



CALIFORNIA ENERGY COMMISSION

2016 EPIC Summer Workshop Distribution Automation

Connie Sichon, P.E.

Energy Systems Research Office

Energy Research & Development Division

June 22, 2016



Developing the Smart Grid of 2020: Clean, Safe, and Highly Intelligent GFO-15-313

- Fund applied research and development projects that develop technologies, tools, and strategies to efficiently and reliably integrate distributed and renewable generation into California's electric grid. *(2012-2014 EPIC Investment Plan, Strategic Objectives S6 & S7)*
- Three Project Groups
 - Smart Grid Operation and Management Practices (S6.3, S6.4, S7.4)
 - Distribution Automation Enhancements (S6.2)
 - Bi-Directional Distribution Equipment, Devices, and Technologies (S6.1)
- Notice of Proposed Award released March 2016, projects approved in May & June Energy Commission Business Meetings



Group 2: Distribution Automation Enhancements (Funding Initiative S6.2)

- Enhance existing distribution automation systems to integrate distributed energy resources and improve grid reliability.
- Develop new and emerging technologies to increase the amount of renewables that can be connected at the distribution level and to provide greater control over the operation of distributed energy resources.
- Meet all applicable safety requirements and, if applicable, NERC CIP requirements.

**Four projects awarded totaling \$4,762,875 with \$1,253,708 in match funds
(Approved at May and June 2016 Energy Commission Business Meetings)**

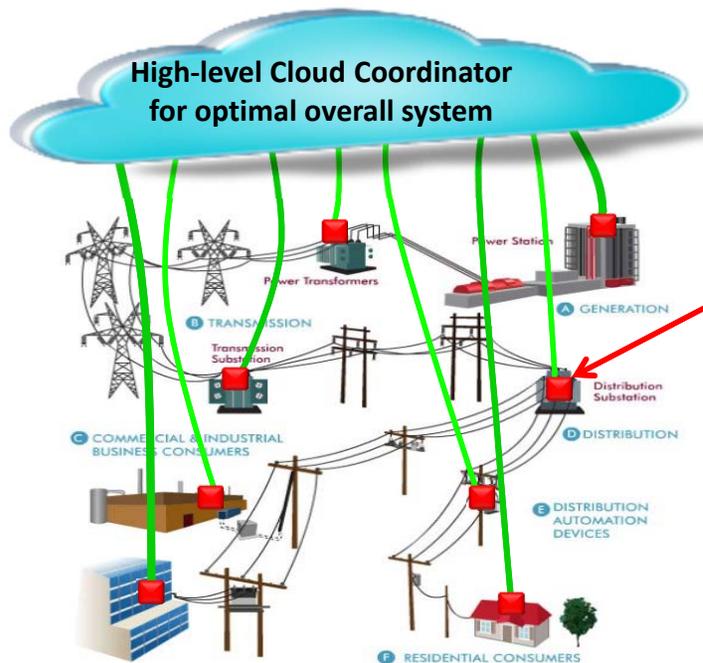


Distribution Automation Projects (2016)

Recipient	Title	Funding Amount
UC Riverside	Integrated Distributed Energy Resources Management System (iDERMS)	EPIC = \$1,119,437 Match = \$686,427
Siemens Corporation, Corporate Technology	Developing a Distribution Substation Management System	EPIC = \$500,000 Match = \$455,000
UC Irvine (Advanced Power and Energy Program)	Substation Automation and Optimization of Distribution Circuit Operations	EPIC = \$932,718 Match = \$112,281
SLAC National Accelerator Laboratory	Powernet – A Cloud Based Method for Managing Distribution Resources	EPIC = \$2,210,720



Powernet – A Cloud Based Method for Managing Distribution Resources DOE-SLAC National Accelerator Laboratory



Low-level Hub: networked embedded intelligence to measure and control power flow, voltage, VAR and other grid attributes

- Manage energy resources in homes and businesses.
- Conduct behind-the-meter pilot test for Navy housing in Monterey, CA
- Understand how aggregated data from residences can be used to more efficiently run the distribution grid.

Agreement Number: EPC-15-047
Project Term: June 2016 - March 2019
Agreement Amount: \$2,210,720

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Questions

Related Information:

- **Sign up for the Listservers by selecting “Opportunity:”**

www.energy.ca.gov/listservers/

- **Information on EPIC:**

www.energy.ca.gov/research/epic/index.html

- **Information on other EPIC solicitations:**

www.energy.ca.gov/contracts/epic.html

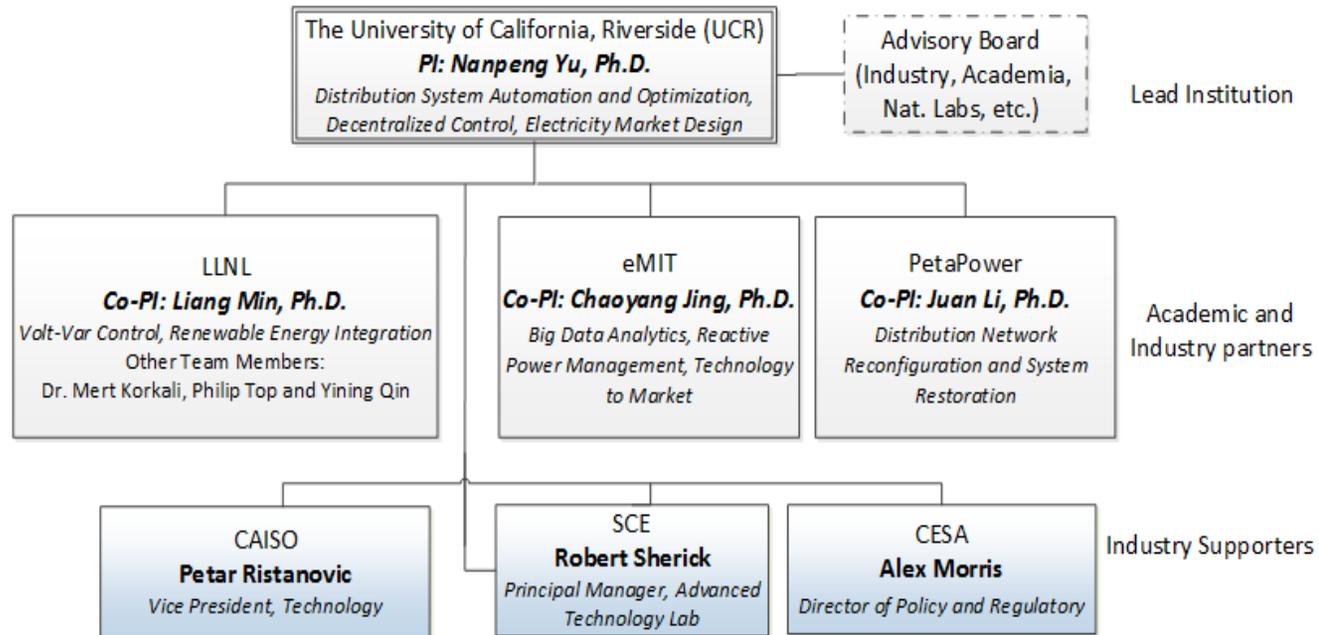


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Integrated Distributed Energy Resources Management System (iDERMS) UC Riverside

Principal Investigator: Dr. Nanpeng Yu



LLNL: Lawrence Livermore National Laboratory
SCE: Southern California Edison

CAISO: California Independent System Operator
CESA: California Energy Storage Alliance

Agreement Number: EPC-15-090

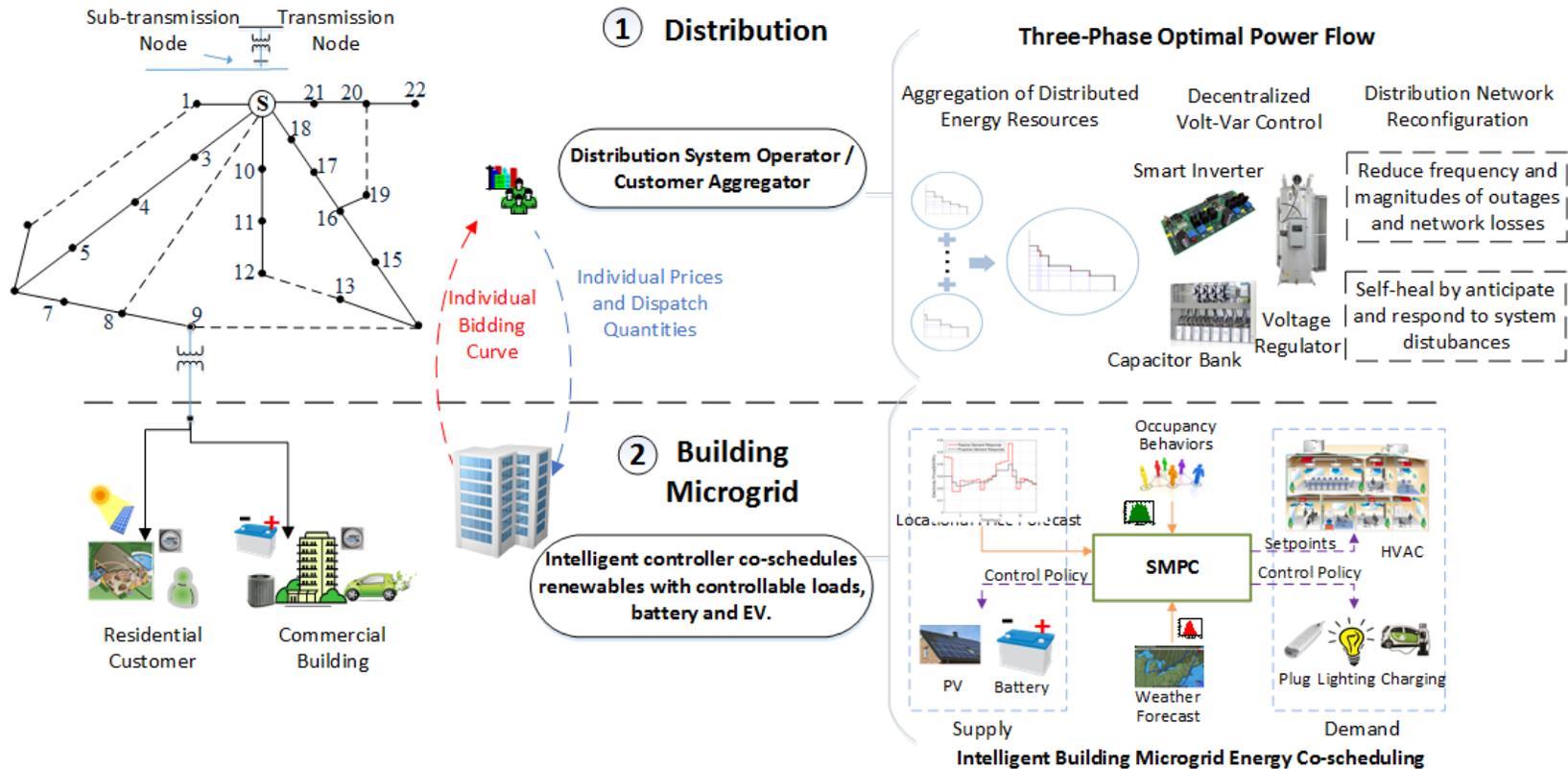
Project Term: July 2016 - March 2019



Integrated Distributed Energy Resources Management System (iDERMS)

UC Riverside

Principal Investigator: Dr. Nanpeng Yu



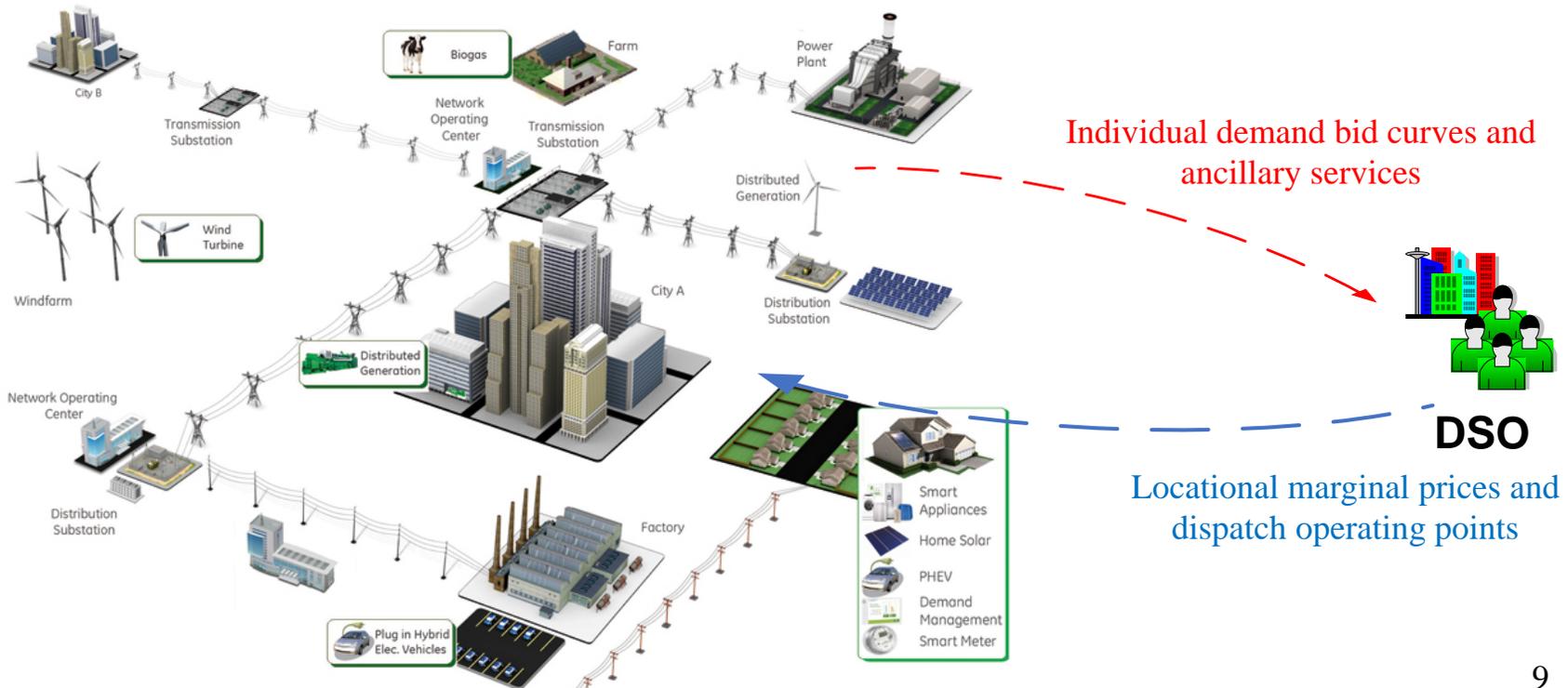


Integrated Distributed Energy Resources Management System (iDERMS)

UC Riverside

- Distribution System Operator (DSO) Market

Market mechanism to coordinate operations of flexible loads and distributed energy resources

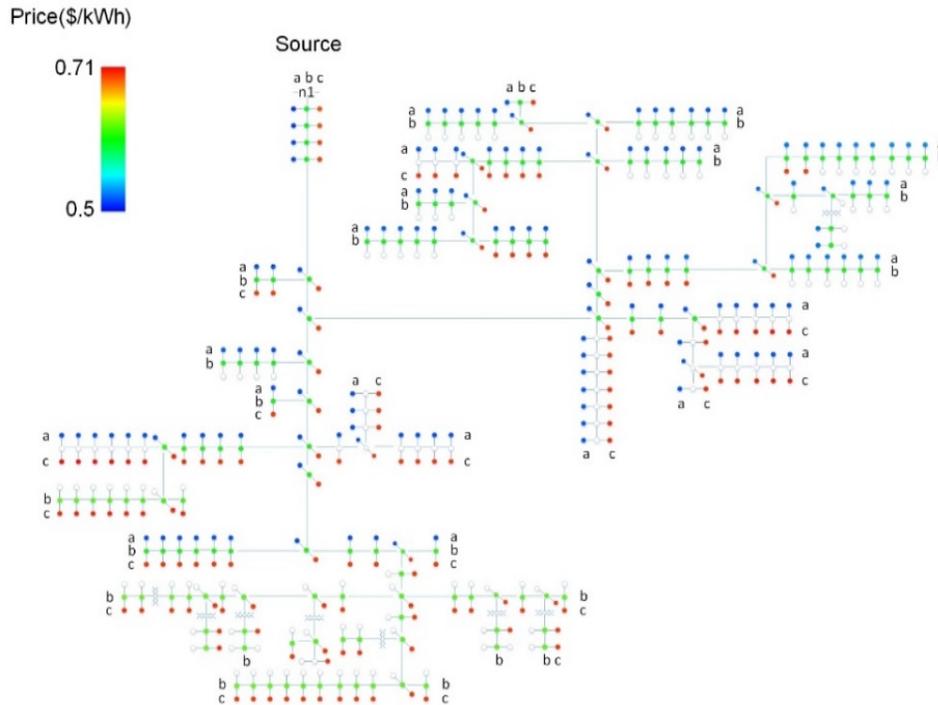


DSO market does not currently exist. This project would help enable development of a future DSO market.



Integrated Distributed Energy Resources Management System (iDERMS) UC Riverside

Three-Phase Direct Current Optimal Power Flow & Alternating Current Optimal Power Flow

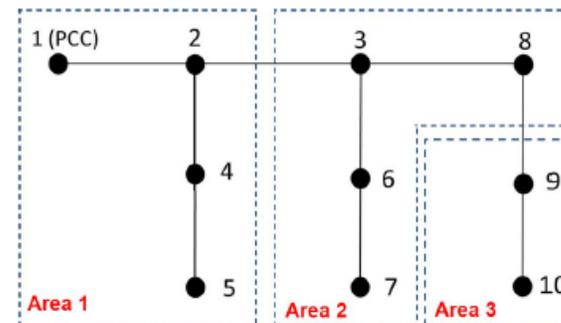


Three-Phase Locational Marginal Prices
(Realistic SCE Distribution Circuit with Secondary Feeders Omitted)

Limitation of the existing approaches:
Scalability

Number of buses	Computation Time (Centralized)
8	1.85 s
34	298 s
123	Out-of-memory

Solution: Tree Network → Decomposability



Parallel Computing

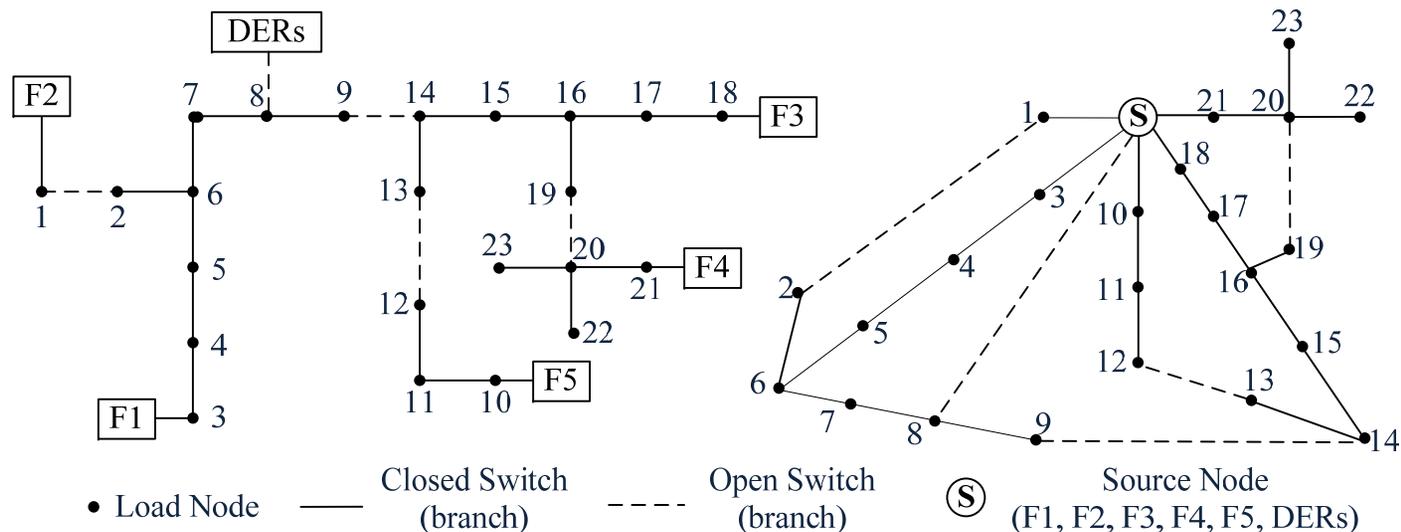


Integrated Distributed Energy Resources Management System (iDERMS) UC Riverside

➤ Self-Healing Distribution System

A smart grid should have the ability to “self-heal” by anticipating and responding to system disturbances

- ❑ Distribution system restoration: restore loads after a fault by altering the topological structure of the distribution network while meeting electrical and operational constraints.
- ❑ Helps achieve a higher level of renewable penetration and energy efficient buildings





Questions



Agreement Number: EPC-15-090
Project Term: July 2016 - March 2019
Agreement Amount: \$1,119,437
Match Amount: \$686,427

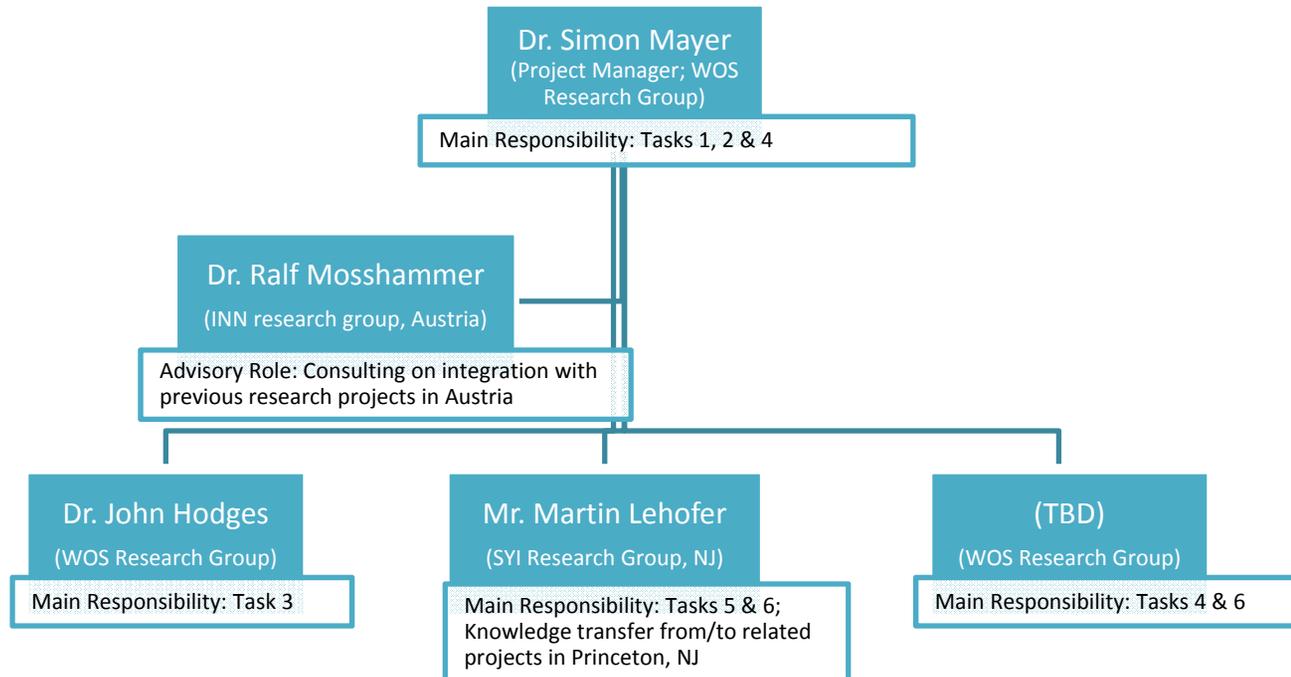
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Developing a Distribution Substation Management System

Siemens Corporation, Corporate Technology

Principal Investigator: Dr. Simon Mayer



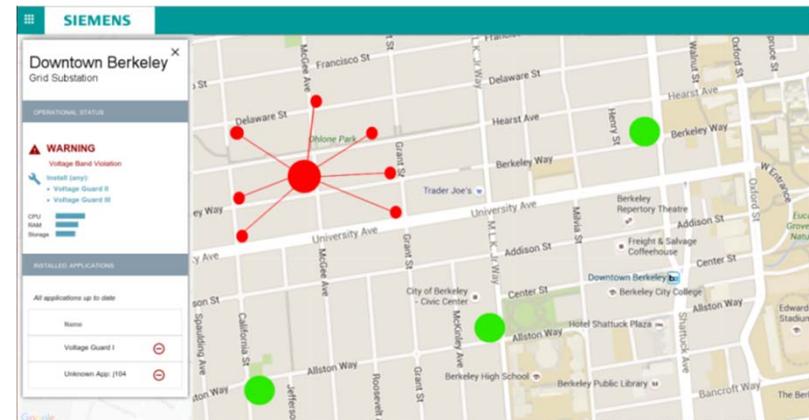
Agreement Number: EPC-15-046

Project Term: June 2016 - March 2019



Developing a Distribution Substation Management System Siemens Corporation

1. **Dashboard display** displays state of the distribution grid in real time, shows warnings for detected problems, and automatically suggests potential solutions to these problems
2. **Semantic model** of the smart grid that encodes information about common problems and solutions to these problems in a machine-readable format
3. **Classification engine** that can semi-automatically classify smart grid data streams (e.g., voltages, switching decisions, loads)



Together, these allow the faster execution of routine and non-routine tasks that are performed on a substation



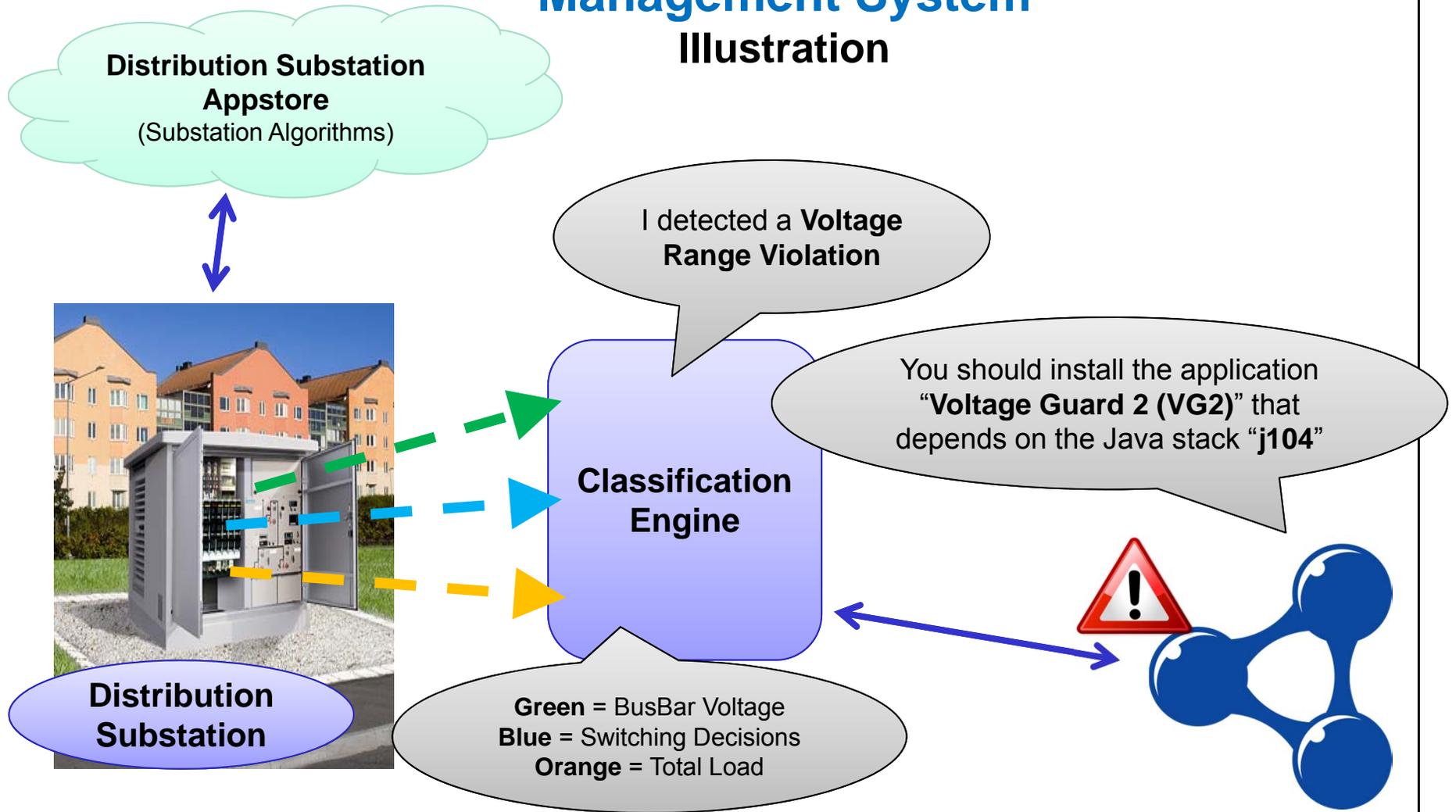
Developing a Distribution Substation Management System

Technical Tasks

1. Extension of semantic model to integrate operational smart grid data
2. Semi-automatic classification of data streams
3. Self-configuration of distribution substation apps
4. Semantically-integrated operational dashboard
5. Automatic deployment of apps across the distribution substation network
6. Extension of operational dashboard with global management capabilities



Developing a Distribution Substation Management System Illustration





Questions

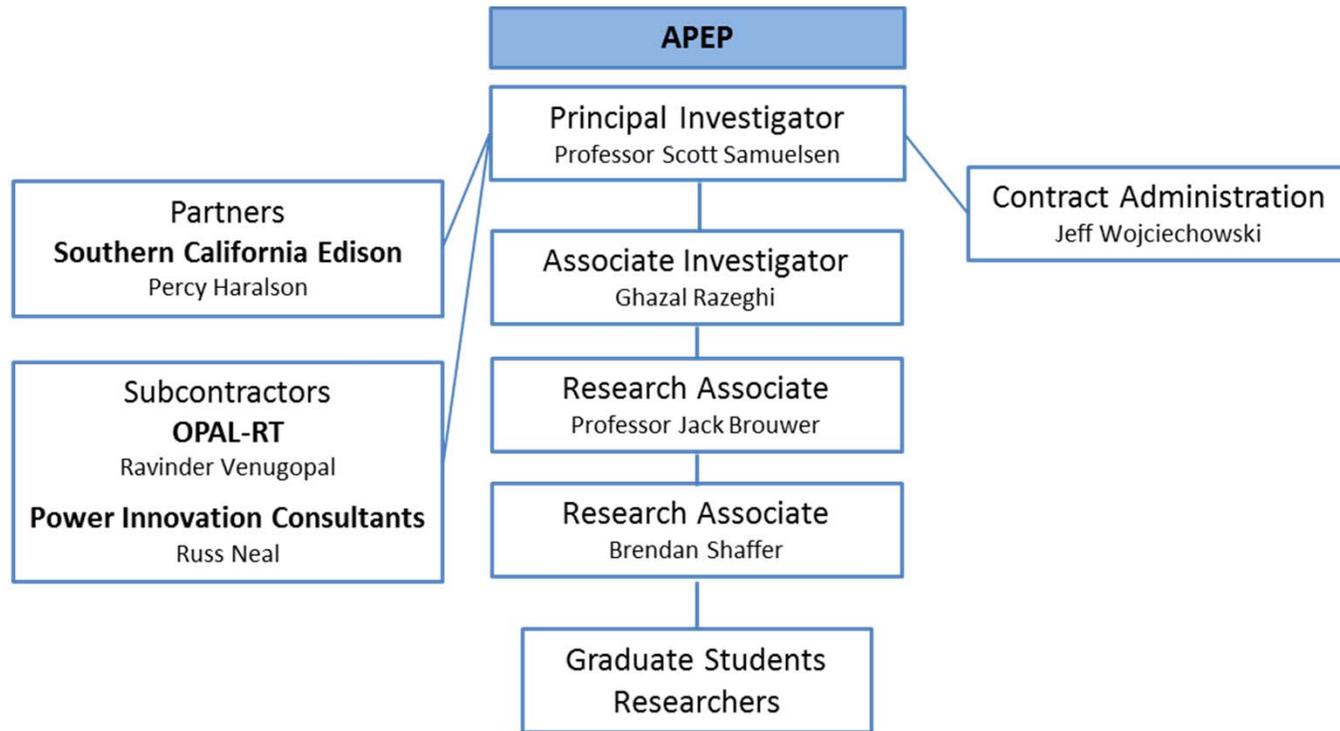


Agreement Number: EPC-15-046
Project Term: June 2016 - March 2019
Agreement Amount: \$500,000
Match Amount: \$455,000

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Substation Automation and Optimization of Distribution Circuit Operations

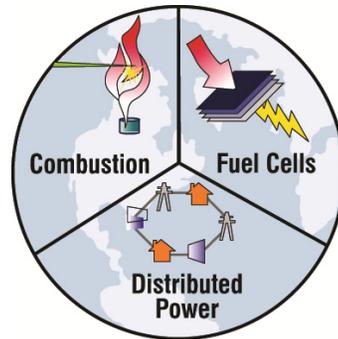


Agreement Number: EPC-15-086
Project Term: July 2016 - March 2019

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Station Automation and Optimization of Distribution Circuit Operations

Agreement Number EPC-15-086

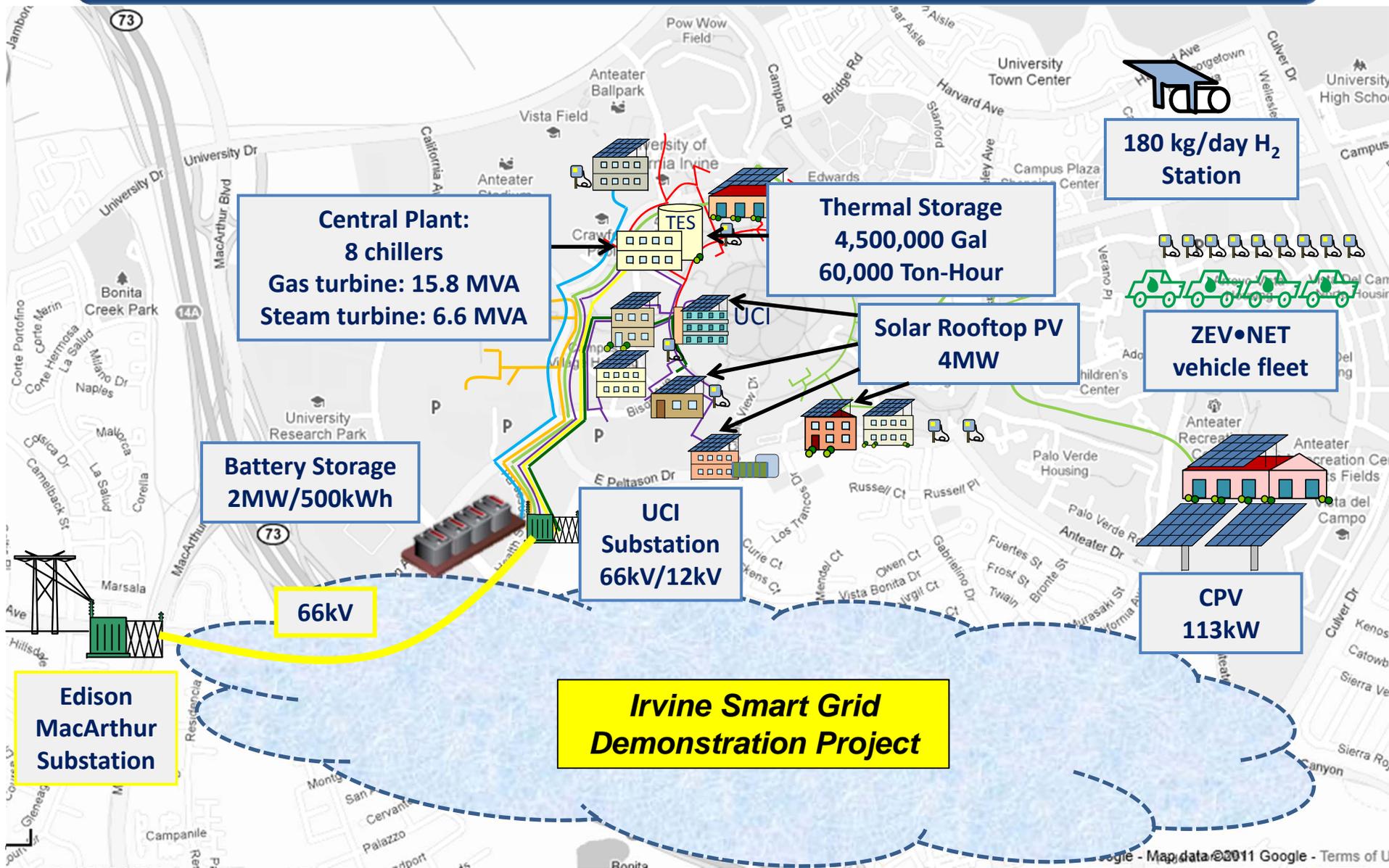


**ADVANCED POWER
& ENERGY PROGRAM**
UNIVERSITY of CALIFORNIA • IRVINE

Ghazal Razeghi, Ph.D.
Senior Research Scientist
Professor Scott Samuelsen
Principal Investigator

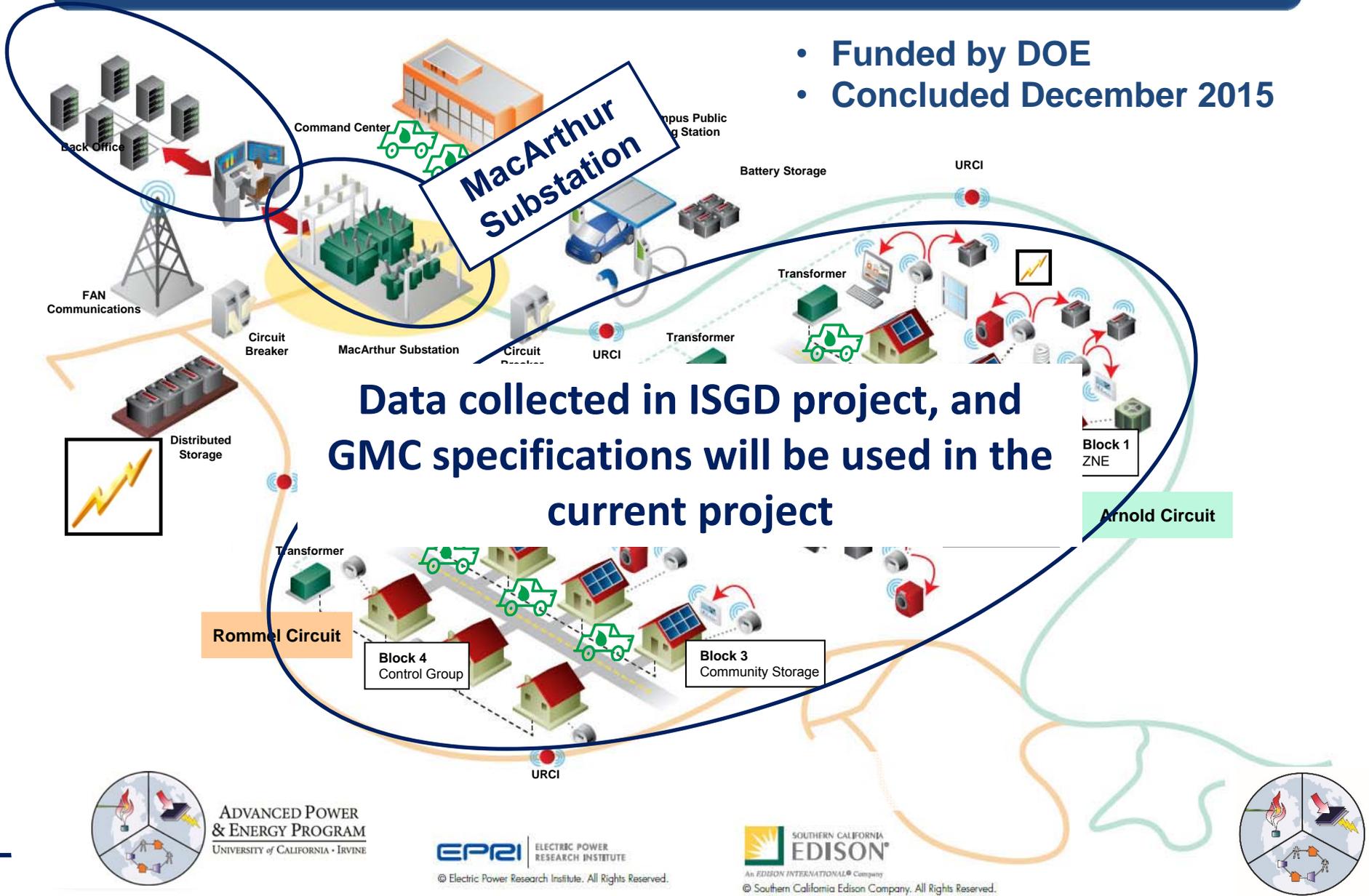
June 22, 2016

UCI



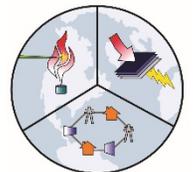
Project will Use Data from ISGD

- Funded by DOE
- Concluded December 2015



Station Automation and Optimization of Distribution Circuit Operations

- **Project Goal:**
 - **Establish the substation control capabilities necessary to manage distribution energy assets as a single unit with**
 - A high-penetration of renewable power generation, and
 - The emergence of retail/distribution electricity markets.
- **Objectives:**
 - **Maximize the penetration of renewable resources and distributed energy resources**
 - **Develop and assess the viability of a retail electricity market**
 - **Develop strategies for better distribution system management and use of smart grid technologies**
 - **Simulate and assess the deployment of fuel cells at the substation**
- **Project Team:**
 - UCI APEP
 - SCE
 - OPAL-RT
- **Project Duration**
 - **Start Date: July 2016**
 - **End Date: March 2019**



Approach

- **Data collected from the Irvine Smart Grid Demonstration Project will be used to develop and verify models**
- **GMC specifications will be applied to MacArthur substation and the two circuits previously part of ISGD**
- **The system and the controller will be modeled using OPAL-RT**
- **Using the models and the controller, various scenarios will be simulated:**
 - **Deployment of DERs such as fuel cells**
 - **Smart grid technologies**
 - **Demand response strategies**
 - **Increase renewable penetration**
- **A fictitious retail/distribution market will be specified and assessed**

