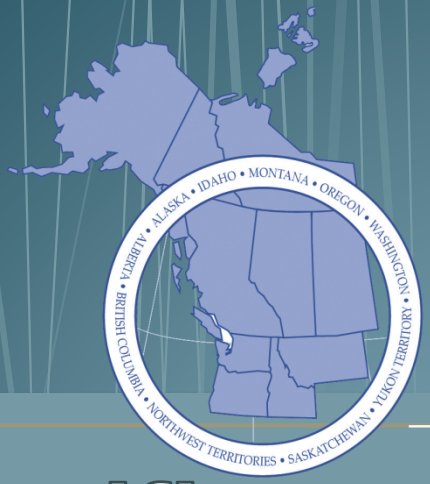


Pacific NorthWest Economic Region

The Pacific Northwest: Energy Trends & Opportunities

Building an Energized Future

May 18, 2016

Matt Morrison, PNWER CEO

Pacific Northwest Economic Region

- PNWER is a statutory, public-private partnership chartered in 1991 by the U.S. States of Alaska, Washington, Idaho, Montana, Oregon and the Canadian Provinces of British Columbia, Alberta, Saskatchewan, Yukon and Northwest Territories to increase the economic competiveness of the region, while maintaining and enhancing our natural environment.

- The region has a GDP of over $1 trillion, with a population of 22.9 million people, making it the 11th largest economy in the world.

Pacific Northwest Economic Region

- Facilitates 22 Working Groups, co-chaired by legislative leadership and industry representative
- Several Energy Working Groups
- Workforce Development
- Innovation
- These Provide a forum for sharing of best practices and developing solutions to regional challenges.

The Electric Distribution System in Transition

The structure and operation of distribution systems will change as "smart" infrastructures are built out and new distributed technologies are deployed.

- Ultimately, power will flow in 2 directions across distribution systems.
- Investing in a safe and reliable grid infrastructure is critical to the deployment of new technologies.

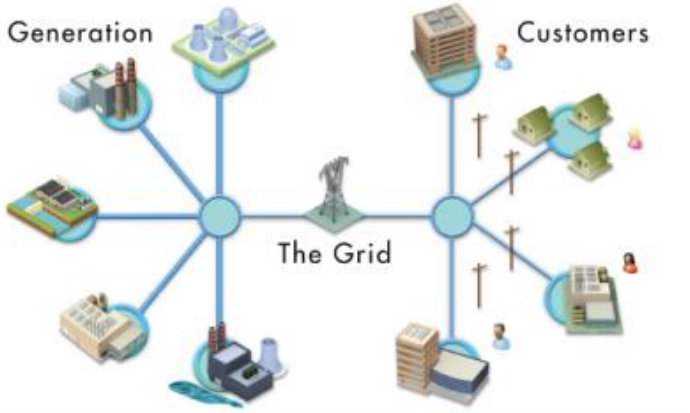


Figure 1: Today's Power System Characterized by Central Generation of Electricity, Transmission, and Distribution to End-Use Consumers

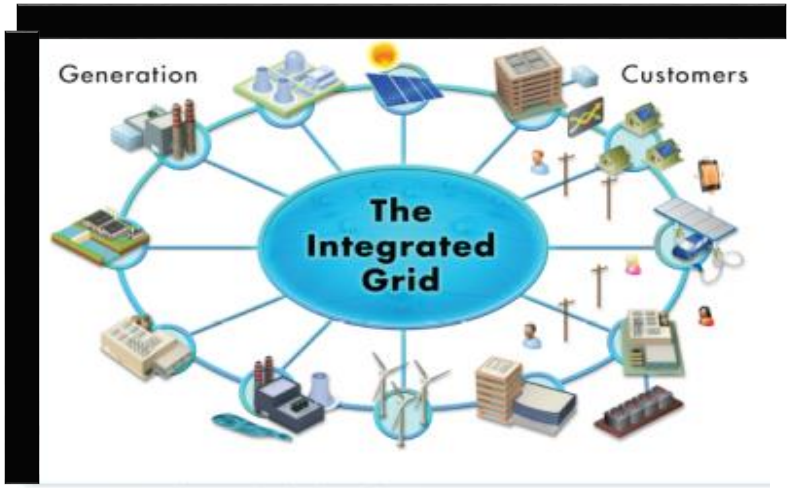


Figure 12: Creating an Architecture with Multi-Level Controller [44]

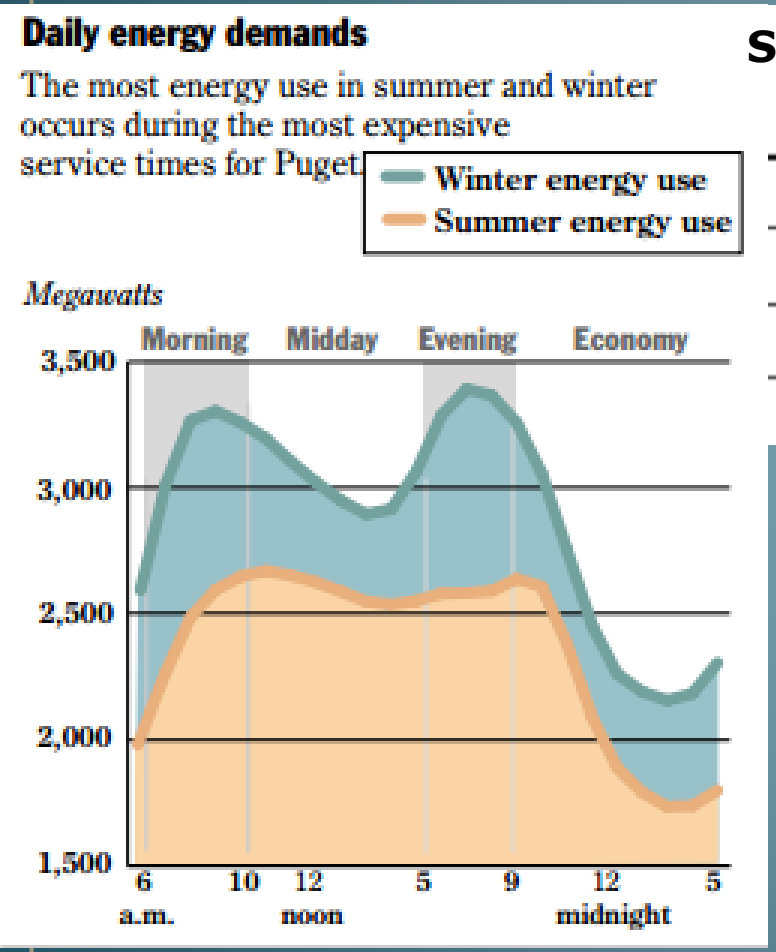
Source for graphics: EPRI, *The Integrated Grid: Realizing the Full Value of Central and Distributed Energy Resources*, February 2014

Energy System in Transition

- Utility Business Model of Volumetric compensation is changing
- More change coming in the next 5 – 7 years than has happened in the past 50 years
- This is primarily being driven by customers

Utility Rates

Flat Rate v. Time of Use Pricing



Seattle City Rates: Large General Services 2013
Time of Use Pricing

Peak energy charge/kWh	$0.0657
Off-peak energy charge/kWh	$0.0438
Peak demand charge/kW	$1.52
Off-peak demand charge/kW	$0.23

Changing Landscape of Pricing

- **Time of Use:** Prices vary by season and/or time of day. Seattle has time-of-day rates for large and high demand general service customers.

- **Demand-side response:** Customers can reduce or shift their electricity usage during peak periods in response to time-based rates or other forms of financial incentives.

- **Other disrupting factors:** accelerated technological change, shifting consumer preferences, business model disruption, a rapidly evolving fuel market, and a changing public policy landscape

No Clear Pathway to the future

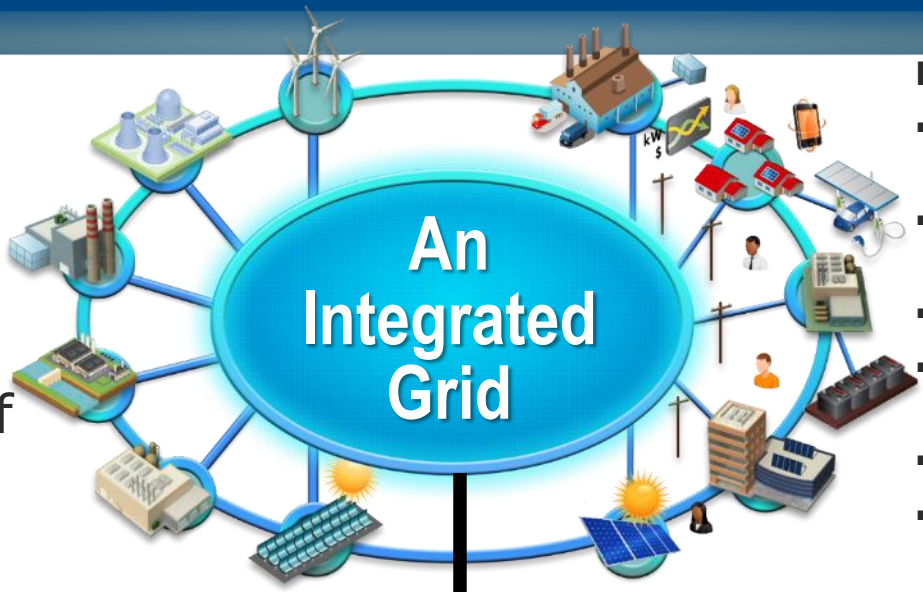
- Transactive Energy Model
  - Customers exchange values over the smart grid
  - Project what they need, and what they will produce
  - Smart Grid (SCADA) balances with market rate
- Performance Based Model
  - Consumer pays based on their values
  - Based on Performance Milestones – Green, Resilient, etc

The New Distribution System Characteristics

- Increased efficiency, resiliency, and overall reliability (not just microgrids).
- Ability to integrate adoption of Distributed Energy Resources, including:
  - Distributed Generation, Renewable Generation, Energy Storage, Demand Response (control of timing of customer energy usage) and Electric Vehicles.
- Provide a platform for greater customer information, options and energy-related controls.
- This Digital Transformation
  - Requires New Investments in Operational Control & Protections Systems, Telecommunications Systems
  - Requires new approaches to planning, operations, and rate making

Outcome of Integrated Grid Technology Pilots

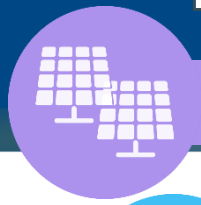
Technology pilots demonstrate the value to all stakeholders of an integrated approach



Expected Learnings

- Consumer behavior and acceptance
- Technology performance and life cycle costs
- Installation, O&M costs
- Grid integration and architecture
- Benefit/cost assessment
- End-of-life environmental impact assessment

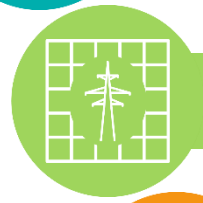
Putting IG Framework to the Test Demonstration Pilots



Utility Scale Solar

Utility Scale Solar with Energy Storage

Distributed Energy Storage



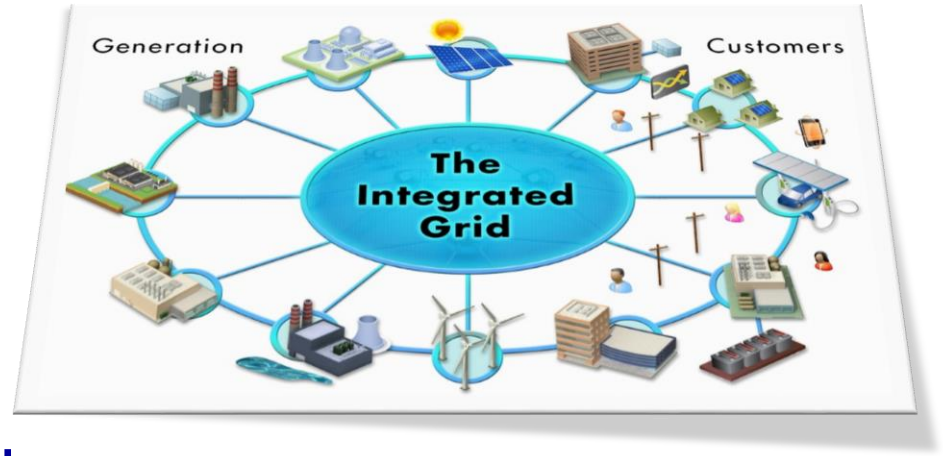
Microgrids

Electric Vehicle Charging Infrastructure

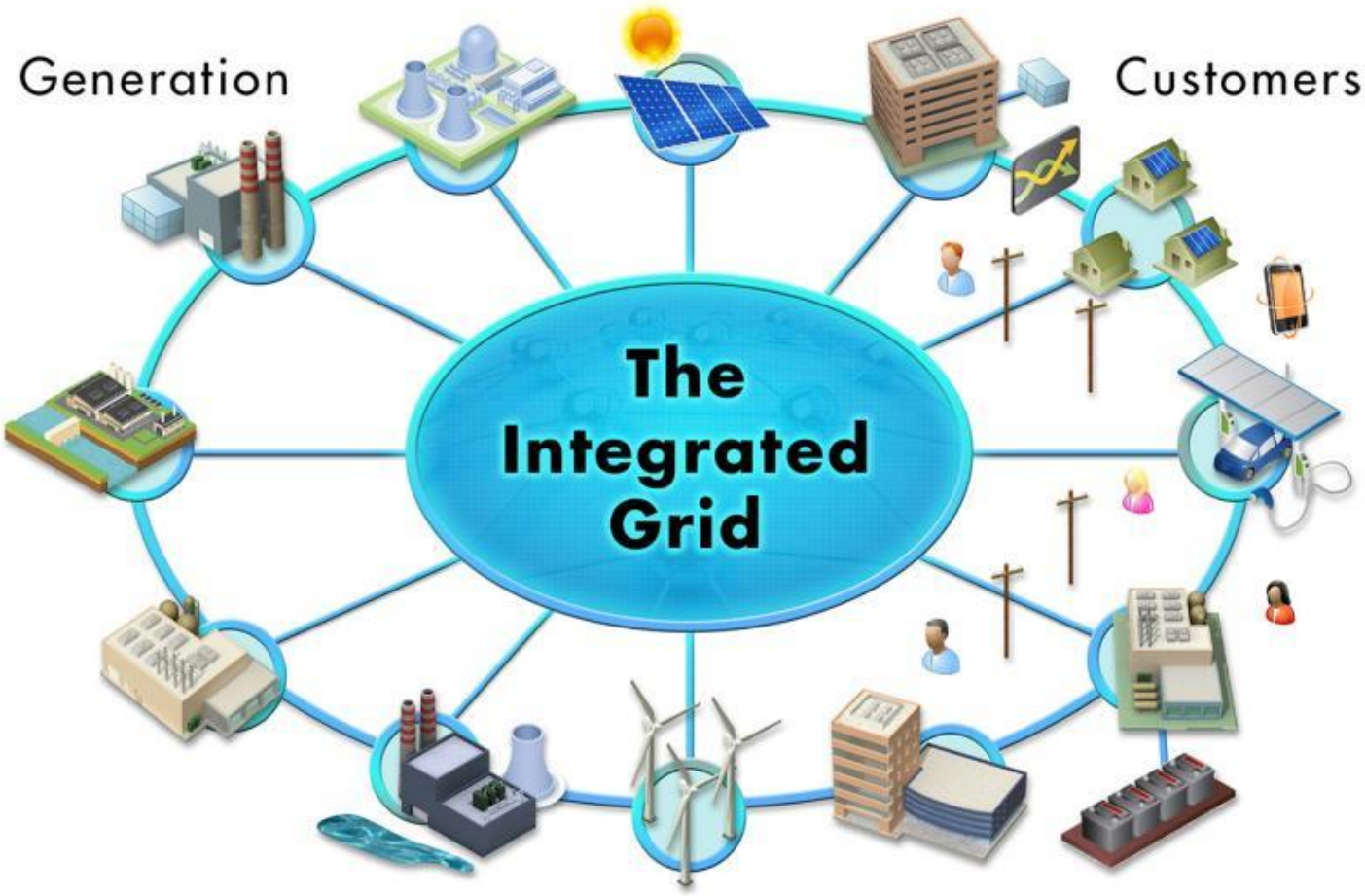
Customer-Side Technologies

Foundation of An Integrated Grid

1. Grid Modernization
2. Communication Standards and Interconnection Rules
3. Integrated Planning and Operations
4. Informed Policy and Regulation



Meeting the Challenge



Pacific Northwest Demonstration Project

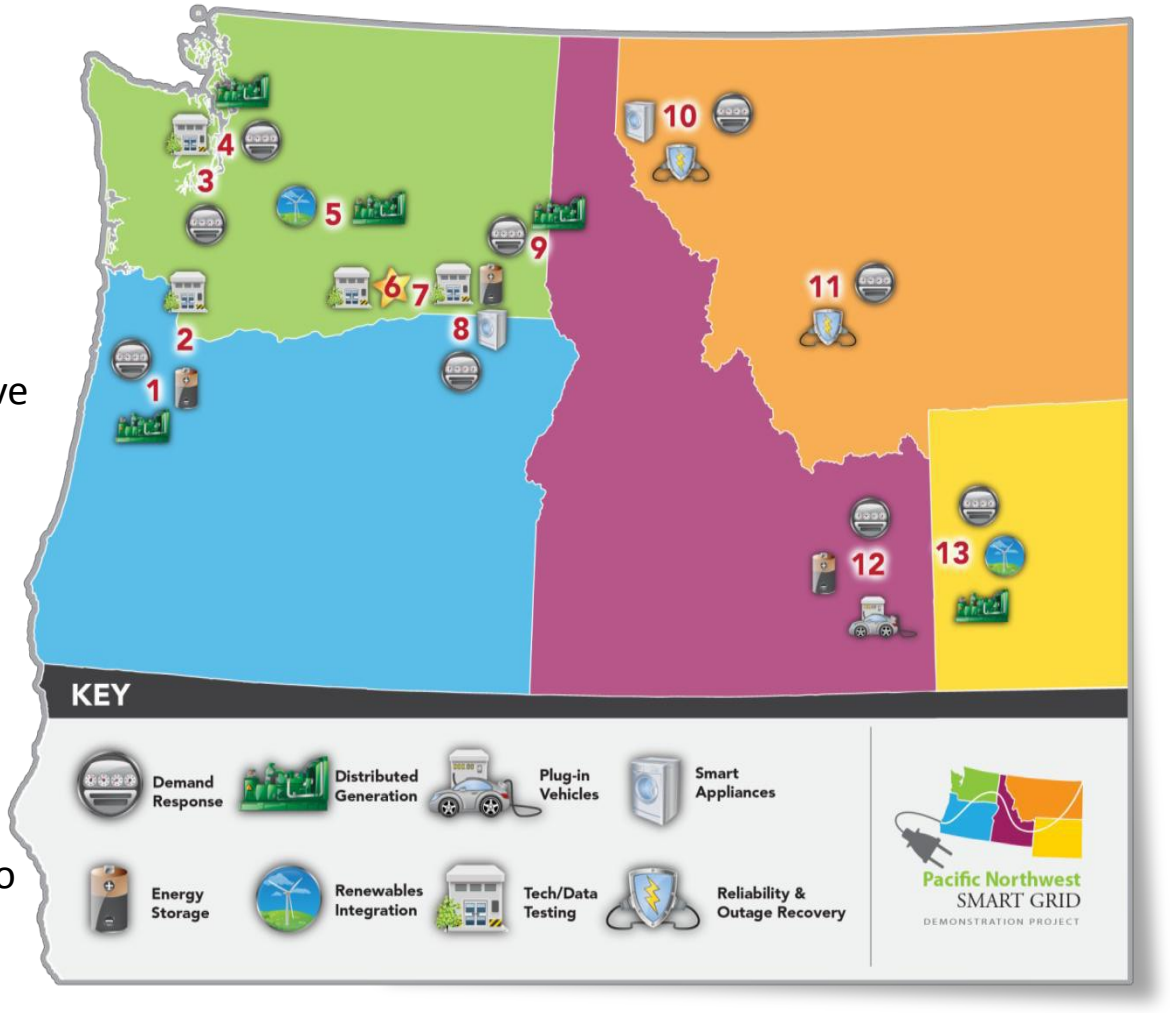
What:

- $178M, ARRA-funded, 5-year demonstration started in 2010
- 60,000 metered customers in 5 states

Why:

- Develop communications and control infrastructure using incentive signals to engage responsive assets
- Quantify costs and benefits
- Contribute to standards development
- Facilitate integration of wind and other renewables

Only project of its kind integrating resources across multiple utilities to achieve regional benefits.



Project Objectives

Lay the foundation for a regional Smart Grid

$

Measure and validate costs and benefits

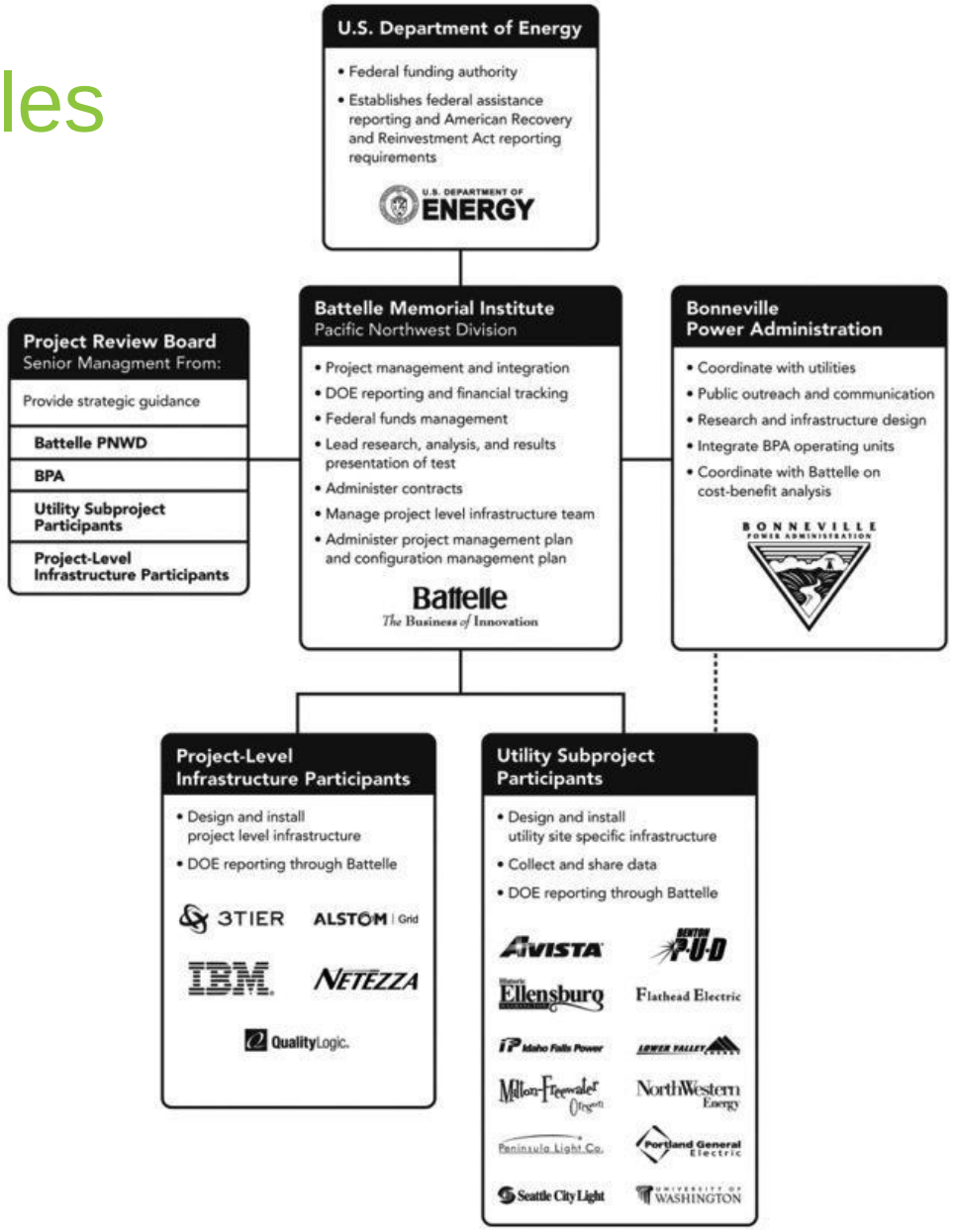
Develop Standards for interoperable Smart Grid

Develop communications and control infrastructure using incentive signals

Integrate renewable Energy

Project Structure / Roles

- Battelle Memorial Institute, Pacific Northwest Division
- Bonneville Power Administration
- 11 utilities (and UW) and their vendors
- 5 technology infrastructure partners



Transactive Control 101

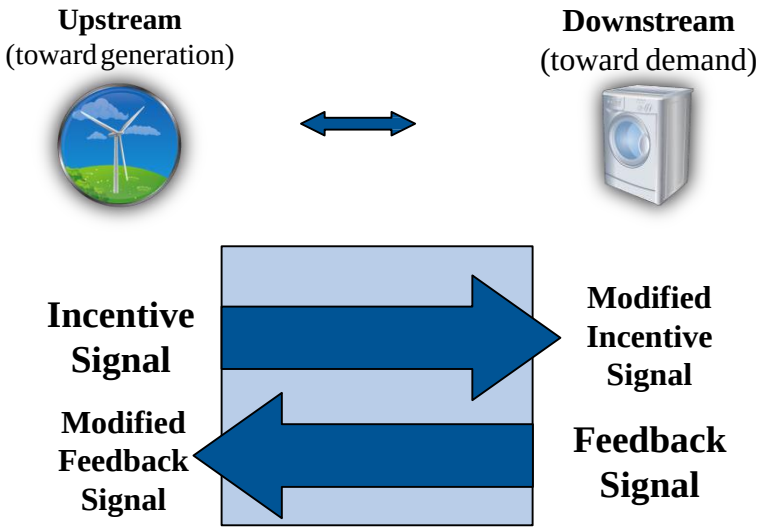
Pacific Northwest SMART GRID DEMONSTRATION PROJECT

What is it?

- Transactive control is a distributed method for coordinating responsive grid assets wherever they may reside in the power system.

Incentive and feedback signals

- The incentive signal sends a synthetic price forecast to electricity assets
- The feedback signal sends a consumption pattern in response to the incentive.

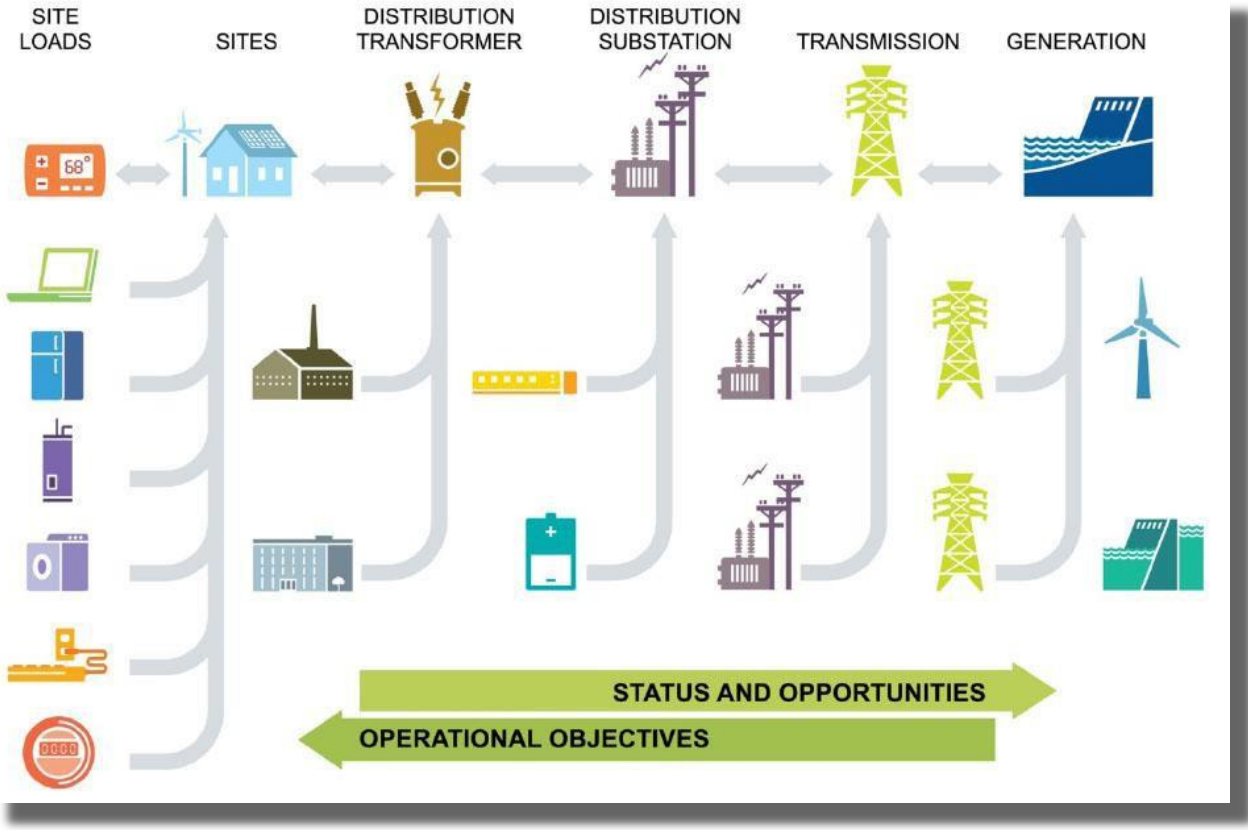


Project Basics

Pacific Northwest SMART GRID DEMONSTRATION PROJECT

Transactive Control Operational objectives

- Manage peak demand
- Facilitate renewable resources
- Address constrained resources
- Improve system reliability and efficiency
- Select economical resources (optimize the system)



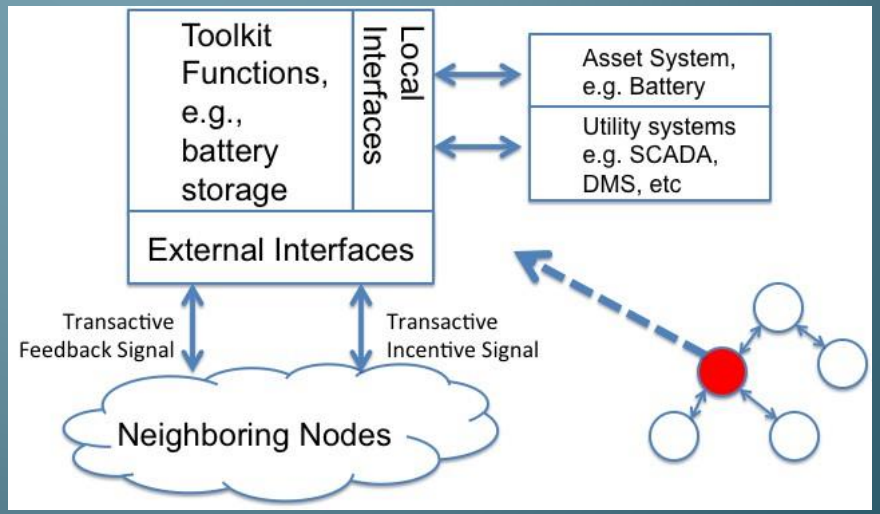
Aggregation of Power and Signals Occurs Through a Hierarchy of Interfaces

Project Success

Developed and demonstrated ability to coordinate incentive signal response across 11 utilities in five states using transactive control technology

Transactive control system design and reference implementation suitable for standardization

At the end of the project:



Project Successes

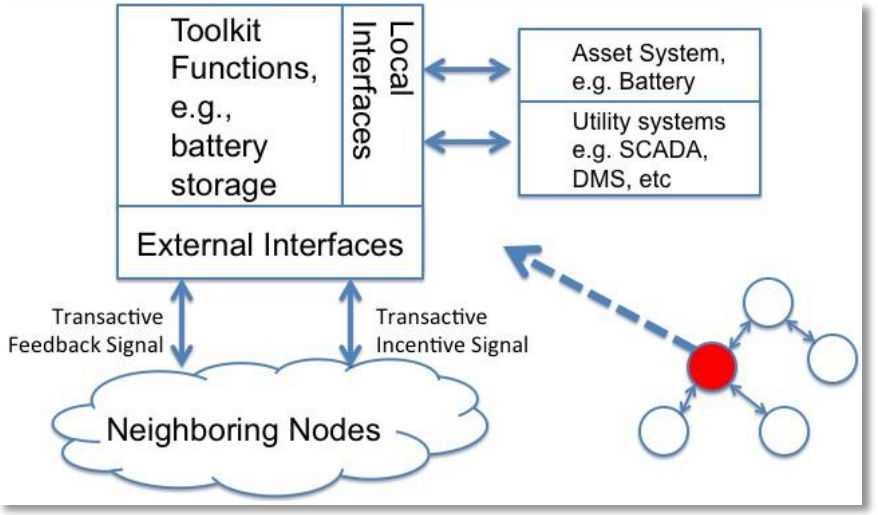
Pacific Northwest SMART GRID DEMONSTRATION PROJECT

Developed and demonstrated ability to coordinate incentive signal response across 11 utilities in five states using transactive control technology

Transactive control system design and reference implementation suitable for standardization

At the end of the project:

- ~ 80 Megawatts of distributed responsive assets engaged
- ~ $80M Base of smart grid equipment installed at 11 utilities



Challenges

- Utility Commissions need authorization from Legislatures
- Our infrastructure does not respect our political boundaries
- Very complex systems to understand
- Legislative background and understanding of these complex issues is often lacking
- Legislative turnover also a big challenge

- CHALLENGE : High turnover in legislatures decreases institutional knowledge of complex energy issues.
- SOLUTION : 60-hour certificate program in energy policy planning awarded through PNWER's Energy Horizon Institute and the University of Idaho.

LEHI was created to address a recognized need for legislators to better understand of the basic energy system, including how the infrastructure works, and how public and private utility managers make business decisions to prepare for the region's future energy needs.

PNWER's LEHI – 60 Hour Course

- **3.5 Days at PNNL in Richland, and 3.5 days in Washington, DC - COURSE TOPICS INCLUDE:**
  - Global Energy Picture
  - U.S. and Canadian Energy Situation
  - Electric Power Generation, Transmission and Distribution
  - Future of the Grid, and Smart Grid
  - Natural Gas Production, Transmission, and Delivery
  - Petroleum – upstream, downstream, midstream
  - The Future of Coal
  - Renewable Energy Development
  - Integrated Resource Planning
  - How Generation is planned, financed, and built
  - US Clean Power Plan, Section 111D
  - Developing Outcome Based, Technology Neutral Energy Policy

LEHI

To date, over 130 have graduated from the LEHI Program. The list of alumni includes:

Alabama
Rep. Mac Buttram '12

Alaska
Sen. John Coghill '12
Rep. Bryce Edgmon '14
Rep. Anna Fairclough '10
Rep. Eric Feige '12
Rep. Neal Foster '12
Sen. Berta Gardner '15
Sen. Cathy Giessel '12
Rep. Doug Isaacson '14
Rep. Andy Josephson '15
Sen. Lesil McGuire '14
Rep. Charisse Millett '13
Rep. Mark Neuman '10
Rep. Dan Saddler '14
Sen. Bert Stedman '10
Sen. Gene Therriault '10
Rep. Chris Tuck '13

Alberta
MLA Arno Doerksen '12
MLA Kyle Fawcett '10
MLA Richard Marz '10
MLA Diana McQueen '10
MLA Len Mitzel '10
MLA Len Webber '10

Arizona
Sen. Gail Griffin '13
Rep. Frank Pratt '12
Rep. T.J. Shope '13

Arkansas
Rep. Jonathan Barnett '12
Rep. Ken Bragg '15
Rep. Lane Jean '14

British Columbia
MLA Mike Bernier '14

California
MLA Autumn Burke '15
MLA Matthew Harper '15
MLA Devon Mathis '15
MLA Sebastian Ridley-Thomas '14

Colorado
Sen. Matt Jones '14
Rep. Dominick Moreno '15
Sen. Jeanne Nicholson '13
Sen. Gail Schwartz '12
Christopher Scolari '15 (advisor)
Rep. Mac Tyler '13

Florida
Rep. Jose Felix Diaz '14

Georgia
Sen. Frank Ginn '15
Sen. Rick Jeffares '15
Sen. Ross Tolleson '13

Hawaii
Rep. Denny Coffman '12

Idaho
Rep. Robert Anderst '13
Rep. Merrill Beyeler '15
Sen. Cherie Buckner-Webb '13
Rep. Greg Chaney '15
Rep. Brian Cronin '10
Rep. Mat Erpelding '13
Sen. Russ Fulcher '12
Rep. Stephen Hartgen '10
Sen. Lee Heider '15
Rep. Paulette Jordan '15
Rep. Phylis King '14
Sen. Curt McKenzie '10
Rep. Kelley Packer '14
Rep. Ilana Rubel '15
Sen. Michelle Stennett '12
Rep. Jeff Thompson '12
Rep. Janet Trujillo '14
Sen. Elliot Werk '10
Sen. Chuck Winder '13

Illinois
Sen. Dave Koehler '14
Rep. Linda Chapa LaVia '15

Kansas
Sen. Pat Apple '13

Kentucky
Rep. John Short '15

Massachusetts
Rep. Thomas Golden, Jr. '12

Michigan
Rep. Aric Nesbitt '13
Sen. John Proos '12

Minnesota
Rep. Pat Garofalo '15
Sen. John Hoffman '14
Rep. Bob Loonan '15
Sen. John Marty '13
Rep. Will Morgan '13
Rep. Jim Newberger '15

Montana
Rep. Duane Ankney '10
Rep. Pat Connell '13
Rep. Mike Cuffe '15
Rep. Robyn Driscoll '10
Sen Kristin Hansen '15
Sen. Doug Kary '15
Sen. Cliff Larsen '10
Sen. Sue Malek '13
Rep. Mary McNally '13
Sen. Chas Vincent '12
Sen. Ed Walker '13
Rep. Daniel Zolnikov '15

Nebraska
Sen. Chris Langemeier '12

New Jersey
MLA Upendra Chivukula '12
Sen. Bob Smith '15

New Mexico
Sen. Lynda Lovejoy '10
Rep. Tom Taylor '13

New York
MLA Kevin Cahill '12
Sen. George Maziarz '13
MLA Amy Paulin '13
MLA Angelo Santabarbara '14
MLA Latrice Walker '15

North Dakota
Sen. Randall Burckhard '13

Northwest Territories
MLA David Ramsay '14

Ohio
Sen. Troy Balderson '13
Sen. David Daniels '12
Rep. Peter Stautberg '13
Rep. Andy Thompson '12
Sen. Joseph Uecker '14

Oklahoma
Rep. Mike Jackson '12
Rep. Weldon Watson '15

Oregon
Rep. Deborah Boone '13
Sen. Jackie Dingfelder '12
Sen. Chris Edwards '15
Sen. Bill Hansell '14
Rep. Ken Helm '15
Rep. John Huffman '12
Rep. Mark Johnson '15
Rep. Caddy McKeown '14
Sen. Alan Olsen '14
Rep. Jeff Reardon '14
Rep. Matt Wingard '10
Rep. Brad Witt '10

Pennsylvania
Rep. Ron Miller '13

Québec
MNA Guy Bourgeois '14
MNA Sylvain Gaudreault '12
MNA Mathieu Lemay '15

Saskatchewan
MLA Fred Bradshaw '12
MLA Michael Chisholm '10
MLA Dan D'Autremont '12
MLA Larry Doke '13
MLA Doreen Eagles '12
MLA Tim McMillan '10

Saskatchewan (cont.)
MLA Warren Steinley '13
MLA Randy Weekes '10
MLA Nadine Wilson '10
MLA Gordon Wyant '12

South Dakota
Matt Konenkamp '15 (advisor)

Utah
Rep. Stephen Handy '12
Sen. Kevin Van Tassell '12

Washington
Sen. Marlyn Chase '12
Rep. Cathy Dahlquist '12
Sen. Jerome Delvin '10
Debbie Driver '14 (staff)
Rep. Deb Eddy '10
Sen. David Frockt '12
Rep. Mark Harmsworth '15
Clay Hill '14 (staff)
Sen. Janea Holmquist '10
Sen. Jim Honeyford '10
Rep. Zack Hudgins '14
Nikkole Hughes '15 (staff)
Rep. Jim Jacks '10
Rep. Chad Magendanz '14
Rep. Terry Nealey '12
Sen. Linda Evans Parlette '12
Sen. Kevin Ranker '10
Sen. Phil Rockefeller '10
Rep. Cindy Ryu '15
Rep. Sharon Tomiko Santos '15
Rep. Shelly Short '10
Rep. Norma Smith '13
Rep. Gael Tarleton '13
Rep. Dave Upthegrove '12
Jasmine Vasavada '13 (staff)
Kathy Vaughn '15 (commissioner)
Rep. Jesse Young '15

Wisconsin
Sen. Mark Miller '13

Wyoming
Rep. Lloyd Larsen '13

LEHI Washington Alumni

Sen. Marlyn Chase `12
Rep. Cathy Dahlquist `12
Sen. Jerome Delvin `10
Rep. Deb Eddy `10
Sen. David Frockt `13
Rep. Mark Harmsworth '15
Rep. Zack Hudgins '14
Sen. Janea Holmquist `10
Sen. Jim Honeyford `10
Rep. Jim Jacks `10
Rep. Chad Magendanz '14

Sen. Bob Morton `10
Rep. Terry Nealy `12
Sen. Linda Evans Parlette `12
Sen. Kevin Ranker `10
Sen. Phil Rockefeller `10
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Rep. Sharon Tomiko Santos '15
Rep. Shelly Short `10
Rep. Norma Smith `13
Rep. Gael Tarleton `13
Rep. Dave Upthegrove `12
Rep. Jesse Young '15

LEHI Director – Rep. Jeff Morris

PNWER Roadmap to Resilient, Ultra-Low Energy Buildings

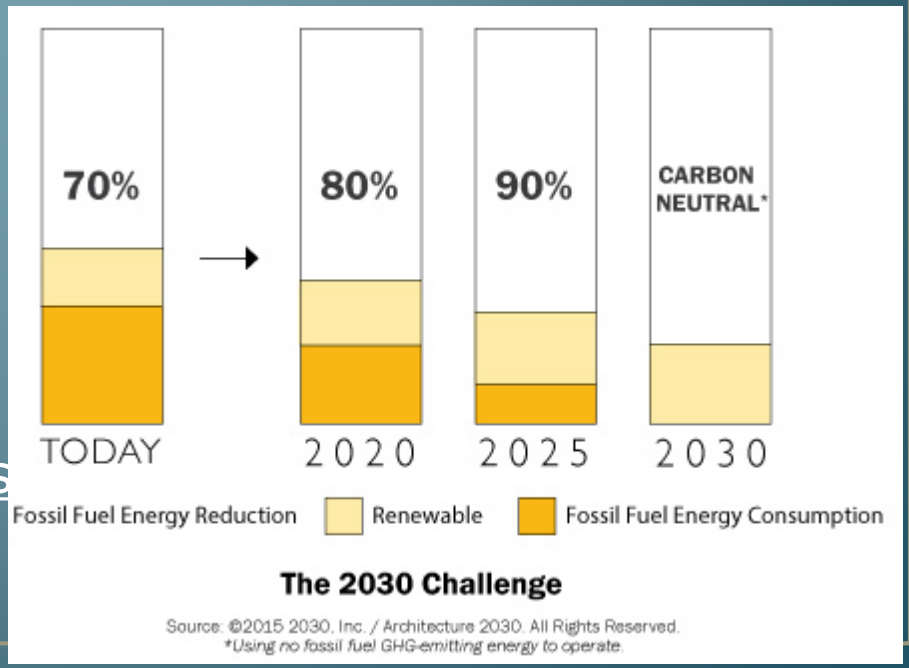
Elements:

New Construction: net zero emissions, including an energy efficiency target and use of clean energy (including renewable natural gas) after 2030

Existing Private Buildings: "deep" energy retrofits at the time of major renewals; optimizing economics of upgrades for future costs (including externalities)

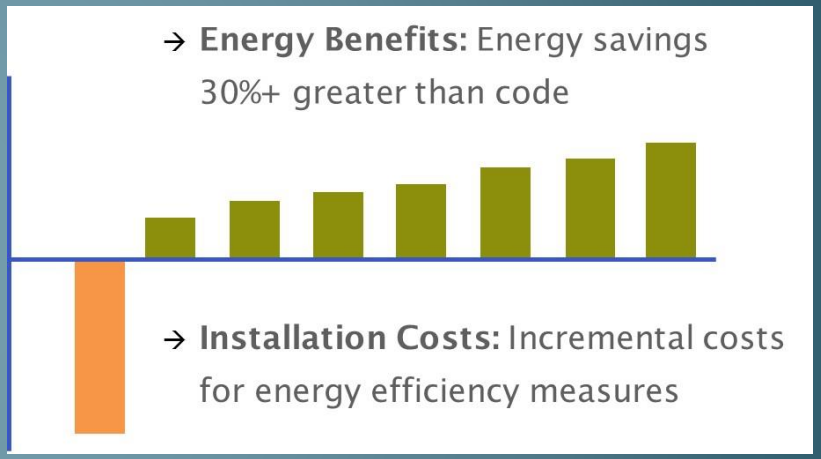
Existing Public Buildings: achieving previous goal for 100% of public sector stock by 2030

Focuses on collaborative measures



PNWER Net-Zero Networks

- State/provincial/territorial governments
- Construction industry associations
- Professional associations
- Developers/builders/contractors
- Energy efficiency agencies
- Local governments
- Public utilities
- Public interest organizations



4 founding sponsors sought to prepare "White Paper"

Foundation for PNWER Roadmap to be presented at PNWER Annual Summit in July 2016

Net-Zero Roadmap White Paper

Foundation and toolkit for stakeholders to promote suitable tools/policy options appropriate for each state or province

- Evaluates current market conditions
- Reviews case studies to determine best practices
- Defines goals, targets and scope for Roadmap
- Evaluates impacts on consumers and society
- Forecasts new jobs in PNWER constituent areas

Retrofitted condominium in Vancouver, BC – RDH Engineering

Contact Information

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pnwer.org