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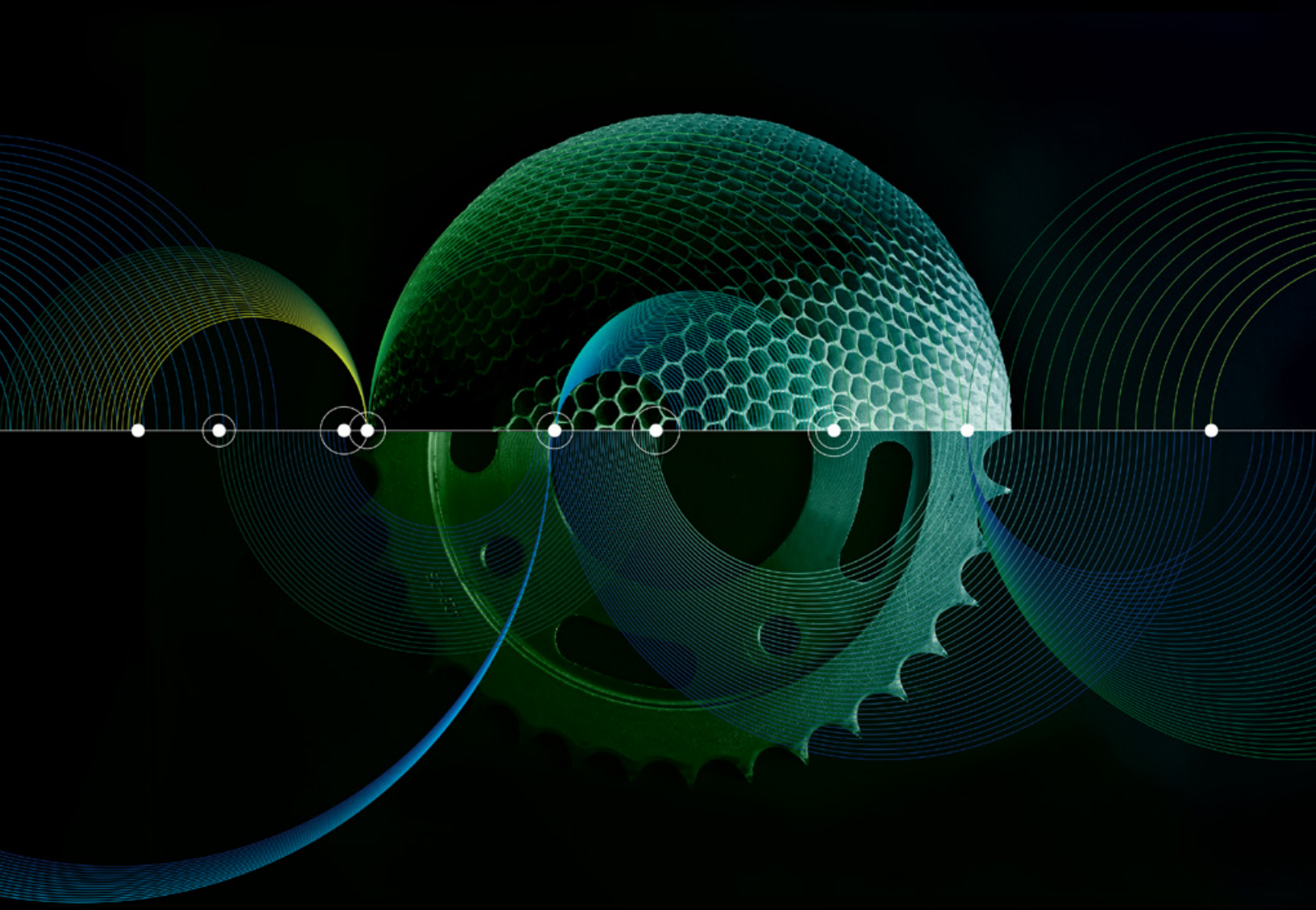


Energy transition:
Building the framework for the future of energy

Contents

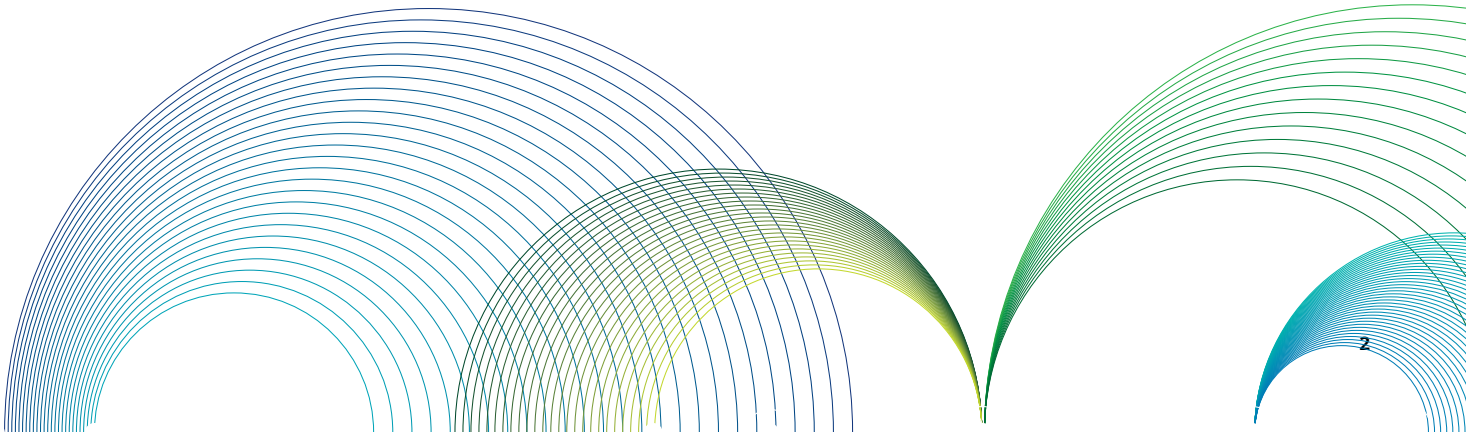
Energy transition: Decisions made today by executives, customers, and policy makers are laying the groundwork for the energy future

In March 2020, Deloitte surveyed 600 executives in the energy and industrial sectors about their preparedness for a lower-carbon future and their organizations' strategies for the energy transition. The survey findings were published in *Navigating the energy transition from disruption to growth* and showed three significant results. First, the transition away from fossil fuels is already well underway and not merely a distant future. Progress in the power sector seems most notable, for example, where in the United States, cheap domestic natural gas and renewables are backing out coal generation and have contributed to a substantial emissions reduction. Second, 89% of energy and industrial sector executives reported that decarbonization strategies were already fully in place or under development in their companies, and, in many cases, executive compensation was already linked to meeting emissions targets. Third, even as the COVID-19 crisis was already unfolding, the longer-term focus on decarbonization (and sustainability in general) remains a strategic priority, due to perceived benefits such as enhancing a company's competitive edge and reducing compliance and other costs.[1]

The business decisions company executives are making today, even in the wake of COVID-19, will determine the degree and nature of their company's advantage through the energy transition. There are six channels along which we track progress to date that can provide a road map for the next decade:

1. Decarbonization of energy sources
2. Increasing operational energy efficiency
3. Commercialization of new technologies
4. Investment in new business models
5. Adapting to new policy and regulation
6. Managing customer and stakeholder expectations

As companies find their footing post-crisis, progress in a few of these channels could slow as capital discipline, employee health and safety, and operational reliability take top priority. For example, the current economic downturn and uncertainty about the trajectory of COVID-19 could slow investment by companies in new business models as they instead focus on strong balance sheets amid economic upheaval. However, over the longer term, progress in these six channels will likely shape the changes expected in the energy industry. And significant gains can be expected in three of these areas in particular: (1) decarbonization of energy sources, (2) increased operational energy efficiency, and (3) commercialization of new technologies.[2] Many companies have already made substantial progress in these three channels, and our research shows that by 2035 these channels could well emerge as broader macro trends that could have a critical impact on the further evolution of the energy sector. Thus, the decisions and investments made by executives today in these areas will likely shape the future of energy.



Decarbonization of energy sources

Deloitte's energy transition research identifies decarbonization as the primary trend across the energy and industrial sectors during the transition.

Decarbonization in the power and utilities sector is expected to be propelled by further cost declines in wind and solar power and energy storage technologies. In the United States, the Energy Information Administration projects renewables will rise from the 2019 level of 19% to account for 38% of power generation by 2050.[3] Others project a faster increase, including BloombergNEF, which forecasts renewables could reach 58.9% of the US generation mix in 2050.[4] In Europe, renewables currently account for 32% of power generation, and that share is expected to grow in order to reach a carbon-neutral target by 2050. Renewables deployment will also likely be buoyed by the power grid reliability recently demonstrated in many areas that saw significant, pandemic-driven electricity demand declines, thus allowing renewables to reach an unprecedented market share in those systems due to lower-cost dispatch.

In the oil and gas sector, decarbonization is currently largely driven by customer and stakeholder pressure for demonstrated carbon and methane emissions reductions in field operations. Additionally, the oil and gas companies that have already invested in clean energy businesses (such as renewables and battery storage technologies) saw returns from those businesses compare favorably against the volatility of the oil markets. In industrial manufacturing, a growing number of companies are setting targets for electrification of industrial processes, heating and cooling, and even equipment and fleets.

The progress on decarbonization identified in our energy transition research is expected to continue apace in spite of the COVID-19 pandemic and resulting economic downturn, due to the key drivers of customer focus and digital technologies that expedite decarbonization of energy sources. Indeed, decarbonization will help shape the future of the energy sector and is expected to become a global imperative as global temperatures are expected to continue to rise and natural disasters may become more severe and frequent.[5]

Increasing operational energy efficiency

Energy efficiency is another area in which substantial progress has already been made.

Most notably, gains in energy efficiency have already allowed economic growth to "decouple" from electric power demand, and we see that trend continuing, driven by new technologies and also by cost savings. According to Deloitte's energy transition survey, energy efficiency remains the top investment priority on the path to a lower carbon future, with executives citing the cost benefits. Furthermore, power and utilities executives indicated a strong mandate to help their customers increase their energy efficiency principally through demand management and electrification of new areas such as vehicles and space heating and cooling.

Global energy demand is expected to continue to grow, but efficient lighting and appliances, energy management systems, and other new technologies mean energy demand growth will not likely match the pace of population and economic growth. In addition, incremental energy demand may well be less carbon intensive. More than 90% of the increase in energy demand through 2035 may come from emerging economies in non-OECD (Organisation for Economic Co-operation and Development) countries, with some communities gaining energy access for the first time.[6] Moreover, that energy demand is increasingly likely to be met with renewable rather than fossil fuel resources.[7]

Commercialization of new technologies

The emergence of new technologies, and in particular the declining costs of these technologies, has been a key element in the energy transition so far and will likely continue to be a critical element in determining the future of the energy sector.

Advances in certain technologies or commercialization of new technologies may speed the transition to a lower carbon future (figure 1). For example, dramatic declines in renewable costs have increased their availability, and that trend is expected to continue. Simultaneously, declining costs of energy storage have improved the reliability and availability of wind and solar. In addition, the use of renewables to produce green hydrogen for longer-duration storage applications is also garnering interest and investment. Furthermore, when asked about drivers for the energy transition, 57% of executives surveyed cited the key role of digital technologies in energy efficiency and sustainability. For example, the application of digital technologies such as artificial intelligence has allowed power companies to adjust quickly to the new patterns of demand following the COVID-19 crisis, and technologies such as augmented and virtual reality have enhanced remote monitoring and operations in the post-COVID-19 environment. As more workers are forced to work remotely, even digital back-office procedures have facilitated a new level of efficiency and reliability. Indications are that executives across the energy sector are now embracing these and other digital technologies faster than they had previously. However, there may be cases in which commercialization of some new technologies could be slowed by the immediate need in the current downturn for companies to allocate scarce resources to areas such as employee health and safety and shoring up company balance sheets amid a challenging market environment. But in the longer term, technological advancement is expected to be a key element underpinning the new future of energy.

Figure 1. Technologies that can enable the energy transition

Digital technologies
Deploy digital technologies that enhance operational efficiencies across the power; oil, gas and chemicals; and industrial products value chains to help enable the energy transition.

Renewables
Invest in next-gen technologies for harnessing the energy from wind, solar, biomass/biofuels, geothermal, hydroelectric, marine (wave, tidal), and green hydrogen.

Circular economy
Improve recycling technologies to reduce energy/greenhouse gas emissions from industrial production; convert excess heat from industrial processes to power (CHP).

Energy storage
Scale and reduce costs for energy storage technologies, particularly long-duration and seasonal storage of electricity generated by renewables.

Carbon capture, utilization, and storage
Reduce carbon emissions with technologies to capture, store, and utilize carbon emissions. This is currently most economically viable in the oil and gas industry.

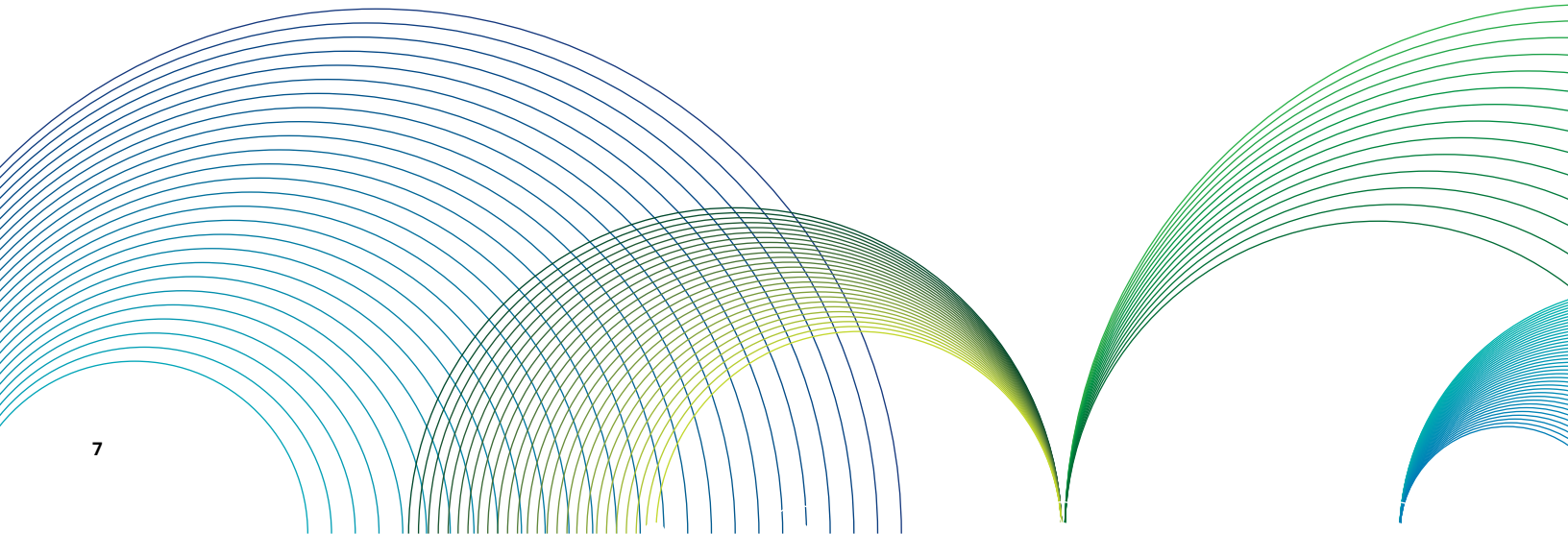
Electrification technologies
Improve technologies to help electrify transportation (electric vehicles), buildings (space and water heating and cooling), and industrial processes—and power them with cleaner sources.

Looking to the future of energy: Macro trends and key drivers

In early 2020, Deloitte executed a global study to develop our Future of Energy Scenarios, the foundation of our comprehensive approach for navigating inevitable uncertainty using the tools of scenario planning. The scenarios are data-driven narratives about how the future could unfold; they are not intended as predictions or strategies. The elaboration of these scenarios is built on our close analysis of the three macro trends discussed above—decarbonization, energy efficiency, and commercialization of new technologies. (See ***Future of Energy Modeling Approach*** below.) In addition, the research work highlights two additional macro trends, which are taken as "given" as we view the energy landscape in 2035:

- **Global economic and population growth will likely increase.** The current world population of 7.8 billion[8] is expected to reach 8.9 billion by 2035, with growth centered outside the 34 developed countries that compose the OECD.[9] Long-term global economic growth may be pausing from the pre-COVID-19 2.8% compound annual growth rate (CAGR) forecast for global gross domestic product from 2020-2035.[10] But moderate growth is likely to continue in the coming years despite current uncertainty.[11]
- **Emissions growth could slow but will likely not decline to target levels by 2035.** Emissions growth is expected to slow over the next 15 years to a CAGR of 0.9%.[12] But in order to meet commitments that countries made under the Paris climate agreement, a -0.4% growth rate is required.[13]

As we considered all the uncertainties and driving forces likely to shape the energy system of 2035, two stood out as the most fundamental drivers of outcomes: (1) societal action around climate change and (2) the level of global collaboration among states. We used these two forces to define our scenarios and frame the alternate versions of the future, so that in each we could explain how each of the other uncertainties could resolve.



Societal action on climate change

The current crisis has highlighted the need for agility and preparedness and has proven that the unexpected can happen. Compounding those risks with that of extreme weather events has galvanized societal response in many places in favor of climate action in the longer term. Our energy transition survey revealed that customer support for reducing carbon emissions is one of the most important drivers of decarbonization action across the energy and industrial sectors. Customers are increasingly demanding environmental accountability from their providers, employees from their companies, shareholders from their investments, and in some countries, governments from their businesses. In the *Deloitte Resources 2020 Study*, almost 60% of businesses surveyed across the US economy said they were feeling pressure from stakeholders to address climate change, especially employees, customers, and shareholders. And over a 10-year survey period, on average, more than 70% said their customers are demanding that they offer them more environmentally considerate solutions.[14]

Given this growing appetite for action, our societal response axis monitors pressure from markets, businesses, consumers, and governments to address climate change. The framework (figure 2) measures this response on a spectrum from reactive to proactive. Two of the channels Deloitte has been monitoring to measure progress in its energy transition research are (1) customer and stakeholder expectations and (2) policy and regulation.

Global dynamics

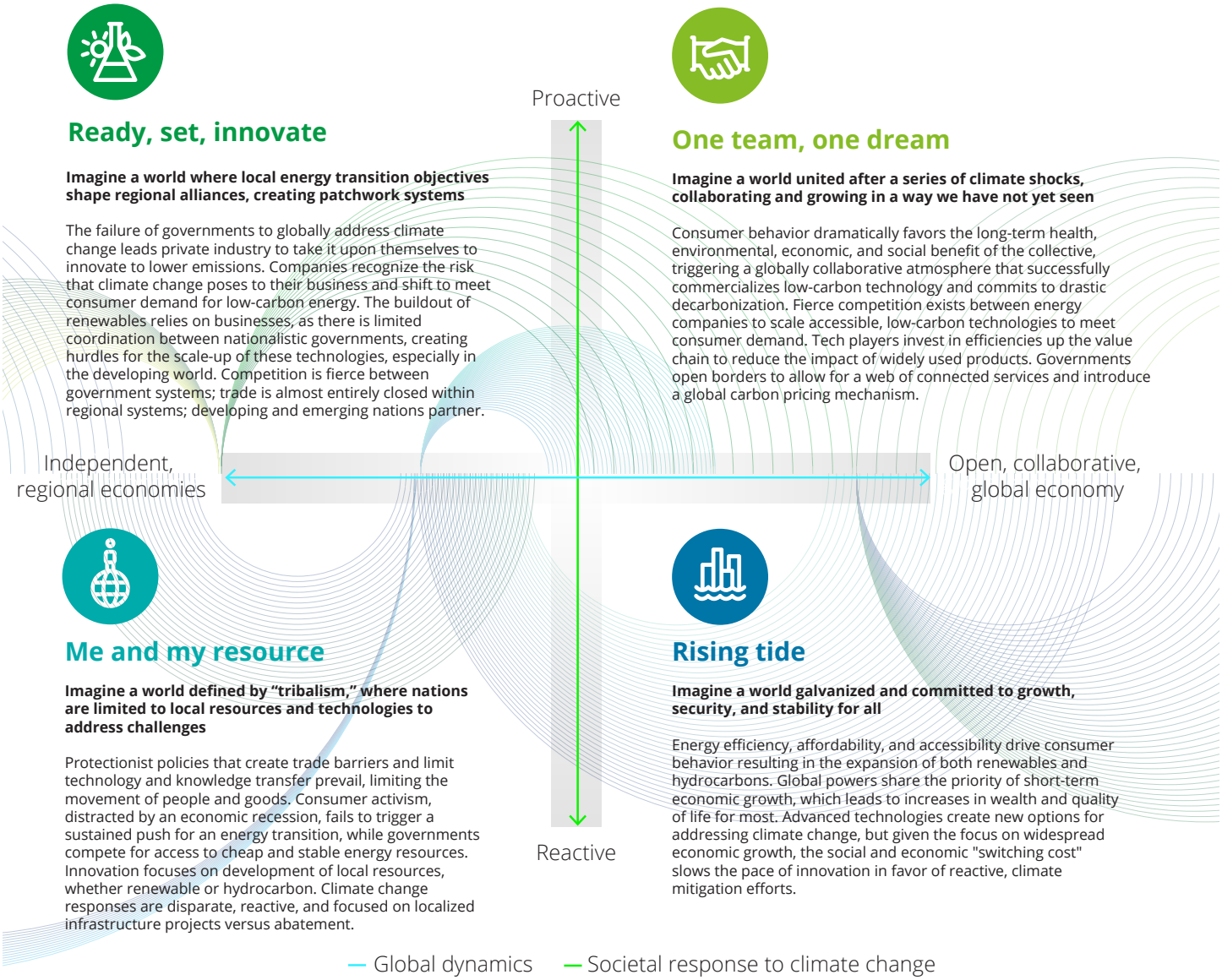
The second axis is the impact of global dynamics and international collaboration on the future of the energy sector. Global dynamics monitors the direction of geopolitical relations and their impact on global energy supply and demand, measuring the degree of economic independence versus openness. As the energy system relies on a globally interconnected ecosystem, geopolitical relations are high impact yet highly uncertain. Whether the world moves toward collaborative global relations or a more insular world with increasingly insular economies will shape the nature and pace of the energy transition. In turn, it can affect uncertainties like the type and rate of capital and IP flow, as well as the likelihood of shared technological standards. While global connections between countries may be attenuated as a result of the COVID-19 pandemic, it's not clear today whether the effects will be enduring enough to affect the 2035 energy landscape.

Four Future of Energy scenarios

Deloitte's four scenarios incorporate analysis of the aforementioned macro trends (i.e., things we know are going to continue, even if we don't know exact specifics of pace and landing point) and nineteen of the most critical uncertainties that will likely continue for the foreseeable future. How they resolve is built into the narrative behind each scenario, all supported by detailed modeling of the energy system and "what would need to be true" for each scenario to arise (figure 2).

These scenarios represent four plausible futures against which any company—whether an energy producer or energy consumer—can pressure test its strategic plans, capital allocation, and capabilities system.

Figure 2. Four Future of Energy scenarios



Future of Energy Modeling Approach

The inputs to the modeling exercise derive from Deloitte's extensive analysis of historical and current industry data. First, we analyzed trends such as energy supply and demand fundamentals, the rate of urbanization, growth of electric vehicles, regional enactment of carbon policies, the public's uptake of clean energy, the growing monetization of data, and changing consumer preferences. We then identified 92 driving forces and grouped them into 19 uncertainties under five headings: social, technological, environmental, economic, and political. For example, under the "social" heading are uncertainties such as qualified talent, society and the customer's voice, energy access, and consumer behavior. Using these 19 uncertainties, we developed four plausible and divergent scenarios for what the world might look like in 2035, plotting them along the two axes of social response to climate change and global dynamics, our two key drivers. We can then explore how relationships between different components of the global energy system could play out differently across the four scenarios illustrated in figure 2. The results (figure 3) are not precise forecasts but directional estimates of multiple, credible views of the future.

Figure 3. Relationships between components of the global energy system play out differently across the four scenarios

	One team, one dream	Ready, set, innovate	Me and my resource	Rising tide
	Global adoption of renewable technology accelerates electrification and drastically reduces energy demand growth and emissions	Private-sector leaders drive high electrification and adoption of renewables in select regions, leading to low energy demand growth and emissions	Regionally disparate outcomes, with high, hydrocarbon-based energy demand in some regions and leapfrogging to renewables in others	Emphasis on economic growth leads to high growth of energy demand and emissions and use of all available energy sources
Global GDP growth	2-3%	1.5–2.5%	1.5–2.5%	2.5–3.5%
Total annual energy demand (EJ)	500–550	600–650	700–750	750–800
Annual CO_2 emissions (Gt)	15-20	25-30	30–35	35-40
Share of fossil fuels in primary energy (%)	55–60%	65–70%	70–75%	75–80%
Share of renewables in electricity consumption (%)	70–75%	65–70%	55–60%	50–55%
Electrification – Industry	35–40%	30–35%	<30%	30–35%
Electrification – Transport	>10%	5–10%	<5%	19–21%
Electrification – Buildings	>60%	55–60%	40–45%	40–45%

Implications for industry sectors

The four scenarios can provide insights for specific industry sectors as well as for individual companies. For example, in the power, utilities, and renewables sector, while the pace of adoption is uncertain, renewables are expected to continue to grow in any scenario. Therefore, players who meaningfully invest in renewables could be well positioned for future success. Utilities should consider exploring new, customer-centric, digital business models and adding low-carbon sources to their portfolios, specifically in **"One Team, One Dream"** and **"Ready, Set, Innovate"** scenarios. Low-carbon energy adoption rises based on location in **"Me and My Resource,"** where global operating models are disrupted. And **"Rising Tide"** presents the most incremental shift to renewables, with utilities also expanding legacy infrastructure in support of natural gas.

Turning to scenario implications for oil and gas companies, however, the two axes spell different risks. For the two scenarios that assume aggressive societal action to mitigate climate change—**"Ready, Set, Innovate"** and **"One Team One Dream"**—the oil and gas industry would face accelerated demand decline, additional transactions costs, and stakeholder pressure. But even in the two scenarios that presuppose slower progress toward a zero-carbon future—**"Me and My Resource"** and **"Rising Tide"**—oil and gas companies could face competitive risks based on the degree of economic globalization (or regionalization). For example, in a world of **"Me and My Resource,"** the national oil companies and other national energy champions would provide increased competition to the international oil companies and smaller regional players. But critically, all four scenarios suggest that challenges facing the industry today will only be more extreme a decade on. These challenges include stranded assets, competition with cleaner fuels, and competition for talent, particularly for employees skilled in digital technologies, data, and analytics.

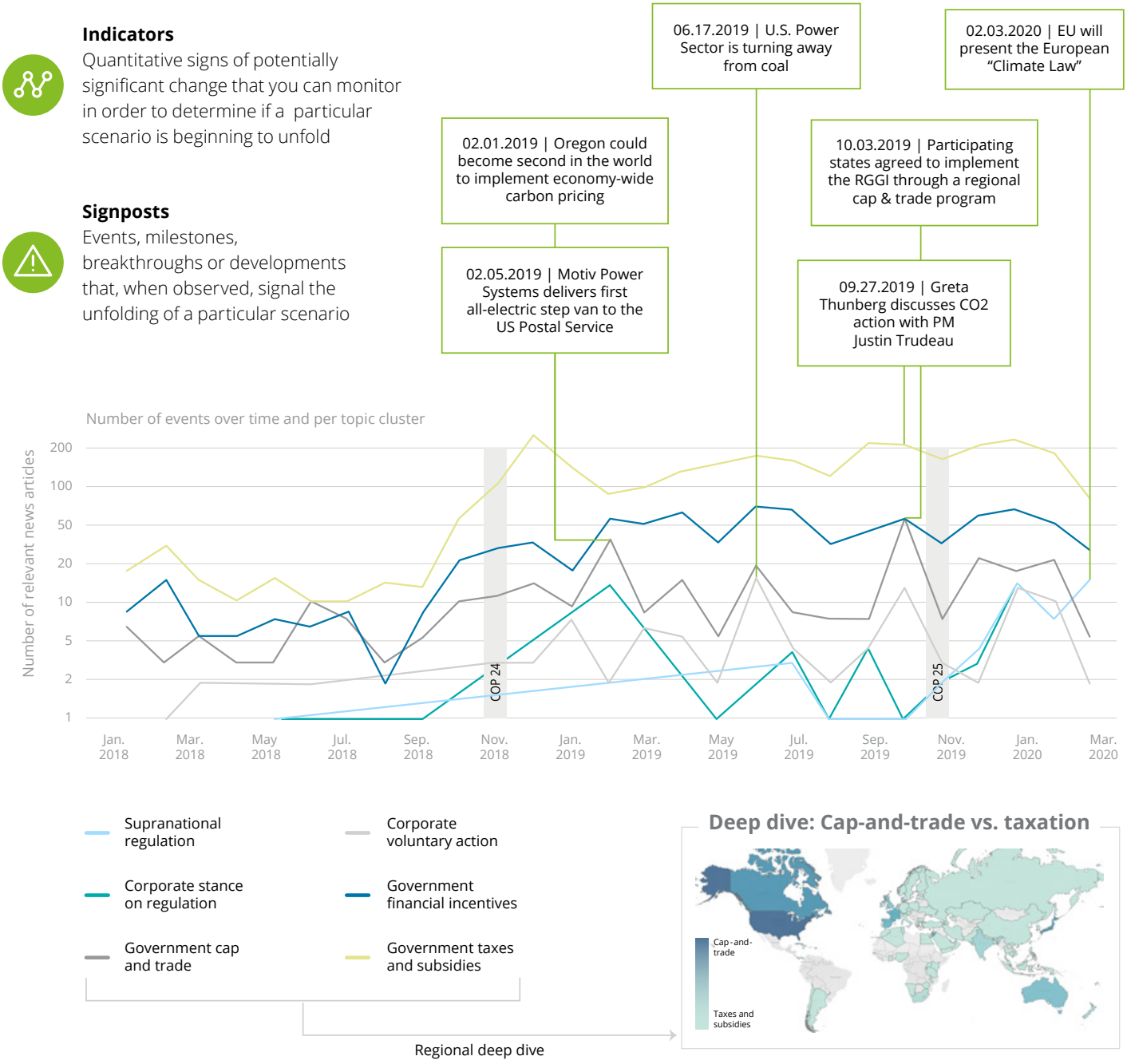
The road ahead

The investments and decisions made today by executives, investors, and consumers will shape the pace and progress of their sectors' march toward the new future of energy. We already see the impact today in three key areas, which become the macro trends with high impact by 2035: decarbonization, energy efficiency, and commercialization of new technologies. Whether a company is developing short- or medium-term strategies during the current energy transition or imagining its role in the longer-term energy future, it could be useful to keep an eye on several indicators of progress in the transition (figure 4):

- **Energy intensity of global economy** — As businesses and households continue to adopt increasingly energy-efficient technologies, the global economy will likely become less energy-intensive, meaning it would take less energy to produce each unit of GDP.
- **Share of electricity in energy consumption** — As the world continues to electrify additional energy end uses (in the transportation, industrial, and building sectors) it may facilitate decarbonization and potentially accelerate the energy transition. The costs of electrifying these applications still remain higher, in some cases, than using fossil fuels, and so the changes in cost of these technologies will also be an important indicator.
- **Share of renewables in power generation** — As the share of renewables in electricity generation rises, decarbonization of the economy is expected to accelerate.
- **Changes in greenhouse gas emissions and related policies** — Reducing emissions of CO2 and other greenhouse gases, such as methane, is a key goal of the energy transition, so any changes in carbon emission levels, negative or positive, could be a very significant metric along the transition path.
- **Share of responsibility taken by the private sector versus the public sector** — Which sector will achieve collaboration and galvanize change? This tension may be more evident in some industries than others and will likely be affected by the two key drivers: (1) societal action on climate change and (2) level of global collaboration.

Figure 4. Leading indicators and signposts help signal relative likelihood of scenarios

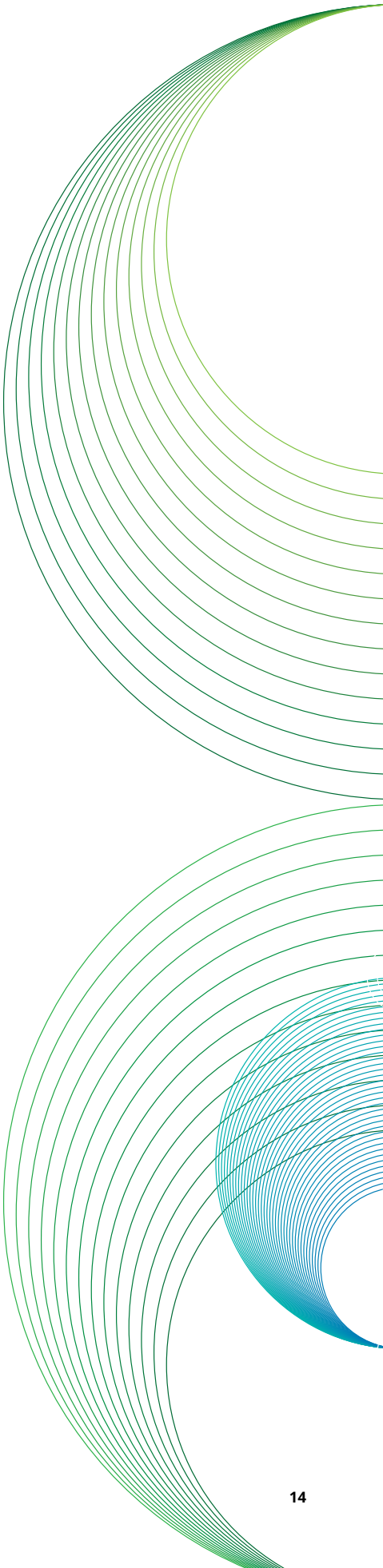
One of the most critical ways to take short-term action is to develop sensing capabilities to track how the future is unfolding.



Notes: The graph shows illustrative tracking metrics between January 2018 and March 2020. Cap-and-trade policy in the United States and Canada is determined at the state or province level, rather than the national level."

Finally, we have to evaluate our starting point in light of current events.

Substantial progress has already been made in the energy transition, but it may be too soon to tell how the disruption of the pandemic and the economic downturn will shape the future of energy. Disrupted supply chains and trade patterns could have a lasting impact on levels of global collaboration. Similarly, the inclusion of low carbon targets into economic stimulus could create lower-carbon energy demand in some regions as economic activity resumes. Finally, the upheaval of the pandemic has, in many cases, accelerated acceptance of digital and other technologies for energy efficiency and decarbonization. This trend is likely to continue and could expedite the energy transition.



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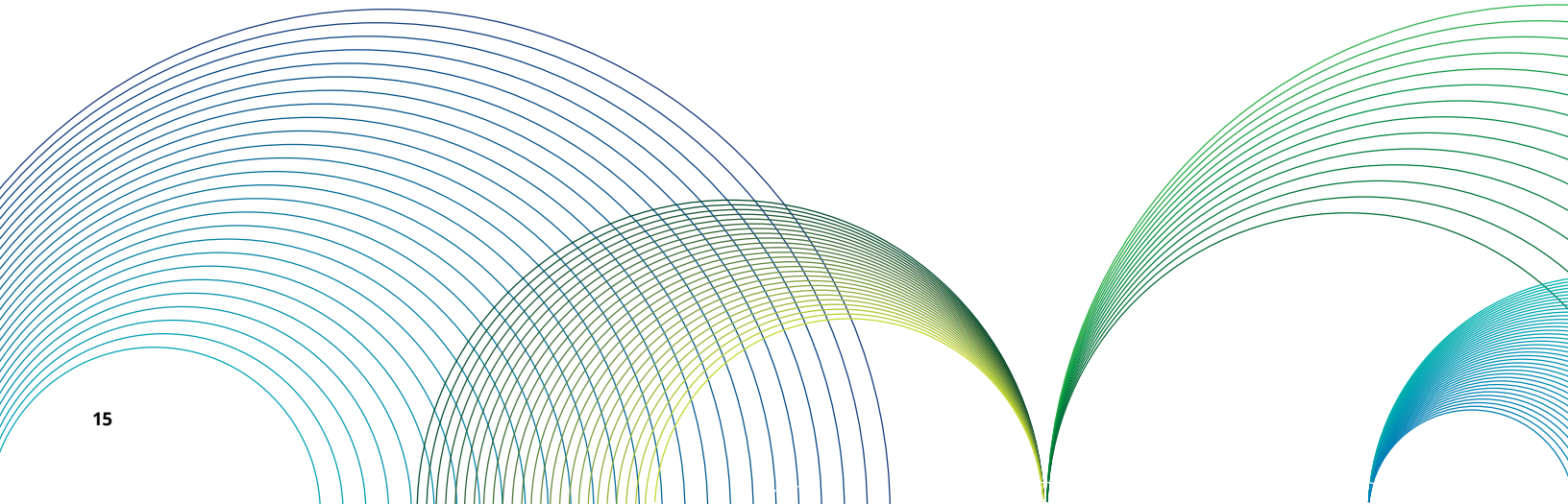

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