CLIMATE CHANGE BUSINESS JOURNAL®

Innovation in the Climate Change Industry

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Climate change may be more universally regarded as the steadily mounting existential challenge of our lifetimes with each passing season, but many would regard the progress of humanity to slow or reverse anthropogenic climate change — and minimize its impacts on civilization and the natural environment — as being only one of fits and starts.

The climate change industry as defined and quantified by CCBJ continues to grow there is no doubt, but behind revenues measured in the commercial market across nine segments and over 60 subsegments, lies a foundation of research and development. This R&D is expected to sustain growth throughout the energy transition and climate change mitigation eras, and what looks to be the never-ending climate change adaptation & resilience challenge — a challenge that one could argue our species has already endured for 100,000 years.

So just where are we in continuing to build on this foundation and just how does it manifest itself in innovation in climate change industry segments? Measuring the pace of innovation across the climate change industry is challenging because of a number of factors.

First is the difference in innovation in science and technology that can create transformative breakthroughs versus innovation in engineering and implementation that lead to incremental improvements and commercialization milestones.

Second is the variation across climate change industry segments from renewable energy to energy storage to carbon capture to transportation to greening the built environment and infrastructure.

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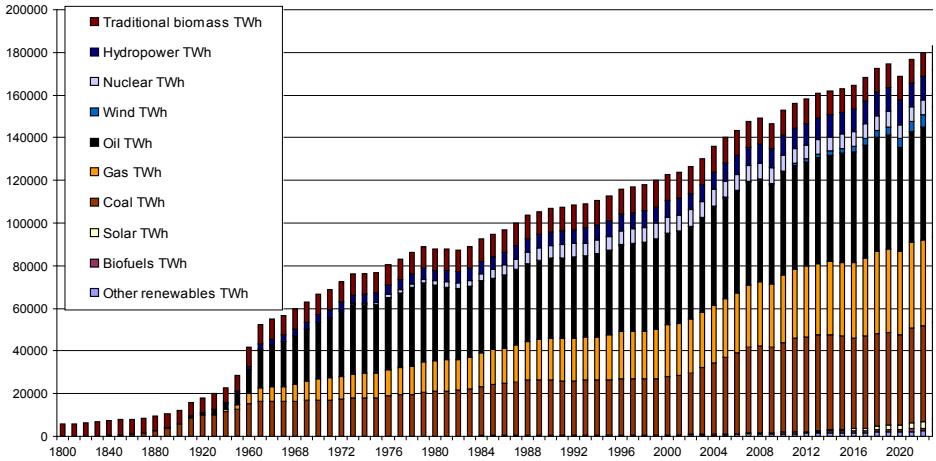
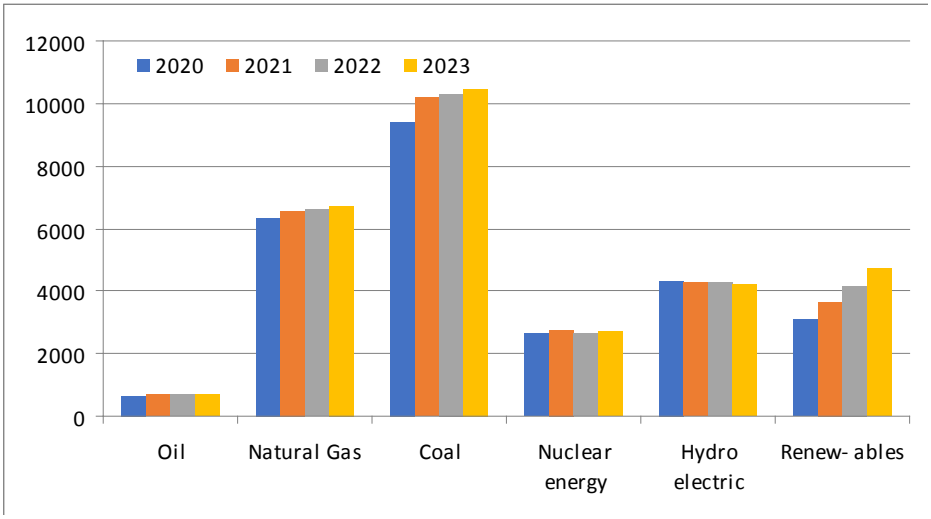
Global Energy Consumption by Fuel 1800-2023 in Terrawatt-hours

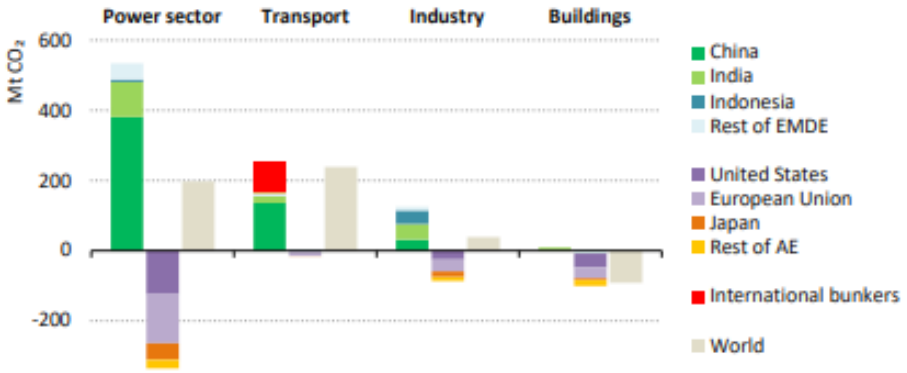


Global Electricity Generation by Fuel in Terawatt-hours, 2020-2023



Change in CO2 emissions by Sector and Region, 2022-2023

Figure 15: Change in CO_2 emissions from combustion by sector and region, 2022-2023



Source: International Energy Agency, IEA's report CO2 Emissions in 2023 issued in April 2024

At the sector level, IEA's CO2 Emissions in 2023 reports that transport experienced the most pronounced growth in emissions, surging by 240 Mt globally. The power sector contributed the second largest increase with the highest level of regional disparity, as emissions in advanced economies collapsed while those in emerging developing economies soared. Industrial emissions saw a slight uptick, as the combination of moderately weaker industrial output, efficiency gains, and fuel switching in advanced economies was insufficient to counterbalance the emissions increase from industrial development in emerging economies. Buildings was the only sector to see emissions fall at the global level, largely attributable to milder temperatures experienced in 2023.

Xendee Uses AI-Powered Software to Optimize EV Charging, Microgrids and Distributed Energy Systems

Xendee provides a suite of AI-powered software products that help developers, consultants, researchers, and engineers alike optimize microgrid and distributed energy resource financial returns while eliminating carbon emissions. A small yet robust startup, Xendee's DESIGN platform that plans renewable energy projects in just 10% of the time and money than traditional approaches was awarded the 2021 Edison Awards for Critical Human Infrastructure. Based in San Diego, California, Xendee sits in the heart of rapid electrification and movement towards renewable mobility solutions. Xendee aims to help clients from the very first step of conceptualizing a microgrid site or renewable energy project all the way to the finished product of real-time operation. The algorithms and methodologies used in Xendee have been researched for more than 20 years and supported by the US government, local governments, and multiple universities. Respondent: Michael Stadler, Co-Founder, CTO, CMO

CCBJ: How have your key markets evolved over the last five years?

Michael Stadler:

Electric Vehicles

The electric vehicle (EV) market has faced a complex and significant evolution over the last five years. EV sales have surged globally, and EVs continue to gain larger shares of the global auto market. This growth has been fueled by a combination of technological advancements, diversifying offerings, cost reductions, supportive government policies, renewable energy integration, and consumer awareness. What was before a niche and infrequent sighting on the road is now a common addition to car dealerships everywhere.

Though, the adaptation of EVs has not been without challenges. Despite EV's growing popularity, one of the biggest obstacles is the lack of charging infrastructure and the long interconnection times to connect EV charges to the utility system. Shortcomings of the charging infrastructure include lack of charging availability and constrained utility systems, lack of proper maintenance, long charging times, and competition against at-home charging. Combined with other EV pre-sale disadvantages such as high price tags, lower driving range, and maintenance, consumers may be hesitant to choose an EV over a gasoline-powered vehicle. Additionally, chargers powered by typical utility generation may still face the problems as traditional electricity usage, both in terms of cost and carbon emissions. However, programs such as National Electric Vehicle Infrastructure (NEVI) are seeking to alleviate the stress of inadequate charging infrastructure. More on NEVI below.

Microgrids

A microgrid is a group of interconnected loads and distributed energy systems (e.g. PV, battery systems, wind turbines, but also thermal resources such as Combined Heat and Power running on hydrogen, among others) within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can operate in either grid-connected or in island mode, including entirely off-grid applications.

Not only over the last five years- microgrids have seen significant evolution over the past decade. As the need for renewable energy and resilient infrastructure become more urgent, the energy industry is seeking out alternatives to fossil fuel and coal-fired power plants. Additionally, the ever-increasing costs of energy and energy demand are inspiring new business models surrounding energy generation. Energy models such as energy-as-a-service (EaaS) and power purchase agreements (PPA) facilitate shared investment for greener energy while reaping benefits for multiple stakeholders. Microgrids have shown high potential for cost reduction and resilience increases. Now, they are the primary solution for EV charging infrastructure limitations - Energy is generated where it is needed and this relieves the national grids and reduces costs while reducing carbon emissions.

Complex Distributed Energy Systems

Along with microgrids and the increasing adaptation of renewable energy, complex Distributed Energy Systems have intrinsically also experienced rapid growth. As amazing as renewable energy and microgrids powered by green energy sound, the benefits would not be fully realized without effective distribution. This spurred advancements in energy storage, as excess generated energy can then be stowed away for later usage.

To effectively manage all energy generation and usage, microgrids are also becoming increasingly "smart". This includes real-time monitoring systems, automated controls, predictive forecasting, and adaptive response to optimize the distributed energy system. Xendee's latest software product, OPERATE, seeks to solve this exact challenge by enabling users to efficiently monitor and control their microgrids in a one-stop shop platform. OPERATE is a Model Predictive Control (MPC) system which has forward-looking capabilities that can anticipate weather or demand changes and respond to them before they happen. In this way, microgrids can provide enormous cost savings in addition to carbon reductions. We have seen up to 80% cost reduction in utilizing a smart MPC compared to existing rule-based controllers, which do not perform reliably as they do not utilize forecasting.

CCBJ: In which ways are microgrids solving grid and cost challenges for EV charging projects?

Michael Stadler: As aforementioned, the EV evolution has not transpired without its own specific challenges. Between patchy charging infrastructure and complex means of electricity generation, EV demand is not always the easiest to integrate into microgrids. Nevertheless, EV charging is increasingly being coupled with renewable energy resources- particularly solar PV. Fortunately, a chargepoint such as this does not have to be a massive undertaking either; it can be as simple as a parking lot with solar PV on the roof of the carport. It can also be as complex as an array of chargers for a bus port or rest station. As the implementation of EV charging infrastructure becomes more streamlined, microgrids will undoubtedly continue to play an essential role. Business models such as charging-as-a-service can also enable financial incentives for both developers and customers.

We have conducted multiple surveys in the microgrid and EV industry, from which we found very interesting results: 75% of all surveyed industrial professionals see utility grid limitations as the biggest roadblock for EV deployment. In return, 78% of the respondents believe that microgrids and distributed energy systems are the solution for this problem. 63% believe that microgrids need to be colocated with EV chargers. Those microgrids contain PV, battery systems, but also fuel cells or traditional combustion engines running on hydrogen (for example).

CCBJ: Can you provide an overview of the National Electric Vehicle Infrastructure (NEVI) funding and what impact has it had so far in the Electric Vehicle Market?

Stadler: The NEVI program is a keystone program that will tackle many of the challenges involved with EV charging infrastructure. This program allocates federal funding to states for the expansion of EV charging networks, and eligible projects will receive funding of up to 80% of project costs. Though still in progress, many states have already begun to leverage funding from the program. By the end of 2023, approximately 5,000 new DC fast chargers have been installed or are in the process of installation across the United States, as part of the NEVI program. This includes both new installations and upgrades to existing infrastructure. The goal of the program is to deploy a robust network of charging stations along major highway corridors, ensuring that no more than 50 miles separates fast chargers on these routes.

CCBJ: What metrics or indicators does Xendee use to measure the success and impact of projects funded by the NEVI program?

Stadler: While Xendee feels optimistic about the NEVI program and has incorporated the NEVI incentive into our extensive catalog of grant-based funding sources, the success of our clients' projects are not up to us to define. The success and impact of our users' EV charging projects are subjective to their standards; our goal is to help them build the optimal distributed energy system through data-driven modeling. Nevertheless, one success metric is the number of users that model EVs and microgrids. The number of optimization runs and projects in this space has increased by 30% in the last year.

CCBJ: Elaborate on the founding story of Xendee, and what unique challenges or gaps in the market you aimed to address?

Stadler: The planning, implementation, and control of microgrids and Distributed Energy Resource (DER)projects was a burdensome process 10 years ago. There was no approach or software tool that could guide the engineers, financiers, or installers through the entire process of screening, designing, implementing, and controlling a DER project. The process was fragmented, error-prone, and not easily replicable. There was simply no standardization around those methodologies. However, in the early 2000s, a co-founder of Xendee started working on standardizing techno-economic methodologies and applying them to research projects for e.g. the US DOE of US DoD. These methodologies have been well-proven in peer-reviewed publications and allow for sizing of DER, assessment of carbon savings, as well as cost savings in a methodological way. However, it was a job for researchers and not easy to use outside of academia. In parallel, the second co-founder of Xendee was focusing on power flow and distributions system modeling. It became very clear that techno-economic assessments and distribution system modeling go hand-in-hand with Microgrid and DER projects. Also, to make the technology accessible and widely used so that hundreds or thousands of projects can be handled effectively and efficiently, a smart graphical user interface with a lot of database driven support was needed. In 2018, Xendee was created for that reason. Since then, the final stage- the control of microgrids and DER- has also been added.

CCBJ: How do Xendee's solutions stand out from other players?

Stadler: What's unique about Xendee's suite of products is that we cover the distributed energy system from the conceptual stage to the final operational stage. Our DISCOVER solution helps developers identify the most viable sites for pursuing microgrid implementation. Our PROPOSE software helps our users make rapid proposals (e.g. for government RFPS) without tedious modeling details. Our award-winning DESIGN platform helps modelers fully build out their microgrid in detail to give them the optimal dispatch and investment scenario. Post-construction, our OPERATE software ties it all together through active monitoring and engagement of on-site energy distribution. With this approach the project planning phase can be shortened by 90%. Detailed studies for the US DoD have been performed and without the standardized and streamlined approach from Xendee we have seen feasibility study costs ranging from 1% to 75% of the total microgrid project costs for example. Xend-

ee constantly delivers feasibility studies with less than 1% of total project costs and this allows for cheaper projects and faster execution.

Xendee's research-based approach and platform also are able to handle and streamline complex projects that include various common and new or emerging DER technologies, or multi-node scenarios. The technologies and demands of these distributed energy projects are constantly evolving, and Xendee's ability to be a research-backed tool that engineers and project owners can rely on to make business and technical decisions has made it the go-to resource for projects with solar, energy storage, and other DERs.

CCBJ: What emerging technologies do you see as game-changers for the distributed energy systems (DES) market in the next five to ten years?

Stadler: While the energy industry is constantly making incredible progress through various technology improvements, co-generation capabilities, and novel functionalities, an integral part of effective energy distribution is energy storage. Solar PV, amongst other renewable energy resources, cannot guarantee consistent electricity generation. Coupled with battery energy storage systems (or new to be developed long term storage systems), excess power generation can then be used when there is a need. Battery energy storage systems can take advantage of Time of Use (TOU) tariffs by purchasing electricity from the utility when rates are the cheapest.

While energy storage is not the only solution for dealing with volatility and price fluctuations, it certainly changes the game for implementing effective and impactful distribution of energy. However, from our perspective it is less of a technology question than a political one. It is clear that upgrading and rebuilding our aging utility infrastructure is not the cheapest undertaking and Microgrids clearly reduce the cost burden on distribution systems and transmission lines. However, it is hard to change one hundred years of perception and decision making. In other words, there is not enough support for the cheaper DES and microgrid systems when it comes to utility regulation.

CCBJ: Has Xendee formed any strategic partnerships that have been crucial in expanding your EV charging solutions? How have these partnerships influenced your business strategy?

Stadler: Xendee does not provide charging solutions or hardware, we provide tools to model them. Our software platforms enable quick and optimal modeling of EV charging infrastructure. Use cases can include EV charging instructure ranging from small installations at offices, all the way to large bus depots or other fleets. Our team is continuously improving our EV-centric functionalities in Xendee. We just recently overhauled our Charging-as-a-Service functionality to highlight the savings for both the developers and customers.

While we are not solely EV-focused, we have several crucial relationships that have been instrumental to our success on many fronts. Our collaborations with research entities such as the Rocky Mountain Institute, Idaho National Laboratory, University of Illinois Urbana-Champaign, and Arizona State University have allowed us to partake in visions towards creating a resilient and sustainable energy future. In the EV space, we work with Prologis and this has helped us improve our EV fleet management modeling.

CCBJ: What strategies does Xendee employ to educate and engage potential users about the benefits of your solutions?

Stadler: One of the biggest emphases of our Customer Success team is ensuring that our users learn all about the potential applications of standardized microgrid modeling. One of Xendee's core pillars is education and continuous learning. Both of the founders, Adib Nasle (CEO) and Michael Stadler (CTO), taught Microgrid Design & Economic Optimization at the University of California, San Diego. Xendee also collaborates with Arizona State University's Laboratory for Energy and Power Solutions (LEAPS) for recurring courses on microgrid modeling. This course prepares participants with the necessary contextual knowledge and skills to effectively model microgrids using techniques like Xendee. Lastly, Xendee regularly presents webinars revolving around different topics in microgrid development. These webinars are often collaborations with our users' organizations, and they highlight how our users have been successful players in the microgrid industry leveraging our software tools. ☼

Xendee Developments

Xendee released two new products in 2023 and doubled its customer base, enhancing its EV modeling, addressing the needs of commercial electricity consumption and Google route information, incorporation of the Low Carbon Fuel Standard (LCFS) incentive, and multiple technology and vendor databases. Other key developments were energy-as-a-service and charging-as-a-service agreements. In order to move EV charging, DER, or microgrid project forward, Xendee advocates feasibility analysis and design approval using their proposal tool that includes standardized databases and third-party API integration, vendor catalogs and utility rate integration, with the load profile database and funding programs. Xendee saw 160% growth in optimized projects in 2023 and 197% growth in university accounts, launching a "Master DED and Microgrid Design" certificate course at Arizona State University.

In June 2022 distributed energy resources (DER) planning and operation software leader Xendee raised $12 million Series A financing to accelerate its Net-Zero DER and ultra-fast EV charging platform deployments. Anzu Partners led the round, with additional financing from TravelCenters of America, Evergy Ventures and Surlamer Investments.