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EXECUTIVE SUMMARY

The Energy Transition: Gearing Up for Smarter Utility and Industrial Power Grids

Visions of 2040: What's in Store for the Energy Industry?

Phillip Cornell, Principal at The Economist Intelligence Unit; Senior Fellow, Atlantic Council
Michael Weinhold, Head of Technology and Innovation, Siemens Smart Infrastructure

MAY 19, 2021

KEY TAKEAWAYS

- Ambitious and aligned global policy consensus is prioritizing climate change.
- Fossil fuels are in structural decline, but at different speeds.
- Low-cost renewables are booming, but integration poses a challenge.
- Energy systems in 2040 will be digitized, decentralized, and interconnected.
- Digitalization is critical for the energy system of the future.

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Visions of 2040: What's in Store for the Energy Industry?

OVERVIEW

Countries around the world—from Britain to China to the US and India—are prioritizing climate change policies, committing to driving down their emissions. Ambitious and aligned global policies, coupled with the low cost of renewable energy, are driving a shift away from fossil fuels and toward renewables, particularly wind and solar power.

While fossil fuels will still be in use in 2040, the focus two decades down the road is expected to be on renewable energy systems, as well as the digitized, decentralized, and globally interconnected smart grids that enable energy transmission.

CONTEXT

Phillip Cornell provided an overview of the shift occurring in the global energy industry, and along with Michael Weinhold, shared a vision of what the industry and grids might look like in 2040.

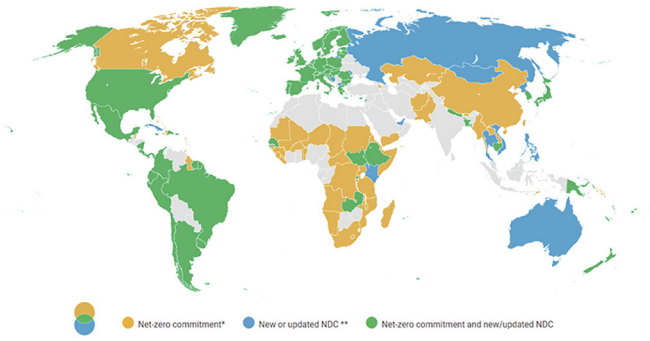
KEY TAKEAWAYS

Ambitious and aligned global policy consensus is prioritizing climate change.

Policy consensus prioritizing climate change is coming into focus, driving a shift in market and corporate values. The 2020 pandemic helped catalyze policy thinking around energy, spurring on numerous net-zero emissions commitments from major economies, including Britain and China, as well as from individual companies.

> When the market is convinced of government commitment, the underlying climate change logic, and the direction of peers, a virtuous cycle of sustainable finance is possible.
>
> *Phillip Cornell, Economist Intelligence Unit, Atlantic Council*

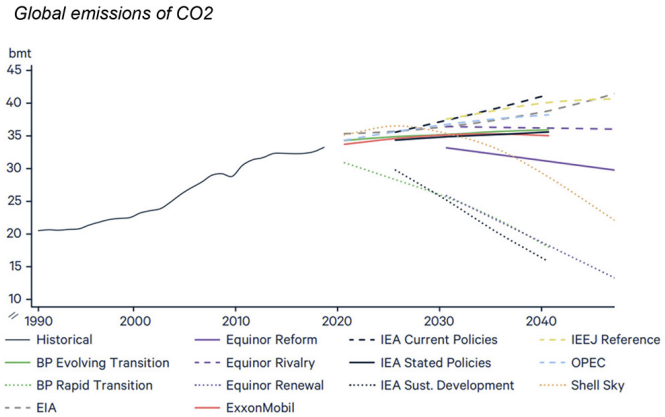
Figure 1: The 2020 inflection: Pandemic, post-Paris and energy policy momentum



Today's rising carbon prices, such as the sharp rise in Europe to over $50 a ton since the European Union (EU) toughened its targets, is a reflection of the policy change, and is expected to remain one of the powerful forces driving investment.

Unpredictable learning curves drive the projections from now to 2040 and beyond, creating a wide spectrum of potential emissions outcomes. COVID, policy, technology, and long-term demand can all shift the outlook of global emissions of carbon dioxide (CO2) to 2040 and beyond.

Figure 2: Uncertainty creates a spectrum of potential outcomes for 2040 and beyond



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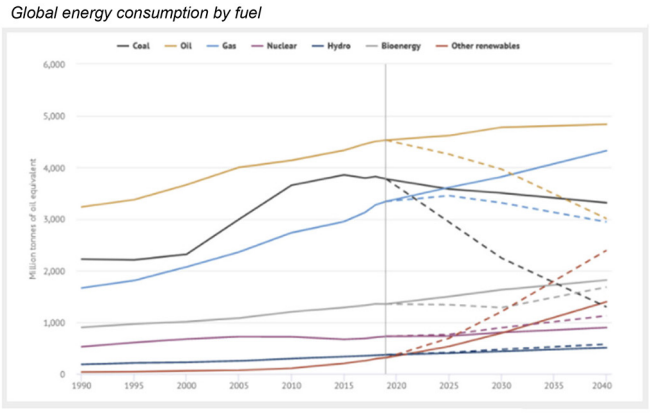
Fossil fuels are in structural decline, but at different speeds.

Fossil fuels are in a long-term, structural decline, but the speed of that decline depends on the type of fuel and the region. Coal has peaked and is in decline around the world. Gas demand continues to grow, especially in China, India, and Southeast Asia, where it replaces coal. The popularity of gas may soon begin to change in those regions as the total cost of renewable energy starts to fall below the operating costs of gas plants, within five years in some parts of the world.

Figure 3: Across the globe, fossil fuels are experiencing structural decline, but at different speeds



Source: IEA

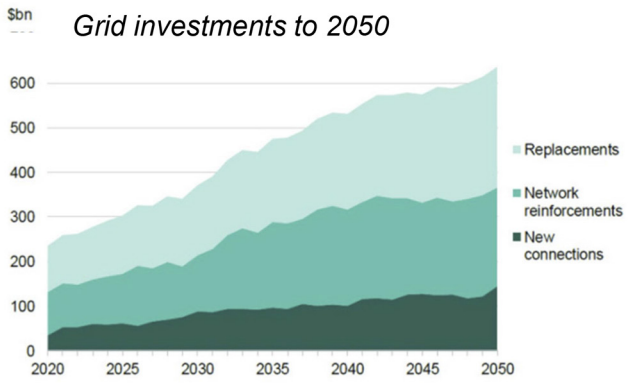
Despite the popularity of electric vehicles (EVs), oil remains in demand, especially in the East. Policies in Asia, as well as production management by the Organization of Petroleum Exporting Countries (OPEC), will play critical role in how rapidly oil demand declines. Even with a decline in oil demand by 2040, the expectation is that there will still be a need to drill for 23 million additional barrels of oil per day.

Low-cost renewables are booming, but integration poses a challenge.

Renewable energy, especially wind and solar, is the cheapest new source of electricity today in countries that make up 75% of the world's population. The real challenge to adopting renewable energy comes from integration: grid investments, storage, and flexibility resources.

Bloomberg New Energy Finance assessed that by 2040, annual global power grid investments would grow to over $530 billion annually, with almost 40% focused on the digitization necessary for new connections, network reinforcement, and replacement on the grid. The necessary infrastructure depends on more than just cash; it requires policy changes and local support, especially for transmission. Utility storage and other resources are also required to manage variability, although the energy storage space is now realizing steep cost declines.

Figure 4: Grid investments are expected to top $530 billion annually by 2040



Source: BNEF

Energy systems in 2040 will be digitized, decentralized, and interconnected.

By 2040, smart grids will be digitized, and energy systems will be both decentralized and interconnected with one another.

- **Digitization** includes cloud-based systems management as well as artificial intelligence (AI) and machine learning (ML) that enhance the ability of integrated smart grids to manage load, balancing, trading, and storage across billions of household and industrial devices.

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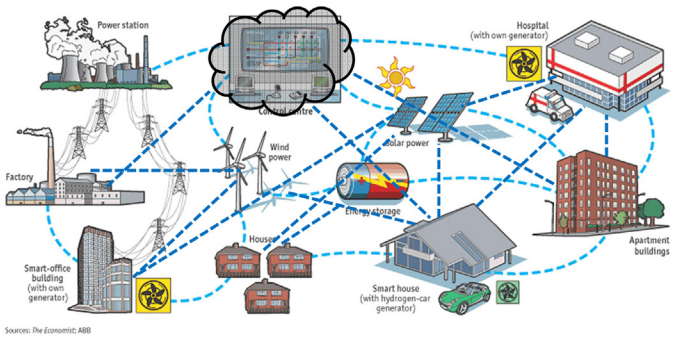
- **Decentralization** allows prosumers, network operations, and data operations to collaboratively establish decentralized energy supply, especially in cities.
- **Interconnection** enables automated peer-to-peer energy trade as well as trade between distributed mini grids and utility scale systems based on algorithms.

Figure 5: The smart grid of tomorrow is digitized, decentralized, and interconnected



Sources: *The Economist*; ABB

Integrated grids aren't just regional; international interconnections are already emerging, not just in Europe, but in other areas where the rising demand for renewable energy and market reforms are changing the cost calculus of interdependence. The key to ensuring these super-grids are accessible will be harmonized multinational regulation and institutions that build trust and pool system management.

Figure 6: Integrated grids are already emerging and are expected to continue beyond 2040.

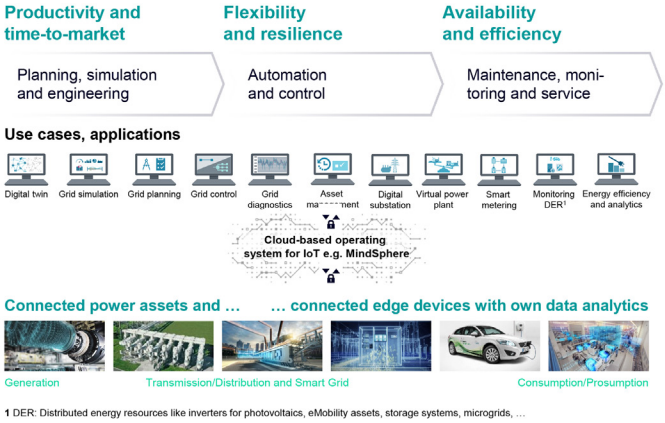
Source: GENI

> The smart money is on future forms of electrification, which are decentralized and hyperconnected. They will require policy, regulation, and geopolitics to keep up.
>
> *Phillip Cornell, Economist Intelligence Unit, Atlantic Council*

Digitalization is critical for the energy system of the future.

Digitalization, including connectivity and data analytics, is one of the key technologies supporting energy systems of the future. Already, Internet of Things (IoT) sensors are collecting data that is digested and analyzed by edge devices close to those sensors, enabling improved productivity and time to market, more flexibility and resilience, as well as increased availability and efficiency.

Figure 7: Digitalization is critical for the smart grids of today and the future



> Digitization is not only helping to raise efficiencies, but also helps us have a more convenient life and more agile usage of our infrastructures.
>
> *Michael Weinhold, Siemens Infrastructure*

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BIOGRAPHIES

Phillip Cornell

Principal at The Economist Intelligence Unit; Senior Fellow, Atlantic Council

Phillip Cornell leads the Public Policy and Thought Leadership consulting practice in the Americas. He is also a Senior Fellow at the Atlantic Council Global Energy Center specializing in energy and foreign policy, global energy markets, and international energy governance, and has served as an advisor to the World Bank, the US government, and private sector institutions.

Prior to joining the Atlantic Council, Mr. Cornell held senior advisory and management positions at Saudi Aramco (Senior Corporate Planning Advisor), the International Energy Agency (Senior Advisor to the Executive Director), and NATO (NSO Director of International Programs; SG Energy Security Task Force).

Mr. Cornell has held research positions at the Naval Postgraduate School (Monterey), the Royal United Services Institute (London), and the Center for International Security and Cooperation (Stanford), and authored various publications and articles on international energy security, economics, and governance. He holds Masters degrees with distinction in International Economics (energy) from the Johns Hopkins School of Advanced International Studies, and received his BA cum laude in International Relations from Stanford University.

Michael Weinhold

Head of Technology and Innovation, Siemens Smart Infrastructure

Michael Weinhold deals with leading-edge technologies in the fields of power grids, intelligent buildings and the use of digitalization to interconnect them. His area of responsibility also includes data analysis and artificial intelligence, as well as power electronics and network security.

He started his career with Siemens as a system planning engineer in 1993, then project manager and commissioning engineer for medium and high voltage FACTS Controllers. Since 2004 Michael has been leading the Technology and Innovation Department of the Power Transmission and Distribution Division (2004-2008), Energy Sector (2008-2014) and Energy Management Division (2014-2019) of Siemens.

Mr. Weinhold is an executive board member of the German industry association Bitcom. He was Adjunct Professor at the Danish Technical University from 2011 until 2017. He studied Electrical Engineering at Ruhr-University Bochum, Germany and Purdue University, USA and obtained his doctorate degree at the Institute of Generation and Application of Electrical Energy, Ruhr-University in 1993.

Siemens named him "Inventor of the Year" in 1997 and "Top Innovator" in 2008.