Smart Grid & the Renewable Energy Transition: Evolution or Revolution?

Innovative interdisciplinary research on energy system change

Integrating social & technical change

Electricity Use in Rural and Islanded Communities
A Workshop Supporting the Quadrennial Energy Review
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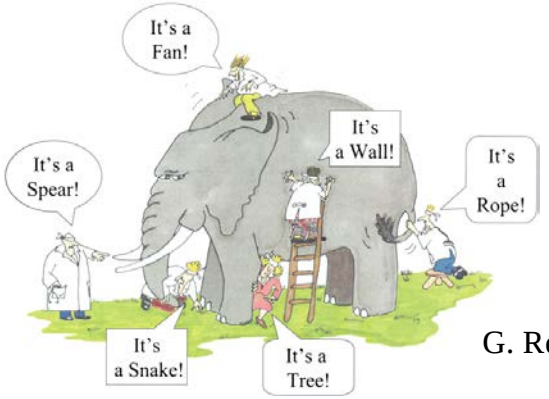
Jennie C. Stephens, Ph.D.
Associate Professor
Blittersdorf Professor of Sustainability Science & Policy
Rubenstein School of Environment & Natural Resources
College of Engineering & Mathematical Sciences

The University of Vermont
The Energy-Climate Transitions Research Group

Smart Grid (R)Evolution: Electric Power Struggles

Social Science Research on Diverse Perspectives on Smart Grid



G. Renee Guzlas, artist

Different perspectives on social vs. technical change

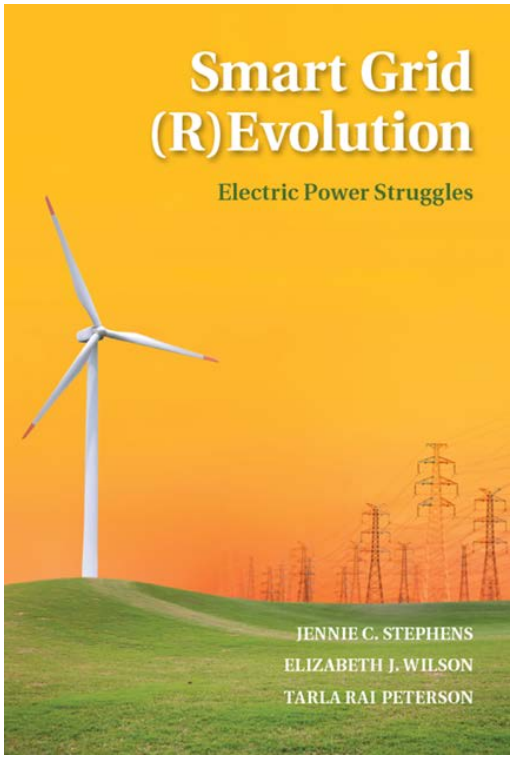
- Changes in consumption include social & cultural change – more research needed in this area

Tension between centralization vs. decentralization

- Scale versus modularity, flexibility, and adaptation
- More distributed/local generation raises awareness and can help with demand-side changes

Opportunities for broader civic engagement in energy system change

- Broaden energy education beyond engineering
- More social science research on energy



Cambridge University Press
February 2015

Macro-Scale: In the Midst of a Renewable Energy transition

Includes major demand-side changes, changes in consumption

Transitions are necessarily disruptive, non-linear

Unrealistic to expect a smooth transition

Fossil based energy systems

Renewable based energy systems

Much more than a technical substitution

A shift from fierce competition for a scarce resource (Fossil fuels) to a system based on abundant, plentiful, perpetual energy

Tend to focus on supply but changes in energy demand/consumption also required

Cultural and institutional changes

Different Policy Framings of Energy Transition

National Level

GHG reduction targets for Deep Decarbonization

- Obama's GHG reduction targets - 17% (below 2005) reduction by 2020, 26-28% by 2025
- Path toward deep decarbonization - 80% reduction by 2050

State Level

Hawaii 100% RPS by 2045

Vermont 90% Renewables by 2050

- Renewable Energy Transition

International Competition

Germany's Energiewende: National-level commitment to the renewable energy transition, 60% renewables by 2050

Reminder: Prices for renewables determined by international landscape

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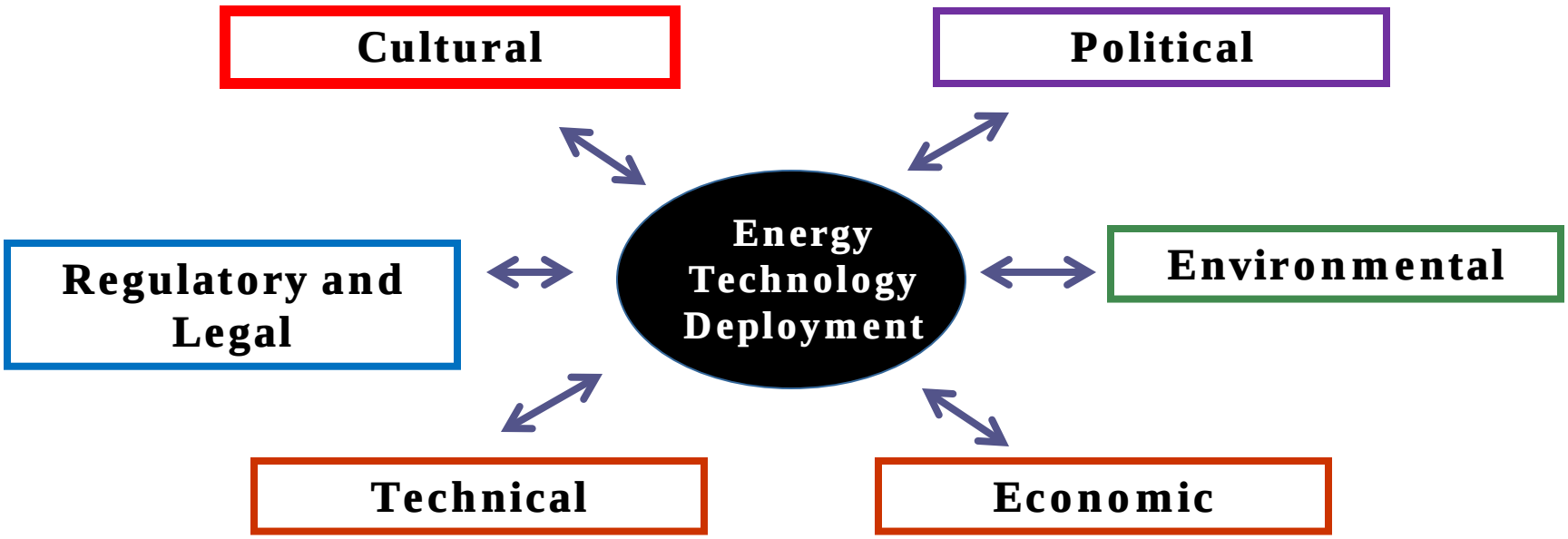
SPEED (Socio-Political Evaluation of Energy Deployment)

A framework to assess factors influencing energy system change

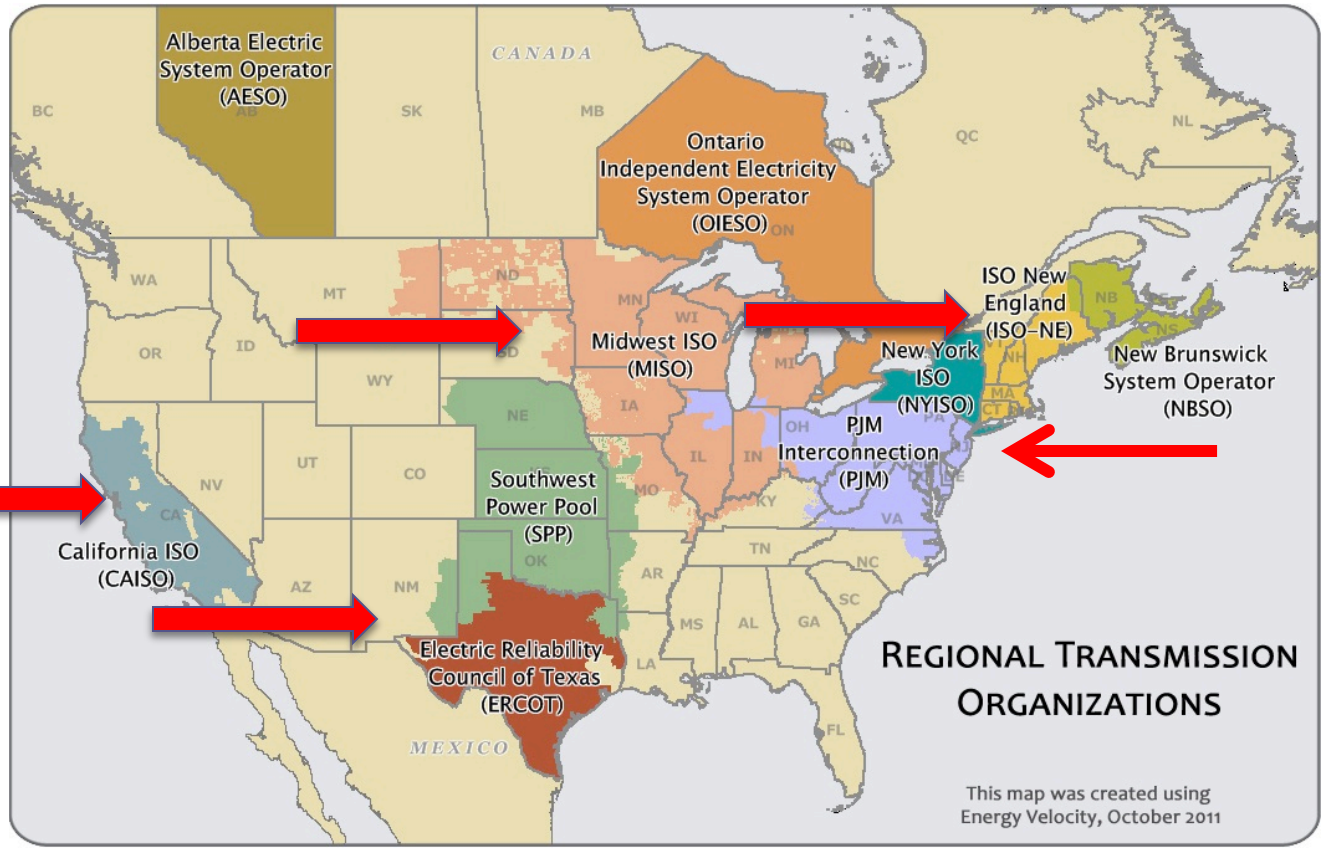


Stephens, JC, EJ Wilson, TR Peterson. 2008. "Socio-Political Evaluation of Energy Deployment (SPEED): An Integrated Research Framework Analyzing Energy Technology Deployment" ***Technological Forecasting and Social Change.*** 75: 1224–1246

Stephens, JC, EJ Wilson, TR Peterson, 2014 Smart Grid: Promoting System Innovation in Complex Multi-jurisdictional Socio-Political Contexts, ***UCLA Law Review***, Volume 61, Issue 6, July 2014

Applying the SPEED Framework for Smart Grid

Regional Heterogeneity in US Electricity System



Source: FERC, 2012

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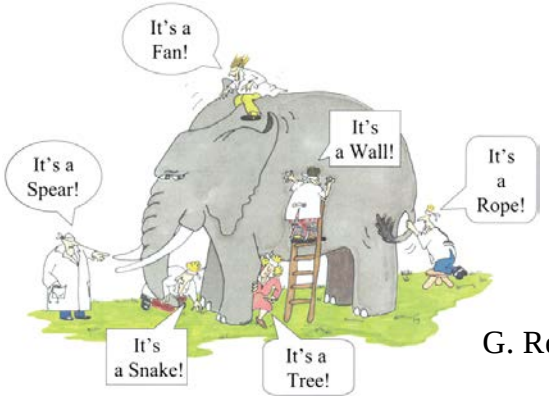

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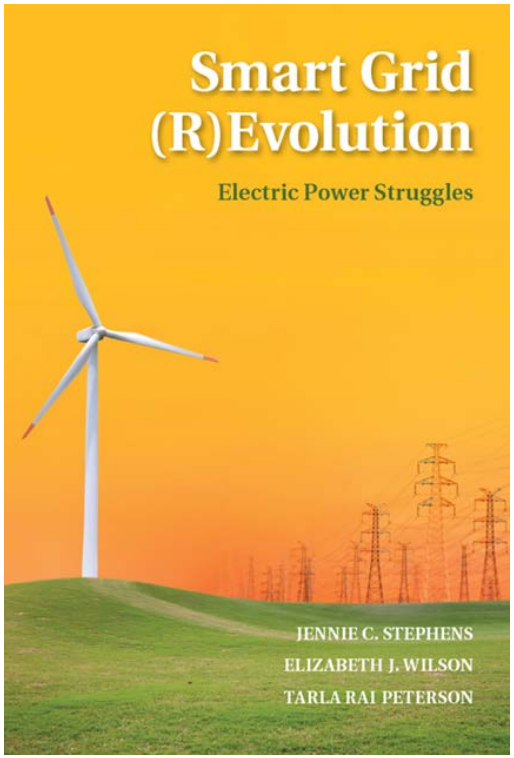

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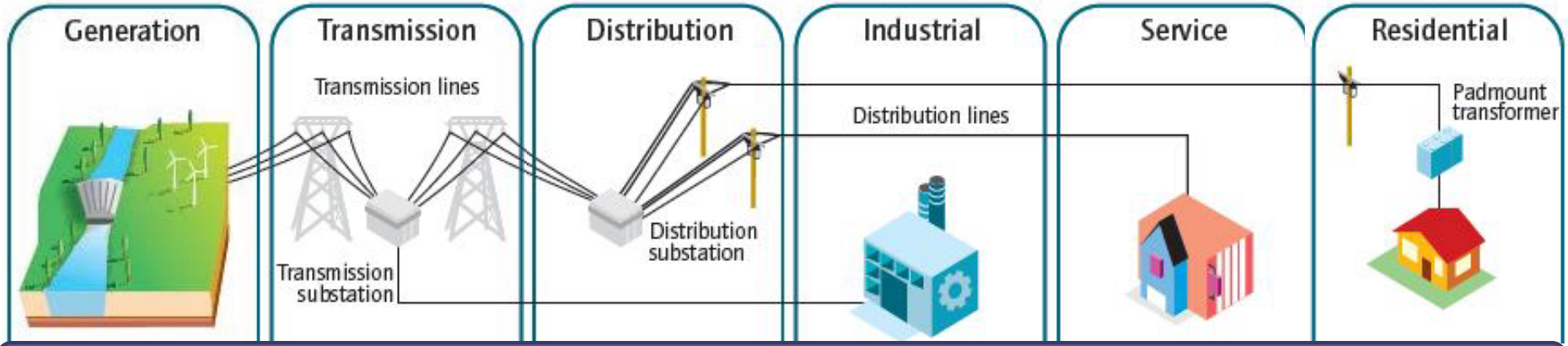
Technological components of “Smart Grid” electricity system change



Information and Communications Technology Integration

Renewable Energy and Distributed Generation Integration

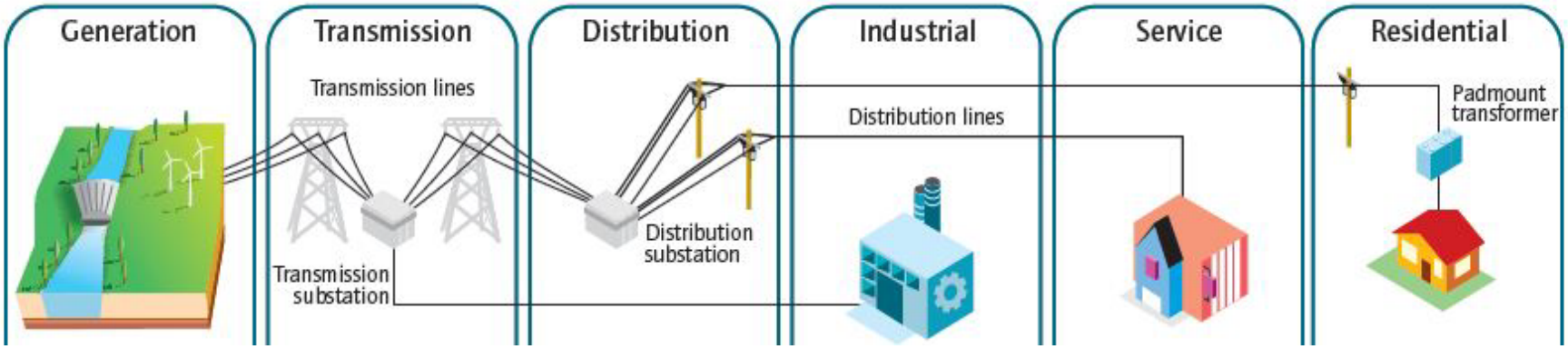
Demand Response, Price Controls

Advanced metering infrastructure

Consumer Interface tools, load appliances

Key Actors in Smart Grid Development

Electric System



Stakeholders

RTO/ISO

Generation Utilities Distribution Utilities

State- PUC, Energy Office (Policies &Planning), Environmental

Industrial, Commercial & Residential Consumers

Mixed Methods Research

Media Analysis

Focus Groups

Policy and Document Analysis

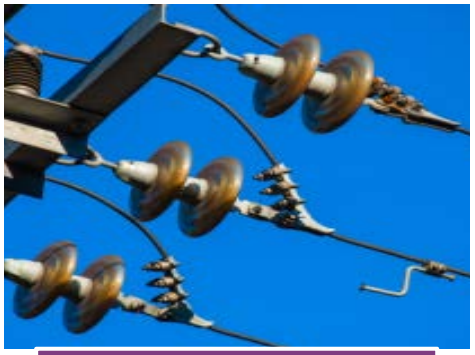
Extensive set of focus groups (39)

Table - Focus Groups Conducted in Seven States

Stakeholder and State	RTO	Regulatory	IOU	Co-op/Muni	Tech/Acad.	Environ-mental	Consumer
MA	Holyoke	Boston	Worcester	Shrewsbury	Worcester	Boston	Boston
VT	Holyoke, MA	Montpelier	Rutland	Johnson	Burlington	Montpelier	Montpelier
NY	New York	White Plains	Liverpool	Uniondale	Albany	New York	New York
MN	St. Paul	St. Paul	Minneapolis	Maple Grove	Minneapolis	Minneapolis	St. Paul
IL	St. Paul, MN	Springfield	Oakbrook Terrace	Champaign	Urbana	Chicago	Chicago
TX	Taylor	Austin	Austin	College Station	College Station	Austin	Austin
CA	Folsom	San Francisco	San Francisco	Sacramento	Sacramento	San Francisco	San Francisco

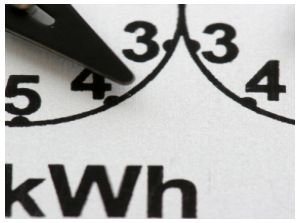
Blue = focus groups conducted after Superstorm Sandy. Light green = focus groups conducted before Sandy.

Adjusting to New Societal Expectations for Electricity Systems

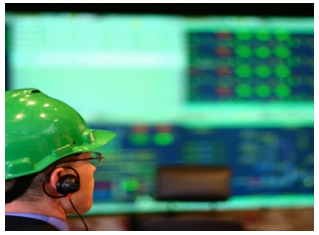


Reliability

Affordability



Efficiency



Resilience

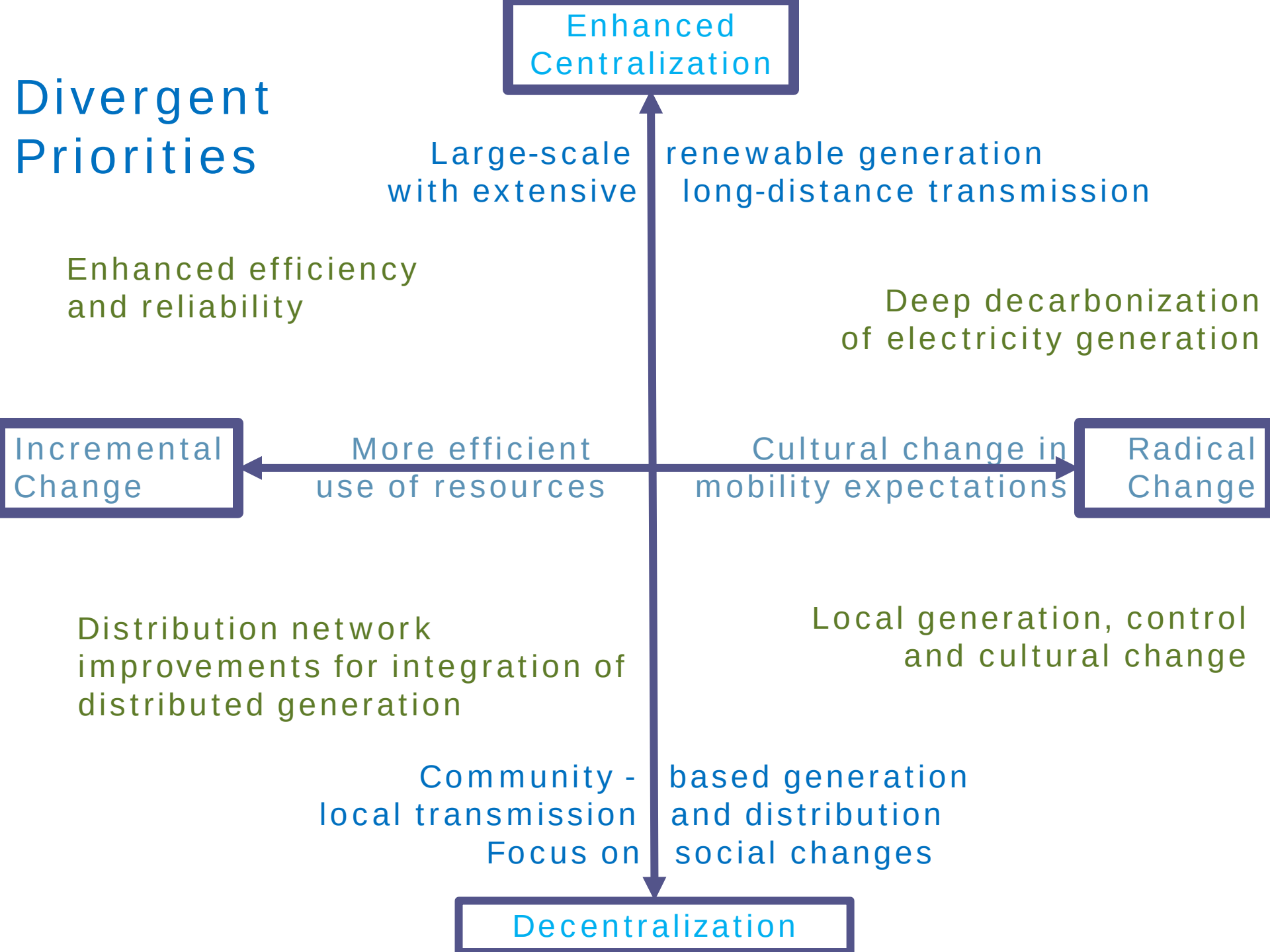
Security

Sustainability

Complex Tensions Emerge

Diversity of Smart Grid priorities/perspectives

Key Actors	Priorities & Perspectives
Consumers	Reliability, low-rates, reduced environmental impact – but sense of limited influence
Government (National, Regional, State, Local)	Jurisdictionally complex regulation
Private Sector	Accountable to shareholders
Electric Utilities	Maintaining reliable service, responding to consumers and regulators
Technology companies	Innovative & entrepreneurial
Environmental advocates	Low carbon shift & renewable energy, local land use
Energy system researchers	Technologically optimistic – tend to assume minimal social change


Divergent Priorities
Enhanced Centralization
Large-scale renewable generation with extensive long-distance transmission
Enhanced efficiency and reliability
Deep decarbonization of electricity generation
Incremental Change
More efficient use of resources
Cultural change in mobility expectations
Radical Change
Distribution network improvements for integration of distributed generation
Local generation, control and cultural change
Community - based generation local transmission and distribution Focus on social changes
Decentralization

Centralization versus decentralization

- For rural and islanded communities, distributed electricity particularly powerful
- Rural and islanded communities have lower energy affordability – Distributed renewables have large potential for economic independence, resilience, self-sustaining.
- Critical role of different types of electric utilities
  - Rural Electric Cooperatives
  - Municipal Utilities

Broader Societal Value of Decentralization of Energy

- With distributed renewable generation, opportunities for individuals, households and communities to be more engaged in energy

- Centralized power – not just the grid - but also control, management, profits, and influence is concentrated – more decentralized systems spreads the wealth and provides local control

- Energy Democracy – growing social movement for local, community control of energy enabled by renewable energy
  - Potential to redistribute profits going to large energy companies
  - Address inequality and low and moderate-income households
  - Create jobs and engagement

Photo Source: Georgia Mountain Wind

Electricity Consumption Data

- Smart grid enables collections of lots of customer energy usage data, CEUD
  - Consumption data challenges
- Data from rural and smaller-scale utilities often not integrated into analysis
  - Average not necessarily representative of rural
- Data surprisingly difficult for governments, energy efficiency service providers, and researchers to obtain and evaluate
  - Creates impediment to necessary developments in energy management

Policy Recommendations

- Adjust Assumptions in Models & Projections
- Govern Energy Consumption Data
- Invest in more social science research on deployment to advance energy system change
- Broaden energy education & engagement

Change Occurring Fast: Need to Adjust Assumptions

Embrace/Accept the Disruptive Transition that is Occurring

- Adjust assumptions to more dynamic landscape

Current electricity system models for planning and operations need to adjust assumptions

- Integrate renewables with its variable resources
- More flexible assumptions related to demand

Energy projections have underestimated renewables penetration in past 5 years

- Projections missing key trends - Results in missed opportunities

Policies to Govern Energy Consumption Data
(Klass and Wilson, 2016)

- Need to invest in analysis & application of energy consumption data
  - Data centralization – an Energy Data Center
  - Data standardization – The Green Button Program
  - Data aggregation
  - Data Security & Access
    - Privacy important for residential (only 38%) but not as much for commercial and industrial customers

Policy to Expand Energy Research, Teaching, & Learning

National Council for Science and the Environment
Improving the scientific basis for environmental decisionmaking

Need for universities to develop energy curriculum, majors, etc

Potential to recruit a more diverse set of students studying energy women & underrepresented minorities

Opportunities for university extension to expand into energy

Expand energy education in K-12, valuable context for STEM education

Expanding Energy Research, Teaching, & Learning

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Viewpoint

Getting the engineering right is not always enough: Researching the human dimensions of the new energy technologies

Thomas Webler *, Seth P. Tuler

Social and Environmental Research Institute, Suite 404, 278 Main Street, Greenfield, Massachusetts 01301, USA

Webler, T. and S. P. Tuler (2010). Energy Policy **38**: 2690-2691.

Sovacool, B. K. (2014). "Energy studies need social science." Nature **511**: 529-530

- Under-evaluation of social dimensions
- Under-representation of women and minorities
- Minimal integration of engineering and social science
- Minimal collaborative efforts

If DoE not going to support social science research, other sources of support needed

Societal Value of Broadening Energy Engagement & Education

- Renewable-based systems potential for cultural change in consumption expectations

- Beyond price signals, social, institutional & cultural change

Greenamerica.com

- **Example:** Value of broader engagement: greater diversity in the energy workforce

Diversity in the Energy Workforce

Gender imbalance in the energy sector widely apparent but limited characterization

Information gap – in data-driven society we know what is measured more likely to be addressed

Need to compile data, highlight information gap, and explore potential benefits of promoting gender diversity in energy

Research demonstrates that diversity strengthens organizations, communities, & sectors and encourages innovation (Page 2008)

EXAMPLE: Lack of Gender Diversity Hinders Innovation

The New York Times

Science

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Chilly at Work? Office Formula Was Devised for Men

Molly Mahannah wears a sweatshirt and blanket at work in Omaha, wrapping herself up "like a burrito."
CHRIS MACHIAN FOR THE NEW YORK TIMES

By PAM BELLUCK
AUGUST 3, 2015

1163

Summers are hot in Omaha, where heat indexes can top 100 degrees. But Molly Mahannah is prepared.

NYT August 3, 2015

Concluding Thoughts

Landscape rapidly changing – need to alter the rules or the game doesn't make sense

Conventional rules, assumptions and disciplinary analysis may need to be adjusted

If broaden engagement and social science in energy, will more effectively integrate needs of rural and islanded communities

Photo courtesy of Didac Ferrar

Thank you!

Publications available upon request
Email: **jennie.stephens@uvm.edy**
Website: blog.uvm.edu/jstephe1

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