CAPCO

THE ENERGY TRANSITION

A NEAR-CERTAIN ENDPOINT WITH AN UNCERTAIN TRAJECTORY

INTRO

The ongoing energy transition, in its simplest form, is a fundamental evolution in the way we produce, transport, store, and consume energy across the entire energy value chain. It encompasses a myriad of changes, some small and some hugely transformational. For companies that operate in the energy markets, the array of market drivers, regulations, and commercial and operational constructs will be different. But all will experience some level of operational and commercial disruption as renewables continue their inexorable penetration of power grids and as alternative sources of fuel (green fuels) gain market share.

Given the scale and complexity of the investments that must be made prior to achieving a "net-zero carbon" energy infrastructure, numerous challenges must be overcome. Global economic conditions, uncertain development costs, consumer behaviors, and differing operational profiles of the various sources of renewable energy create headwinds for the widespread adoption of renewable energy and its eventual replacement of most hydrocarbon-based energy sources. However, regulators and legislators at all levels of governments around most of the world are applying consistent pressure to ensure their share of the global CO2 reduction target of net-zero by 2050 is met, all but ensuring the continuing advancement of renewable energy resources.

AN ARRAY OF RENEWABLE ASSETS AND MARKET INFLUENCES

Technology advancements and economies of scale have helped reduce the costs for some renewables, particularly solar and wind. The International Renewables Energy Agency (IRENA) notes that for the period from 2010-2020, utility-scale solar PV power costs fell 82%, while onshore wind development costs dropped 39%.[1] That report also notes utility-scale solar PV costs in 2019 reached a global average of 6.8 cents per kilowatt-hour (kWh) and onshore wind reached 5.3 cents/kWh, undercutting the costs of coal-fired generation, and helping accelerate the retirement of those facilities.

The inevitability of renewables has attracted increased funding, with new green investment funds emerging and institutional investors adjusting their portfolios away from conventional energy, particularly oil and gas related projects. Research firm BloombergNEF notes that "New investment in renewable energy projects and companies totaled $174 billion in the first half of 2021, supported by record public market financing and record levels of venture capital and private equity commitments... the highest total ever recorded in the first half of any year, and 1.8% more than during the same time a year prior, although it is 7% below the high water mark set in the second half of 2020."[2] Still, to reach the net zero goals by 2050, substantially more funding will be required. Estimates by BP indicate as much as $500-$750 billion per year through 2050 will need to be invested globally in new solar and wind projects alone. This forecast reflects approximately a 200-300% increase over current investment levels which reached $78 billion for solar and $58 billion for wind in the first half of 2021, according to BloombergNEF.

Addressing the highly variable output and the operational issues associated with wind and solar is driving the development of virtual power plants (VPPs), in which renewable sources are operationally tied to other assets, including battery facilities, combined-cycle generation, and flexible energy consumers. The purpose of these facilities is to combine these various resources to create an operationally efficient portfolio of assets that can help reduce grid loads and improve financial performance of the individual components. Though more prevalent in Europe, VPPs are finding increasing interest in U.S. markets. Resi-Station, a 550MW facility in California being developed by Sidewalk Infrastructure Partners and OhmConnect, will be the largest VPP in the world once it reaches full capacity. One of the key components of this VPP is the aggregation of a large pool of smart-meter connected consumers willing to allow their energy consumption to be modulated during periods of peak demand in return for a portion of the value of the energy saved. Once fully operational, it's estimated that Resi-Station could result in 5GW of differed generation.[3]

Distributed generation and demand response are also a key component in the evolving power markets. The Federal Energy Regulatory Commission Order 2222, which opens the market to distributed generation sources, will essentially force utilities to adopt net-metering schemes for their customers. However, widespread adoption of net-metering schemes will require significant additional investments in smart metering technologies and grid management tools prompting several ISO/RTOs to request delays in its implementation. But, once deployed, these advanced technologies should enable more granular demand response programs (such as within individual neighborhoods or microgrids) and further VPP development, all helping reduce the demand for non-renewable peaking facilities.

Green hydrogen, produced by the electrolysis of water, is also being viewed as a potential source of not only clean energy, but also as a method of renewable energy storage. Produced by non-dispatchable generation during periods of low demand, the produced hydrogen can be used in fuel-cells to supplement power grids or to power transportation, including buses and fleet vehicles. Hydrogen is also being investigated as a potential heating fuel – blended with natural gas and transported by existing pipeline infrastructures. Reuters noted that "at least two dozen U.S. energy firms, including Dominion Energy Inc and Sempra Energy, have started producing hydrogen or testing its viability in natural gas pipes to take advantage of existing infrastructure as the world prioritizes lower-carbon fuels."[4]

Continuing investment in battery storage is also helping advance the penetration of renewables. The EIA notes that battery storage in the U.S. continued growing in 2020, with a 35% increase in installed capacity, bringing the year-end total to 1,650 megawatts (MW). This represents a 300% growth over the last five years. And, with the recently enacted FERC Order No. 841, which directs regional grid operators to remove barriers to the participation of electric storage devices in the wholesale capacity, energy and ancillary services markets, the barriers to full commercial operations of battery storage facilities are being removed. The order also applies to smaller, distributed energy facilities, which will help further their development, as well. Though not fully implemented in most regions, FERC 841 is expected to spur additional battery storage development co-located with wind and solar generators. Co-locating will essentially allow these renewable assets to become dispatchable as their off-peak energy production can be stored for use during peak demand.

Other sources of renewable energy are also receiving funding and renewed attention. Wave and tidal power generation, which are estimated to be able to provide more than 64% of the U.S.'s annual consumption alone, have been under development for decades. Tidal generation, which relies on large-scale fixed facilities to capture tidal induced water movements, has been commercially successful in areas exposed to large tidal swings, with facilities as large as 250MW currently in operation in South Korea and France. Wave generation, which to date has had limited commercial deployment, has received increased investment from private sources and governmental agencies in recent years. Though almost all currently operating wave generation projects are technology demonstrators, wave energy could prove to be a valuable addition to the renewables mix with additional investment.

Moving from a hydrocarbon-based energy market to renewables will require significant investments in the electrification of many, if not most, energy systems, including transportation. In 2020, total spending for electric passenger vehicles hit a record $118 billion, while spending for buses and other commercial fleet vehicles was $15 billion. Given the increasing success in selling electric vehicles, a number of traditional automakers have committed to move toward producing only electric cars in the near future, including Jaguar by 2025 and Volvo by 2030. Additionally, with heavy truck manufactures embracing battery powered vehicles, including the entrance of Tesla into that market, it can be assumed that much of the diesel-powered truck fleets will be displaced over the next decade. Though long-haul trucking using Internal Combustion Engines (ICE) may persist beyond 2030 due to range constraints and/or equipment costs, local and delivery trucking will likely move to battery and/or fuel cell power within the next decade. Air travel, a high carbon intensive transportation mode, is under pressure to reduce emissions, while current battery technologies are unlikely to address the needs of commercial aviation in the foreseeable future. Instead, airlines will increasingly rely on biofuels and electrified ground support vehicles, such as aircraft tugs and bagging handling and service trucks, to reduce their carbon footprints as much as possible.

MARKET HEADWINDS DO EXIST

Clearly, the momentum behind the energy transition is considerable and sustainable; however, the trajectory of the adoption curve toward electrification and for the various "green sources" of energy is uncertain.

Extreme weather events, such as those experienced in the Electric Reliability Council of Texas (ERCOT) market during winter storm Uri in February 2020, point to challenges in the full electrification of energy systems. As extreme weather events become more frequent and more energy systems are electrified, hardening electricity grids and their supply chains is critical. During Uri, the lack of winterization in the generation fleet serving ERCOT resulted in a near meltdown of the ERCOT grid. While natural gas and coal fired generation units were critical assets in the generation mix that failed, so was wind generation, which failed primarily due to freezing precipitation building ice on blades. All these assets need to be winterized, each of which has its own price tag. For wind generators, the cost of winterization is estimated to be as much as $500,000 per turbine or more.

Another challenge highlighted by Uri is consumer reluctance to move away from natural gas for heating, cooking, and back-up generation. With massive power outages across the state, many Texans were reliant on their fireplaces, gas stoves, and back-up generators to get them through the storm. Convincing a consumer to invest in electrifying these assets is challenging and will likely require some sort of subsidization. There is also a significant reliability concern at the consumer level. For customers in ERCOT who can afford it, the installation of batteries/roof-top solar for back-up power may alleviate some of the concern. However, given the increased frequency of multiday power outages, such as the one many experienced in Uri, the reliability of natural gas for back-up power generation is a compelling argument when compared to the installation of batteries to resolve power disruptions.

Key materials, particularly metals, such as lithium, neodymium, and indium, will be required in far greater quantities should the pace of renewables penetration continue. By some estimates, the supplies of rare earth and minor metals will need to increase 10-fold or more by 2030 to meet CO2 reduction commitments under the Paris Accords.[5] Unfortunately, these metals are not widely distributed around the globe, and many are found only in environmentally sensitive areas or within the borders of potentially adversarial countries, such as China or Russia. Aside from the environmental effects of significantly increased mining activity, the limited distribution of supplies increases the risks of supply chain disruptions caused by the pandemic, geopolitical conflict, and even operational issues, such as the blockage of the Suez Canal. Additionally, as most mining activities are generally perceived as "dirty" by most new green investors and activist shareholders, even critical mining activities in support of the energy transition could negatively affect access to capital and market valuations. As ESG scoring becomes a more widely adopted metric around the globe, there will be a need to ensure a proper balancing of the value of producing vital resources against the perceptions that such activities are harmful or otherwise undesirable.

The existing infrastructure of conventional generation, transmission, and distribution equipment is also facing stresses as the transition continues. Favorable wind and solar conditions that make such technologies economically feasible means that siting these facilities can create grid imbalances that necessitate additional investments in transmission lines and in some other cases, abandonment of existing assets as conventional facilities close. Funding new infrastructure and recovering the cost of equipment that is abandoned can be contentious issues for consumers and the regulators that oversee utilities and transmission operators. Siting new renewable facilities will require careful consideration as many of the ideal locations, such as Southwestern U.S. states, are already heavily developed and the loads they serve nearby may be nearing a level of renewable "saturation" that is starting to affect system reliability. Other ideal locations are areas remote from the load they are intended to serve and require significant investment in transmission lines and the attendant energy losses that come with long distance power transmission.

Given the highly variable nature of wind and solar necessitating near real-time energy dispatch, it's increasingly important to understand fine-grain consumer behavior with low-to-no latency to support real-time market operations. Gaining these insights will require more widespread deployment of smart meters, potentially with signaling by high consumption appliances. Despite efforts over the last decade to entice consumers to allow such data collection (and potential control), adoption of the types of efforts has been slower than initially anticipated. Those programs that have found momentum, such as allowing utilities to modulate heating and air conditioning within customers' homes, have been met with recent backlash, particularly when it occurs during periods of extreme heat or cold. Changing consumer attitudes either through enticement (such those provided by VPPs) or by regulation may be required as more conventional generation is scuttled and more aggressive demand response programs are required to ensure grid stability.

As distributed generation also becomes more prevalent, particularly behind the meter solar generation with battery storage, the need for smart metering and an intelligent grid becomes even more pressing. As more consumers move to become prosumers, load forecasting will become more difficult and could lead to increasing grid instability. Transmission and distribution companies will be required to play a vital role in facilitating and managing these loads through equipment and software upgrades. However, given that these companies have traditionally been tasked with, and rewarded for, ensuring reliable service, a rethinking of their role in the new energy markets may be required; and, may ultimately necessitate a recasting of their business models. Consumer behaviors and attitudes also play a role in the electrification of transportation. Though significant strides in improving battery performance and range in automobiles has occurred, the automotive industry is starting to exhaust the potential for further improvements using existing technologies, primarily lithium-ion. With ranges usually limited to less than 300 miles on a single charge, and with re-charge times to 80% taking a half hour or more (even with high voltage chargers), consumers outside of urban areas have been more reluctant to adopt electric automobiles. European and some Asian countries, with greater population densities and less distance between population centers have seen much greater adoption rates than geographically larger countries such as the U.S. or Australia. Though regulators have moved to force a phase out of ICE cars in various countries and states, including a proposal by EU regulators to ban the sale of ICE vehicles by 2035, such policies may have to be revisited if consumers/voters prove unwilling to accept such edicts.

Perhaps the most challenging issue to overcome on the path to a fully renewable power infrastructure is the lack of universally adopted frameworks on emissions tracking and reporting. With a patchwork of state level regulation within the U.S. and differing agendas and regulations by countries around the globe, it is highly unlikely that a true benchmark for carbon pricing will ever emerge. Without such a standard, progress to a fully realized global "green" energy infrastructure will be uneven and future development prone to market imbalances driven by regulatory uncertainties, leading to volatile risk/return profiles for investors.

ADDRESSING CHANGE REQUIRES NEW INSIGHTS, CONTINUING TECHNOLOGY INVESTMENTS AND AGILITY

Regardless of where one sits within the energy industry, change has come rapidly and persistently, but also with more than a fair amount of uncertainty as to future trajectory. Going forward, the energy transition will continue encompassing a multitude of changes, some small and some hugely transformational. For companies that operate in the energy markets, the array of market drivers, regulations, commercial and operational constructs will vary. But all will experience some level of challenge or disruption as they seek to leverage the new opportunities that the energy transition will create.

Addressing these changes requires a constant view of market drivers, regulations, new investments, new technologies, consumer habits and investor sentiments. Though some of these changes may take years to become fully realized, the interplay of forces behind the energy transition means that investment returns, and even day to day market prices, could be more volatile as the market reacts to technical advances, regulatory pronouncements and even changing consumer sentiment.

For market participants anywhere along the energy value chain, it is more important than ever to have an infrastructure of software solutions that is adaptable to changing market conditions, business imperatives, and operational constraints. Advanced risk management, data sciences, and analytics will need to be key components of every company's arsenal of capabilities to ensure profitable operations and positive returns on investments.

Capco is committed to helping our customers transform their organizations, business processes and critical systems as they adapt, evolve, disrupt, and flourish during this energy transition. Our team of highly experienced resources with deep energy domain experience is committed to helping create a sustainable future by ensuring our customers are properly equipped to address emerging challenges and capitalize the new opportunities that arise in this transition.

SOURCES

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AUTHORS

Chris McNeely, Partner, Chris.McNeely@capco.com

ABOUT CAPCO

Capco, a Wipro company, is a global technology and management consultancy specializing in driving transformation in the financial services and energy industries. With a growing client portfolio comprising of over 100 global organizations, Capco operates at the intersection of business and technology by combining innovative thinking with unrivalled industry knowledge to deliver end-to-end data-driven solutions and fast-track digital initiatives for banking and payments, capital markets, wealth and asset management, insurance, and the energy sector. Capco's cutting-edge ingenuity is brought to life through its Innovation Labs and award-winning Be Yourself At Work culture and diverse talent.

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