Energy Transition

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Real Assets, August 2021

Executive Summary

Introduction and Overview

What is Energy Transition?

- On a broad level, the energy transition can be understood as a structural change in our global energy systems brought about by
  - The increasing appeal of renewables into the energy supply mix
  - Rise in ESG investing and focus
- Current energy transition differs from past transitions in that it is closely tied with notions of sustainability and a reduction of fossil fuel technologies
- Fossil fuel technologies, in being massive carbon dioxide emitters, are thus in the process of being replaced by cleaner technologies

The top 5 energy sources being taken into consideration in the energy transition can be seen on the right figures:

- Wind Energy
- Solar Energy
- Bio Energy
- Hydropower
- Geothermal Energy

WIND ENERGY

SOLAR ENERGY

BIO ENERGY

HYDROPOWER

GEOTHERMAL ENERGY

Drivers of the Energy Transition

One important thing to consider is the impact that the climate change has had on entities, whether it be corporations or sovereign nations.

- Sovereign nations are increasing their commitments towards drastically lowering their emissions and creating sustainability commitments for the near future
  - Recently, China announced efforts in creating a carbon market in their region which is forecasted to double the carbon allowances market worldwide[1]
- US and European carbon markets are also continuing to better develop and expand as time progresses

Renewable Energy Appetite

→ renewable energy investment went up by 2% from 2019 to $303.5 Billion in 2020

→ massive growth potential exists in distributed renewable energy

→ market performance of renewable power shares offer higher returns relative to fossil fuels in US, UK, and Europe

Fossil Fuel Sentiment Weakens

→ BP, Shell and Total announce strategic shifts focused on hydrogen and CCS

→ peaks in demand for oil and gas remain in the near future, coming in 2029 and 2037, respectively

→ energy growth set to be driven by growth in electrification (renewable energy dominated)

Green Investments Surge

→ Investments under ESG guidelines currently at $38 Trillion in AUM

→ Green bond market reached $1 Trillion in issuance since 2007 in 2020

→ $665 Billion in sustainable debt issued in 2020

Source: Forbes, Five Market Trends Driving Energy Transition

Drivers of the Energy Transition

Moreover, there are many efforts by corporations in becoming more sustainable.

- As has been occurring recently, many fossil fuel-based companies have come to recognize the shift in attitude towards an energy transition. This has led to organizations such as
  - BP[1] to begin transitioning themselves away from an only fossil fuel-based corporation
  - Exxon to heavily consider concretely placing goals to reach net zero emissions by 2050[2]
- Larger macroeconomic developments have also contributed to a reality in which the world experiences the energy transition
  - An ever-increasing electricity demand and technological development have equally contributed towards making energy transition efforts worldwide much more feasible.

'Green New Deal'

→ US returns to Paris Agreement under Biden Administration

→ US Announces plans for nearly $2 Trillion in infrastructure and clean energy investment

→ Experiencing a continuing tightening of policies around the world related to emissions

Sustainability Impacts PPAs

→ PPAs are gaining traction worldwide as a means for corporations to address sustainability challenges

→ Acceleration of clean energy adoption in Asia

→ Corporations continue to work towards cutting emissions from their entire value chain which holds global implications

Source: Forbes, Five Market Trends Driving Energy Transition

Energy Transition and ESG

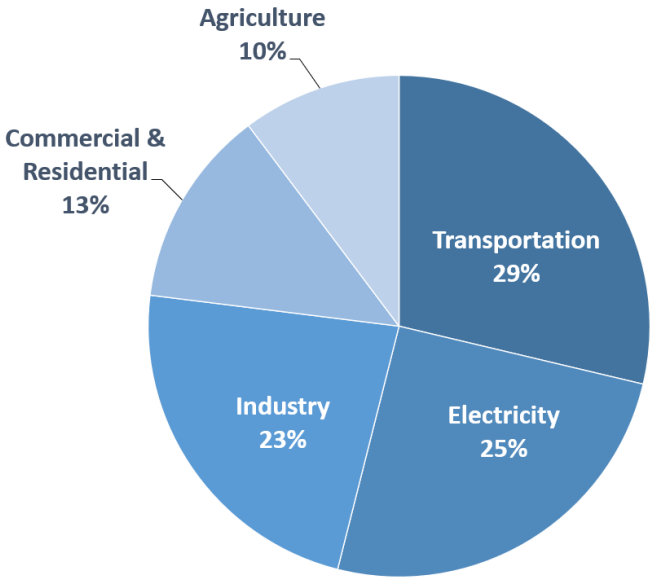
Climate change conditions are ever worsening. These negative conditions, coupled with an ever-increasing investor trend in being more sustainable/conscious, has provoked a rethinking of current energy infrastructure on a global scale.

As presented in the *Climate Change Analysis in the Investment Process*, the net present value costs of climate change are calculated to be $4.2 Trillion USD total, making climate change a force with enough potency to negatively impact economies and financial markets everywhere.

With that being said, the relationship between the ongoing energy transition and ESG is crucial given that on a percentage basis, energy production is one of the biggest contributors to the current climate crisis.

More specifically, intense use of fossil fuels can be understood to be a major contributor to greenhouse gas emissions.

Total U.S. Greenhouse Gas Emissions by Economic Sector in 2019



U.S. Environmental Protection Agency (2021). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019

Environmental	Social	Governance
Climate Change	Customer Satisfaction	Board Composition
Carbon Emissions	Data Protection	Audit Committee
Air/Water Pollution	Data Privacy	Structure
Biodiversity	Gender and Diversity	Bribery and Corruption
Deforestation	Employee Engagement	Executive Compensation
Energy Efficiency	Community Relations	Lobbying
Waste Management	Human Rights	Political Contributions
Water Scarcity	Labor Standards	Whistleblower Schemes

Source: CFA Institute, ESG Investing / CFA Institute, Climate Change Analysis in the Investment Process 2020 / EPA Sources of Greenhouse Gas Emissions

Carbon Markets

- Value of carbon markets increased by 20% in 2020 to $272 Billion
- Carbon markers have expanded fivefold since 2017 as nations continue to implement them as a form of reducing aggregate emissions
- China, a big emitter and entity growing in energy demand, sets 2060 climate target and announced a carbon cap-and-trade program
  - Set to double carbon market worldwide

Three Types of Carbon Markets

Market Elements	ETS Carbon Markets	International Carbon Markets	Voluntary Carbon Markets
Description	• Mandatory participation for large emitters • Some allow limited amount of international Clean Development Mechanism (CDM) credits	• The CDM was the first major international market under the Kyoto Protocol • Emissions reductions transferred across countries	• Independent markets for non-regulated entities to voluntarily reduce emissions • Variety of industry-created standards
Current Status	• Covers 8% of global emissions, growing to 14% with the launch of the China ETS	• Large market, currently stagnating • Article 6 of the Paris Agreement aims to reignite international markets	• Mainly used for corporate social responsibility (CSR) activities • Attractive for small projects
Regulation	• Highly regulated, with robust monitoring, reporting, and verification (MRV)	• UN-recognised accounting methodologies, such as Gold Standard (GS) accounting	• Low to no regulation, different accounting methodologies with varying degrees of rigour
Liquidity	• Highly liquid • In 2018, more than US$200 billion traded in the WCI, RGGI, and EU ETS	• Medium liquidity • Average of US$14 billion traded per year since 2006	• Low liquidity • In 2018, nearly US$300 million traded
Carbon prices	• Range from US$5.7–US$31.5/tCO_2e	• Range from US$0.2–$US0.4/tCO_2e	• Range from US$0.1–US$70/tCO_2e

Source: CFA Institute, Climate Change Analysis in the Investment Process / S&P Global Platts, Energy Transition

State of Energy

State of Energy – Energy Related Policy Adoptions

- As it stands today, almost every developed country worldwide has either began to commit or think about making commitments related to green energy and infrastructure development.
  - These commitments stretch across all market sectors.
- Moving forward, it can thus be expected that mounting pressures for energy related policy adoptions will continue to grow.
  - Notable developments include China announcing that they plan to implement a carbon market which is set to double the shares of global emissions covered under carbon cap programs[1]

New Energy-Related Policies Adopted in 2019 and 2020 by Country

	New energy-related policies	Countries adopting in 2019 or 2020	Countries adopting as a part of Covid-19 response
Industry	• Industrial energy efficiency standards and incentives	Brazil, China, Germany, India, Netherlands, Turkey, United Kingdom, Viet Nam	China, European Union
Transport	• Electric vehicle or efficient vehicle incentives	China, France, Germany, India, Italy, New Zealand	China, European Union, Italy, Spain, United Kingdom
	• Biofuel blending or incentives	Brazil, Ireland	Indonesia
	• Cash-for-clunkers	China	France, Spain
	• CO_2 emissions standards	European Union, New Zealand	
	• Fleet modernisation (e.g. taxis, buses, police)		European Union, Germany, Korea
	• EV production support	India	Germany
	• EV charging infrastructure	Austria, India, Netherlands	European Union, Germany
Buildings	• Appliance efficiency standards	Canada, China, Egypt, Nigeria, United States, Viet Nam,	China
	• Cooling plan	China, India	
	• Higher efficiency building codes	Argentina, China, France, Ukraine , United States	
	• Clean heating incentives	Australia, Germany, New Zealand, United Kingdom	United Kingdom
	• Retrofit subsidies	Estonia, Germany, Ireland, Poland, Ukraine	China, European Union, Germany
	• Public housing & government building retrofits		Germany, Portugal, United Kingdom
	• Efficient appliance incentives	Italy, Korea	Korea
	• Energy efficiency audits	Morocco	Korea
	• Financing for community energy transitions	Canada, Poland	
Cross-cutting	• Carbon pricing	Canada, Singapore, South Africa	
	• Circular economy	European Union	European Union, Korea
	• Energy and emissions reduction targets	European Union, Italy, New Zealand, United Kingdom	
	• Energy poverty or access	Italy	India
	• Hydrogen	Japan	Australia, European Union, Spain
	• CCUS	United States	
Rollback of policies	• Emissions/efficiency standards	United States (CAFE)	China (intensity targets), South Africa (SO_2 emissions)

Source: International Energy Agency, World Energy Outlook 2020

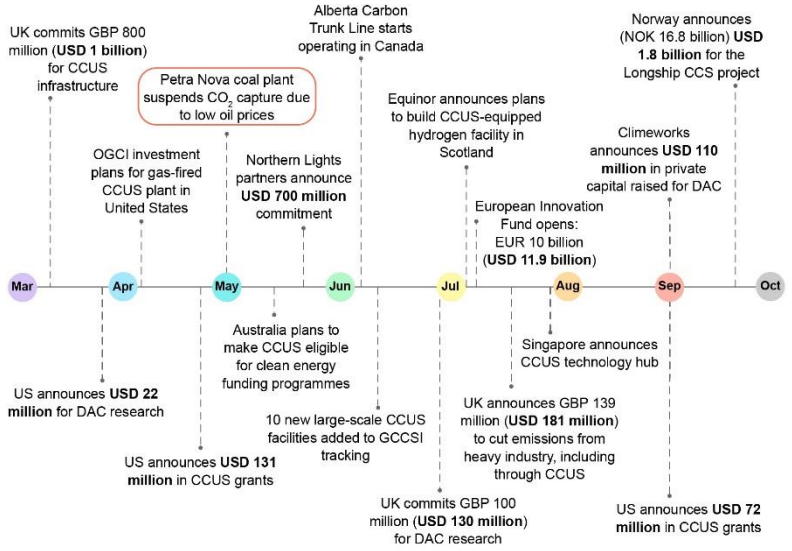
State of Technology – Carbon Capture, Utilization, and Storage (CCUS)

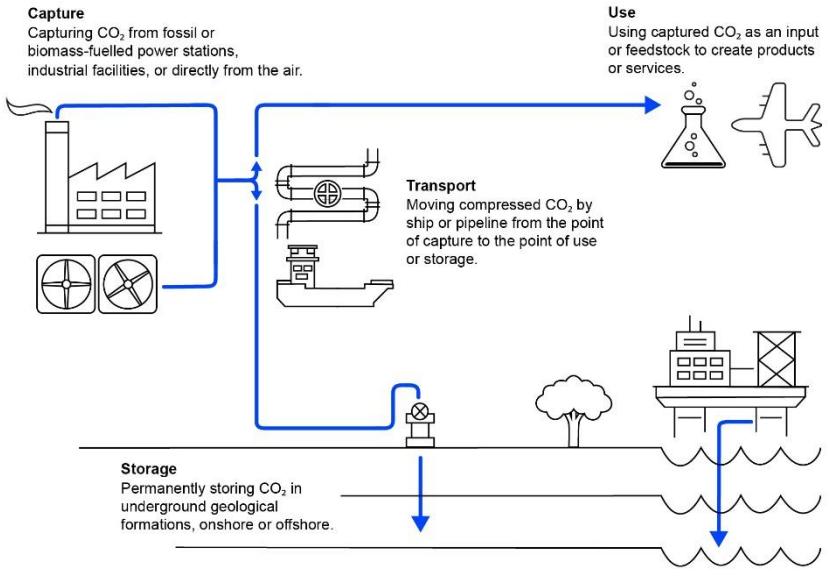
- As can be seen from the March-September 2020 timeline included in this section,
  - CCUS investments remain above a billion in terms of aggregated investments
  - As is stated in the report extract, CCUS holds investor appeal in that is offers high strategic value moving forward in the energy transition
  - As of Q4 2020, a total of **$27 Billion** has been invested in Carbon Capture, Utilization, and Storage (CCUS) technologies; this value represents advanced stage projects

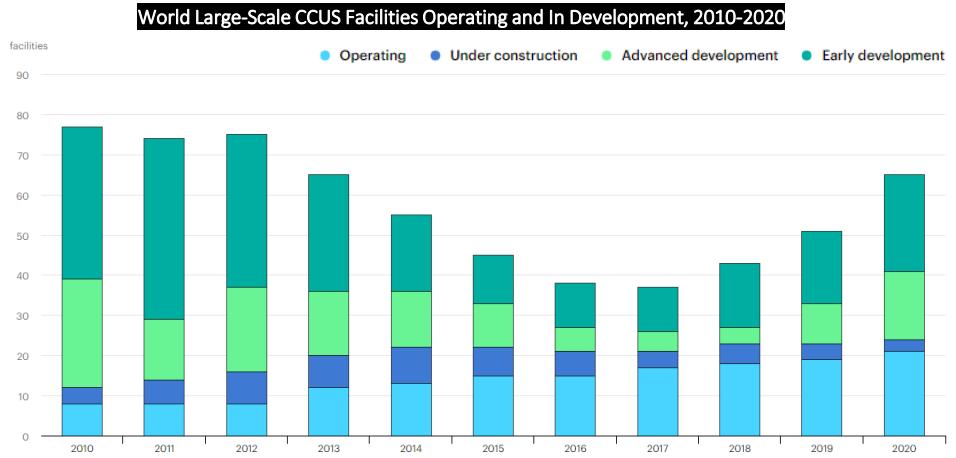
An important detail to note however, is that on an annual basis, investment in CCUS compared to other clean energy technologies has been relatively low

- CCUS investment has consistently accounted for less than 0.5% of global investment in clean energy technologies.

Furthermore, from 2017-2020 it can be observed that there was a significant increase in early development CCUS projects (bottom figure).







Source: International Energy Agency, Report Extract: A New Era For CCUS

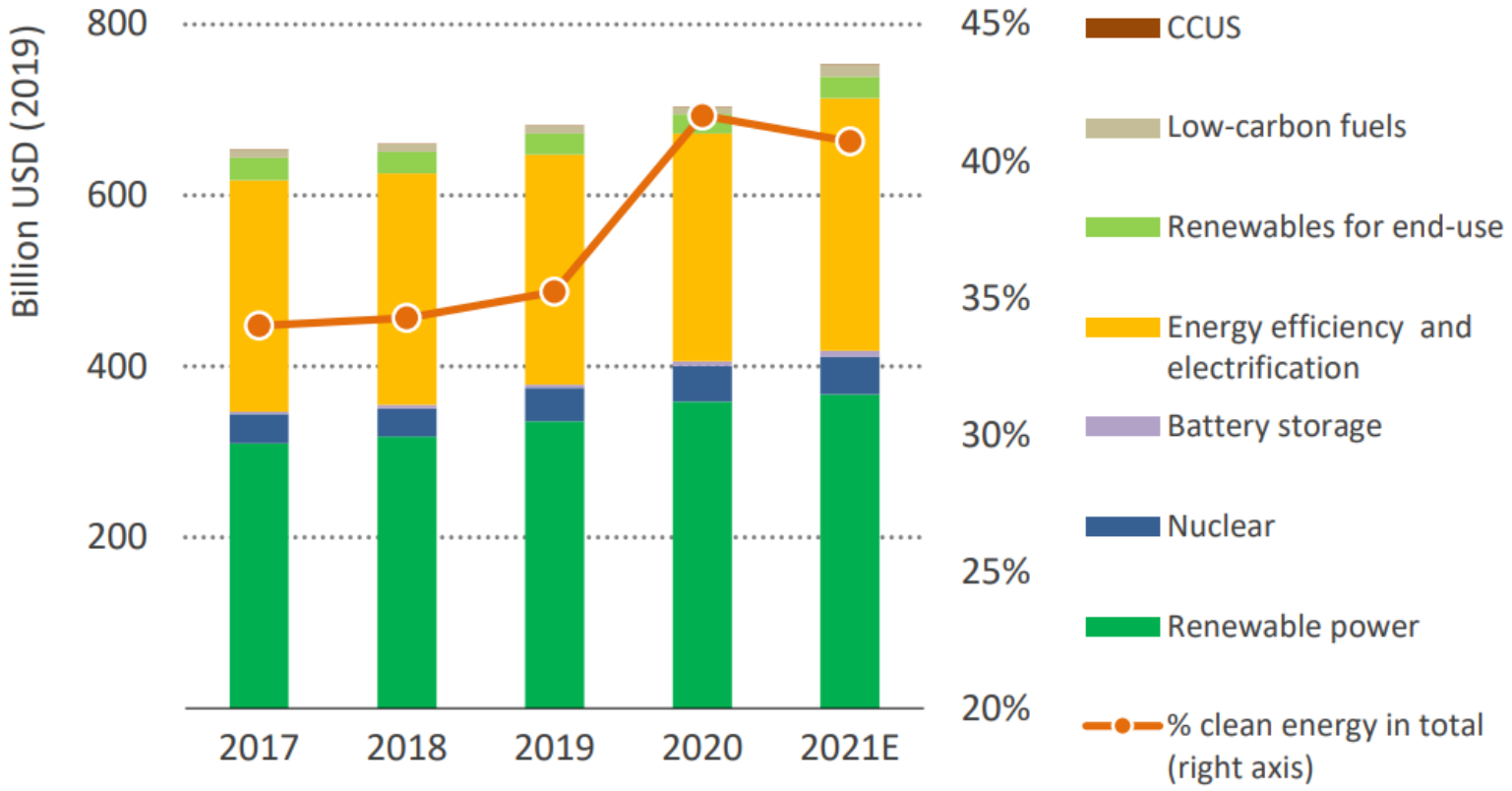
State of Energy - Clean Energy Investment

In attempting to quantify the level of renewable energy development, and as is the case for any technological innovations in markets, one must always take into consideration the interconnectedness of many efforts.

- From the figure included, it can be observed that most investments in the energy transition occur in **renewable power** and **energy efficiency/electrification**.
  - This is an important detail to consider as we consider growing demand in these two markets
- There is thus hints in opportunities related to growing markets such as
  - **battery storage**
  - **carbon capture**, **utilization and storage** technology

As stated in the IEA, World Energy Investment report, the forecasted investment in clean energy and energy efficiency worldwide has been impacted by the ongoing pandemic. Thus, aside from 2021, global investments have approximately gone up continually from 2017 to 2020.

Global Investment in Clean Energy and Energy Efficiency, 2017-2021



Source: IEA, World Energy Investment 2021

State of Energy – U.S. Energy Consumption by Sector

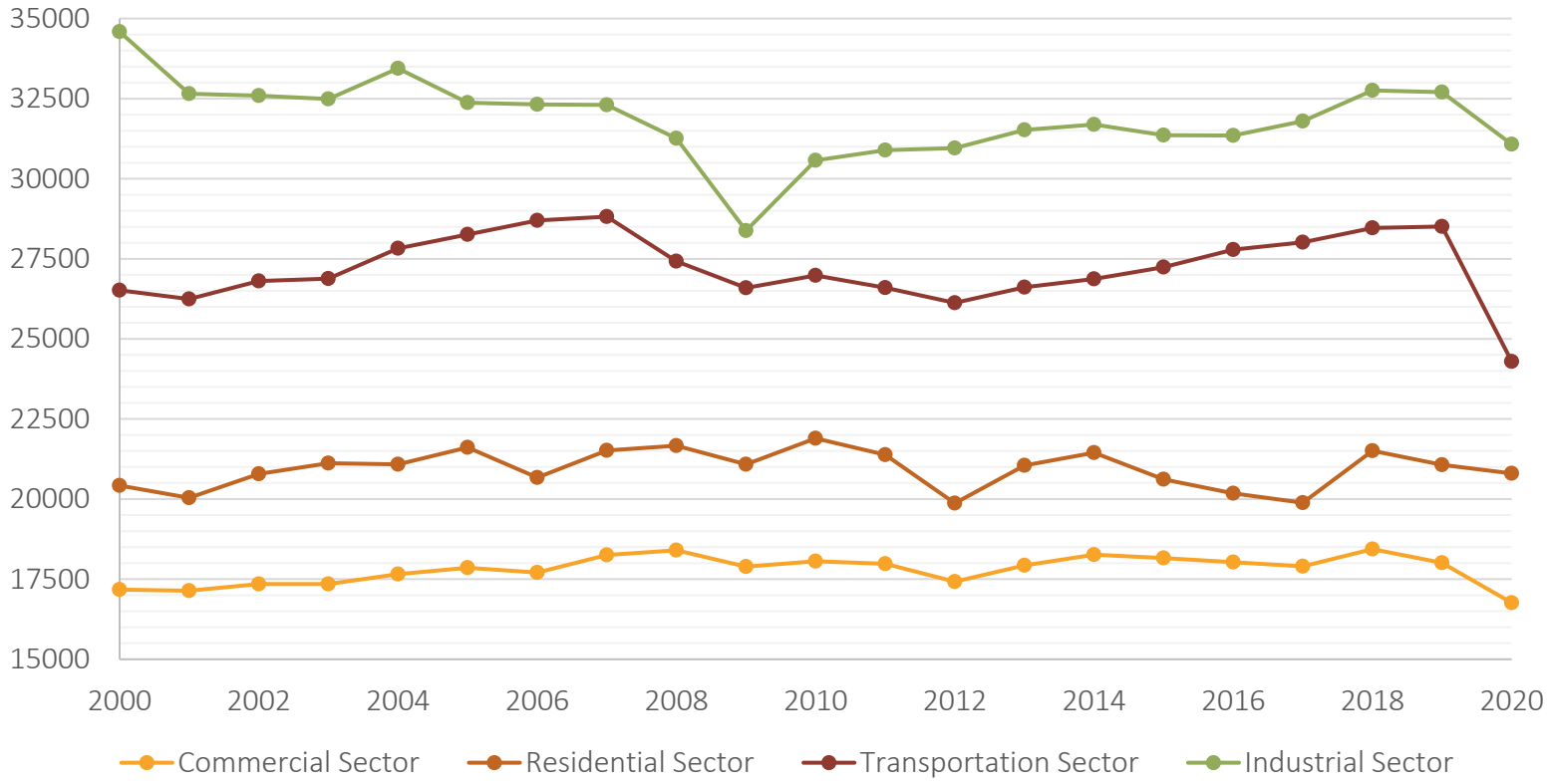
This figure shows total energy consumption in trillions of British Thermal Units (Btu) by sector.

There is an observed massive drop in consumption within the industrial, commercial, and transportation sector from 2019-2020. This drop can be understood to be largely caused by the COVID-19 Pandemic, in which there were heavy supply chain constraints and travel inefficiencies worldwide causing the sectors worldwide to experience logistical challenges in the delivery and development of goods and service.

Looking at the bigger picture, it can be observed that industrials and transportation were on a relatively healthy growth trend since 2008 and 2012, respectively.

On the other hand, it can be observed that the commercial and residential sector have remained growth neutral over a similar time period.

Total Energy Consumption by Sector (2000-2020) (Trillion Btu)

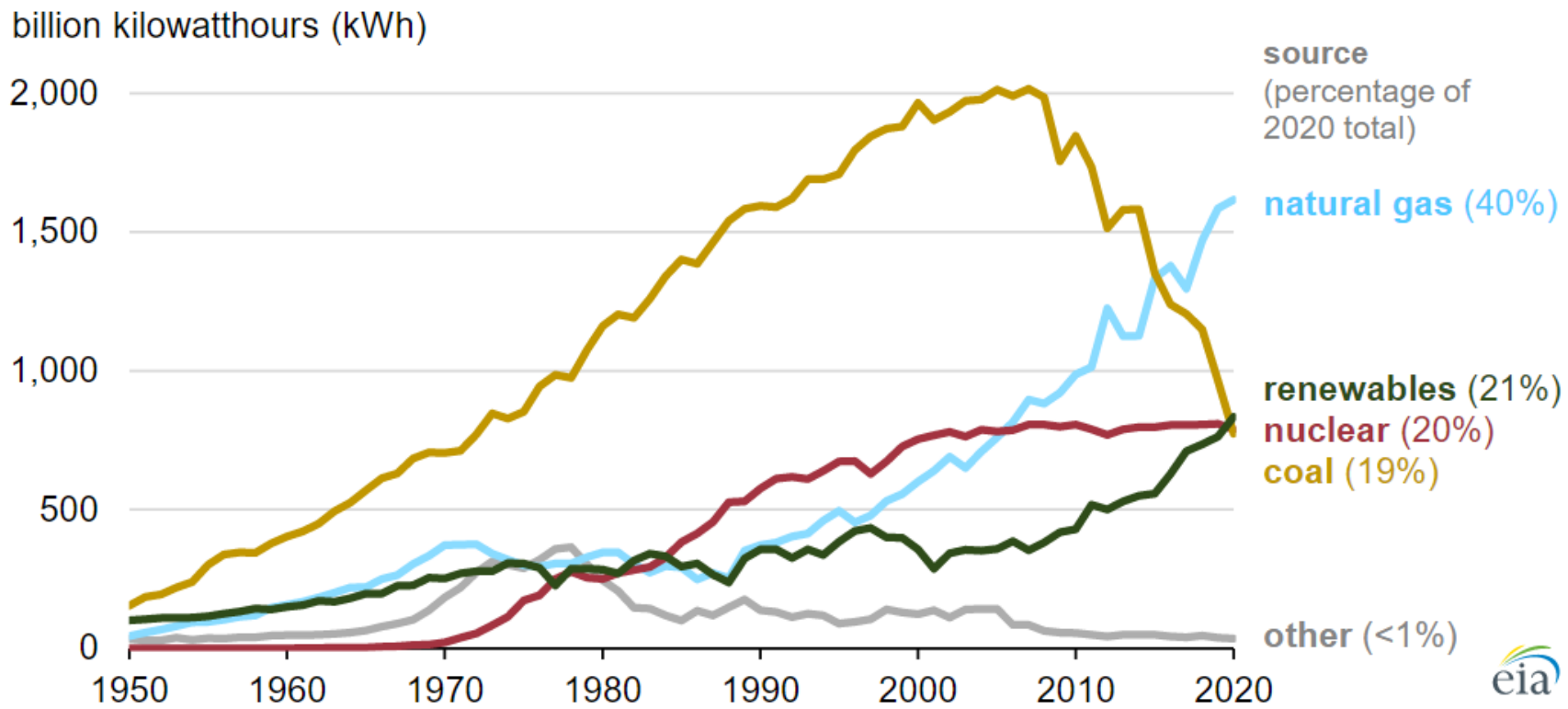


Source: U.S. Energy Information Administration

State of Energy – U.S. Electric Power Sector Consumption

- 21% of all the electricity generated in the U.S. came from Renewable Energy (Wind, Solar, Hydroelectric, Biomass, and Geothermal) in 2020
  - This put renewable energy as the second biggest producer of energy in the electric power sector for the first time.
- In 2020, renewables surpassed nuclear and coal. The biggest takeaway from this section is that nationwide, projects and investments in coal continue to exponentially decrease as the U.S. moves forwards with efforts in reducing emission heavy energy technologies
- An increase in appeal of natural gas, which has been shown to be less emissions intensive, has picked up in appeal by investors across all energy related sectors which is reflected as it accounted for **40%** of electricity generation in 2020

Annual U.S. Electricity Generation From All Sectors, 1950-2020

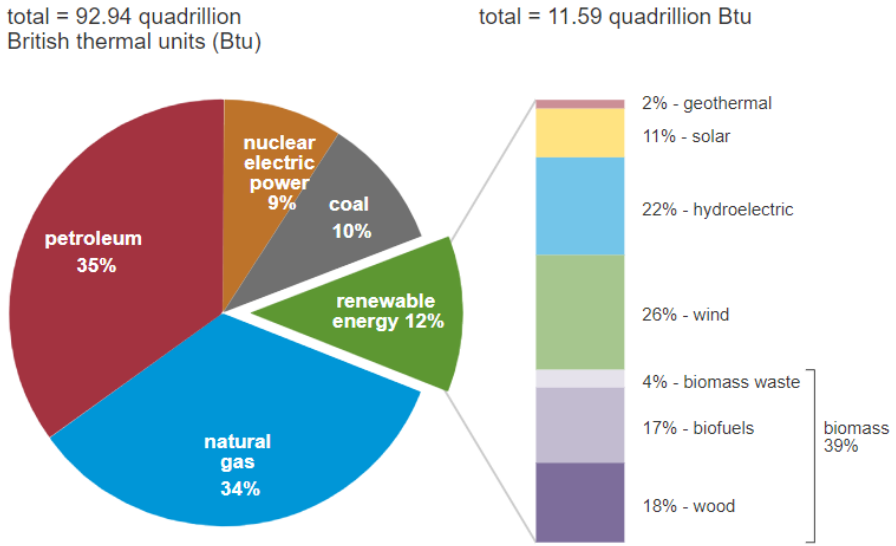


Source: U.S. Energy Information Administration

State of Energy – U.S. Energy Consumption 2019-2020

- Energy Related Carbon Dioxide Emissions
  - Petroleum: 45%
  - Natural Gas: 36%
  - Coal: 19%
- Energy Consumption per Capita: 282M Btu per Person
- Energy-related carbon emissions per capita: 13.9 metric tons per person
- Energy Consumption by Sector
  - Electric Power: 35.74 quads (38.45%)
  - Transportation: 24.23 quads (26.07%)
  - Industrial: 22.10 quads (23.78%)
  - Residential: 6.54 quads (7.04%)
  - Commercial: 4.32 quads (4.65%)
- Energy Trade
  - Imports: 20.01 quadrillion Btu
  - Exports: 23.47 quadrillion Btu
  - Net Exports: 3.46 quadrillion Btu

U.S. Primary Energy Consumption by Energy Source



U.S. Total Energy Consumption (Trillion Btu), 2019

State	Consumption (Trillion Btu)	State	Consumption (Trillion Btu)
Texas	14227.4	Arizona	1550.2
California	7802.3	Massachusetts	1467.9
Florida	4376.4	Maryland	1352.6
Louisiana	4294.5	Kansas	1123.2
Illinois	3958.5	Arkansas	1094.7
New York	3855.9	Mississippi	1086.3
Pennsylvania	3815.5	Oregon	1028.1
Ohio	3634.5	Nebraska	900.6
Georgia	2963.1	Utah	854.6
Michigan	2882.3	West Virginia	827.1
Indiana	2777.5	Nevada	774
North Carolina	2652.8	Connecticut	736
Virginia	2419.1	New Mexico	735.6
Tennessee	2170.4	North Dakota	667.9
New Jersey	2100.6	Alaska	615.1
Washington	2076	Idaho	563.4
Alabama	1922.8	Wyoming	540.8
Minnesota	1900.2	Montana	446.2
Wisconsin	1846.7	South Dakota	401.7
Missouri	1804.3	Maine	383.7
Kentucky	1723	New Hampshire	319.8
Oklahoma	1675.6	Delaware	296.5
Iowa	1634.3	Rhode Island	190.3
South Carolina	1628.5	Dist. of Col.	167.7
Colorado	1576.5	Vermont	136.9

Source: U.S. Energy Information Agency / EIA State Energy Data System

State of Energy – U.S. Fossil Fuels Consumption

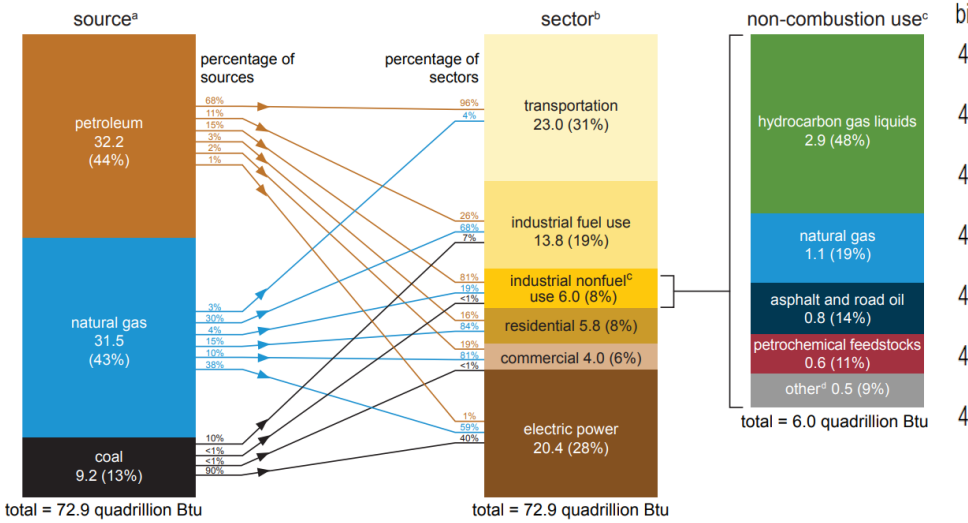
Figure 1 (Left): In acknowledging the vital role that fossil fuels continue to play in U.S. consumption, it is crucial to understand where the biggest share of fossil fuel energy is being used.

- In 2020, **Transportation** was the highest consuming sector followed closely by **electric power**
- On the other hand, commercial, residential, and industrial non-fuel were the lightest fossil fuel consumers in the US.

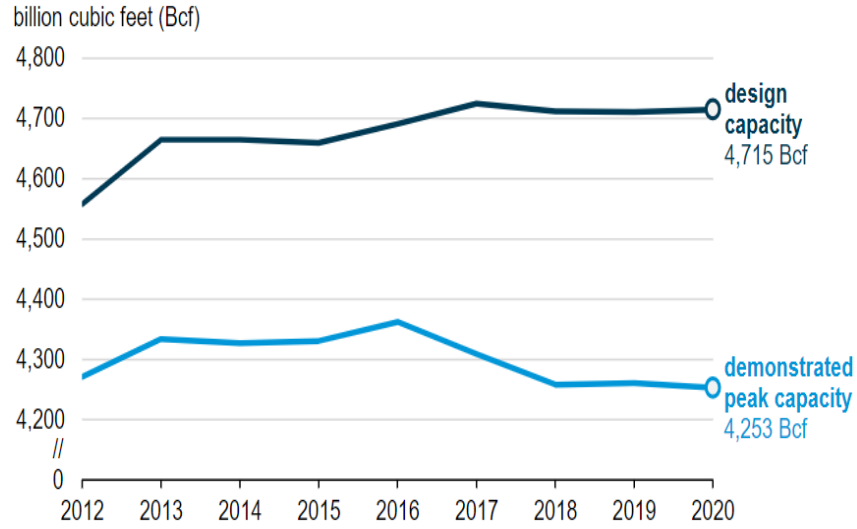
Moreover, as a source, the supply of Petroleum and Natural Gas were just about the same with 32.2 quadrillion Btu and 31.4 quadrillion Btu in consumption, respectively.

Figure 2 (Right): Since 2012, design capacity can be observed to have remained essentially flat.

U.S. Fossil Fuel Consumption by Source and Sector, 2020 (quadrillion Btu)



Annual Working Natural Gas Storage Capacity in Lower 48 States, 2012 - 2020



Source: U.S. Energy Information Agency

State of Energy – Metals and Minerals Market Developments

In Q1 2021, The World Bank's Metals and Minerals Price Index rose 16%. Moreover, there has been an increase of metal prices due to demand growth.

As can be seen from the figure on the bottom left, China has been experiencing a massive increase in metals demand growth which undoubtedly contributed to the Q1 2021 year on year price increase of 70% (Q1 2020 to Q1 2021).

» This increase resulted in ten-year highs for copper, tin and iron ore prices as stated in the Commodity Markets Outlook 2021.

» Other factors impacting an increase in price include the ongoing world pandemic, supply disruptions, and a weaker USD.

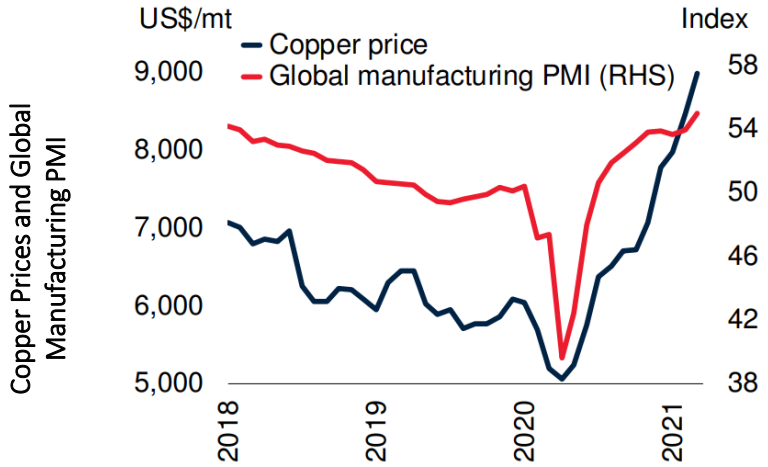
Looking forward, Metal prices are forecasted to hover at around 30% higher in 2021 compared to last year. Metals prices are then expected to ease in 2022.

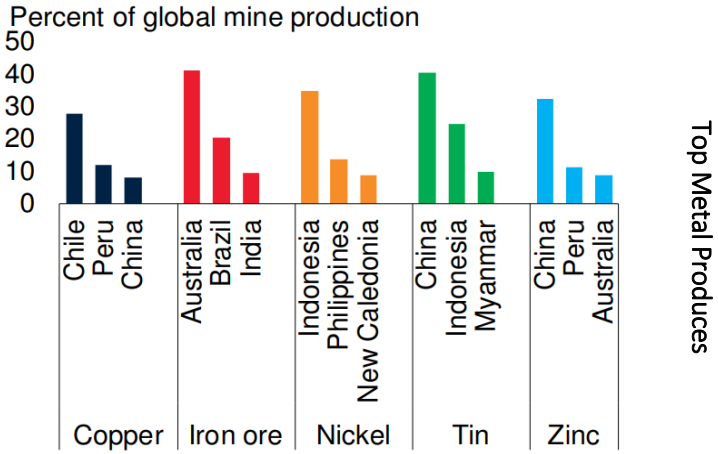
Upside Risks to Consider

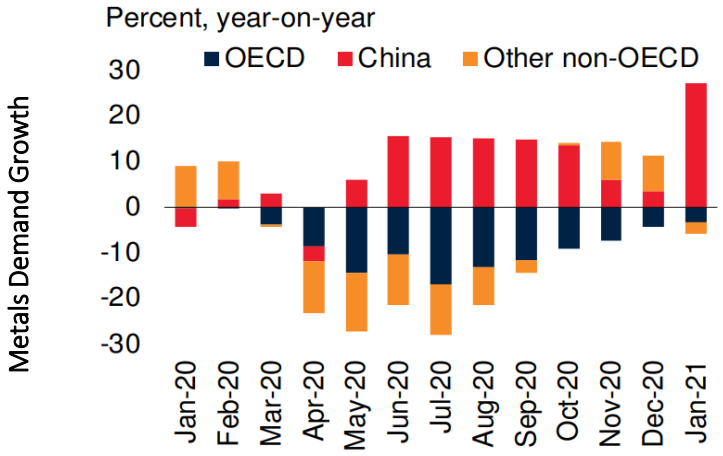
- Further stimulus programs
- Intensified efforts in decarbonization

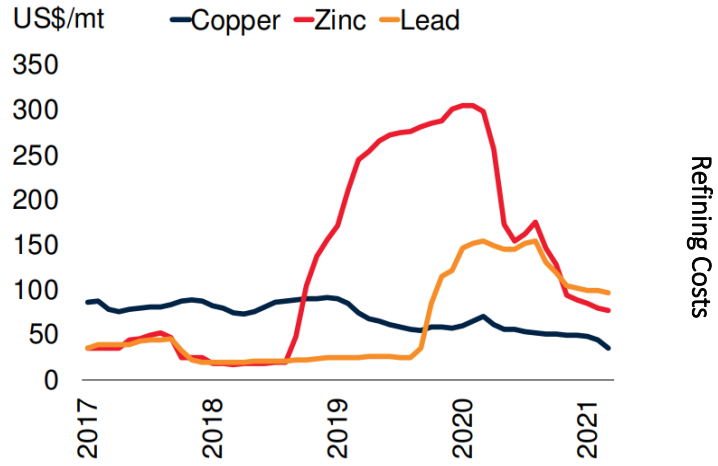
Downside Risks

- Resurgence of COVID-19 via variants
- Premature withdrawal of stimulus measures in China









Source: The World Bank, Commodity Markets Outlook, April 2021

Global Energy Outlook

Global Energy Outlook – Energy Demand

Mtoe is defined as **Million Tonnes of Oil Equivalent**

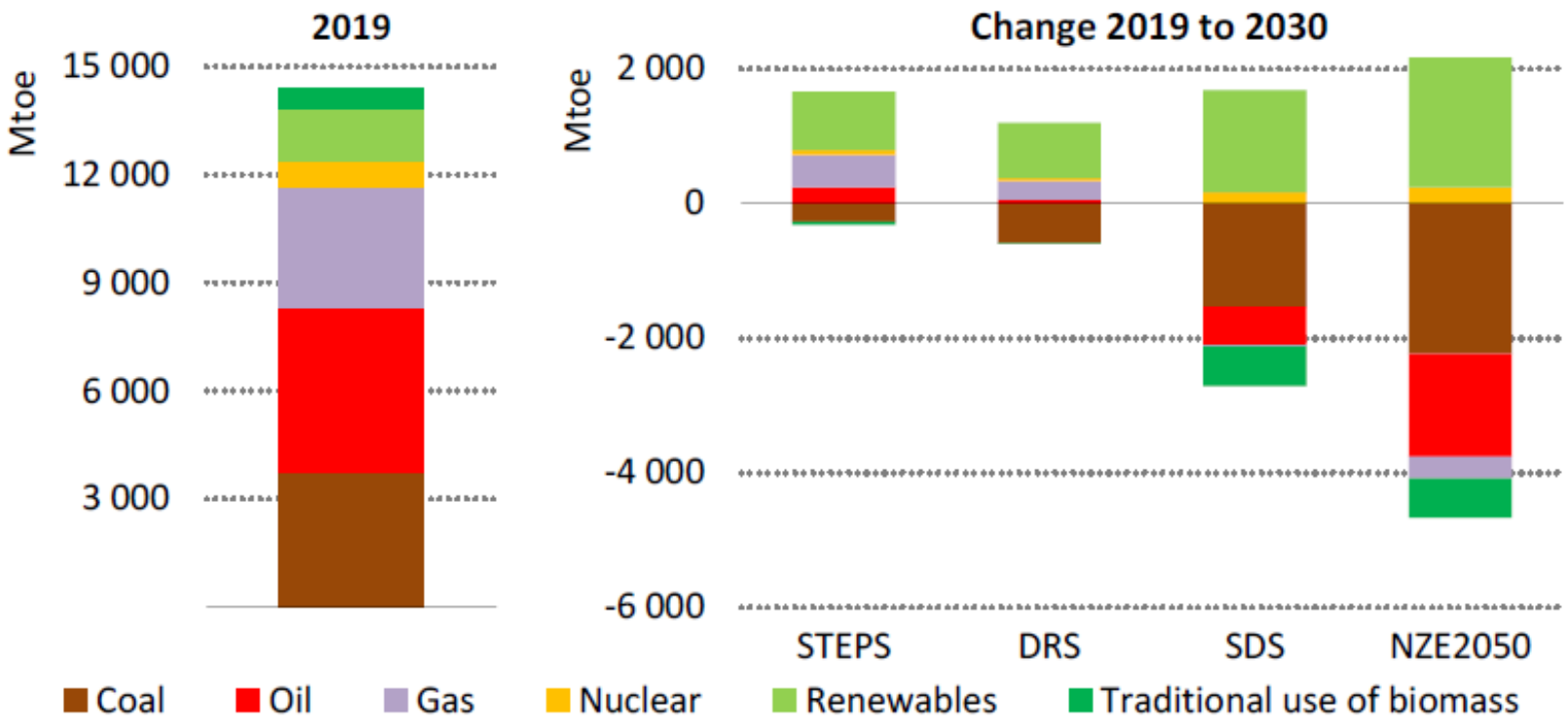
STEPS Scenario: In this scenario, Coal's share of demand dips below 20% . There continues to be an increase in gas demand in 2030 as well as nuclear. Coal declines in demand along with biomass.

DRS Scenario: In this scenario, coal energy demand loss is essentially double that in the STEPS. Moreover, natural gas demand experiences a demand increase that is essentially half of demand in the STEPS

SDS Scenario: In this scenario, coal demand significantly decreases (~1650 Mtoe decrease) along with oil demand and biomass.

NZE2050 Scenario: In this scenario, which happens to be the most sustainable and intense in terms of energy transition goals, coal experiences a demand decrease of ~2150 Mtoe by 2030. Oil demand falls by ~1650 Mtoe. Moreover, this is one of the only scenarios where gas demand experiences a decrease.

Total Primary Energy Demand by Fuel and Scenario

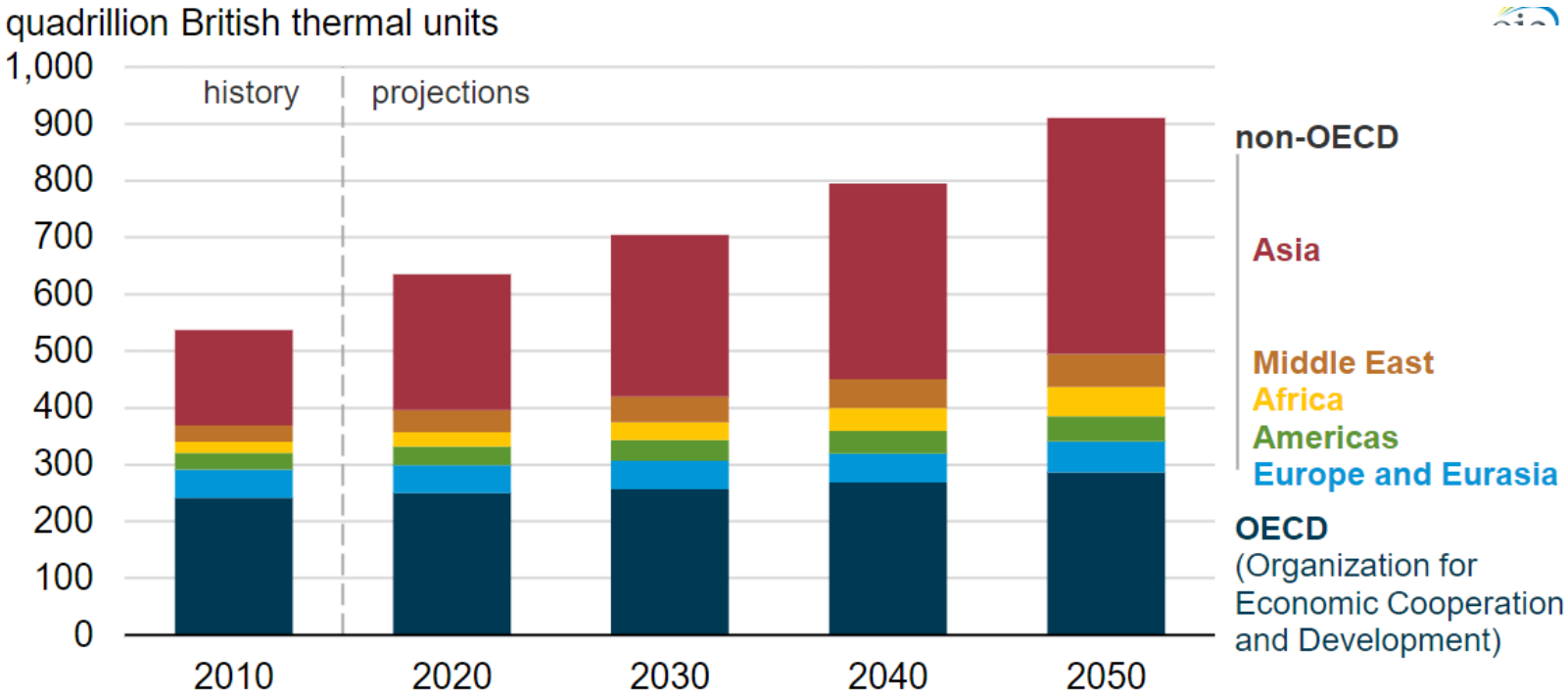


Source: International Energy Agency, World Energy Outlook 2020

Global Energy Outlook – Energy Consumption

- By 2030, global primary energy consumption is expected to be higher in Asia than in OECD countries for the first time since 2010.
- Overall, world energy consumption is forecasted to rise 50% between 2018 and 2050, being pushed by non-OECD countries. Increase in consumption by non-OECD countries will be caused by strong economic growth, and increase in access to energy related markets, and very rapid population growth.
- OECD countries are expected to remain neutral in energy consumption growth up to 2050.
- China and India are among the fasted growing economies in the past decades and moving forward. This fact is reflected in forecasted consumption increases up to 2050.
- Non-OECD Europe and Eurasia countries will experience the smallest increase of energy consumption between 2018 and 2050 (11%).

Global Primary Energy Consumption by Region, 2010-2050



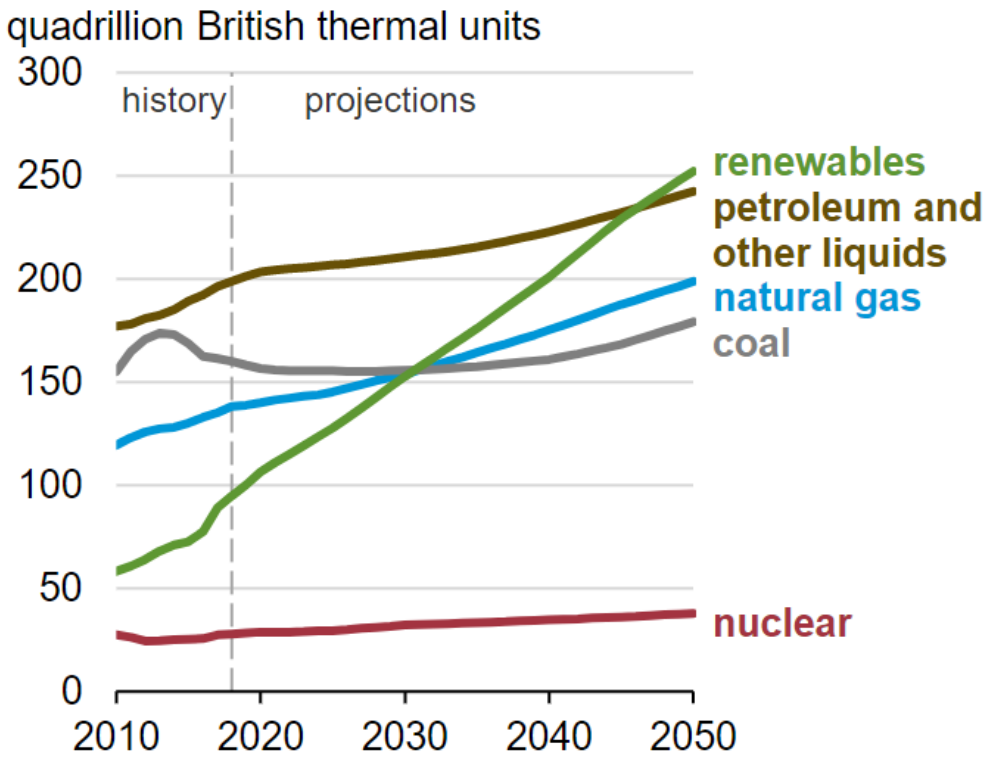
Source: U.S. Energy Information Administration, International Energy Outlook 2019 *Reference Case*

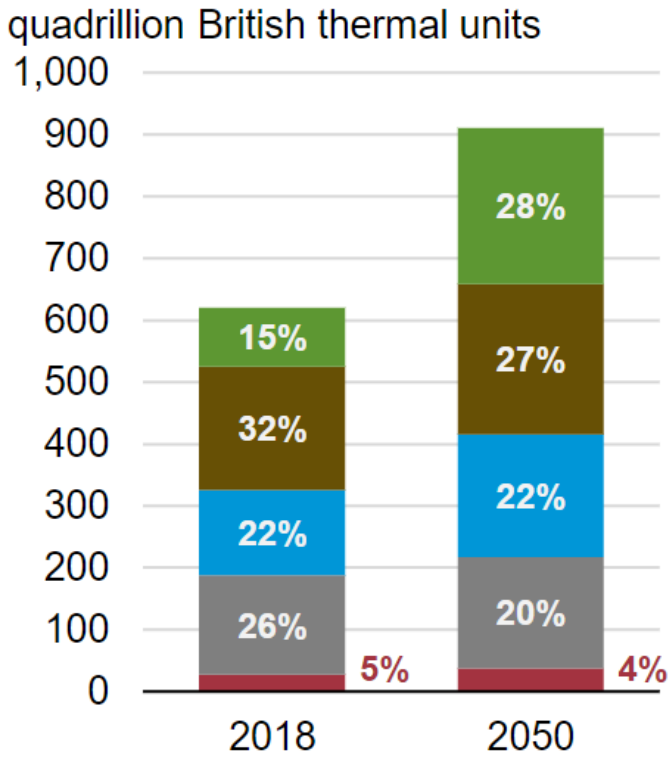
Global Energy Outlook – Energy Consumption

Fossil fuels continue to meet much of the world's energy demands even amidst exponentially rising renewables consumption increased.

- By 2050, non-renewables make up roughly **72%** of all energy consumption, whereas renewables make up only **28%**
  - Nonetheless, all non-renewables experience a decrease in consumption except for natural gas
- **Renewable energy** consumption increases 3% per year due to an increase in electricity demand growth and policy drivers related to energy transition efforts.
- **Natural gas** increases 1.1% on a yearly basis, compared with liquids' 0.6% and coal's 0.4% yearly growth.
- **Coal** is expected to follow a decreasing trend until 2040, when coal use is forecasted to increase as a result of increased industrial usage and rising use in electric power generation in non-OECD Asian countries (excluding China)

Global Primary Energy Consumption by Energy Source, 2010-2050





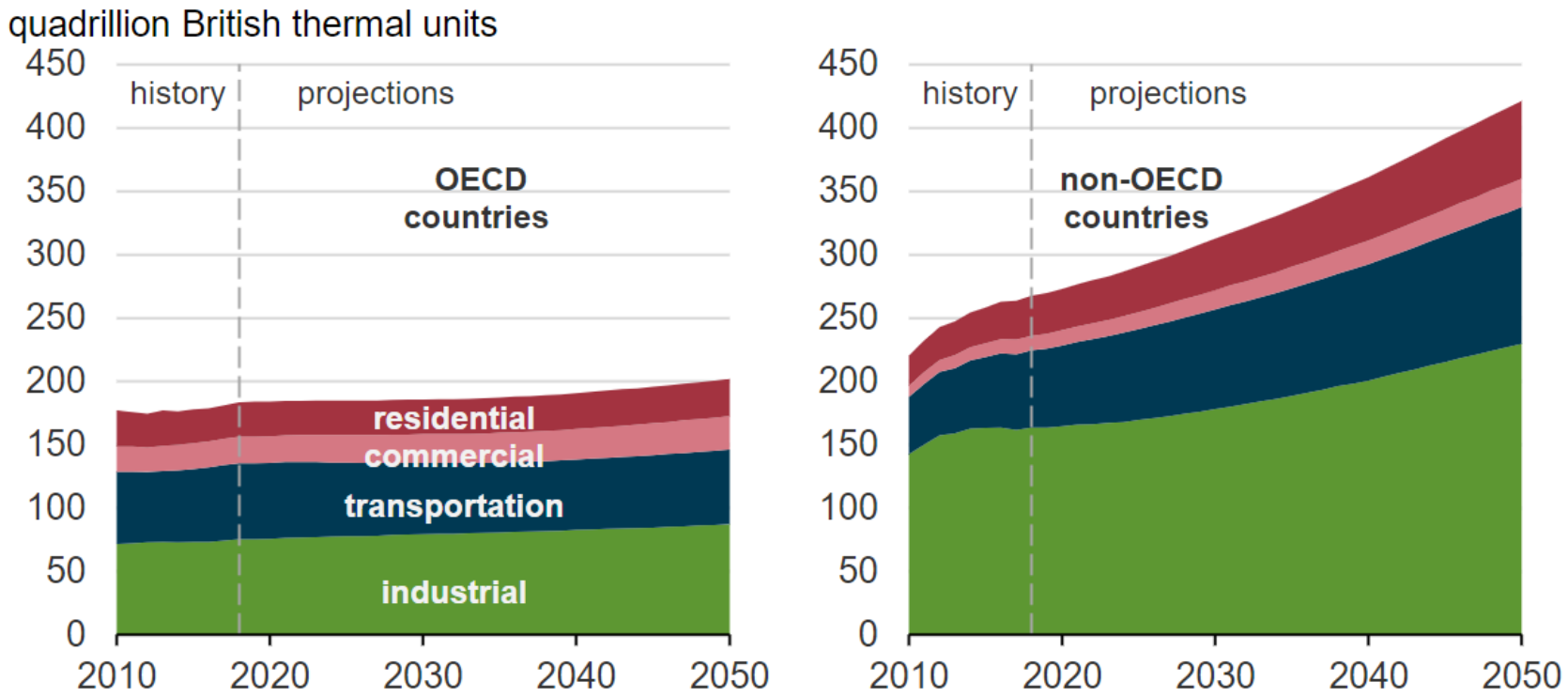
Source: U.S. Energy Information Administration, International Energy Outlook 2019 *Reference Case*

Global Energy Outlook – Energy Consumption

More than 50% of end-use energy consumption is forecasted to be caused by the Industrial sector (refining, mining, manufacturing, agriculture, and construction). In essence, energy use in the industrial sector will increase by roughly 30% from 2018 to 2050 (reaching 325 Btu in 2050). Remain large growth drives include the service sector.

Non-OECD countries will be behind the majority of industrials energy use growth, growing at approximately 1.0% per year in said countries (compared to 0.5% annual growth in OECD countries).

Global Energy Consumption by Sector, 2010-2050



Source: U.S. Energy Information Administration, International Energy Outlook 2019 *Reference Case*

Global Energy Outlook - Electrification

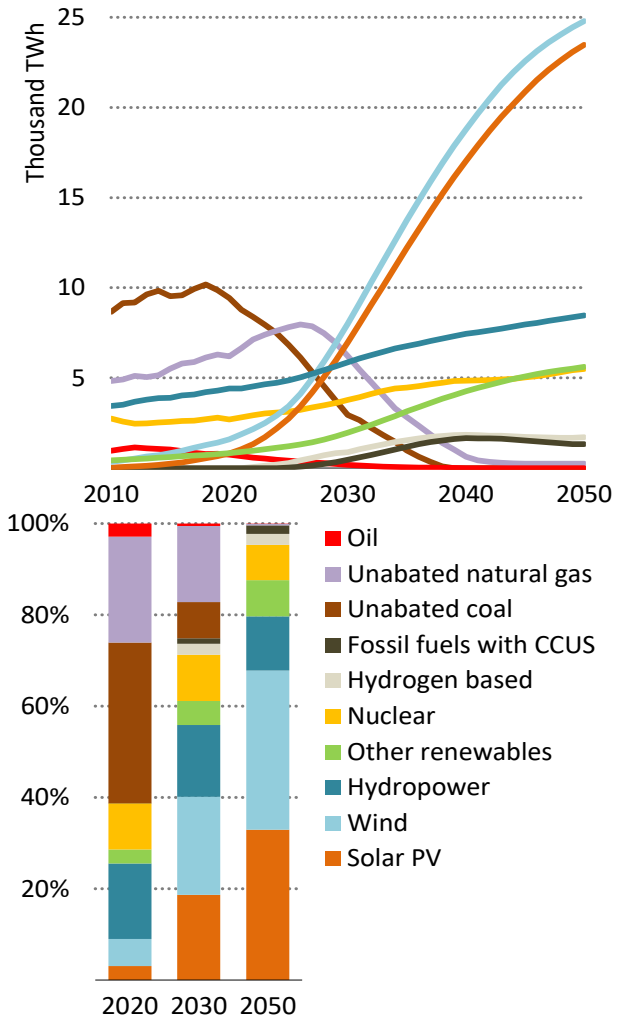
Net Zero by 2050 Scenario (refer to appendix for more details)

As can be seen, by 2050 Solar PV and Wind are set to make up more than **60%** of electricity generation in this scenario.

Although this scenario is the least likely out of the other three given scenarios, it nonetheless provides us with insights on how electricity would need to be generated in a net zero scenario.

- » Wind and Solar PV are expected to continue to grow worldwide whereas coal is expected to be phased out by 2050.
- » Additional Policy Changes
  - – Halting sales of new IC engine passenger cars by 2035
- » Key Supply/Demand Changes
  - – Annual clean energy investment need to reach $5 Trillion globally by 2030
  - –Total energy supply falls by 7% between 2020-2030
  - – Coal demand declines by 90% in 2050 (600 Mtoe)
  - – Oil demand declines by 75% to 24 mb/d
  - –Natural gas declines by 55% to 1,750 bcm

Global electricity generation by source in the NZE



International Energy Agency (2021), Net Zero by 2050, IEA, Paris

Key Milestones in Transforming Global Electricity Generation

Category	
Decarbonisation of electricity sector	• Advanced economies in aggregate: 2035. • Emerging market and developing economies: 2040.
Hydrogen-based fuels	• Start retrofitting coal-fired power plants to co-fire with ammonia and gas turbines to co-fire with hydrogen by 2025.
Unabated fossil fuel	• Phase out all subcritical coal-fired power plants by 2030 (870 GW existing plants and 14 GW under construction). • Phase out all unabated coal-fired plants by 2040. • Phase out large oil-fired power plants in the 2030s. • Unabated natural gas-fired generation peaks by 2030 and is 90% lower by 2040.

Category	2020	2030	2050
Total electricity generation (TWh)	26 800	37 300	71 200
Renewables			
Installed capacity (GW)	2 990	10 300	26 600
Share in total generation	29%	61%	88%
Share of solar PV and wind in total generation	9%	40%	68%
Carbon capture, utilisation and storage (CCUS) generation (TWh)			
Coal and gas plants equipped with CCUS	4	460	1 330
Bioenergy plants with CCUS	0	130	840
Hydrogen and ammonia			
Average blending in global coal-fired generation (without CCUS)	0%	3%	100%
Average blending in global gas-fired generation (without CCUS)	0%	9%	85%
Unabated fossil fuels			
Share of unabated coal in total electricity generation	35%	8%	0.0%
Share of unabated natural gas in total electricity generation	23%	17%	0.4%
Nuclear power	*2016-20*	*2021-30*	*2031-50*
Average annual capacity additions (GW)	7	17	24
Infrastructure			
Electricity networks investment in USD billion (2019)	260	820	800
Substations capacity (GVA)	55 900	113 000	290 400
Battery storage (GW)	18	590	3 100
Public EV charging (GW)	46	1 780	12 400

Note: GW = gigawatts; GVA = gigavolt amperes.

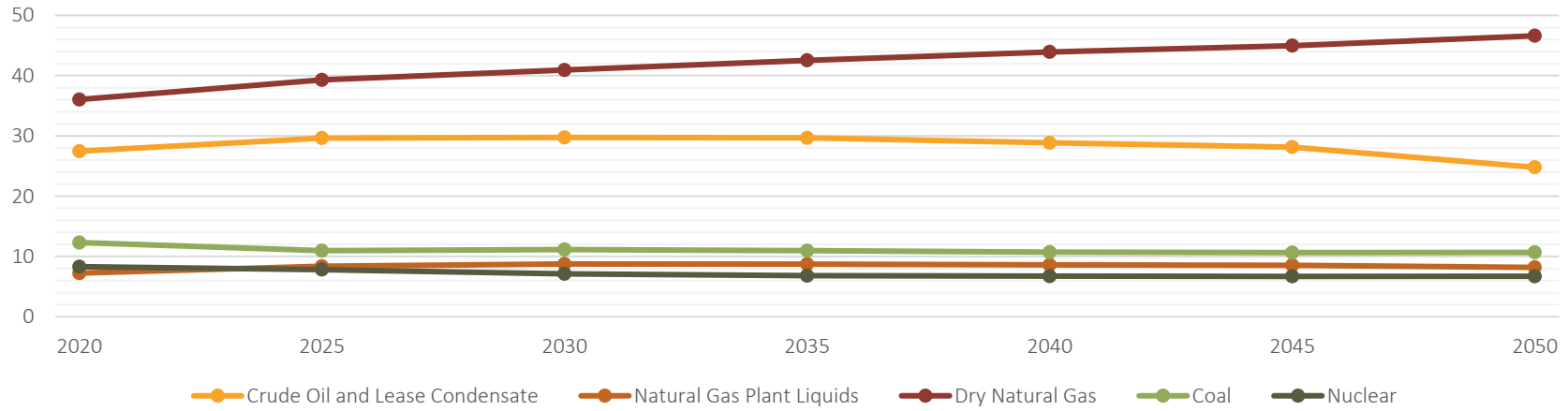
U.S. Energy Outlook

U.S. Energy Outlook – Energy Production

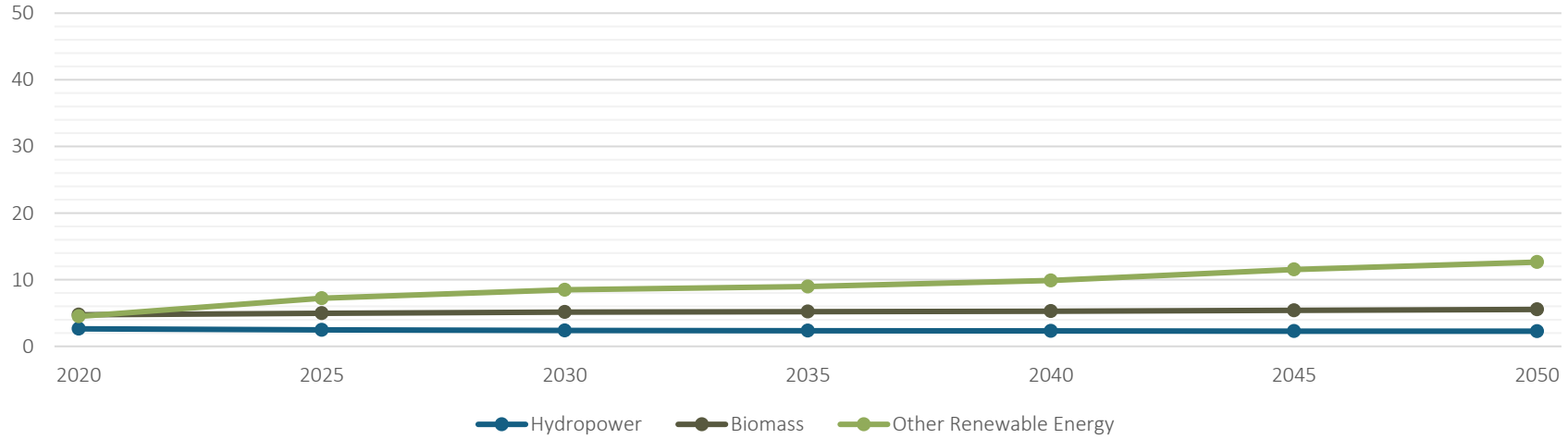
Top Figure (Non-Renewable): From 2020 to 2050, dry natural gas is forecasted to grow in production from 36.03 quads to 46.62 quads. That is approximately a 30% increase. Crude oil and lease condensate, of which 27.47 quads were produced in 2020, is forecasted to peak in 2035 to 29.68 quads in production and afterwards decrease annually until reaching 24.80 quads. This is approximately a 9.7% decrease in crude oil and lease condensate from 2020 to 2050.

Bottom Figure (Renewable): Wind and Solar energy production, which falls under 'other renewable', is forecasted to grow from 4.49 quads in 2020 to 12.64 quads in 2050. That is approximately a 181.5% increase in production over the mentioned time period. Hydropower is set to decrease in energy production by approximately 50% by 2050.

Total Non-Renewable Energy Production (quads) by Source, 2020-2050



Total Renewable Energy Production (quads) by Source, 2020-2050



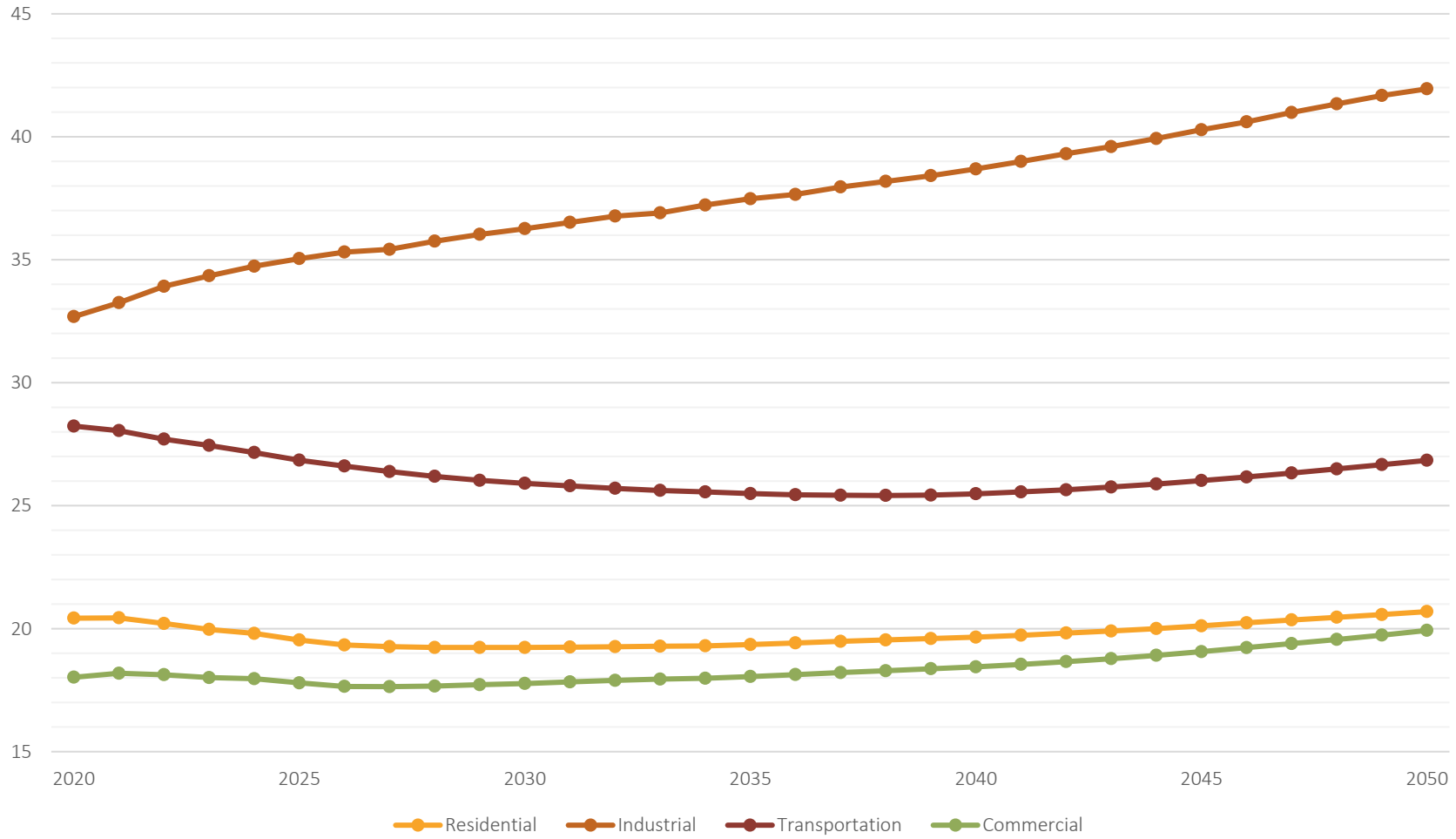
Source: U.S. Energy Information Administration

U.S. Energy Outlook – Energy Consumption by Sector

In looking at energy consumption by sector, the industrial sector is observed to have the highest growth rate amongst all other sectors.

- **Industrial**: From consuming 32.68 quads of energy in 2020, energy consumption is set to grow by 28.35% to 41.95 quads of consumption by 2050.
- **Transportation**: forecasted to hit a low in 2038 with a value of 25.42 quads in energy consumption.
  - Overall, the transportation sector, consuming 28.23 quads in 2020, is expected to shrink by 4.9% to 26.84 quads by 2050.
- **Residential**: forecasted to remain growth neutral and increasing only by a mere 1.3% to 20.69 quads in energy consumption by 2050.
- **Commercial:** will experience 6.6% growth from 2020 to 2050.

Energy Use (quads) by Sector, 2020-2050



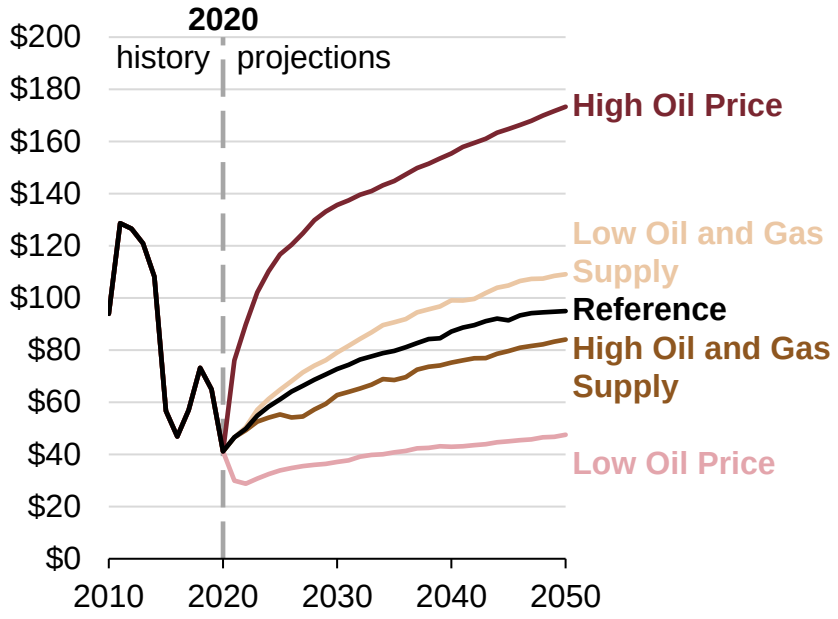
Source: U.S. Energy Information Administration

U.S. Energy Outlook – Oil & Gas Price Projections

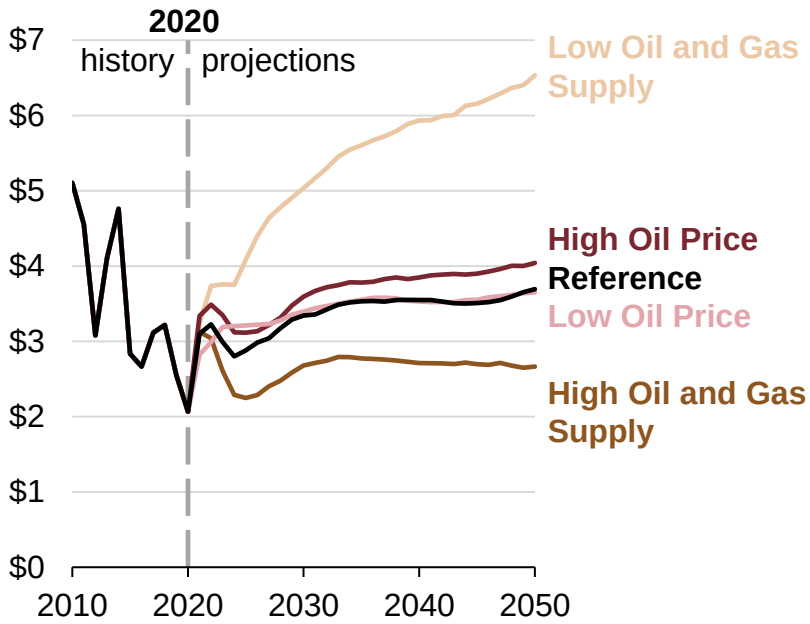
Low Oil Price Case: Energy consumption experiences small growth due to lower economic activity in non-OECD countries. In this scenario, greater resource availability and decreased extraction costs incentivize and increase in additional petroleum supplies even amidst low economic growth activity. Lastly, low oil prices encourages liquid fuels consumption and discourages energy conservation/fuel transitions.

High Oil Price Case: Energy consumption experiences large growth due to high economic activity and growth in non-OECD countries. Higher oil prices limit liquid fuels consumption growth as consumers conserve or switch to alternative fuels. There exist tighter petroleum supply constraints.

North Sea Brent crude oil price
AEO2021 side cases
2020 dollars per barrel



Natural gas price at Henry Hub
AEO2021 side cases
2020 dollars per million British thermal units



Source: U.S. Energy Information Administration, Annual Energy Outlook 2021

U.S. Energy Outlook – Energy Installation Prices

Reference Case:

From 2020 to 2050, wind energy installation costs are forecasted to drop by 27.60% to $918.36 per kilowatt. Solar energy installation costs are forecasted to drop by 47.97% to $640.78 per kilowatt and Natural gas installation costs are projected to drop by 31.56% to $655.97 per kilowatt.

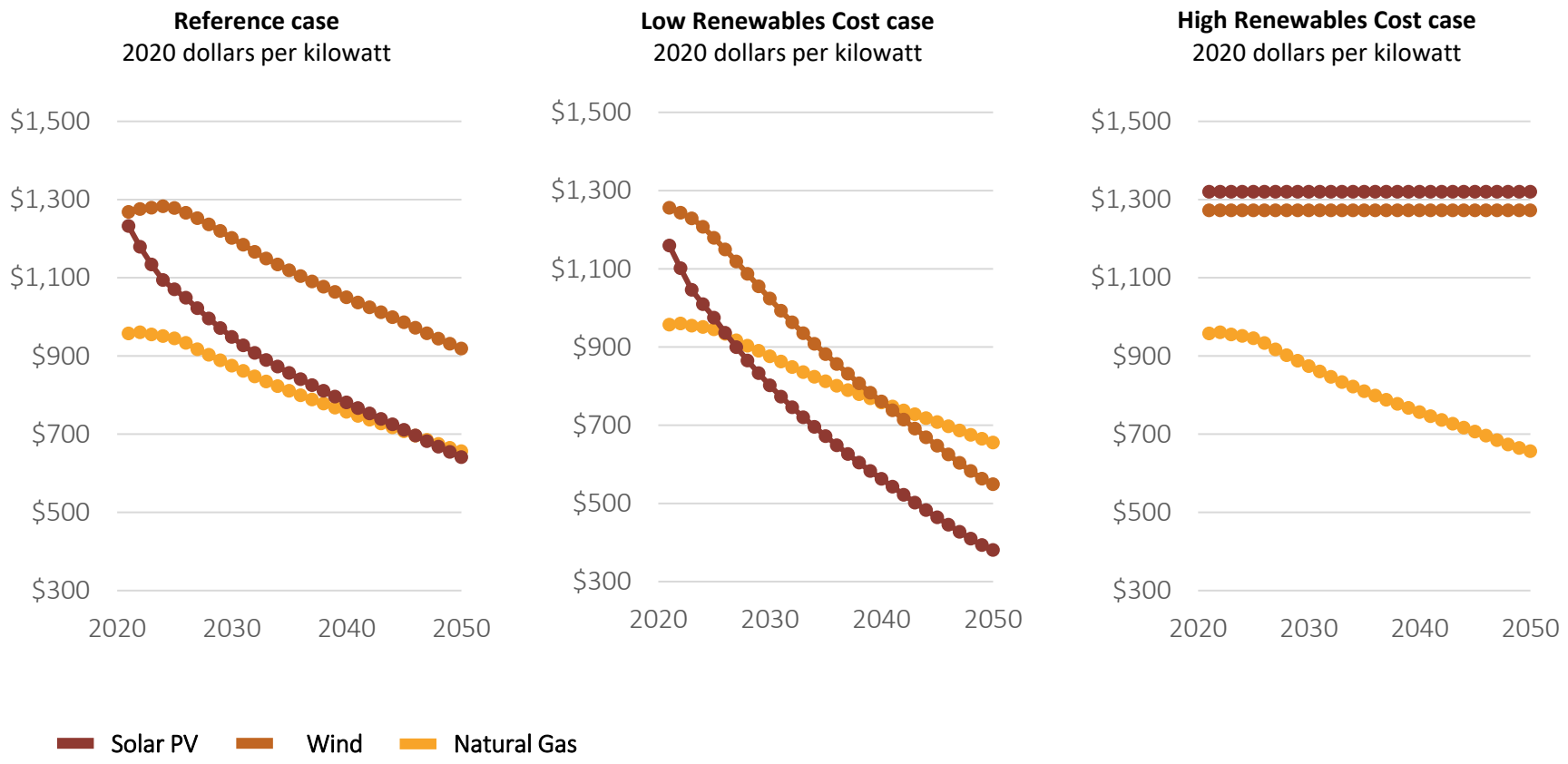
Low Renewables Cost Case:

From 2020 to 2050, wind energy installation costs are forecasted to drop by 56.30% to $548.88 per kilowatt. Solar energy installation costs are forecasted to drop by 67.16% to $380.65 per kilowatt and Natural gas installation costs are projected to drop by 31.50% to $655.54 per kilowatt.

High Renewables Cost Case:

From 2020 to 2050, wind energy installation costs are forecasted to drop by 0% to $1271.82 per kilowatt. Solar energy installation costs are forecasted to drop by 0% to $1319.65 per kilowatt and Natural gas installation costs are projected to drop by 31.47% to $655.89 per kilowatt.

Overnight installation cost, AEO2021 renewables cost cases



Source: U.S. Energy Information Administration, Annual Energy Outlook 2021

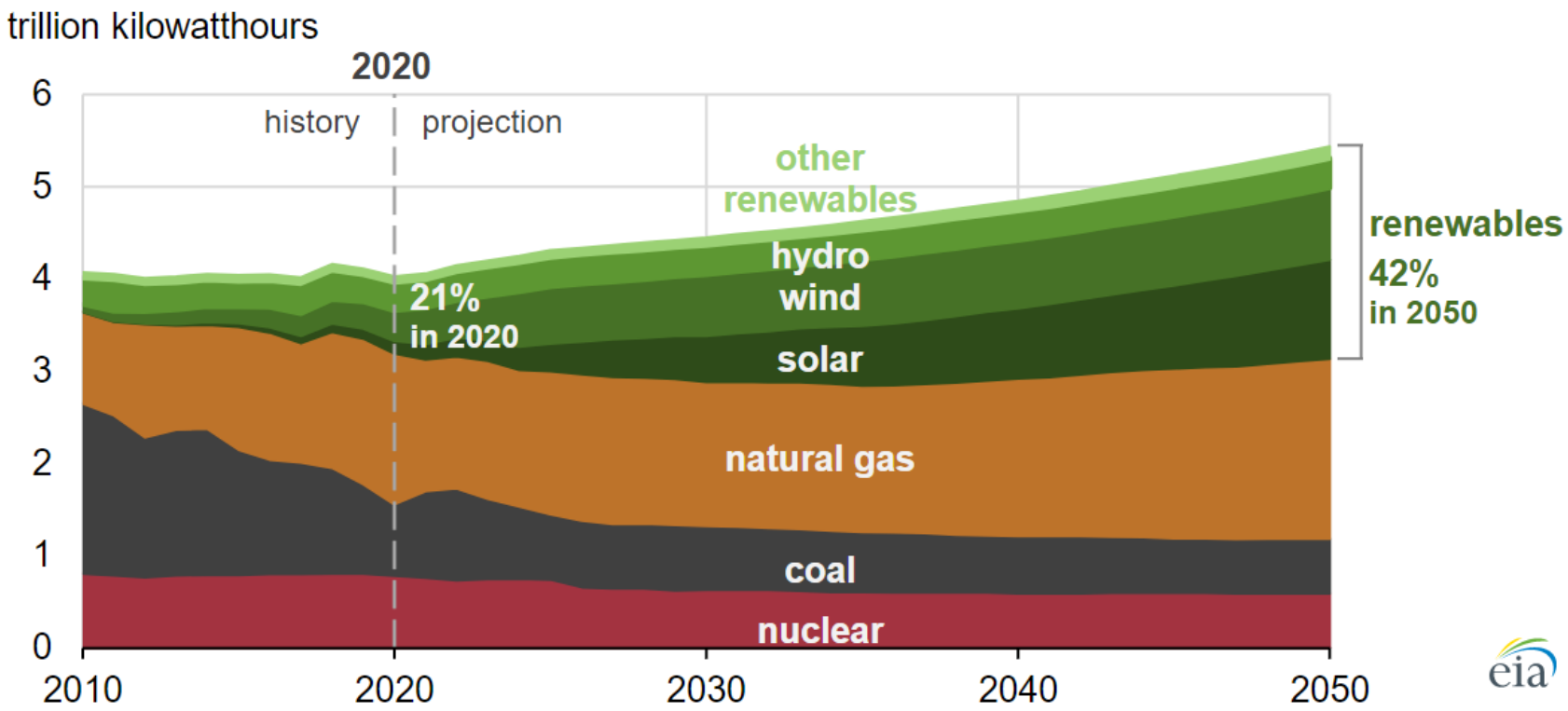
U.S. Energy Outlook – Electricity Generation Mix

Shares of Renewables in U.S. electricity generation mix are set to increase from 21% in 2020, to 42% in 2050 (Wind and Solar lead growth).

Moreover, by 2030, renewables are expected to collectively surpass natural gas in becoming the dominant source of electricity generation in the U.S. as is show in the figure to the right.

By 2040, Solar PV will surpass Wind to become the leading renewable energy source for electricity in the U.S.

U.S. Electricity Generation, Annual Energy Outlook 2021 Reference Case, 2010-2050



Source: U.S. Energy Information Administration, Annual Energy Outlook 2021 (AEO2021)

Energy Transition and Global Finance

Energy Transition and Global Finance – Renewable Energy Investments

Figure 1 (top left): From 2013 to 2018, Renewable energy investments have been conducted through the avenue of private investments. From 2013-2018, public investments averaged 14.33% of total investments in renewable energy while private investments averaged 85.67% of total investments.

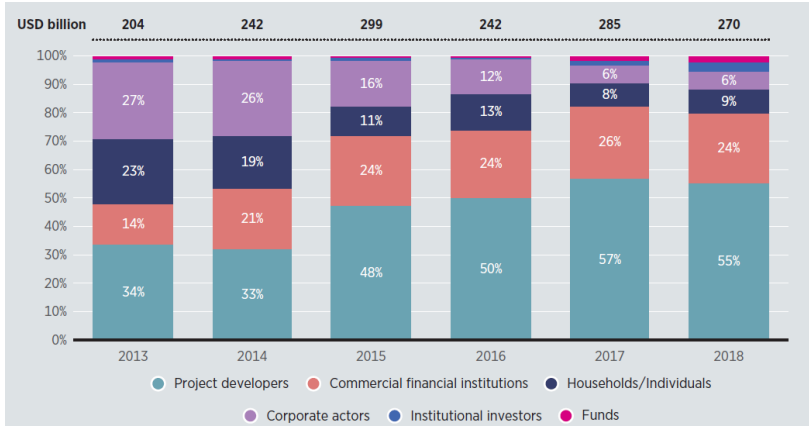
Figure 2 (top right): In private investments, 46% of investments were made by project developers from 2013-2018. Project developer investments have increased by 214.1% from 2013 to 2018. Pertaining to institutional investors and funds, in 2018 said entities made up 6% of all private investments in renewable energy, or approximately 16.2 Billion USD. Compare this to 2% of total investments in 2013 which amounted to 4.08 Billion USD.

Figure 3 (bottom left): from 1990 to Q2 2019, foundations and endowments made up 0% of directly invested in renewable energy deals while making up 10% of entities invested in funds focused on renewables.

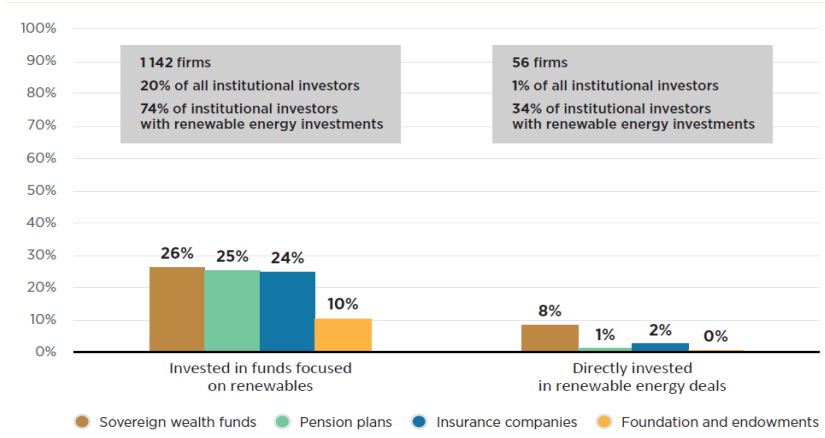
Figure 4 (bottom right): From 2010 to 2019, there has been a 75% increase in clean energy transactions by Oil Companies.

Public and Private Investment in Renewable Energy Finance, 2013-2018

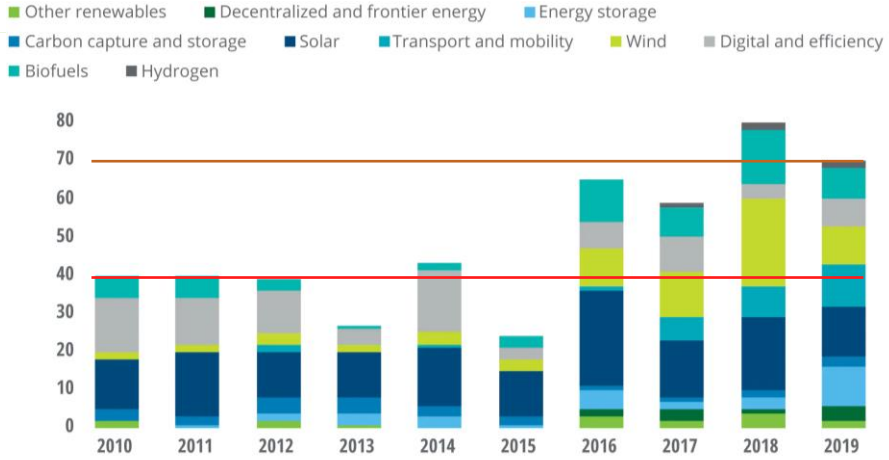
Private Investment in Renewable Energy, by Investment Source, 2013-2018



Number of Institutional Investors with Investments in Renewable Energy (Projects and Renewable-Focused Funds), 1990 to Q2 2019



Clean Technology Transactions by Oil Companies (Number of Deals)



Source: Figures 1-3, IRENA, CPI Global Finance 2020 / Figure 4 (bottom-right), Deloitte Insights, Navigating the Energy Transition from Disruption to Growth

Energy Transition and Global Finance - Risks

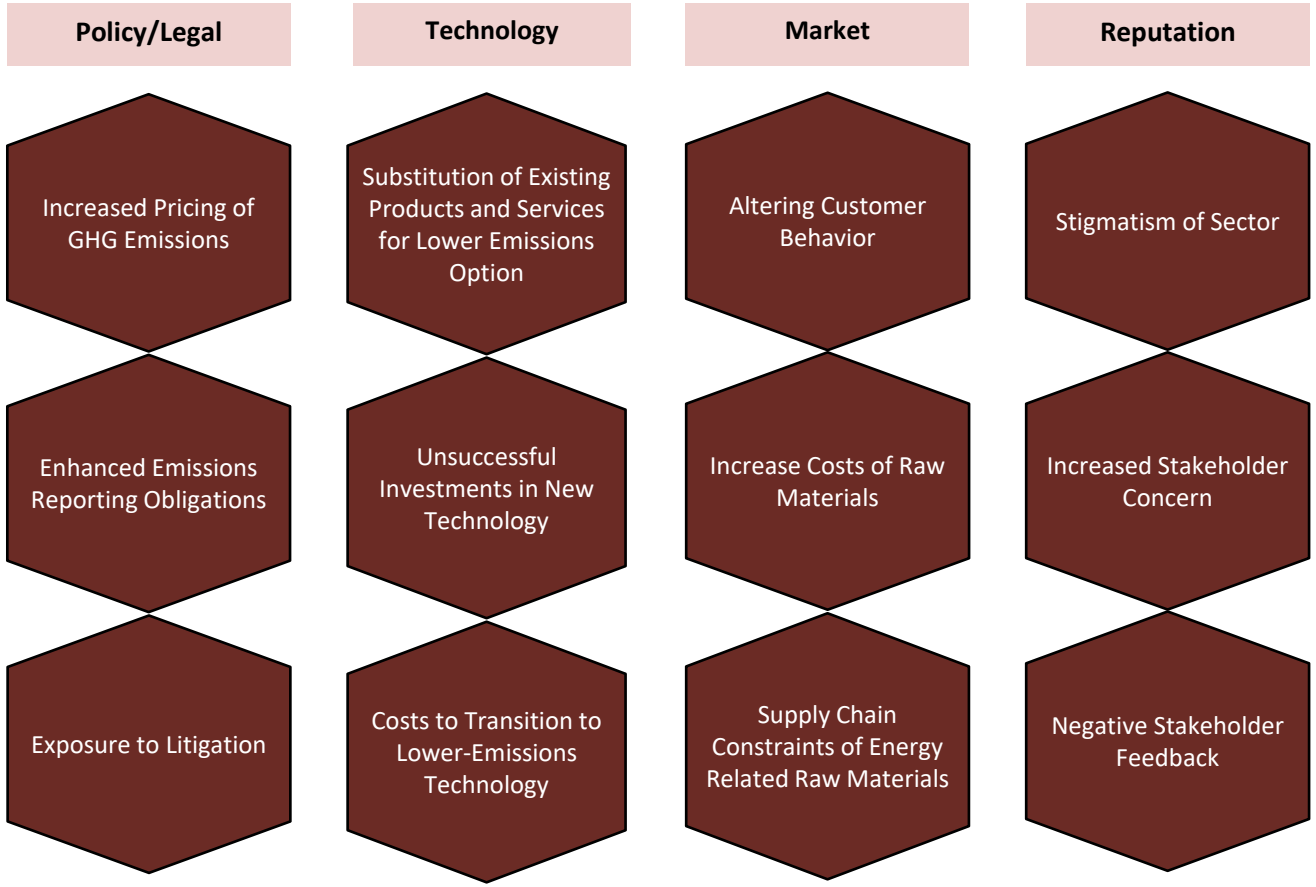
Potential Financial Impacts

Policy/Legal: An increase in a higher level of compliance and judgement is expected to lead to an increase of operating costs for products and services leading to negative financial impact

Technology: An energy transition to cleaner technologies is expected to lead to early retirements of existing assets that fail to meet sustainability standards. Moreover, high amounts of capital investments in technology development will be required. With unprecedented levels of investments in the next decades, companies may experience an erosion of liquidity needed to service short-term and long-term debt commitments.

Market: Increased production costs as a result of changing input prices (e.g. energy and water). Reduction in goods and services demand.

Reputation: Reduction of revenue from decreased demands for goods and services. Moreover, a decreased productivity capacity.



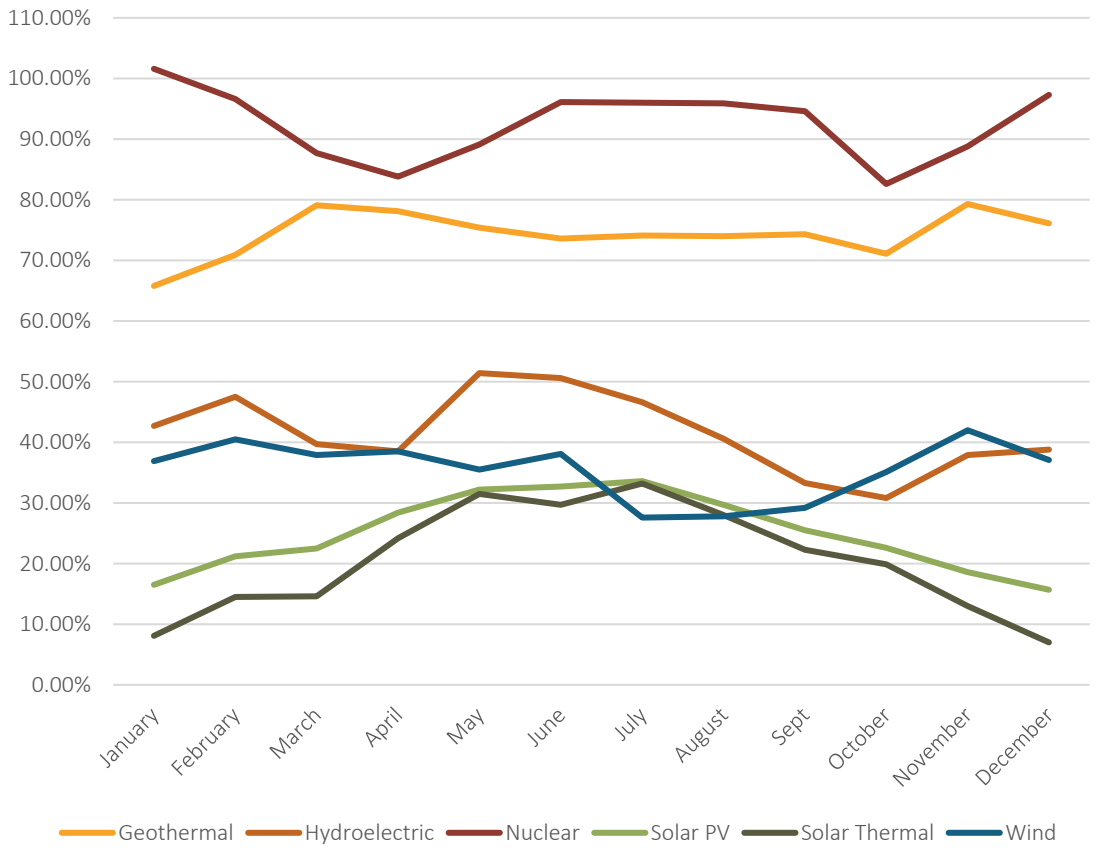
Source: Kepler Chevreux Transition Research, Transition Risks: How to Move Ahead

Conclusion and Considerations

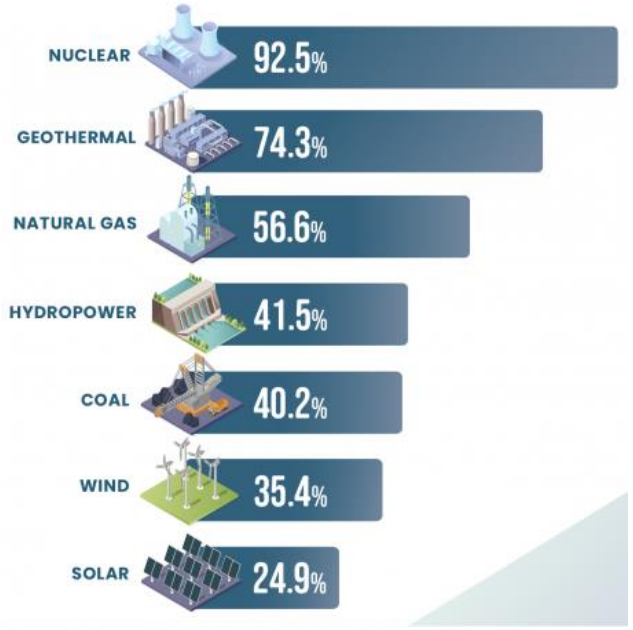
Energy Grid Transition – Renewable Energy Challenges

- Since massive amounts of energy cannot be easily stored, electricity must be produced as it is used. This poses challenges in a renewables dominated grid transition moving forward.
- A big challenge in our electricity grid is the reliability and availability of renewable energy. As can be seen in the figures to the right, renewables all rank towards the bottom in terms of capacity factor
- **Capacity definition:** ratio of an actual electrical energy output over a given period of time to the maximum possible electrical energy output over that period
- Case Study: California's Duck Curve
  - Increase of energy generation during the day from solar energy (11AM-4PM) which is then replaced by more traditional energy sources in the evening given natural constraints (sunlight)
  - This process leads to solar curtailment, which negatively impacts costs for utilities
- Overall, capacity factors for renewable energy resources being so low suggests it will be very difficult to fully transition into solely renewable energy grids without massive innovation in technology and energy storage

Capacity Factors for Utility Scale Generators Primarily Using Non-Fossil Fuels, 2020



Capacity Factor by Energy Source in 2020

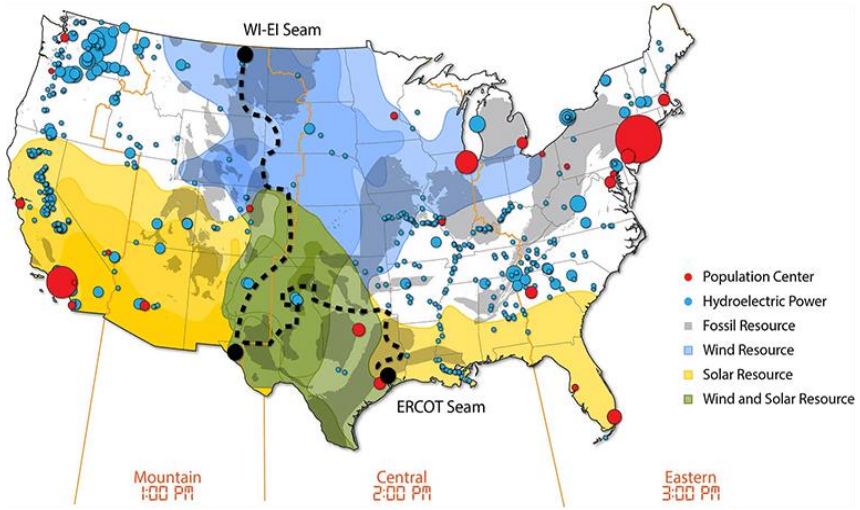


Source: Source: U.S. Energy Information Administration, Electric Power Monthly / U.S. Office of Nuclear Energy

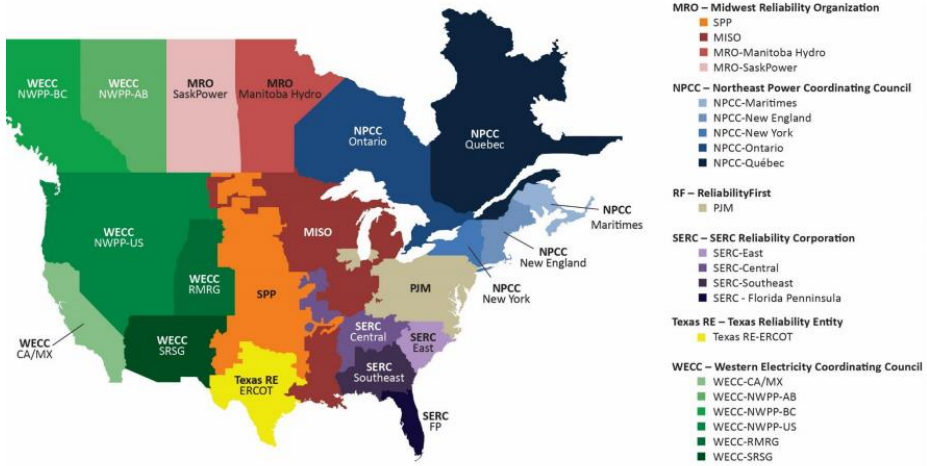
Energy Grid Transition – Grid System Challenges

- U.S. existing energy transportation infrastructure is geared toward moving power as a fuel and converting it to electricity nears its final use location
- Renewables like Solar and Wind cannot be transported as fuels and thus must converted into electricity the moment they are harvested and moved around via a transmission line
- U.S. has a transmission capacity issue as it is not built to move such large amounts of converted energy via transmission lines
  - This is reflected in price differences across U.S. regions where some regions do not have access to adequate transmission capacity and thus experience higher costs
  - Leads to lack of cost effectiveness and disincentivizes the increasing of renewables share in electricity grid

Renewable Resources and Load Centers



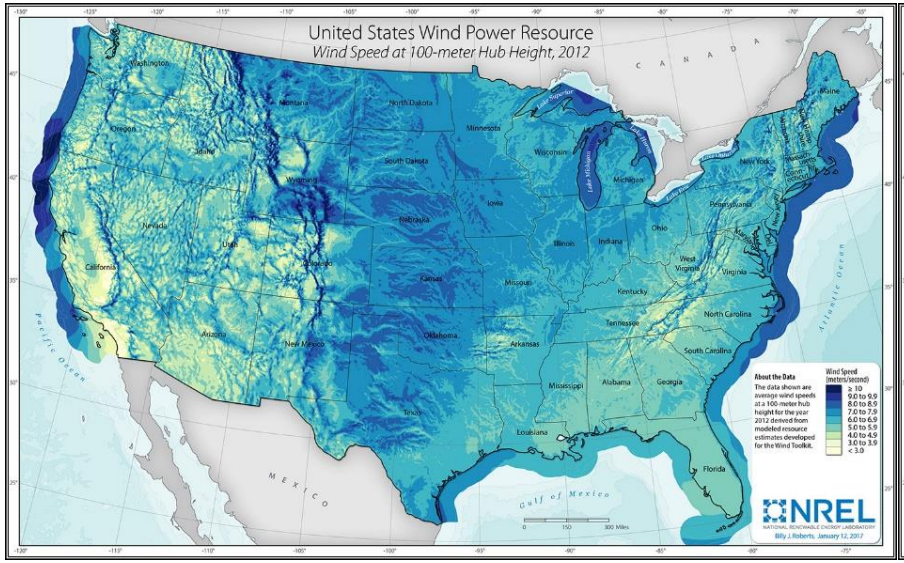
North American Electric Grid, 2020

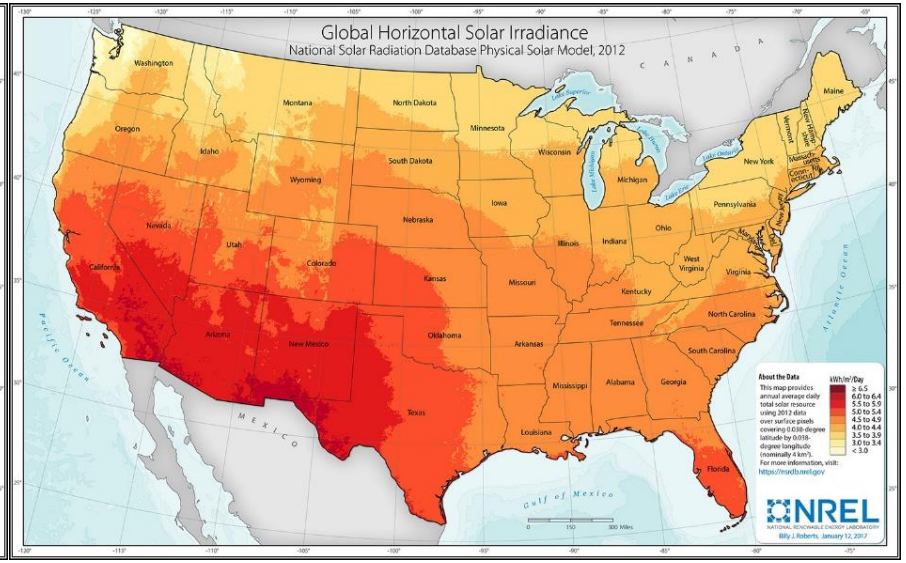


Source: North American Electric Reliability Corporation, 2020 Summer Reliability Assessment / NREL Interconnections Seam Study / EPIC, Decarbonizing the US Economy with a National Grid

Energy Grid Transition – Grid System Challenges

- State governments rely on Renewable Portfolio Standards (RPS) to produce renewable energy within their jurisdiction
  - Does increase share of renewables in electricity grid but not in an efficient manner
- Possible Solution: Encourage the use of existing rights of way for new high-voltage transmission lines
  - Avoids struggle of fighting to use eminent domain to secure easements from unwilling property owners
- Possible Solution: Make FERC the primary venue for transmission project permitting
  - Already exists for oil and gas pipelines (Natural Gas Act of 1938)



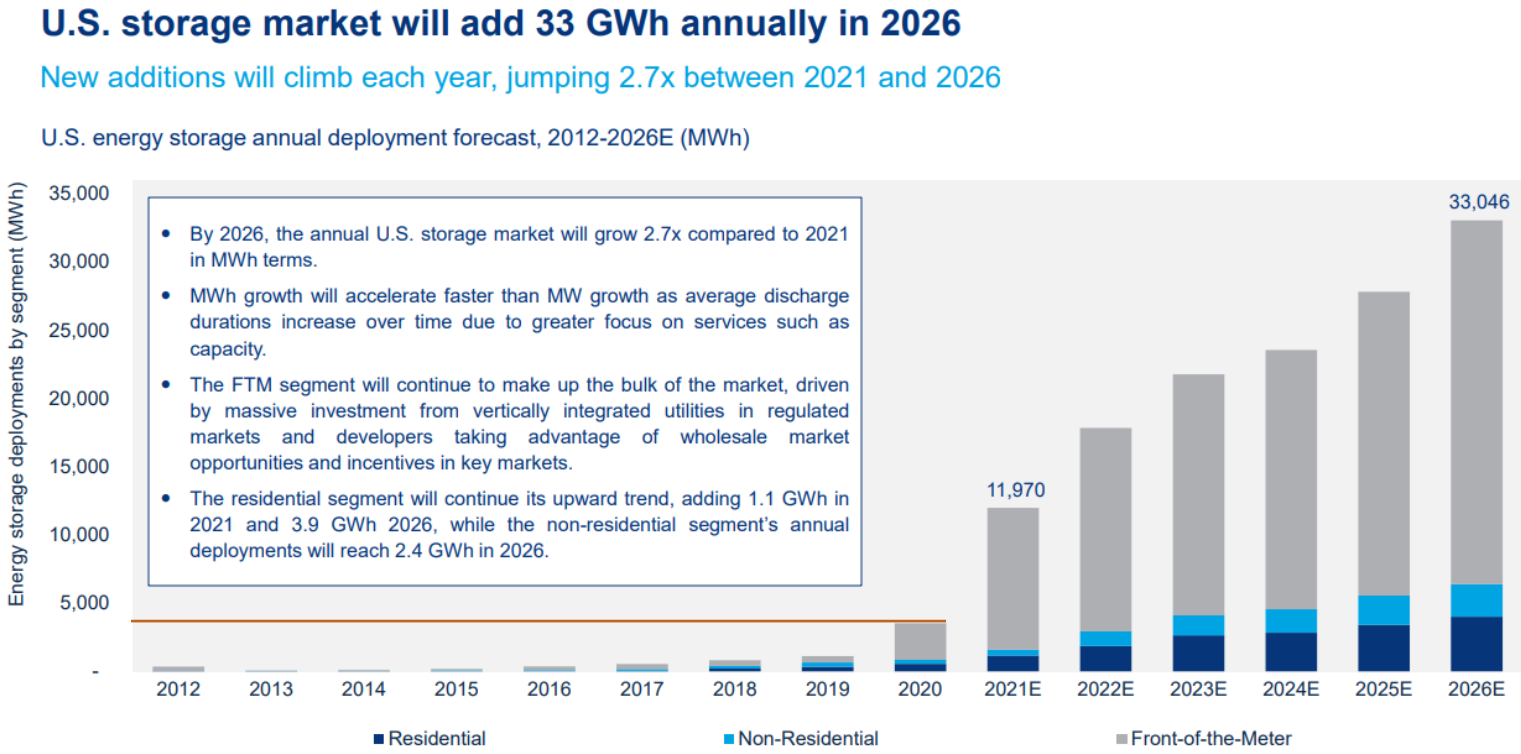


Source: North American Electric Reliability Corporation, 2020 Summer Reliability Assessment / EPIC, Decarbonizing the US Economy with a National Grid

Energy Transition – Intermittency Challenges

A major concern for renewable energy technology expansion is concerned with intermittency challenges.

- Developments in battery storage markets continue to rapidly grow, which will increase storing capabilities and thus increase reliability
  - Rising installations in energy storage set to push market to $8.5 Billion annual threshold
- Front of the Meter (FTM):
  - Utility Scale Generation
  - Utility Scale Energy Storage
  - Transmission and Distribution
- The figure indicates an estimated seven-fold increase in energy storage deployment (MWh) from 2020 to 2026
  - Referring to the past decade, this change in the storage market will undoubtedly have a positive impact in solving intermittency challenges
- Further Improvement in generation and storage will continue driving down costs on a per KWh basis and thus will likely lead to an increase in the appeal of renewable investments and a decrease in intermittency concerns/challenges



Source: Wood Mackenzie Power and Renewables

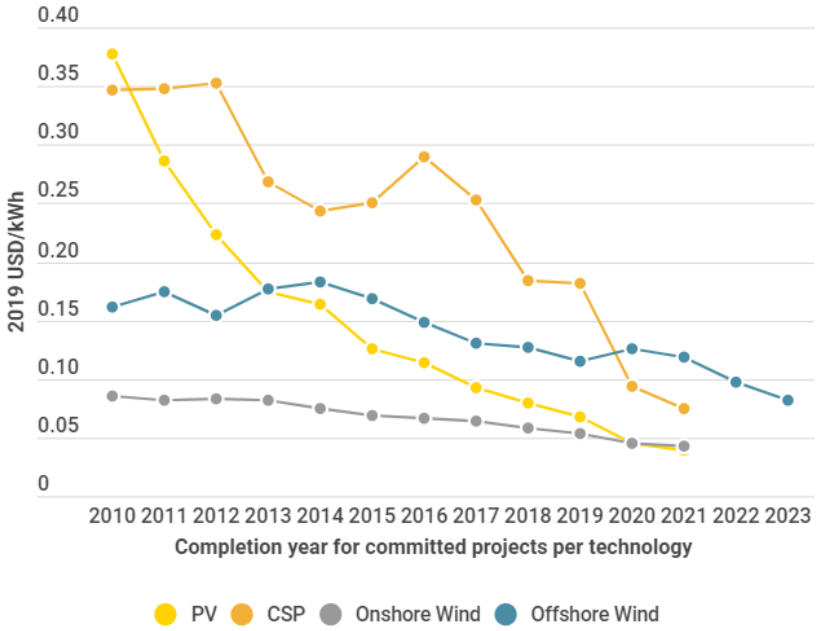
Energy Transition – Costs of Renewable Energy

Another common concern held by many as it relates to renewable energy is as follows: The Energy Transition will be too expensive.

- Solar and Wind technologies, the most popular renewable energy technologies, continue to drastically fall in price on a USD/KWh basis
- Solar PV fell bellow 0.05 USD/KWh in 2020
- On Shore Wind set to fall below 0.10 USD/KWh in 2023
- 56% of capacity additions for utility scale power in 2019 achieved lower costs than cheapest new coal plant
- According to the World Economic Forum[1], if the costliest 500 GW of existing coal was replaced by solar/wind energy, 23 Billion USD would be saved on costs
- Overall, renewables are expected to get cheaper and thus more cost-effective in comparison to fossil fuel energy

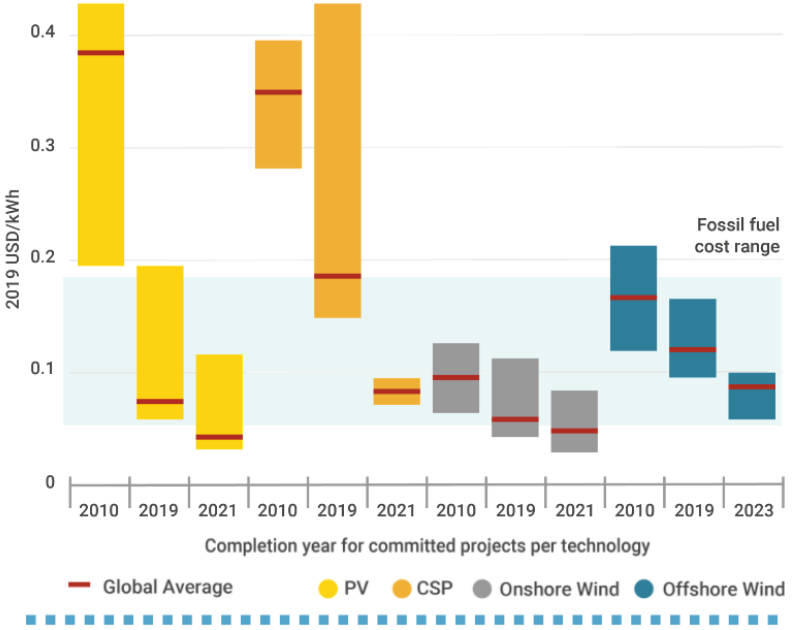
POWER GENERATION COSTS IN 2019

Costs continued to fall in 2019 for solar and wind power technologies



RECORD LOW PRICES IN 2019

Recent auctions results and record low auction prices underpin the downward trend in costs



Source: World Economic Forum, Race to Zero

Energy Transition – Natural Resource Demand in Power Generation

Given that the ongoing energy transition aims to increase the use of clean energy technologies across all sectors (industrials, manufacturing, transportation, etc.), it is important to understand the shift in mineral demand moving forward. Further, It is important to see where these resources will be originating from as way of analyzing economic impacts worldwide.

Top 5 Players Across the World

Copper: Chile, Peru, China, Democratic Republic of Congo, and United States

Nickel: Indonesia, Philippines, Russia, New Caledonia, and Canada

Manganese: South Africa, China, Australia, Gabon, and Brazil

Cobalt: Democratic Republic of Congo, Russia, Australia, Philippines, and Cuba

Chromium: South Africa, Kazakhstan, Turkey, India, and Finland

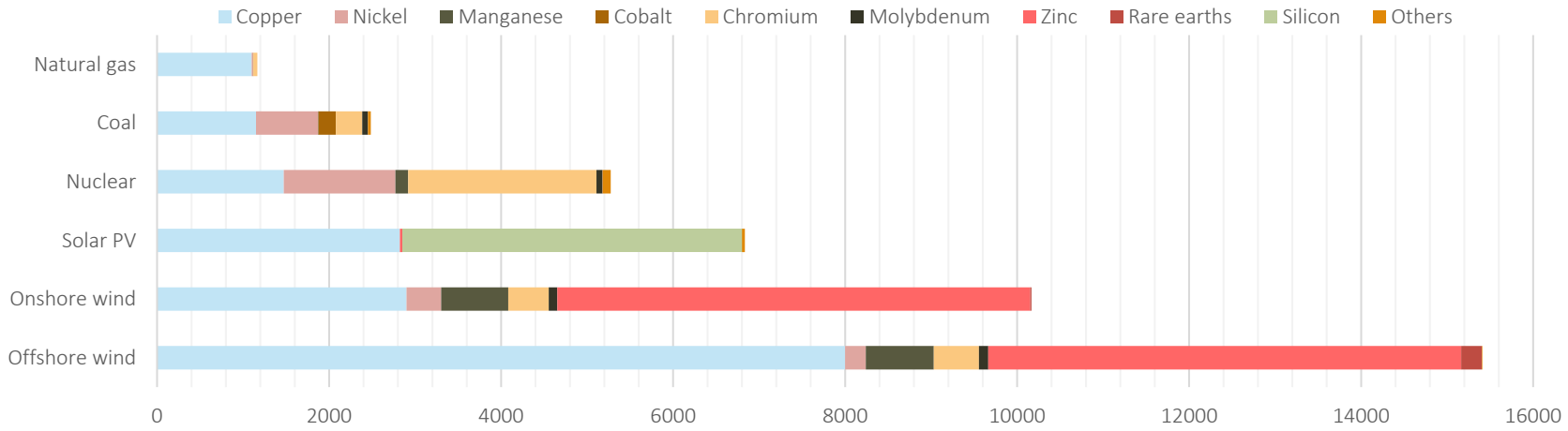
Molybdenum: China, Chile, United States, Peru and Mexico

Zinc: China, Australia, Peru, India, and Unites States

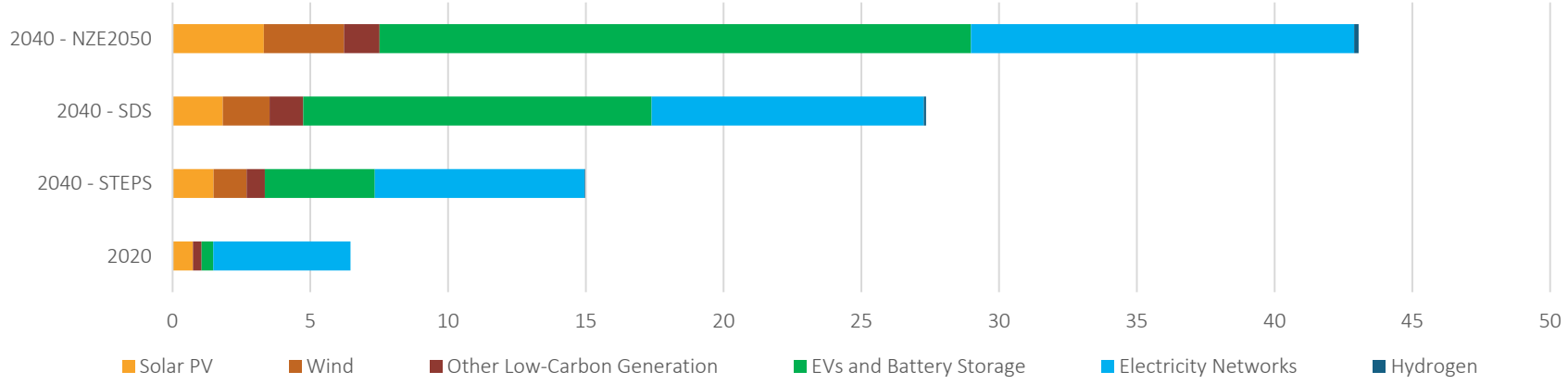
Rare Earths: China, Vietnam, Brazil, Russia, and India

Silicon: China, Russia, Norway, United States, and Brazil

Mineral Use in Power Generation (kg/MW)



Total Mineral Demand for Clean Energy Technologies by Scenario, 2020 vs 2040

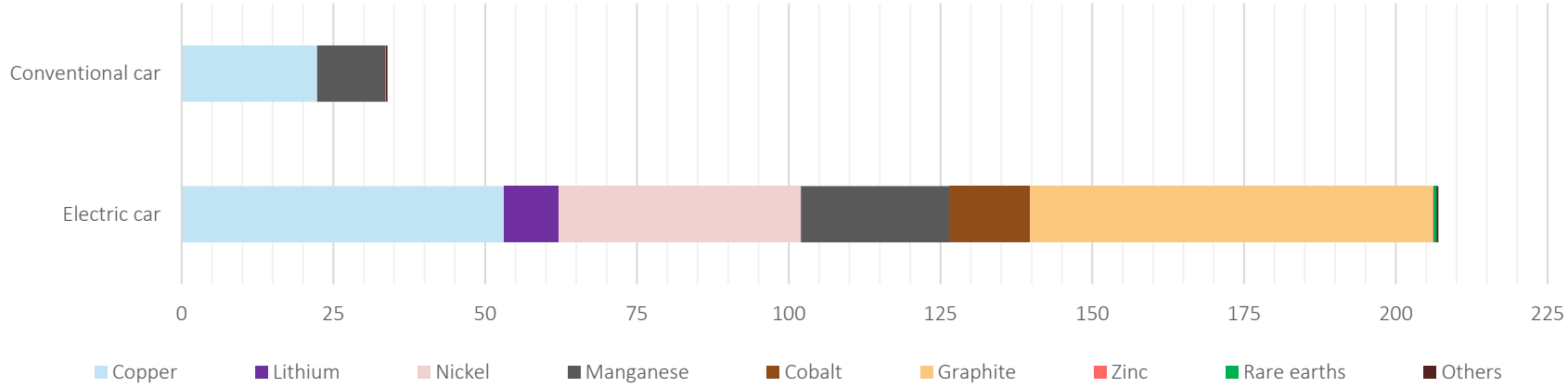


Source: International Energy Agency, World Energy Outlook 2020

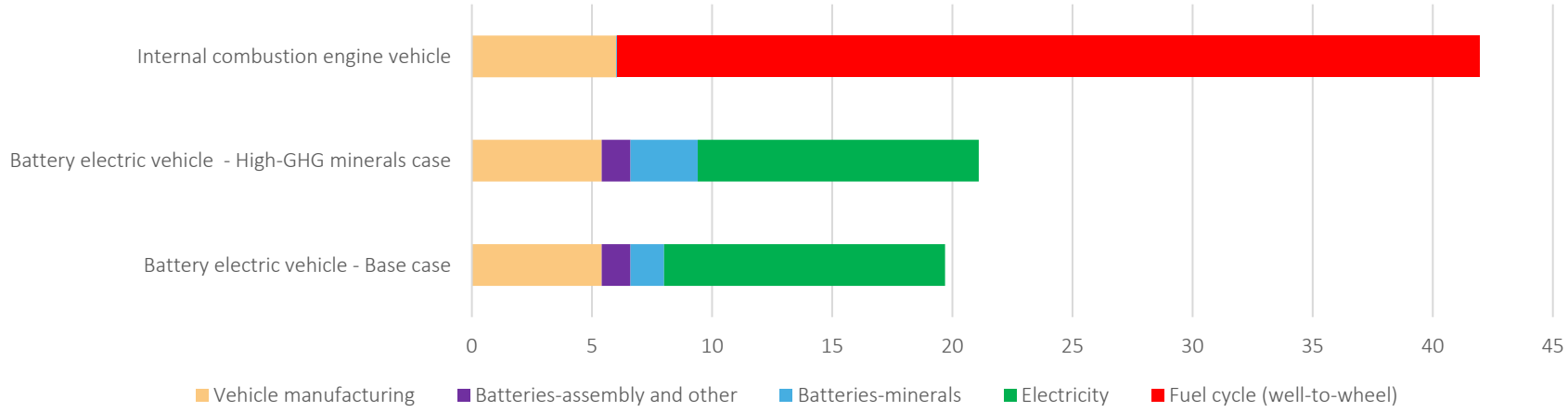
Energy Transition – Natural Resource Demand in Electric Vehicles

- A typical EV requires six times the mineral inputs of an ICE vehicle
- According to the International Energy Agency, since 2010, the average amount of mineral needed for a new unit of power generation capacity has increased by 50% as the share of renewables in new investments has risen
- The shift to a clean energy system is set to drive a huge increase in the requirements and demand for these minerals, meaning that the energy sector is emerging as a major force in mineral markets
- In a scenario that meets the Paris Agreement goals, clean energy technologies' share of total demand rises significantly over the next two decades to
  - over **40%** for Copper and rare earth elements
  - **60-70%** for Nickel and Cobalt
  - almost **90%** for Lithium
- EVs and battery storage have surpassed consumer electronics in becoming the largest consumer of Lithium
- EVs and battery storage are set to take over from stainless steel as the largest end user of Nickel by 2040

Minerals Used in Conventional Cars vs Electric Vehicles (kg/vehicle)



Comparative Lifecycle Greenhouse Gas Emissions of a mid-size EV and ICE Vehicle (ton of carbon dioxide emission per vehicle lifetime)



Source: IEA, The Role of Critical Minerals in Clean Energy Transitions

Commodity Markets Forecasts

Energy (Constant USD), 2015 to 2035E

- Crude Oil ($/bbl) is in line with McKinsey Q1 2021 Forecasts[1]
  - 51.9 → +13.68% → 59.0
  - McKinsey Q1 2021 Report States $50 to $60/bbl equilibrium price range in the long term
- Natural Gas (US, $/mmbtu) is in line with EIA Annual Energy Outlook 2021 Reference Natural Gas Price (refer to slide #) at Henry Hub[2]
  - 2.7 → +25.93% → 3.4
- Coal, Australia ($/mt): 60.1 → -29.53% → 46.4

Metals and Minerals (Constant USD), 2015 to 2035E

- Aluminum ($/mt): 1,701 → +18.99% →2,024
- Copper ($/mt): 5,631 → +23.58% →6,959
- Iron Ore ($/dmt): 57.1 → +18.21% → 67.5
- Lead ($/mt): 1,827 → -3.07% →1,771
- Nickel ($/mt): 12,122 → +25.24% → 15,182
- Tin ($/mt): 16,418 → +28.43% →21,086
- Zinc ($/mt): 1,974 → +6.84% →2,109

World Bank Commodities Price Forecast (Nominal USD)

				Forecasts						
Commodity	Unit	2015	2020	2021	2022	2023	2024	2025	2030	2035
Energy										
Coal, Australia	$/mt	58.9	60.8	78.0	76.1	74.2	72.4	70.6	62.3	55.0
Crude oil, avg	$/bbl	50.8	41.3	56.0	60.0	61.0	61.9	62.9	68.2	70.0
Natural gas, Europe	$/mmbtu	6.8	3.2	5.5	5.6	5.6	5.7	5.8	6.1	6.5
Natural gas, US	$/mmbtu	2.6	2.0	2.8	2.9	2.9	3.0	3.1	3.5	4.0
Liquefied natural gas, Japan	$/mmbtu	10.9	8.3	8.0	8.0	7.9	7.9	7.9	7.7	7.5
Metals and Minerals										
Aluminum	$/mt	1,665	1,704	2,000	2,050	2,075	2,100	2,126	2,259	2,400
Copper	$/mt	5,510	6,174	8,500	7,500	7,555	7,611	7,667	7,953	8,250
Iron ore	$/dmt	55.9	108.9	135.0	100.0	98.3	96.6	95.0	87.2	80.0
Lead	$/mt	1,788	1,825	1,950	1,900	1,910	1,920	1,930	1,982	2,100
Nickel	$/mt	11,863	13,787	16,500	16,000	16,146	16,293	16,441	17,203	18,000
Tin	$/mt	16,067	17,125	25,000	23,000	23,148	23,297	23,447	24,211	25,000
Zinc	$/mt	1,932	2,266	2,700	2,400	2,408	2,415	2,423	2,461	2,500
Precious Metals										
Gold	$/toz	1,161	1,770	1,700	1,600	1,550	1,525	1,500	1,549	1,600
Silver	$/toz	15.7	20.5	25.0	22.0	20.0	19.0	18.0	19.0	20.0
Platinum	$/toz	1,053	883	1,100	1,110	1,120	1,131	1,141	1,194	1,250

World Bank Commodities Price Forecast (Constant USD, 2010 = 100)

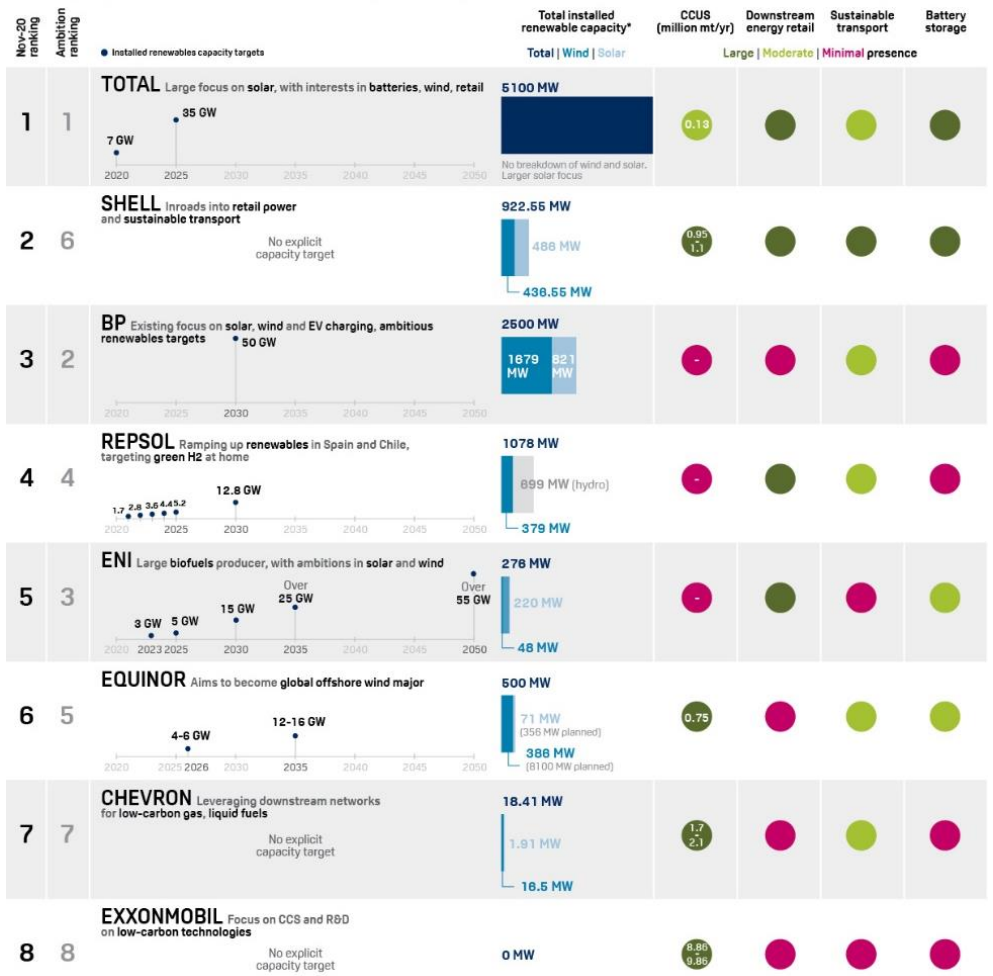
				Forecasts						
Commodity	Unit	2015	2020	2021	2022	2023	2024	2025	2030	2035
Energy										
Coal, Australia	$/mt	60.2	61.4	77.6	74.4	71.3	68.4	65.5	52.6	46.4
Crude oil, avg	$/bbl	51.9	41.7	55.7	58.7	58.6	58.5	58.4	57.5	59.0
Natural gas, Europe	$/mmbtu	7.0	3.3	5.5	5.4	5.4	5.4	5.4	5.2	5.5
Natural gas, US	$/mmbtu	2.7	2.0	2.8	2.8	2.8	2.9	2.9	3.0	3.4
Liquefied natural gas, Japan	$/mmbtu	11.2	8.4	8.0	7.8	7.6	7.5	7.3	6.5	6.3
Metals and Minerals										
Aluminum	$/mt	1,701	1,721	1,989	2,005	1,995	1,984	1,972	1,905	2,024
Copper	$/mt	5,631	6,237	8,452	7,335	7,262	7,188	7,111	6,708	6,959
Iron ore	$/dmt	57.1	110.0	134.2	97.8	94.5	91.3	88.1	73.5	67.5
Lead	$/mt	1,827	1,844	1,939	1,858	1,836	1,813	1,790	1,672	1,771
Nickel	$/mt	12,122	13,928	16,406	15,647	15,520	15,387	15,249	14,510	15,182
Tin	$/mt	16,418	17,299	24,858	22,493	22,251	22,002	21,747	20,421	21,086
Zinc	$/mt	1,974	2,290	2,685	2,347	2,314	2,281	2,247	2,076	2,109
Precious Metals										
Gold	$/toz	1,186	1,788	1,690	1,565	1,490	1,440	1,391	1,307	1,350
Silver	$/toz	16.1	20.7	24.9	21.5	19.2	17.9	16.7	16.0	16.9
Platinum	$/toz	1,076	892	1,094	1,086	1,077	1,068	1,058	1,007	1,054

Source: The World Bank, Commodity Markets Outlook: Causes and Consequences, April 2021

Energy Transition – Fossil Fuels' Role in Transition

- International oil companies have continued to further ramp up investments in the renewables space as well as carbon capture technologies
  - this trend has been accelerated in developed economies by the ongoing pandemic and rising ESG investing
- Installed Renewables Capacity by Firm, 2020, Ranked
  - BP: 2500 MW
  - REPSOL: 1078 MW
  - Shell: 922.56 MW
  - EQUINOR: 500 MW
  - ENI: 276 MW
  - CHEVRON: 18.41 MW
  - EXXONMOBIL: 0 MW
- CCUS by Firm (million mt/year), 2020 Ranked
  - EXXONMOBIL: 9.36 (Average)
  - CHEVRON: 1.9 (Average)
  - Shell: 1.025 (Average)
  - EQUINOR: 0.75
  - BP: 0
  - REPSOL: 0
  - ENI: 0

Energy Majors' Transition Strategies



Source: S&P Global Platts, Company Reports

Energy Transition – Fossil Fuels' Role in Transition

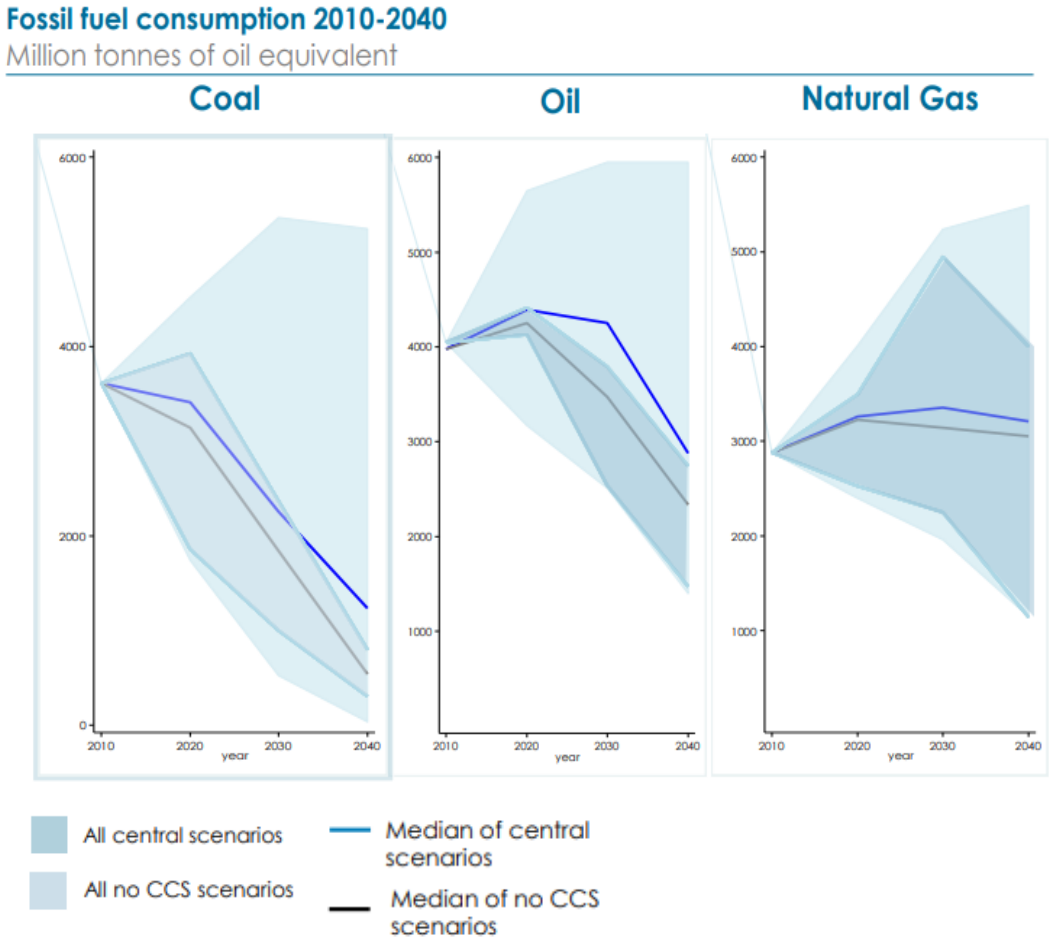
- Central Scenarios
  - Limit the risk of a global temperature rise of more than 2° by less than 33% (Likely)

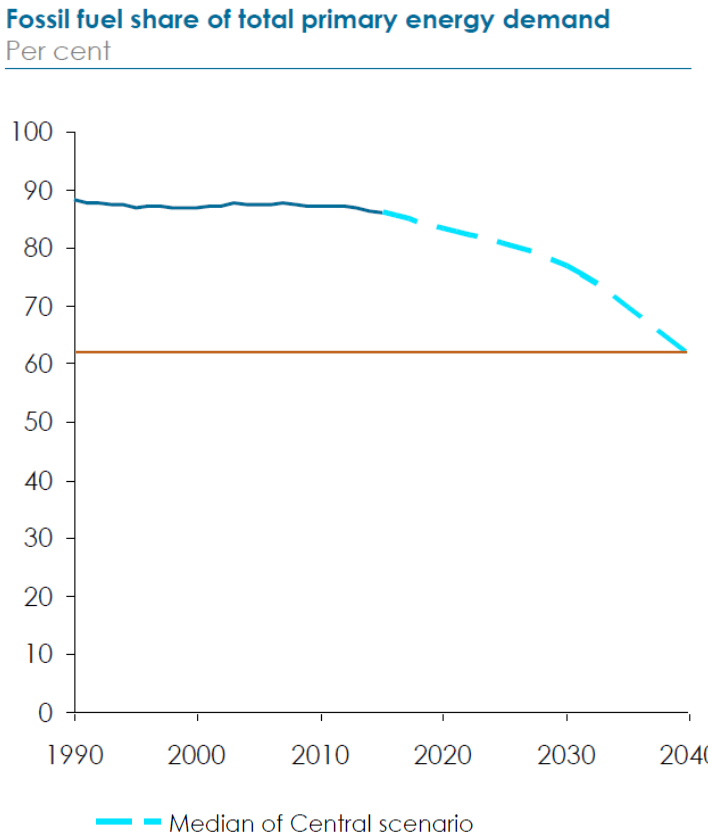
Right Figure: It can be observed that in this analysis, by 2040:

- Coal, when looking at median of central scenarios, will sharply decline to approximately **1275 Mtoe**
- Oil, when looking at median of central scenarios, will decline to approximately **2950 Mtoe**
- Natural Gas, when looking at median of central scenarios, will be decline to approximately **3300 Mtoe**

Left Figure: Although declines in all fossil fuel consumption is expected, when considering the median of central scenarios, it can be observed that by 2040, **fossil fuel share of total primary energy demand will remain above 60%**

- With a 2020 fossil fuel share of 79%, a forecasted ~17% share decline is expected in the median of central scenarios
- By 2040, coal prices are expected to drop as is forecasted in the World Bank Commodities Forecast[1]
- In 2040, natural gas is expected to remain above 2010 levels as shown in the median line and this is reflected in the price of natural gas[2]



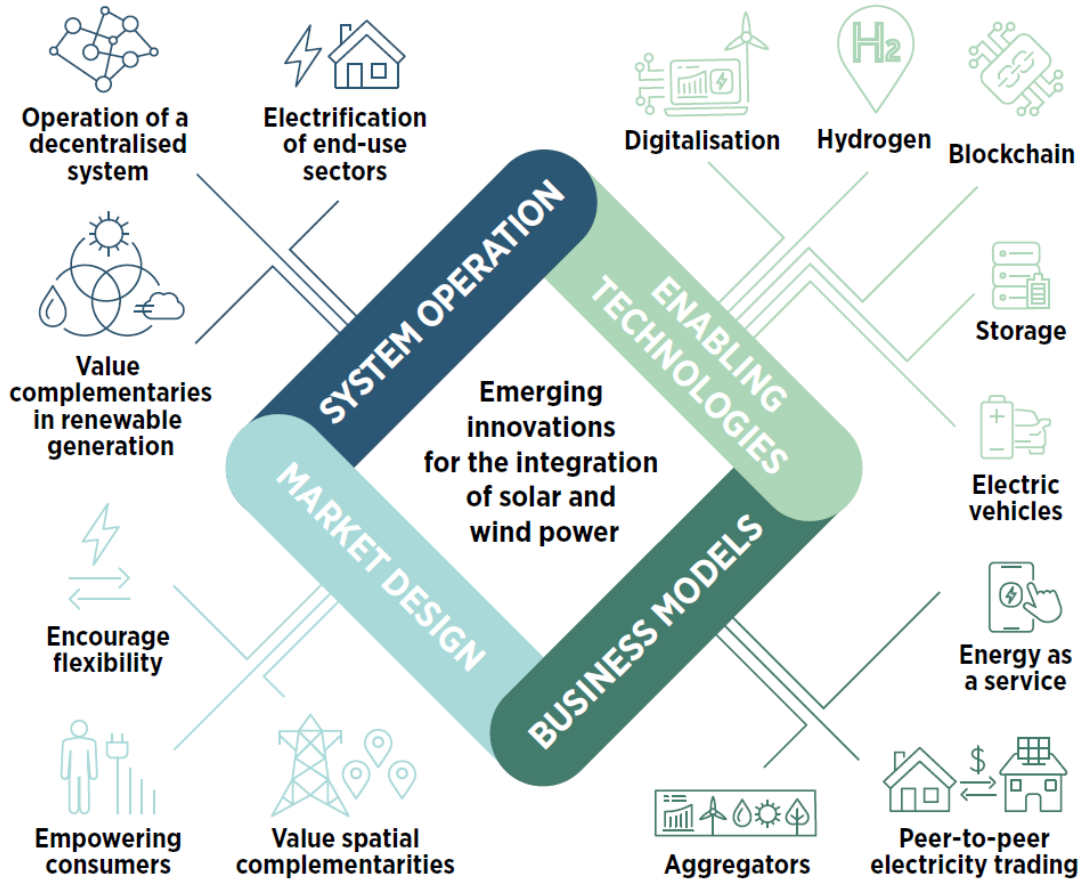


Source: Copenhagen Economics, The Future of Fossil Fuels

Energy Transition – Conclusion

- The ongoing Energy Transition will affect the entire economy but will have a large focus along value chains of renewable energy technologies
  - Includes areas such as energy-efficient appliances/machines and all other goods and services requires to make transition process occur
- EV technology development and production increases will very likely have an impact on the minerals market as well as increase demand for
  - Battery development
  - Energy storage development
  - Electricity infrastructure worldwide
- Non-Renewable fuel use has the *potential* to decline by more than 75% by 2050 (based on rapid transition measures being implemented in developed economies)
- Electricity will be a crucial component in the energy system, exceeding 50% of final energy use by 2050
- The Energy Transition will require heavy development of mining production and overall production logistics across value chains in order to achieve emissions reduction goals by 2050
- Renewable energy, electrification, and energy efficiency are the core pillars of the energy transition

Emerging innovations for the integration of variable renewable energy sources

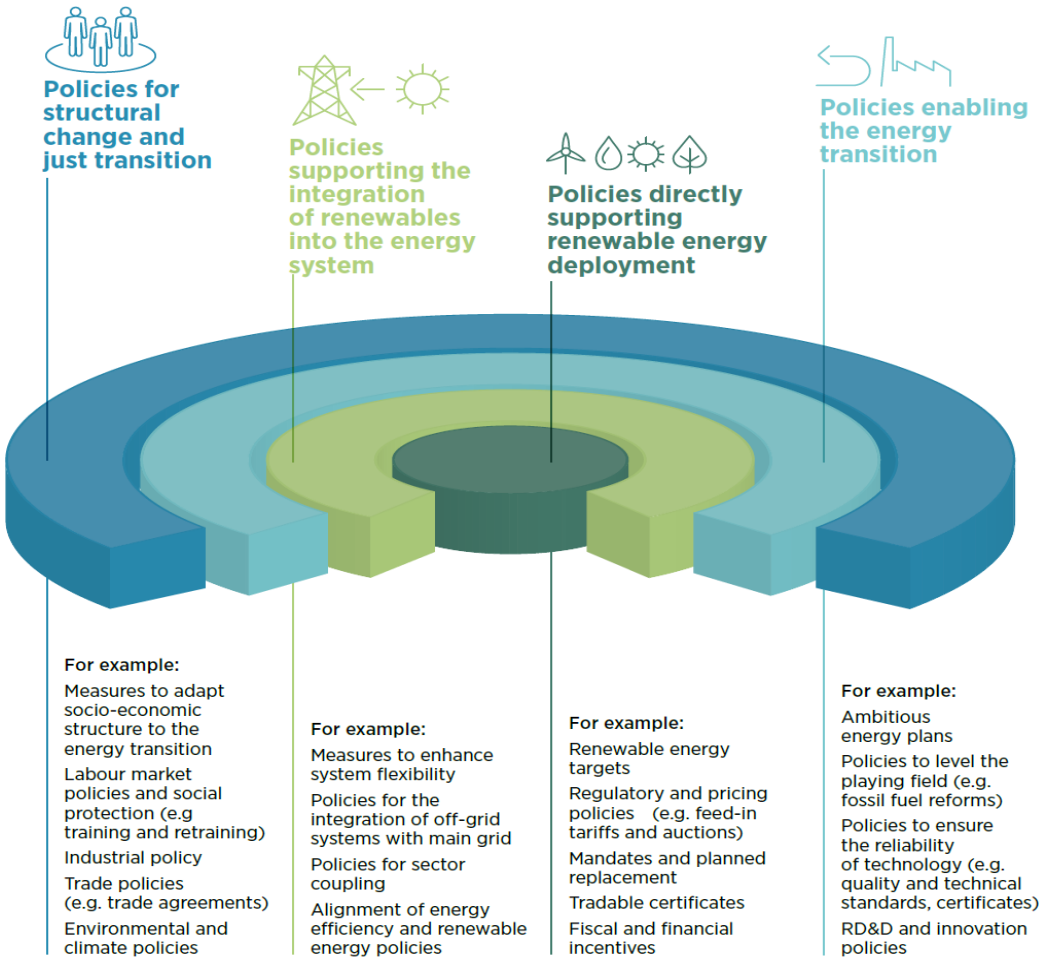


Source: IRENA, World Energy Transitions Outlook 2021

Energy Transition – Conclusion

- The ongoing Energy Transition will require far-reaching cooperation between countries in order to ensure a globally successful solution as it relates to an energy transition core issue being addressed (climate change)
- Energy Transition scenarios, of which there are many, will be brought into reality and be heavily impacted by targets set by nations and whether said targets are reached
- Limitations to Global Cooperation
  - US Bipartisan Cooperation will be required to lead world in green energy innovation and adoption (political limitation)
  - Firms worldwide may not share the same level of outlook. Some firms may only consider short term outlooks while others may consider long terms outlooks (economic limitation)
  - Inefficiencies between entities (firms, nations, etc.) in agreeing on development paths
- Financial markets and investors globally have been reorienting their attention towards opportunities in new energy technologies; this will prove to be crucial for the successful development and deployment of green energy technologies into energy infrastructure worldwide

Enabling Policy Framework for a Just Energy Transition

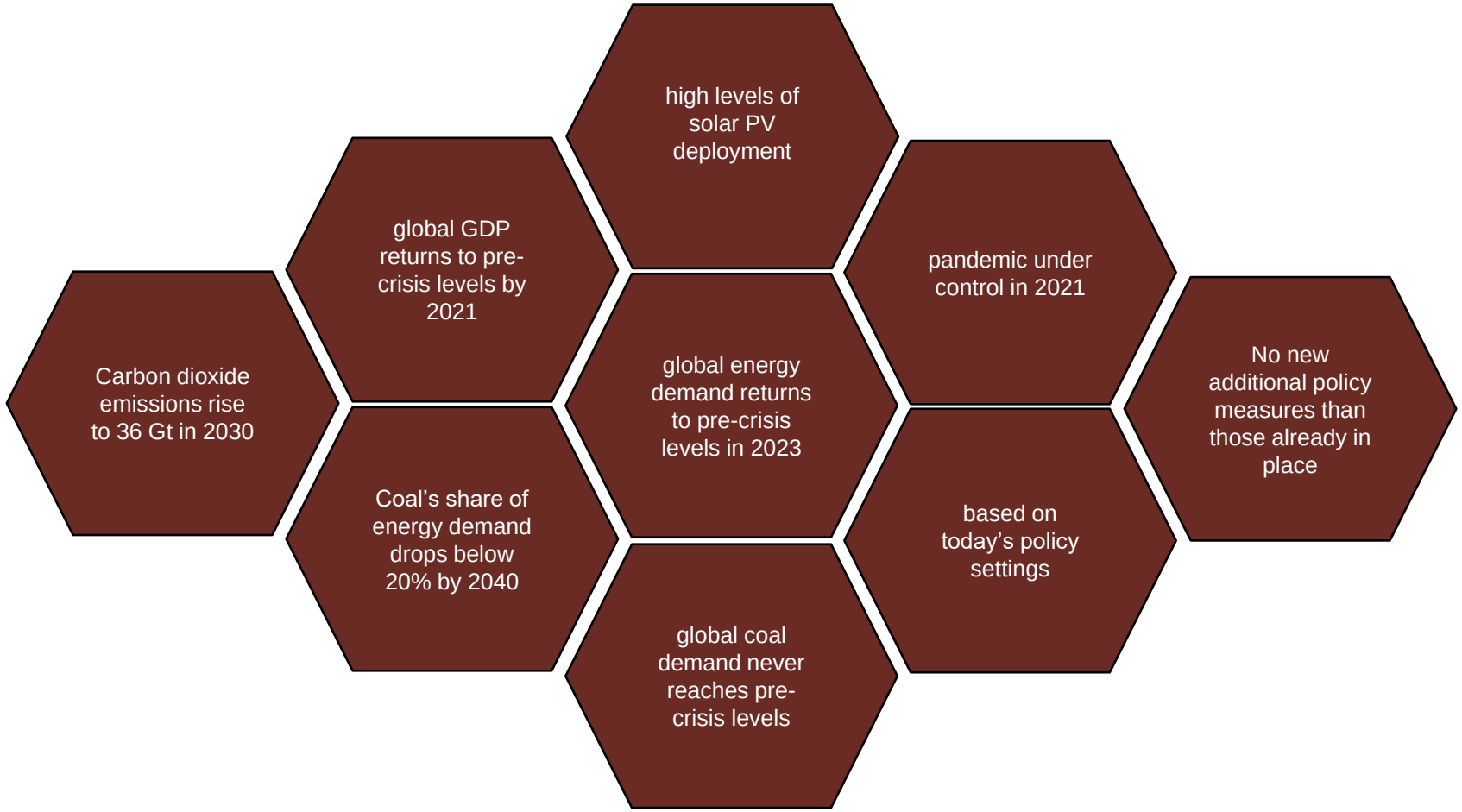


Source: IRENA, World Energy Transitions Outlook 2021

Appendix: Scenarios

Global Energy Outlook – Stated Policies Scenario (STEPS)

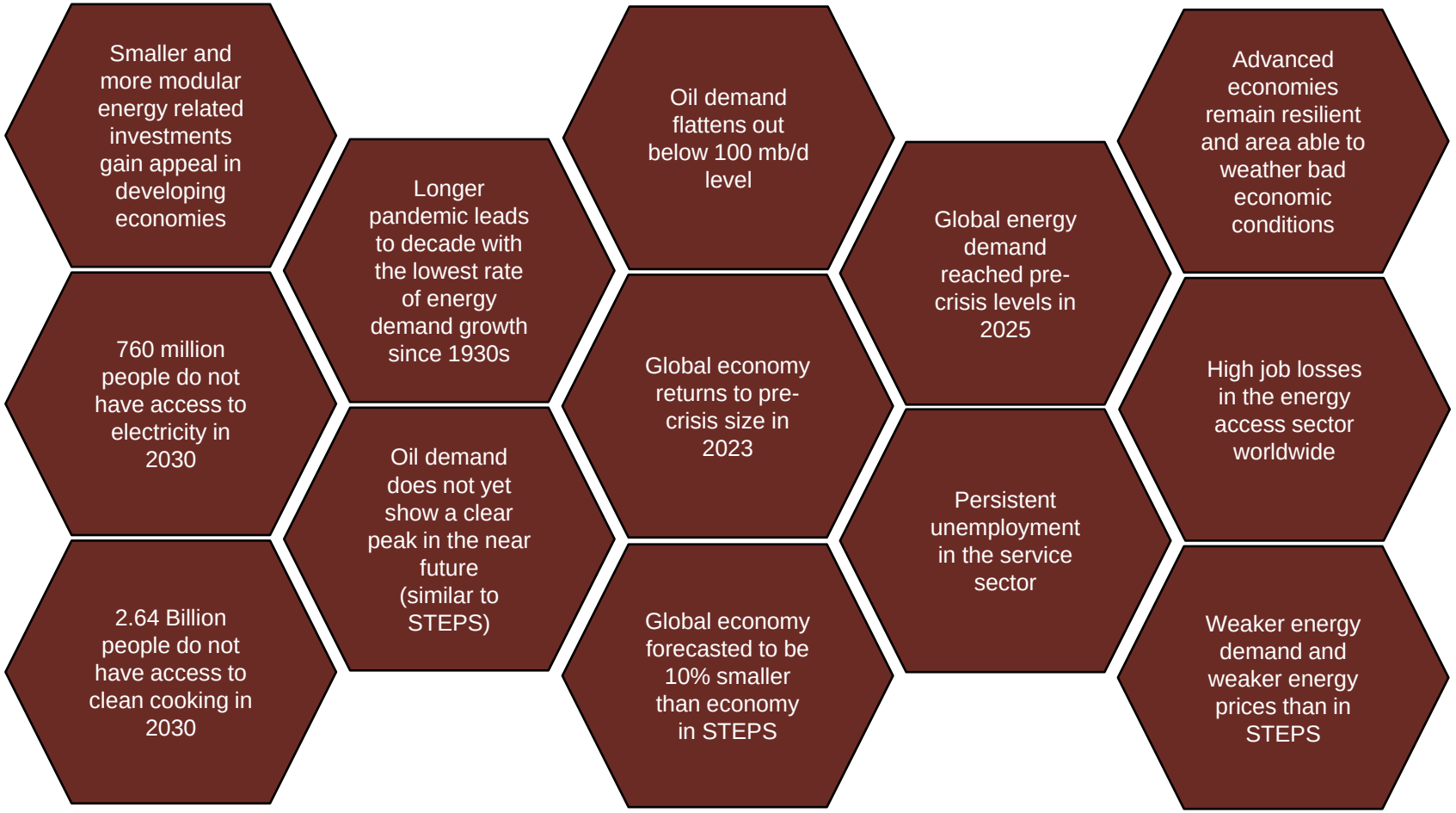
- Reflects all of today's announced policy measures and targets that are backed up by detailed information related to their realization by proposing entities
- Reflects progress with the implementation of corporate sustainability commitments in
  - Outlook for industrial use
  - Emissions
  - Prospects for renewable electricity
- Negative impacts on growth and energy consumption remain in existence in a significant number of low-income countries, leading to a delay in stated goals towards energy access and clean cooking within affected countries
- Major conventional resource holders act to prevent prices from reaching levels that cause
  - A return to very rapid growth in US tight oil production
  - An increase in faster substitution away from oil by consumers



Source: IEA, World Energy Outlook 2020

Global Energy Outlook – Delayed Recovery Scenario (DRS)

- Designed with the same policy foundations as in the Stated Policies Scenario (STEPS) except in this specific scenario the pandemic lasts longer and thus leads to larger economic and social damages
- High debt and political constraints limit the effectiveness of fiscal stimulus and private debt overhang, along with weak confidence results in ineffective monetary expansion in the US
- There exists a lower level of energy consumption as a result of negative near-term economic conditions in emerging markets and developing economies
- Less progress is made in this scenario when compared to STEPS in closing the gap with pre-crisis GDP forecasting; the gap narrows by 2025 in STEPS and there is a less certain date for DRS
- With an attraction in more steady cash flow profiles, renewable power investments should continue to benefit as well as electricity networks

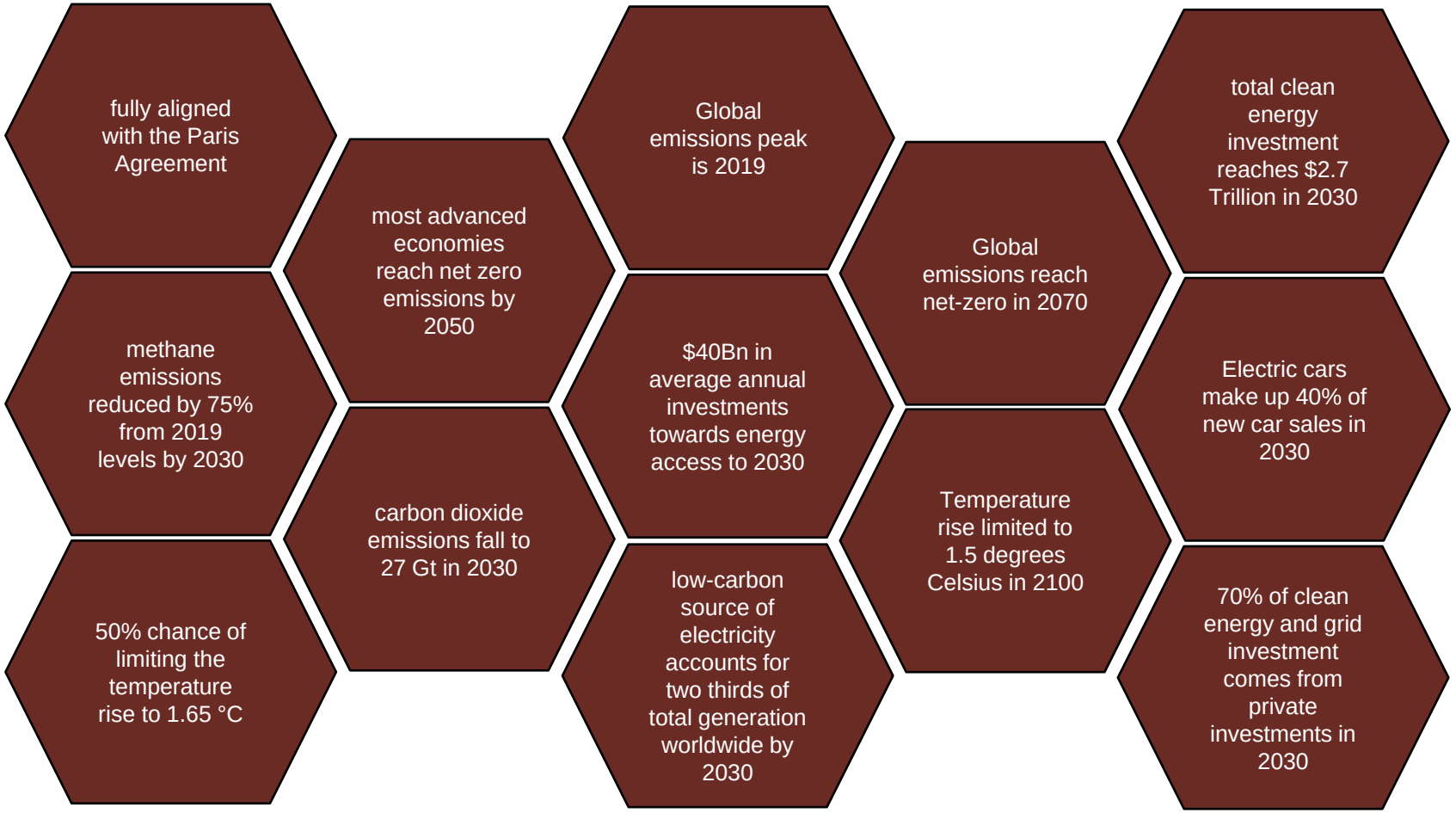


Source: IEA, World Energy Outlook 2020

Global Energy Outlook – Sustainable Development Scenario

- Rapid increase in clean energy policies and investments place energy system on path to achieve sustainable energy objectives in full
- Based on the same economic and public health outlook as in the State Policies Scenario (STEPS)
- Provides a way to explore the impacts of more far-reaching changes in policies aiming to make modern energy services universally accessible, affordable, and reliable by 2030
- Drawn from the IEA Sustainable Recovery Plan, which aims for cost-effective measured to revitalize economies while creating jobs and constructing cleaner and more resilient energy systems
- Spans six key sectors:
  - Electricity
  - Transport
  - Industry
  - Buildings
  - Fuels
  - Emerging Low-Carbon Technologies

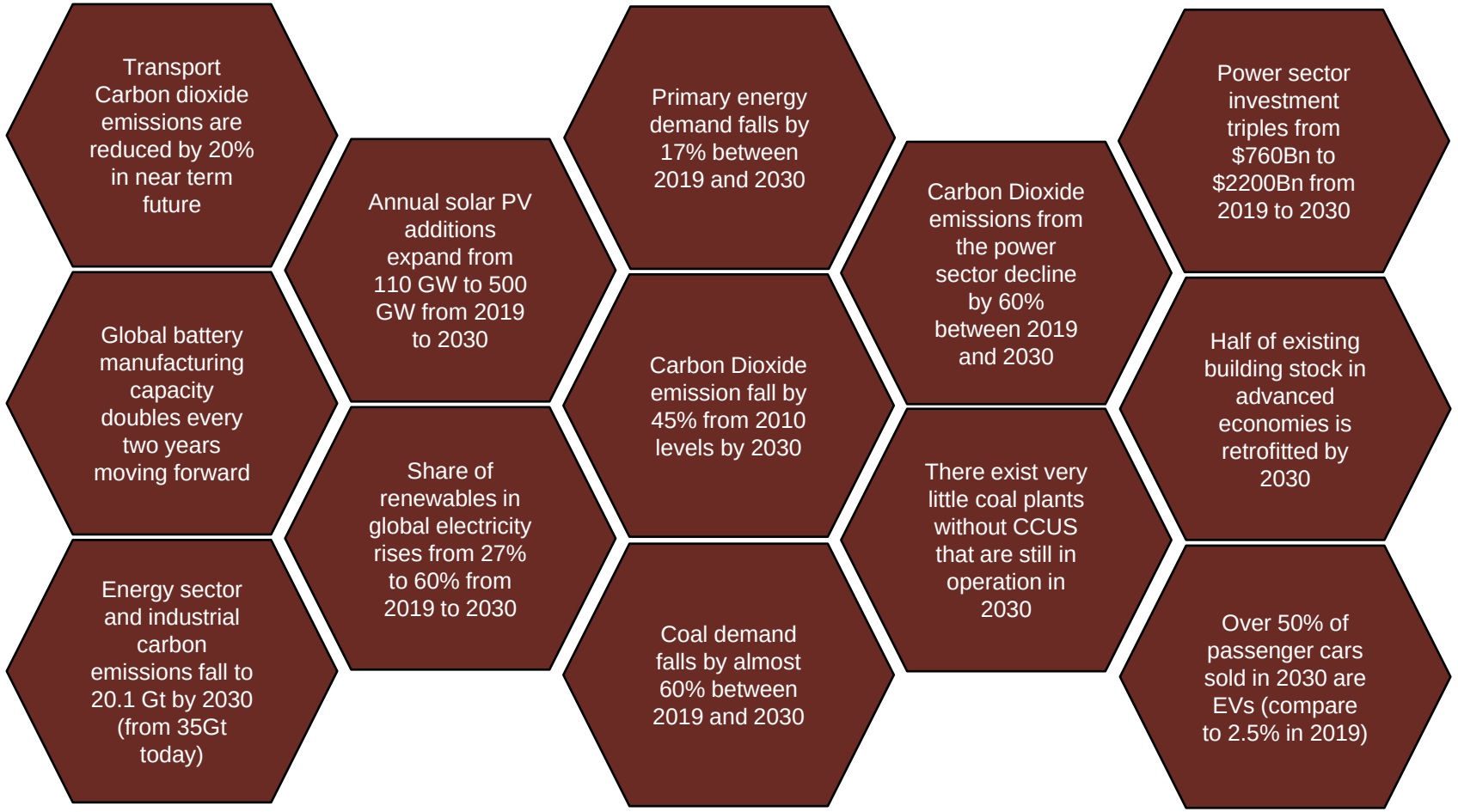
Figure 3: SDS Key Points



Source: IEA, World Energy Outlook 2020

Global Energy Outlook – Net Zero Emissions by 2050 (NZE2050)

- Carbon dioxide emissions in this scenario are 6.6 Gt lower than in the SDS in 2030 (20.1 Gt is the forecasted emissions under NZE2050)
- Global Electricity Supply Make up in 2030
  - Renewables: 60%
  - Nuclear Power: 10%
  - Coal Plants (no CCUS): 6%
- More than one third of forecasted power sector investments from 2019 to 2030 are expected to be used to expand, modernize, and digitalize electricity networks
- Unparalleled transformation of the energy sector and major consumer and entity behavioral changes within the next decade would need to take place to achieve this scenario
- Lessons from existing Net-Zero commitments:
  - Electrification is central to emissions reduction
  - Low-carbon fuels such as hydrogen are still relevant
  - There is an urgent need to boost support for technology innovation
  - It will be critical to engage with consumers to engage public acceptance and energy affordability



Source: IEA, World Energy Outlook 2020

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