various carbon pricing schemes. These initiatives covered about 20% of global GHG emissions. Tightening of allowances has led to price increases, most notably in the EU (from 5 to 30 Euros).

Global Mix of Fuels

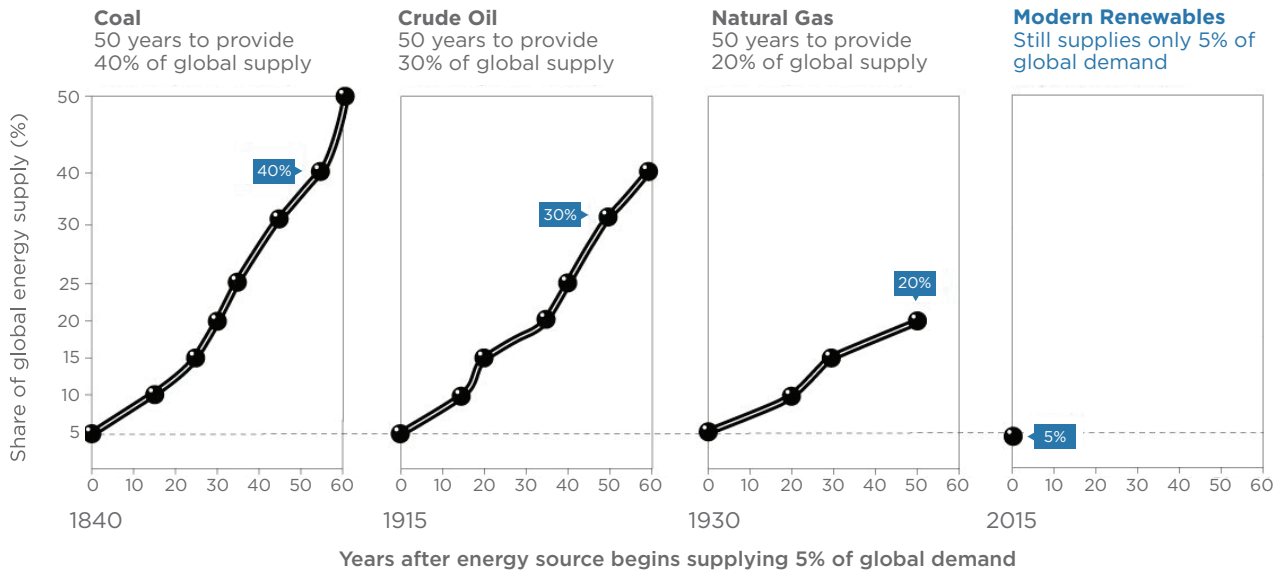


Source: Smil, Energy Transitions (1800-1960)

When it comes to climate action, there is a marked gap between ambition and reality

The world is far from being on track to achieve the Paris climate goals of well below 2°C. Hydrocarbon use has continued to rise (even the share in the energy mix is unchanged over the past two decades), and despite much policy support, renewables, CCS and other mitigation technologies remain a very small part of the global energy system.

- After being roughly flat from 2014 to 2016, global energy-related GHG emissions continue to rise, and reached an all-time high level of 33 Gt in 2018, the fastest rate of growth since 2011.
- Fossil fuels account for 85% of global primary energy consumption in 2018, only marginally lower than in 1990, when the share of fossil fuels in the energy mix was 88%. Despite considerable investment in renewable energy sources in the power generation sector over the last three decades, fossil fuels retain the same 64% share of global power generation as they did in 1990.
- Estimated 2018 indirect GHG emissions from oil and gas operations were 5.2 Gt of CO_2 equivalent - about 15% of total energy-related GHG emissions. Methane was the largest indirect emissions component
- To close the gap between ambition and reality, global greenhouse gas emissions must decrease by 13-18 Gt/year by 2030 for a 2°C target (25-33% of total GHG emission), more than all power or all transportation emissions. For a 1.5°C target, 29-35 Gt/year (55-66% of total) is needed by 2030.
- Energy intensity improvements slowed to 1.3% in 2018, third consecutive year of slowdown. Annual energy intensity needs to improve by 2.6% to be consistent with the Paris goals.
- Coal power generation grew 3% in 2018, mainly in China, India and South-East Asia.
- Of the 31 major emitters Climate Action Tracker assessed, it found 24 inadequate or worse with respect to the 2°C objective. Most signatories of the Paris agreement are not on track to meet their nation specific Paris pledges.
- Following years of exponential growth, electric vehicles represent only 0.6% of the global passenger car stock. Though growing rapidly, wind and solar energy combined still only account for 3% of global primary energy supply and 7% of electricity generation.



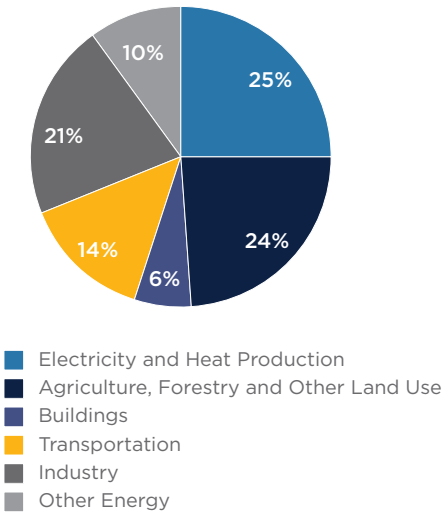
Source: Vaclav Smil. Modern renewables include: wind, solar, and modern biofuels

Deep decarbonization remains immensely challenging

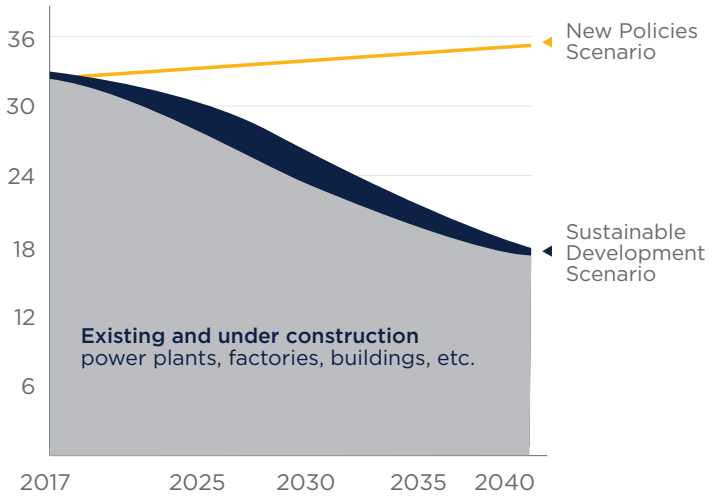
Historically, energy "transitions" have occurred only in percentage terms; in terms of total energy use, they have more accurately reflected energy "additions" as all forms of energy rise to meet growing energy demand. Reducing emissions, however, requires that total hydrocarbon use decline (along with technologies to capture or remove their emissions). Even then, they required over 50 years to achieve global market penetration.

- Existing industrial facilities and power plants will consume 95% of the budget for a 2ºC stabilization trajectory if not prematurely retired or retrofit with CCS.
- In advanced economies nuclear energy is the largest source of low-carbon electricity accounting for about 40% of low-carbon generation. About 25% of nuclear capacity in advanced economies is scheduled to shut down by 2025, and without further lifetime extensions as much as two-thirds of the nuclear capacity could be lost by 2040.
- Electric vehicles could be on track to achieve a 30% market share by 2040. But passenger transport only accounts for about a quarter of global oil consumption and 8% of global GHG emissions.
- The industrial sector represents 24% of global emissions, more than the entire transportation sector globally. On average, industrial emissions have grown by more than 3% every year since 2000. No nation has included industrial emissions reductions in their Paris pledges, in part because there are few technical options to manage them.
- Although most studies and key assessments do not achieve a 2ºC or 1.5ºC climate target without widespread CCS, especially for industrial sources, deployment remains slow. CCS received less than 1% of global clean energy investment from 2006-2016.
- Agriculture, forestry and other land use activities, accounted for about 23% of global anthropogenic GHG emissions in the 2007-2016 period and have yet to achieve global coordinated mitigation efforts. Like industrial emissions, these sectors have few technical options and are politically challenging.

Global Greenhouse Gas Emissions by Sector



Global Energy Related CO_2 Emissions



Source: (left) US EPA, 2017, (right) IEA WEO 2018