Bringing Emissions Solutions to Scale for a Sustainable Future

Outcomes from the 2017 NYC Low-Emission Solutions Conference
New York, NY | September 20-21, 2017

The second Low-Emissions Solutions Conference (LESC) took place during Climate Week NYC 2017 at Columbia University in New York. LESC is focused on technological developments that can support the implementation of the Paris Agreement. It aims to promote problem-solving, brainstorming and global co-creation of multi-sector solutions to address climate change. The solutions are within reach and yet, our targets fall short and our timelines do not align. Most alarmingly, global climate change is still rapidly approaching dangerous tipping points due to the slow pace of implementation.

How do we make these solutions practical and accessible to all? And how do countries around the world access the knowledge, resources and partners they need to realize ambitious nationally determined commitments (NDCs) to reduce emissions? Working in a three-way partnership, ICLEI- Local Governments for Sustainability (ICLEI), the Sustainable Development Solutions Network (SDSN) and the World Business Council on Sustainable Development (WBCSD) have brought together world-leading scientists, engineers and technical experts from business, academia and local government to share knowledge, identify bottlenecks, discuss best practices and prioritize future research. The goal is to identify the potential technologies and pathways for the necessary transformation in each sector.

Climate champion **Ms. Laurence Tubiana** opened LESC NYC 2017 with a vision of the road ahead, including the importance of aligning efforts and rapidly scaling solutions in order to achieve national energy transformations for a low-emissions world. The keynote remarks also included insights from **Mr. Francesco Starace**, CEO of multinational manufacturer and energy distributor Enel. Mr. Starace explained why the old electric utility business model is no longer effective for integrating the array of new technology options before us, and posited that only those actors who look ahead and act now will thrive in decades to come. He outlined Enel's road to zero emissions and its take on the future of energy.

SDSN Director **Professor Jeffrey Sachs**, renowned economist and sustainable development champion, spoke on the important role of technology and the need to connect the decision-makers with low-emissions innovators to accelerate progress on climate change. Following the opening remarks, there were five substantive panel sessions on issues of "scale" including the quantitative scale of the emissions problem; the geographical scale of policy action; and the physical, financial and time scales of technical solutions. Throughout these sessions, a variety of scalable solutions and initiatives were presented that will help realize a low-emissions world. The following is a summary of those solutions.

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A. Deep Decarbonization Pathways: Where Do They Lead?

Transformative decarbonization demands long-term, spatially explicit, multi-sector and technically detailed pathways analysis of the infrastructure and fleet transformation required in each country, region, state and city. **Professor Jim Williams** of the University of San Francisco explained the origins of the Deep Decarbonization Pathways Projects (DDPP), through which technological scenarios were mapped for 16 of the world's highest greenhouse gas (GHG) emitting countries, accounting for more than 70% of global emissions. Aligning these strategies with long-term low-emission development strategies led by government, as called for in Paris Agreement Article 4.19, is a necessary step to increase traction of NDCs and support domestic policy development and implementation. Professor Williams concluded that analysis that is both transparent and rigorous provides a foundation for sectoral planning, coordination among jurisdictions and the design of policy packages. While scientists and policy makers are designing curated solutions to address these needs, political forces often render complex, multi-sectoral approaches less ambitious and specific. Weakened action can result in emission lock-in, as the infrastructure we build today commits us to emissions output decades into the future, increases the costs of low-emissions solutions and decreases the likelihood of their success. Pathways analysis and subsequent advocacy conducted by outside parties – sub-nationals, academia, nongovernmental organizations (NGOs), businesses and neighboring jurisdictions – is needed to inform, challenge and increase the ambition and effectiveness of governmental strategies.

Canada is a primary example of government-led action, **Dr. Chris Bataille** of Simon Fraser University explained. The country is bridging this gap, using integrated energy fleet back-casting models to inform its national framework. The Canadian Deep Decarbonization Pathways Project has had a significant effect on the Canadian climate policy debate. The Canadian DDPP report, published in two phases in 2015, was explicitly cited in the summary report of the climate policy stakeholder process that led to Alberta's Climate Leadership Plan, which is now law. The Canadian DDPP – and in particular the Alberta cap-and-trade system for large emitters – had a significant impact on the proposed Canadian federal carbon pricing backstop plan.

Australia and Southeast Asia are also working on regional approaches to decarbonization, according to Head of Climateworks Australia **Ms. Meg Argyriou**. **Dr. Noah Kaufman**, an economist from the World Resource Institute (WRI), emphasized the feasibility of these decarbonization plans. He also noted the important role of national government in the development and execution of national decarbonization exercises, but cautioned that government bureaucracies may lead to more conservative pathways.

Dr. Daniel Buira discussed the status of the Mexico Miles project, an attempt to match the national NDC commitments to a real-life decarbonization plan, so far the projections don't quite

align. Dr. Buira's presentation highlighted the importance of a price on carbon to help technologic transformation accelerate in Mexico to meet their national emissions targets.

Ms. Grace Wu, a PhD candidate at U.C. Berkeley and researcher at the Lawrence Berkeley National Lab, turned the conversation to the next phases of research in this realm, detailing her work alongside **Dr. Margaret Torn** on land use and the impacts of various activities on the global carbon budget. Ms. Wu expressed the need for land use pathways that can simultaneously meet multiple competing needs, including carbon storage, food and fiber production, ecosystem services and siting of renewable energy facilities. The Food, Agriculture, Biodiversity, Land use and Energy (FABLE) project is a promising new research project that considers the impact of land use decisions and mirrors the successful DDPP – long-term energy pathways – method.

B. Demand Side Solutions to Renewable Integration: Do They Scale?

Demand side solutions cover an array of applications, from consumer-managed demand and decentralized storage options to new digital load management techniques. Space heating, the dominant source of GHG emissions in many areas, typically relies on burning on-site fossil fuels. There is wide agreement that this issue will be addressed by the electrification of heating via heat pumps (HP), but that solution will in turn affect the demand curve. Therefore, we need to consider efficiency measures, digitization and automation alongside fuel switching and water heater phase-out. Other solutions include real-time pricing, power electronics, wider geographic areas of integration, scheduling loads, improved forecasting, differentiated reliability, pumped hydro and microgrids that can be used as dispatchable storage. One project trying an array of these solutions is the BQDM Program in New York.

This session brought together experts working with these solutions to explain the current state of technology and what to expect moving forward. The past few years have shown an explosion of research in demand side solutions for energy management as the world becomes more electrified and reliance and pressure on the grid increases. As renewables and other technologies come to market and costs become more competitive, the market is shifting from a utility-owned and -operated commodity to something that consumers can choose, control and even produce on their own property. As stated by **Mr. Ben Haley** from Energy Evolved Research (EER), "The loss of control on the supply side necessitates the introduction of flexible loads to manage the balance of supply and demand on all timescales."

Columbia University **Professor Vijay Modi** provided a look into the current state of demand side solutions, discussing the role of batteries as both an enabling and a limiting factor for renewables and decentralized grids. **Mr. Chen Li**, CEO of Gotion, Inc., joined this panel to speak on the various applications of different battery types and highlighted the promising future of lithium ion technology. Gotion designs electric vehicles and is advancing lithium battery technology and research. Storage is the enabling factor helping demand and supply meet when

an established grid cannot integrate variable resources. The “Unfortunate Tetrahedron” of batteries, as explained by **Dr. Daniel Steingart** from Princeton University, is the limited applications of batteries due to tradeoffs and feedbacks between variables (tradeoffs may include: capital cost, amortization operating cost (cycle life and safety), power density, energy density, and utility space).

Another issue discussed in this panel included the need for digitization and data sharing among utilities, which is crucial for a decarbonized grid but also raises concerns about privacy and security. Over the last decade, the energy industry has proven that demand management saves customers money and helps manage peak loads, but these solutions need more public awareness and buy-in in order to be widely adopted. **Mr. Greg Geller** from EnerNoc spoke to this point. He advocated for the use of technology and automation to change how people use energy.

The panel concluded that the grid will be the enabler for demand side solutions. As transport and heating systems switch to electrical systems, the grid will need to evolve to support these new demands. Storage is probably the most commonly known and discussed demand side solution. The lesser-known side of this sector is electro-fuels and chemicals, which are the frontier for distributed energy solutions. According to Professor Modi, these may just be the key to the needed transition.

C. Renewable Electricity Systems: How High Can You Go?

In the not-too-distant past, a 100% renewable energy (RE) grid seemed implausible. Today, communities as diverse as Aspen, Colorado and Georgetown, Texas supply residents with electric power sourced entirely by renewables. They are joined by hundreds of local governments worldwide who have announced their commitments to 100% renewable energy.

In early 2017, a paper was published in *Joule* by Jacobson et. al on 100% Clean and Renewable Wind, Water, and Sunlight All-Sector Energy Roadmaps for 139 Countries of the World. Many scientists and decision-makers questioned if 100% renewability were actually possible and, if so, what actions must be taken to reach that goal. The authors of that paper concluded that job creation, economic development, increased reliability and access, and improved social health can all be achieved in 139 countries with 100% renewable penetration. This session explored research on where energy systems supported by a high percentage of renewables are functioning and which system models are working where. Cities and subnational governments have been leading the way in setting ambitious emissions targets, but are these goals realistic and feasible?

One of the notable initiatives aligning efforts towards 100% renewables is ICLEI’s 100% Renewable Cities and Regions Network, a partnership with the Sierra Club and Renewable

Cities under the Global 100% RE Campaign. The network is open to all motivated cities, towns and regions committing to 100% renewable energy. Meanwhile, nations like Denmark, Costa Rica, Germany and Morocco are demonstrating concrete progress towards this transition. Such bold commitments and concrete actions will also help to keep global warming well below 2°C and to achieve carbon neutrality by mid-century. One program supporting this progress is the carbonn Climate Registry, an online reporting platform available for cities and towns to publically report on and align their efforts in a global movement.

Ms. Angie Fyfe, executive director at ICLEI USA, described the following city and regional public commitments to deep penetration of renewable energy (RE):

- Vancouver, Canada: 100% RE before 2050
- Portland, Oregon? Maine?: 100% RE by 2035
- Aspen, Colorado: 100% RE electricity by 2015
- Malmö, Sweden: 100% RE by 2030
- Växjö, Sweden: 100% RE by 2030
- Inje County, South Korea:100% RE electricity by 2045
- Jeju Province, South Korea: 100% RE by 2030
- Byron Shire, Australia: 100% RE by 2025
- Australian Capital Territory, Australia: 100% RE electricity by 2020

Another example of sub-national commitments to reduce emissions is the #WeAreStillIn initiative, through which U.S. cities, states, universities and businesses can commit to uphold the principles of the Paris Agreement, despite the lack of national leadership.

This session provided perspectives from both national and sub-national governments, represented by panelists from some of the leading nations transitioning to majority renewable energy systems. **Mr. Said Mouline**, head of the Moroccan Agency for Renewable Energy and Energy Efficiency, discussed the importance of renewable technologies in meeting the Paris Agreement goals. He laid out Morocco's vision for renewable energy deployment, noting that renewable technologies have provided a low-cost electricity source and new economic activity in the country.

Dr. Trieu Mai – session speaker and a member of the forecasting and modeling group in the Strategic Energy Analysis Center at the National Renewable Energy Laboratory (NREL) – co-authored the Renewable Electricity Futures Study of 2012. The study found that renewables could provide 80% of the U.S. commercial and residential electricity needs by 2050 using current technologies. Dr. Mai discussed NREL's research and electric sector capacity expansion modeling for high-penetration renewable scenarios, including the current state of renewables penetration as shown by the chart below. The map below illustrates the rates of renewable energy penetration in Australia, three European countries and portions of the U.S. electric grid.

While there are still challenges of intermittency, reliability, storage, seasonality and transmission, increased renewable penetration is growing worldwide. This map illustrates progress toward renewable solution penetration and the long road ahead to ensure we stay within the 2°C global warming limit.

World Peak Load and Renewable Penetrations

Map developed by NREL (2017)

An electric utility company that is rethinking how renewables are incorporated into their systems is Portland General Electric (PGE). PGE serves 8,700 customers in 52 cities in the northwest U.S. **Dr. Elaine Hart**, a power analyst with PGE, noted that customers are demanding transition to renewables at a pace that is greater than what regulation legally allows the utility to pursue. For her, the question should be framed not as how "high" can we go, but at what pace and at what cost?

The final panelist, **Mr. Jean-Pierre Maugendre**, sustainable development deputy manager with Suez Environnement, discussed the 2020 roadmap Zero Energy, Zero Waste of EMASAGRA (a public-private partnership between Suez Environnement and the city of Granada, Spain), in which waste-to-energy technologies will be used in reaching towards a complete reduction of fossil fuels. Suez Environnement is not only a provider of these fossil-fuel reducing technologies but also leads by example, setting corporate commitments to renewables and high expectations for government and research partners.

D. Autonomous and Electric Vehicles: On the Road to Deep Decarbonization

Electric vehicles are starting to replace combustion engines. Some regions (such as Norway and Silicon Valley) are as high as 10%, while most other parts of the developed world still only

have 1-2% market penetration. This panel explored what is in store for electric vehicles and how the market will be impacted by the evolving technology of autonomous vehicles.

This session hosted five industry stakeholders, each providing a unique perspective on the future of the automobile industry. **Dr. Lewis Fulton,** director of Sustainable Transportation Energy Pathways at UC Davis' Institute of Transportation Studies, opened the panel by explaining concurrent revolutions in the space. He described three vehicle revolutions currently underway – electric vehicles, autonomous vehicles and shared mobility –all overlapping and influencing one another in this rapidly changing sector of individual transport. Speaking from the manufacturing and supplier side Renault VP of Environment Strategy & Planning **Mr. Jean-Philippe Hermine** explained that the sustainable business model for automakers is no longer to advertise to the individual. Rather, the future of automakers lies in fleet models as demonstrated by leaders such as Uber and Lyft, both of which are expanding rapidly and often providing a more affordable option for mobility in congested cities. Mr. Hermine stated that Renault's research and development (R&D) in autonomous vehicles is already two years ahead of schedule. With improved production, the company is expecting as much as a 30% decrease in costs for electric vehicles in the near future. One of the driving forces for this is that demand is currently higher than supply, so the company is constantly pushing its capacity to meet customer demand for electric vehicles.

Mr. Jason Babbie, deputy director of the Urban Solutions & Strategic Program Development at the National Resources Defense Council (NRDC), provided the perspective of cities, where many of these new mobility models are currently being piloted. Mr. Babbie explained that market forces cannot enable all the solutions for electric and autonomous vehicle success in cities. In fact, in order to build a robust and sustainable transport system, he argued we will need public-private partnerships to facilitate the transition away from single occupancy vehicles.

Lyft is looking to invest in electric vehicles and is "going all in" on autonomous vehicles, according to its Transportation Policy Manager **Mr. Corey Ershow**. He noted that one important aspect of electric vehicle proliferation is access to infrastructure, including charging stations and a reliable grid. Lyft and other auto fleet companies are working closely with utilities to explore the types of partnerships necessary to facilitate progress in this new era. **Mr. Doug Kaufman**, CEO of transit technology company Transloc, argued that the main hurdle is not technology, but consumer behavior and government regulation. According to Mr. Kaufman, the challenge of behavior is three-fold: range anxiety, customer familiarity and upfront costs, all of which are surmountable but will take a concerted effort.

The panel concluded that the individual transport solution will always be context-specific. Developing and developed countries and cities will have different needs and capacity to implement these technologies. However, all of the major players in the auto industry are looking

ahead and see the potential for growth in electric and autonomous vehicles through economic, public safety and technological factors.

E. Alternative Energy, Nuclear and CCS: What are the Prospects?

While the expansion of energy decarbonization, renewable energy and demand side solutions encourage optimism in the future prospects of reducing emissions within our economies, some argue that the prospects of staying within the Paris Agreement's 2°C temperature increase limit are quickly fading, if not already far out of reach. This session focused on three alternative low-emission technologies that may be crucial in balancing our carbon budget and achieving that goal: nuclear fission, nuclear fusion and carbon capture and sequestration (CCS). **Dr. William Horak**, chair of the Department of Nuclear Science and Technology at Brookhaven National Laboratory, detailed these technologies, which are often referred to as key building blocks in our transition to a decarbonized future. But what do scientists, engineers, business leaders and economists say about their potential?

The first presenter for this session was **Dr. Rachel Slaybaugh**, an assistant professor in the Nuclear Engineering Department at UC Berkeley. Dr. Slaybaugh discussed the current state of generation III reactors in the United States and globally. One of the notable observations of nuclear technology is that it is no longer solely a government activity. Due to advances in the technology and applications of nuclear power, many private startups have been created, with more than 50 nuclear startups in the United States alone. These private companies often work with generation III + reactors, which are safer than their predecessors due to improved design, automation and meltdown safeguards. While the design and application of these reactors are unique and context-specific (e.g. some focus on eliminating nuclear waste, some on safety, some on cost and some on the generation of co-products), the point is that this is a growing industry. Despite puplic opinion, many nuclear engineers believe generation III + reactors may be the strategic lever to deep decarbonization. However, they argue we need more monetary resources for nuclear R&D.

Ms. Lenka Kollar of NuScale Power, a U.S.-based startup, described how her company is currently working to create modular nuclear solutions that can be designed to meet the specific needs of a community, using revolutionary design to reduce safety and proliferation concerns. The NuScale Diverse Energy Platform can provide energy to critical facilities (such as hospitals and army bases), produce hydrogen for fuel cells, help with energy storage and desalination, decarbonize oil and chemical refining, and help with load balancing on wind farms, among other applications. With $600 million in funding, NuScale is currently working to raise another $600 million to make its vision a reality and demonstrate the diverse application of today's nuclear reactors.

As a follow-up, **Mr. Howard Hornfeld**, founder and president of Fusion Advocates, presented on the current state of nuclear fusion technology and its potential applications once brought beyond theoretical practice. In his research, Mr. Hornfeld is working to prove the feasibility of fusion technology and raise funds to build a demonstration plant.

The conversation then turned to the status of CCS and where that technology stands for reducing emissions. **Dr. Klaus Lackner**, who runs the Center for Negative Carbon Emissions at Arizona State University, put it very plainly: All we need to do is monetize the externalities caused by our GHG emissions, and the economics for CCS would become feasible. One of the most pivotal parts of implementing this technology at scale will be putting a price and cap on carbon and, instead of leveling off emissions, realizing that we must actually have negative emissions in the future if we are going to grow as a society and still expect to remain within our global carbon budget. In order to bring this technology to market, the cost of carbon will need to be on the order of $30 per ton CO2e. This will require strong regulatory intervention, without which CCS applications will remain academic and limited.

The final panelist in this session was **Mr. Bjørn Otto Sverdrup**, senior vice president of Corporate Sustainability at Statoil ASA. Mr. Sverdrup presented on Statoil's Climate Roadmap and the company's goals and targets to meet ambitious emission reductions and transform their business model to meet the low-emission energy demand the company is currently experiencing.

To wrap up LESC NYC 2017, **Professor Jeffrey Sachs** emphasized the need for more communication across sectors. Academics, investors, technical experts and government leaders need to connect, network and collaborate to elevate conversations like those held at LESC NYC 2017 to the global stage and accelerate the application of low-emission technologies in the next generation of energy production and transport infrastructure. The first step to achieving this will be to highlight these solutions to the UNFCCC negotiators at a follow-up LESC event at COP23 in November 2017 and to feed in these important initiatives to the Marrakech Partners for Global Climate Action.

Overall the conference had over 30 expert solution presentations and 420 registrations. All of the presentations from this LESC event can be found archived online at lowemissions.solutions.