Electricity Matters

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Scaling and Sustaining Innovations: No Turning Back

History shows that innovations in technology and the businesses that bring them to market radically change economies, societies, and cultures. New businesses and industries form around the innovations to commercialize and scale innovations—making them commonplace. New businesses and business models and supply chains supporting commercialization of innovative technologies have revolutionized the way we live, work, and play. And with technological breakthroughs new products and services are created, requiring new ecosystems to support them.

Take, for example, the introduction of hybrid electric vehicles and the ramp up to all-electric vehicles (EVs). The steady improvements in electric transportation technologies and components, vehicle design, and battery efficiencies are lowering the costs of EVs. Economies of scale in manufacturing, with all major automobile companies and several new start-ups entering the market, creating a more competitive market for EVs, is further reducing costs. Yet, without a well-developed and reliable supply chain for vehicle components and parts, and a ubiquitous infrastructure for EV charging, electrifying transportation would be nearly impossible.

This is not a "chicken and egg" analogy or a "circular argument" over which comes first. Rather, products, supply chains, and supporting infrastructures are invested in and built simultaneously and in concert with one another. The process is not always smooth and can be rather lumpy and disjointed, leading to business failures, lack of investment capital, and slowness in manufacturing or low market adoption. Investment capital needs to be available to support the entire value chain deemed critical and necessary for bringing new products and services to market.

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SUSTAINING INNOVATIONS AND SUPPLY CHAINS

Inventors wanting to bring innovations to market must identify the businesses and services needed to underpin and support the innovation, making it sustainable and acceptable to users—with a primary goal of ensuring all supporting factor inputs are available. This provides the support infrastructure necessary to sustain commercialization and reduces risk to investors. Aaron Brown, commenting in Bloomberg on a recent Citigroup Inc. report on cryptocurrencies, cites an automotive example and Henry Ford

to opine on the future of cryptocurrencies. The thesis is that blockchain and related technologies will need to grow in depth and breadth with widespread access to support cryptocurrencies as its own asset class. A similar analogy holds for clean energy technologies.

The Citigroup Inc. report "starts with the example of someone in 1900 predicting the eventual massive economic and cultural change caused by the automobile. It was not practical to invest directly. Most automobile start-ups at the time failed. Ford as a company was not founded until 1903 and didn't go public until 1956—53 years later! Short selling buggy-whip companies might have sounded clever at the time, but it wasn't any more practical than investing in car companies. Plus, buggy-whip companies were able to shift to making other consumer products. What would have made sense was realizing that automobiles needed gasoline, gas stations, and roads and highways, including bridges. And the infrastructure built to support the automobile and greater mobility of people and transportation of goods, would create demand for motels, restaurants, suburban development, rubber, glass, concrete, and many other things."[1] All in all, mobility and auto manufacturing ushered in a radical change in the way people lived, worked, and played.

Investors with foresight into the businesses and services required to support automobile manufacturing, and the cultural and societal shifts to be brought about by increased mobility, didn't need to invest in a competitive automobile start-up to earn sustainable returns. Rightly so, automobile companies, petroleum exploration, mining and refining companies, fueling stations, companies specializing in road and bridge construction, and related products and services provided a wide array of investment opportunities. When a new product or service catches on, whether rapidly or slowly, once widely demanded by consumers, a myriad of investment opportunities present themselves. Visionaries, entrepreneurs, and investors alike go broke or make riches betting on the future.

At the time, investors didn't need to bet on a single automotive company or technology. As Aaron Brown sees it, "there's small reason to believe massive growth in the crypto-technology sector will increase the value of most existing crypto assets. A more promising investment approach is to think about what general technologies will be needed if crypto takes off."[2] An interesting perspective.

As with automakers and other innovations over the years, clean energy technologies and electrification of, and for, alternative forms of transportation and heating and cooling of buildings, offers investment opportunities for businesses and technologies that are needed for the clean energy sector to scale.

Research and development (R&D) efforts almost by definition consider the supporting technologies and businesses needed to bring innovations to market. Often, however, line of sight into what might be needed to support widespread commercialization and scale lags product development. Information and foresight are imperfect, yet businesses are created and expanded to support new products and services. R&D functions within organizations assist in developing competitive advantage for existing product extensions. These can be horizontal extensions, which involve maintaining the same price and quality of a product but changing specifications like color or adding ingredients to differentiate products, or vertical extensions, which involve increasing or decreasing the quality and price of a product to create a lesser quality or luxury product. Near constant attention to remaining competitive and gaining market share with existing or new products requires consistent and

[1] Thomas, A. (2022, October 20). *Briefing series: What Congress needs to know about COP27.* EESI. Retrieved from http://bit.ly/3ZrF3Rs

[2] Ibid.

sustainable investment. Companies investing in R&D are investing in their future.

R&D can be an increasingly valuable strategy and tool for remaining relevant and thriving in the marketplace. There is general acceptance in government and societies today that the damage we are doing to our planet and environment is likely to be irreversible unless something is done now to reverse or slow the trend toward near destruction. This has led to many science and business innovations as we search for new sustainable or clean energy and renewable alternatives to support the world's economies.

ROLE OF ARTIFICIAL INTELLIGENCE

Artificial intelligence (AI) and the many applications emerging that support it will impact virtually all industries and businesses—and bring about societal and cultural changes that we might only imagine today. And AI and its application and uses are in their infancy. Take the medical profession. A recent *Wall Street Journal* essay discusses the virtue of the medical training doctors receive and the wealth of knowledge, experience, wisdom, and judgment they possess is no match for what AI can bring to support diagnosis and treatment.

The authors argue that even the greatest of human brains can't remember or interpret a tiny fraction of the information now available on human health and disease like AI can. "Just a few years ago, most medical decisions were based entirely on the knowledge in the head of the doctor at the time the decision was made. Today that is beginning to change, thanks to the rapid development of artificial intelligence. The evolution that brought the world ChatGPT and similar large language models is making AI one of the most quickly adopted technologies in history, promising profound changes for the way we live and work. Some of the most important will take place in the field of healthcare. As the technology behind these systems progresses, AI will soon be as much a part of our healthcare experience as doctors, nurses, waiting rooms and pharmacies. In fact, it won't be long before AI has mostly replaced or redefined all of these."[3]

This implies that a host of AI infrastructure and support systems, some already developed and used, will need to expand to provide the underpinnings for AI. Already AI is giving physicians access to a wealth of information at the point of care that was not previously available. In effect, these supporting systems leverage what computers are good for—storing, recalling, and correlating vast amounts of information virtually instantaneously—and linking it to the ability of a human expert to reason intuitively and think creatively.

The authors go on to note that when early so-called expert systems were first developed in the 1980s and 1990s, "they were met with hostility by many physicians who worried that computers would soon be in charge of medical decision-making, taking the 'doctor's touch' out of the equation and binding the hands of physicians whose opinions differed from the computer's analysis. But that's not what happened. Research has shown that these systems have gotten better and better at helping doctors spot potential outcomes that they might have missed, without taking the ultimate decision-making authority out of their hands."[4] Once again, supporting infrastructure, supply chains, and new businesses and industries are being built around the hopes and promises of AI.

Similarly, the legal profession stands to gain and perhaps face some risks as AI becomes more widespread. As Steve Lohr reports in an April 10, 2023, *New York Times* article, "more than a decade ago, lawyers were singled out as an endangered occupational species, their livelihoods at risk from advances in artificial intelligence. But the doomsayers got ahead of themselves. While clever software has taken over some of the toil

[3] Hood, L., & Price, N. (2023, April 7). The AI Will See You Now. *Wall Street Journal.* Retrieved from http://bit.ly/3odmhPw
[4] Ibid.

of legal work—searching, reviewing, and mining mountains of legal documents for nuggets of useful information—employment in the legal profession has grown faster than the American work force as a whole."[5]

For AI to impact the medical and legal professions in ways to improve the outcomes of both professions, a great deal of research is required as are digital platforms to house data and information and parse it, making it available to doctors and lawyers instantaneously. This requires new jobs, new skills, new platforms to be built, and coding to provide the most relevant and accurate information possible when needed. Absent all the behind-the-scenes work, AI assisting the medical and legal professions would not be possible.

IMPLICATIONS FOR ENERGY INNOVATIONS

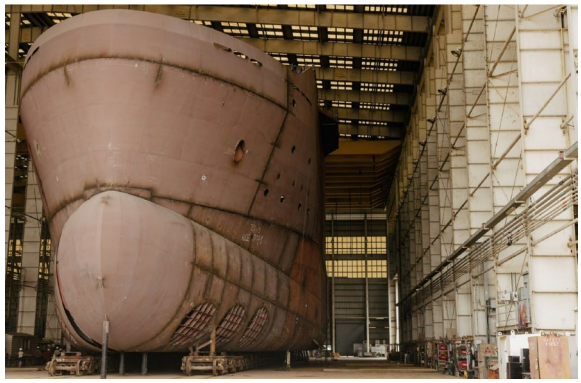
As with other sectors of the economy and professions, AI has a role to play in improving forecasting demand and managing the electric grid to improve reliability and safety and improve operating efficiencies. AI can ensure resources are available regardless of source and location on the grid, when and where needed. Predicting demand and supply and controlling clean energy and distributed renewable resources to balance loads is particularly important when adding intermittent energy resources to the grid.

Improving grid efficiencies is increasingly important as electricity is generated by smaller and distributed resources, having many different owners, and connected to the grid at various locations—including both behind-the-meter (customer-sited) and on the utility transmission and distribution (T&D) grid itself. Coordinating the integration and efficient operation of these resources by grid operators requires modern operating systems, including integrated automated distribution management systems (ADMS) and all the hardware and software infrastructure needed to support them.

Likewise, building a sustainable and robust market for clean and distributed energy technologies requires significant investment in supporting industries and technologies and supply chains. Consider the plans many states and the federal government are supporting for siting over 9,000 MW of wind generation off the Atlantic Coast. Federal and state funding and permitting assistance is available to support these plans, along with the transmission needed to deliver the power to demand centers. Absent this support, such ambitious plans would likely never materialize. Consider the various seaports, specialized transportation and shipping, and construction components and equipment needed to build the offshore wind farm, and the T&D infrastructure to move the power to markets. **Figure 1** is illustrative of a typical ocean vessel specifically designed and built to support the offshore wind industry.

Without this vessel and other specially designed equipment, the offshore wind industry could not be sustainable. While offshore wind is not new, the size and scale of wind turbines and farms planned off the Atlantic Coast is

Figure 1. The 262-Foot Eco Edison Will Operate Out of New York to Service Three Wind Farms in the Atlantic Ocean



[5] Lohr, S. (2023, April 10). AI is Coming for Lawyers, Again. *New York Times.* Retrieved from http://bit.ly/41sf2ls

unprecedented. Wind farms contemplated for the West Coast, Gulf of Mexico, and Great Lakes would require similar equipment. Seaports are being re-imagined and modified to transport wind turbines, towers, and blades manufactured onshore and needed offshore, creating the need for port refurbishment and specialized rail cars, trucks, and containers for transporting components.

Amazon, Apple, and other tech and retail providers like Walmart are committing to purchasing electricity produced by renewable energy resources and siting EV charging stations in parking lots for employees and customers. Private sector investment coupled with available federal and state funding for clean energy innovations and technologies is accelerating demand for clean technologies and supporting services. Amazon's recently announced agreement to purchase wind-generated electricity is "part of a greater collaboration that will support the development of large-scale renewable energy projects and leverage Amazon Web Services, Inc.'s (AWS) cloud computing technology to enhance digitalization through the energy transition, supporting smarter grids, customer engagement, and connected clean power."[6] AWS is committing to advancing the adoption of renewable energy and helping Amazon power its operations with 100 percent renewable energy and reach net-zero carbon emissions. Private sector investment and commitment to clean energy innovations and technologies creates multiple opportunities for investors to earn returns as countries and economies continue the push toward decarbonization.

Ali Zaidi, the Biden Administration's national climate adviser, is seeing individuals and companies making bets on America's commitment to clean energy, noting that since President Joe Biden took office, thanks to three recent laws—the Bipartisan Infrastructure Investment and Jobs Act (IIJA), the CHIPS Act, and the Inflation Reduction Act (IRA)—firms have announced approximately $200 billion in investments in everything from batteries and EVs to renewable energy and hydrogen. Some $65 billion of this amount has come just since the IRA was signed into law last August.[7]

CONCLUSION

As noted before in this column, siting clean energy infrastructure—including renewable and distributed energy resources (DERs) and T&D grid enhancements—is challenging. Public policy objectives to deliver zero- to low-carbon energy requires significant capital investment by many market participants across a wide variety of technologies and supply chains. Planning for the decarbonized electric grid of the future is preoccupying regulators, lawmakers, and policymakers, and requires sophisticated analysis of the costs and benefits of energy infrastructure investments and deliberate action.

Investors have many opportunities to consider the best investments to make, be they in clean energy technologies themselves or the factor input and supply chains needed to support a sustainable clean energy economy. Trade-offs will always be required and there will be winners and losers and some economic dislocation, as there is no perfect solution to decarbonizing economies. Yet, expanding our perspective on what is needed to support decarbonizing economies across the value chain of clean energy products and services provides insights into future investment opportunities. As the clean energy industry and electrification, and alternative and new sources of energy, become available and scale, there is no turning back.

[6] Smart Energy Decisions, Commercial, Solar, Wind. (2023, March 31). *Amazon Signs PPAs for Global Wind and Solar.* Retrieved from http://bit.ly/3zVxVBl

[7] The Economist. (2023, April 7). America's chance to become a clean-energy superpower. *The Economist.*Retrieved from http://bit.ly/3odq3Zc