Energy Transition

→ Combating Climate Change

Michael Alowitz P.E.
GHD

World Energy Outlook

Setting the stage

- Global Energy Market under stress – Russia's Invasion of Ukraine
- Energy Transition is key to Energy Security and long-term climate goals
- Renewables, Energy Efficiency and Electrification key to Energy Transition
- Geopolitics will play a major role in accelerating future energy transition
- The Russian invasion of Ukraine and the EU's dependence on Russia show that a diversification of energy supplies is critical to establishing energy security
- Global Environmental Justice
- Will impact EHS roles

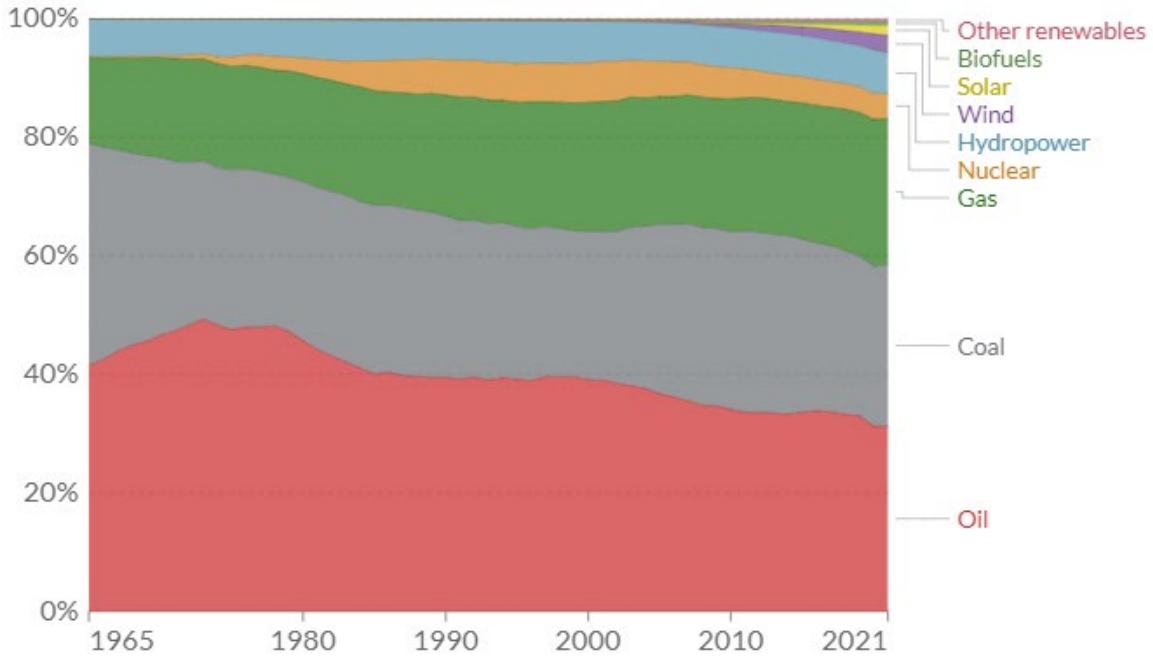
World Energy Outlook

Energy consumption by source, World

Our World in Data

Primary energy consumption is measured in terawatt-hours (TWh). Here an inefficiency factor (the 'substitution' method) has been applied for fossil fuels, meaning the shares by each energy source give a better approximation of final energy consumption.

Change region | Relative



Source: BP Statistical Review of World Energy
Note: 'Other renewables' includes geothermal, biomass and waste energy.

CC BY

1965 — 2021

CHART | TABLE | SOURCES | DOWNLOAD

Source:

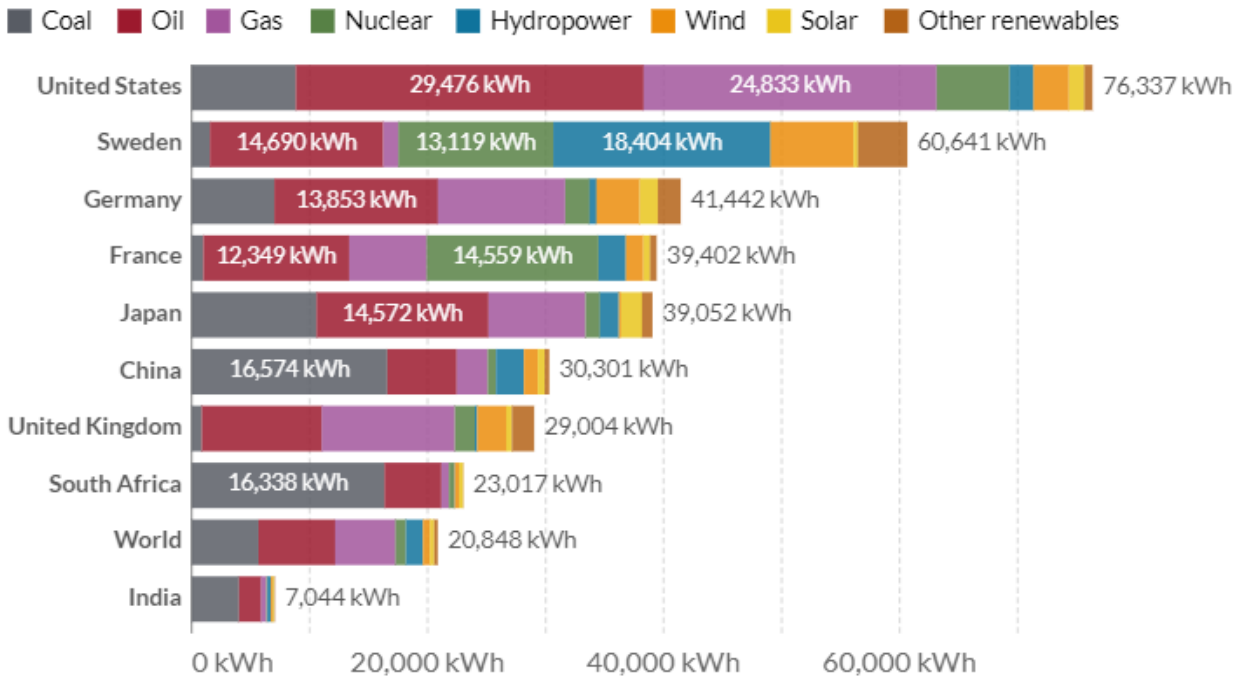
Edit

Per capita primary energy consumption by source, 2021

Our World in Data

Primary energy is calculated based on the 'substitution method' which takes account of the inefficiencies in fossil fuel production by converting non-fossil energy into the energy inputs required if they had the same conversion losses as fossil fuels.

Add country | Relative



Source: Our World in Data based on BP Statistical Review of World Energy

CC BY

1965 — 2021

CHART | TABLE | SOURCES | DOWNLOAD

Source: https://ourworldindata.org/grapher/per-

Edit

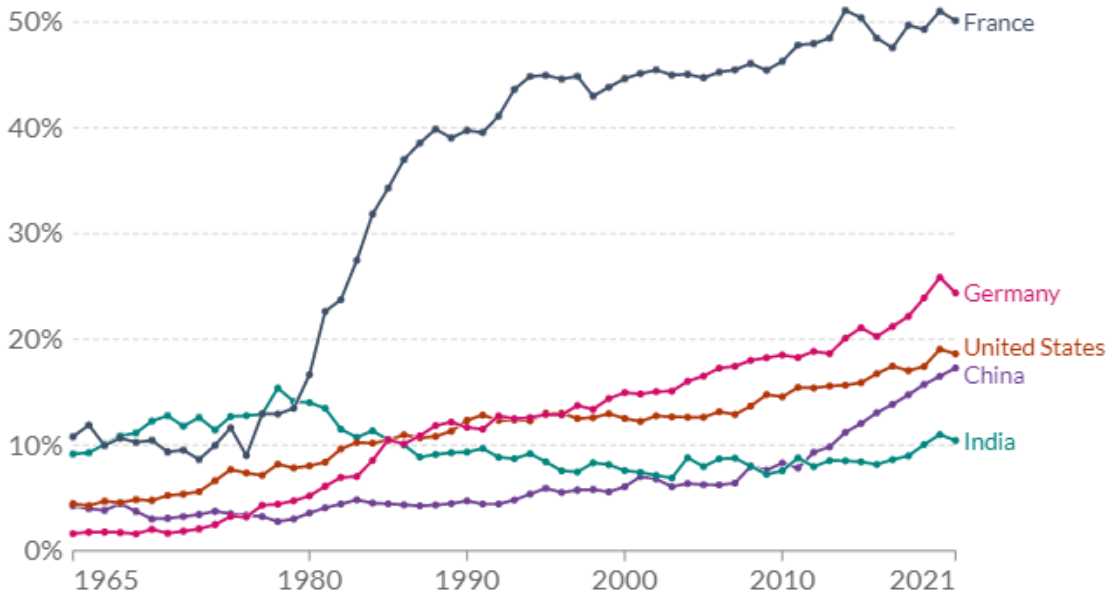
World Energy Outlook

Share of primary energy from low-carbon sources

Our World in Data

Low-carbon energy is defined as the sum of nuclear and renewable sources. Renewable sources include hydropower, solar, wind, geothermal, wave and tidal and bioenergy. Traditional biofuels are not included.

Add country



Source: Our World in Data based on BP Statistical Review of World Energy (2022) CC BY
Note: Primary energy is calculated using the 'substitution method' which takes account of the inefficiencies energy production from fossil fuels.

1965 2021

CHART MAP TABLE SOURCES DOWNLOAD

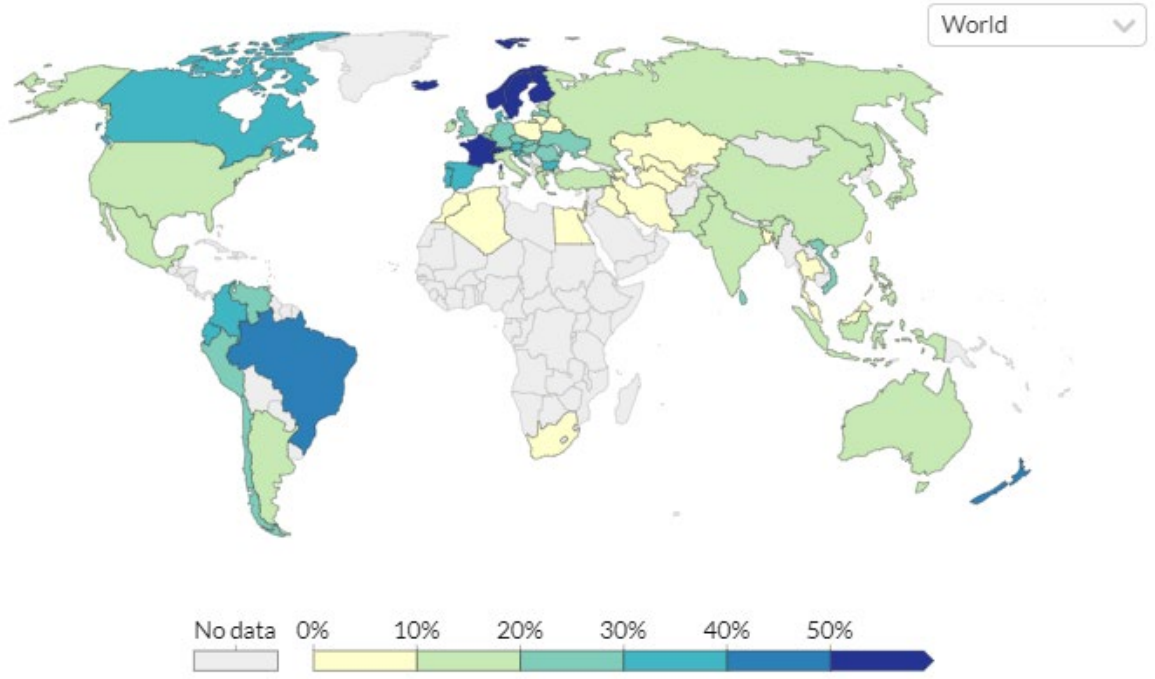
Source: https://ourworldindata.org/grapher/low-carbon-share-energy?

Edit

Share of primary energy from low-carbon sources, 2021

Our World in Data

Low-carbon energy is defined as the sum of nuclear and renewable sources. Renewable sources include hydropower, solar, wind, geothermal, wave and tidal and bioenergy. Traditional biofuels are not included.



Source: Our World in Data based on BP Statistical Review of World Energy (2022) CC BY
Note: Primary energy is calculated using the 'substitution method' which takes account of the inefficiencies energy production from fossil fuels.

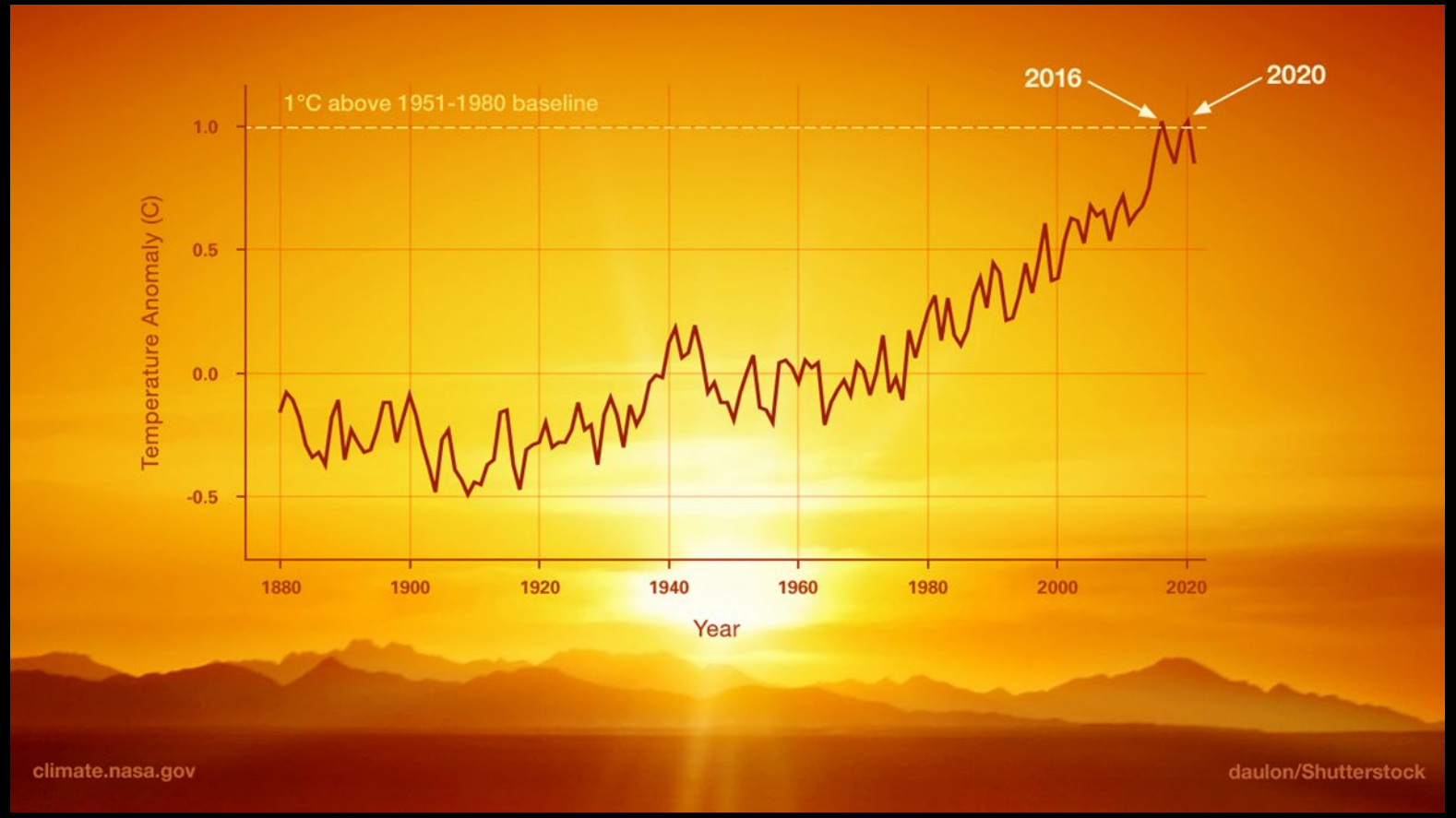
1965 2021

CHART MAP TABLE SOURCES DOWNLOAD

Source: https://ourworldindata.org/grapher/low-carbon-share-energy

Edit

Energy Transition – Framing and Context



This graph illustrates the change in global surface temperature relative to 1951-1980 average temperatures, (Source: NASA's Goddard Institute for Space Studies).

Global warming: Long-term heating of Earth's climate system observed since the pre-industrial period (between 1850 and 1900) due to human activities which increases heat-trapping greenhouse gas levels in Earth's atmosphere.

Climate Change: Long-term weather pattern changes due to human and natural processes

Human-induced warming reached approximately 1°C above pre-industrial levels in 2017, increasing at 0.2°C per decade

Impact of 1.5 °C in global warming will be rising sea levels, increasing ocean acidification, and extreme events, such as floods, droughts, and heat waves (IPCC)

If all anthropogenic emissions were reduced to zero now, any further warming would likely be less than 0.5°C over the next two to three decades (high confidence), and likely less than 0.5°C on a century time scale (medium confidence)

Solution:

Ambitious mitigation actions are indispensable to limit warming to 1.5°C

Energy Transition and decarbonization to achieve net-zero carbon goals

Energy Transition – Action to mitigate Climate Emergencies

Global Response: UNFCC in coordination IPCC organized series of conventions (COPs) to review data, set targets and formulate global reaction to climate change:

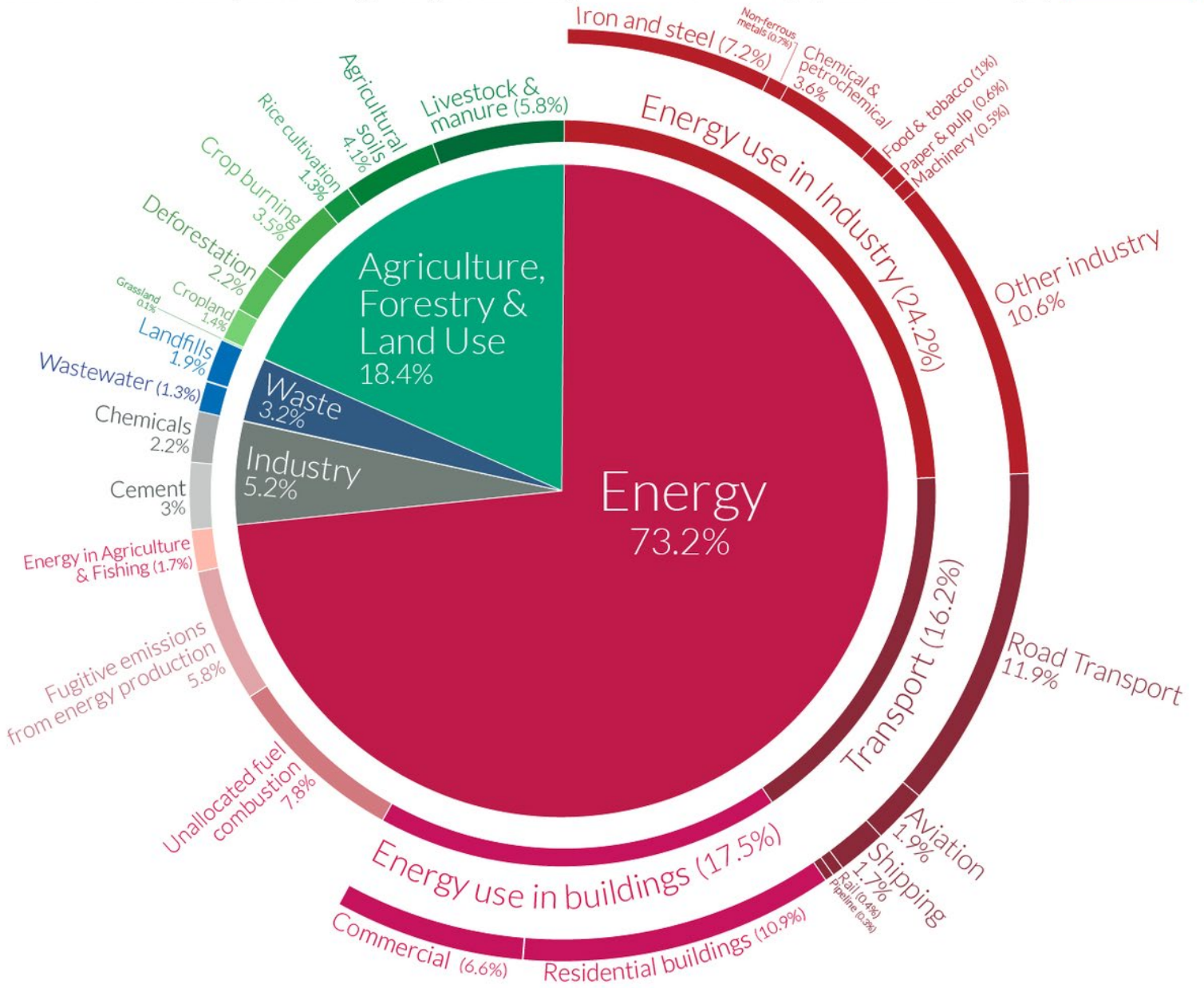
- **COP21 Paris in 2015**: Limit Global warming by 2 °C above pre-industrial levels by 2050 with stretch goal of 1.5 °C. Countries setting voluntary emission targets

- **COP26 Glasgow in 2021**: Countries collectively agreed to work to reduce the gap between existing emission reduction plans and what is required, so that the rise in the global average temperature can be limited to 1.5 degrees. For the first time, nations are called upon to phase down unabated coal power and inefficient subsidies for fossil fuels. Focus on Energy Sector (**accounts for 75% of GHG emissions**)

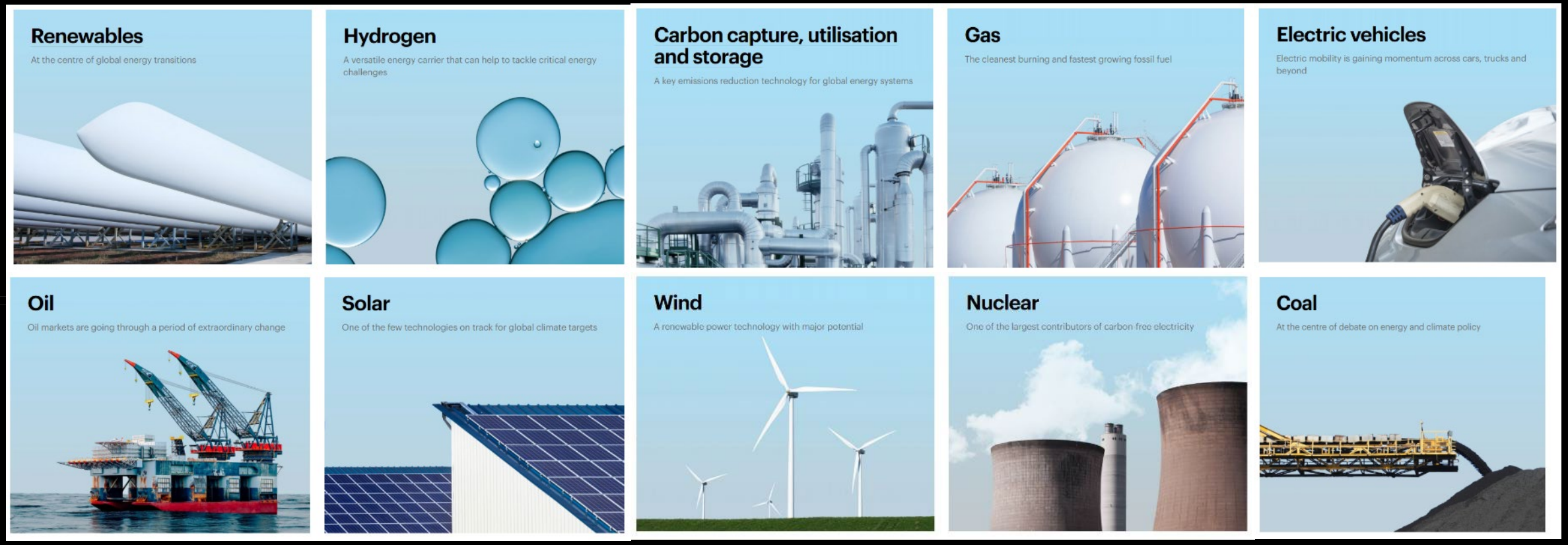
Global greenhouse gas emissions by sector

This is shown for the year 2016 – global greenhouse gas emissions were 49.4 billion tonnes CO_2eq.

Our World in Data



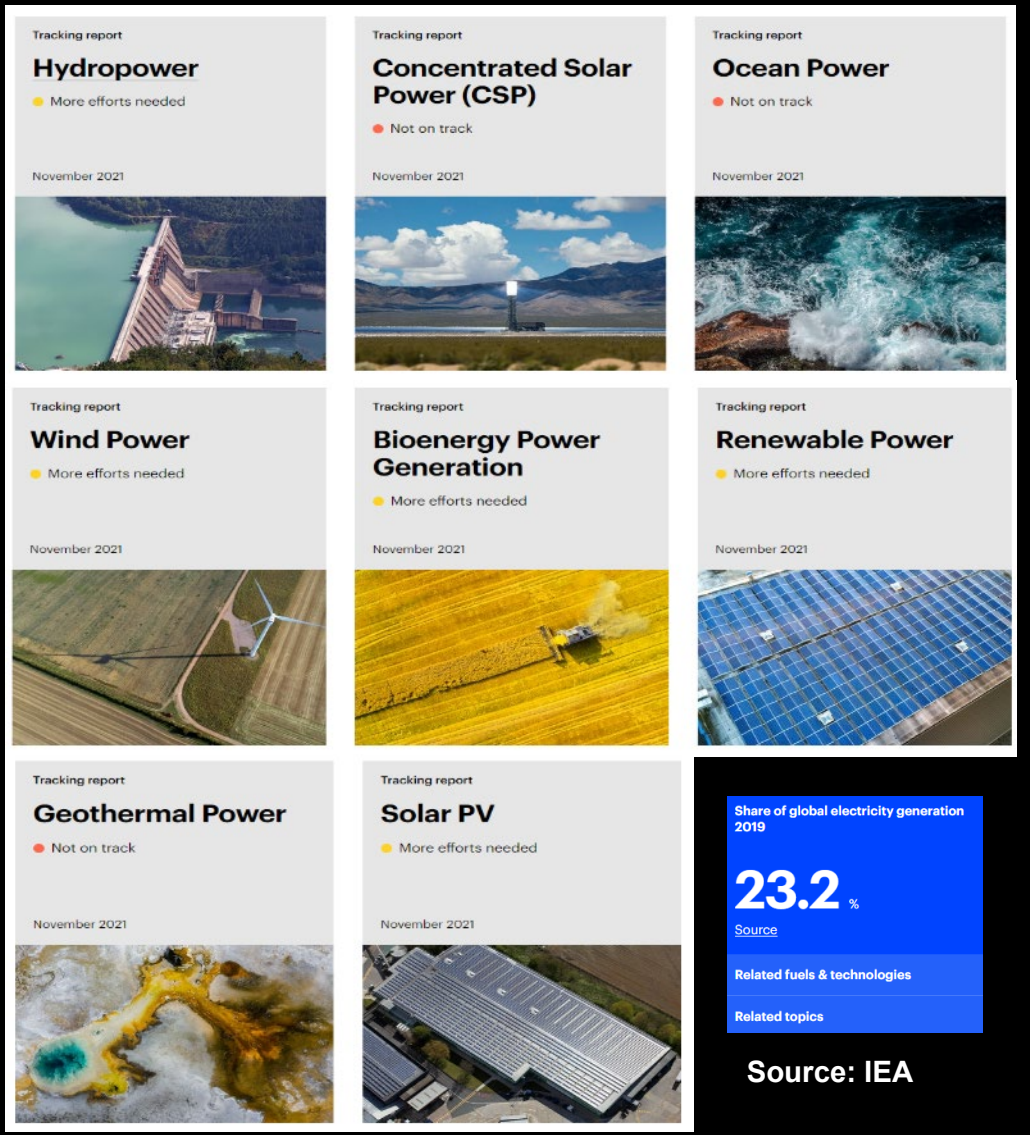
Energy Transition – Fuels and Technologies



Renewable Power

More efforts needed

Needs to expand significantly (60%) to meet the net zero goals by 2050. Government policies are critical for renewable energy market



Source: IEA

Wind Power

More efforts needed

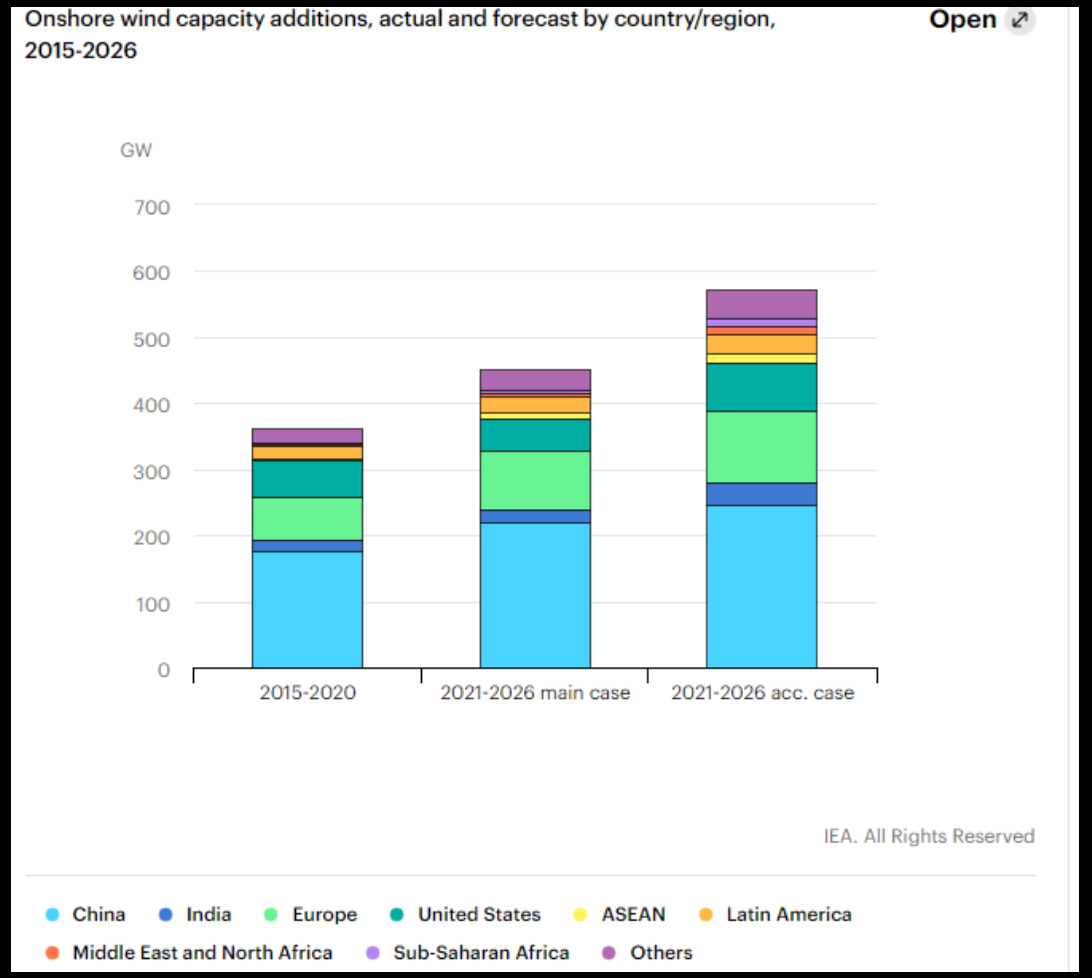
Onshore wind: Proven, mature technology with an extensive global supply chain
Offshore wind: wind is also expected to grow rapidly
Forecast: Average 75 GW per year over the 2021-2026 period.

Pros

- Green Energy
- Low Maintenance
- Employment

Downside

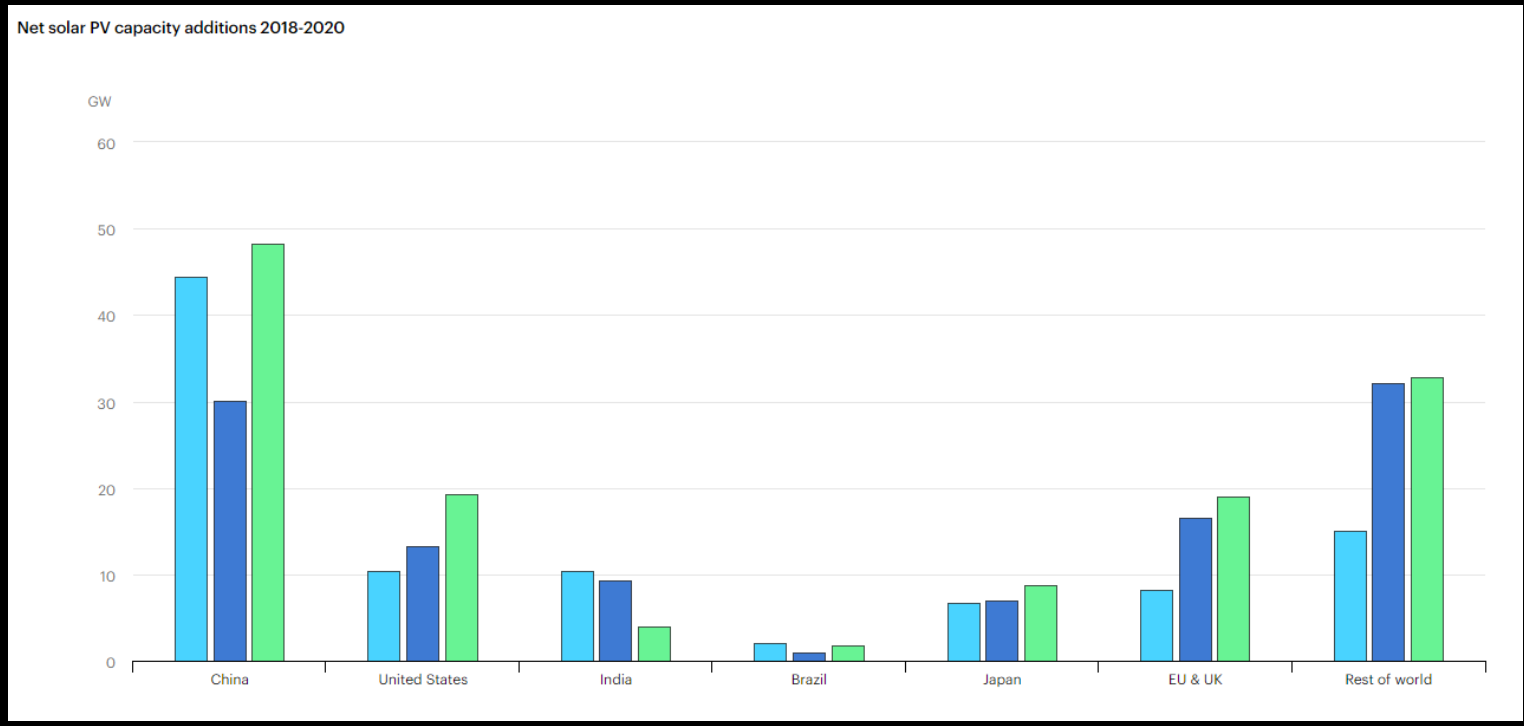
- Wind Reliability
- Threat to wildlife
- Noise and Visual Pollution
- Expensive setup cost
- Efficiency – Location-specific
- Shadow Flicker
- Large footprint. Ecological risk



Solar PV

More efforts needed

- Solar PV generation increased a record 156 TWh (23%) in 2020 to reach 821 TWh
- Solar PV is becoming the lowest-cost option for electricity generation in most of the world, which is expected to propel investment in the coming years.
- 3rd Largest renewable source (off-shore wind, hydropower)



Hydrogen

- More efforts needed

Why blend H_2 in natural gas systems anyway?

Utilities and energy companies are increasingly looking to blending hydrogen into their existing natural gas systems to:

1. Decarbonise their operations
2. Provide energy storage
3. Enable a hydrogen economy

Hydrogen colour palette

Colour code	Brown	Grey	Blue	Turquoise	Green
Energy source	Coal or lignite	Natural gas	Any non-renewable energy source	Methane	Any renewable energy source
Process of getting hydrogen	Gasification	Steam methane reformation	Steam methane reformation and carbon capture & storage	Pyrolysis	Electrolysis of water
Highest to lowest greenhouse gas emissions	←				→
Lowest to highest acceptance level	←				→

Unlocking organic waste for a greener future, sooner

No time to waste

Barring change, our solid waste will increase by

70%

Globally, almost half of municipal waste is food and green waste

40%

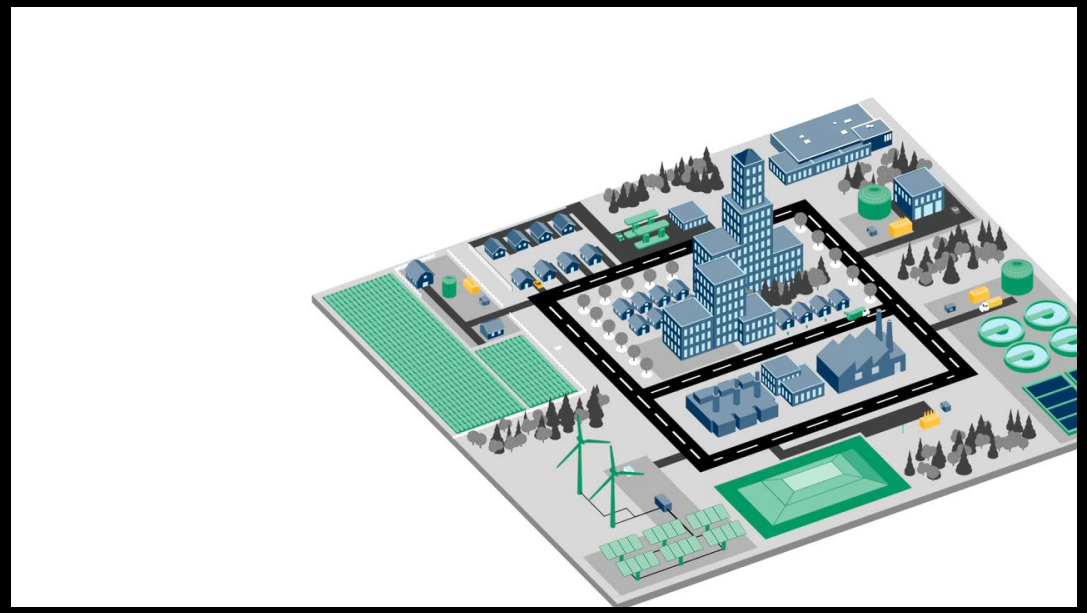
Everyone needs to manage their waste – from large-volume producers to everyday consumers.

And if individuals, communities and governments start to think of waste not as a problem, but as a growing resource to be leveraged – then we can start tapping into this exciting closed-loop energy opportunity to achieve a greener future, sooner.

Right time to act

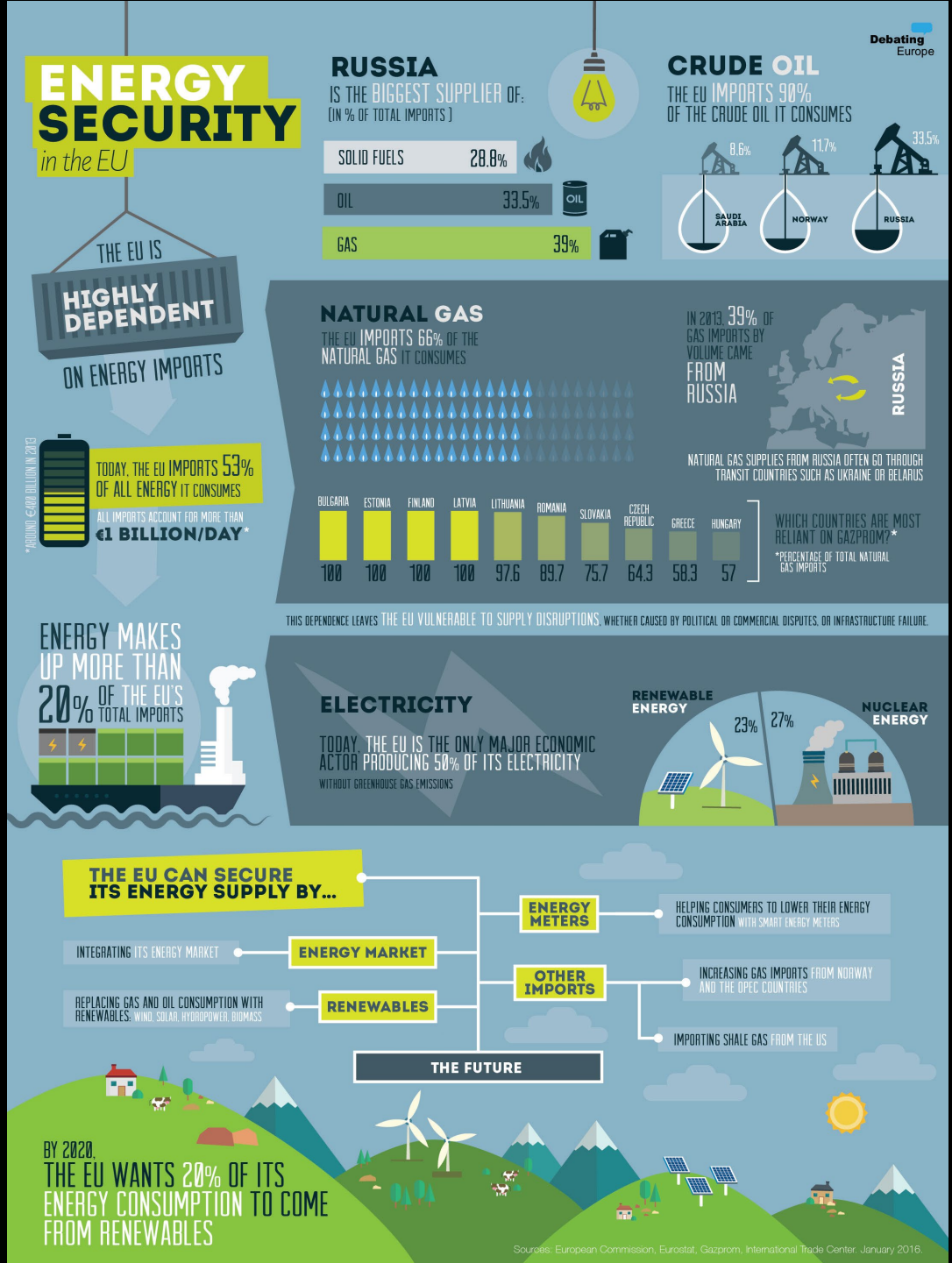
Solid waste-related greenhouse gas (GHG) emissions could increase by

2.6B tonnes²



Natural Gas

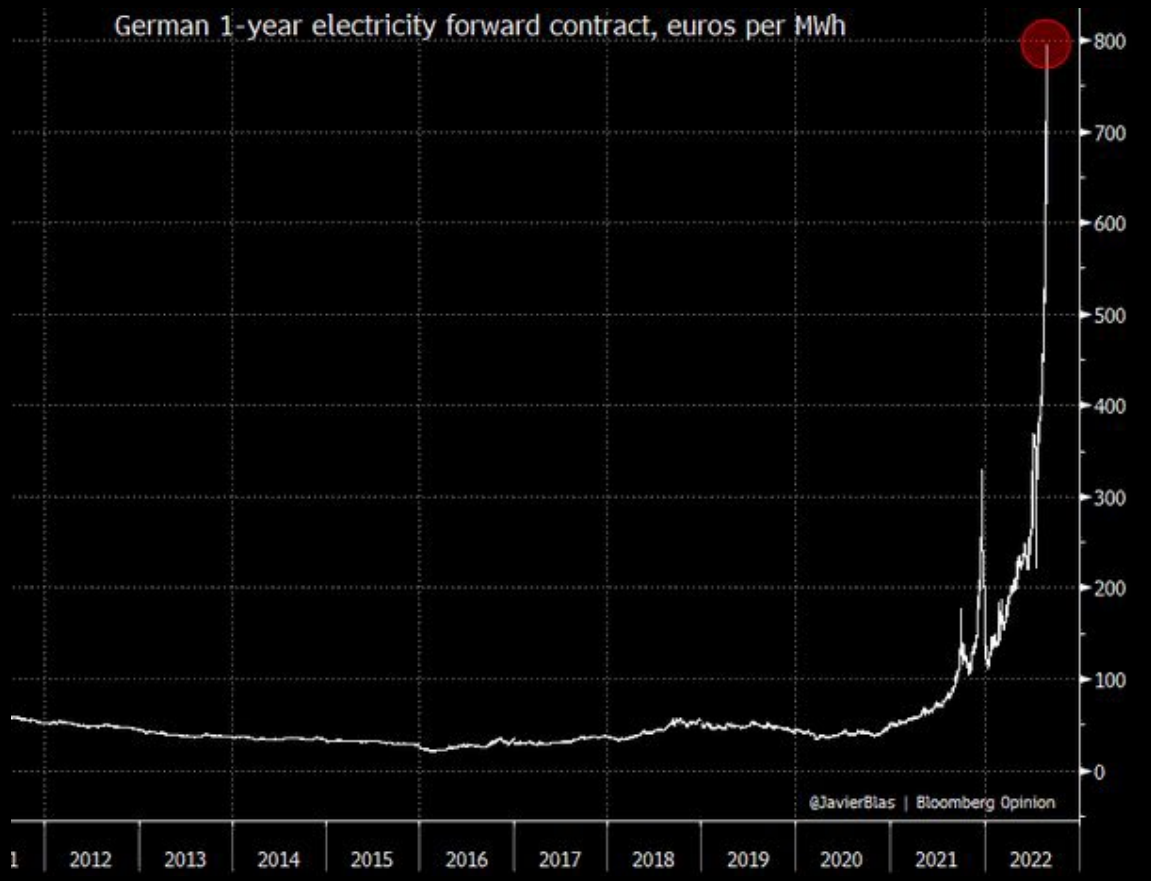
- Russia's invasion of Ukraine has triggered a major energy supply and security crisis that has sent commodity prices to new highs, with wider implications for the global economy.
- Europe has been at the epicenter of market tensions
- Total natural gas demand in the United States, including exports, increased by an estimated 3% y-o-y in 2021 (LNG and pipeline exports
- LNG exports ramped up during 2021, recording a 50% y-o-y increase, while pipeline flows to Mexico grew by 9%. US expects production growth due to exports
- Asia Pacific region saw its gas demand increase by an estimated 6% in 2021
- Oil and Gas companies have pledged net zero carbon goals
- Future outlook for Natural Gas depends on the speed of energy transition



Financials Matter

Renewable Energy Prices Hit Record Lows: How Can Utilities Benefit From Unstoppable Solar And Wind?

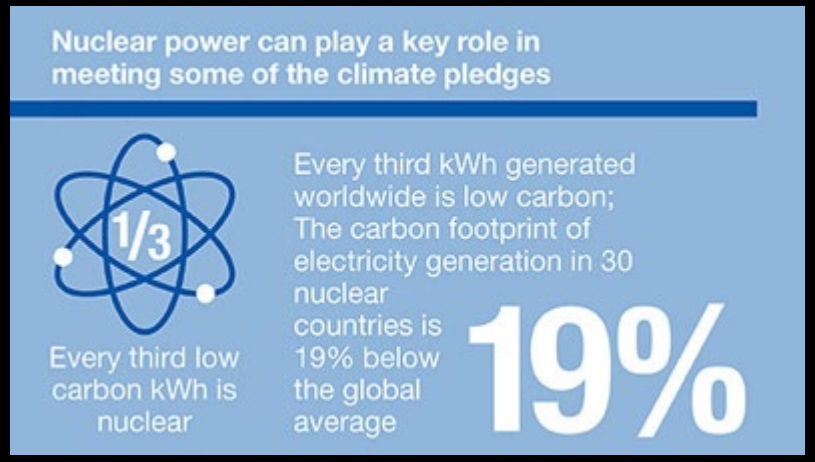
Forbes, Jan 2020

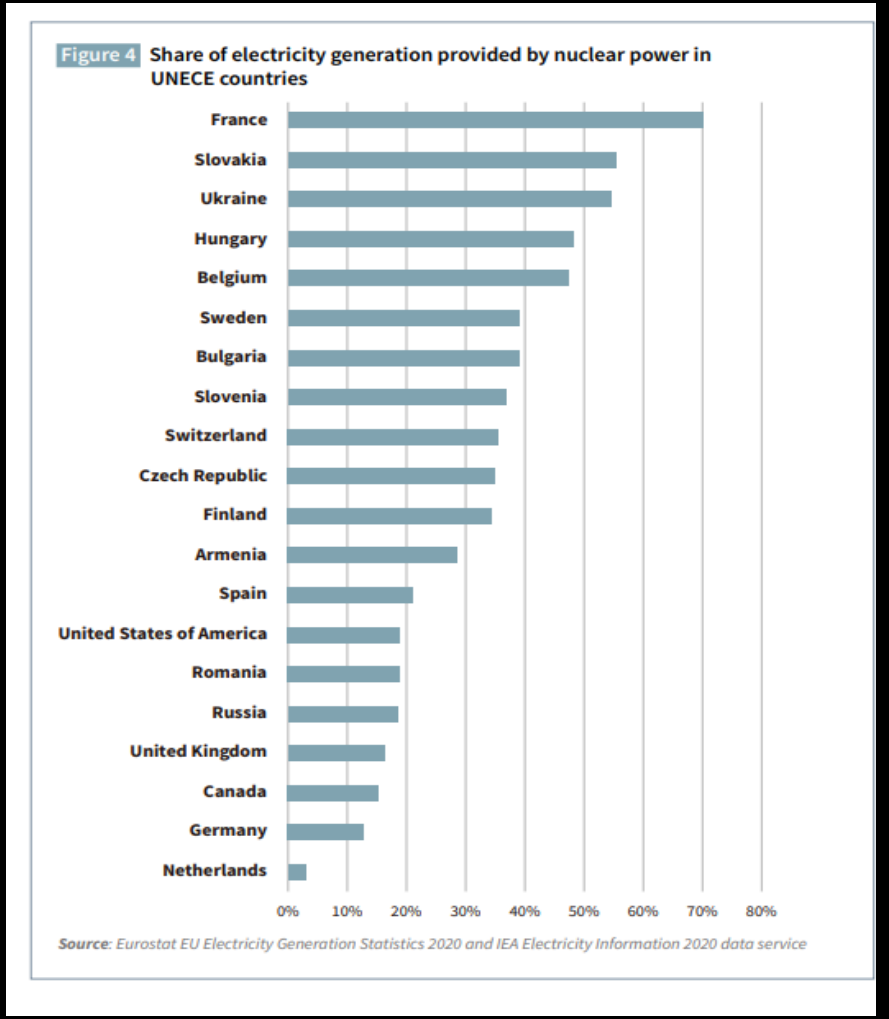


Nuclear Power

Not on track

- Nuclear power ~ 10% of electricity generation globally
- Large up-front costs and long lead times for projects, trouble competing against natural gas units
- Nuclear power plants keeps power grids stable and complementing decarbonization strategies
- The Net Zero Scenario targets 20 GW of new nuclear capacity annually between 2020 and 2050





Carbon Capture, Utilization and Storage

- Not on track

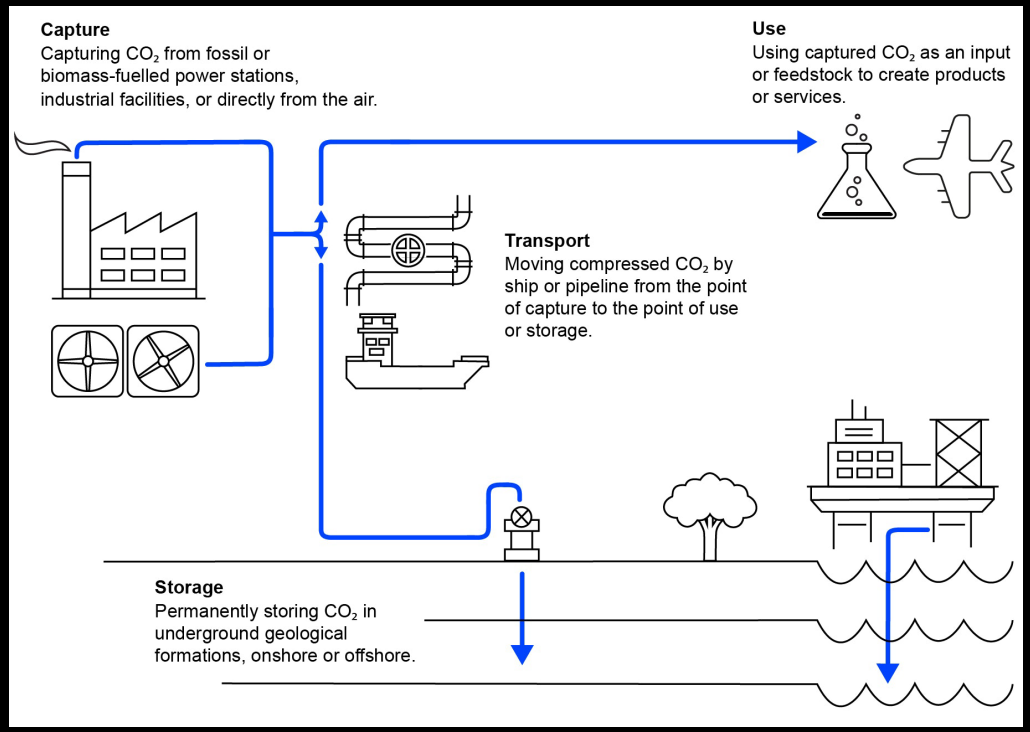
Tracking report – November 2021

Capture of CO_2 from fuel combustion or industrial processes and either its use as a resource to create valuable products or services or its permanent storage deep underground in geological formations.

Strengthened climate goals and new investment incentives are delivering unprecedented momentum for CCUS, with plans for more than 100 new facilities announced in 2021

CCUS technologies contribute to clean energy transitions:

- Tackling emissions from existing energy infrastructure such as power and industrial plants;
- Providing a solution for some of the most challenging emissions from heavy industries like cement and chemicals, as well as from aviation;
- Offering a cost-effective pathway for low-carbon hydrogen production in many regions;
- Removing CO2 from the atmosphere.



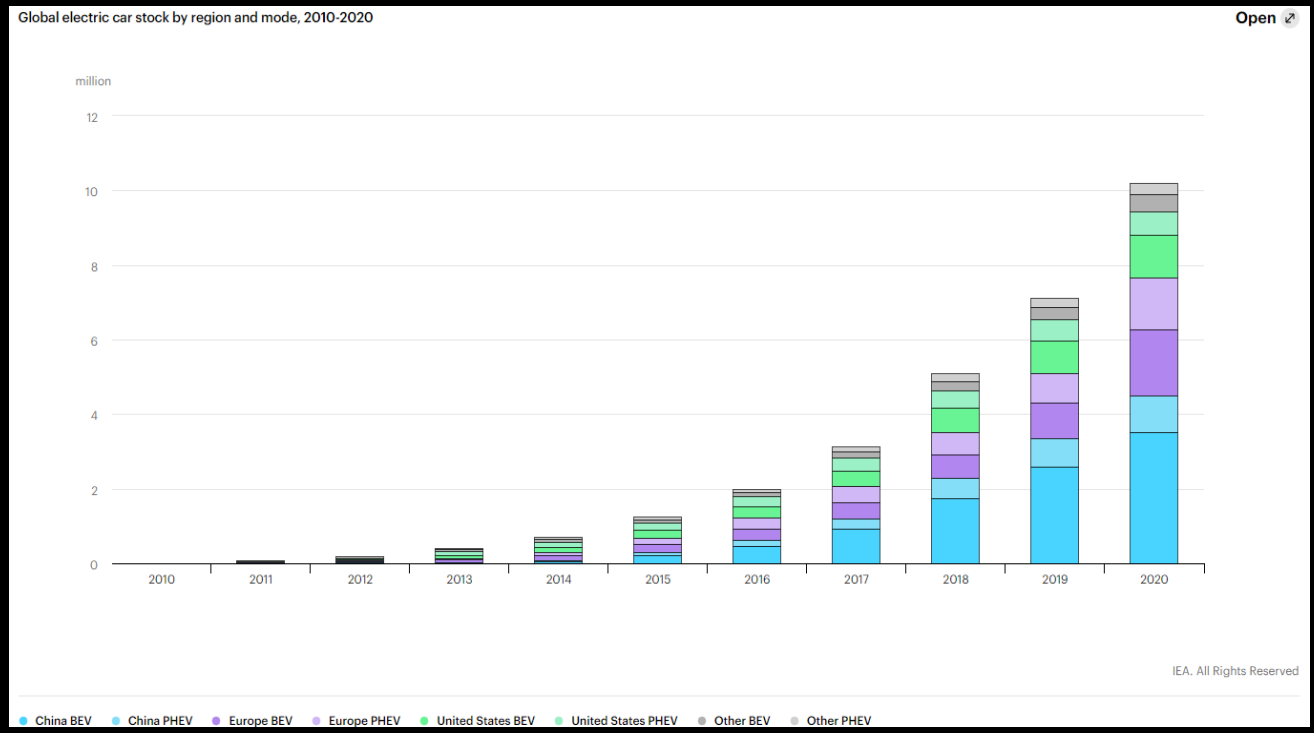
Electric Vehicles

On track

Electric car sales reached a record 3 million in 2020, up 40% from 2019.

Strong growth was a stark contrast with general car market sluggishness globally, with overall car sales down 16% due to the Covid-19 crisis

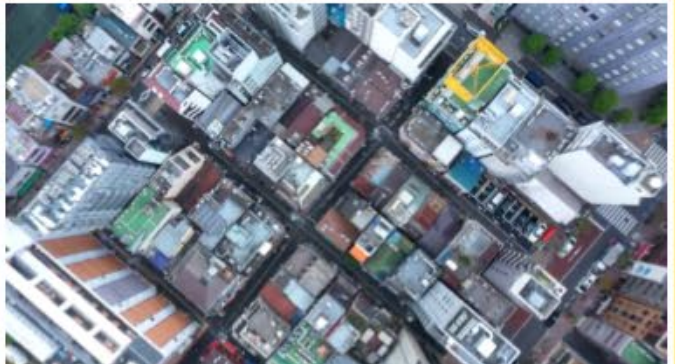
- Electrification continues to expand in other road transport modes
- Battery manufacturing has increased, but must accelerate to meet Net Zero needs
- Strong policy support is key to electric car market
- EU revised key regulations to accelerate EV deployment
- China strengthens its New Energy Vehicle mandate but scales back EV subsidies
- Canada and the United States strengthen EV targets, and India extends incentives



The race to **Energy Transition** is on.

Shifting World's Socio-Technical systems away from production and consumption of fossil fuels and reimagine our energy systems – for the better.

The global energy transition is not just transformation of energy systems. It is transformation of communities and economies.



Sustainability, affordability and accessibility are vital elements of any energy system design

Whether it's a high density urban community, an island nation seeking improved energy security and reliability, a remote off-grid mine site seeking to decarbonise operations, or an industrial or water asset owner – the ingredients are the same.

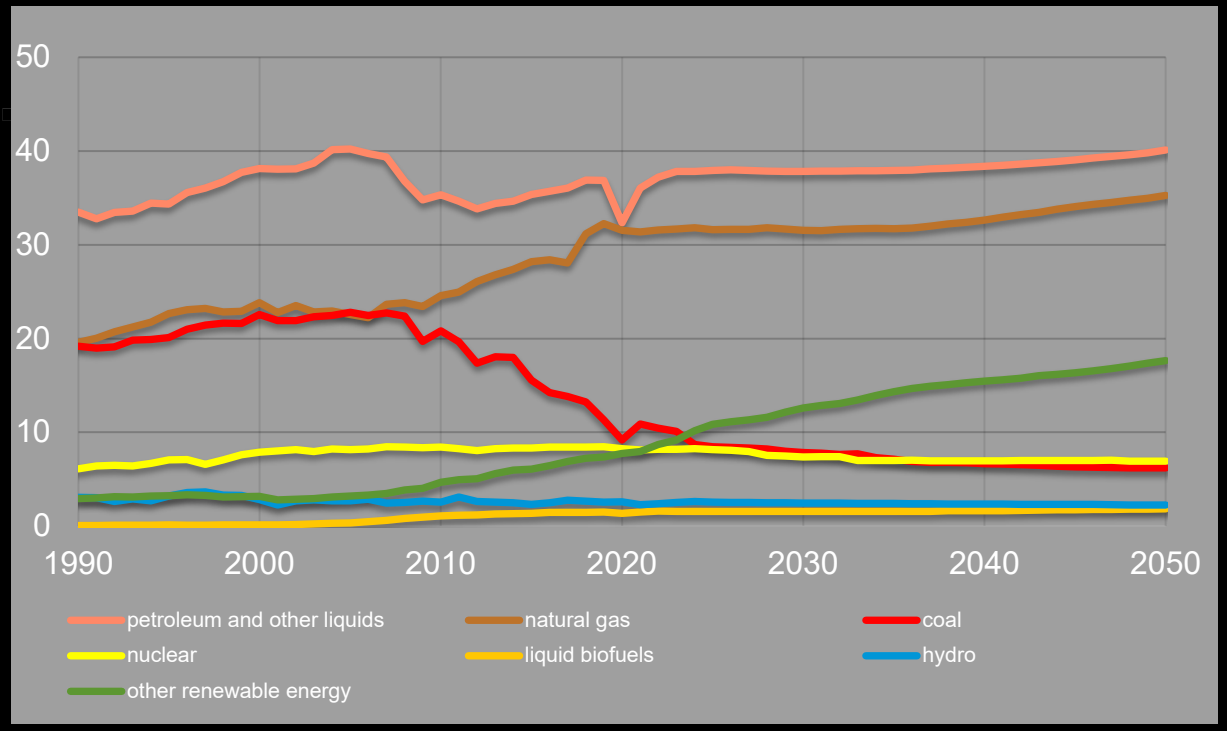
Energy Transition in USA

USA Energy Outlook

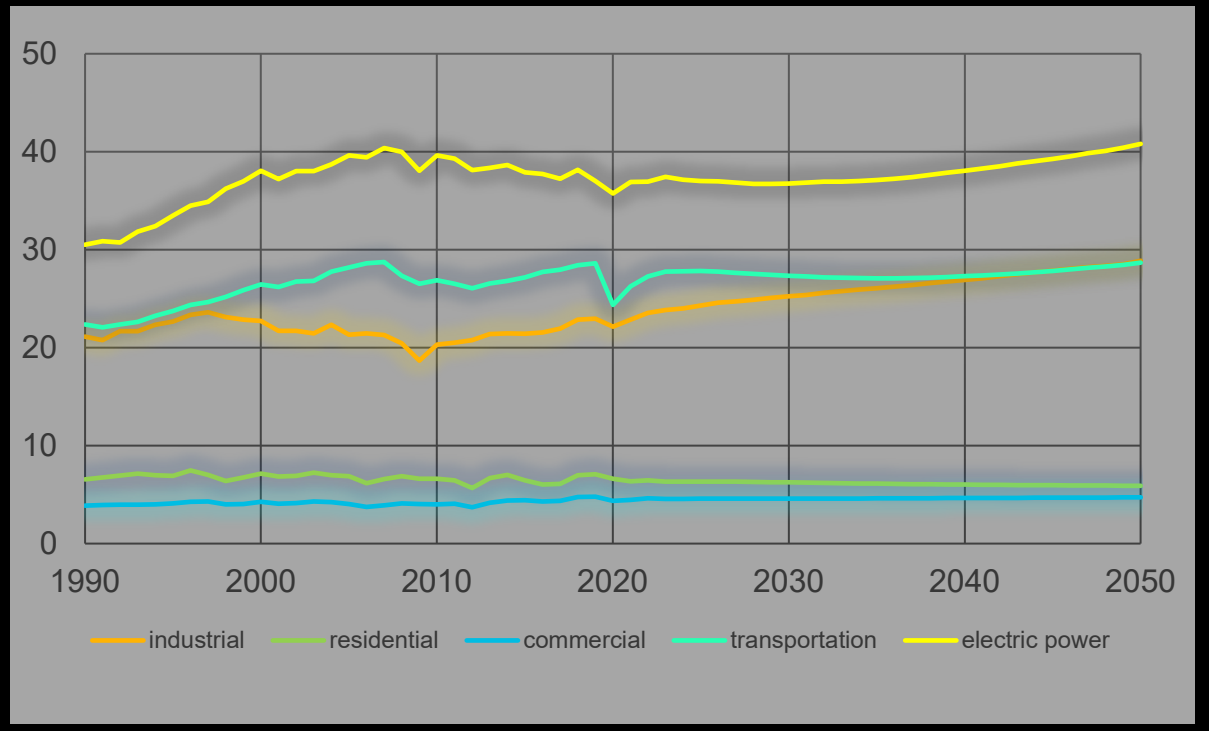
Petroleum and natural gas remain the most-consumed sources of energy in the United States through 2050, but renewable energy is the fastest growing

Wind and Solar Incentives along with technology advancement support strong Renewable growth

Energy consumption by fuel
quadrillion British thermal units



Energy consumption by sector
quadrillion British thermal units

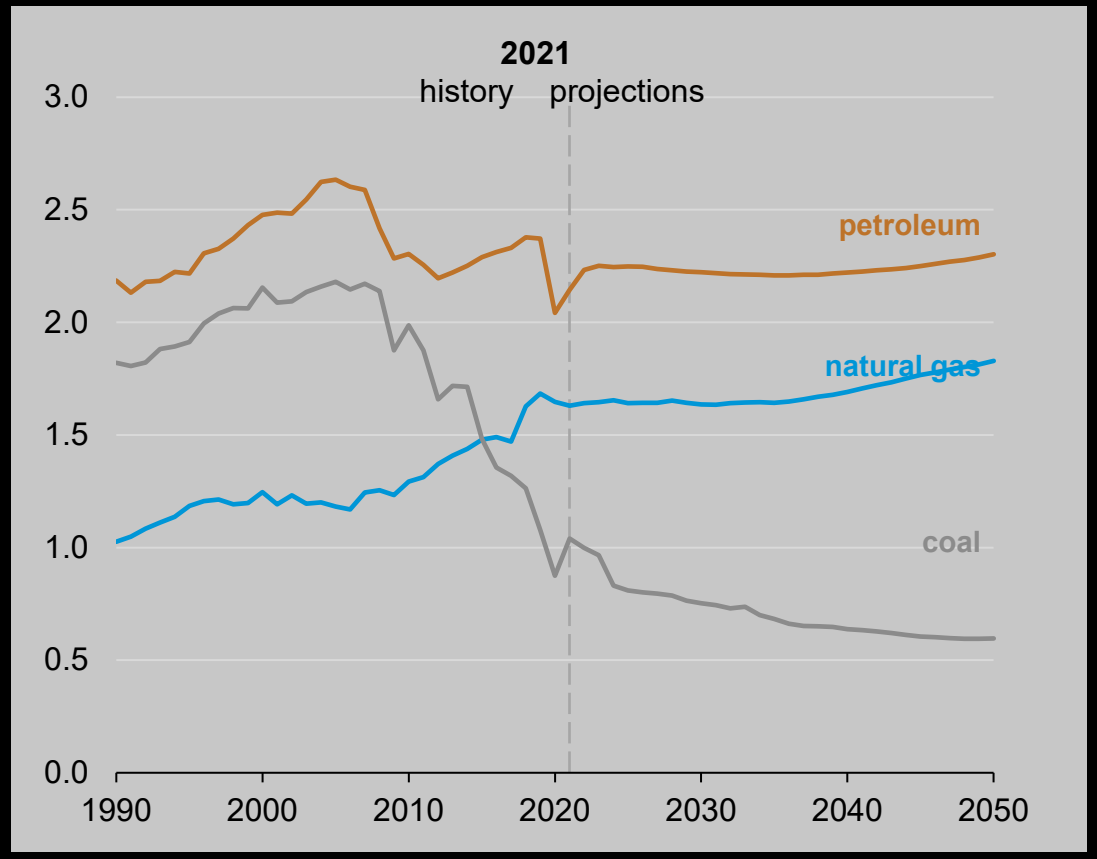


USA Energy Outlook

Energy-related CO_2 emissions by sector and fuel

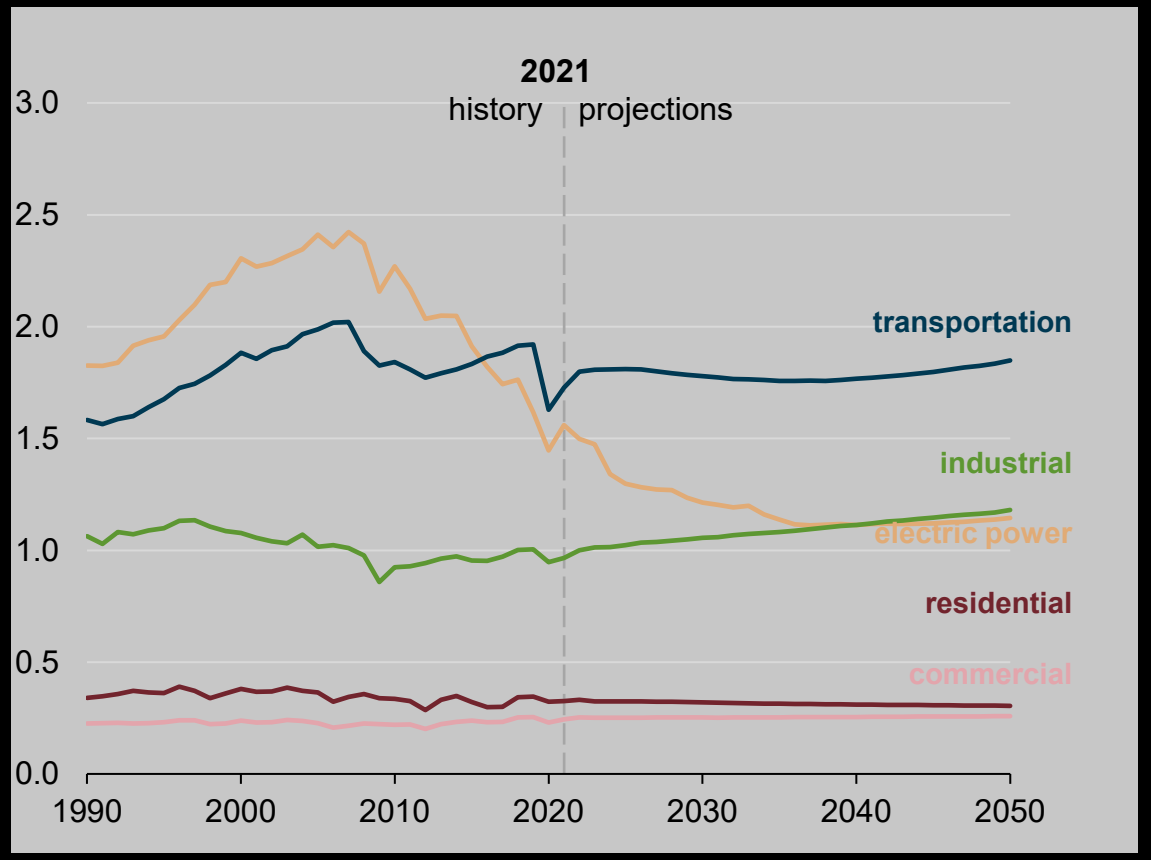
Energy-related CO_2 emissions by fuel

billion metric tons



Energy-related CO_2 emissions by sector

billion metric tons



Note: Series does not include greenhouse gases other than CO_2. Industrial sector CO_2 emissions do not include process emissions, such as the emissions from cement clinker production.

Source: AEO2022 Press Release
March 3, 2022

Energy Transition Opportunities – The Biden Plan

The Biden Plan

$1.7Ⓣ investment → **100%** clean energy by **2050**

10yrs time → **net 0** emissions

1 Hydrogen

↳ **The Biden Plan** calls for investing $400 billion over 10 years to support clean energy research and innovation, including producing carbon-free hydrogen from renewables at the same price as shale gas.

2 Water-energy nexus

↳ **The Biden Plan** has prioritized access to safe drinking water for communities experiencing a water crisis through improved water infrastructure to address contamination and accessibility.

3 Energy from waste

↳ **The Biden Plan** supports the deployment of methane capture and treatment technologies at landfills to reduce emissions from waste breakdown and generate renewable fuels and electricity.

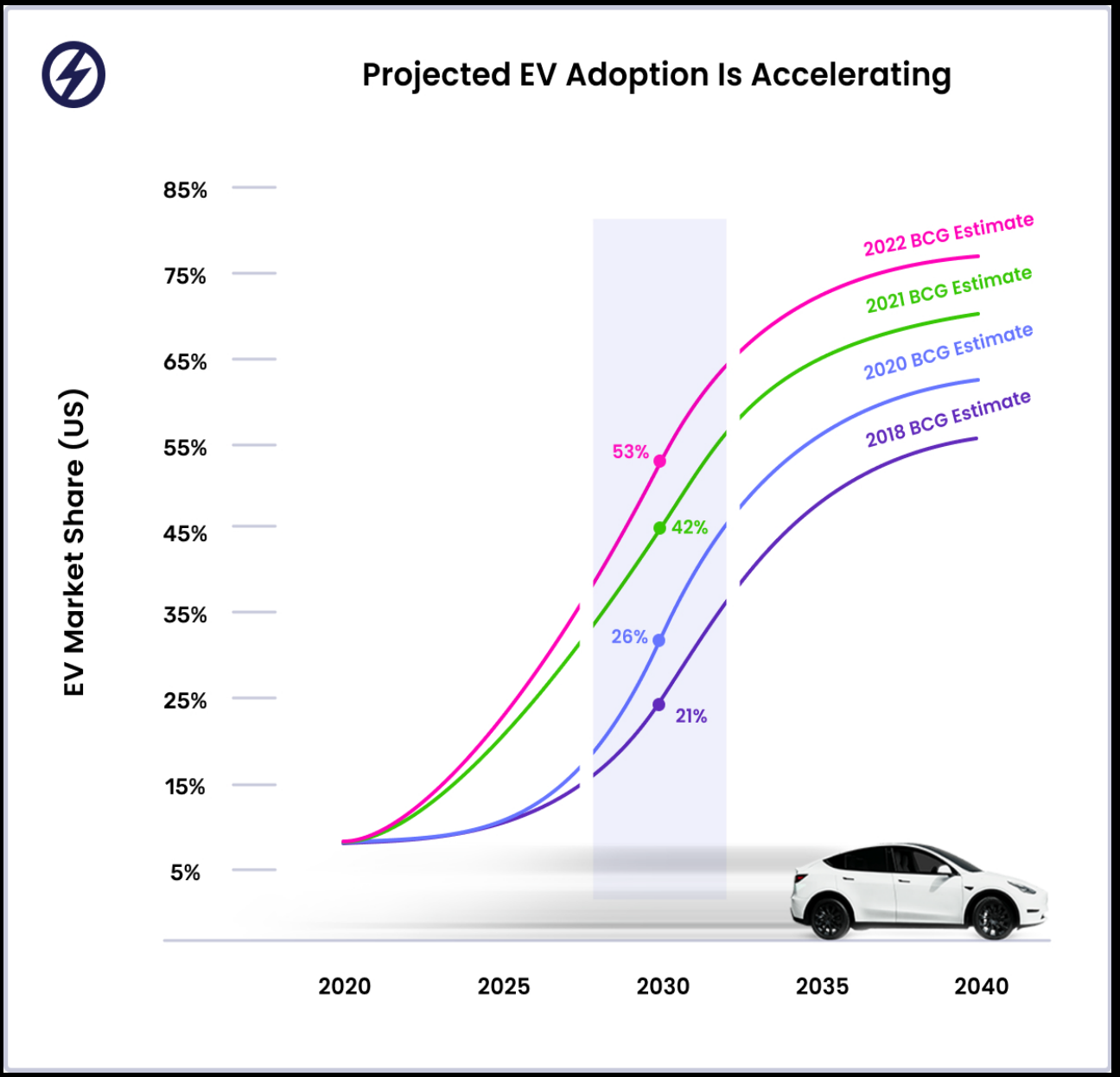
4 Oil and gas decarbonization

↳ **The Biden Plan** calls for requiring aggressive methane pollution limits for new and existing oil and gas operations.

5 Transportation decarbonization

↳ **The Biden Plan** calls for developing new fuel economy standards to drive towards 100% clean energy, zero-emission vehicles, and the entire federal fleet's conversion to electric vehicles.

ELECTRIC VEHICLES



Washington, Massachusetts, and California – 2035

Average Vehicle Trip in US 45 miles (NHTS 2009 Transferability Stats)

The rate of change calls for rapid decision-making – it's time to get onboard or be left behind

2/3 of the global banking sector are now aligned with Paris Agreement goals

>$9T will be cumulatively invested in renewables by 2050

+100 cities and 77 countries have committed to net zero carbon targets by 2050

WHAT DOES THIS MEAN FOR YOU?

ESG

Critical to Financing

Evolution of Factors Deciding Projects

The energy transition has reached a critical tipping point.

The global energy order is changing.
The geopolitical drivers around energy security and the price of crude oil have the potential to change the ‘energy order’ forever.

The global energy transition is not just a transformation of energy systems. It’s a transformation of communities and economies.

Underpinning this shift is an urgent need to develop clean energy solutions to tackle the impacts of climate change, as we collectively engage in the complex and important process of decarbonization.

.

References

1. International Energy Agency – World Energy Outlook – https://www.iea.gov
2. GHD Future Energy – https://www.ghd.com/futureenergy
3. US Energy Information Administration – https://www.eia.gov
4. Our World in Data – https://www.ourworldindata.org
5. NASA – Global Climate Change – https://climate.nasa.gov
6. Renewable energy 101 – National Geographic https://www.youtube.com/watch?v=1kUE0BZtTRc
7. Intergovernmental Panel on Climate Change – IPCC https://ipcc.ch
8. Dr. Birol, Faith, Executive Director, IEA and Kant Amitabh, CEO NITI Aayog (National Institute of Transforming Media) Commentary – January 2022, "*India's clean energy transition is rapidly underway, benefiting the entire world",* Commentary published in the Times of India

COMMENTS AND QUESTIONS