Energy Systems Network (ESN) – Foreign Relations Committee Hearing

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ABOUT ENERGY SYSTEMS NETWORK

Overview

Energy Systems Network (ESN) is a not-for-profit based in Indianapolis that is building an energy ecosystem which integrates all aspects of the energy landscape: energy generation, distribution, the built environment, and transportation. ESN's mission is to leverage our network of corporate and institutional partners and global thought leaders to develop integrated energy solutions that increase quality of life for today and tomorrow. Our collective focus is to: reduce costs, emissions and waste; influence policy; and advance technological innovation.

Launched in 2009, ESN has since implemented several collaborative projects and public private partnerships resulting in over $700 million invested. Our partner organizations include representatives from industry (including a dozen Global and Fortune 500 companies), leading research universities, federal labs, non-profits and government agencies. These partners are active in a diversity of industries including transportation, energy generation, transmission and distribution, equipment manufacturing, real estate development, information technology, and many others. Our facilitation of collaboration across traditional industry boundaries allows for innovation of new energy technology and accelerates commercialization and market adoption.

ESN also provides a range of services to support innovation including market studies, technology evaluation, project development and management, formation of joint ventures, brainstorming workshops, and research efforts.

ESN's Approach

ESN has developed the Path to Sustainability, a framework which guides our approach to project development and implementation. The framework consists of the following elements:

- People and Place: Each project starts with the customer/consumer in mind. Our goal is to use energy systems solutions to improve quality of life to individuals, organizations, and geographic locations.
- Policy: Once the customer and objectives are defined, ESN works directly with regulators, government agencies, and policymakers to build support for, or remove barriers to, project implementation.
- Finance: A wide range of creative financing models using public and private funding sources are leveraged to implement our projects.
- Assets: Financing is used to support the deployment of "assets," which refers to all hardware, software, systems, and other tangible resources that are required to deliver integrated energy-related system solutions.
- Total Cost of Ownership (TCO): We take a holistic approach to calculating the return on investment that our projects generate. By taking into consideration all possible costs of owning

and maintaining the equipment or service, in addition to upfront capital costs, ESN provides TCO data to justify sustainable business models and solutions.

Partnerships

Since its founding, ESN has built upon its network of partner organizations – representing industry, academia, government agencies, non-profits, and others – to continue collaboration and broaden engagement to achieve the most innovative energy solutions. Past and current partners on ESN projects include, but are not limited to, the following:

- A123 Systems
- AECOM
- Allison Transmission
- Altairnano
- Battery Innovation Center
- Bolloré Group
- Cummins Inc.
- Delphi Automotive
- Duke Energy
- EnerDel
- Hunt Construction
- IBM
- Indiana Economic Development Corporation
- Indiana Housing and Community Development Authority
- Indianapolis Power & Light
- ITOCHU Corporation
- Ivy Tech Community College
- LHP Engineering Solutions
- MISO
- Naval Surface Warfare Center Crane
- Nissan
- Purdue University
- Rocky Mountain Institute
- SAIC
- Simon Property Group
- Sumitomo Electric
- Toshiba
- Toyota
- Underwriters Laboratories (UL)
- Vectren Corporation
- Wanxiang Group

Leadership – Board of Directors and Technical Advisory Council

ESN has engaged executive leadership representation on its Board of Directors, which includes Fortune 500 companies, academia, non-profits, and others. Current and past Board members include the following:

- John Bear, President and CEO – MISO
- Carl Chapman, Chairman, President and CEO – Vectren Corporation
- Mitch Daniels, Jr., President – Purdue University
- Doug Esamann, Executive Vice President of Energy Solutions; Midwest and Florida Regions – Duke Energy
- David Glass, Chief Executive Officer – LHP Engineering Solutions
- David Johnson, President and CEO – Central Indiana Corporate Partnership and BioCrossroads
- Eizo Kobayashi, Chairman – ITOCHU Corporation
- Tom Linebarger, Chairman & CEO – Cummins Inc.
- General Gene Renuart, Commander of North American Aerospace Defense Command and U.S. Northern Command (retired)

- Thomas Snyder, President Emeritus – Ivy Tech Community College

Previous Board Members

- Hisao Tanaka, former CEO of Toshiba
- Amory Lovins, Chief Scientist at Rocky Mountain Institute
- John Kelly, Chief Technology Officer at IBM
- Jeff Owens, former Chief Technology Officer at Delphi
- Jim Rogers, former President and CEO of Duke Energy
- France Cordova, former President of Purdue University

ESN has also gathered some of the greatest technical experts in advanced energy technologies to form a Technical Advisory Council (TAC) that helps direct and advise on ESN's current and new project activities. Current and past TAC members include the following:

- Koji Abe, General Manager, Corporate Development Department – ITOCHU Corporation
- Dr. Dan Hirleman, Chief Corporate and Global Partnerships Officer – Purdue University
- Gary Johansen, Executive Director of Engineering for High Horsepower – Cummins Inc.
- Alec Proudfoot, Engineering Consultant – Proudfoot Design, Google
- Michael Rowand, Director of Technology Development – Duke Energy
- John Waters, Chief Technology Officer – Energy Systems Network

Previous TAC Members

- Dr. John Wall, former Chief Technology Officer – Cummins Inc.
- Dr. James Lyons, Chief Technologist – Novus Energy Partners
- David Mohler, former Chief Technology Officer – Duke Energy

ESN PUBLIC-PRIVATE PARTNERSHIPS

Among ESN's portfolio of activities, there are four primary areas of work that fully demonstrate our strengths in public-private partnership development and implementation. ESN's most long-standing programs are centered around transportation electrification, through an initiative named Project Plug-IN. Additionally, ESN incubated and launched the Battery Innovation Center (BIC) in southern Indiana outside Naval Surface Warfare Center (NSWC) Crane. We have led a number of microgrid system projects including MicroGreen, a first-of-its-kind mobile microgrid. Finally, ESN's most recent program is called Moving Forward, which is a partnership with the Indiana Housing and Community Development Authority (IHCDA) to develop net-zero energy efficient affordable housing with integrated multimodal transportation options for low- to moderate income families.

Project Plug-IN

What began as one of the largest initial demonstration projects of plug-in vehicles in the nation in 2010 has evolved into supporting more than $100 million invested in transportation electrification in Indiana. The first step in Project Plug-IN was an early adopters pilot in 2010 to introduce the first plug-in electric vehicles (PEV) in the state of Indiana. This resulted in more than 125 vehicles and nearly 200 charging stations deployed to support government and corporate fleets as well as private citizens across central Indiana. This pilot also led to one of the first time-of-use rates for PEV charging in the nation approved

by the Indiana Utility Regulatory Commission. After our completion of the early adopters pilot, ESN engaged with the City of Indianapolis in 2013 to become the first city in the nation to announce conversion of its entire fleet to non-oil sources (i.e. electric, natural gas, and biofuels) by 2025. As a first step toward this goal, ESN worked with the City of Indianapolis to deploy 225 plug-in vehicles into its municipal fleet, representing the largest PEV fleet of any city in the nation.

ESN continued its partnership with the City of Indianapolis in 2014-2015 to establish a largest-in-the-nation all-electric car sharing program in Indianapolis with Bolloré Group of France. BlueIndy launched publicly in 2015 as the largest all-electric car sharing program in North America and operates more than 300 shared electric vehicles with more than 500 charging points located across the city. More than 50,000 trips have been taken in the first 18 months of operations and there are plans to grow the system to as many as 500 cars and 1,000 charging points. This project represents a public-private partnership with nearly $10 million pledged by the City and local utility company and more than $40 million from Bolloré Group.

ESN has also consulted with the city's public transportation corporation, IndyGo, to help select electric bus suppliers and technology options to include in the city's bus fleet, as well as provide our transportation electrification expertise to support the deployment of the nation's first electric Bus Rapid Transit (eBRT) line, the Redline, that consists of a 13.6-mile route through the heart of the city. Today, IndyGo operates 21 electric buses – more than any city in the nation.

Battery Innovation Center

ESN launched the Battery Innovation Center in 2013 to accelerate the advanced energy storage market by linking manufacturers, government agencies and research labs, academia, and Fortune 500 companies. The $20 million R&D and prototype manufacturing facility is located next to NSWC Crane, which houses a U.S. Department of Defense center of excellence in battery development and power electronics.

The BIC's proven capabilities attracted the attention of Underwriters Laboratories (UL), which made the BIC its Battery & Energy Storage Technology (BEST) Test Center. The BIC also serves as a U.S. Department of Commerce Proof of Concept Center and the first MESA Standards Alliance interoperability and testing center in the world.

To date, the BIC has contracted with more than 65 companies for a wide range of battery and energy systems development, testing and validation, or engineering services. This list includes large companies (Rolls Royce, SAIC, Cummins, Duke Energy, AES, GE, NEC, etc.) as well as emerging startups (BrightVolt, SiNode Systems, Black Diamond Structures, Pellion, etc.) and government labs and research institutions (NSWC Crane, Penn State University, Purdue University, Argonne Labs, etc.)

MicroGreen

In 2010, ESN launched a public-private partnership among technology, utility, and defense industry partners to develop a first of its kinds mobile renewable microgrid to provide scalable power to forward operating bases in remote locations without access to reliable power and who face dangers associated with delivery of diesel fuel. The project brought together a number of companies and institutions operating in the state of Indiana who worked together to design and build the MicroGreen solution. Partners included SAIC, Cummins, EnerDel, Duke Energy, and NSWC Crane. Funding for MicroGreen came from a $1.5 million grant from the U.S. Department of Energy and was matched with more than $3 million in private investment. In 2011, a prototype mobile microgrid system was completed that was

capable of providing one megawatt of power using a combination of biomass, solar, and energy storage. The product was fielded and tested at Naval Support Activity Crane. System integrator SAIC used the IP and learnings to support a range of future projects for the U.S. Department of Defense and commercial customers.

Moving Forward Program

According to the U.S. Department of Housing and Urban Development, the budgeting rule of thumb for housing and transportation is 30 percent and 15 percent, respectively. That means that families usually spend nearly half of their income on these two necessities, and many spend more. For many families, covering these costs is a significant hardship. Current public subsidies, where applicable, do not consider the total cost of ownership (TCO) for either the home or the vehicle, such as utility costs, fuel, maintenance, and energy usage.

Moving Forward is a program that was developed between ESN and the Indiana Housing and Community Development Authority (IHCDA) in 2015 to address this challenge of affordable housing and transportation. Moving Forward approaches housing and transportation simultaneously to reveal additional solutions and efficiencies not typically seen when these topics are treated separately.

The program is an innovative, first-of-its-kind program to address the challenge of providing sustainable, integrated affordable housing and transportation. The program uses ESN's systems approach to create affordable sustainable housing that increases the quality of life for tenants, while decreasing the cost of living and transportation for low- to moderate income individuals and families. Using existing federal tax credits, IHCDA provides funding to support two affordable housing developments per year that integrate energy efficiency, the built environment, and transportation. The developers and their teams, selected by IHCDA, participate in ESN's Innovation Workshop, a charrette-style brainstorming workshop which brings together an impressive collection of subject matter experts in built environment, transportation, systems integration, energy efficiency and supply, policy, finance, and poverty alleviation together to create two high-level designs. Developers then identify their own sites within Indiana and design their full-scale development plan.

Because the challenges of affordable housing and transportation are not specific to the state of Indiana, the Moving Forward program is one that can be replicated in other states with the same low-income housing tax credit programs as well as in other countries in which creating cross-efficiencies through a systems approach would result in cost savings and improved quality of life outcomes. This public-private partnership already has four net-zero housing developments with integrated multimodal transportation options for tenants in progress across the state, with two more beginning the process in November 2017. When completed these developments will house more than 200 low income families in six cities across the Indiana.

ESN INTERNATIONAL ENGAGEMENT

U.S.-China Advanced Vehicle Technology Summit, 2010

One successful example of our work to use energy technology to act as a bridge for international development was the U.S.-China Advanced Technology Vehicle Summit, held in 2010 in Indianapolis. The event brought together the largest ever delegation of automotive industry executives from China with a number of U.S. automotive technology supplier CEOs to discuss how the emergence of new hybrid and electric vehicle solutions developed in the U.S., including many from Indiana, could help China

accelerate its adoption of cleaner vehicles. The summit hosted approximately 300 participants, including a number of government, institutional and corporate leaders including, among others:

- Mitch Daniels, Jr., Governor of Indiana
- Chao Wang, Assistant Minister, Ministry of Commerce, Republic of China
- David Sandalow, Assistant Secretary for Policy and International Affairs at U.S. Department of Energy
- President France Cordova, Purdue University
- CEOs and senior executives from a number of U.S. and Chinese automotive companies, including:
  - Allison Transmission
  - Cummins
  - Delphi
  - Remy International
  - BYD
  - China FAW Group Corporation
  - Dongfeng Motor Corporation
  - Geely Automotive Holdings Limited
  - SAIC

Several memoranda of understanding (MOUs) were signed at the event between U.S. and Chinese companies, establishing international collaborative partnerships for advanced vehicle technology development and strategic cooperation. The signed MOUs include the following:

- MOU of Two-Way Investment Promotion Cooperation: Investment Promotion Agency of the MOFCOM of China, Indiana Economic Development Corporation
- MOU on Cooperation: China Chamber of Commerce for Import and Export of Machinery and Electronic Products (CCCME), ESN, China Association of Automobile Manufacturers (CAAM)
- Electric Vehicle Battery Joint Venture: Wanxiang Group, Ener1 Group
- Agreement on Strategic Cooperation on Vehicle Energy Efficiency and Environmental Issues: Guangxi LiuGong Machinery Company, Cummins Inc.
- Agreement on Strategic Cooperation on Research of Vehicle Energy Efficiency and Environmental Issues: Zhengzhou Yutong Group, Cummins Inc.

ESN AND INTERNATIONAL DEVELOPMENT

There are a number of ways in which ESN has impacted international development directly and indirectly though our projects and our diverse network of partners. Furthermore, there are several projects we have led which could be scaled internationally in ways that would support a variety of development goals and objectives including energy access, sustainable and efficient energy supply, energy security, improved quality of life, and economic development. One of our founding principles is that no one company or institution has all the tools to solve our energy challenges. Solutions require a collaborative approach that cuts across traditional industry boundaries and leverages a range of corporate, academic, and government partners. This same guiding principle is directly analogous to addressing challenges of international

development. It is the power of public-private partnerships and the collaboration that drives them, which is best able to address the complex and varied challenges of international development.

While ESN is based in Indiana and implements most of our work in the state, we ensure that our projects are scalable well beyond the Hoosier state. In order to drive scalability, we work to bring in partner companies that are working around the world and we reach out to other nations to find ways for our learnings to be adopted abroad. ESN has formed partnerships with companies and institutions in a number of countries including Japan, China, and France; we have also conducted outreach and engagement in the Republic of Georgia. Many of our past and present board member companies like Cummins, ITOCHU, Toshiba, Delphi, and IBM are active in nearly every corner of the world.

ESN's outreach and engagement around the world has taught us that energy solutions are truly global in nature. Many of the same challenges that we face bring sustainable, cost effective, and environmentally responsible energy solutions to the citizens of Indiana are present in most countries around the world, including those that are still struggling to develop modern energy infrastructure and supply. For example, the emergence of the increased adoption of distributed energy resources (DER) – such as renewables (solar, wind, biomass) as well as smaller scale fossil fuel plants, often coupled with energy storage in the form of advanced batteries – offers a revolutionary new approach to scaling modern energy supply. This approach moves away from a dependence on traditional centralized power plants with miles of transmission and distribution infrastructure needed to reach customers. Instead, energy supply is located closer to the demand and can be scaled up or down faster and with less cost over time. This DER approach is supported by advancements in controls systems that allow for microgrids to operate independently or link together in a broader system. Most traditional energy companies, including all of our ESN partners, are embracing this new approach to energy development and including it in their current and future systems buildout or upgrade plans.

A second revolutionary movement impacting the energy industry is the rapidly increasing adoption of transportation electrification. The development of hybrid and electric vehicles can trace their roots back to the state of Indiana. Indiana was the home of the General Motors Delco Remy Propulsion Division which developed the first modern electric vehicle, the EV1. The hybrid and electric powertrain technology from this effort preceded Toyota's famed hybrid Prius program. Later, the learnings of the EV1, developed largely in Indiana, resulted in the launch of the first hybrid bus system by Allison Transmission of Indianapolis. Today electric vehicles are becoming commonplace and nearly every major vehicle manufacturer for both light duty passenger cars to medium- and heavy-duty trucks and buses are rolling out electric products. Indiana's own Cummins, a global leader in diesel engines for more than a century, recently announced that it will be selling an all-electric powertrain into the market for trucks and buses by 2019. The trend toward more electric vehicles can, if managed correctly, perfectly complement the adoption of a DER approach to energy generation and distribution. This is because electric vehicles can charge and eventually, with improved technology, discharge into DER microgrid or networks in a way that supports the overall energy efficiency of the system. The electric vehicles, and specifically the batteries in the vehicles, in a sense become another distributed resource integrated into the network. This can be especially important in developing countries where the development of a DER network can support new forms of lower cost and lower emissions transportation, and where the alternative of building a traditional central power plan in addition to a supply chain for gasoline or petrol can be very expensive and take years to reach remote villages or communities.

The intersection of the DER and transportation electrification revolutions as well as other energy systems innovations are happening today through the work of ESN and our partners. We are leveraging Indiana as a launching pad for the innovative technologies, business models, and regulatory policies that will support its adoption. Our many successful public-private partnerships – including, but not limited to, the deployment of the largest electric car sharing network, the first mobile microgrids powered by renewable energy, development of advanced battery and energy storage solutions, and building of six net-zero affordable housing developments with integrated transit – are examples that our collaboration is working. The ability to share these learnings and models with other nations is a logical next step, and one that ESN and our partners are eager to pursue with the guidance and support of this committee.