POLICY PATHWAYS FOR MICROGRIDS – Progress Cases from Multiple Jurisdictions

A collaborative effort between
National Regulatory Research Institute
and
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Preliminaries…

- The authors appreciate the following sources for research support and assistance in preparing this presentation, including:
  - the Microgrid Institute
  - George Washington University Law School
  - Advanced Energy Economy
  - S&C Electric Company
  - North Carolina State University Clean Energy Technology Center
  - Energy Storage Association
- Ideas expressed are those of the presenters, and do not necessarily reflect those of the NRRI Board of Directors or other NRRI personnel.

Today's topics: Microgrid Policy Pathways

- Where is progress being made?
  - What are the policy keys to unlocking that progress?
- Are there viable roles for existing regulated monopoly utility companies in microgrid development and operations?
  - If yes, what are those roles and how might they be adequately regulated?
- How do emerging off-grid and dual-use (meaning either on- or off-grid) technologies apply in different contexts?
  - What regulatory approaches apply to them?

State microgrid policies are changing: Several states are starting to move the needle

- Laws favoring microgrids have passed:
  - March 2018 Colorado law affirms customers have the right to install, interconnect, and use energy storage systems, and directs PUC rulemaking
  - May 2018 Puerto Rico rules recognize three microgrid types (personal, cooperative, and third-party) and set a basic framework for their regulation
  - July 2018 law directs Hawaii PUC to establish microgrid tariffs
  - September 2018 law directs California PSC to facilitate commercializing microgrids for distribution customers by December 2020
- Many more microgrid laws are proposed but not passed, including in Massachusetts (S1825), Michigan (HB 5862 & 5865), New Jersey (A3931 & S1611), New York (A06134, A10233, & A8212), and Pennsylvania (HB1412)
- Several states are enabling public purpose microgrids: Connecticut, Massachusetts, New Jersey, New York

- Several states already require utilities to analyze *non-wire alternatives* (Connecticut, Maine, Rhode Island) and many others are exploring it (California, Colorado, Hawaii, Michigan, Missouri, Nevada, New Hampshire, New York, North Carolina, Texas)
- Several states – 14 and growing – are supporting utility proposals for microgrid pilots, including Arizona, California, Colorado, Illinois, Indiana, North Carolina, and Utah
- No U.S. utility is preventing microgrid installations – with help from DOE – at U.S. Department of Defense, facilities

Major source: North Carolina Clean Energy Technology Center, *The 50 States of Grid Modernization, 2017 & 2018.*

Microgrids are progressing on six major fronts

- Department of defense bases
- "Public purpose" microgrids
- Utility pilot or experimental microgrids
- Microgrids as "anchors" for non-wire alternatives
- Private microgrids – for campuses, for communities, or for single customers behind-the-meter
- Remote microgrids (often called "mini-grids")

Preliminary use-cases

- Enhanced service quality for single loads, circuits, meters, buildings (premises, facilities), customers
- Critical needs facilities – public purpose microgrids and portable power for emergency services
- Single- or multi-owner contiguous facilities or campuses (usually, but not exclusively, behind the meter)
- Feeder segment or substation balancing areas – non-wire alternatives and/or special districts
- Sub-service-territory balancing areas, with clustered and nested microgrids, maximizing reliability and resilience

Preliminary regulatory issues & concerns

- What kinds of microgrid services might trigger a provider's need for a special license or registration, or for regulation as a public utility?
- Do microgrids need to obtain franchises for certain facilities, or can they obtain permission (and under what terms and conditions) to utilize existing infrastructure?
- How do interconnection standards, rules and procedures, address advanced inverter functions (IEEE 1547-2018), microgrid communications (IEEE 2030 family of standards), and intentional islanding? Are there appropriate variations for different system types and sizes, and for export versus non-export systems?
- What rates, tariffs, and terms and conditions apply for customers taking partial requirements service, for wholesale and retail purchasing of non-utility generation, and for sales for resale?
- What utility microgrid costs are allowed and how are they recovered?
- What are the rules for opt-in or opt-out participation in community microgrids?

Critical issues in regulatory parameters

- Utility role(s)… Owner? Operator? Orchestra conductor?
  Active or passive participant? – What if any investments belong in rates?
- Number of utility customers served, a single customer or more than one? What state laws/rules trigger regulatory treatment as a public utility,
  and is there a work-around for microgrids of any kind?
- Geographic proximity? – All one piece of property? Contiguous properties (contiguous physically or electrically)?
- What are the franchise rights and utility regulations for serving electricity, steam, hot water, thermal energy, etc.?
- Rate designs for self-service (DG) and partial requirements customers?
- Interconnection rules and procedures – a right to intentional islanding?
- Light-handed regulation? Will at least some microgrids be treated like EV charging stations, ancillary to the provision of electricity?

Preliminary regulatory issues/concerns

Customer / Type	Interconnection	Regulatory implications	Provider roles
Off-grid equipment	N/A	• Product selection, quality assurance/quality control • Rate design • Reasonable return on investment	• Financing • Billing • QA/QC
Single customer, no grid export	Minimal concern	• Rate design • Retail partial requirements service	• Who can serve behind the meter?
Single customer, grid export	Meets IEEE 1547 & 2030 standards	• Wholesale and retail compensation for exports and for ancillary services • Retail NEM or successor tariffs	• Aggregating for wholesale market
Multi-customer, no grid export	PCC meets IEEE 1547 & 2030 standards	• Participants opt-in or –out • Franchises & rights-of-way – private wires & pipes • Sales for resale	
Multi-customer, grid export	PCC meets IEEE 1547 & 2030 standards		• IRP & DSP • DSO

Preliminary case study types

- Princeton University – utility control and operating with the utility as partner.
- – utility owner/operator with ratebase cost recovery
- – utility owner/operator with fee-for-service cost recovery
- – third-party owner/operator for single customer or campus
- Connecticut and New York – third-party owners & operators for public purpose microgrids
- Marcus-Garvey project (New York) – for low-income participation and benefits
- Clean Coalition projects in San Francisco, Long-Island, etc. – non-wire alternatives projects
- – stand-alone / off-grid equipment, e.g. "fuel rod" or portable solar power supplies… solar lanterns, solar home systems.
- – remote mini-grids, e.g. African countries, Argentina, etc.
- – remote separate grids, e.g. service in Alaska
- – customer-driven project for reliability/ resilience, e.g. Hawaii's Parker Ranch

POLICY PATHWAYS FOR MICROGRIDS

SUPPLEMENTAL SLIDES

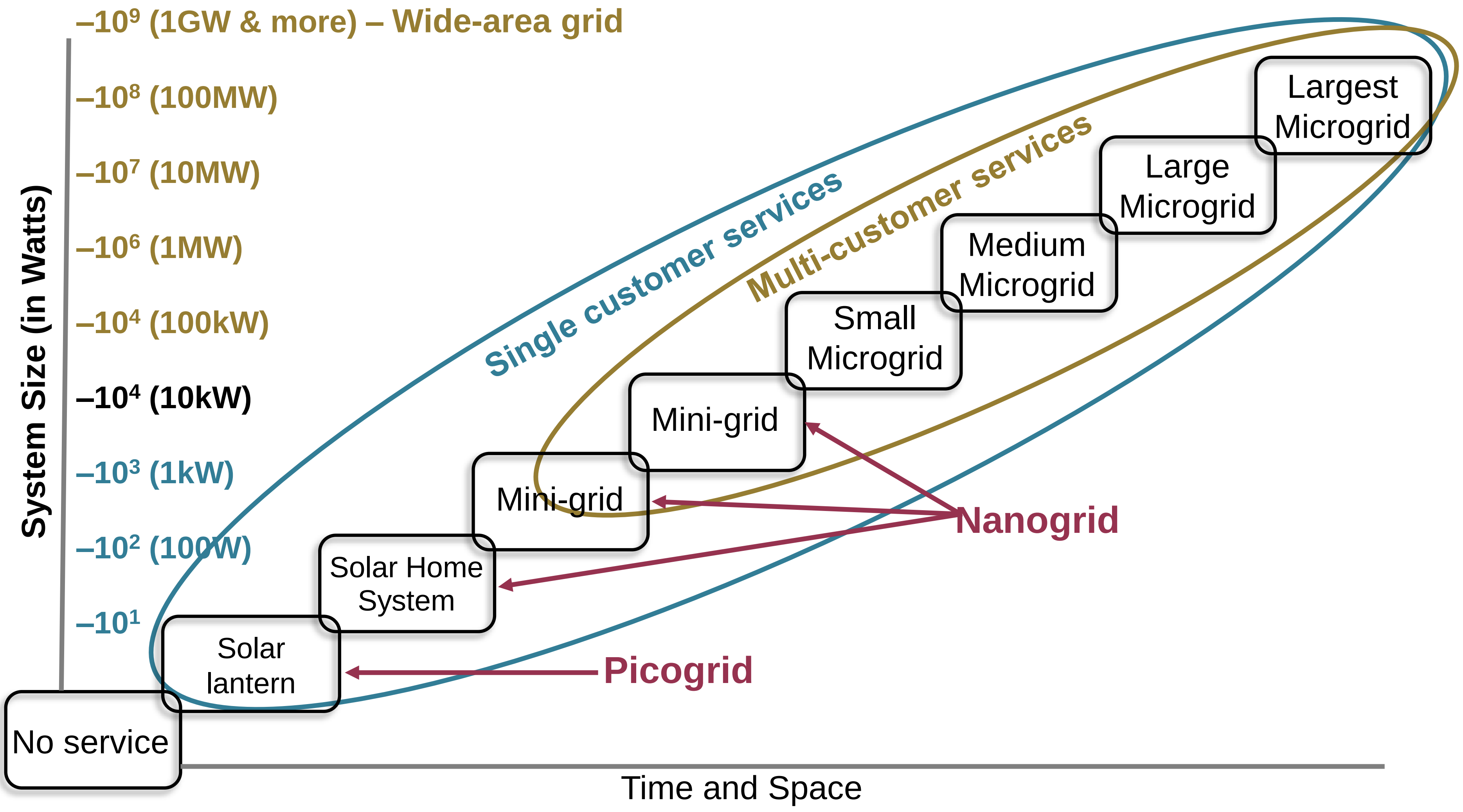
Definitions… inconsistency prevails

- **Microgrid –** US DOE definition: A group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island mode.
- **Mini-grid –** A remote microgrid of any size, not interconnected with a wide-area grid
- **Nano-grid –** A small microgrid or mini-grid, on the order of 100 Watts to 10kW
- **Pico-grid –** A miniature electrical system, serving only a few loads, on the order of 1 to 10 Watts
- **Wide-area grid** (a.k.a. macrogrid, megagrid, mains grid, or just *the* grid) **–** A state, country, or regional electric grid, owned and operated by one or more regulated utility companies
- **The lack of standardization in definitions implicates a bigger problem:**
  - **Policy uncertainty means each microgrid is handcrafted, suppressing the market.**
  - **Can we foster more standardization of design? Better scale management? Will that lead to lower costs?**
  - **Does the status quo foster more complexity, and for what value? Does this restrict access to capital?**
  - **Who pays?**

Heading up or down the "energy ladder"…

Possible steps to a more energized future

- *"Single customers" range from users of stand-alone solar appliances, all the way to the biggest campuses and military bases*
- *Utility laws and regulations are implicated, for both single, "partial requirements customers," and for service to more than one customer*



The same ‘energy ladder’ steps, with or without a pre-existing grid

- Individual loads served by stand-alone (off-grid) or dual-use (on- or off-grid) equipment, for high reliability and portability
- Remote facilities – long-distance wires and small loads
- Mini-grids with redundant supplies and back-up service, for critical power, power quality, and resiliency needs
- Public-purpose microgrids for emergency response functions and services
- Campus-wide microgrids (notably in “MUSH” markets, tech-centers, and new multi-use developments) for high reliability and resilience

Note: “MUSH” is short for municipals, universities, schools, and hospitals.

The changing U.S. utility landscape

- Aging, brittle infrastructures for both energy & water, prone to breakdown necessitating expensive repairs, and with enormous replacement costs
- More large expenditures needed for grid-modernization
- Growing threats for physical and cyber security, with associated added costs
- More and bigger climate- and weather-related natural disasters, resulting in long-term outages and billion-dollar damages
- Growing recognition of the critical importance of the food/energy/water nexus
- Environmental pressures, both pushes from regulators and pulls from customers
- Flat or declining utility sales & revenues
- Proliferating, cost-effective utility and customer DER options that can produce and deliver multiple benefits
- Changing consumer needs and choices for clean energy, power quality and reliability, and resiliency

What's new and different for customers?

- Major world-wide efforts to bring basic energy services to everyone – "Sustainable Energy for All" – #SE4All (See more on slide 22.)
- Changing consumer choices and customer needs for 21st Century power sources, with high power quality, reliability, & resilience, security, with more consumers evolving into prosumers
- Increasing numbers of wide-spread, long-lasting weather-related outages
- Increasing electrification; electricity uses for mission-critical applications
- A granular view of reliability and resilience, all the way to individual facilities, circuits, and even devices, including increasing choices for portable power and mobility
- Increasing non-utility developer, vendor interest fostering new business cases built on microgrids as a service to the customer, and new customer-friendly delivery and financing models

What's new and different for energy ladder technologies?

- Growth in practical, cost-effective technologies at any scale, including solar plus batteries, plus a dozen other distributed energy resource (DER) options
- Solar, wind, and CHP – even with battery storage – are poised to be the least-cost alternatives for generation… some beating even the operating costs alone of existing fossil-fueled generators
- Standards for advanced inverters and microgrid communications and controls (IEEE 1547-2018 and IEEE 2030 family of standards)
- Emerging DC equipment standards at every scale, from USB-3 to 12Volts, 24V, 48V, and up to 384V for commercial buildings
- Innovative financing for consumers, including pay-as-you-go
- Growing experience with off-grid systems and services, including flourishing markets in remote and rural areas

Top energy ladder opportunities for areas where a wide-area-grid already exists

- Customers want ultra-high reliability and resilience for some end uses or facilities, including public purpose microgrids for critical needs facilities (e.g., transportation, medical care)
- Sometimes and for some uses, customers value portability and remote, off-grid usage
- Non-wire alternatives can be fully cost-effective
- Electric vehicles will present multiple opportunities, including vehicle-to-grid and second-life batteries
- Increased self-reliance and resilience for different kinds of campuses, and commercial or industrial parks
- Bonuses from special government support policies for selected technologies

Top energy ladder barriers for areas where a wide-area-grid already exists

- Rules for monopolies vs third-party providers, about who can do what for whom
- Rules and regulations for public rights-of-way, private wires and self-generation
- Rate design, including poorly-designed standby and backup rates, sometimes added utility charges for B.Y.O. DG, and poorly designed compensation for energy outflow
- Few if any pathways for monetizing ancillary services
- Interconnection rules and procedures, including costs, timing, standardization, and lack of interoperability and intentional-islanding rules
- Outmoded centralized-power models for utility IRP and DSP, combined with incomplete understanding & recognition of the full benefits and costs of DER
- Obstacles in financing, insurance, building and fire codes, tax rules
- Lack of consumer awareness of choices and opportunities

Energy ladder regulatory challenges for areas where a wide-area-grid already exists

- Roles for regulated utilities versus competitive service providers
- Interconnection technical standards, rules and procedures that allow and enable any practical and safe operations, including intentional islanding
- Product and service quality assurance and quality control
- Full compatibility for products and services up and down the energy ladder
- Comprehensive stakeholder consultation and participation in setting institutional, social, and technical roles
- Fair rates and tariffs for partial requirements service customers, that account fully for both benefits and costs
- Rules enabling mini- and micro-grids:
  - for single customer facilities and campuses;
  - for public-purposes; and,
  - for multi-customer facilities and campuses

Test beds, pilots, & more are proliferating

W. Feng et al.
Applied Energy 228 (2018) 1656–1668
doi 10.1016/j.apenergy.2018.06.096

Notes:

SPIDERS stands for Smart Power Infrastructure Demonstration for Energy Reliability and Security.

ESTCP stands for Environmental Security Technology Certification Program.

SGDP stands for Smart Grid Demonstration Program.

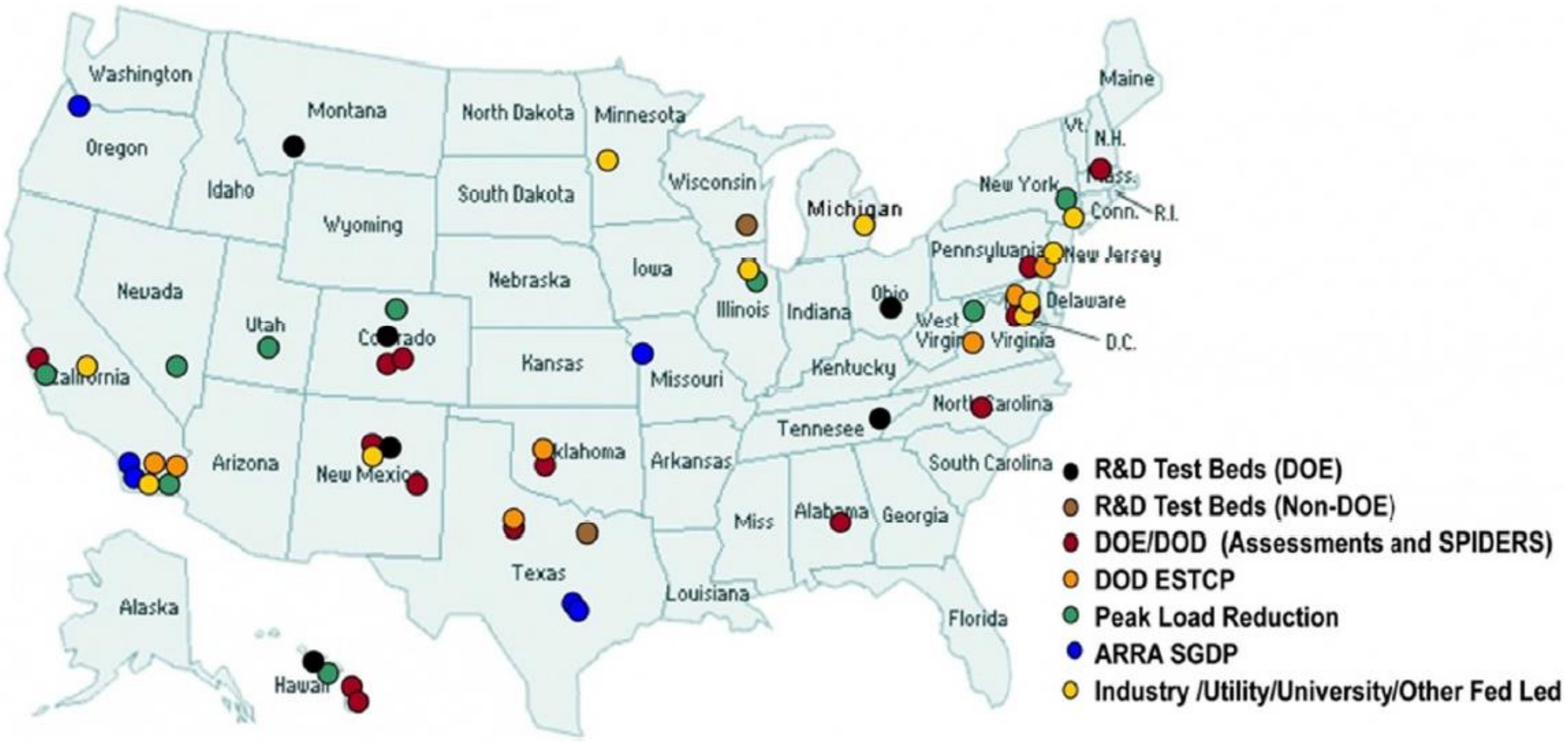


Fig. 1. Select U.S. Federal microgrid assessment and demonstration projects, U.S. DOE, Office of Electricity, Microgrid Portfolio of Activities
Source: OE, https://www.energy.gov/oe/services/technology-development/smart-grid/role-microgrids-helping-advance-nation-s-energy-syst-0

Top energy ladder opportunities for areas where there is no pre-existing grid

- Solar lanterns with batteries – a "killer app" with a cell-phone charger
- Solar Home Systems (SHS) with batteries
  - Smallest systems run a few lamps and one or more low-voltage appliances (like a fan, computer, radio or TV)
  - Larger systems add one or more higher-voltage appliances, like a refrigerator
- Neighborhood or village systems:
  - Solar charging systems as a service, like kiosks
  - Solar streetlights, solar water pumping
  - Critical needs services, like remote medical facilities
  - Mini- or micro-grids, with an agricultural or industrial facility host or anchor tenant, also serving neighboring homes

Top energy ladder barriers for areas where there is no pre-existing grid

- Lacking economic viability for many possible steps
  - Earliest steps up the ladder begin with minimal demand, because consumers have few if any immediate uses for electricity
  - Lack of consumer awareness of choices and opportunities
  - Widespread unfamiliarity with electricity
- Consumer distrust – Consumers might have already experienced poor performance, durability, and reliability of less-than-adequate devices
- Financing obstacles – Subsistence-markets are often largely non-cash economies
- Need to build business capabilities in remote locations – There are often institutional voids, and long-distances make it harder to provide service, maintenance, and spare parts
- Few empirical studies, providing few lessons from early experiences

Energy ladder regulatory challenges for areas where there is no pre-existing grid

- Roles for regulated utilities versus competitive service providers
- Product and service quality assurance and quality control
- Interconnection technical standards, rules and procedures that enable any practical and safe operations, including intentional islanding
- Full compatibility for products and services up and down the energy ladder
- Comprehensive stakeholder consultation and participation in setting institutional, social, and technical roles
- Rates, tariffs, and payment and collection methods, enabling consumer progress up the earliest few energy ladder steps
- Continuity and long-term plans for each community: service from mini- or micro-grids or viable succession plans for extending a wide-area grid

Learn more here… key literature (1)

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- Microgrid Institute. www.microgridinstitute.org

Learn more here... key literature (2)

- Microgrid Knowledge. https://microgridknowledge.com/
- North Carolina State University, Clean Energy Technology Center, *50 States of Grid Modernization*, *https://nccleantech.ncsu.edu/the-50-states-reports/*
- Patterson, 2007, *Keeping the Lights On*, and, 1999, *Transforming Electricity: The Coming Generation of Change*. www.earthscan.co.uk
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- Smart Electric Power Alliance (SEPA, www.smartpower.org): *51st State Ideas: 'Role of the Utility' Summary of Submissions; Beyond the Meter* reports; *Planning the Distributed Energy Future; and, Microgrid Business Models*
- U.S. Department of Energy, *Microgrid Portfolio of Activities*. *https://www.energy.gov/oe/services/technology-development/smart-grid/role-microgrids-helping-advance-nation-s-energy-syst-0*

University microgrid research institutes

- Arizona – Arizona State University
- California – Berkeley/LBNL & New Mexico partners at microgridlabs.com
- Colorado – Colorado State University, Fort Collins
- Illinois – Galvin Center at Illinois Institute of Technology
- Indiana – Notre Dame Energy E3 Innovation Center
- Massachusetts – MIT Energy Institute; Boston University
- Michigan – Wayne State University, NextEnergy Center
- Pennsylvania – Penn State Navy Yard; Pittsburgh
- South Carolina – Clemson Real-Time Power and Intelligent Systems Lab
- Tennessee – Lamar University
- Utah – University of Utah Smart Energy Lab
- Washington – Washington State University
- Wisconsin – U of W Madison and Milwaukee

Related NRRI & Stanton Reports

- Stanton and Nordman, 2017,"Regulating 'Energy Ladder' Products and Services: Delivering Vital Energy Services Using Off-Grid, Mini-Grid, and Micro-Grid Power Systems," *ICER Chronicle* 7(August 2017), 37-45. http://icer-regulators.net/download/icer-chronicle-edition-7/
- Barua, Costello, Kline, Phelan, Stanton, 2016, "Future Drivers and Trends Affecting Energy Development in Ontario: Lessons Learned from the U.S." (Mowat Energy Research Report #137). https://mowatcentre.ca/emerging-energy-trends/
- Stanton, 2012, *Are Smart Microgrids in Your Future? Exploring Challenges and Opportunities for State Public Utility Regulators, NRRI 12-15.*
- Stanton, 2012, *Consultant Report for Maine PUC Docket 2010-267: Smart Grid Coordinator, NRRI 12-02.*
- Stanton, 2015, *Distributed Energy Resources: Status Report on Evaluating Proposals and Practices for Electric Utility Rate Design, NRRI 15-08.*
- Stanton, 2015, *Getting the Signals Straight: Modeling, Planning, and Implementing Non-Transmission Alternatives, NRRI 15-02.*
- All NRRI Reports are available for free download at www.nrri.org

Energy Ladder Resources

- Appropriate Technology Collaborative (Ann Arbor, MI) – www.apptechdesign.org
- *Energypedia* (a wiki platform for collaborative exchange on renewable energy, energy access, and energy efficiency in developing countries) – https://energypedia.info/wiki/Main_Page
- Global Off-Grid Lighting Association (GOGLA) – www.gogla.org
- Johns Hopkins School of Advanced International Studies, Initiative for Sustainable Energy Policy (ISEP) – sais-isep.org
- Sesame Solar: Turnkey, Mobile Nanogrids (Ypsilanti, MI) – www.sesame.solar
- Sun-Connect Off-Grid News – www.sun-connect-news.org
- Sustainable Energy for All (SE4All) – www.seforall.org
- United Nations, Environment, Sustainable Development Goal 7 (SDG7): Affordable and clean energy – https://goo.gl/nSBKEJ
- World Bank, Energy – www.worldbank.org/en/topic/energy