CASE STUDIES IN CLEAN ENERGY INNOVATION: THE ROLE OF LARGE COMPANIES

1. Direct Procurement of Emerging Technologies

Fuel Cells: Walmart was among the first customers for Bloom Energy's solid-oxide fuel cells when the technology was in pilot mode, using renewable biogas. Equinix and eBay have incorporated Bloom fuel cells into their data centers for primary on-site power, reducing the need to use expensive and higher-emitting backup generators. Bloom Energy (NYSE:BE) had its initial public offering in 2018.

Hydrogen-Powered Forklifts: Amazon and Walmart were early adopters of Plug Power's hydrogen-powered forklifts, which can provide both operational efficiencies and reduced emissions in warehouses. The two large companies served as key early customers as well as technology optimization partners, and recently both struck $600-million dollar deals with Plug Power.

Alternative Fuels: UPS set a goal of sourcing 40% of its ground fleet fuel from low-carbon or alternative fuels by 2025, including renewable natural gas (RNG) that can be derived from organic waste in landfills, wastewater treatment, and agriculture. The company has become one of the largest consumers of RNG, including a long-term 10-million-gallon annual purchasing deal with Big Ox Energy.

Renewables + Storage: Kaiser Permanente recently finalized a PPA with NextEra that will include not only new construction of 131MW of solar power and 50MW of wind power, but also a 110MW battery system that improves reliability. This will make Kaiser Permanente the largest purchaser of renewable energy in the U.S. health care sector, using one of the first corporate PPAs with a defined storage component.

Solar Perovskite: Construction company Skanska is using electricity from a perovskite photovoltaic panel in one of the first real-world deployments of the technology, an essential step in future commercialization. Pervoskite cells have made dramatic improvements in power conversion efficiency over the last 5 years may have the potential to reach over 30%, which would eclipse existing solar technologies.

Low-Carbon Concrete: The McDonald's flagship store in Chicago was built with CO2-capturing concrete, reducing emissions associated with construction and industrial materials. This process, developed by CarbonCure Technologies, both lowers the emissions involved in cement manufacturing and strengthens the concrete.

Landfill Biogas: General Motors has invested in technology that allows its auto assembly plants in Fort Wayne, Indiana and Orion, Michigan to run on electricity from methane captured at nearby landfills.

2. Demand Signals for New Technologies

Rooftop Unit (RTU) Challenge: McDonald's, Target, Walmart, and other members of the Commercial Building Energy Alliance (CBEA) partnered with the U.S. Department of Energy (DOE) to stimulate the market for 10-ton capacity commercial air conditioners (aka "RTUs") that would dramatically outperform then-available models on cost and efficiency. The General Services Administration (GSA) provided a real-world warehouse test site, and the Pacific Northwest National Laboratory (PNNL) evaluated RTU designs from five manufacturers, finding that the Daiken Rebel model delivered 26% energy savings.

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Low-Cost Wireless Metering Challenge: CBRE, Whole Foods, Yum! Brands and over 200 other commercial building partners issued a challenge to manufacturers: If you can build wireless sub-meters that cost less than $100 (90% savings) and meet DOE performance specifications, we will buy them. Meazon met this specification in real-world testing, with a sub-meter that provides granular data allowing building operators to save energy and money.

3. Incentive Prizes

"Little Box" Inverter Challenge: Google partnered with IEEE to launch a $1 million open competition for teams to design and build super-compact kW-scale inverters. Over 2,000 teams registered, 80 proposals qualified for in-depth review, 18 finalist designs were tested by the National Renewable Energy Laboratory (NREL), and 3 designs from CE+T Power, Schneider Electric, and Virginia Tech passed the bar. The CE+T design won the prize by demonstrating the highest power density and smallest volume.

Carbon XPRIZE: NRG and Canada's Oil Sands Innovation Alliance (COSIA) sponsored the $20 million Carbon XPRIZE, a 4.5-year open competition for solutions that convert power plant CO2 emissions into valuable products. A field of 27 semifinalists at pilot scale yielded 10 finalist teams dividing a $5 million milestone prize, and moving on to testing their technologies at a coal-fired power plant in Wyoming or a natural gas-fired plant in Alberta. End products for the captured CO2 include methanol, plastics, concrete, and carbon nanotubes.

4. Startup Accelerators and Testbeds

Advanced Energy Lab: Microsoft launched the Advanced Energy Lab in Seattle, partnering with McKinstry and Cummins to build the world's first data center directly connected to natural gas pipes and powered by integrated fuel, which could almost double energy efficiency.

Innovation Incubator (IN2): Wells Fargo partnered with the National Renewable Energy Laboratory (NREL) to create a startup accelerator program for commercial building efficiency and other clean energy technologies, moving teams from proof of concept to lab testing to beta installation at a Wells Fargo or other partner facility. Since 2014, 25 companies have participated and received grants of up to $250,000, and the program now supports sustainable agriculture startups through a partnership with the Donald Danforth Plant Science Center (Danforth Center).

GameChanger Accelerator: Shell partnered with NREL to launch an invitation-only startup accelerator providing access to financial support, testing facilities, and technical experts. Technology focus areas include energy storage, grid integration, and fast charging.

Techstars Energy Accelerator: Equinor partnered with Techstars, one of the world's largest startup accelerators, to design a Norway-based program for teams pursuing new technologies in the broad categories of oil and gas, renewables, new business models, and digitalization.