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## Informing Electricity Systems of the Future: Key Analysis Needs

*Industry researchers, including the National Renewable Energy Laboratory, are analyzing potential changes to the Electric System of the Future as new technologies begin to disrupt traditional utility business models. This article synthesizes priority challenges identified by utilities and regulators, and identifies key analysis needed to inform decisions on the ESF. NREL's current analyses and remaining gaps are also examined.*

*Karlynn Cory and Alexandra Aznar*

### I. Introduction: Fundamental Changes in U.S. Energy Systems<sup>1</sup>

Elements of the U.S. electric sector are transitioning away from large, conventional, central-station generators to those characterized by increasing amounts of variable renewable energy (VRE) generation, distributed generation (DG), storage, and customer-controlled options such as dynamic pricing and demand response programs. Some existing generation, transmission, and

distribution assets are nearing retirement; their impending exit presents opportunities and challenges for replacement. Investments in new, cleaner generation and advanced transmission and distribution technologies have yielded alternatives that are now economic in select U.S. areas.<sup>2</sup> As technologies improve their cost and operational performance, and as electricity markets evolve, new resources and locations may become economic in the next 15–20 years, offering decision-makers a

variety of new supply- and demand-side options.

New technologies and customer demand for change are outpacing market rules, regulations, policies, and business models. Analysis and optimization of technology and demand changes can help to

achieve priority objectives across U.S. energy systems. For example, analysis is particularly needed to inform states' net energy metering policies and the anticipated impact on rate structures under the EPA's Clean Air Act §111(d) implementation activities,<sup>3</sup> where the agency is

developing carbon pollution standards.

Stakeholders have begun efforts to analyze, better understand, and address potential changes in electricity systems from a variety of perspectives. They are targeting technology changes as well as market rules, regulations, policies,

**Table 1:** Analyses of Electricity Sector Changes from Various Perspectives

Utility Perspective	<ul style="list-style-type: none"> <li>• “The Integrated Grid” by the Electric Power Research Institute (EPRI)<sup>a</sup></li> <li>• “Disruptive Challenges” by the Edison Electric Institute<sup>b</sup></li> <li>• “The Grid Edge: Grid Modernization” by GreenTech Media<sup>c</sup></li> <li>• “Distributed Energy Resources and the ‘Utility Death Spiral’” by the electric utility NRG Energy<sup>d</sup></li> </ul>
Regulator Perspective	<ul style="list-style-type: none"> <li>• “[The] Future of Hawaii’s Electric Utilities” by the Hawaiian Public Utility Commission<sup>e</sup></li> <li>• “Practicing Risk Aware Electricity Regulation” by CERES<sup>f</sup></li> </ul>
Financier Perspective	<ul style="list-style-type: none"> <li>• “Fight, Flight, or Adapt: How are US Utilities Coping with Distributed PV?” by Bloomberg New Energy Finance<sup>g</sup></li> <li>• “Rating Criteria for Solar Power Projects” by Fitch Ratings<sup>h</sup></li> </ul>
International Perspective	<ul style="list-style-type: none"> <li>• “Future Grid Forum: change and choice for Australia’s electricity system”<sup>i</sup></li> </ul>
Industry Analyst Perspective	<ul style="list-style-type: none"> <li>• “New Utility Business Models. . .for the Modern Era” by Ron Lehr<sup>j</sup></li> <li>• “Solar Valuation and the Modern Utility’s Expansion into Distributed Generation” by researchers at University of Texas-Austin<sup>k</sup></li> <li>• “New Business Models for the Distribution Edge” by Rocky Mountain Institute<sup>l</sup></li> <li>• “Smart Power” by Peter Fox Penner<sup>m</sup></li> </ul>

<sup>a</sup> The Integrated Grid: Realizing the Full Value of Central and Distributed Energy Resources, 2014, February. Electric Power Research Institute. <http://www.epri.com/Our-Work/Pages/Integrated-Grid.aspx>.

<sup>b</sup> Kind, P., 2013, January. Disruptive Challenges: Financial Implications and Strategic Responses to a Changing Retail Electric Business. Edison Electric Institute. <http://www.eei.org/ourissues/finance/documents/disruptivechallenges.pdf>.

<sup>c</sup> The Grid Edge: Grid Modernization in the Age of Distributed Generation. GreenTech Media. <https://www.greentechmedia.com/gridedge> (accessed 30.07.14)

<sup>d</sup> Corneli, S., 2014, March. Distributed Energy Resources and the “Utility Death Spiral”, what it is, why it is happening, what to do (and not do) about it. NRG Energy. [http://www.jisea.org/pdfs/2014\\_annual\\_meeting\\_corneli.pdf](http://www.jisea.org/pdfs/2014_annual_meeting_corneli.pdf).

<sup>e</sup> Exhibit A: Commission’s Inclination on the Future of Hawaii’s Electric Utilities, Aligning the Utility Business Model with Customer Interests and Public Policy Goals, 2014, April. Hawaii Public Utility Commission. <http://puc.hawaii.gov/wp-content/uploads/2014/04/Commissions-Inclinations.pdf>.

<sup>f</sup> Binz, R. (Public Policy Consulting), Sedano, R. (Regulatory Assistance Project/RAP), Furey, D. (RAP), Mullen, D. (RAP), 2012, April. Practicing Risk-Aware Electricity Regulation: What Every State Regulator Needs to Know: How State Regulatory Policies Can Recognize and Address the Risk in Electric Utility Resource Selection. CERES. <http://www.rbinz.com/Binz%20Sedano%20Ceres%20Risk%20Aware%20Regulation.pdf>.

<sup>g</sup> Fight, flight, or adapt: How are US utilities coping with distributed PV? 2014, May. Bloomberg New Energy Finance. U.S. – Solar – Research Note. Available with subscription.

<sup>h</sup> Rating Criteria for Solar Power Projects, Utility-Scale Photovoltaic and Concentrating Solar Power, 2011, February. Fitch Ratings. <http://www.businesswire.com/news/home/20120223006221/en/Fitch-Updates-Rating-Criteria-Solar-Power-Projects>.

<sup>i</sup> Future Grid Forum: change and choice for Australia’s electricity system, updated 2013, December. Australia’s Commonwealth Scientific and Industrial Research Organisation. <http://www.csiro.au/Organisation-Structure/Flagships/Energy-Flagship/Future-Grid-Forum-brochure#>.

<sup>j</sup> Lehr, R., 2013. New utility business models: utility and regulatory models for the modern era. *Electr. J.* (October), <http://www.sciencedirect.com/science/article/pii/S1040619013002091>.

<sup>k</sup> Blackburn, G. (University of Texas-Austin/UT Austin), Magee, C. (UT-Austin), Rai, V. (UT-Austin), 2014. Solar valuation and the modern utility’s expansion into distributed generation. *Electr. J.* (January–February). <http://www.sciencedirect.com/science/article/pii/S1040619013002868>.

<sup>l</sup> Lacy, V., Newcomb, J., Hansen, L., 2013. New Business Models for the Distribution Edge (eLab New Business Models Report). Rocky Mountain Institute. [http://www.rmi.org/Knowledge-Center/Library/2013-06\\_eLabNewBusinessModels](http://www.rmi.org/Knowledge-Center/Library/2013-06_eLabNewBusinessModels).

<sup>m</sup> Fox-Penner, P., 2010. Smart Power: Climate Change, the Smart Grid, and the Future of Electric Utilities. Island Press.

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