Weaving the DER Pieces Together in the 'Land of Steady Habits'

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Outline of presentation

- Why is Connecticut called the 'Land of Steady Habits' and how is change important
- Policies and practices that make Connecticut a leader in implementing DER investments to provide T&D services
  - What services and what benefits?
  - How are these investments evaluated? And by whom?

Exploring the 'Land of Steady Habits'

- Nickname reflects Connecticut's history of political, social, and religious conservatism, but with a modern counterpoint economic development and tourism campaign built around the theme, "Still Revolutionary"
  - Still Revolutionary "tells the stories of companies that are inventing the future today through innovation …showcasing …groundbreaking advances that are happening in Connecticut because of the forward-thinking companies that do business in the state."

    -- Connecticut Governor Dannel Malloy, 17 September 2012
- These themes reflect Connecticut's progress on DER policies, which is steady, broad, and deep, and at the same time innovative and even groundbreaking

Connecticut's Example: Major Pieces of DER Policy Regime

- Comprehensive energy strategy law (2012) – requires triennial updates of the state's strategies by the Department of Energy and Environmental Protection (most recent, 2018)
- Comprehensive grid modernization (Executive Order No. 59, Docket No. 17-07-32, and Docket No. 17-12-03)
- Public Purpose Microgrids Program (since 2012)
- Broad "Conservation & Load Management Plan"
  - Energy efficiency resource standard (EERS) laws passed in 2007 and 2013, covering all IOUs
  - Requires pursuit of "all cost-effective efficiency"
  - Averaging 1.51% of annual sales, 2016-18.
- Global Warming Solutions Act (Public Act 08-98) – Goal: reduce GHG 80% below 2001 levels by 2050

Connecticut's Example: Working on grid-modernization

Jurisdiction	Broad Grid-Modernization Proceeding(s)	Business Model Review/Revisions	DER in IRP	DSP	Geo-targeting, Microgrids, Non-wire alternatives	Energy Storage Studies, Procurement	Other
Connecticut	Yes	Yes	Yes	Yes	G, M, NWAs	Yes	Broad rate reform docket; Green Bank, RGGI, EERS, C-PACE, EV & BRT programs
Hawaii	Yes	Yes	Yes	Yes	G, M, NWAs	Yes	BTM energy storage rates
New York	REV	Yes	Yes	Yes	G, M, NWAs	Storage demonstration projects	Rate reform docket; DER value and compensation docket

- Connecticut is one of only three states working on all six of these grid-modernization actions, plus related efforts

Connecticut's Example: Implementing multiple DER projects

- Statewide public purpose microgrids program, serving critical use facilities during wide-area grid outages
  - 5 operational, 5 under development, many more in planning and design
- Conservation & Load Management Plan
  - On-bill repayment
  - Includes focus on heating oil and propane conservation
  - Major focus on serving low-income customers with energy efficiency and renewable energy programming
- 2016 Department of Environmental and Energy Programs RFP for long-term contracts, <20MW each
  - 25 bids selected, totaling >400MW of capacity
  - Includes 34MW of energy efficiency projects

Some of Connecticut's Key Terms and Guiding Principles

- Consistent, holistic actions, leadership, and collaborating for achieving a lower-cost, cleaner, more reliable energy future
- Leveraging private capital, tracking progress toward climate goals, and catalyzing jobs in the energy efficiency industry
- Strategically expanding electrification
- Advancing energy efficiency market transformation
- Intersections: energy, health, and safety
- Intersections: energy, jobs, economic development, and competitive advantage through energy productivity

Some of Connecticut's Key Terms and Guiding Principles

Breakthroughs? Barriers? Both?

The 2018 Connecticut Comprehensive Energy Strategy includes:

- "Collaborating with property and insurance industries …and other sectors not traditionally linked to energy, to create long-term, sustainable funding mechanisms…"
- A proposal to study the natural gas/electric nexus, vis a vis reliability and resilience
- A proposal for utilities to help "… identify locations where critical facilities are located within geographic proximity of each other and share this information… ."
- Plans for both behind the meter DG and Shared Clean Energy Facilities (e.g. community solar), but the benefit-cost analysis assumes non-participant subsidies and does not analyze options for optimizing benefits (e.g. using battery & thermal storage), nor for smart-inverters to produce and deliver grid services

Non-Wire Alternatives (NWAs)

- Connecticut is committed to filing NWA projects as part of the large facility Demand Response Pilots in the 2017 update of its 2016-18 C&LM Plan. For these pilots, utilities will consider geo-targeting areas across Connecticut that have been identified by ISO New England and other energy stakeholders as critical peak demand reduction areas.
- Outside of the energy efficiency program planning process, Connecticut utilities are also considering NWA projects as part of their Grid Side Enhancement Demonstrations.

Source: Northeast Energy Efficiency Partnerships, *A Look Inside the Region's Latest Non-wires Alternative Projects and Policies* [Web page]. http://www.neep.org/blog/look-inside-region%E2%80%99s-latest-non-wires-alternative-projects-and-policies

CT legislation supports Localized targeting of DER

- "Localized targeting" means implementing DER where it will provide the greatest value to the utility system as a whole
- Conn. Gen. Stat.§16-244w. "demonstrating and investigating how [DER] …can be reliably and efficiently integrated into the operation of the electric distribution system in a manner that maximizes the value provided to the electric grid, electric ratepayers and the public… ."
- Proposals "shall be approved by [PURA] if the authority concludes that investment in such grid-side system enhancement is reasonable, prudent and provides value to ratepayers."
- "The costs of the proposals [shall] be recovered from all customers through… electric rates for all customers of the electric distribution company pursuant to Conn. Gen. Stat. §16-244w(c)."

Source: PURA 24 January 2018 Order in Docket No. 17-06-03

United Illuminating Company's geo-targeting program (1)

- Program includes: (1) targeted marketing of existing conservation & load management programs; (2) modified interconnection conditions; and, (3) "incentivizing DER rate rider."
  - Incentive will require "battery-ready advanced inverters" configured for "riding through certain electric system disturbances and allow the utility to specify various control settings [e.g. voltage control and reactive power] to provide system benefits"
- Goals: increase customer or third-party owned, behind the meter, residential solar PV installations from <1% to 10% of customers on two selected substation circuits, and to achieve peak demand reductions of over 1MW per circuit.
- Two specific distribution circuits are targeted because they are at risk of exceeding their rating, over a five-year planning horizon

Source: PURA 24 January 2018 Order in Docket No. 17-06-03

UI geo-targeting program (2)

- If successful, residential and commercial DER adoption from solar PV, energy storage, and other base load DG will increase DER nameplate capacity from 2% to at least 15% of combined circuit ratings, which would be higher than any other United Illuminating Company circuit.
- This level may be sufficient to defer a distribution capacity investment for the two Ash Creek substation circuits: If so, the experience gained this program may be applied to future planning efforts."
- DG participants will be compensated for their lost production opportunity, if they deliver ancillary services when needed, instead of energy.

Source: PURA 24 January 2018 Order in Docket No. 17-06-03

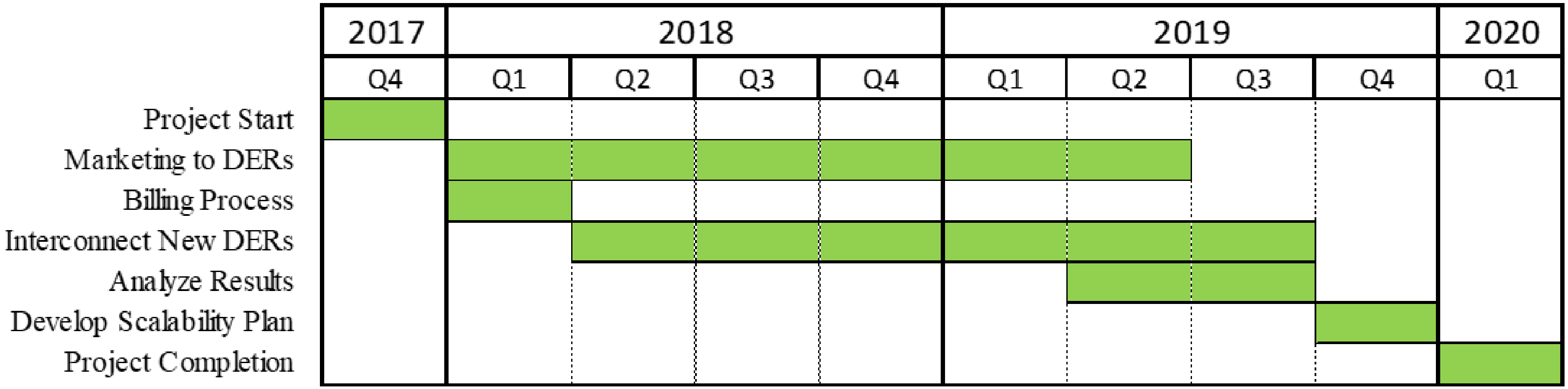
UI geo-targeting program (3)

- "Absent implementation and success of the Localized Targeting project, the Company would apply a traditional utility approach to relieving the load on circuit 2660: construction of a new distribution circuit to provide 4.9 megawatts of load relief at an estimated cost of $625,000."
- Advanced inverter settings to include voltage regulation, real and reactive power output

Source: PURA 24 January 2018 Order in Docket No. 17-06-03

UI geo-targeting program (4)

- UI proposed localized targeting program timeline:



- DER geo-targeting has to work in "Goldilocks" time – not too fast and not too slow – allowing ample time to nurture sufficient DER resources, to avoid specific T&D expenses

Source: 1 June 2017, United Illuminating Company Application in PURA Docket No. 17-06-03, Attachment 3, *Localized Targeting of DERs*

UI geo-targeting program (5)

- Integrates with existing state objectives

	Targeting of DERs	
Innovative Marketing	✓	Targeted marketing campaigns to engage customers
Deferred Costs	✓	Customer DERs defer a distribution capacity upgrade
Proactive Planning		
Energy Storage		
Transparency	✓	Stakeholders are engaged to address a local need
Procurement	✓	Solarize model is used for economies of scale
Policy Change	✓	Results inform future interconnection standards
Existing Synergies	✓	Existing programs are leveraged
Other	✓	DER transmission disturbance ride through capability

Source: 1 June 2017, United Illuminating Company Application in PURA Docket No. 17-06-03, Attachment 3, *Localized Targeting of DERs*

UI geo-targeting program (6)

- UI proposal to PURA for evaluating the program…

Use Case	Metric	Measures of Success
Effectiveness of localized targeting	Customer participation in existing programs and the targeted Solarize campaign	1. Percent attainment toward enrollment of 137 residential customers (10% adoption rate) in the targeted Solarize campaign 2. Number & capacity of non-residential customers enrolled
Effectiveness of an incentivizing customer rate	Customer DERs generate during the defined summer peak	Customer DERs installed during the demonstration project deliver over 1MW of summer peak load reduction
Advanced Inverter Functionality	Advanced inverter technology is leveraged to support interconnection and grid operations	1. Advanced Inverter ride through performance is verified 2. The number of interconnections where local inverter settings mitigated the need for additional interconnection costs
DER Integration into system planning	Performance data collected informs system planning efforts	A study of the operational performance of DERs and a statistical assessment of their actual peak coincidence factors. Successful deferral of a distribution capacity upgrade at Ash Creek Substation

Source: 1 June 2017, United Illuminating Company Application in PURA Docket No. 17-06-03, Attachment 3, *Localized Targeting of DERs*

Breakthroughs? Barriers? Both?

- Incomplete analysis by the utility of options and customer choices can leave valuable resources untapped
  - What would the customers want?
  - What would third-party developers offer?
- Commission recognizes risk of failure and paying for both DER deferment and distribution system upgrades
- We can have a smart grid and smart meters but still have inefficient rates and tariffs
- Is robust modeling of non-wires T&D alternatives a new standard for prudent utility planning?

CT/DEEP Microgrid Program

- Initiated by [PA 12-148 §7](), in 2012, as a "result of multiple episodes of severe weather that caused widespread power outages for extended periods…to ensure that critical buildings remain powered during electrical grid outages."
  - "Critical facility" means any hospital, police station, fire station, water treatment plant, sewage treatment plant, public shelter or correctional facility, any commercial area of a municipality, a municipal center, as identified by the chief elected official of any municipality, or any other facility or area identified by the Department… as critical.
  - "Microgrid" means 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 and that connects and disconnects from such grid to enable it to operate in both grid-connected or island mode.

Microgrid Program Specifics

- Multiple grants in a four-round sequence, using state funds for a pilot program for "projects that support local distributed energy generation for critical facilities during times of larger electricity grid outages… ."
  - "[A] proposal must address how the microgrid will support the identified critical facilities during times of electricity grid outages. The proposed microgrid must be able to continuously operate for a minimum of four weeks with its combined generation resources. The proposed microgrid should include access to uninterruptable fuel resources either on site or delivered for a minimum of two weeks and present a plan to secure additional fuel resources beyond two weeks as part of storm preparation and management."

Microgrid Round 1 Pilot

- Round 1, Pilot Projects: $15 million total for the development and implementation of microgrid projects.
- $1.5 million set aside to fund reasonable and prudent RFP proposal development costs… maximum of $60,000 per project.
- $13.5 million minimum to fund costs to implement selected projects, including eligible design, engineering, and interconnection infrastructure costs in the post-RFP evaluation period. Maximum of $3,000,000 per project.
- The Program does not fund any generation. The Program also does not fund any infrastructure, design, and engineering for non-critical facilities.
- 19 applications received; 9 funded in 2013.

Microgrid Pilot Grants Awarded

Project	Facilities	Generation	Grant Value
UConn Depot Campus/Storrs	Campus Buildings	400 kW fuel cell, 6.6 kW PV	$2,144,234
City of Bridgeport-City Hall/Bridgeport	City hall, Police Station, Senior Center	(3) 600 kW natural gas microturbines	$2,975,000
Wesleyan/Middletown	Campus, Athletic Center (Public Shelter)	(1) 2.4 MW and (1) 676 kW Natural Gas Combined Heat and Power Reciprocating Engine	$693,819
University of Hartford-St. Francis/Hartford	Dorms, Campus Center, Operation Building	(2) 1.9 MW diesel (existing), 250 kW diesel, 150 kW diesel	$2,270,333
SUBASE/Groton	Various Buildings and Piers	5 MW cogen turbine, 1.5 MW diesel	$3,000,000
Town of Windham/Windham	2 Schools (Various Public Purposes)	(2) 130 kW natural gas, 250 kW solar, 200 kWh battery; (2) kW diesel,	$639,950
Town of Woodbridge/Woodbridge	Police Stations, Fire Station, Department of Public Works, Town Hall, High School, Library	1.6 MW natural gas, 400 kW fuel cell	$3,000,000
City of Hartford- Parkville Cluster/Hartford	School, Senior Center, Library, Supermarket, Gas station	600 kW natural gas	$2,063,000
Town of Fairfield- Public Safety/Fairfield	Police Station, Emergency Operations Center, Cell Tower, Fire Headquarters, Shelter	50 kw natural gas recip engine, 250 kW natural gas recip engine, 27 kW PV, 20 kW PV	$1,167,659

Learn more here…

- Connecticut's Energy Agenda. http://www.ct.gov/deep/cwp/view.asp?a=4405&Q=499356&deepNav_GID=2121
- Connecticut Legislation and Executive Orders on Climate. http://www.ct.gov/deep/cwp/view.asp?a=4423&q=530290
- 2018 Connecticut Comprehensive Energy Strategy, http://www.ct.gov/deep/lib/deep/energy/ces/2018_comprehensive_energy_strategy.pdf
- Docket No. 17-12-03 – PURA Investigation into Distribution System Planning of the Electric Distribution Companies. http://www.dpuc.state.ct.us/dockcurr.nsf/(Web%20Main%20View%5CAll%20Dockets)?OpenView&Start=3830
- Docket No. 17-06-03 – Application For Review Of The United Illuminating Company's Distributed Energy Resource Integration Plan http://www.dpuc.state.ct.us/dockcurr.nsf/8e6fc37a54110e3e852576190052b64d/14e47a0f16712f2585258133005047 62?OpenDocument
- Connecticut Dept. of Energy & Environmental Protection (DEEP), Microgrid Program. http://www.ct.gov/deep/cwp/view.asp?a=4405&Q=508780&deep_Nav_GID=2121
- Connecticut Institute for Sustainable Energy. http://www.easternct.edu/sustainenergy/
- Northeast Energy Efficiency Partnerships, *Energy Efficiency as a Transmission and Distribution Resource Using Geotargeting* [Web page]. http://www.neep.org/energy-efficiency-transmission-and-distribution-resource-using-geo-targeting
- Stamford, CT, Architecture 2030 District. http://www.2030districts.org/stamford

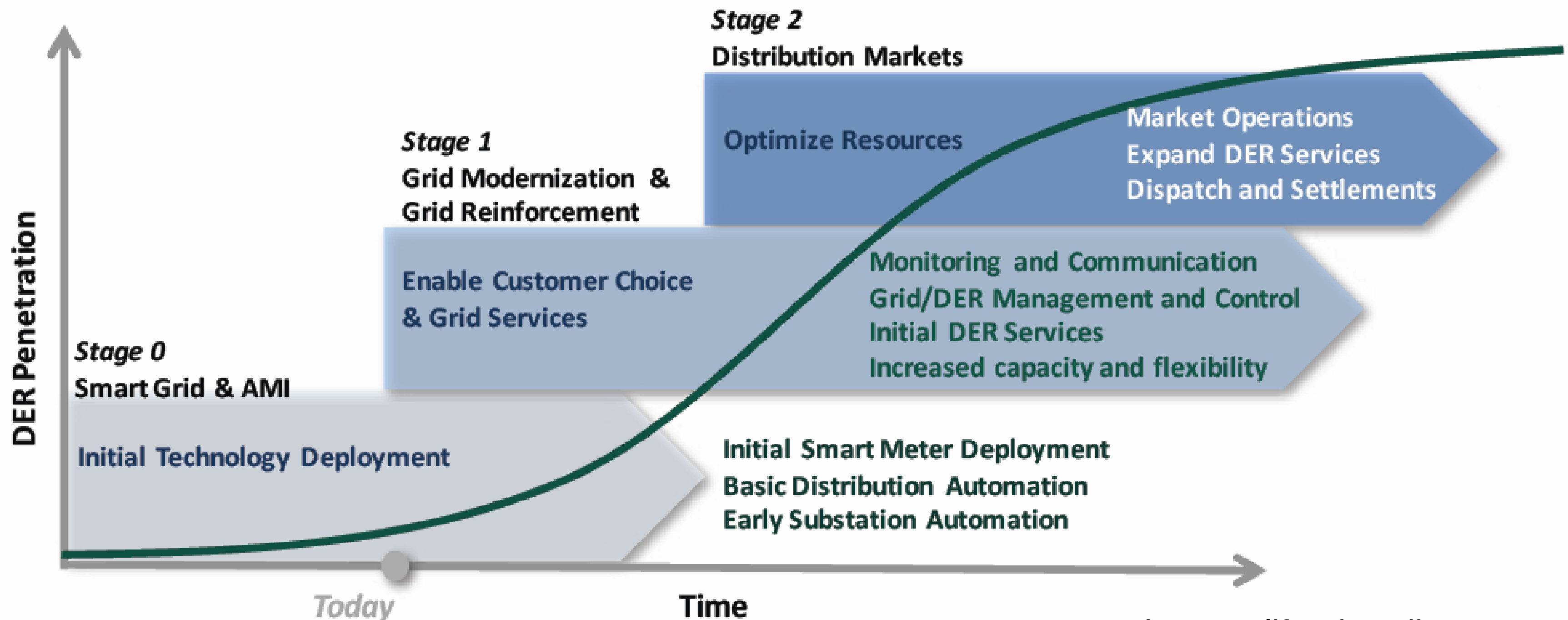
Selected NRRI Reports on DER

- 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, 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.*
- 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.*
- All NRRI Reports available for free download at www.nrri.org

APPENDIX A: GEOTARGETING & NWA METHODS

Crawl, Walk, Then Run…

Figure 7: Potential development of markets over time[xv]



Source: Southern California Edison, 2016.

Ramping up system upgrades and modernization is necessary today to enable future benefits

[xv] Adapted from De Martini, Paul and Kristov, Lorenzo. "Distribution Systems in a High Distributed Energy Resources Future." Future Electric Utility Regulations. October 2015. https://emp.lbl.gov/sites/all/files/FEUR_2%20distribution%20systems%2020151023.pdf

Baby Steps

- Expand D modeling capability and incorporate it into utility and state wide IRP, at least for high LMP and DLMP geo-targets
- Transform IRP modeling, using modern-grid infrastructure data and GIS, with new software capabilities
  - Resources: EDD's *Distribution Engineering Workstation & Integrated System Management* (DEW/ISM) software, www.edd-us.com/dewism/product/, Energy Zones Mapping Tool (see Appendix B), Integral Analytics' *Load Seer*, www.integralanalytics.com, *Intellicon*, http://intellicon.biz/, and Qado Energy's *GridUnity* Software, www.qadoenergy.com

First Baby Steps, Then Training Wheels

- Perform deep energy makeovers for all facilities where taxpayers pay energy & water bills, linked to:
  - Transform old-style voluntary "green rates" into community-based investment opportunities (e.g. community solar, and much more)
  - Provide value-based PPAs (wholesale, PURPA) and rate offerings (retail) for early distributed energy resources producers
- Identify and build out at least one:
  - "DER Development Zone" for treatment using any and all non-wires alternatives
  - public-purpose microgrid
  - electricity storage project
- Begin new utility business-model makeover process, including rate-design changes needed to incentivize cost-effective DER

Why Be an Early-mover?

- Service territory "inside game" for growth via import substitution and growth via local economic multipliers, direct, indirect, and induced
- Slow movers can be severely disrupted (examples: IBM, Kodak, etc.)
  - Yes, there really can be a slippery slope that looks a lot like a death spiral: The more and harder utilities try to prop up the old infrastructure, the more customers and loads can (and will?) physically move to greener pastures – "load defect" or "grid defect" to DER-technologies.
- Resources: RMI "Economics of Grid-Defection" report (search at www.rmi.org) and eLabsLandscape (http://elablandscape.rmi.org/)

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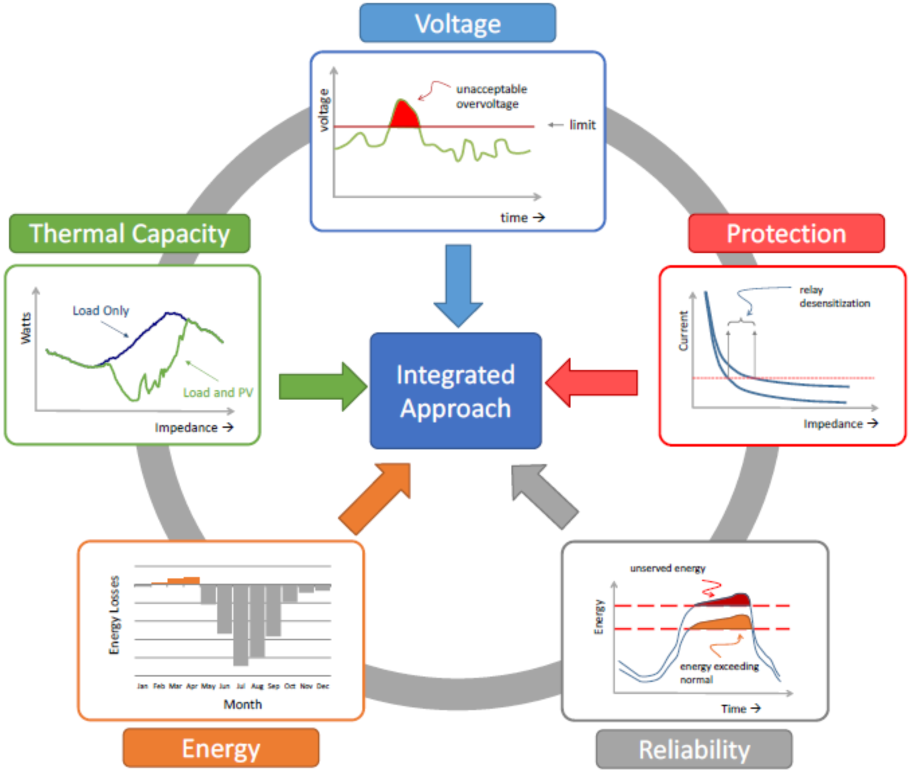
Multi-DER Complements

- DR and load management to reduce peak usage (>10%)
- "Flexible loads" time-shifting (early estimates show as much as 40-80% of all end-uses have *some* flexibility)
- Thermal storage (several %)
- Electricity storage (a few %)
- DG to reduce line losses; avoid T&D costs
- "Smart" EE to achieve deep savings (e.g. 1/3 bill savings with 3 year payback, and repeat as needed)
- In total: DER with today's technologies is already capable of saving ~$1 trillion over the next ~20 years.

EPRI's Integrated Approach

- **Step 1: Minimize Cost of DER**
  - Identify feeder hosting capacity
  - Avoid driving new capital upgrades with DER
  - Maintain voltage, protection, thermal capacity,and reliability standards
- **Step 2: Maximize Benefit of DER**
  - Identify locational value of DER
  - Defer or avoid planned capital upgrades
  - Improve system efficiency
  - Enhanced power quality, reliability, and resiliency



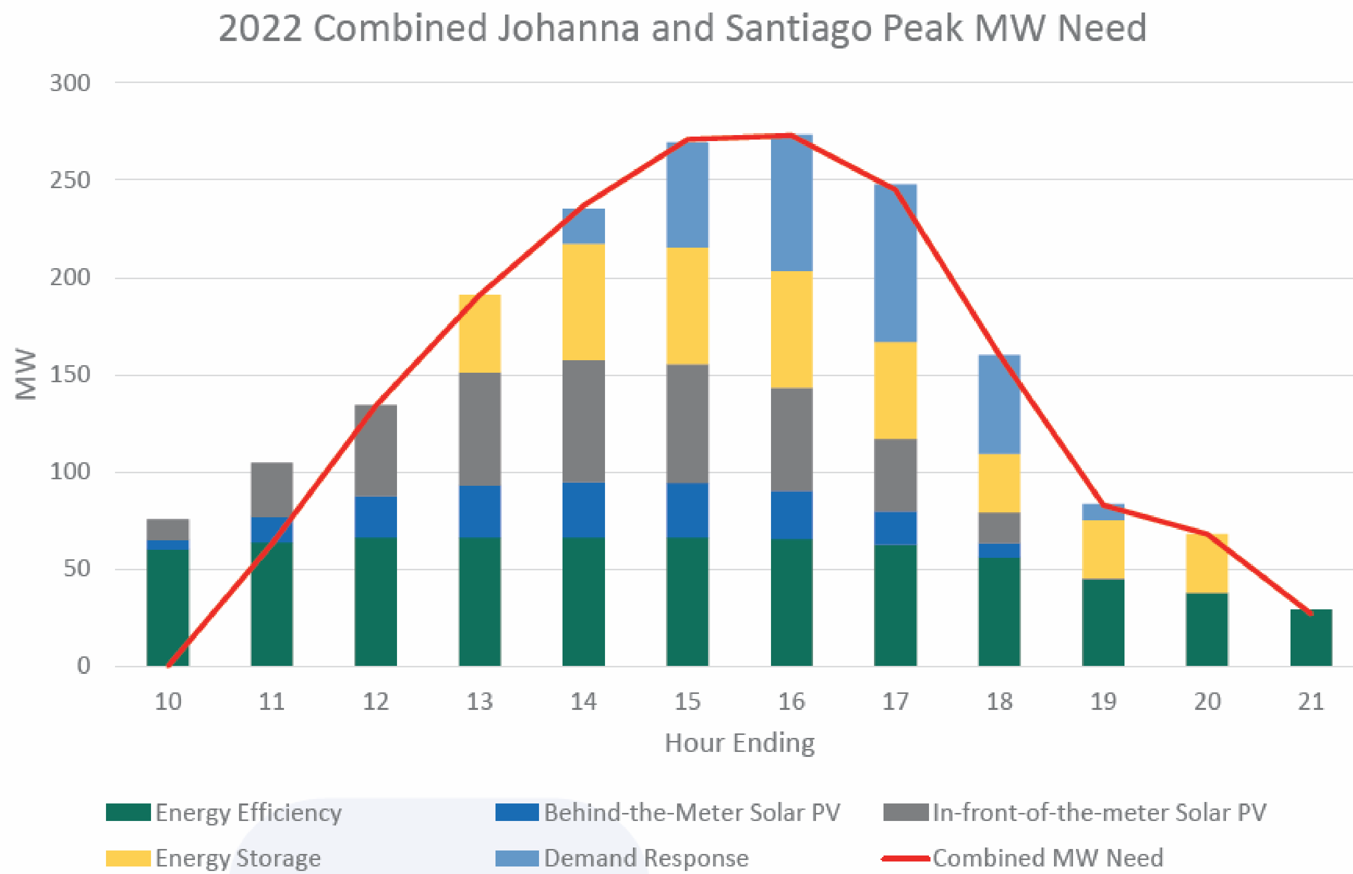
Components for determining optimal type and location of DER

Source: [EPRI White Paper No. 3002005793] (see also No. 3002004777 and No. 3002004878)

Relationship to Utility Planning

- Taken as a whole, geo-targeted, multiple DERs can avoid or postpone “alternative” investments in G, T, and/or D.

Figure 6: Sample DER Portfolio[xiii]

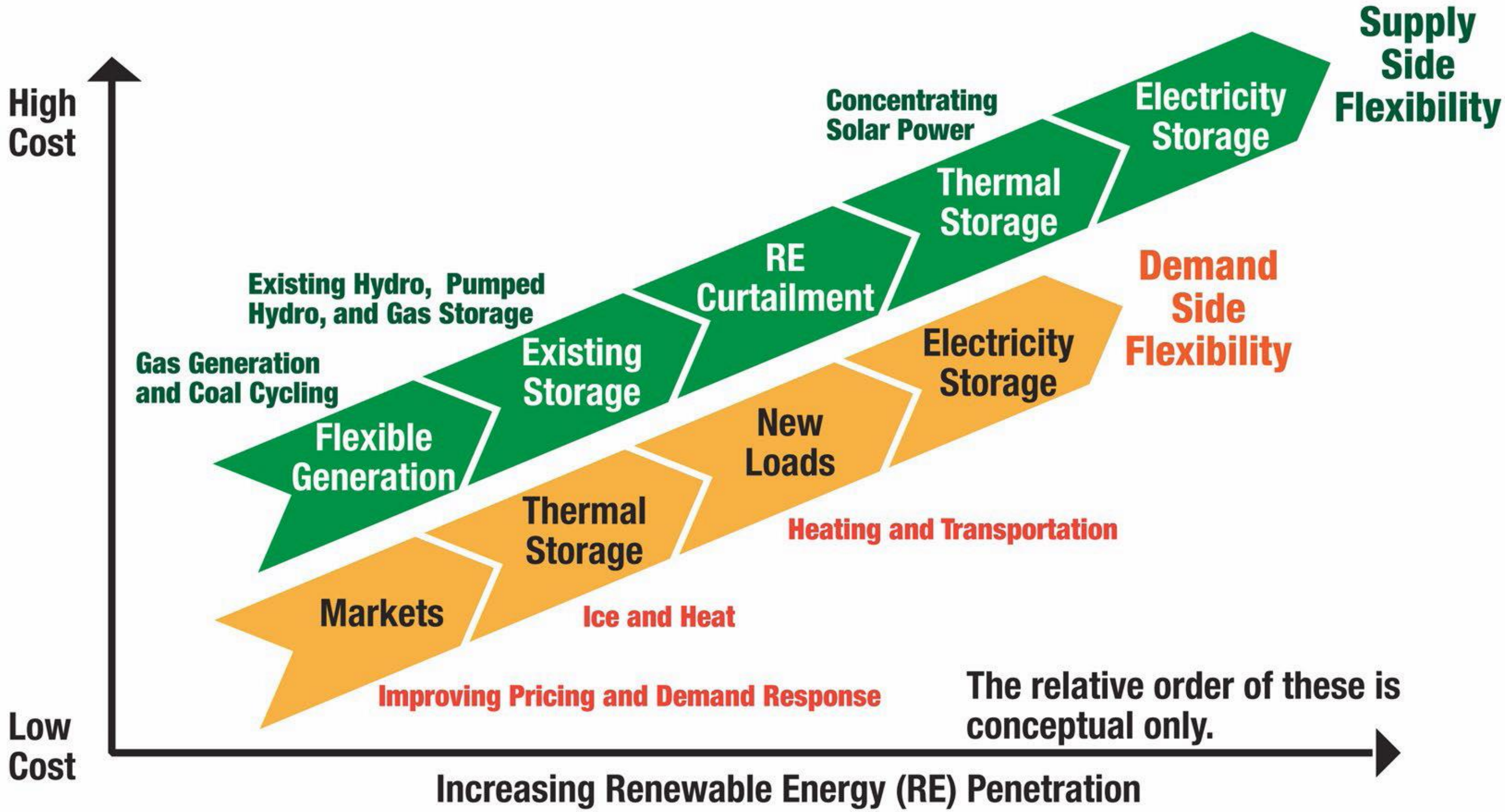


A mix of DERs sought to fill local needs on circuits out of Johanna and Santiago substations in Orange County, CA.

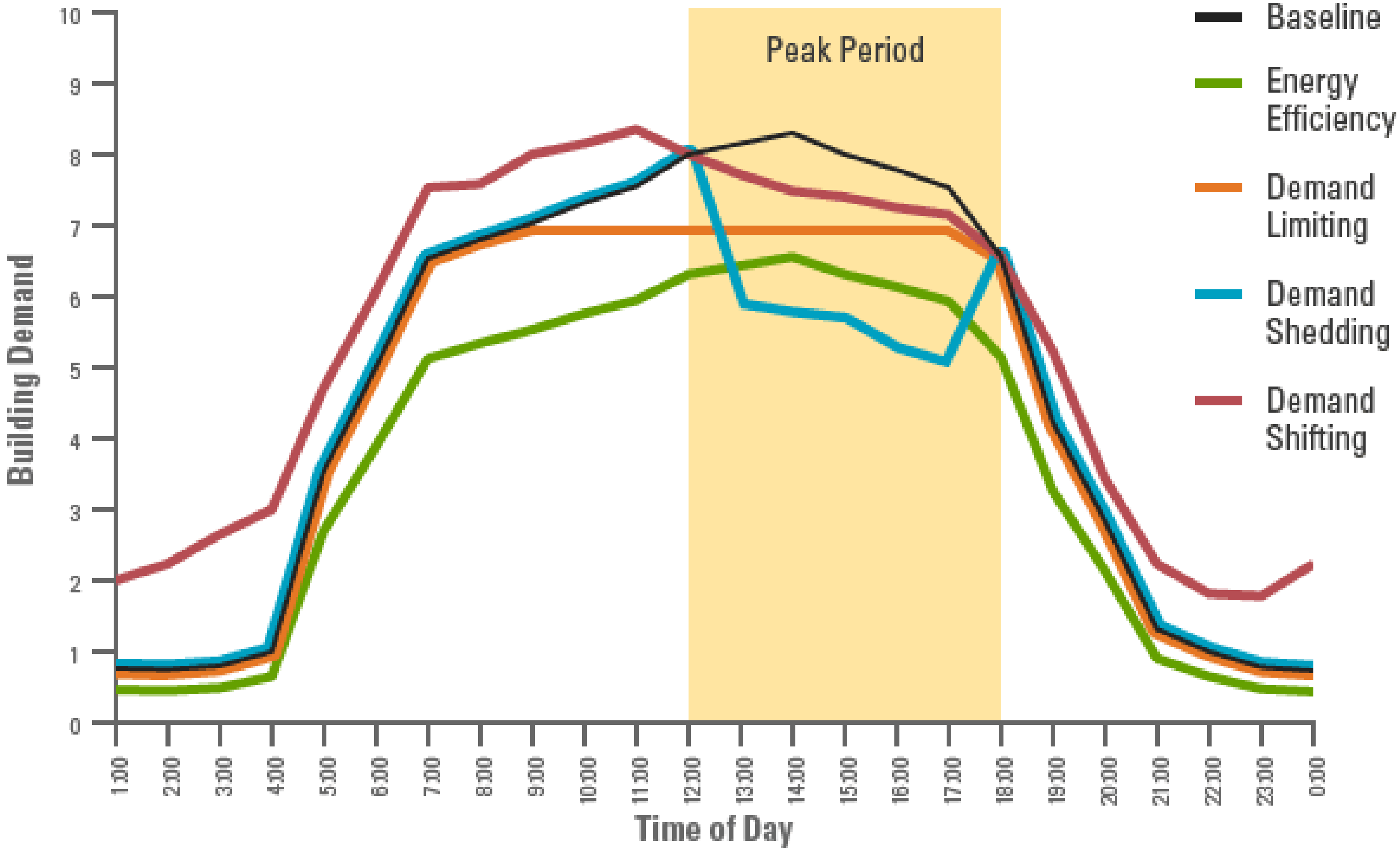
Source: Southern California Edison, 2016.

Flexible Demand

Source: Denholm et al. 2010,



Demand Response (DR)

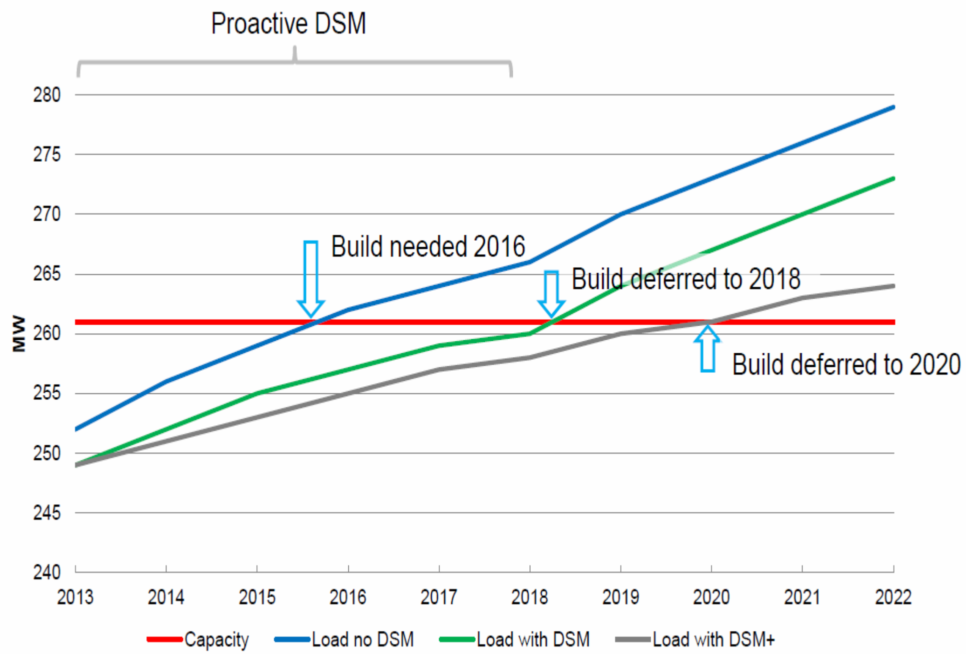


Locational Values Clinch Benefits–Costs

- One study shows a 60:1 ratio in locational benefits across one utility's service territory (Callaway et al. 2015)
- Multiple utilities are already deploying geo-targeted non-transmission alternatives, costing 1/5 to 1/10 as much to build (Stanton, NRRI 15-02)
- Important customer-side benefits can inspire customers to cost-share (Stanton, NRRI 12-15)
- Customer-investors have special affinity for local and public purpose projects – Community-solar is only one of many investment opportunities for crowd-investers

Plan and Build for Deferral, Be Ready to Accept Complete Replacement

Infrastructure build deferrals via system-wide programs and targeted DSM



In this illustrative example, accounting for DSM in the forecast defers build two years. Add'l targeted DSM pushes build two more years.

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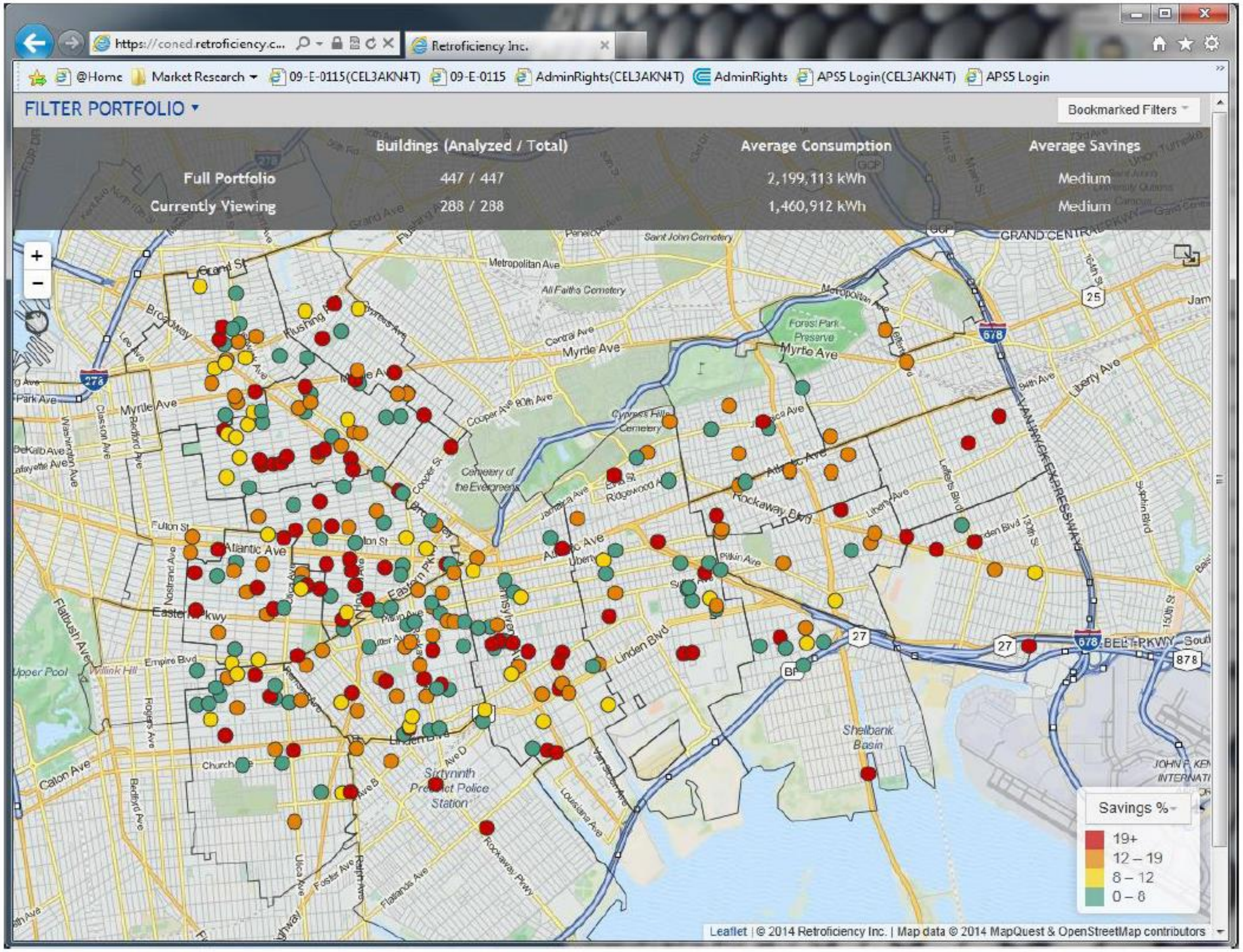
Solutions Will Leverage Multiple Utility Systems, including GIS, AMI, Modern-grid Sensors & Controls



More States Grappling with Changes Needed to Support Localized, Distributed IRP

Distribution Resources Plans

Clean Coalition

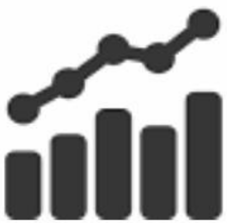
Requirements per CA Public Utilities Code Sec. 769 – from AB 327 (2013)

- Identify **optimal locations** for the deployment of Distributed Energy Resources (DERs)
  - DERs include distributed renewable generation, energy efficiency, energy storage, electric vehicles, and demand response
- Evaluate **locational benefits and costs** of DERs based on reductions or increases in local generation capacity needs, avoided or increased investments in distribution infrastructure, safety benefits, reliability benefits, and any other savings DERs provide to the grid or costs to ratepayers
- Propose or identify **standard tariffs, contracts, or other mechanisms for deployment** of cost-effective DERs that satisfy distribution planning objectives
- Propose cost-effective methods of effectively **coordinating existing commission-approved programs, incentives, and tariffs** to maximize the locational benefits and minimize the incremental costs of DERs
- Identify **additional utility spending** necessary to integrate cost-effective DERs into distribution planning
- Identify **barriers to the deployment of DERs**, including, but not limited to, safety standards related to technology or operation of the distribution circuit in a manner that ensures reliable service

Solutions Require Systematic Approaches and New Modeling Capabilities

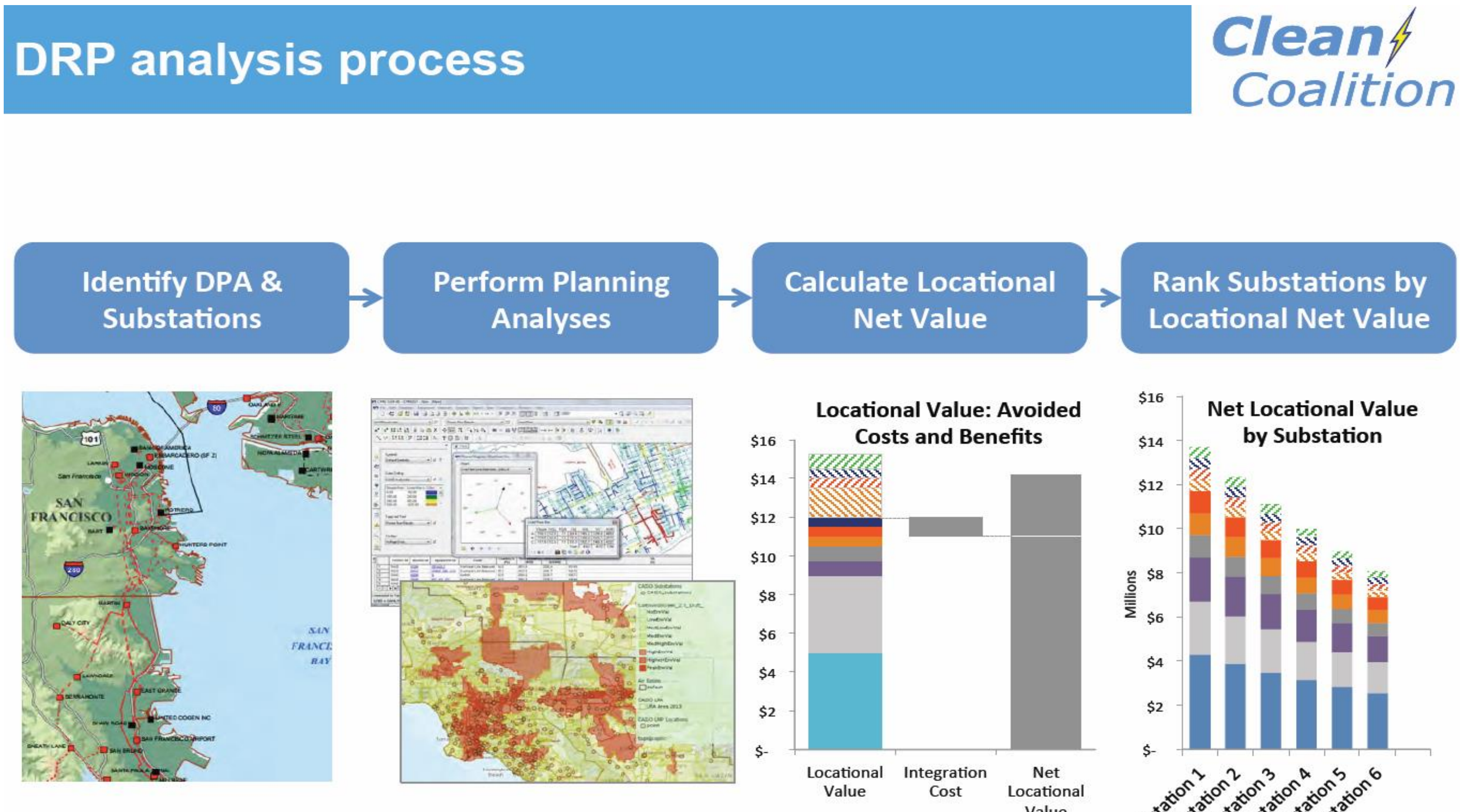
Stages of DRP optimal location implementation

Clean Coalition



Analysis & Planning	Grid Modeling & Optimization	Distribution Resource Plan Design	Distributed Energy Resource Deployment
Full cost and value accounting methods for DER	Siting analysis; powerflow modeling; DER optimization	Design and approval	Implementation: procurement and interconnection programs

Successful Methodologies Lead to Transparency + Constituent-engagement Opportunities



Source: Clean Coalition, www.clean-coalition.org

Let's Get Methodological

Community Microgrids in Six Steps

Clean Coalition

1. Goals:

Desired goals and performance metrics of the target grid area based on local resources and known or anticipated grid issues.

Includes renewables penetration goals, grid reliability & power quality performance targets, and power backup requirements.

2. Baseline Grid Analysis:

Inventory of the existing grid assets including load profiles, voltage regulation, feeder and transformer capacities, and existing generation.

Includes identifying prioritized services that require backup power during outages.

3. Renewable Siting Survey:

Comprehensive survey of the renewable energy potential in the target grid area specific to local resources & site characteristics.

Informs other requirements such as energy storage capacity needs and control system functionality.

4. DER Optimization:

Design of optimal DER portfolios combining renewables, energy storage, and demand response.

Incorporates Baseline Grid Analysis and Renewables Survey to achieve optimal outcomes based on local resources and grid assets.

5. Economic Analysis:

Full analysis of the cost-benefits and net value including reductions in T&D investments, ratepayer benefits, and local job creation.

Includes bulk procurement & interconnection that achieve a "plug-and-play" model, further reducing costs.

6. Deployment Plan:

Final system design, financial model and operational plan for the Community Microgrid.

Includes vendor analysis (e.g. RFIs, RFPs) appropriate to the final design criteria, financial model, and operational requirements.

Result: Distributed energy resources can deploy at scale in months rather than years.

Microgrids

- Possible progressions from here to there:
  - Single customer, critical loads
  - Single customer full load
  - Single “campus” customer
  - Public purpose microgrids
  - Multiple related customers/meters on adjacent properties
  - “Private wire” solutions
  - Microgrids on a fee for service basis
- Side-issues and tangents for microgrid policy:
  - Sales-for-resale rates and tariffs
  - Standby, backup, and supplemental power rates
  - Metering and sub-metering

Microgrids Regulatory and Policy Issues
(Source: Adapted from Hyams et al., 2010, pp. 22-67)

Microgrid Components and Functions	Ownership and Operations Options	Regulatory and Policy Issues and Concerns
Distribution wires up to and at the point of common coupling	Utility, except for off-grid, private systems which could be owned by customer, landlord, or third-party	• Interconnection standards & procedures • Will off-grid private systems be regulated as public utilities? • What is a private system's obligation to serve, if any?
Distribution wires (and pipes?) inside the microgrid	• Utility • Customer • Landlord or third-party	• Does the microgrid serve a single customer or campus owned by a single entity, or multiple customers on multiple land parcels? • Are any private wires allowed? • Does the installation of wires (or pipes) need any public right-of-way, franchise, or CPCN?
Individual meters or submeters inside the microgrid	• Utility • Customer • Landlord or third-party	• Do master-metering or sales-for-resale policies apply? • Are separate meters required for DG? For storage?
Distributed generation and electricity storage	• Utility • Customer • Landlord or third-party	• What rates, wholesale and retail, apply to generation and storage for (a) self service power; (b) net metering; and (c) some, mostly, or entirely wholesale delivery? • Are rules and ownership options the same for electricity and thermal-energy distribution? • Are the thermal-energy-distribution rules the same for steam, hot and chilled water, and air? • Is multiple ownership allowed?
Microgrid controls and communications systems	• Utility • Customer • Landlord or third-party	• Who is authorized to own the switchgear at the PCC, and how are costs allocated between the microgrid customer(s) and utility? • What entities can offer load management and demand-response programming? • Who determines the operating protocols for the microgrid? • Under what circumstances, if any, shall microgrid operations be governed by the utility (or independent system operator)?

References

- *A Review of Distributed Energy Resources*, report for New York ISO by DNV-GL, September 2014.
- *Concepts to Enable Advancement of Distributed Energy Resources – An EPRI White Paper on DER, Electric Power Research Institute, 2010.*
- *Distribution System Pricing with Distributed Energy Resources*, report for Lawrence Berkeley National Lab, Future Electric Utility Regulation Series (FUER), by Ryan Hledik and Jim Lazar, May 2016.
- *Draft Manual on Distributed Energy Resources (DER) Compensation*, NARUC Staff Subcommittee on Rate Design, July 2016.
- Herman Trabish, "How California's utilities are mapping their grids for distributed resources," *Utility Dive*, 27 February 2017.
- NRRI's Future Drivers and Trends Affecting Energy Development in Ontario: Lessons Learned from the U.S. (Mowat Energy Research Report #137)
- U.S. DOE, *Interruption Cost Estimate Calculator, 2015.*

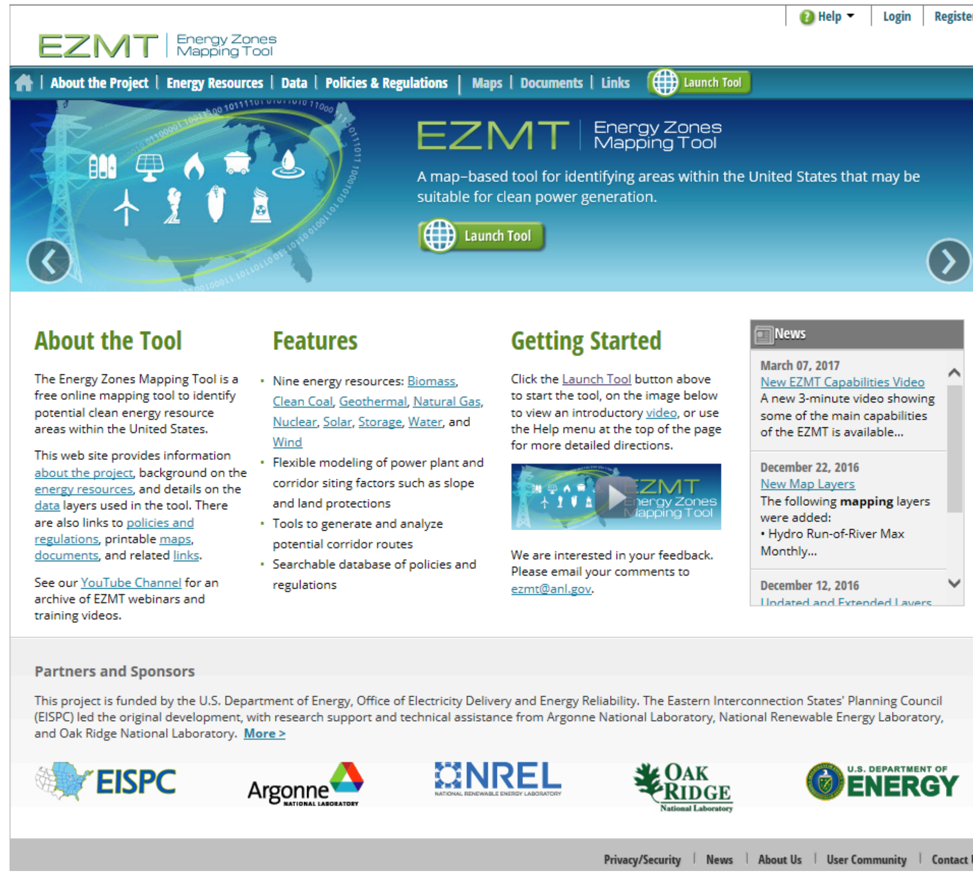
APPENDIX B: ENERGY ZONES MAPPING TOOL FREE, PUBLICLY AVAILABLE UTILITY-MODELING GIS

Energy Zones Mapping Tool

Supports Clean Energy Resource and Corridor Planning

- Free online mapping tool (http://ezmt.anl.gov) helps identify potential clean energy resource areas and energy corridors
- Provides clean energy resource data, screening criteria, and policy information in one website
- Generates user-customized maps of areas that fit specified screening factors and criteria
- Generates potential route alternatives for energy corridors
- Assists with clean energy resource and transmission corridor planning

Over 300 GIS data layers:
- Energy resources and infrastructure
- Environmental/cultural
- Siting factors
- Reference/jurisdictional



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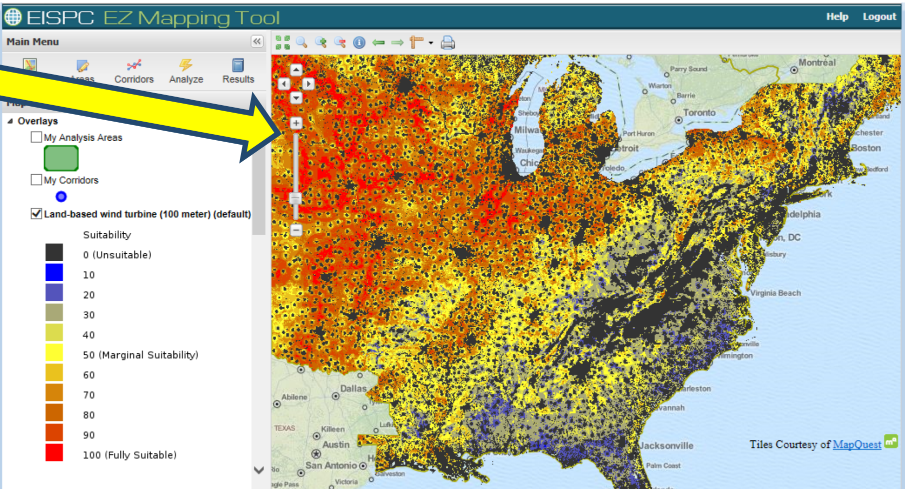
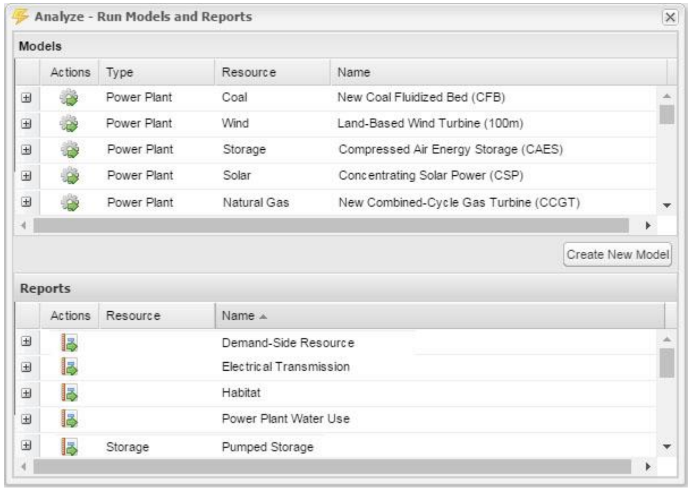
EZMT Allows Users to Perform Customized **Suitability Modeling** of Energy Resources

- Models generate "**heat maps**" showing **suitability** of areas for developing clean energy resources
- Suitability modeling inputs include:
  - Energy resource data
  - Land cover/landforms
  - Environmental factors
  - Population density
  - Existing infrastructure
  - Other suitability factors
- Models are user-configurable and fully customizable
- Users can design new models using any of 72 model input layers





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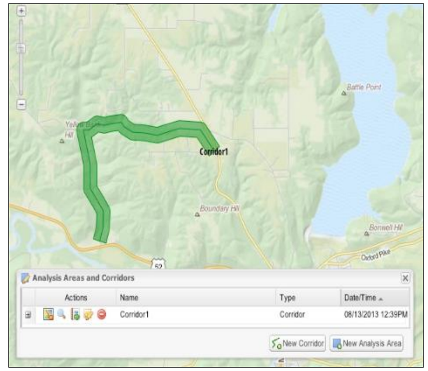
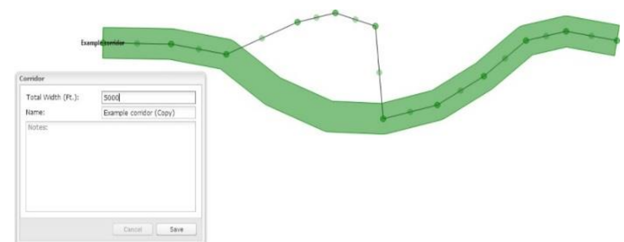
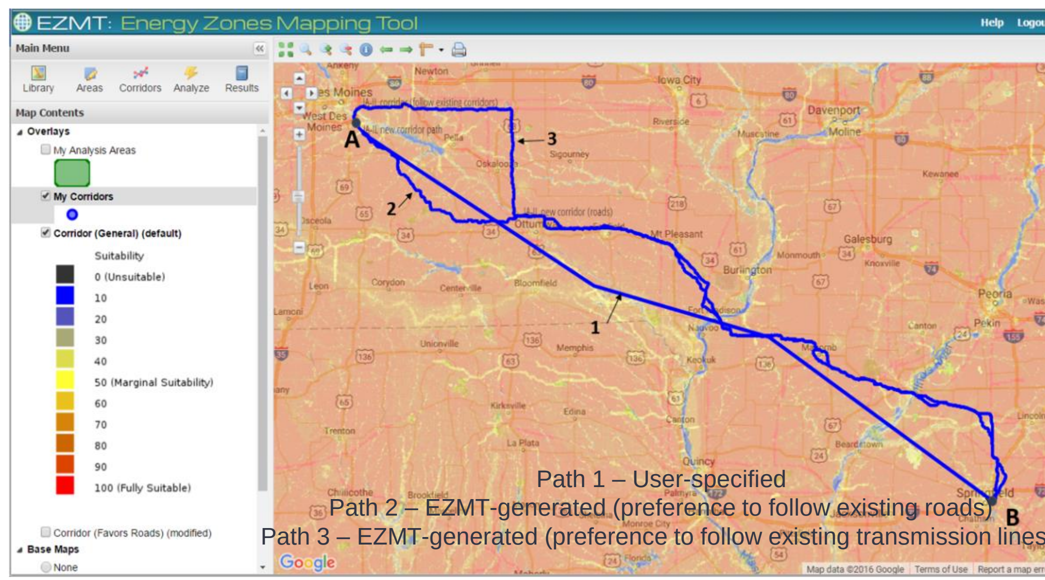
Screening and Optimization of Potential Corridor Paths in EZMT

Two analytical options are available:

- User can draw a corridor path (variable width) on the screen and run a corridor analysis report
- Let the EZMT find the most suitable path between points A and B, subject to user-specified constraints and siting preferences







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