Distributed Energy Resources in the Pacific Northwest

Ken Nichols
Principal – EQL Energy

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ken@eqlenergy.com
503-438-8223

Distribution Utility of the Future

Distribution utilities will no longer just supply electric energy to customers, but will plan for, coordinate, and manage the flow of electric energy to, from, and between customers.

Northwest Power Act

*Priority shall be given: first, to **conservation**; second, to **renewable resources**; third, to generating resources **utilizing waste heat or generating resources of high fuel conversion efficiency**; and fourth, to all other resources.*

"Electric power" means electric peaking capacity, or electric energy, or both.

"system cost" means an estimate of all direct costs of a measure or resource over its effective life, including, if applicable, the cost of distribution and transmission to the consumer and, among other factors, waste disposal
costs, end-of-cycle costs, and fuel costs (including projected increases), and such quantifiable environmental costs and benefits.

https://www.nwcouncil.org/reports/poweract/

Steps Toward the Future

Is Elon Musk the utility of the future?

- Utility business models in transition
  Large Supply-Side Capex >>>> Grid Modernization, Reliability, IT
- “Every feeder is a snowflake”
- DER value: Location, Location, Location
  Battle: Utility Integration Cost vs. DER Value
- Technology (trade allies and vendors) and Customers
  Utility Roadmaps: pilot>demo>scale

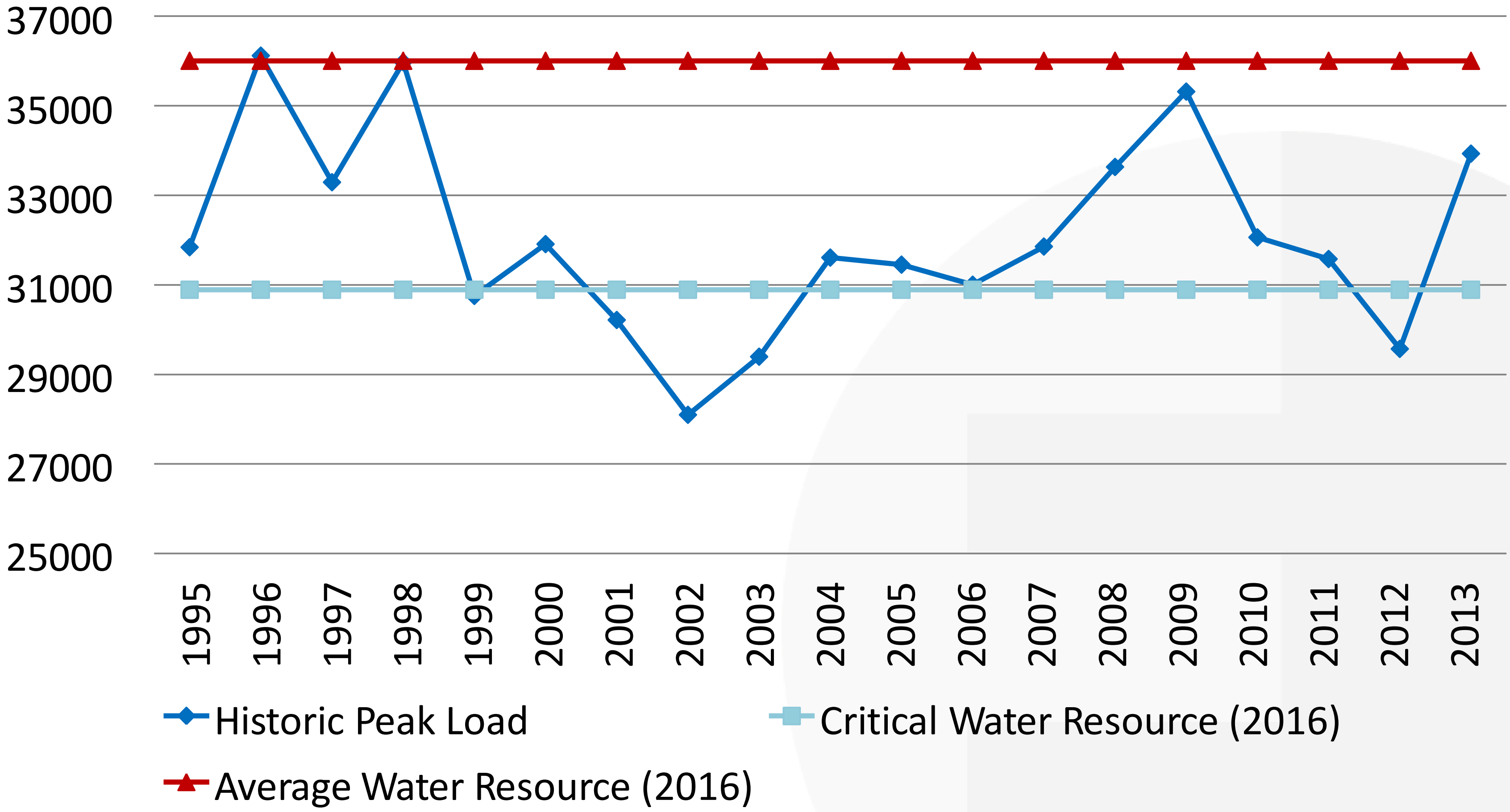
Legislative actions that work

- Value of ~~solar~~ DER >>> DRP
- Distribution Resources Planning (CA AB327, WA 2045)
- Rate Strategies (reflect Utility costs, customer preference)
- Combined Heat and Power (WA E2SHB 1095, OR SB 844)
- Support (Mandate) Standards (OpenADR, IEEE1547)
- Demand Response follows Energy Efficiency (NPCC 7th Plan)

Capacity and Energy

Capacity (dispatchable)	Energy (variable)
Capacity DSM (aka Demand Response)	Energy DSM (aka Energy Efficiency)
Energy Storage (Customer, Utility)	Solar
Dispatched Generation	Wind
Electric Vehicle Charging	
Combined Heat & Power	
Smart Inverter services (e.g., VAR Support)	

PNW Needs Flexible Capacity (MW)



DER Drivers in PNWER

Cost declines in solar, storage, and smart grid

- 40% decline since 2011, Panels $1.31/Watt to $.50/Watt (peaker is $1.2/Watt not including fuel)
- Import tariffs on Chinese solar will slow the steep decline, but decline will continue.
- $.038/kWh 20 year solar PPA for NV Energy
- Tesla's gigafactory to reduce Li-ion battery cost
- Smart building management systems, thermostats, water heaters, motor load, VFDs

Customer Expectations

- Lower costs, reliability, and environmental concern

Economic Development

- PNW: Solar Jobs > 6,000. Energy Efficiency > 25,000 jobs

Reliability

- 90% of outages is on distribution system. (200GW of backup power in US)
- PNW requirement for flexible capacity

Reduced rates

- Avoid costs for Transmission, Distribution, Generation, etc.
- *1990s Puget Sound Reliability: voltage support, targeted EE*

Customers are looking for reliability, self generation, and environmental stewardship.

- Customer desire for self-reliance increasing

– **E&Y**: **33%** of the multi-national firms are expected to meet a greater share of their energy needs through **self-generation over the next five years**

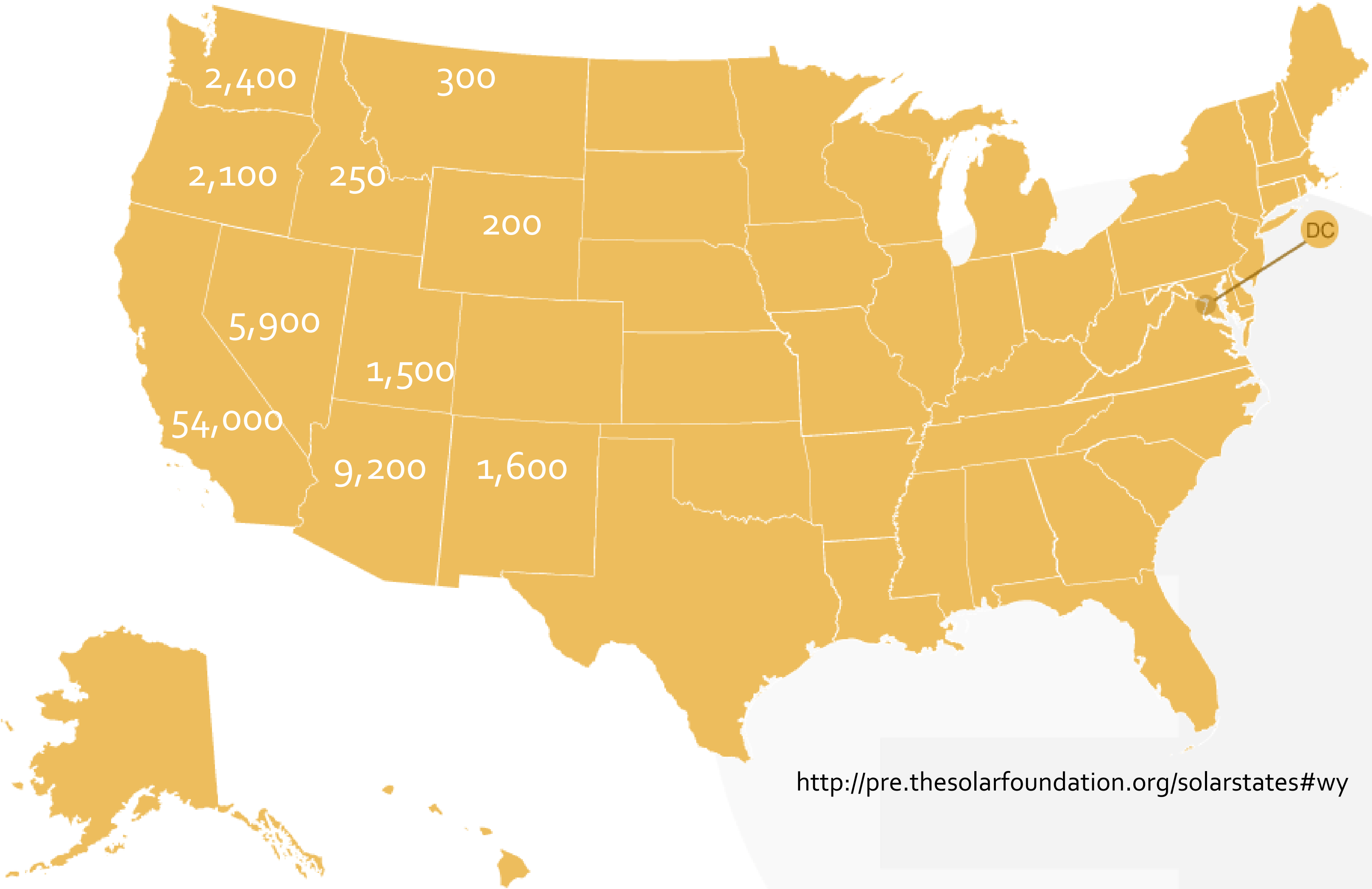
– **Navigant**: nearly **75%** of surveyed **residential customers** have "**concerns about the impact electricity costs** have on their monthly budgets, and **63%** are interested in **managing energy used in their homes**"

– **Best Buy**: **36% of residential** customers desire to "financiall and physically protect the home" (Home Safeguarding persona)

Home Safeguarding	Life Maximizing	Environmentalism
There is wide-spread desire to financially and physically protect the home. This desire drives consumer demand for products and services that help reduce energy consumption through information and automated control features.	A modest number of consumers (the young & wealthy in particular) are motivated by a desire to have a more comfortable & convenient lifestyle. This desire drives demand for remote management features. It also drives demand for home upgrade.	Is not a particularly strong driver in most cases but does make a contribution towards the demand for smart energy programs. This is more of a supporting driver for energy efficiency programs

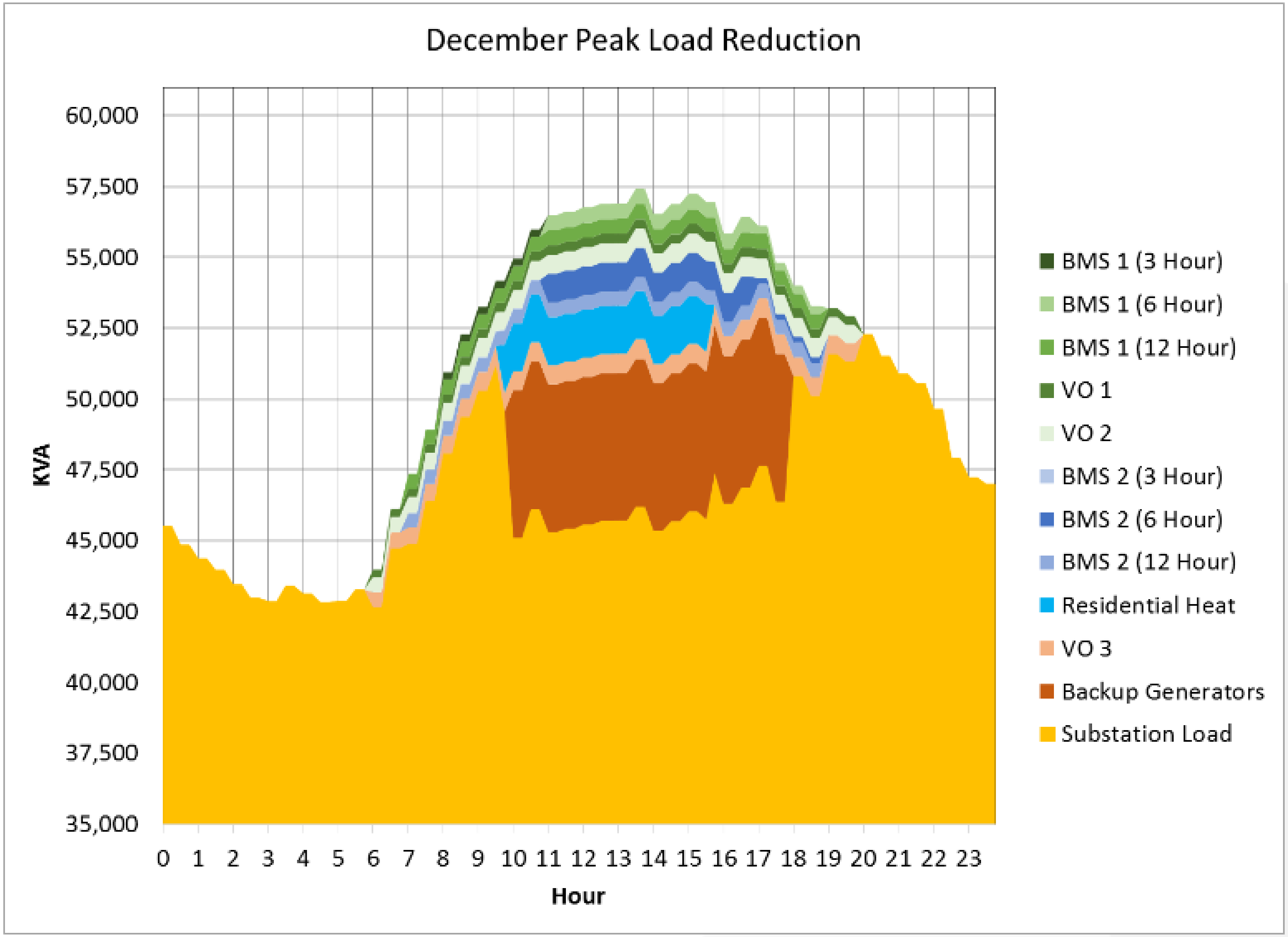
HOME ENERGY

>5,000 Solar Jobs in PNW
>25,000 Energy Efficiency Jobs in PNW

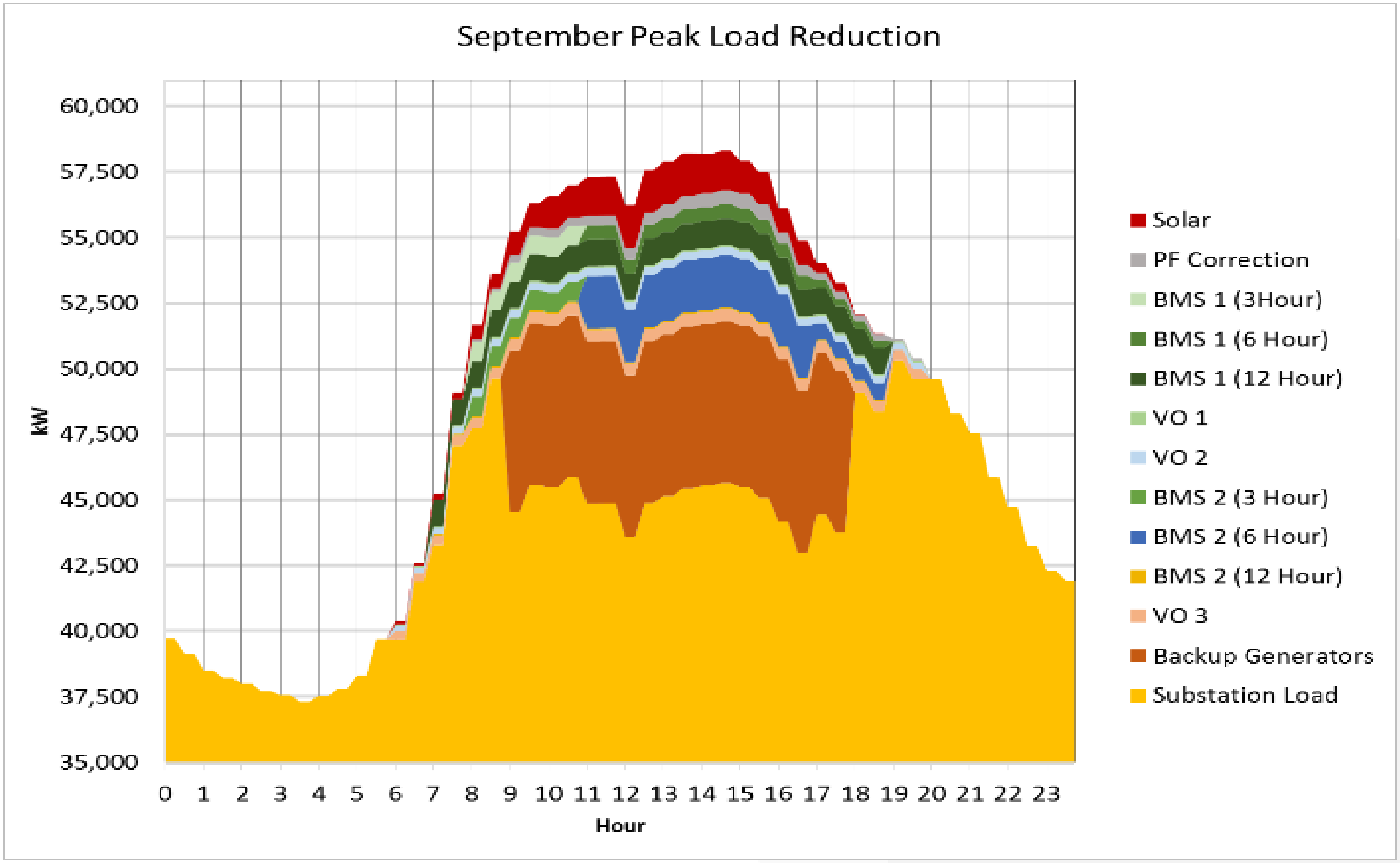


http://pre.thesolarfoundation.org/solarstates#wy

Campus DER for 69kVA Substations



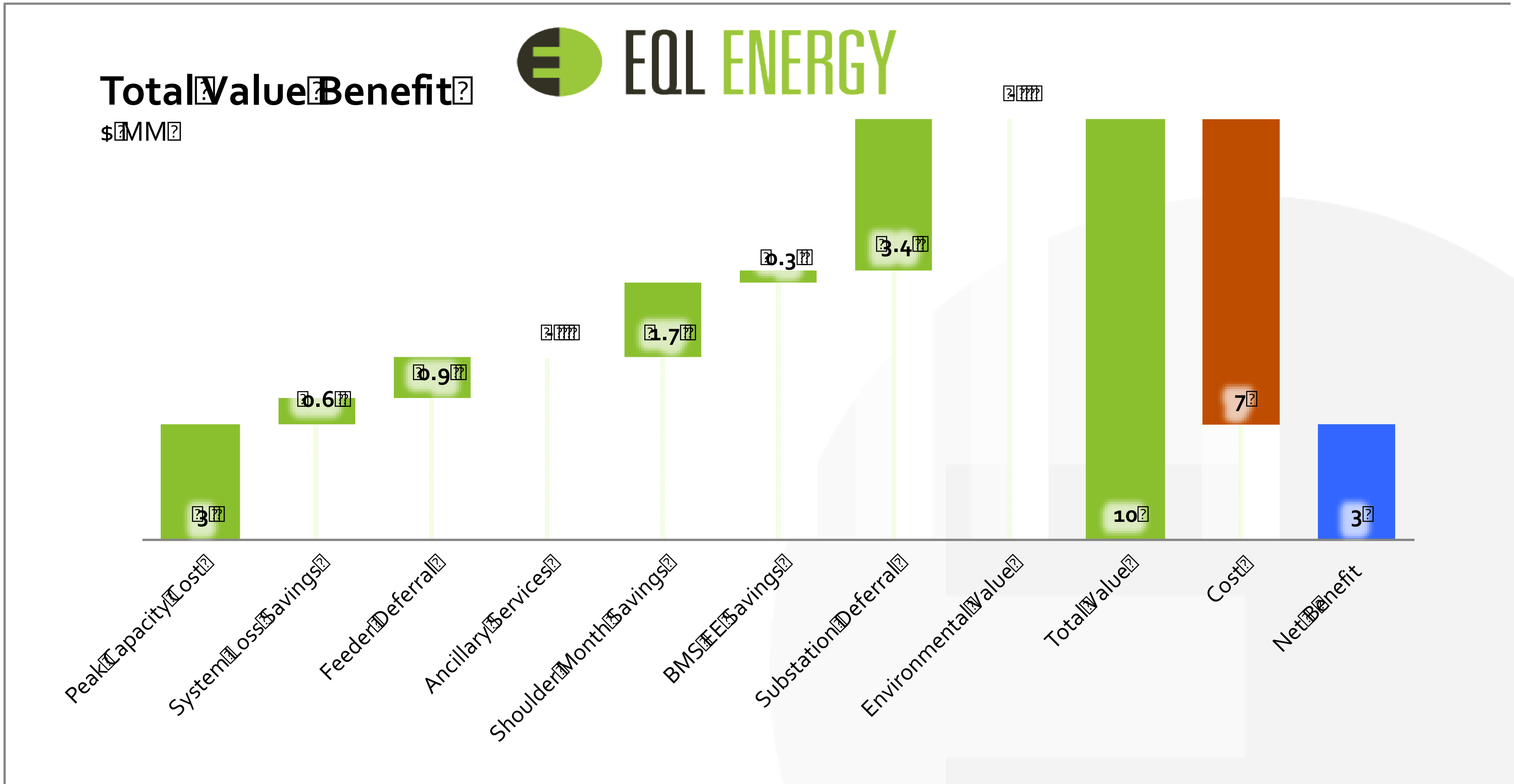
DER for two 69kVA Substations



BMS Measures

Measure	Winter KVA Shed Level 1	Winter KVA Shed Level 2	Summer KVA Shed Level 1	Summer KVA Shed Level 2
Command to Low Speed	4		4	
Command VFD to 50% cfm	0	12	0	12
Convert to Variable Flow Loop	0		0	
Curtail Radiant System	8		8	
Disable Fan Coil Unit Fans	0	0	0	0
Install VFD on Lab Exhaust Fans	83	0	83	0
Lock-Out Elevators	0	120	0	120
Lock-Out EV Chargers	50	0	50	0
Pre-Cool Ice Rink	0	500	0	500
Reduce dP Setpoint	19	0	9	0
Reduce Duct Static Pressure Set Point	321	0	321	0
Reduce Velocity Pressure	9	0	9	0
Remove Bypass Flow Control to dP	11	0	11	0
Shut Off AHU	11	117	11	117
Shut Off Chiller	0	66	0	949
Shut Off DW Booster Pumps	71	0	71	0
Shut Off Electric Boiler	40	0	40	0
Shut Off Heat Pumps	0	108	0	0
Shut Off Heat Recovery	0	146	0	0
Shut Off HR Chiller	0	191	0	0
Shut Off Lights	220	0	220	0
Shut Off Pump	12	21	12	21
Temperature Setback	68	0	274	117
Tune VFD Controls	22	0	22	0
Totals	949	1281	1145	1836

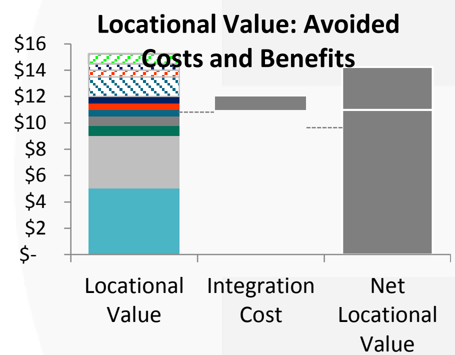
NPV of Substation Capacity DSM

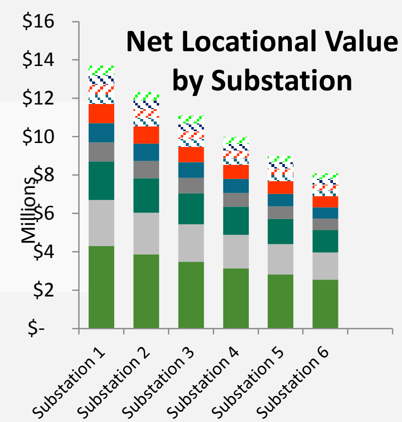


Distribution Resource Planning (DRP)

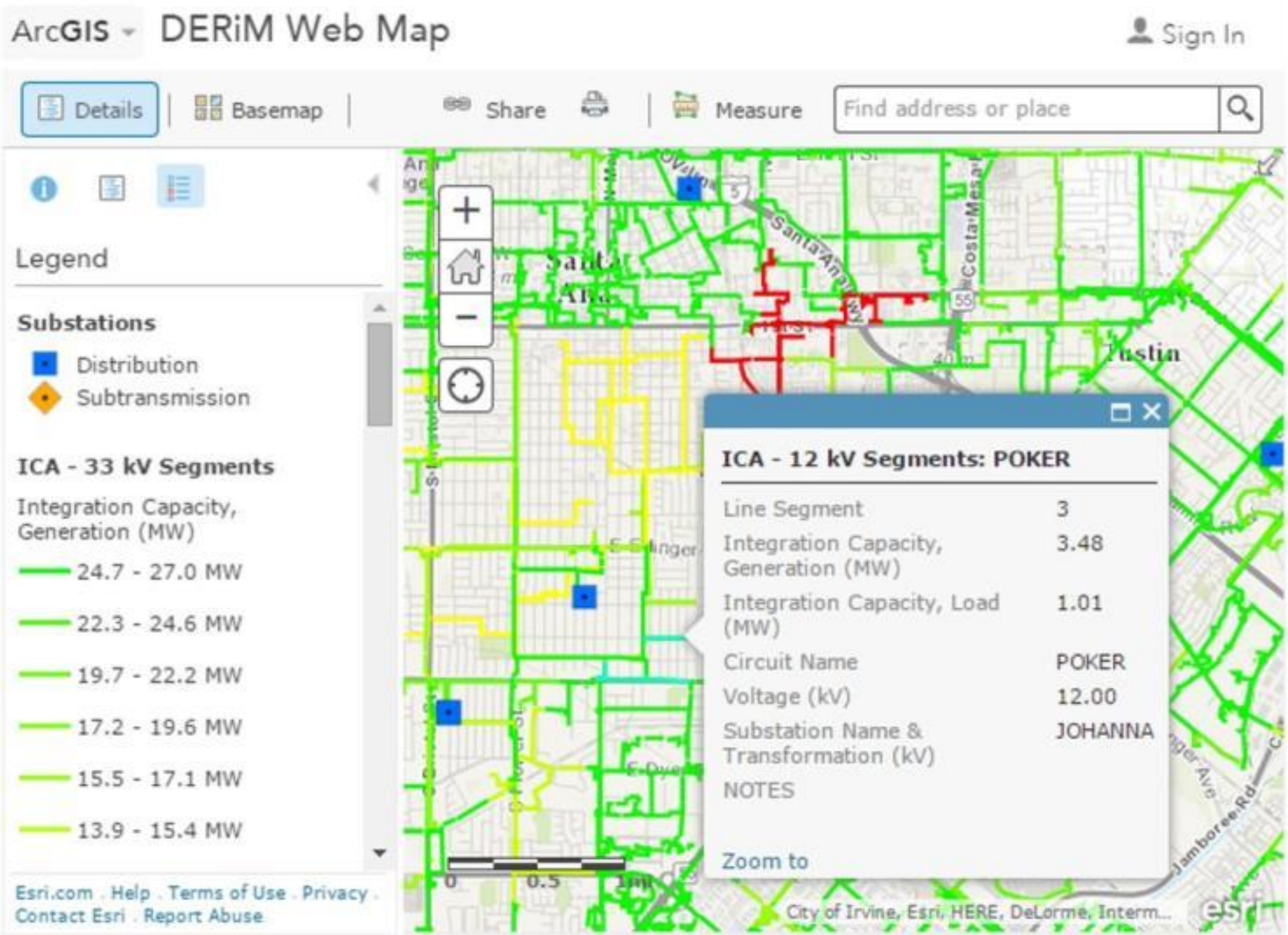
- Purpose is for distribution planning to **include DER** energy capacity, “smart” capabilities, energy efficiency, and market incentives during long-term distribution planning
- These factors would then be balanced against the **avoided costs** of “”traditional” distribution planning

Identify DPA & Substations → Perform Planning Analyses → Calculate Locational Net Value → Rank Substations by Locational Net Value



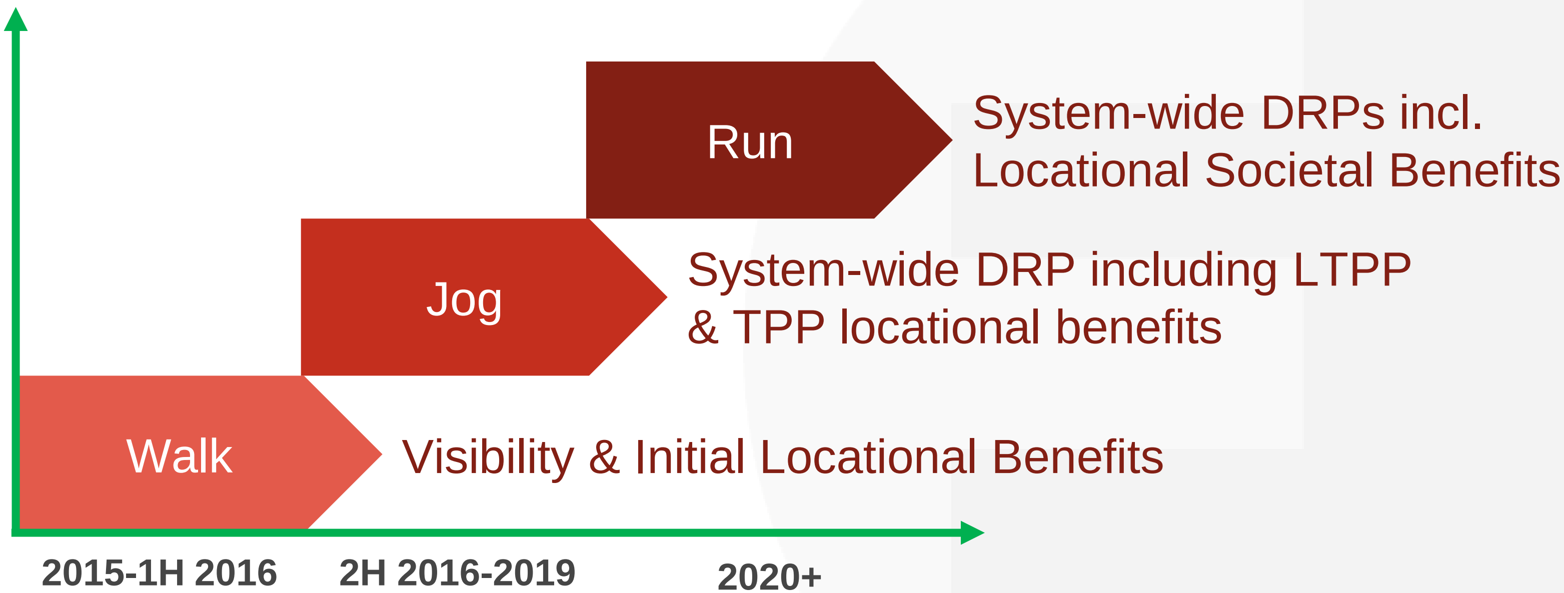


SCE Available Capacity by Line Section

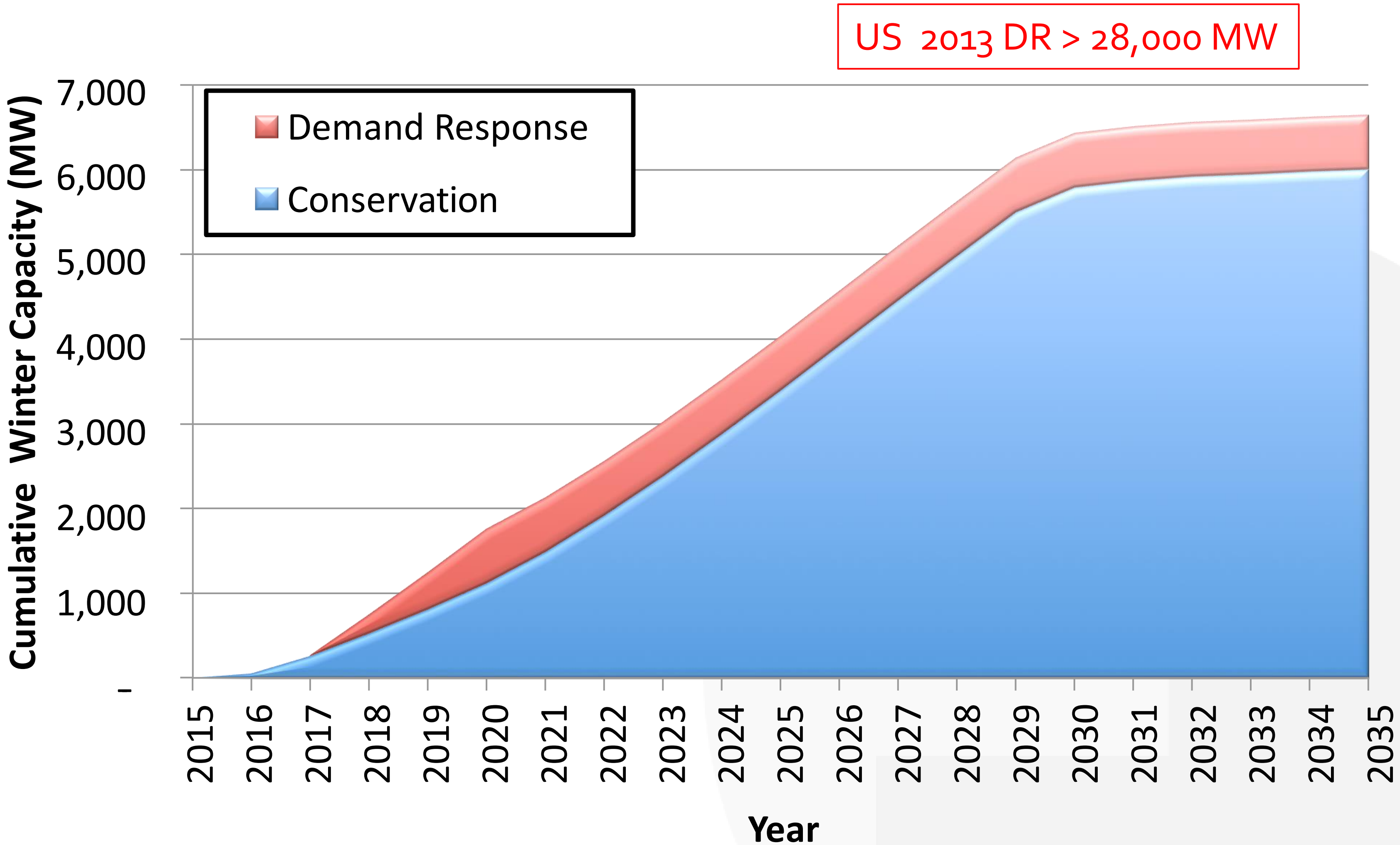


Evolution of DRP Optimal Location Benefits Analysis

- What are the immediate benefit categories that can reasonably be evaluated?
- What are the next logical set (incl. data and tools needed) for system-wide DRPs?

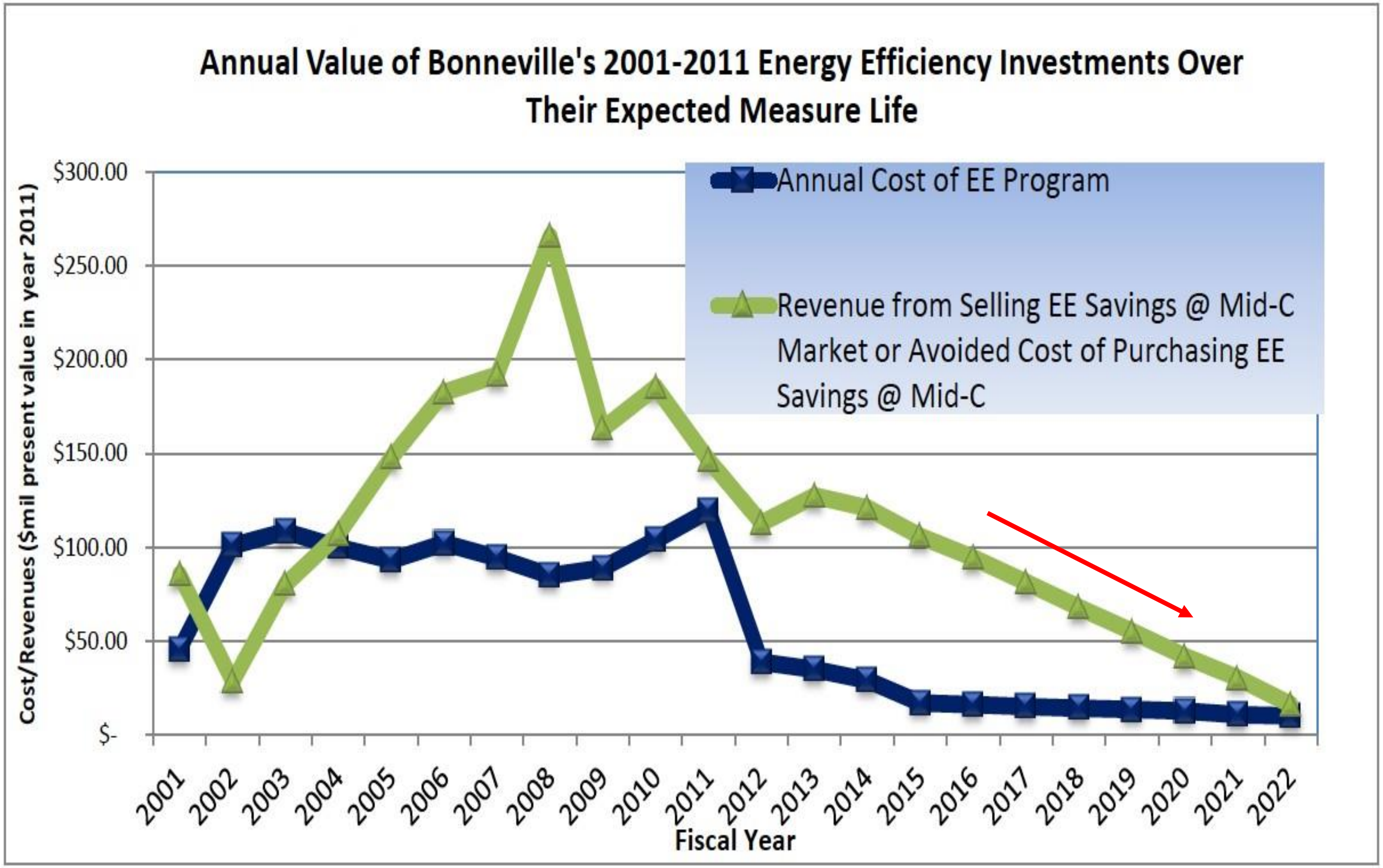


PNW: Conservation and Demand Response Lowest Cost, Lowest Risk

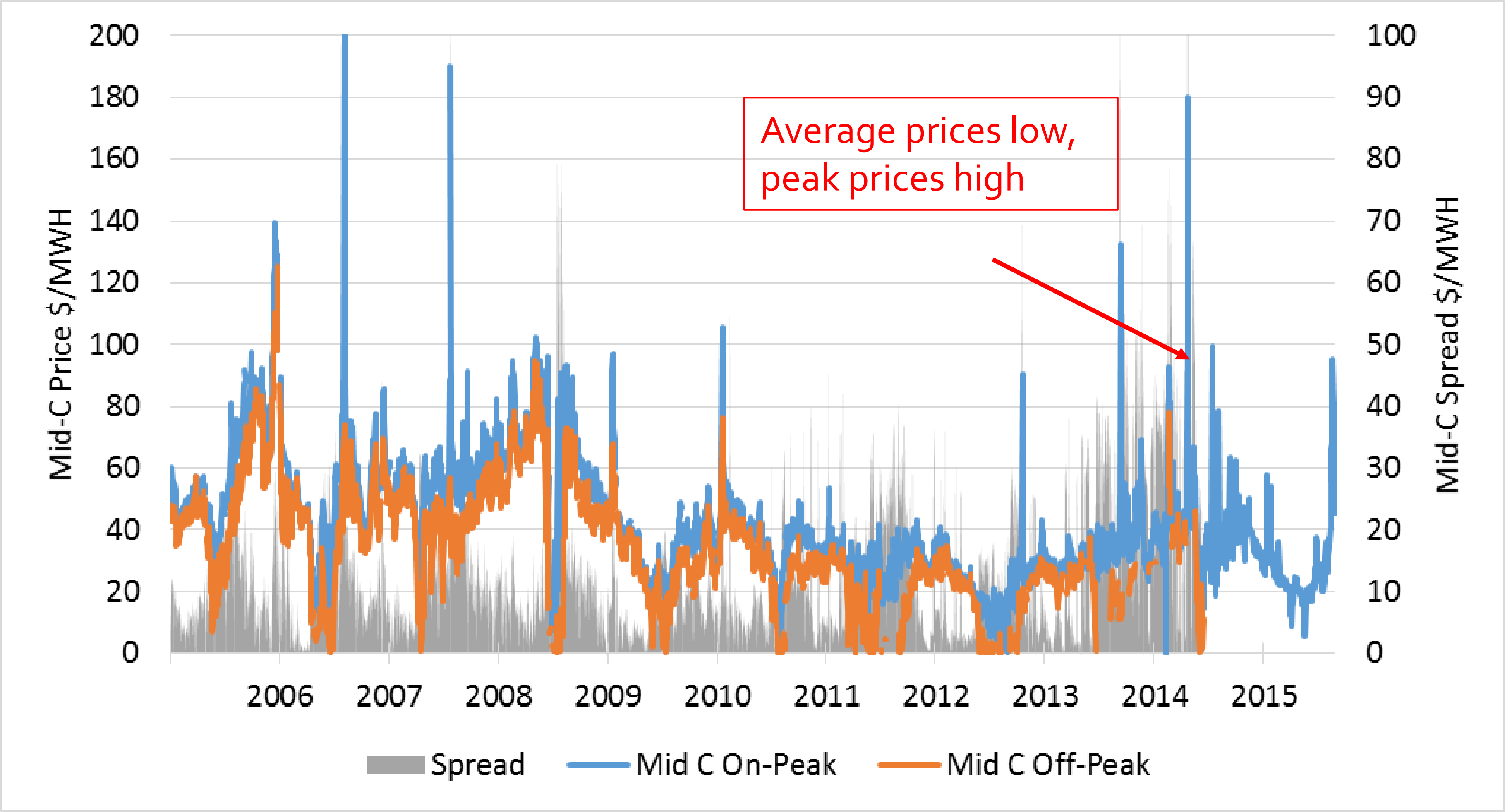


Source: Northwest Power and Conservation Council, Mar. 2015

Energy Efficiency Net Benefit ~$1 Billion for BPA



Focus on Peak Demand Reduction



DER will be 23% of western power by 2022

DER	2022 WECC (MW)[1]	2013 PNW (MW)	2022 PNW Market Potential[2, 3]
Solar (Helena better than Jacksonville FL)	25,000	188	2,300
Combined Heat and Power (CHP)	9,000	15	1,000
Demand Response – Renewable Integration	2,600	0	305
Demand Response – Peak Reduction	4,700	420	1,000
Energy Storage	1,800	5	55
Dispatchable Backup Generators		100	800
Energy Efficiency (amounts not included)			
Total	**43,400**	**713**	**14,660**

1. Source: EQL Energy for Western Interstate Energy Board May 2015,
2. Summary of 2013 TEPPC high DG case, 2013 LBNL
3. http://www.westernenergyboard.org/sptsc/workgroups/dsmwg/webinars/2013/2-HiDSM-DGwebdr.pdf

Stakeholders

- Distribution Utility
- Utility Shareholders
- Regulators
- Ratepayers
- DER owners
- Economic Development
  - (politicians/business associations)
- Solar industry (175,000 employed)
- Cleantech Companies
- Third party DER, Retail energy providers
- Utility Distribution Equipment Vendors
- Concerned Citizens

Summary

Legislative / Regulatory actions

- Support Utility Transition in business models
- Value of ~~solar~~ DER >>> DRP
  - Distribution Resources Planning (CA AB327, WA 2045)
- Utility Roadmaps - pilot>demo>scale
- Combined Heat and Power (WA E2SHB 1095, OR SB 844)
- Support (Mandate) Standards -OpenADR, IEEE1547
- Obtain Demand Response as we have Energy Efficiency (NPCC 7th Plan)

Ken Nichols, Principal, EQL Energy

503 438 8223

ken@eqlenergy.com

www.eqlenergy.com

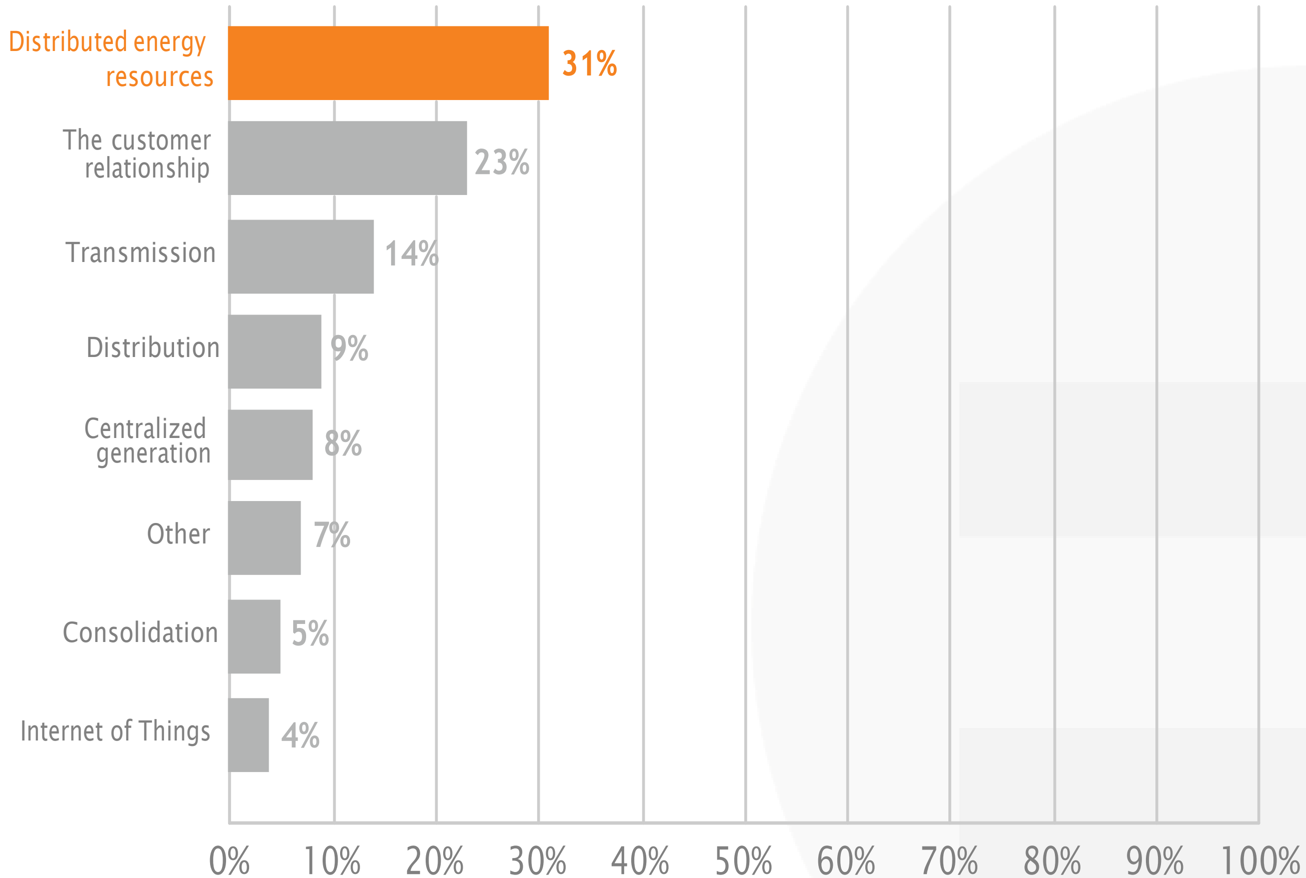
Link to Western Interstate Energy Board paper:
Emerging Changes in Electric Distribution Systems in Western States and Provinces

http://westernenergyboard.org/2015/05/final-report-released-by-eql

Extra Slides

Utility Business Models

What does your utility see as its biggest growth opportunity over the next five years?

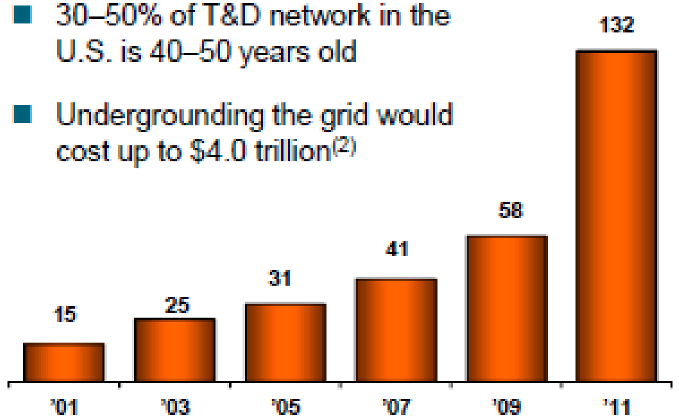


Powerful Macro Trends Drive Home Standby Penetration Opportunity

GENERAC

Aging Grid driving Power Interruptions[1]

- 30–50% of T&D network in the U.S. is 40–50 years old
- Undergrounding the grid would cost up to $4.0 trillion[2]

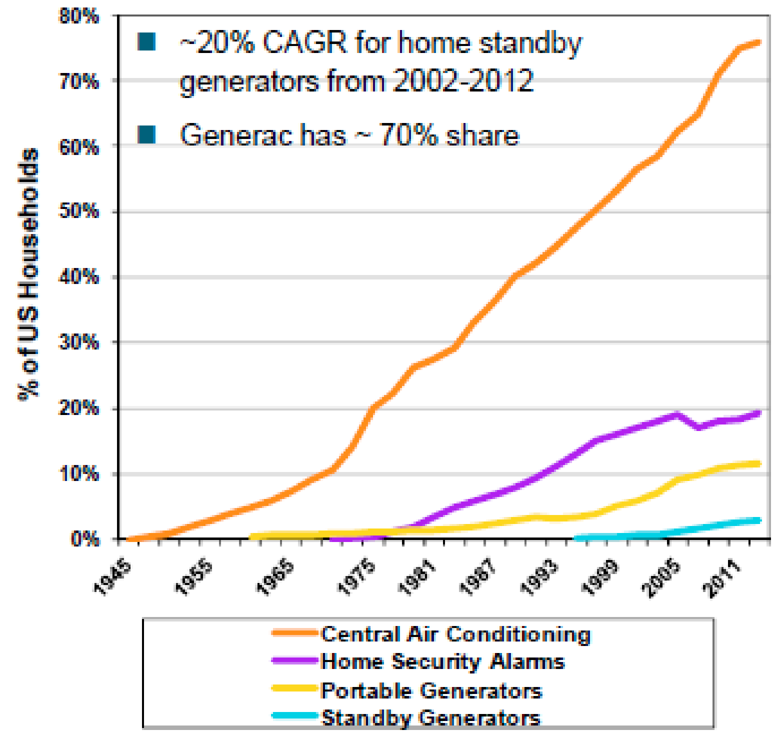


Aging Population fits Demographic[3]

- 75-80% of buyers age 50 and older
- 45-50% of homes valued under $300k
- 85-90% retro-fit application

North American Penetration Opportunity[4]

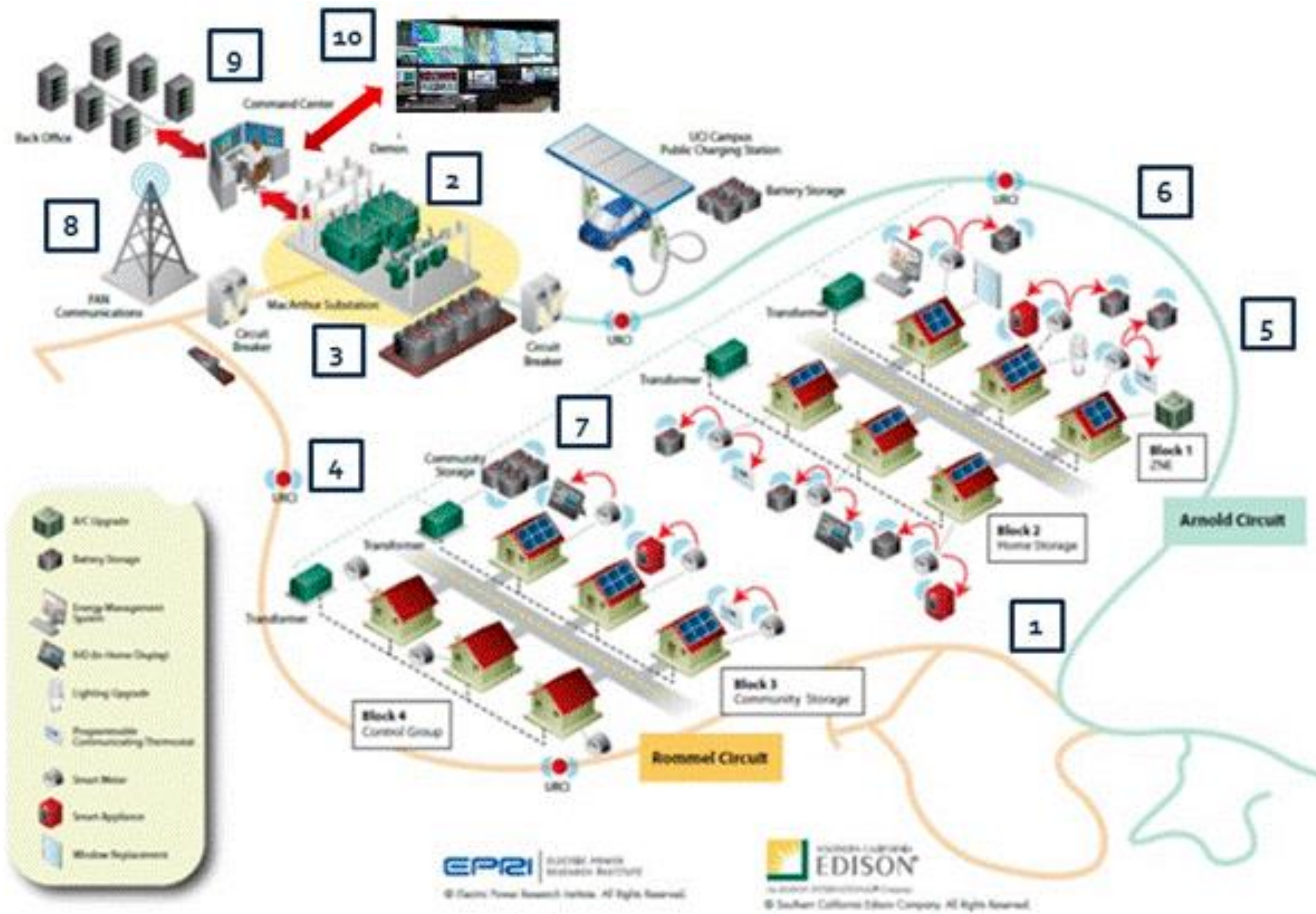
- ~20% CAGR for home standby generators from 2002-2012
- Generac has ~ 70% share



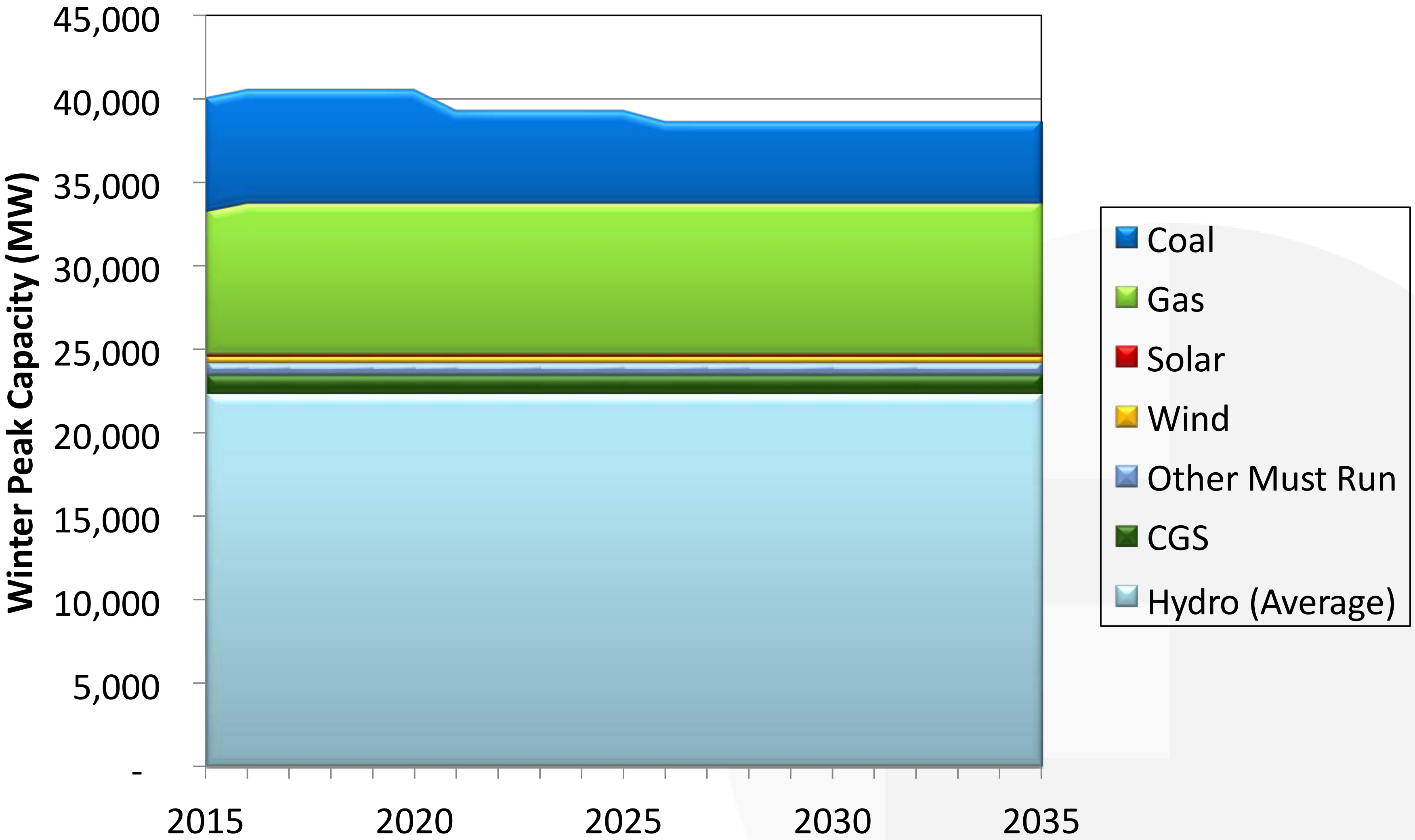
Every 1% of increased penetration equals ~ $2 billion of market opportunity

(1) Source: North American Electrical Reliability Council, U.S. Energy Information Administration. Affecting more than 50,000 customers.
(2) At $1mm/mile.
(3) Source: Company warranty registration data
(4) Source: Management estimates

Utility Distribution of the Future

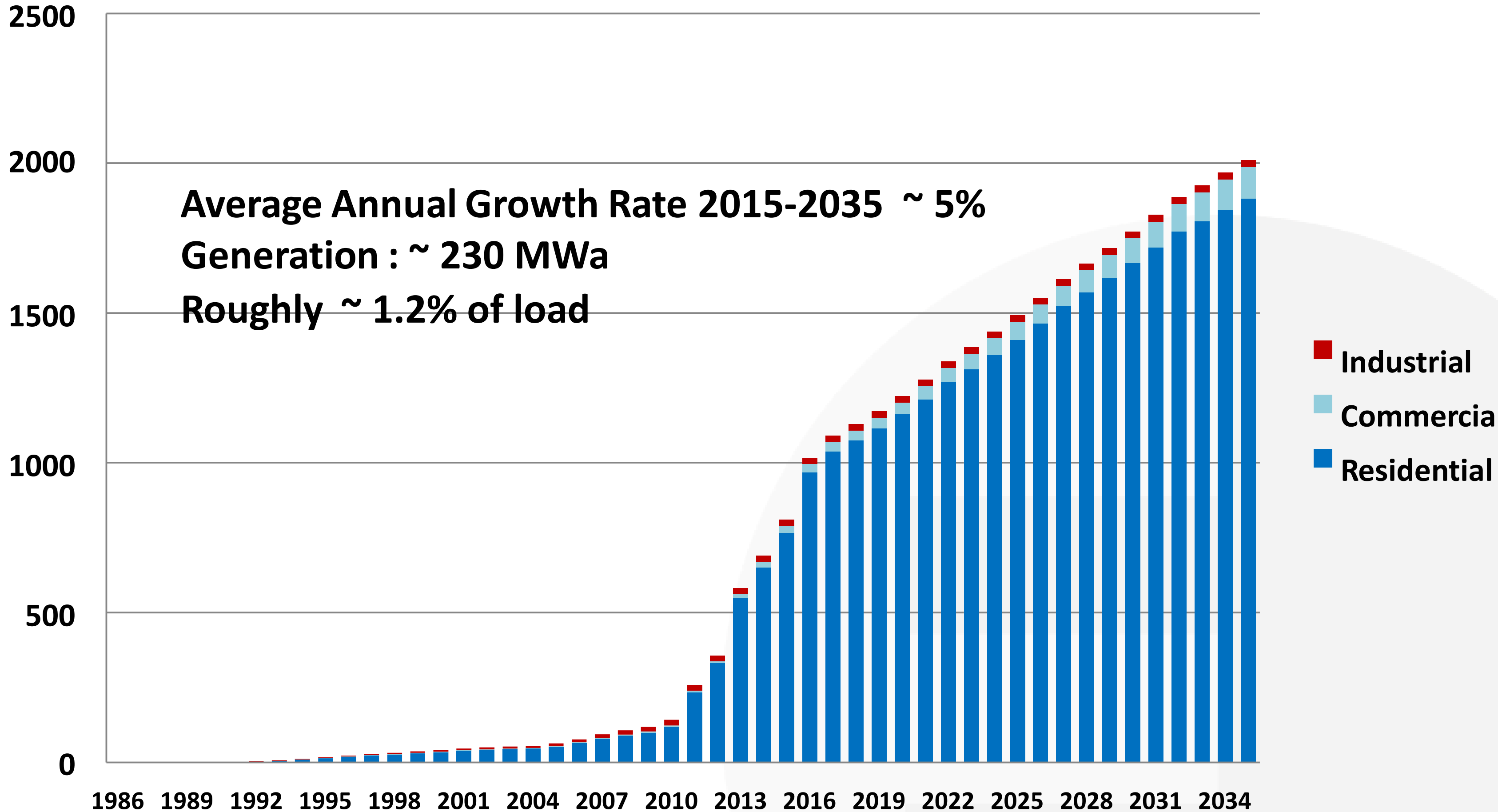


PNW Needs Capacity (MW)



Source: Northwest Power and Conservation Council, Mar. 2015

PNW projection for roof-top solar (GWh)



Source: Northwest Power and Conservation Council, Nov. 2014

Net Metering & Value of Solar

- Net Metering and VOS under review in most states
  - Avoided Costs
    1. Energy Costs
    2. System Generation Capacity Additions
    3. Reduced Transmission line losses (System Losses)
    4. Avoided Transmission and Distribution
    5. Ancillary Services and Grid Support
    6. Avoided Natural Gas Pipeline Costs
    7. Avoided Renewable Costs (RPS states)
    8. Environmental
    9. Financial: Fuel Price Hedge (adjustable mechanism)
    10. Financial: Market Price Response
    11. Security: Reliability and Resiliency (Risk)
    12. Social: Economic Development
    13. "Behind-the-Meter Production During Billing Month
    14. (Valuing the benefit of load reduction from net metering)"
    15. Utility: Integration Costs
    16. Utility: Interconnection Costs
    17. Utility: Administration Costs
    18. "Rate Impacts: Net Metering Credits
    19. (Covers the difference between the retail rate credit for excess generation and the avoided cost rate)"
    20. Rate Impacts: Lost Utility Revenue
    21. Incentive Costs (i.e. utility rebates (NV)
    22. Tax credits (State and Federal)
    23. Location Value

Estimated Value of Solar in Idaho

Component	1 MW DC, yearly	Per MWh
Energy	$43,000 to $48,500	$32 to $35
Line loss	$3,200 to $3,600	$2 to $3
Wheeling	$0 to $6,900	$0 to $5
Peak capacity	$0 to $28,100	$5 to $21
Renewable portfolio standard	$0 to $6,800	$0 to $5
Hedge	$0 to $2,700	$0 to $2
Integration	($1,400) to $0	($1) to $0
Transmission capacity	-	-
Distribution system	-	-
Externalities	-	-
Voltage control	-	-
Total	**$44,900 to $96,700**	**$38 to $71**

EQL ENERGY

British Columbia
- Solar: not now, DR target T&D

Washington
- DRP Proposed (HB 2045)
- Avista - Distribution Automation (DA)

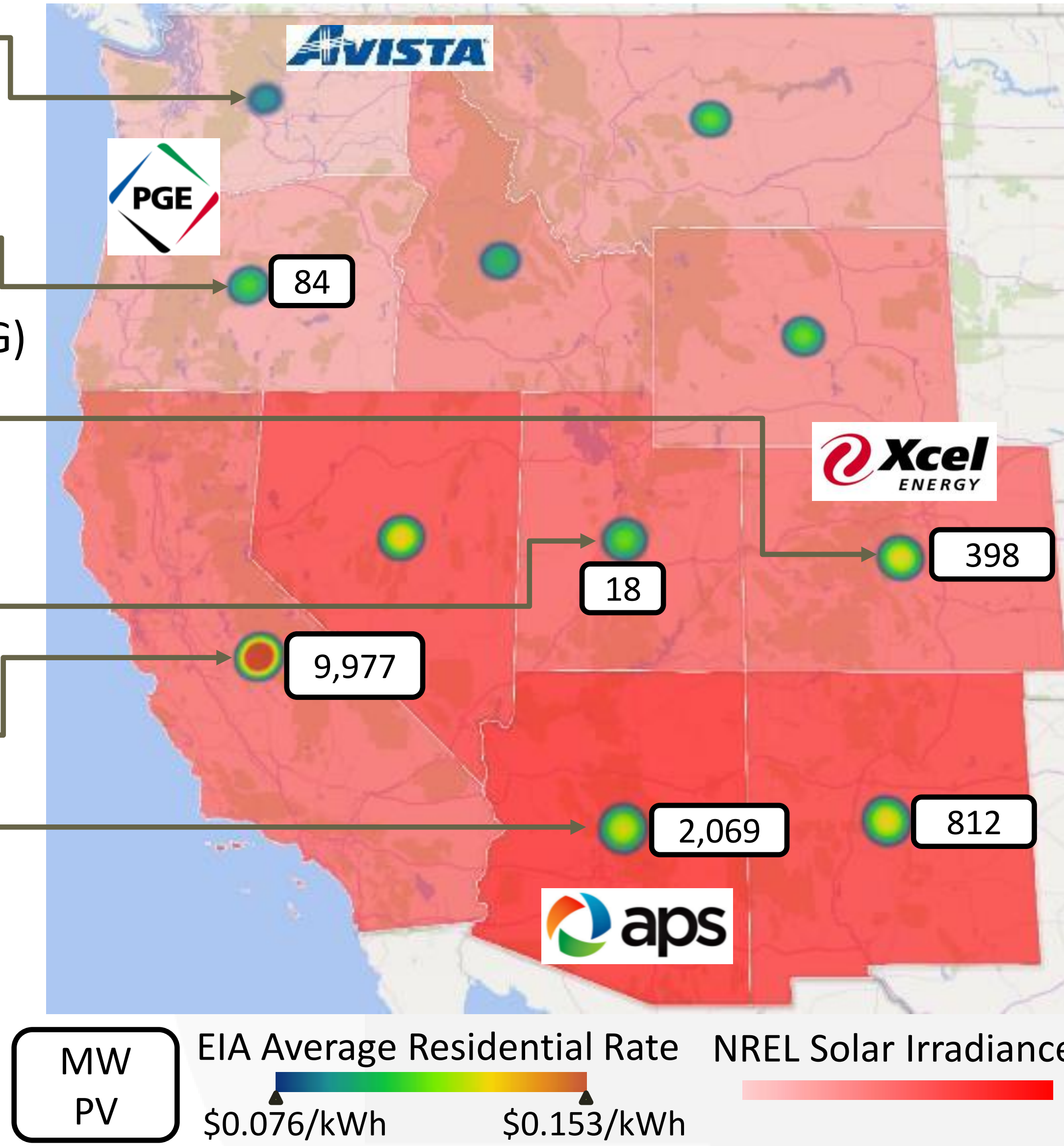
Oregon
- DER Study in PGE IRP
- Dispatchable Standby Generation (DSG)

Colorado
- Wind more pressing concern
- Xcel Energy VVO & DMS Investment

Utah
- Growth potential: QF and utility solar

California
- Distribution Resources Planning
- 12,000 MW DER Target
- Push for DER other than PV (storage)

Arizona
- IOU Rooftop Solar Pilot
- APS VVO, DMS, & DA



Distribution Resources Planning Purposes (1)

- Identify optimal locations for Distributed Energy Resources
- Evaluate locational benefits of DERs based on:
  - Reductions versus increases in local generation capacity needs
  - Avoided costs versus increased investment for distribution infrastructure, safety benefits, reliability benefits
  - Any other savings or costs that DERs may provide to the grid or to ratepayers
- Integrated Capacity Analysis
- Propose or identify standard tariffs, contracts, or other mechanisms for deployment of cost-effective DERs that satisfy distribution planning objectives

DRP Process: “More Than Smart (MTS)” Working Group

- Purpose:
  - **Provide an open, voluntary stakeholder forum** to discuss core issues
- Objectives:
  - Define common parameters for the development of distribution planning scenarios
  - Identify and define the integrated engineering-economic analysis required to conduct distribution planning in the context of AB 327 requirements
  - Identify the considerations to meet customers’ needs and California’s policy objectives.
  - Define the scope and parameters of an operational/DER market information exchange
  - Define distribution services associated with identified DER values, including performance requirements

DER Wholesale Value Components (1/2)

EQL ENERGY

Objective is to define a list of **mutually exclusive and collectively exhaustive (MECE)** value categories

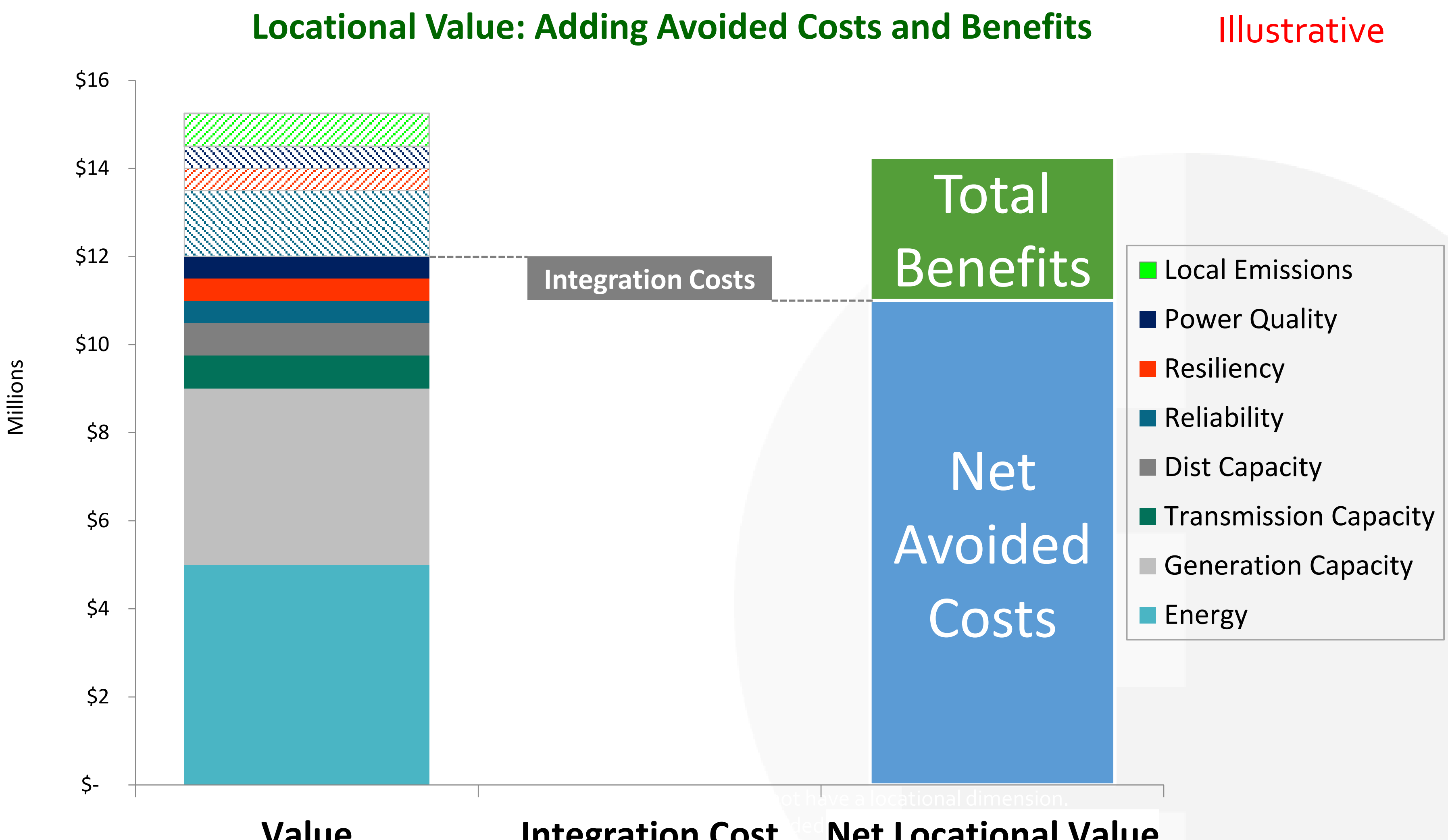
	Value Component	Definition
Wholesale	**WECC Bulk Power System Benefits**	Regional BPS benefits not reflected in System Energy Price or LMP
	CA System Energy Price (NEM 2.0)	Estimate of CA marginal wholesale system-wide value of energy
	Wholesale Energy	Reduced quantity of energy produced based on net load
	Resource Adequacy (NEM 2.0 modified)	Reduction in capacity required to meet Local RA and/or System RA reflecting changes in net load and/or local generation
	Flexible Capacity	Reduced need for resources for system balancing
	Wholesale Ancillary Services (NEM 2.0)	Reduced system operational requirements for electricity grid reliability including all existing and future CAISO ancillary services
	RPS Generation & Interconnection Costs (NEM 2.0)	Reduced RPS energy prices, integration costs, quantities of energy & capacity
	Transmission Capacity	Reduced need for system & local area transmission capacity
	Generation/DER Deliverability	Increased ability for generation and DER to deliver energy and other services into the wholesale market
	Transmission Congestion + Losses (NEM 2.0 modified)	Avoided locational transmission losses and congestion as determined by the difference between system marginal price and LMP nodal prices
	Wholesale Market Charges	LSE specific reduced wholesale market & transmission access charges

DER Distribution Value Components (2/2)

EQL ENERGY

	Value Component	Definition
Distribution	Subtransmission, Substation & Feeder Capacity (NEM 2.0 modified)	Reduced need for local distribution system upgrades
Distribution	Distribution Losses (NEM 2.0)	Value of energy due to losses between wholesale transaction and distribution points of delivery
Distribution	Distribution Steady-State Voltage	Improved steady-state (generally >60 sec) voltage, voltage limit violation relief, reduced voltage variability, compensating reactive power
Distribution	Distribution Power Quality	Improved transient voltage and power quality, including momentary outages, voltage sags, surges, and harmonic compensation. *May also extend the life of distribution equipment*
Distribution	Distribution Reliability + Resiliency+ Security	Reduced frequency and duration of outages & ability to withstand and recover from external natural, physical and cyber threats
Distribution	Distribution Safety	Improved public safety and reduced potential for property damage
Customer & Societal	Customer Choice	Customer & societal value from robust market for customer alternatives
Customer & Societal	CO_2 Emissions (NEM 2.0 modified)	Reductions in federal and/or state carbon dioxide emissions (CO_2) based on cap-and-trade allowance revenue or cost savings or compliance costs
Customer & Societal	Criteria Pollutants	Reduction in local emissions in specific census tracts utilizing tools like CalEnviroScreen. Reduction in health costs associated with GHG emissions
Customer & Societal	Energy Security	Reduced risks derived from greater supply diversity and less lumpiness
Customer & Societal	Water Use	Synergies between DER and water management (electric-water nexus)
Customer & Societal	Land Use	Environmental benefits & avoided property value decreases from DER deployment instead of large generation projects
Customer & Societal	Economic Impact	State and/or local net economic impact (e.g., jobs, investment, GDP, tax income)

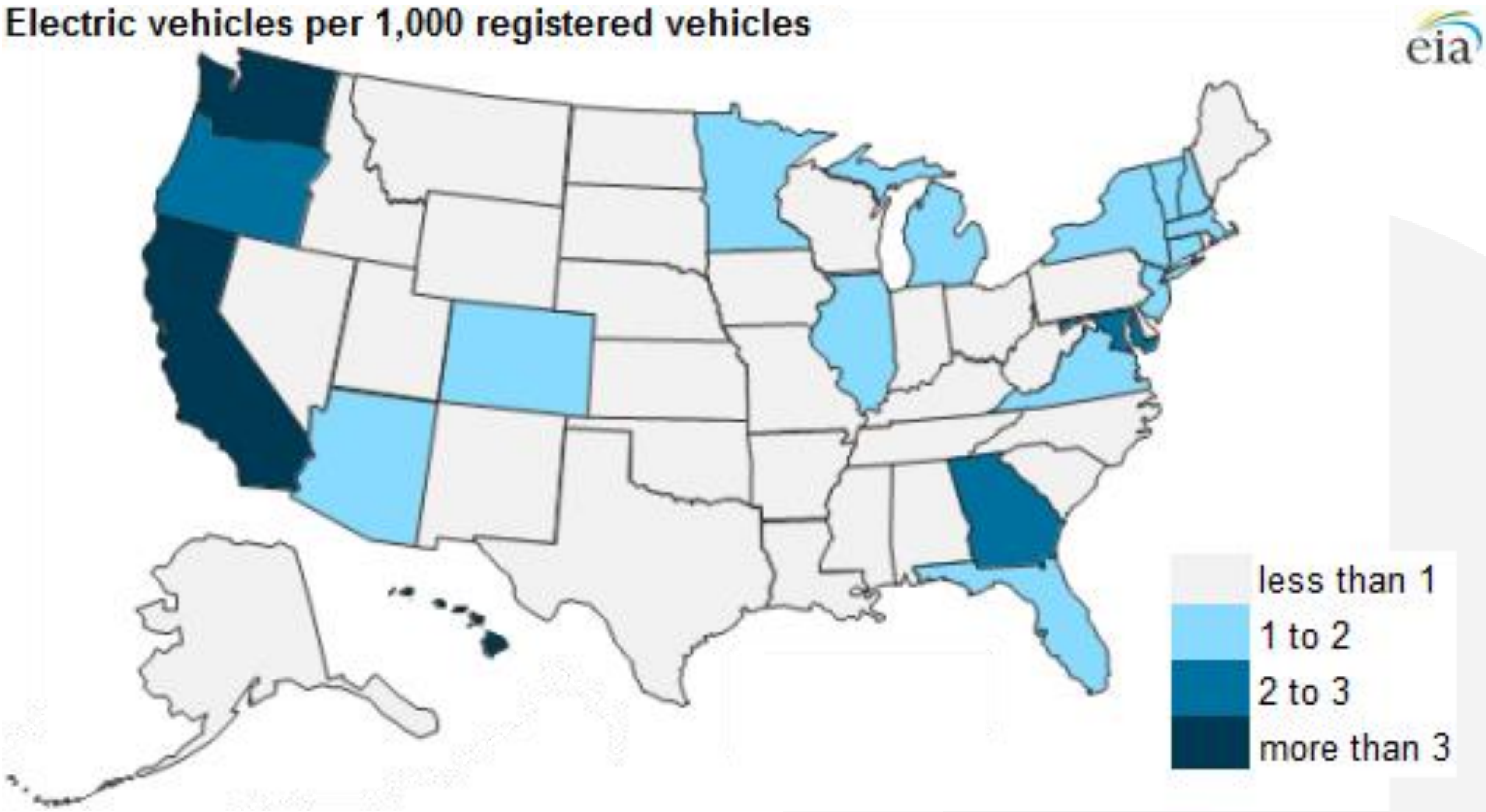
Locational Value: Assessment of DER by Adding Avoided Costs and Benefits



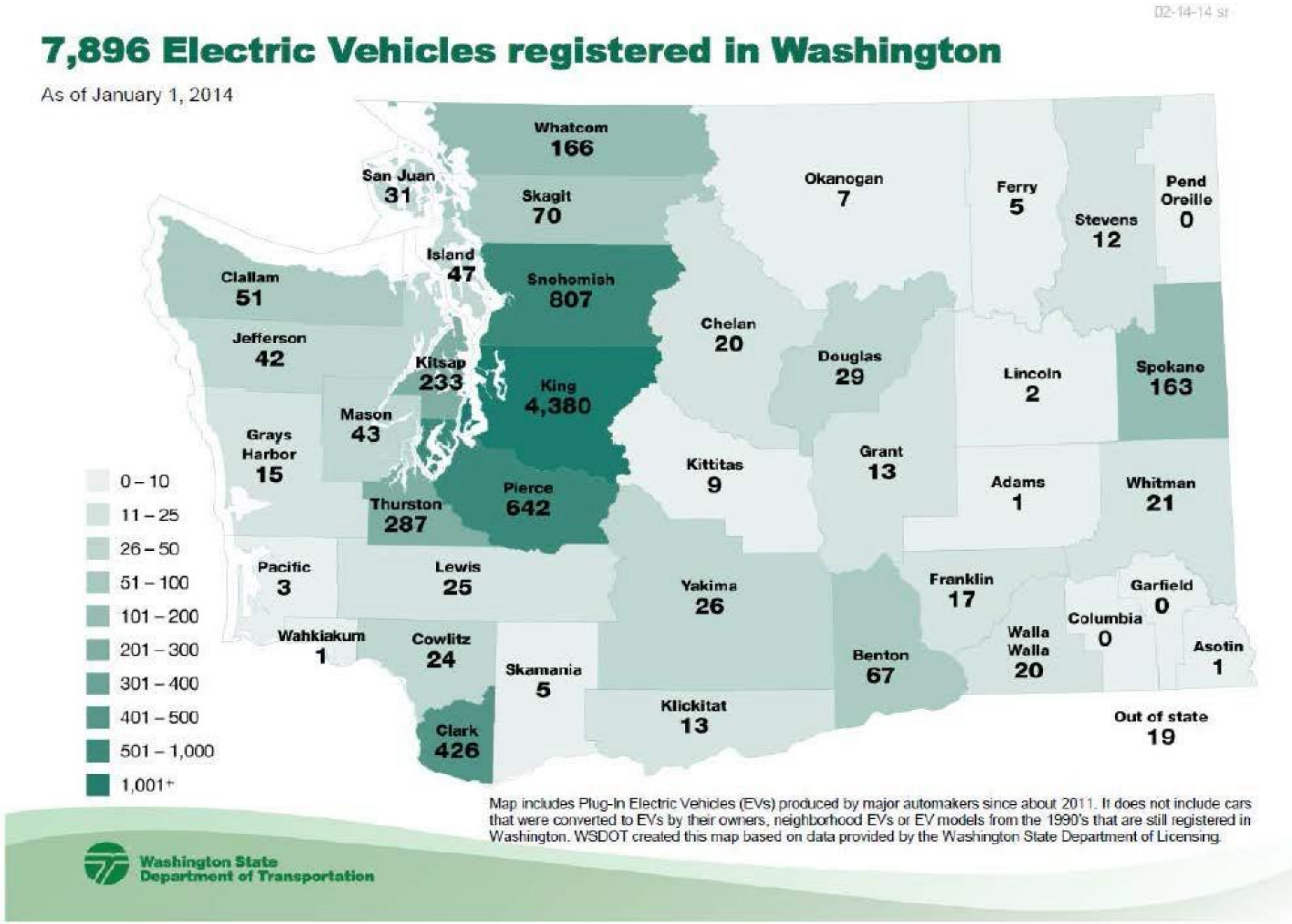
WIEB/SPSC Report: Essential Recommendations

- **Develop long term distribution planning roadmaps**
  - ✓ Use Open Stakeholder process for roadmap
  - ✓ Include if and when formal DRPs are necessary for which locations
  - ✓ Include risk assessments of technologies and reliability of resources
- **Do not re-invent what has already been achieved**
  - ✓ Use existing DRP costing methodology, as applicable
  - ✓ Follow SIWG technological requirements and IEEE 1547 standard
  - ✓ Use existing integration and communication standards for interoperability
- **Address cost allocation early**
  - ✓ Focus on "least regrets" solutions
  - ✓ Enhance market equitability ("fairness") over time (not just the last DER)
  - ✓ Provide pricing and investment stability
  - ✓ Minimize technological obsolescence

Addressing EV Load Growth

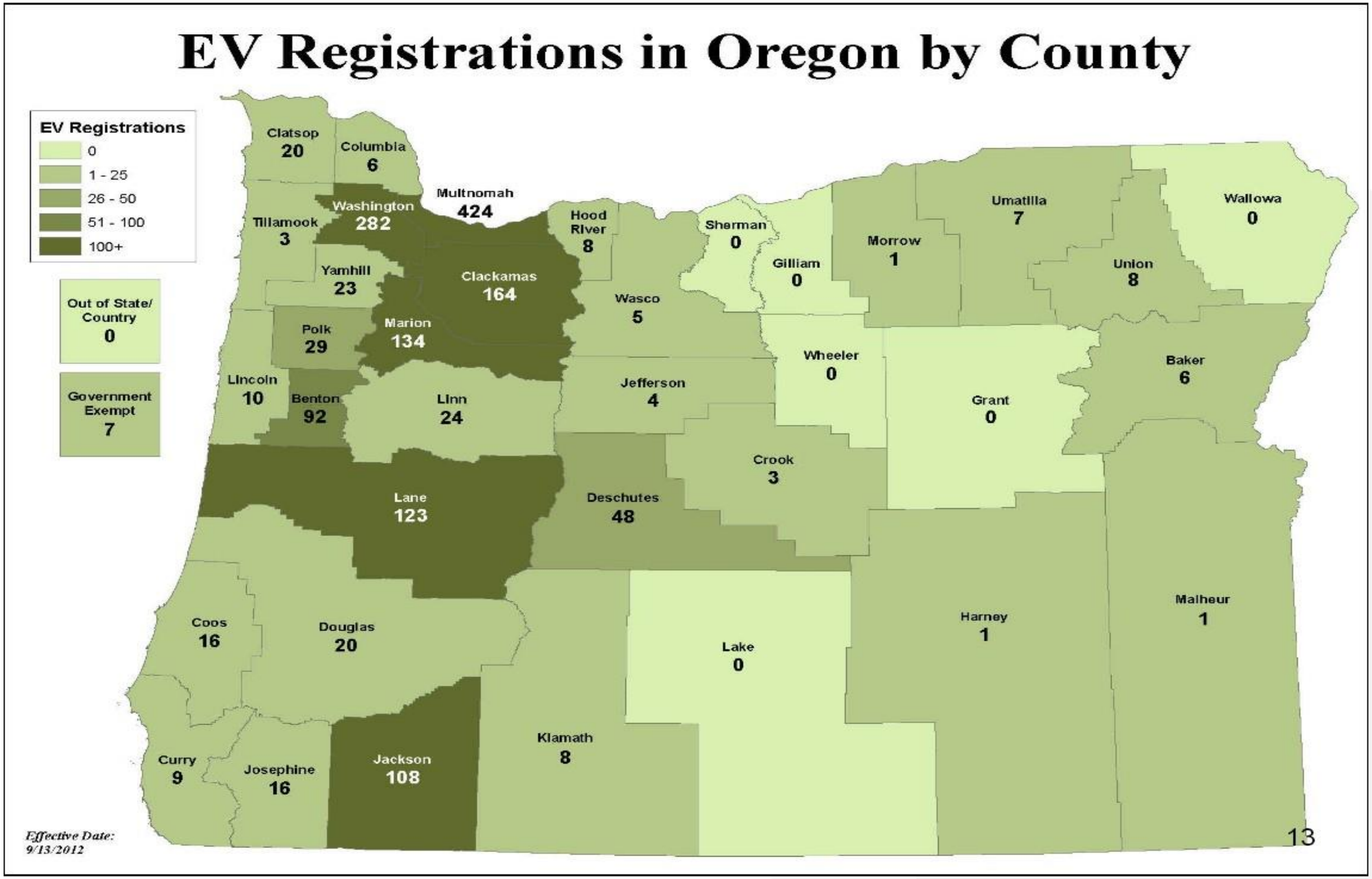


EV Cars in Urban Markets

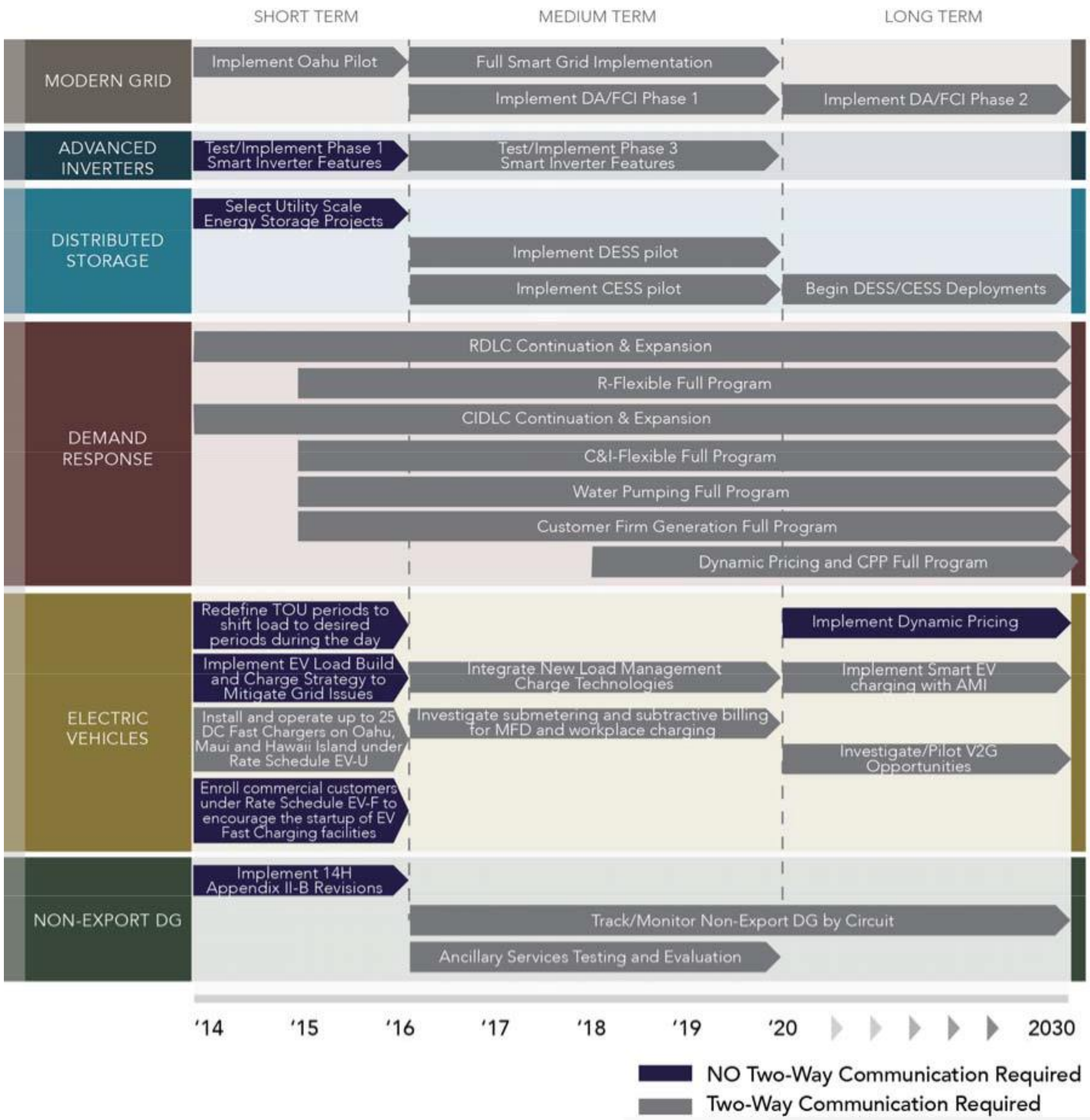


Source: Washington State Department of Transportation

EV Cars in Urban Markets



Roadmaps



SHORT TERM
MEDIUM TERM
LONG TERM
MODERN GRID
Implement Oahu Pilot
Full Smart Grid Implementation
Implement DA/FCI Phase 1
Implement DA/FCI Phase 2
ADVANCED INVERTERS
Test/Implement Phase 1 Smart Inverter Features
Test/Implement Phase 3 Smart Inverter Features
DISTRIBUTED STORAGE
Select Utility Scale Energy Storage Projects
Implement DESS pilot
Implement CESS pilot
Begin DESS/CESS Deployments
DEMAND RESPONSE
RDLC Continuation & Expansion
R-Flexible Full Program
CIDLC Continuation & Expansion
C&I-Flexible Full Program
Water Pumping Full Program
Customer Firm Generation Full Program
Dynamic Pricing and CPP Full Program
ELECTRIC VEHICLES
Redefine TOU periods to shift load to desired periods during the day
Implement Dynamic Pricing
Implement EV Load Build and Charge Strategy to Mitigate Grid Issues
Integrate New Load Management Charge Technologies
Implement Smart EV charging with AMI
Install and operate up to 25 DC Fast Chargers on Oahu, Maui and Hawaii Island under Rate Schedule EV-U
Investigate submetering and subtractive billing for MFD and workplace charging
Investigate/Pilot V2G Opportunities
Enroll commercial customers under Rate Schedule EV-F to encourage the startup of EV Fast Charging facilities
NON-EXPORT DG
Implement 14H Appendix II-B Revisions
Track/Monitor Non-Export DG by Circuit
Ancillary Services Testing and Evaluation
'14
'15
'16
'17
'18
'19
'20
2030
NO Two-Way Communication Required
Two-Way Communication Required

Without Planning DER integration may be utility asset heavy

EQL ENERGY

Item	Violation Trigger	Total
Installed DG (MW)		902
Regulator	Feeder Reverse Flow	$308,000
LTC	Substation Transformer Reverse Flow	$1,642,000
Reconductoring	Exceed 50% Backbone Conductor/Cable	$75,588,700
Substation Transformer and Switchgear	Exceed 50% Capacity	$54,766,000
Distribution Transformer	Exceed 100% Loading, % GDML Linear Relationship to % Transformers Upgraded	$15,617,535
Poles and Secondary	Assumed 15% of Distribution Transformer Replacements need poles/secondary	$3,533,342
Grounding Transformers	Exceed 33% GDML (66% in model)	$43,045,200
Total		**$194,500,777**