TRANSFORM

CATALYZING THE TRANSITION TO A 21ST CENTURY ENERGY ECONOMY

JISEA 2019 ANNUAL REPORT

JISEA
Joint Institute for
Strategic Energy Analysis

TRANSFORMING ENERGY

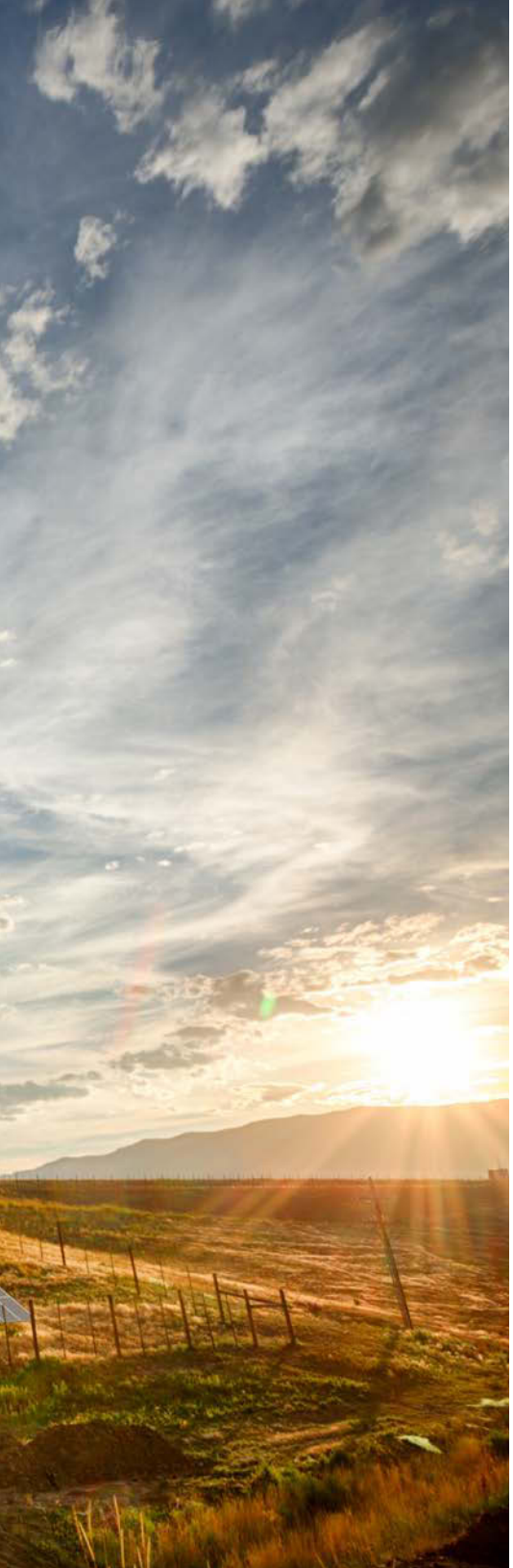
At the National Renewable Energy Laboratory (NREL), we focus on creative answers to today's energy challenges. From breakthroughs in fundamental science to new technologies, to integrated energy systems that power our lives, NREL researchers are transforming the way the nation and the world use energy.

The first year of NREL's new Scientific Computing and Energy Analysis directorate—and my first year at its helm—was a resounding success. The directorate provides an integrated approach to advanced scientific computing capabilities and globally recognized analysis centers. The Joint Institute for Energy Analysis (JISEA) plays a key role by enabling the directorate to work with our university partners and a broad spectrum of global energy and industrial sectors. Now in its ninth year, JISEA helps drive the transformation of the global energy economy through its comprehensive, transdisciplinary research focused on the nexus of energy, financial sector, and society.

As the electrification of the global economy accelerates, JISEA helps advance transformative research and analysis—most notably energy systems integration, the water-energy-food nexus, and circular energy materials supply chains—by fostering collaboration and exploring new links to support the directorate, the lab, and our partners. Many of these projects are highlighted in this annual report.

We look forward to continued collaboration with JISEA university partners and international affiliates to provide cutting-edge insight as the global energy economy experiences transformational change.

Rob Leland
Associate Lab Director,
Scientific Computing and
Energy Analysis



REFLECTING ON A TRANSFORMATIVE YEAR

We chose "transform" as the title of this year's annual report because there is no better descriptor for what is happening in the power and broader energy sector. Manufacturing and other advances have dramatically reduced the costs of solar and wind, and battery prices are experiencing a similar decline. The shale gas revolution is 10 years old and going strong, and it is not only altering the U.S. electric power industry but also the global economy. The rise of electric vehicles is quickly gaining momentum, with 2018 recently being named the peak year for internal combustion engine vehicles, and advanced energy countries like Norway seeing plug-in cars account for just over 49% of all new cars registered. Concurrently, energy generation is not only getting less expensive and more efficient, but also cleaner. Low-carbon energy sources like renewables; nuclear; and carbon capture, utilization, and storage (CCUS) technologies are all finding new ways to work together.

It is important to recognize that this rapid transformation could not happen without government and private sector support of research and analysis. Communities and companies are also responding by setting ambitious clean energy goals. These goals are not just aspirational—they are based on the models and techno-economic analysis done in part by JISEA and its partners. JISEA's leading-edge, objective, high-impact research and analysis is playing a defining role in how the future of this clean energy generation looks and how much it costs to get there.

While we have seen many successes, significant progress is still needed. Industrial processes such as fuel and chemical production need new clean energy solutions. Distributed energy needs to improve its water use per unit of power generated. The supply chain could be enhanced by developing a more circular economy. Tackling challenges like these was the impetus for JISEA's creation, and this organization is uniquely suited to bring together the diverse set of partners needed to solve the world's energy problems.

There is no debate that the global energy economy is going through a transformational change. I am fortunate to lead a team of dedicated staff, collaborating researchers, affiliates, supporters, and stakeholders who are not only illuminating possibilities for the global energy system, but also taking this vision and turning it into reality. As I look ahead to my second year in my role as JISEA Director, I could not be more excited and hopeful about the work and impact that JISEA and its collaborators will deliver.

Thank you for your continued support.

Jill Engel-Cox
JISEA Director

PROVIDING HIGH-IMPACT RESEARCH AND ANALYSIS TO INFORM TRANSFORMATIVE DECISIONS

The Joint Institute for Strategic Energy Analysis (JISEA) provides leading-edge, objective, high-impact research and analysis to guide transformative global energy investment and policy decisions.

Through strategic insights and worldwide dialogue, JISEA explores the intersections of the environmental, social, financial, technological, and political elements of energy systems on the path to a clean energy economy. JISEA's work informs innovative solutions that advance the goals of sustainability, economic prosperity, and resilience.

JISEA research and analysis provided decision-making support to industry, the financial sector, and government with a focus on the following strategic areas:

Energy Systems Integration and Transformation
Along with performing analysis to help build country-level capacity for energy systems integration, JISEA provides thought leadership to advance synergistic solutions that integrate renewable and conventional energy technologies.

Energy @ the Nexus of Sustainability
Through high-impact analysis and partnerships, JISEA provides insights and thought leadership that help enable synergistic advanced energy solutions and address barriers to resilient energy, food, and water systems.

Circular Supply Chains
With an emphasis on global supply chain analysis through the Clean Energy Manufacturing Analysis Center (CEMAC) program and clean power for industrial processes, JISEA provides industry with the foundational knowledge and technology needed to transition from a linear to a clean, circular economy for energy-relevant and energy-intensive materials, processes, and technologies.

This annual report describes JISEA's mission-driven work to guide the transformation of the global energy economy in these key areas in 2018 and highlights how the resulting insights are helping advance strategic goals that support energy transformation.

CONTENTS

ENERGY SYSTEMS

ADVANCING INTEGRATED SOLUTIONS

As a growing number of countries, communities, and corporations set increasingly aggressive clean energy goals in response to market forces and climate science, the global energy transformation is shifting into high gear. To keep pace, power systems must evolve rapidly. Policymakers, energy planners, and system operators navigating the complexities of the changing energy landscape must find ways to not only increase energy access and economic opportunity but also bolster energy security and resilience.

Striking this balance requires a coordinated, proactive approach to change management that leverages new policy, market, and regulatory environments. The resulting upgrades to power system planning and operations enable new synergies between variable and dispatchable generation—and innovative approaches to enhanced system flexibility.

Through multidisciplinary research and objective, cross-functional analysis, JISEA continues to provide government, the financial sector, and industry with critical insights and decision support to advance energy transitions. It also works to address the inherent challenges of grid modernization and systems integration by providing operational support to key Clean Energy Ministerial (CEM) programs and initiatives, and by participating in a variety of training and networking opportunities.

SUPPORTING COUNTRY-SCALE POWER SYSTEM TRANSFORMATION

Transitioning the power sector to clean, reliable, and efficient systems is a complex undertaking that demands expert capacity. JISEA operates the 21st Century Power Partnership (21CPP), an initiative of CEM, to help stakeholders conduct country-level grid integration studies to demonstrate how electricity systems can be operated with higher levels of variable renewable energy, distributed energy resources, and advanced grid technologies.

Brazil

As the newest member of 21CPP, Brazil is laying the foundation for critical energy system reforms. Having increased the contributions of variable renewable generation to its energy mix in recent years, it is actively exploring options for increasing the flexibility of its grid.

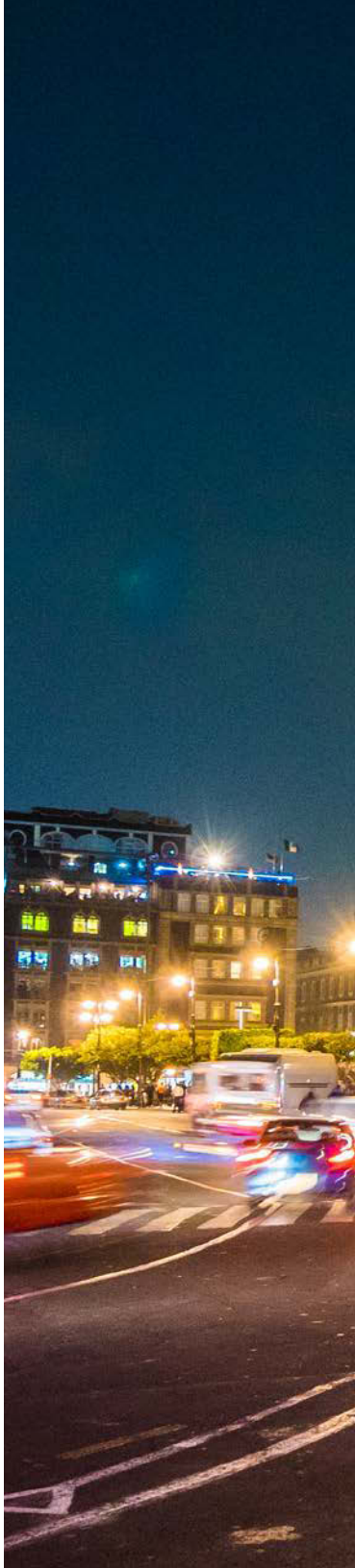
Mexico

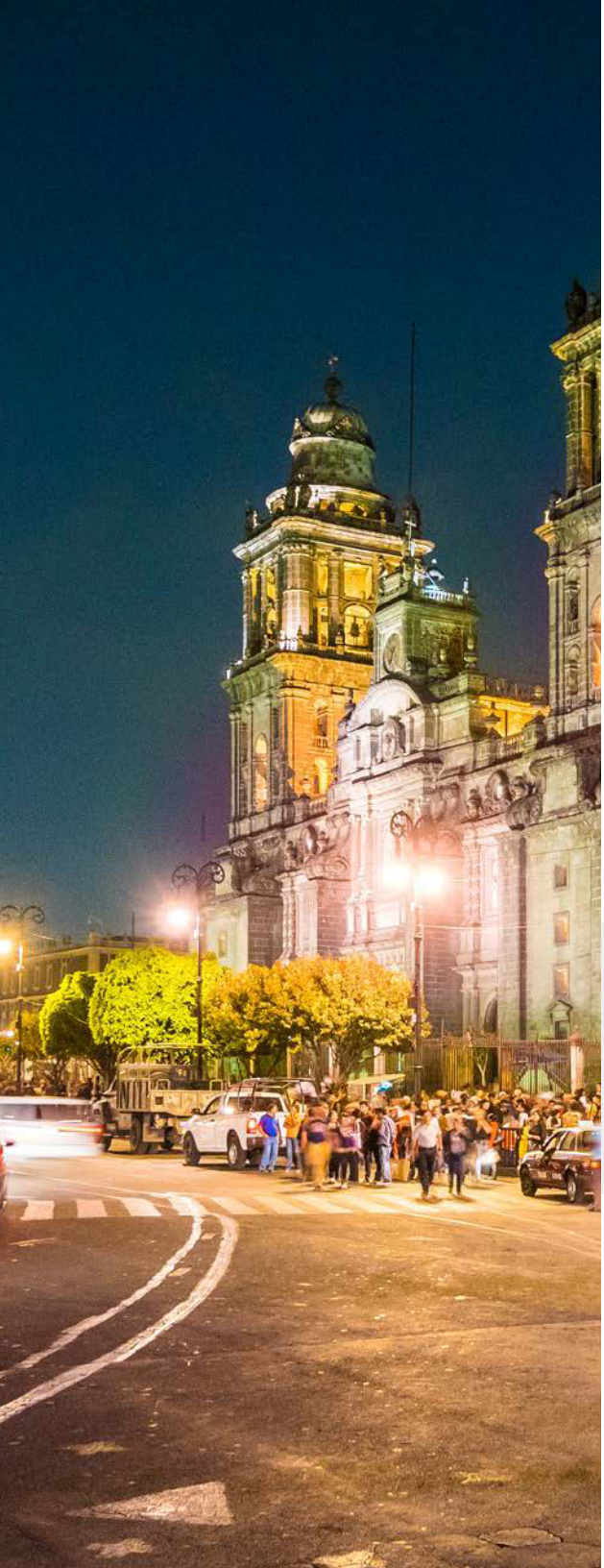
In Mexico, recent clean energy reforms are rapidly transforming the energy landscape as the government pursues its goals of generating 35% of its electricity from clean, reliable, and cost-effective energy sources by 2024. The 21CPP reports helped address critical questions and challenges in support of Mexico's ongoing efforts to accelerate next-generation power system planning; provide operational support for grid integration; evaluate and expand distributed generation policies, smart grid deployment and battery storage options; and implement energy reform directives.

Grid Integration Challenges and Potential Solutions

NREL Research	Solutions	Variability	Uncertainty	Location-specificity	Non-synchronous nature	Low capacity factor
Markets	Improved Market Design	●	●	●		
	Joint Market Operation	●	●	●		
	New Ancillary Service Markets	●			●	
Grids	Transmission Expansion	●		●		●
	Transmission Reinforcement	●		●		●
	Advanced Network Management	●		●		●
Flexibility	Coal, CT, CCGT and Hydro Ramping	●				
Operation	Balancing Areas Consolidation	●	●	●		
	Sub-hourly Dispatch and Scheduling	●	●	●		
	Improved Forecast		●			
	Grid Services by Renewables				●	
	New Grid Codes				●	
	RE Curtailment	●			●	
Load	Demand Response	●			●	
Storage	Energy Storage	●	●	●	●	●
	Hybrid Renewable Plants	●	●	●	●	●

Source: Vahan Gevorgian, NREL.





Mexico Smart Grid Drivers

1. Improved quality, reliability, continuity, safety, and sustainability
2. Improved quality of supply
3. Increased energy efficiency
4. Reduction of electricity losses
5. Efficient operation of the national electric grid
6. Greater deployment of clean energy
7. Increased customer involvement in system management
8. Additional service offerings

EU Smart Grid Drivers

- **Sustainability**
  - Reduction of CO_2 emissions 6
    - System losses 4
    - Transportation 8
  - Integration of DER 6
- **Competitiveness**
  - Increased market participation 7
    - Through aggregation of distributed generation, storage, demand response 3 7
    - Improved market transparency
  - Interregional markets (harmonized)
- **Security and quality of supply** 2
  - Safe integration of large-scale renewable energy sources 6
  - Cyberenergy and data protection
  - Operational improvements 1 5

Comparison of Mexico's smart grid drivers with those of the European Union (EU). 21CPP's 2018 analysis linked available technologies to Mexico's energy transformation drivers and priorities to help advance the Secretariat of Energy's (SENER's) smart grid implementation plan and inform its future investment, policy, and regulatory decisions. Illustration by 21CPP. **LEARN MORE: A Report on the Implementation of Smart Grids in Mexico (https://www.nrel.gov/docs/fy19osti/72699.pdf)**

Exploring Demand Response Program Options to Enhance Grid Flexibility in Mexico

21CPP case studies highlighted potential program options for building a demand response program portfolio in Mexico. **LEARN MORE: Demand Response Compensation Methodologies: Case Studies for Mexico (www.nrel.gov/docs/fy18osti/71431.pdf**)

China

China's recent measures to build a clean, reliable, and efficient energy sector underscore its growing commitment to transition to a modern electricity system that supports these goals. 21CPP's 2018 distributed energy resource (DER) planning and integration analysis supported JISEA's mission-driven commitment to develop and share case studies, international best practices, and lessons learned with China and other developing countries seeking to diversify their energy portfolios.

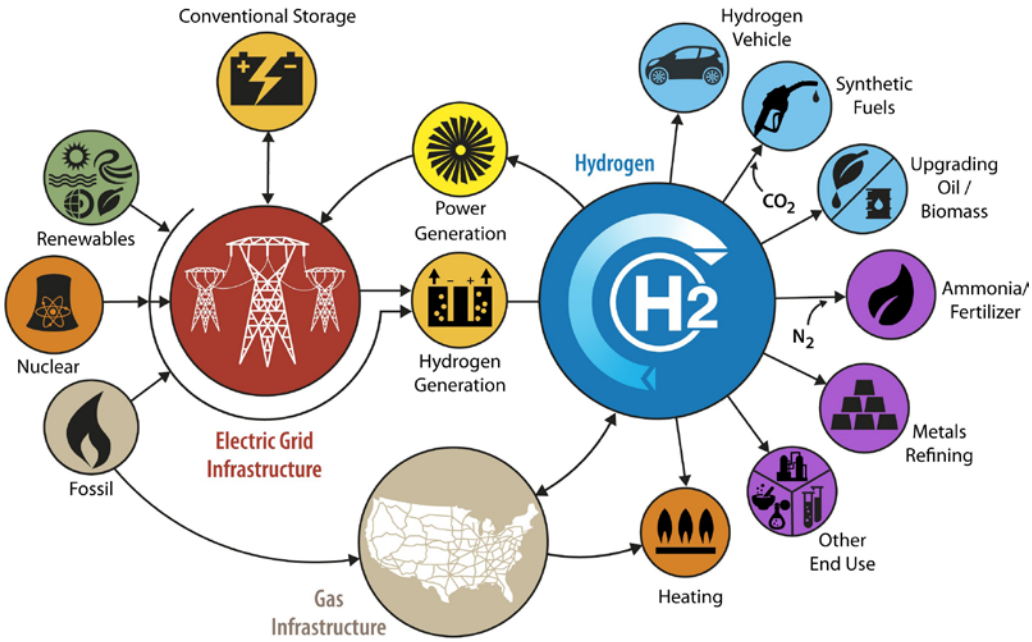
ENABLING NEW SYNERGIES THROUGH THOUGHT LEADERSHIP AND COLLABORATION

Along with collaborative analysis to help build country-level capacity, JISEA provides thought leadership to advance synergistic solutions that integrate renewable and conventional energy technologies. It fosters strategic worldwide dialogue, collaboration, and capacity-building through operational support of the CEM initiative Nuclear Innovation: Clean Energy (NICE) Future, and is building on collaborations with two applied U.S. Department of Energy (DOE) national labs as part of a Tri-Lab consortium.

Innovative Nuclear Solutions

Although the definition of clean energy often excludes nuclear energy, it is one of the world's largest sources of low-carbon electricity, second only to hydropower. Since 2011, JISEA has supported collaborative efforts to foster dialogue about the potential role this energy source can play in clean energy systems of the future through its analysis on the integration of renewable and nuclear energy systems and its leadership of the CEM initiative, NICE Future.

With three lead and six participant countries, JISEA coordinates program design for NICE Future, and starting in 2018, launched a series of webinars and coordinated outreach that emphasized innovative nuclear solutions to industrial decarbonization, grid integration, and other energy transformation challenges.



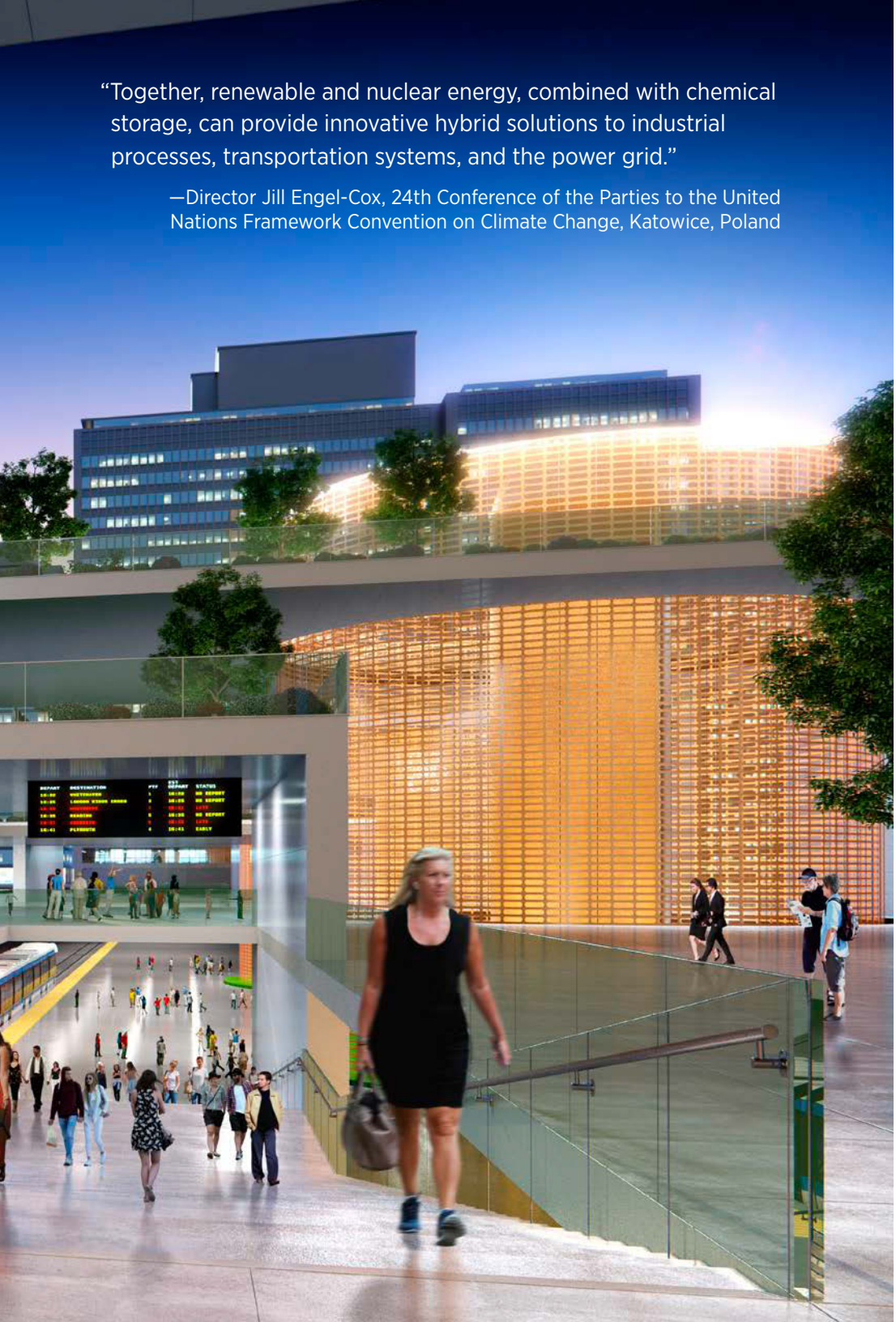
NICE Future
Nuclear Innovation: Clean Energy Future

21st Century POWER PARTNERSHIP
Accelerating the transformation of power systems

Exploring New Models for DER Planning and Integration

21CPP case studies of a California and a New York utility highlighted the importance of considering DER impacts in the distribution planning process and the efficacy of piloting the use of a broad mix of DERs and other nonwire alternatives to offset traditional utility capital expenditures. These findings will have broad global applicability. **LEARN MORE: Exploring New Models for Utility Distributed Energy Resource Planning and Integration: SMUD and Con Edison (www.nrel.gov/docs/fy18osti/70365.pdf)**

At the 6th International Conference on Nuclear and Renewable Energy Resources in Korea, Engel-Cox and Mark Ruth discussed the H2@Scale initiative for nuclear and renewable technology innovations. This conceptual graphic on the left illustrates the potential large-scale production and use of hydrogen to improve the resiliency of the electricity grid, increase energy security, and reduce emissions across all energy sectors. Illustration by Al Hicks, NREL.



"Together, renewable and nuclear energy, combined with chemical storage, can provide innovative hybrid solutions to industrial processes, transportation systems, and the power grid."

—Director Jill Engel-Cox, 24th Conference of the Parties to the United Nations Framework Convention on Climate Change, Katowice, Poland

Tri-Lab Collaboration

JISEA's long-standing programs to cross-cut all forms of energy enables dialogue across research organizations both globally and nationally. JISEA's close alignment with NREL as its founding partner brings high-impact opportunities for cross-cutting collaboration to accelerate U.S. and global energy transformation goals by integrating disparate energy systems.

At a Tri-Lab Workshop in July, lab directors, fellows, and initiative leads from Idaho National Laboratory (nuclear), National Energy Technology Laboratory (fossil), and NREL (renewables) explored pathways to achieving greater resource interoperability to address energy security and resilience, economic stability, and environmental sustainability. Key areas of collaborative research for these three energy sources include: integrated systems modeling, analysis, and optimization; integrated systems engineering, development and testing; innovative tightly coupled energy systems; and security and resilience of integrated energy systems.

@ THE NEXUS OF SUSTAINABILITY

ACHIEVING BALANCE WHERE INDUSTRY AND ENERGY-WATER-LAND INTERSECT

Energy transformation comprises a complex web of environmental, economic, and security priorities. At the intersection, or nexus, of these often-competing priorities are energy, water, and land-limited resources with inherent interdependencies, tightly linked to energy development, both renewable and oil and gas. As worldwide energy demand for these resources expands with global population growth and increased economic development, sustainability hinges on achieving balance at the nexus of energy, water, and land. Energy markets and policies, system performance, environmental regulations, carbon emissions, and socioeconomic impacts are all strands of the web that impact this balance. Industry has the opportunity to lead in sustainable energy development.

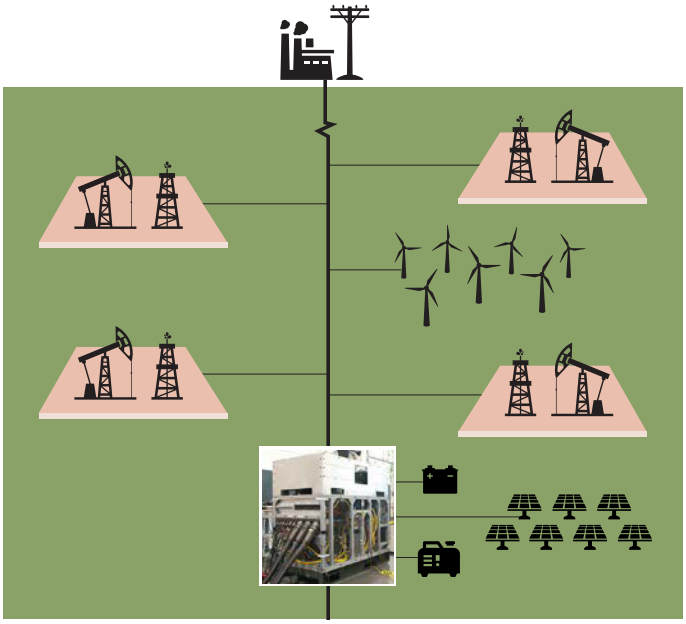
JISEA's seminal analysis and leading-edge research inform critical decisions at the intersections of these diverse systems to advance the goals of sustainability, economic prosperity, and resilience. As it works to address these critical needs, synergistic advanced energy solutions and resilient energy, as well as food and water systems, are among its core strategic areas of focus.

ENABLING SYNERGISTIC ADVANCED ENERGY SOLUTIONS

JISEA, in partnership with the International Energy Agency's Gas and Oil Technologies Programme and the U.S. Department of Energy, is defining how the oil and gas industry can work with the renewable energy industry to identify and implement synergistic advanced energy solutions as a pathway toward a low-carbon, resilient, and affordable power system. Historically viewed as competitors, these industries are increasingly recognized as complementary, from both a technological standpoint and a financial standpoint. In the first major technical report on this topic, JISEA analysts found that there is significant unrealized opportunity for clean energy technologies to reduce emissions and production costs through electrification, heat recovery, hydrogen production, and other technologies.

INTEGRATING RENEWABLE ENERGY TECHNOLOGIES IN OIL AND GAS OPERATIONS

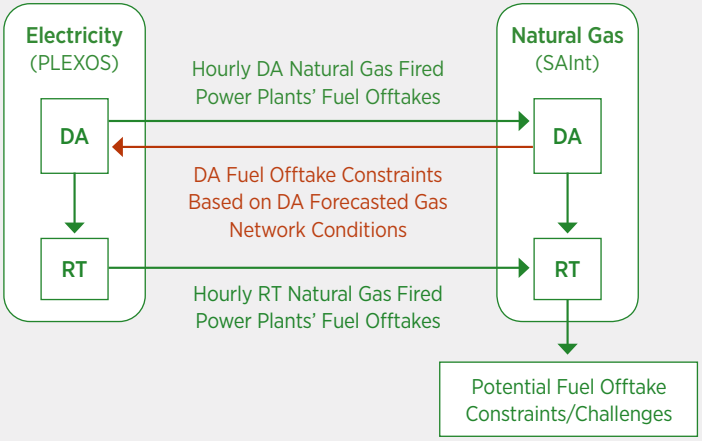
Oil refineries are the largest consumer of fuel in U.S. manufacturing and the largest generator of on-site greenhouse gas emissions in the manufacturing sector. Fuel costs also constitute half of all operations costs. JISEA analysis found renewable technologies can be integrated to reduce emissions and fuel costs. **LEARN MORE: Approaches for Integrating Renewable Energy Technologies in Oil and Gas Operations (www.nrel.gov/docs/fy19osti/72842.pdf)**



JISEA works to advance cost and technology improvements, such as microgrids and electrification of equipment, that enable renewable and other clean energy technologies to be integrated into oil and gas operations economically and to help mitigate the rising costs and environmental impacts associated with burgeoning global energy demand. Illustration by Stacy Buchanan, NREL.

Analyzing the Value of Day-Ahead Coordination of Power and Natural Gas Network Operations

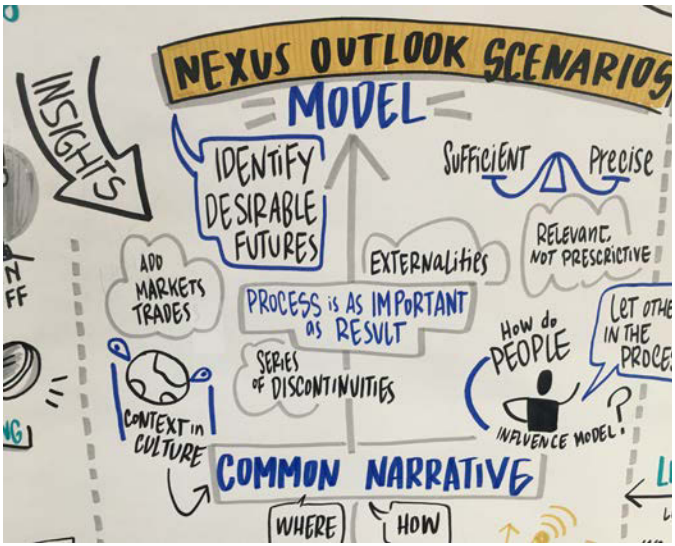
JISEA-sponsored analysis helped demonstrate the importance of considering gas system constraints when analyzing power systems operation with high penetration of gas generators and renewable energy sources. Study results showed day-ahead (DA) coordination contributes to a reduction in curtailed gas during high-stress periods and a reduction in energy consumption of gas compressor stations. **LEARN MORE: The Value of Day-Ahead Coordination of Power and Natural Gas Network Operations (https://www.mdpi.com/1996-1073/11/7/1628)**



PARTNERING TO ADDRESS BARRIERS TO RESILIENT ENERGY, FOOD, AND WATER SYSTEMS

The Knowledge Systems for Sustainability (KSS) Collaborative is a global scientific research alliance that provides decision-relevant science to better manage complex risks and advance innovations related to sustainable provision of food, water, and energy. In 2018, JISEA signed a multilateral memorandum of understanding to operate the Knowledge Systems for Sustainability Consortium, a partnership of the International Maize and Wheat Improvement Center, the Commonwealth Scientific and Industrial Research Organisation, the International Institute for Applied Systems Analysis, and the Alliance for Sustainable Energy, along with university colleagues.

By mobilizing science and technology across multiple disciplines and across public, private, and civil sectors, JISEA supports KSS's efforts to provide system-oriented, scale-appropriate, actionable solutions for addressing the mounting pressures on the Earth's food, water, and energy systems.



At a 2018 workshop, KSS members came together to brainstorm options for supporting practical innovations and redesigned systems capable of sustainably meeting the increasing demand for resources while systematically reducing global risks to security and prosperity. Image from Visuality.

Co-locating Food and Solar Energy Production

A recent study building on JISEA exploratory work in India examined the potential for co-located agricultural and solar photovoltaic (PV) infrastructure to maximize agricultural production and improve renewable energy production while reducing demand for irrigation.

Researchers found the plants in the "agrivoltaic" ecosystem were less vulnerable to drought impacts and achieved greater food production than the control plants. The agrivoltaic model also had cooling and performance-boosting effects on the solar panels. These results represent a "win-win-win situation" to advance at the nexus of food, water, and energy. **LEARN MORE: https://openei.org/wiki/InSPIRE**

CIRCULAR SUPPLY CHAINS

TRANSITIONING TO A CIRCULAR ECONOMY

As innovators and engineers race to respond to the pressing need to transition to a new energy economy, development and deployment of advanced energy technology solutions give rise to new and different challenges. A preeminent challenge emerging as the clean energy revolution gains momentum is really an age-old problem with a new twist: resource constraints.

Demand for materials is increasing, yet we live in a materials-limited world. There are significant materials limitations to renewable energy development and deployment. Sharp increases in demand for the materials needed to manufacture new technologies are driving demand and cost fluctuations.

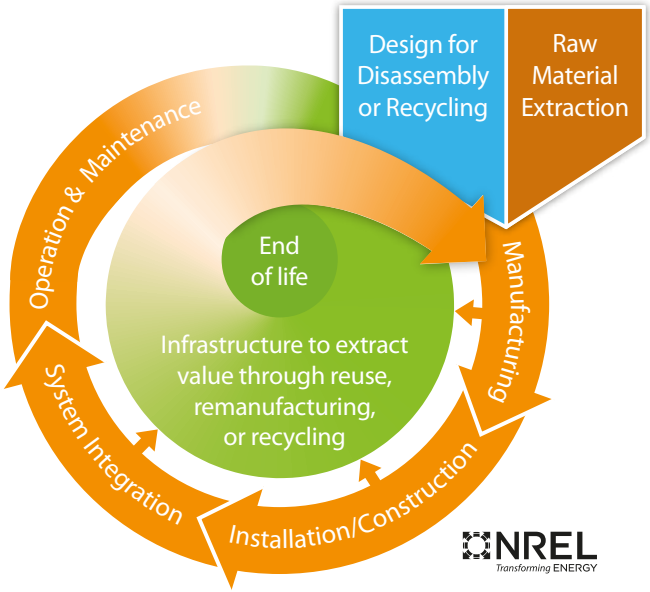
Science must now respond to the need to transition from a linear to a circular economy for energy-relevant and energy-intensive materials, processes, and technologies. Research that establishes the foundational knowledge and technology to sustainably design, reduce, and recycle throughout the supply chain is pivotal to the progress of this transition.

CEMAC Clean Energy Manufacturing Analysis Center

WORKING WITH MANUFACTURERS

Sharp declines in the costs of producing renewable energy have made clean energy an increasingly economical option that creates opportunities for many industries around the world to reduce their operating costs and boost their bottom lines.

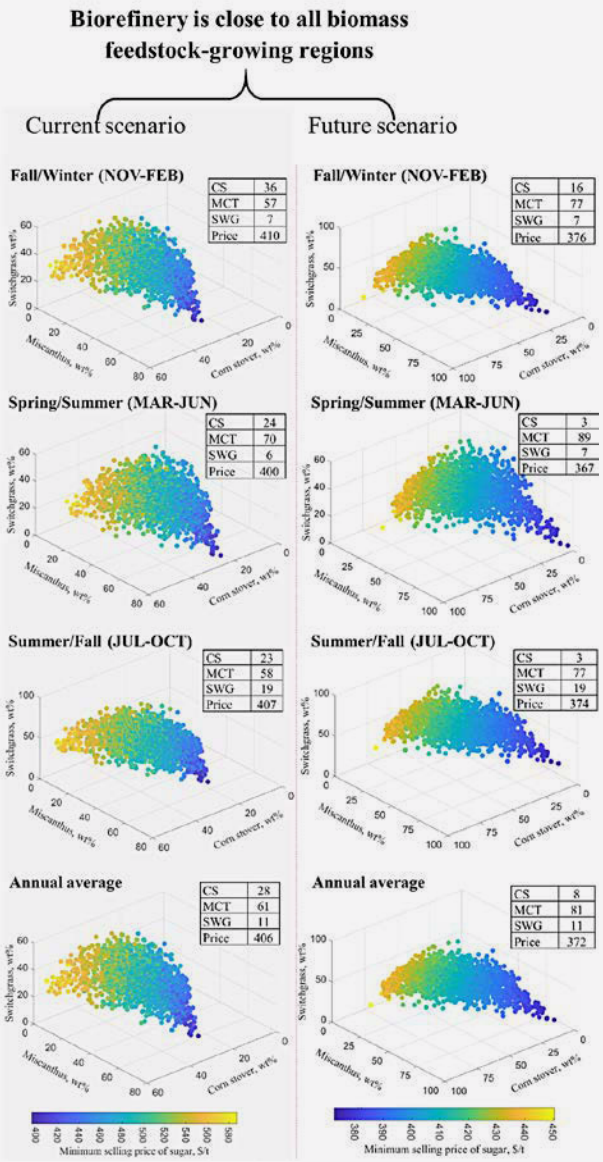
Value Chain for Clean Energy Technologies



Identifying Optimal Approaches To Reduce Biofuel Production Costs

The availability of corn stover feedstock is a major pain point for cellulosic biorefineries in the U.S. Corn Belt. Challenging supply logistics include a short harvesting window, geographically diffuse corn stover fields, long-term storage requirements, high transportation costs, and uncertain or variable feedstock quality.

CEMAC-sponsored techno-economic analysis with researchers at JISEA-partner Colorado State University demonstrated that adopting a year-round feedstock switching strategy or using an optimal mixture of corn stover, miscanthus, and switchgrass can help mitigate these challenges while lowering the cost of sugar production significantly.



Study results showed the optimal mixing ratio of corn stover, miscanthus, and switchgrass can reduce biorefineries' nutrient replacement and feedstock transportation costs and improve the feedstock quality relative to corn stover alone. Graphic from Nawa Raj Baral, Ryan Davis, and Thomas H Bradley.

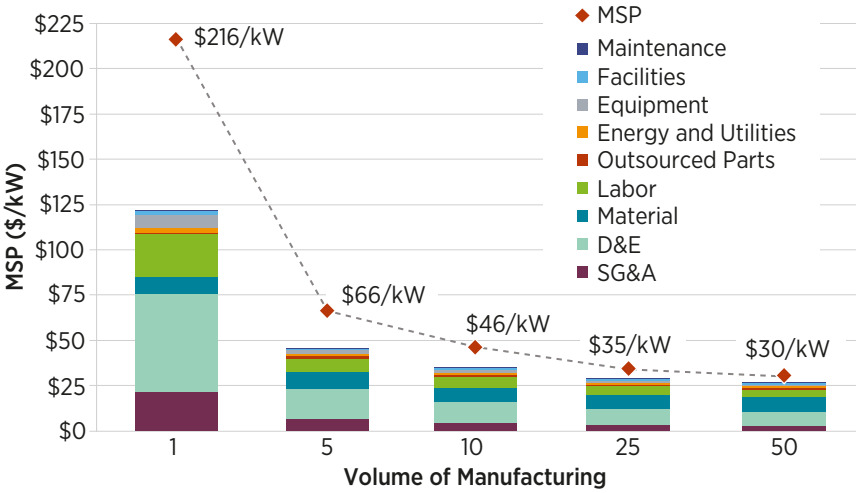
Informing Efforts To Transition To Low Global Warming Refrigerants

The global refrigerants market is large and complex, and it is projected to grow rapidly. A CEMAC assessment of major end-use applications for refrigerants sought to aid efforts to transition toward lower global warming potential refrigerants.

The comprehensive study looked at the three classes of fluorocarbon refrigerants as well as hydrocarbon and other natural refrigerants. It identified foam blowing agents and aerosols as two major refrigerant chemical end uses where hydrocarbons are the dominant refrigerant and projected that the importance of hydrocarbons in these areas is likely to increase as regulations reduce the availability and/or increase the cost of existing fluorocarbons. **LEARN MORE: Supply and Value Chain Analysis of Mixed Biomass Feedstock Supply System for Lignocellulosic Sugar Production (https://onlinelibrary.wiley.com/doi/full/10.1002/bbb.1975)**

Comparing Geothermal Production Costs

CEMAC analysis comparing the manufacturing cost and minimum sustainable price (MSP) of different geothermal turbine designs under various manufacturing volume scenarios found the MSP per kilowatt (kW) for standard-design turbines could be 60%–70% less than that of custom-design turbines at larger manufacturing volumes. **LEARN MORE: Global Value Chain and Manufacturing Analysis on Geothermal Power Plant Turbines (www.nrel.gov/docs/fy19osti/72150.pdf)**



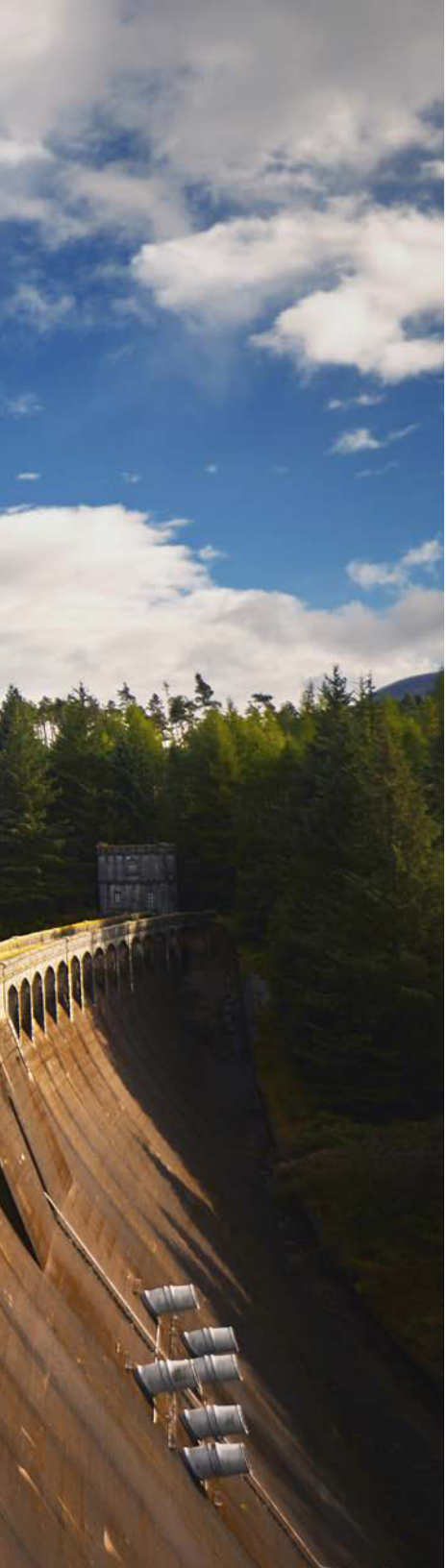
Manufacturing cost drop by cost factor for a standard-design (10 units) 5-MWe ORC turboexpander, up to a volume of 50 units per year.

Identifying Manufacturing Opportunities in the Hydropower Supply Chain

A CEMAC study of manufacturing opportunities in the U.S. hydropower supply chain aimed to inform investment and research strategies, policy, and decisions that could promote economic growth and strengthen U.S. manufacturing capabilities.

Results showed potential for technology advances such as modular turbine designs, standardized units for conduit systems, precast systems, and improved powertrain technologies to help reduce costs, particularly for manufacturing a small number of units. The research also suggested taking advantage of the corrosion resistance, light-weighting, and structural benefits of composites and additive manufacturing could significantly alter hydropower cost structures and installations.

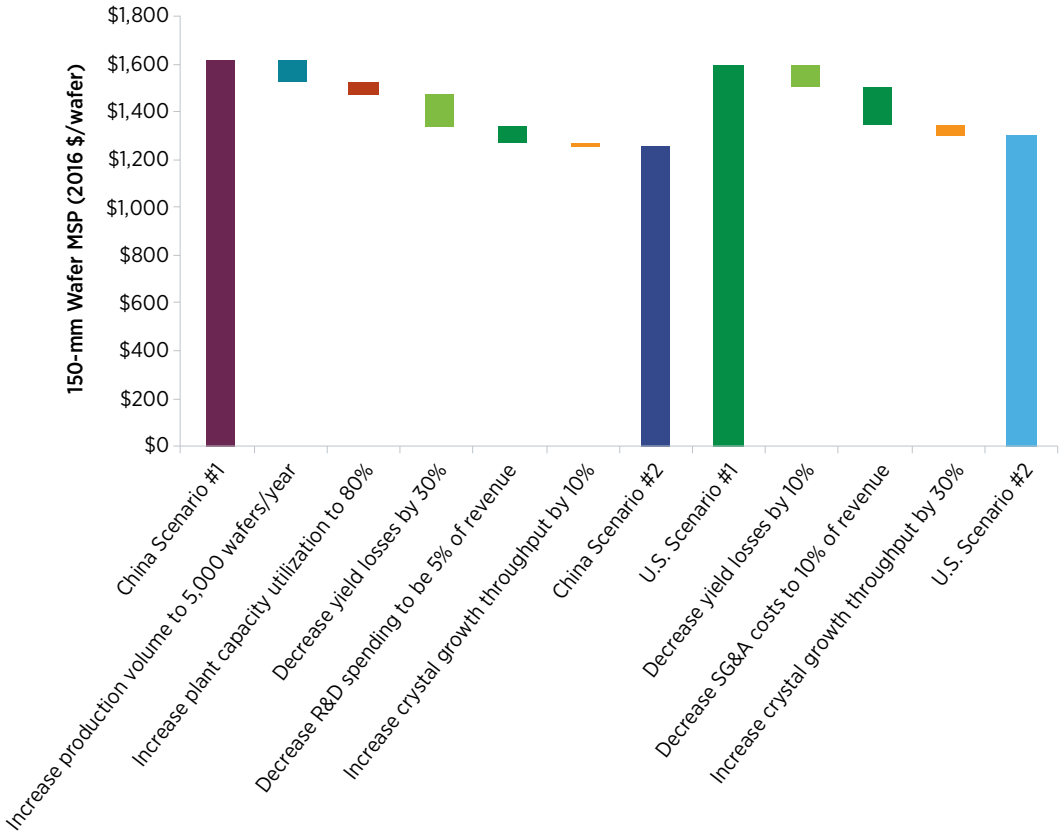
LEARN MORE: Analysis of Supply Chains and Advanced Manufacturing of Small Hydropower Systems (www.nrel.gov/docs/fy19osti/71929.pdf)



Guiding the Path To Reduced Manufacturing Costs of Wide-band Gap Technologies

Wide-band gap (WBG) technologies such as silicon carbide (SiC) are poised to contribute significantly to the global clean energy economy, and the United States is leading on wafer and device manufacturing. CEMAC analysis identified multiple pathways to lower costs across the value chain and bolster economic growth and competitiveness.

Using bottoms-up regional manufacturing cost models in which raw materials costs dominated, CEMAC researchers found that advanced SiC-based power electronics, manufactured in volume, could achieve final product cost parity with those manufactured with conventional silicon (Si).



Potential pathways to reduce SiC wafer costs include technical/engineering advances, policy changes, and changes in business strategy. **LEARN MORE: A Techno-economic Look at SiC WBG from Wafer to Motor Drive, 2018 (https://www.nrel.gov/docs/fy18osti/71240.pdf)**

TEAM

From Left to Right: Jill Engel-Cox, Tsisilile Igogo, Sean Ericson, Liz Weber, Kathleen Watts, Pat Statwick, and Josue Prado

FOUNDING PARTNERS

JISEA is operated by the Alliance for Sustainable Energy, LLC, on behalf of its founding partners.

NREL Transforming ENERGY

COLORADO SCHOOL OF MINES

Colorado State University

MIT Massachusetts Institute of Technology

Stanford University

University of Colorado Boulder

CONTACT US

JISEA partners with numerous research affiliates and sponsors to analyze pathways to a sustainable energy future. To establish a new partnership with JISEA, contact us at **JISEA.Coordinator@nrel.gov** or visit our website: **www.jisea.org.**

JISEA PROGRAM COMMITTEE

JISEA's Program Committee provides guidance on program direction to the executive director and reviews and approves JISEA's research agenda, priorities, and annual research program plan.

Jared Carbone

Associate Professor, Division of Economics and Business, Colorado School of Mines

Kevin Doran

Institute Fellow and Research Professor at the Renewable and Sustainable Energy Institute, University of Colorado Boulder

Robert Leland

Associate Lab Director, Scientific Computing and Energy Analysis, NREL

John Reilly

Co-Director, Joint Program on the Science and Policy of Global Change; Senior Lecturer, Massachusetts Institute of Technology Sloan School of Management

Ron Sega

Vice President and Enterprise Executive for Energy and the Environment, Colorado State University and The Ohio State University

John Weyant

Professor of Management Science and Engineering, Stanford University

JISEA ADVISORY COUNCIL

Joan MacNaughton, Chair, The Climate Group

Bill Ritter, Director, Center for the New Energy Economy, Colorado State University

Deb Frodl, Board Director, Renewable Energy Group, Inc.

CEMAC ADVISORY COMMITTEE

The CEMAC Advisory Committee provides programmatic guidance to the Clean Energy Manufacturing Analysis Center. The CEMAC Advisory Committee is composed of experts from industry, trade associations, academia, and government, as well as CEMAC management.

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Adam O'Malley, Department of Commerce

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Ryan Preclaw, Barclays

Swami Venkataraman, Moody's Investors Service

Charles W. Wessner, Georgetown University

Joan Wills, Cummins Inc.

RESEARCH AFFILIATES

JISEA augments the capabilities of its founding institutions with those of leading analysis centers across the globe.

Rice University's Baker Institute Center for Energy Studies (CES)

BAKERINSTITUTE.ORG/CENTER-FOR-ENERGY-STUDIES

CES provides new insights on the role of economics, policy, and regulation in the performance and evolution of energy markets.

Carnegie Mellon University Department of Engineering and Public Policy

CMU.EDU/EPP

The Department of Engineering and Public Policy, a unique department within the College of Engineering at Carnegie Mellon University, focuses on addressing technology-based policy problems.

Energy Institute at The University of Texas at Austin

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The Energy Institute is dedicated to broadening the educational experience of students by creating a community of scholars around energy issues of importance to Texas, the nation, and the world.

Eskom

ESKOM.CO.ZA

Eskom generates, transmits, and distributes electricity to industrial, mining, commercial, agricultural, and residential customers and redistributors in South Africa and throughout the continent.

Houston Advanced Research Center

HARC.EDU

HARC provides independent analysis on energy, air, and water issues to people seeking scientific answers. HARC focuses on building a sustainable future that helps people thrive and nature flourish.

International Institute for Applied Systems Analysis

IIASA.AC.AT

IIASA conducts policy-oriented research into the most pressing areas of global change—energy and climate change, food and water, poverty, and equity—and their main drivers.

KTH Royal Institute of Technology

KTH.SE/EN

KTH, the largest and oldest technical university in Sweden, offers education and research ranging from natural sciences to engineering, architecture, industrial management, and urban planning.

Masdar Institute of Science and Technology

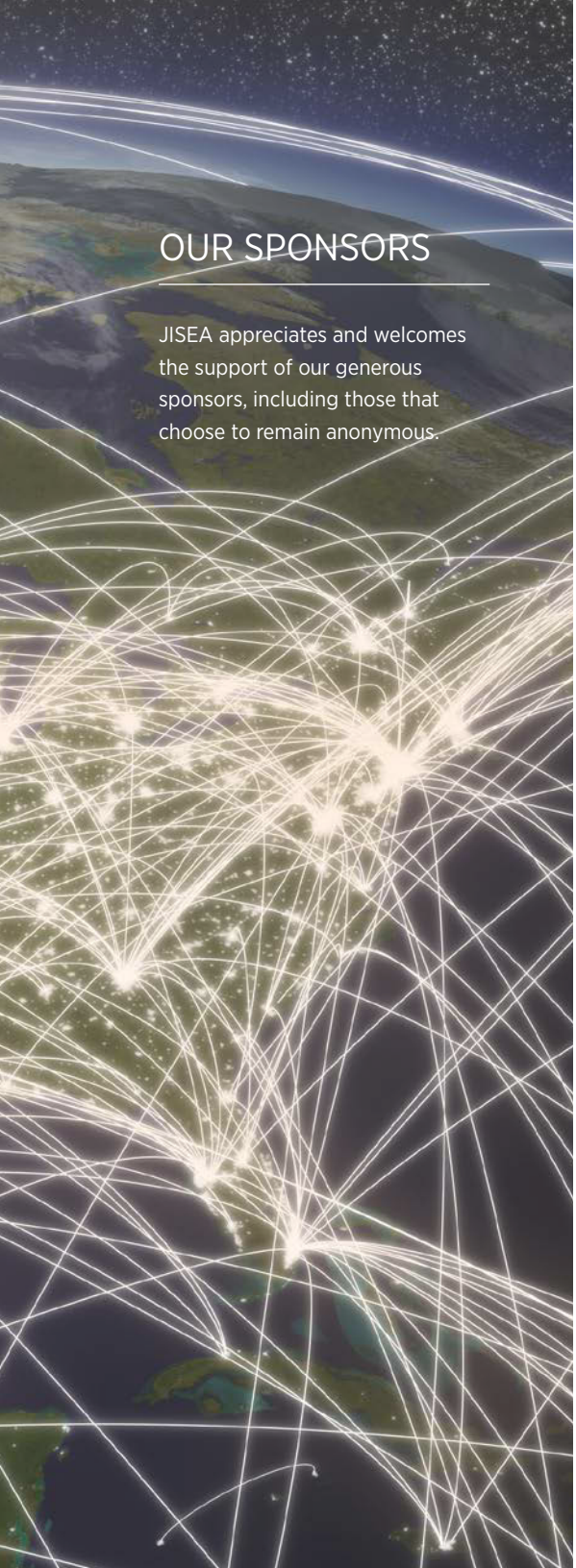
MASDAR.AC.AE

The Masdar Institute is the world's first graduate-level university dedicated to providing real-world solutions to issues of sustainability.

Renewable and Appropriate Energy Laboratory

RAEL.BERKELEY.EDU

Based at the University of California, Berkeley, RAEL focuses on designing, testing, and deploying renewable and appropriate energy systems.



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