

StorageVET[®] in Action

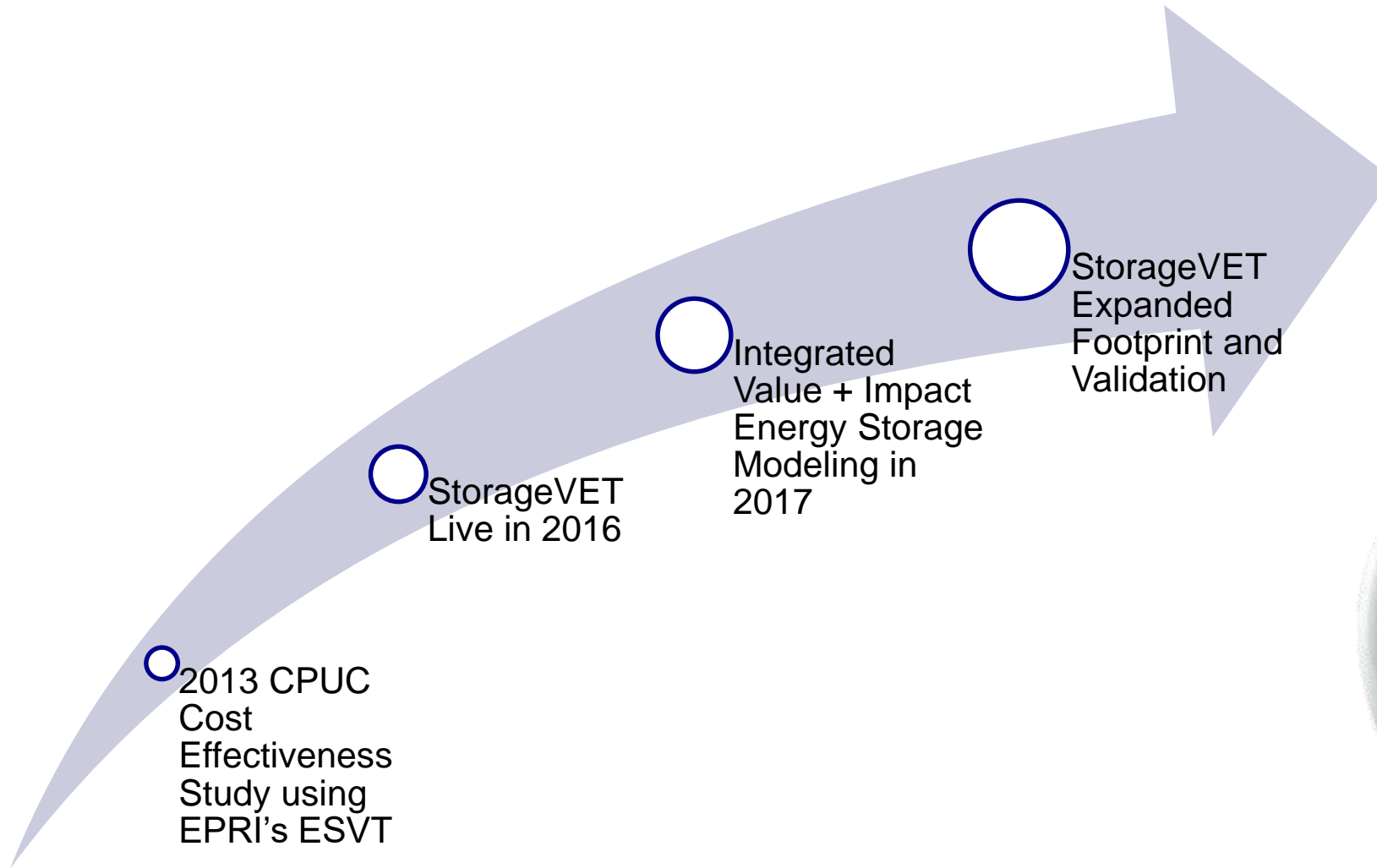
Storage Value Estimation Tool

Giovanni R. Damato
StorageVET Product Manager

October 18, 2017
CEC EPIC Symposium



Storage Made Easy: StorageVET[®] Paving the Way

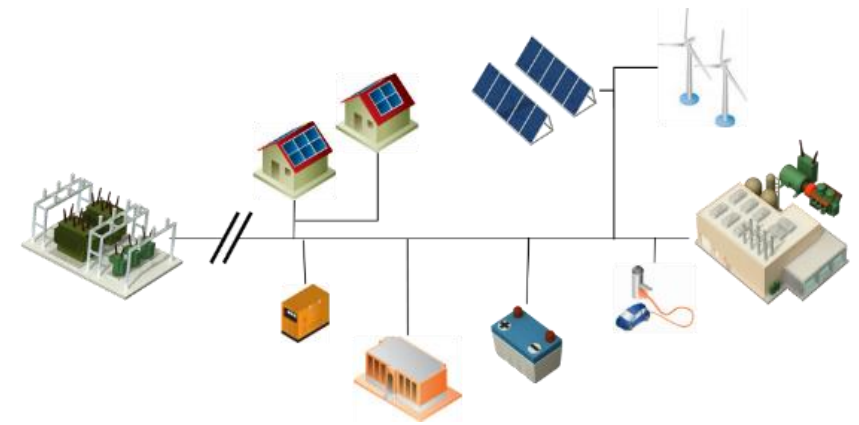
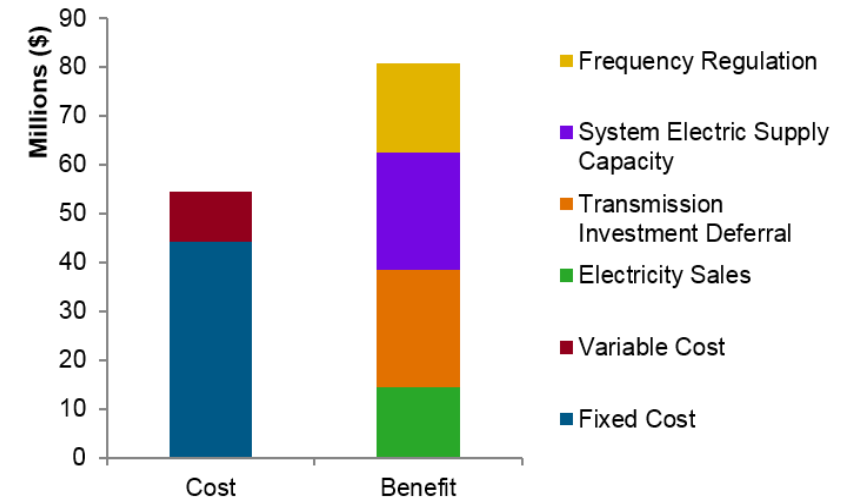


**2020 Goal:
Make
Storage...**



Challenges to Modeling Storage

- Storage and limited energy resources are still not common
- Rules and regulations still are evolving
- Benefit stacking is appealing, but will it be possible
 - More services = more value
 - More services = more requirements → Can they be satisfied?
- Locational value of storage requires site-specific analysis
- Complex optimization between storage degradation and service participation scheduling



StorageVET®

Storage Value Estimation Tool: www.storagevet.com

- Web-hosted tool, free to the public
- Project cost-benefit analysis
- Time-series constraints and dispatch optimization simulation
- Multi-services optimization and stacked services
- Customizable for location, technology, sizing, use cases
- Made possible through funding support from the California Energy Commission (CEC)



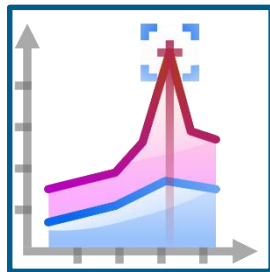
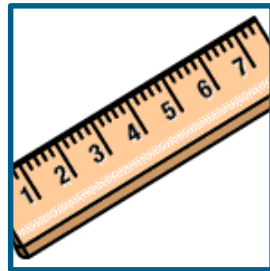
Users of StorageVET® Today

Key Use Cases



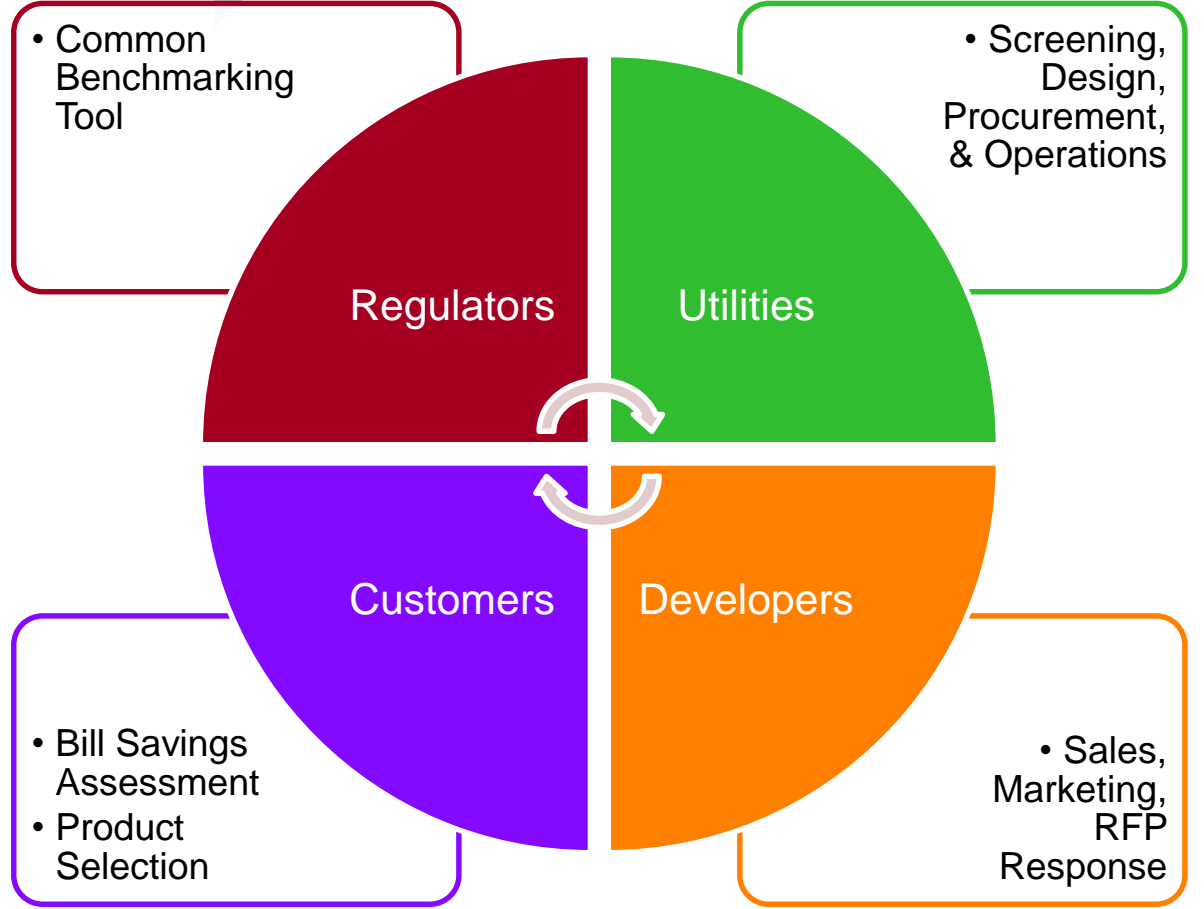
Locating & Screening

Sizing/Designing
(stacked services)



Operational Strategies
(Customer and Grid)

Common Communication Platform



StorageVET[®] Live: www.storagevet.com

EPRI ELECTRIC POWER RESEARCH INSTITUTE **Storage Value Estimation Tool: StorageVET™ V1.0** CLOSE MODEL | SAVE | RELEASE 3.0.0.328

Navigation: About/Help | Quick Start | Project Specs | General Settings | Transmission | Distribution | Customer | Financials | **Results** | Data/Scenarios

Sub-navigation: Dispatch and Operational Results | Deferral Results | **Customer Site Impacts** | State of Health | Service and Constraint Conflicts | Financial Results

Retail Load Profile

Load Profile Results Result

Peak Status Calc

Retail Bill Report

Baseline Retail Bill Summary Calc

Net Retail Bill Summary Calc

Retail Bill Totals Calc

Load Profile Results [L2]

Show customer load profile with storage installation.

Simulation Years: 2015

Day of Year: 8/5

Horizontal Axis: Daily Dispatch Index

Key: Storage Effect

Storage Effect

- Baseline
- With Storage

Powered by analytica

Beyond the Spreadsheet

Combined Energy Dispatch (kW) Calc

Ancillary Service Report Calc

Storage Activity Summary Calc

State of Charge History (0 - 1) Calc

Monthly Revenue

Service Revenue Summary Calc

Load

Net Load (kW) Calc

Powered by analytica

Estimation Tool: StorageVET™ V1.0 CLOSE MODEL | SAVE | RELEASE 3.0.0.328

Navigation: General Settings | Transmission | Distribution | Customer | Financials | **Results** | Data/Scenarios

Sub-navigation: Customer Site Impacts | State of Health | Service and Constraint Conflicts | Financial Results

Service Revenue Summary [L2]

Show summary of revenues from selected services.

Simulation Years: 2015

Horizontal Axis: Month

Key: Service

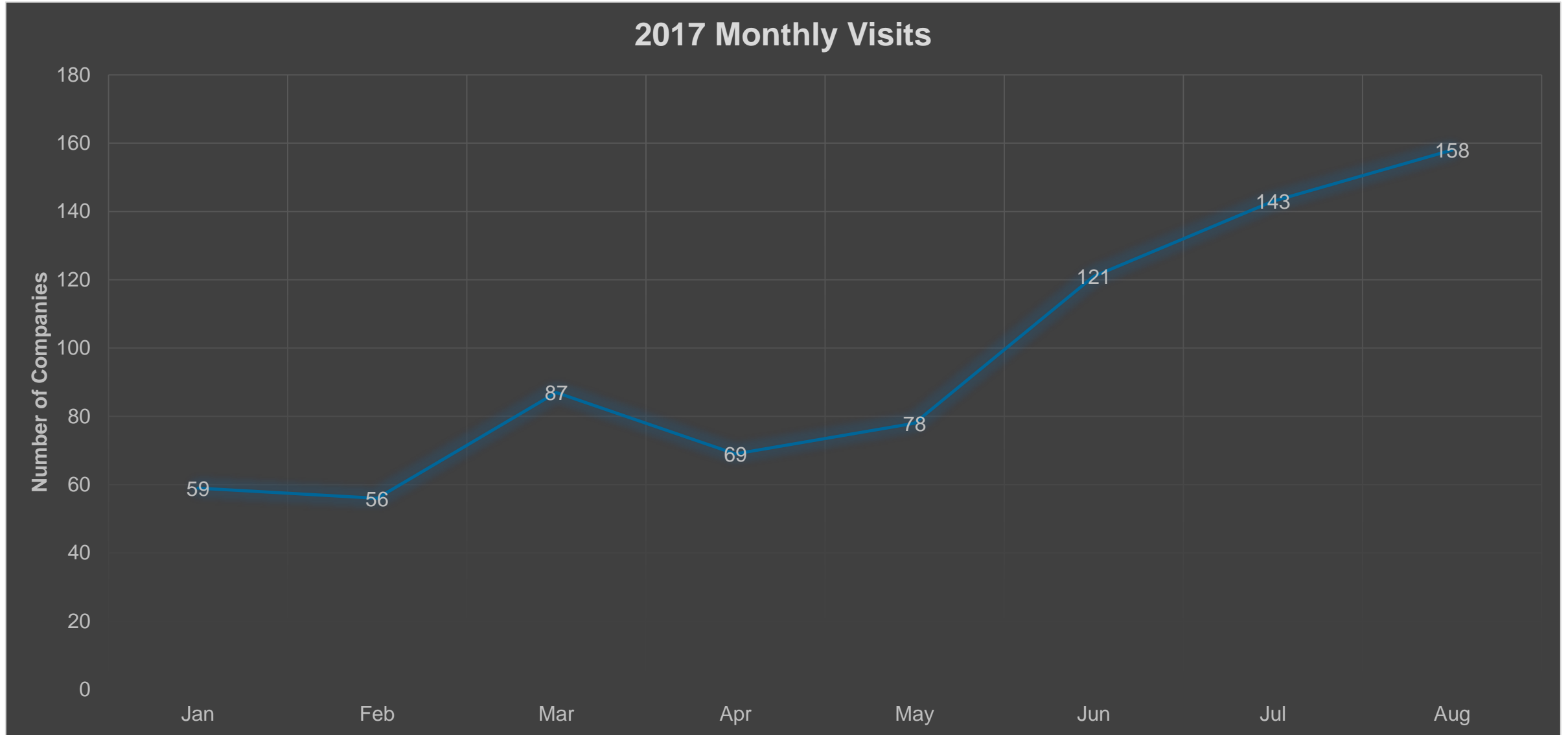
Service Revenue Summary

Service

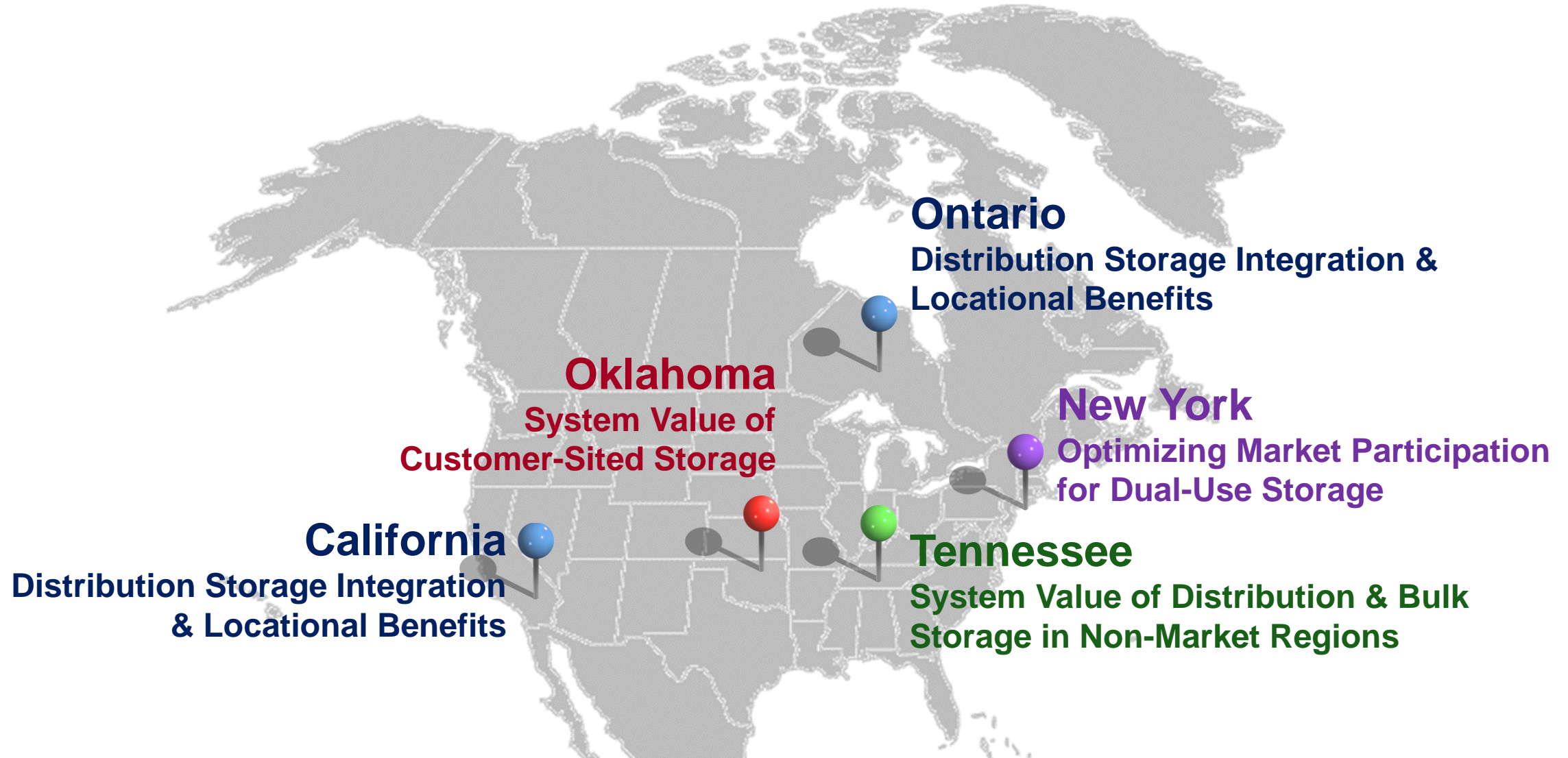
- Day Ahead Energy
- Reg Up
- Reg Down
- Spinning Reserve
- Non-Spinning Reserve
- RA

Beyond the Spreadsheet

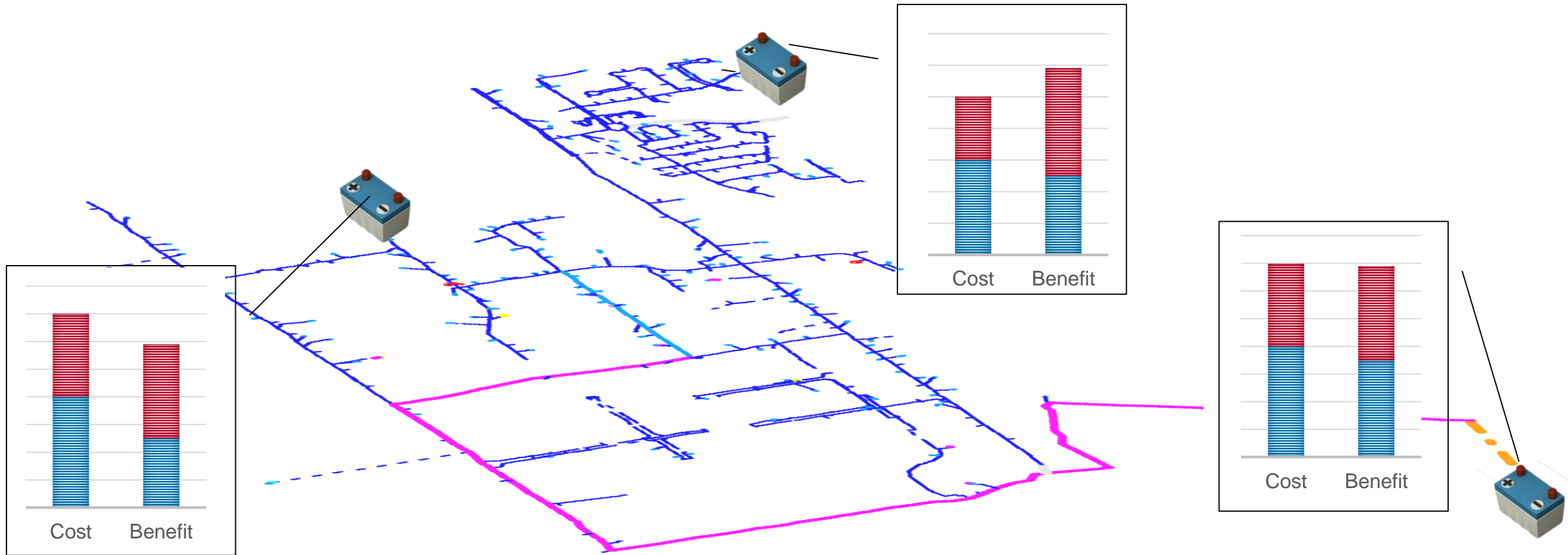
485 StorageVET® Users Across 170 Organizations



Current Storage VET Validation and Research

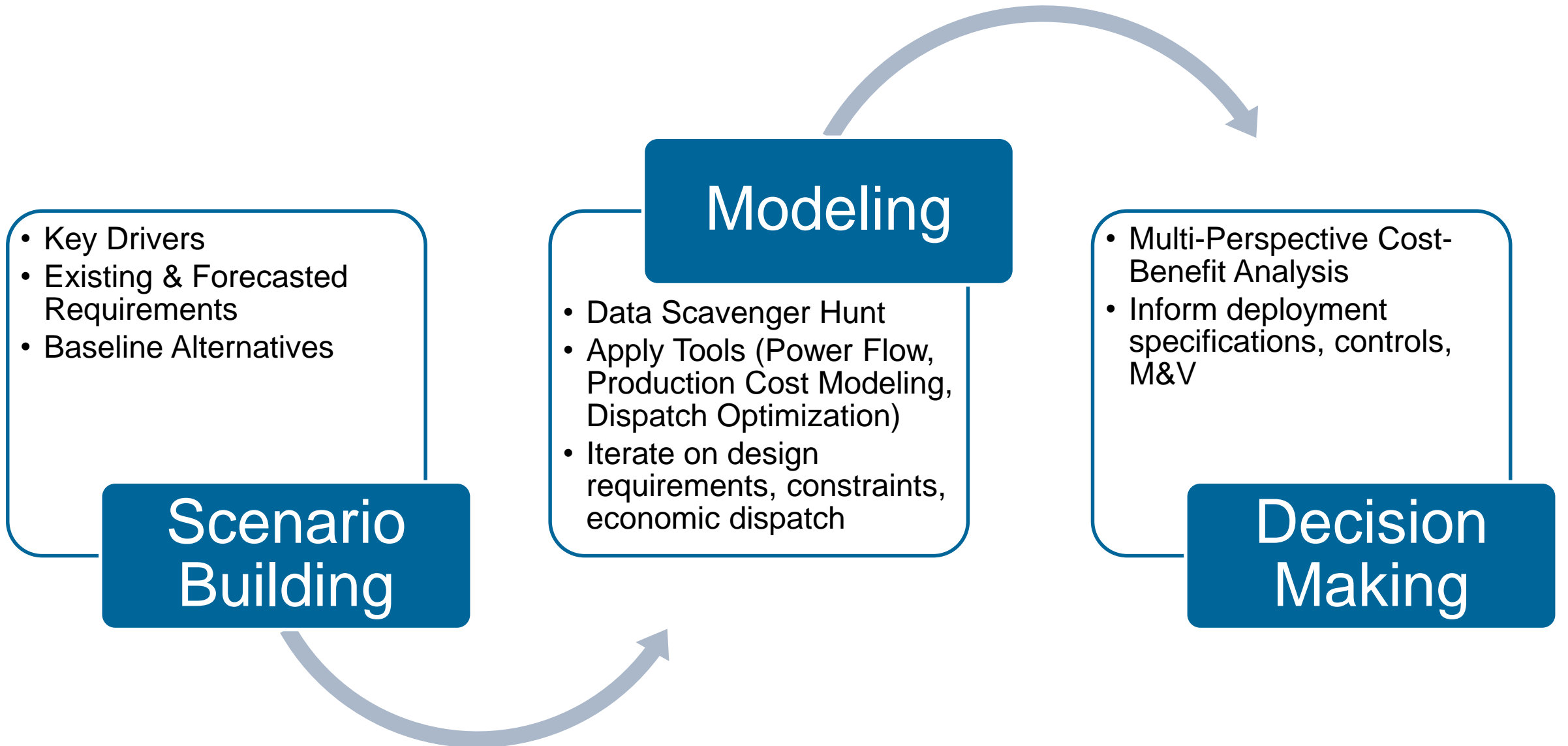


Integrated Energy Storage Modeling Vision



Streamlined and informed decision making...
...just as easy to model storage for deployment as a familiar transformer upgrade

The Framework



What's Next?

- Progress towards a cohesive valuation research portfolio to make storage...
- StorageVET validation and integration:
 - Model Validation Effort Through ESIC
 - Expand Regional Footprint
 - Integrated Energy Storage Modeling Supplemental
 - Impact + Value
 - Host + Participant Collaborative Multi-Year Project
 - StorageVET User Group





Together...Shaping the Future of Electricity

Additional Material

www.storagevet.com

StorageVET Access

www.storagevet.com

Access to StorageVET

- Model is publicly available, but requires registration and log-in (process takes a few days)
- Interested users should first enroll
- Follow instructions at www.storagevet.com
- Join ESIC StorageVET Subgroup (bi-weekly) to engage in stakeholder collaboration to test and improve the tool

Energy Commission Smart Inverter Projects

EPIC Fall Symposium

Angie Gould



Overview

- Projects' Description
- Projects' Status
- Projects' Benefits
- Lessons Learned

Projects' Description

- Five projects testing, verifying, and demonstrating smart inverter autonomous (SIWG Phase I) and communications (SIWG Phase II) functions
- All five projects are from the 2012-2014 EPIC Investment Plan
- \$6,395,533 in EPIC funds across the five projects
- \$3,587,839 in total match funding

Projects' Status

- Three projects started mid-2015; two started mid-2016. All scheduled to complete March 2019
- Projects primarily performing laboratory testing and updating protocols and testing procedures to meet updated IEEE 1547 and Rule 21 updates. Field testing will follow
- Recipients are participating in meetings of the Smart Inverter Working Group and DNP3 User Group, as well as in the development of Rule 21, IEEE 1547, and IEEE 2030.5

Projects' Status, continued

- When projects are complete, will have:
 - Open source software clients for both DNP3 and IEEE 2030.5 communications standards
 - Standardized communications across inverter manufacturers
 - Optimized grid support from inverters, DERs, and consumer devices working together

Projects' Benefits

- Improved power quality and reliability, increased renewable penetration
- Reduced interconnection time and costs for PV and storage
- Optimized coordination of smart inverters with customer-side devices (e.g., smart thermostats), EV charging, and storage to enable high penetration PV
- Freely available software to test for compliance with communications standards

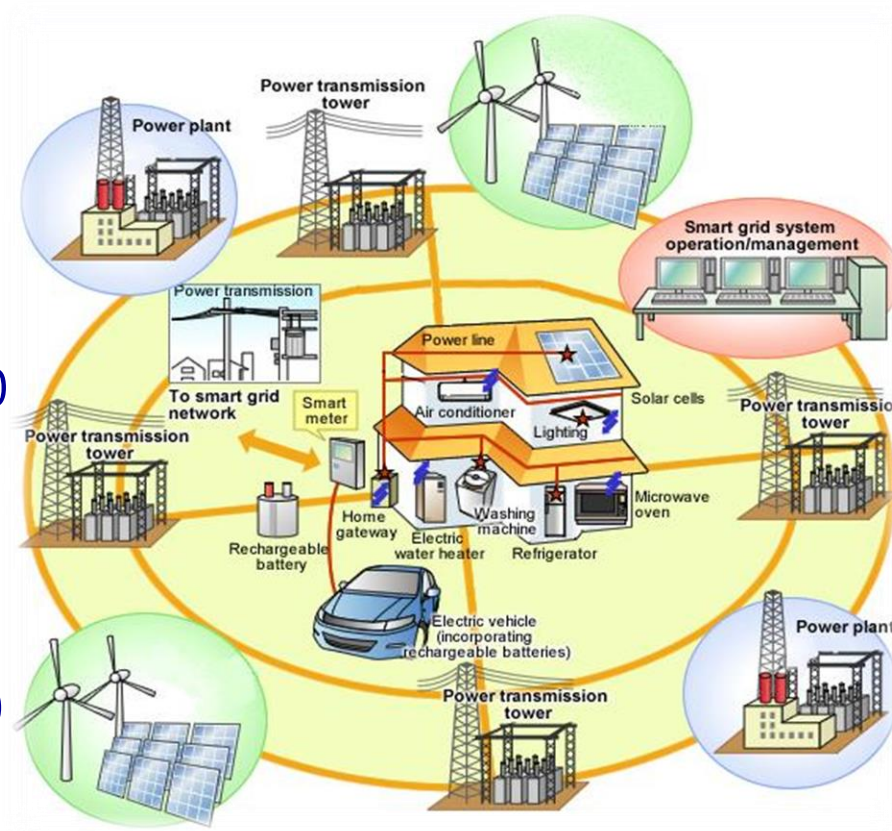
Lessons Learned

- Standards have been updated more slowly than anticipated, delaying some aspects of the projects
- Other areas, like controllable loads, have developed more quickly than anticipated, allowing projects to procure equipment at lower than expected costs

Q&A

Policy Drives Innovation

- Increase RPS to 50% by 2030
- Reduce GHG to 40% below 1990 levels by 2030
- 1.3 GW of storage by 2020



- Double energy efficiency savings by 50%
- 1.5 million ZEVs by 2025
- Increase access to clean energy in disadvantaged communities

South Coast Air Quality Management District Advanced Smart Inverter Project

EPIC Fall Symposium

October 18, 2017



Pam Seidenman

Director, Public-Private Partnerships

Advanced Microgrid Solutions

Overview

- Project Description
- Project Status
- Project Benefits
- Procurement Summary
- Lessons Learned

EPIC Triennial Investment Plan

Solicitation: Solar +: Taking the Next Steps to Enable Solar as a Distribution Asset

Project: South Coast Air Quality Management District Advanced Smart Inverter Project

- **Program Area:** Applied Research and Development
 - **Funding Initiative S3.2:** Develop Integrated and Hybrid Photovoltaic Technologies and Strategies to Reduce Costs and Advance Zero-Net Energy Buildings
 - **Funding Initiative S4.2:** Develop Innovative Tools and Strategies to Increase Predictability and Reliability of Wind and Solar Generation
 - **Funding Initiative S6.1:** Develop Smart Inverter Capabilities to Improve Grid Operations
- **Program Area:** Technology Demonstration and Deployment
- **Funding Initiative S15.1:** Demonstrate Advanced Energy Storage Interconnection Technologies and Systems in Transmission, Distribution, and

Project Description and Goals

- **Project:** Solar + Storage + Smart Inverter + Warm Bridge at South Coast AQMD
- **Goals:** Advance the deployment and grid integration of distributed solar resources through decreased cost; increased circuit hosting capacity; and enhanced value.
- Advance the capabilities of smart solar inverters to manage SIWG Phase III functions and high penetrations of PV
- Demonstrate and measure system performance
 - Scenario A - solar power only
 - Scenario B - solar + storage.



Procurement Summary

EPIC Funding - \$2,729,943

Match Funding - \$2,173,382

Total Project - \$4,903,325

Total Solicitation Funding - \$22,768,717

- Prime is Certified CA Small Business - Advanced Microgrid Solutions (AMS)

System Specs

- 500kW high efficiency solar
- 750 kW/1500 kWh energy s
- Uninterruptable power supp



Advanced Microgrid Solutions



Project Objectives

- Demonstrate the value of a technology-agnostic aggregated DER implementation (solar and storage) with SIWG Phase III solar inverter to:
 - Improve power quality (reduced voltage swings)
 - Provide additional SIWG Phase III functionality
 - Increase hosting capacity by 25%
 - Increase solar while dramatically reducing curtailment
 - Measure and validate data to determine fair levels of compensation for solar curtailment to support grid functionality
 - Provide recommendations for cybersecurity

Project Status

Milestone	Date	Status
Start Date	9/29/17	Complete
South Coast AQMD Board Approval	10/10/17	Complete
Develop Detailed Project Plan	12/8/17	
Solar Design, Engineering, and Installation	8/17/18	
Storage Design, Engineering, and Installation	8/31/18	
Communications Enablement and Bench Testing	7/27/18	
Field Demonstration	7/19/19	
Data Analysis and Recommendations	10/19/19	
Evaluation of Project Benefits	2/24/20	
Technology/Knowledge Transfer Activities	1/17/20	
End Date	3/20/20	

Project Benefits

- Demonstrate a system that provides powerful, flexible distribution-level grid support
 - Can be replicated on any circuit
 - Compatible with a wide range of DERs
 - New and existing solar, fuel cells, wind, building management systems, and others
 - Accelerate the deployment of renewables and achieve the state's energy goals, including AB 32, SB 32, SB 350, AB 1637, AB 2868, and CPUC proceedings

Renewables integration services:

- Renewables intermittency firming
 - Flex ramping
 - Absorbing reverse power flows
 - Renewables capacity increase
- Contribute to identified areas of EPIC Triennial Plan

Project Benefits Continued

Safety

- Decrease the likelihood of blackouts and brownouts
- Absorb dangerous reverse power flows caused by high solar penetration

Reliability

- Provide a more flexible, rapid response to SIWG Phase III functions
- Increase the pool of resources capable of providing grid support
 - Reduce peak energy demand at the host site by 16%
 - Reduce total energy usage by > 10%
 - Increase solar PV DER capacity on the Boothill feeder by 1.25 MW

Cost

- Reduce demand charges at the host site by 28% and overall electric bill by  ELECTRIC POWER RESEARCH INSTITUTE

Lessons Learned

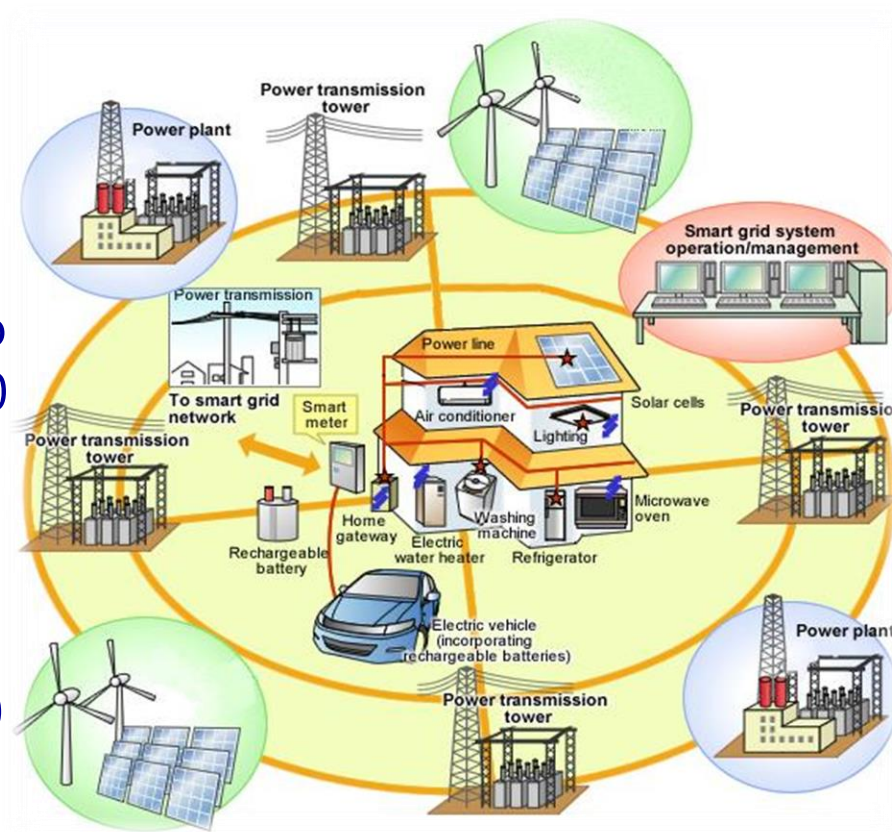
- Useful to have a backup vendor
- CEC has been a critical SME and implementation partner
 - CEC alerted us that the PI for the M&V vendor had left and suggested alternatives
 - Helped to file the CEQA

Contracting

- Reclassified a subcontractor as a vendor
 - Reduced administrative burden for all involved, including the CEC
 - Enables more direct cost control and fiscal surety

Policy Drives Innovation

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- Double energy efficiency savings by 50%
- 1.5 million ZEVs by 2025
- Increase access to clean energy in disadvantaged communities

Thank You and Q&A

Overview

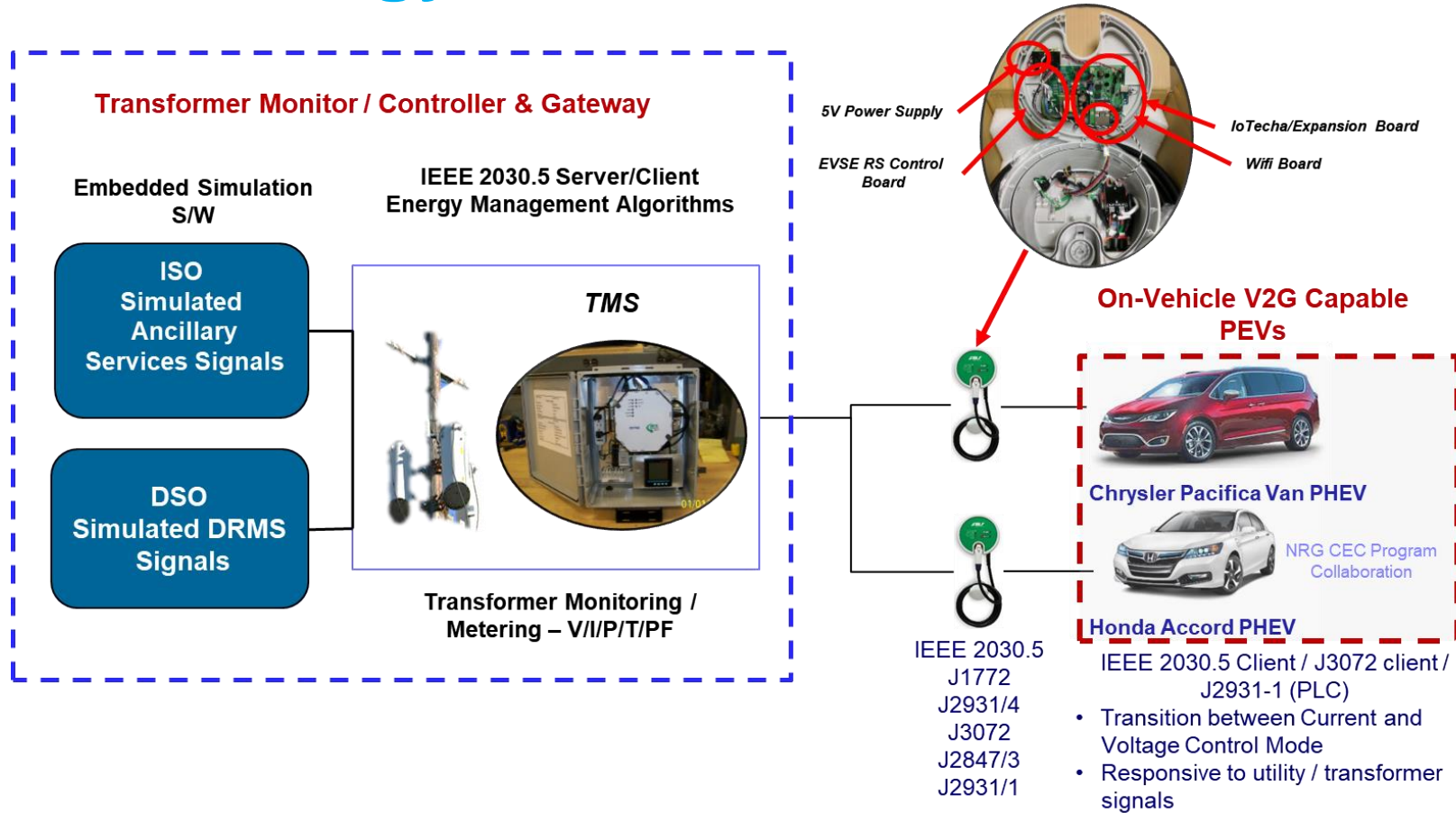
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Project Description

- Transformer level V2G services management for residential or commercial scenarios
 - Transformer Management and Monitoring System as a DA edge of the grid node
 - Charge and discharge scheduling for fleet
 - DER integration
 - Mobility-prioritized implementation
 - ‘End to end’ cybersecurity
- Open standards (IEEE, SAE) based implementation
- Partners: Fiat Chrysler Group, Honda R&D America, Kitu Systems, AeroVironment

- EPIC Wave 1 based investment addressing S9.2
- Advances PEV adoption through enabling vehicle-to-grid services and reduction in GHG emissions

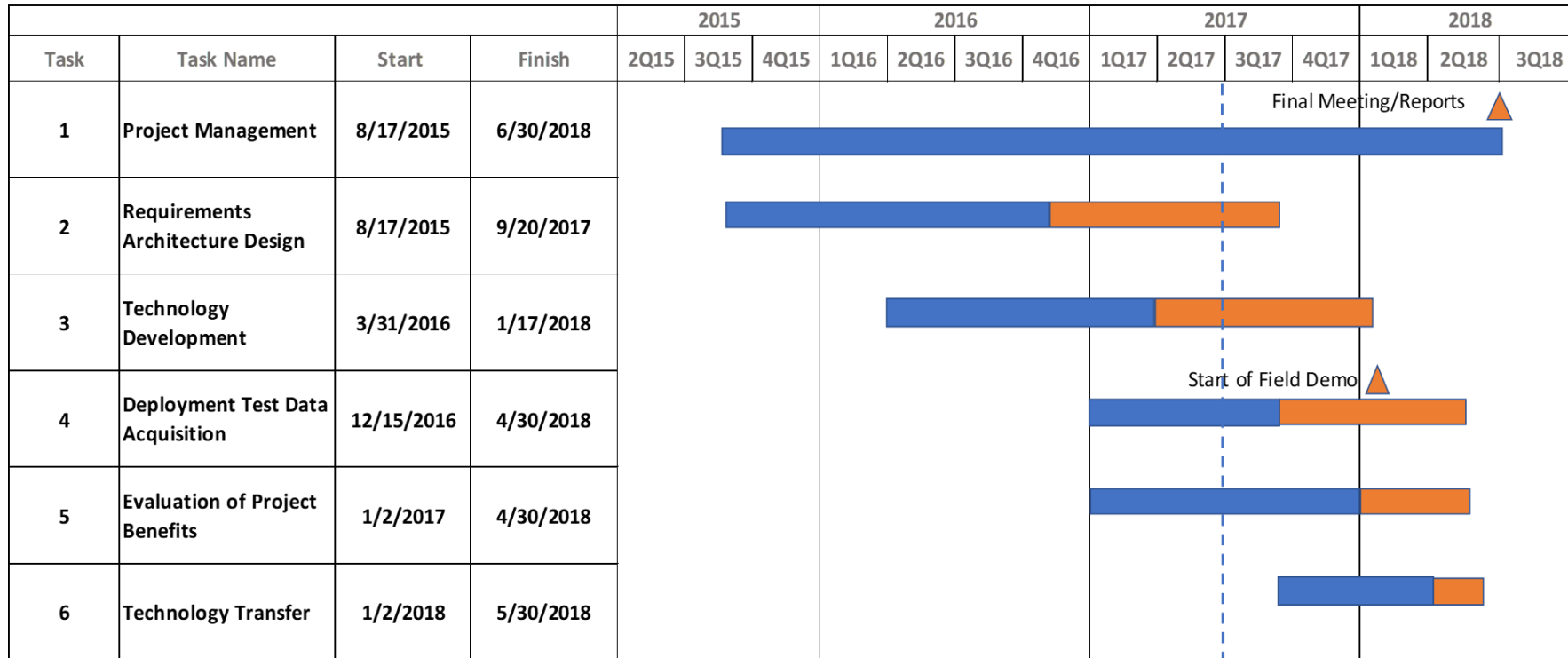
Technology Architecture



Project Goals

- Develop/demonstrate V2G capable PEVs and communication technologies and open standard interfaces
- Develop / demonstrate an end to end integrated system capable to offer distribution and ISO grid services
- Prove technical feasibility by testing the system under a variety of use cases
- Validate the cost/benefit for ratepayers and PEV owners
- Transfer technology to relevant stakeholders

Project Status



- What happens when the project is complete
 - Project is addressing two key challenges: **Demonstrable Value and Clarification of Interconnection Requirements**
 - Technology has Potential for increased level of deployments
 - Adoption by customers – dependent on anticipated consumer value net of incentives

Project Benefits

- Greater Reliability – Directly managing resources at the transformer level
- Lower costs – open standards, vehicle-integrated V2G and scalable implementation
- Increased safety – Interconnection capable with ‘Rule 21-equivalent’ functionality (IEEE2030.5 DER)
- Advances V2G services to accelerate PEV adoption
- Intelligently leverages PEV storage capabilities

Procurement Summary

- EPIC Solicitation PON-14-310
 - \$6.7M grant solicitation
 - \$1.5M grant award for EPC-14-086
 - 1 of 5 awarded projects
 - No DVBE requirement for grants

EPRI Transformer Management System: HW

Transformer Power Measurement Unit

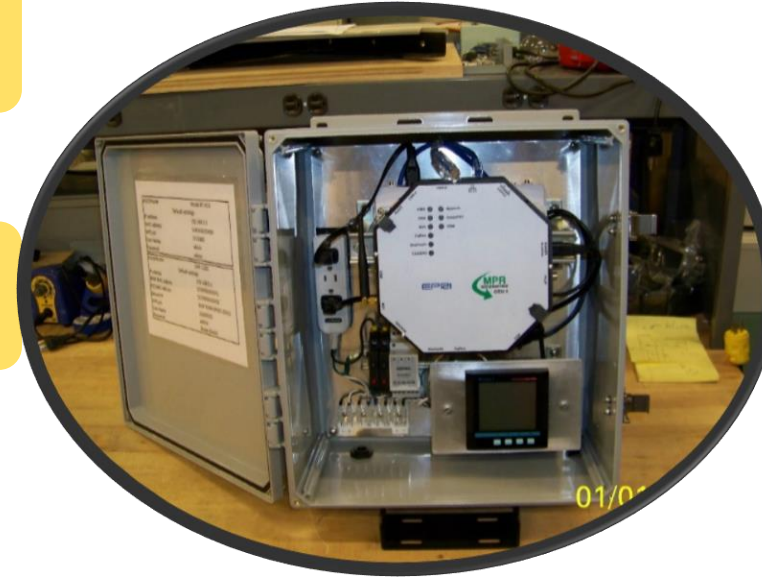
- Measures Voltage, Current and Phase
- RS485 Communications Interface to the TC

Transformer Controller (TC)

- Linux based open Router Platform
- RS485 Communications Interface to the TPMU
- Communications to each EVSE(s) and PEV(s) via HomePlug AV Adaptor
- Performs Energy Management Algorithm

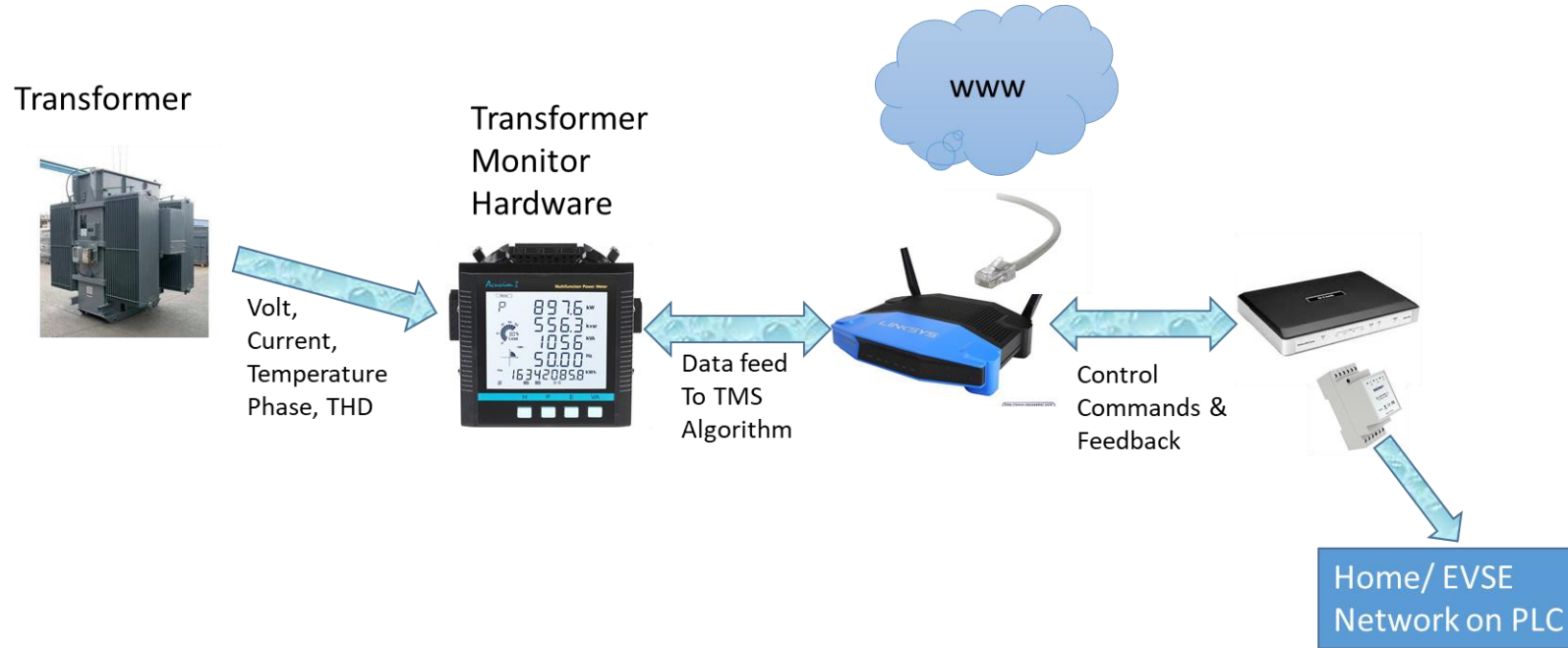
HomePlug AV Ethernet Adaptor

- Ethernet connected to the Transformer Controller
- Communicates to all connected Gateways via the premise drop

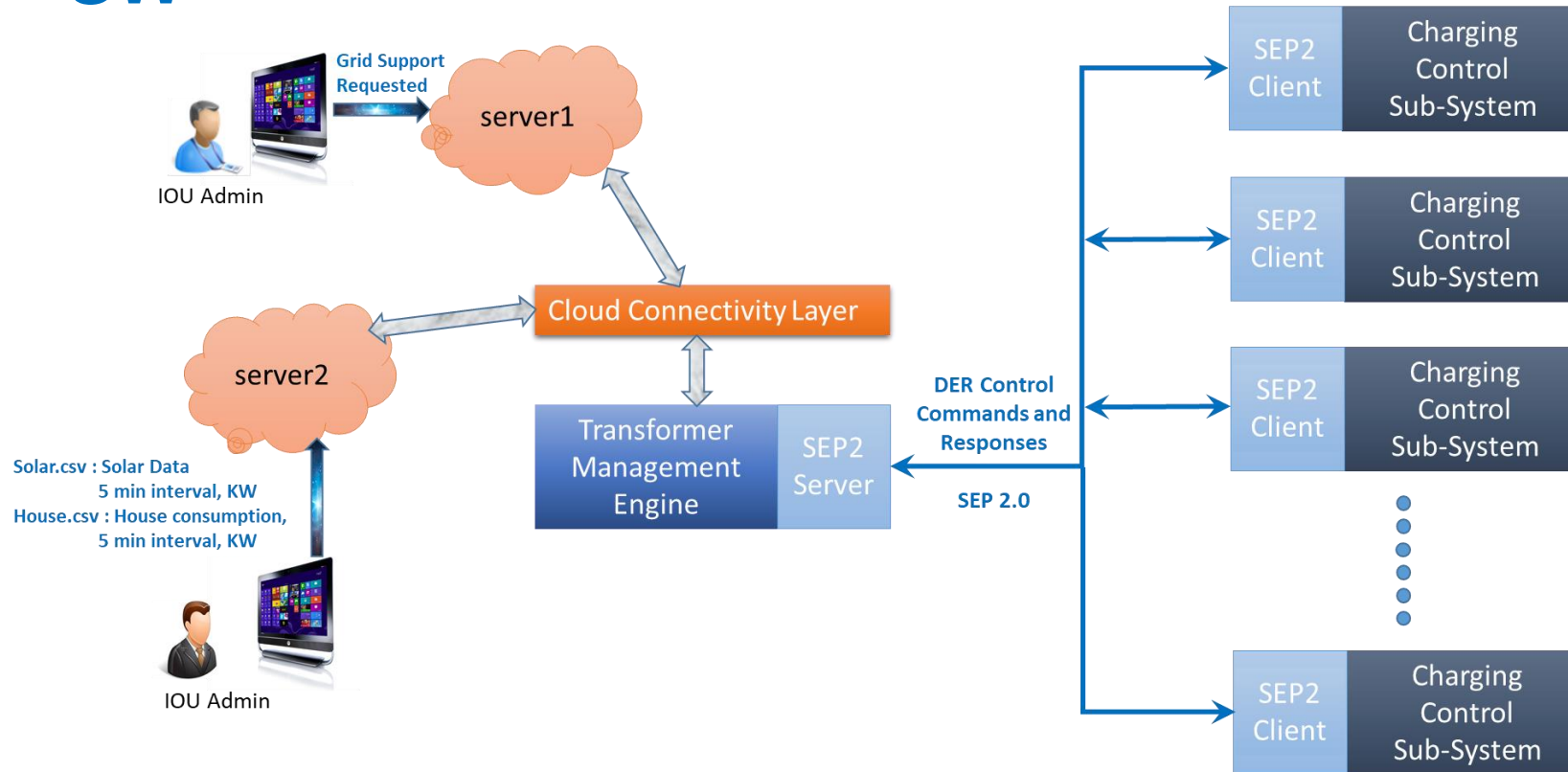


TMS Enclosure NEMA 3R
Outdoor Mounted to L2 Charging
Island 30KVA Transformer

EPRI Transformer Management System: HW

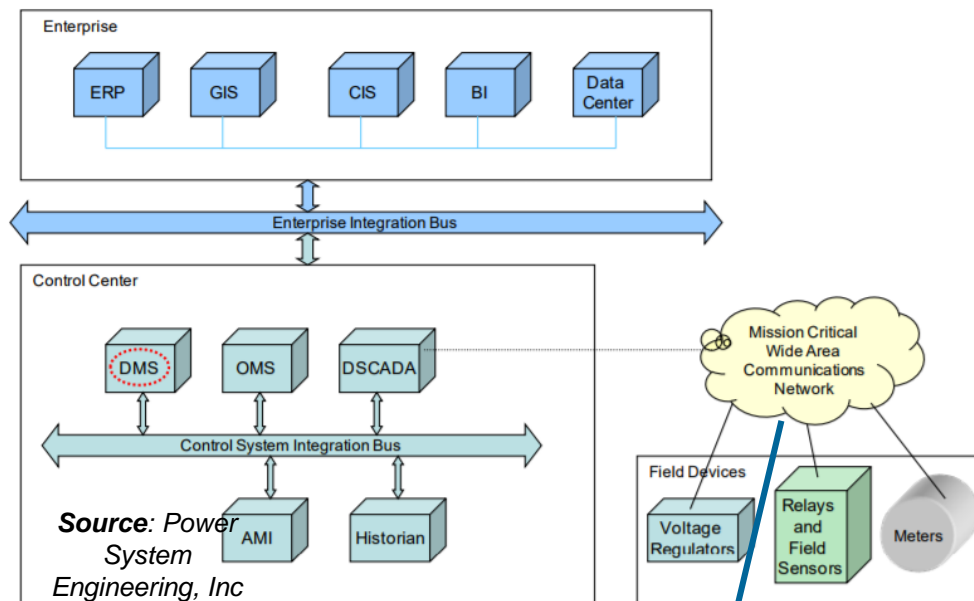


EPRI Transformer Management System: SW



Transformer Management System – as the Edge of the Grid Link to DA System

- Node in the Distribution System Automation by linking up with D-SCADA, DERMS and ADMS
- Streams critical distribution system endpoint data upstream to DERMS, ADMS and to T&D automation via D-SCADA,
- Applications:
 - Visualization,
 - Real-time hotspot identification etc.
- Disaggregation / control node for DMS /ADMS for DERs
 - EVs
 - PV
 - Storage
 - Demand Management including Demand Charges
- Responds in real time to localized distribution system conditions.



UCSD 14-086 Project Site Equipped with EPRI TMS, interacting with PV, Storage and EVs

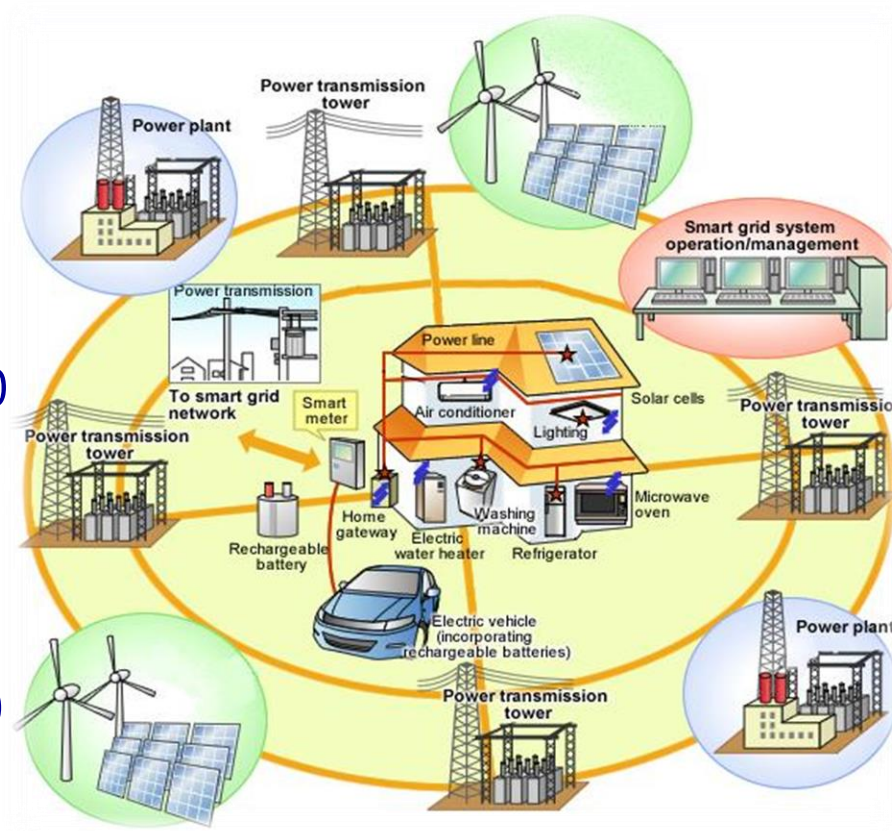
Southern California Edison

Lessons Learned

- Technology
 - On-vehicle: Grid-tied Bidirectional Power Converter / smart inverter – relatively modest risk (Gen 2)
 - On-EVSE: Much lower risk, UL-capable EVSE w/ J3072/IEEE2030.5 can be UL1741 compliant
- Maturity of marketplace
 - For V2G capable vehicles, selling them as ‘storage replacement’ would be possible – help maximize self-consumption either at home or workplace
 - No marketplace exists today because these have not been commercially introduced (except Nissan’s recent announcement)
 - Key barrier is demonstrated value
- New Capabilities / Opportunities: Transformer Management System

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