Accelerating the world's energy transition with partner-driven innovation inspired by co-creation endeavors

By Stefan Raab, Siemens Energy

The road to a sustainable, reliable, and affordable energy future requires both providers and users to navigate uncertainty while engaging each other creatively and co-operatively. Co-creation is one of the most effective ways to achieve such collaboration.

As the disastrous effects of climate change increasingly dominate news headlines around the world, the need for practical and economical net-zero energy models grows more urgent by the day. But achieving these on a global scale requires breakthrough innovations in our energy infrastructure, from sourcing and generation to storage, distribution, and utilization. That's why Siemens Energy has turned its worldwide ecosystem of private, public, and academic partners into a crucible for accelerating truly revolutionary innovations – fired up with the concept of co-creation and facilitated by four regional Innovation Centers in Abu Dhabi, Berlin, Orlando and Shenzhen.

The fact is: incremental improvements are insufficient to address the magnitude of global climate change. As Albert Einstein famously said, "We cannot solve our problems with the same thinking we used when we created them". So, to inspire the leaps in innovative thinking which sustainably address climate change needs, Siemens Energy has combined an incubator approach with results-focused partnerships across entire industries, governments at every level, and academia worldwide.

Our efforts focus on five fields of action:

- **Power-to-X:** Converting renewable power electro-chemically into higher-value products, such as green hydrogen and synfuels.
- **Energy Storage:** Converting electrical energy into a form for storage until it can be converted back for use.
- **Resilient Grid & Reliability:** Using various technologies to enable more efficient electricity networks – especially with large amounts of volatile energy.
- **Decarbonized Heat & Industrial Processes:** Improving the generation from heat with substantial reduction toward zero emission of greenhouse gases.
- **Condition-Based Service Interventions:** Using digital technology to monitor power generation, transmission, and other sophisticated energy equipment in real time to prevent outages while also optimizing maintenance and service cycles to save costs and associated energy expenditures.

Compressing time-to-innovation cycles by months, if not years,

Siemens Energy Innovation Centers are set up to enable the fastest incubation possible of game-changing energy decarbonization ideas, co-created in collaboration with Siemens Energy customers and as needed, relevant third-party experts from industry, government, and universities.

For example, the 30,000-square-foot (2,800 m^2) Orlando location features a Technology Application Center (TAC) workspace adjacent to meeting spaces. The TAC's "concept-to-completion" capabilities include a state-of-the-art machine shop equipped with the latest technology in CNC digital machining; 3D printing/additive manufacturing using high-performance polymer and superalloy metal materials, the latter using Laser Powder Bed Fusion (LPBF); internal and external scanners for reverse-engineering parts; and

17 robotic arms to investigate more efficient manufacturing processes.

Supporting these facilities is a diverse team of automation experts well-versed in industrial automation, robotic integration, and mechatronic design as well as ASNT Level III-certified engineers skilled in the full range of sophisticated Non-Destructive Evaluation (NDE) techniques. By combining this expertise with each Siemens Energy Innovation Center's fabrication and testing capabilities, our customer co-creation efforts can cut months, even years, from innovation cycles – time-savings that cannot only translate into cost-savings but also dramatically accelerate the world's energy transition.

Real decarbonization results from partner co-creation initiatives

Co-creation is not a new concept for Siemens Energy. For nearly a decade and with great success, its principles have guided our collaborations with both customers and consortiums involving customers. To understand better how co-creation works and the outcomes it can produce, consider these five examples of substantive decarbonization results from recent co-creation initiatives:

Solutions for hard-to-decarbonize industries: electrification in Iron & Steel

When it comes to the decarbonization of industrial heat, the processes that require the highest temperatures are those presenting the greatest challenges. Manufacturing of Iron and Steel, foundational materials to our society, is one of these hard-to-decarbonize industrial sectors. Traditionally, many of the processes rely on fuel combustion to reach the high temperatures required. According to data from the U.S. Department of Energy, process heating accounts for 70 percent of onsite energy use and alone it causes about a third of the Scope 1 + 2 emissions of the entire Iron and Steel Sector. Technology options to electrify these duties at industrial scale are still limited.

Addressing these needs, Siemens Energy is developing Turbo Heater technology to decarbonize such applications requiring high-grade heat. It introduces an altogether novel type of turbomachine which utilizes supersonic gas dynamics and shock waves to direct-heat a gas mixture to high process temperature. It uses an innovative concept which does not require fuel combustion or external heat transfer and is inherently scalable. Siemens Energy builds on its vast turbomachinery know-how and world-leading OEM experience to introduce the innovative Turbo Heater, which has already completed successful proof-of-concept testing at Megawatt scale to demonstrate its operating principle and performance.

To validate the impact of this technology in the Iron & Steel sector, Siemens Energy has signed a Memorandum of Understanding (MoU) with ArcelorMittal, the world leading mining and steel company. In this collaboration, the two companies will connect their world-class expertise and their decarbonization visions to identify and evaluate application use-cases for the Turbo Heater in this sector and co-create potential pathways leading to the demonstration and future deployment of this technology in industrial settings.

Synfuel production for decarbonizing the world's transportation sectors

In Chile – in its remote, wind-swept Magallanes region that includes Patagonia – Siemens Energy has built the Haru Oni project in collaboration with HIF Global. It will be further developed to an industrial-scale commercial plant to produce synthetic climate-neutral fuels based on green hydrogen. Such large-scale synfuels production can provide energy for hard-to-abate maritime and aviation applications as well as internal combustion engine surface transportation.

Siemens Energy is serving as the project's system integrator, from power generation via wind energy through electrolysis to fuel production. Other partners include project co-founder Porsche, who will use the synfuels to test in its cars, and ENEL Green Power and ExxonMobil, which has provided its methanol-to-gas (MTG) technology.

It is planned to scale up to a unit size of more than 2 GW producing 550 million gallons of these synfuels from wind energy, water, and CO_2 captured from the air and biogenic sources. Synfuels (also known as "e-fuels") are liquid energy carriers which emit about 90 percent less CO_2 than their fossil-fuel counterparts. In the case of e-gasoline, it is also compatible with existing liquid fuel infrastructures, a critical advantage.

In 2022, HIF Global announced it will build a 1.8 GW facility in Texas to produce a carbon-neutral gasoline substitute. This innovative company shows how the energy transition is opening doors of substantial opportunity for imaginative approaches to solving the world's carbon-emissions problems.

Green hydrogen for further decarbonizing maritime transportation

At the other end of the globe in Sweden, the Danish offshore wind developer Ørsted is building FlagshipONE, Europe's largest e-methanol project. Other co-creation partners in this project include Maersk, European Energy, Liquid Wind, and The Port of Gothenburg.

The plant will use renewable electricity to produce green hydrogen via four proton exchange membrane (PEM) electrolyzers from Siemens Energy with a total capacity of 70 MW. Siemens Energy will also provide plantwide electrification and automation, plus digitalization solutions (such as the use of digital twins), and the entire power distribution and compressor systems.

The e-methanol synthesis process will also include biogenic carbon dioxide from a nearby biomass-fired combined heat and power station. The resulting e-methanol is a carbon-neutral synfuel which is easy to store and transport. When the plant opens in 2025, it will produce up to 50,000 metric tons of e-methanol annually for maritime shipping fleets.

Swedish company Liquid Wind AB originally developed FlagshipONE and is building FlagshipTWO with a capacity of 100,000 metric tons a year.

Robotics for autonomous power plant inspections

Until now, human inspections of power plants, substations, and power lines were required to ensure the reliability of their supply. But now, advanced robots and drones are taking over those tasks, which can be dangerous to humans and therefore require plant shutdowns to be conducted safely.

In another co-creation example, Siemens Energy, Elia Group and Nemo Link together with Ross Robotics are collaborating to develop an inspection robot which can go inside high-voltage direct current converter halls during operation. Other companies involved in co-creation of the robot and drone inspection solutions are ANYbotics, Percepto, and Vattenfall. In fact, a four-legged robot called "ANYmal" has been specially trained to conduct autonomous inspection rounds at Vattenfall's combined heat and power plant in Berlin-Marzahn, Germany.

Blockchain technology ensures clean energy certification

With co-creation partners TÜV Süd, DENA, the German Energy Agency, Siemens Energy has created a blockchain partner ecosystem and introduced the Clean Energy Certificate, CertaLink™.

Using blockchain technology, and by linking tangible assets to a decentralized digital infrastructure, the CertaLink™ Certificate enables companies to verify their products have been manufactured using renewable energy sources.

Products will be automatically affixed with a certificate that identifies the energy origin of the product and tracks it from source to usage. This offers customers an in-depth understanding of the product's low carbon intensity and various energy characteristics throughout the entire supply chain.

Fostering cooperation and collaboration to accelerate the energy transition

Despite the vast size and scope of a global transition to sustainable energy, the urgency to achieve this goal requires more active cooperation and collaboration than ever before among often disparate – even competing – interests. Co-creation facilitated by Siemens Energy experts and using the sophisticated technical resources of our four regional Innovation Centers can help foster the needed levels of joint efforts and coordinate them, as well.

Both industry incumbents and innovators can find opportunities to prosper in their own or joint contributions to the effort. Winning at addressing climate change doesn't mean others must lose. The energy transition challenges ahead of us must involve many different stakeholders, not the least of which are the world's complex ecological systems and humankind.

To learn more about co-creation as well as our other climate change initiatives, technologies, and projects, we invite you to visit our website at http://www.siemens-energy.com/.

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