Piloting the Integration and Utilization of Renewables to Achieve a Flexible, Secure and Climate Neutral Energy Infrastructure

ADVANCED POWER & ENERGY PROGRAM
UNIVERSITY of CALIFORNIA · IRVINE

Energizing California's Communities with Renewables: Recent Successes and Future Opportunities

July 29, 2015

Project Goals

Establish:

1. An energy infrastructure roadmap for the UC Irvine campus community that will maximize the deployment and utilization of renewable energy resources while satisfying reliability criteria, enhancing and sustaining power quality, and minimizing the cost-of-

The primary objective: Develop a methodology using data and lessons learned from pilot projects to study renewable energy deployment at the UCI community and at communities in general.

infrastructures that maximize the deployment and utilization of renewable energy resources while satisfying reliability criteria, enhancing and sustaining power quality, and minimizing the cost-of-electricity (COE).

3. The issues for policy makers and industry leaders that must be addressed to facilitate the implementation of renewable-based energy secure communities throughout the State.

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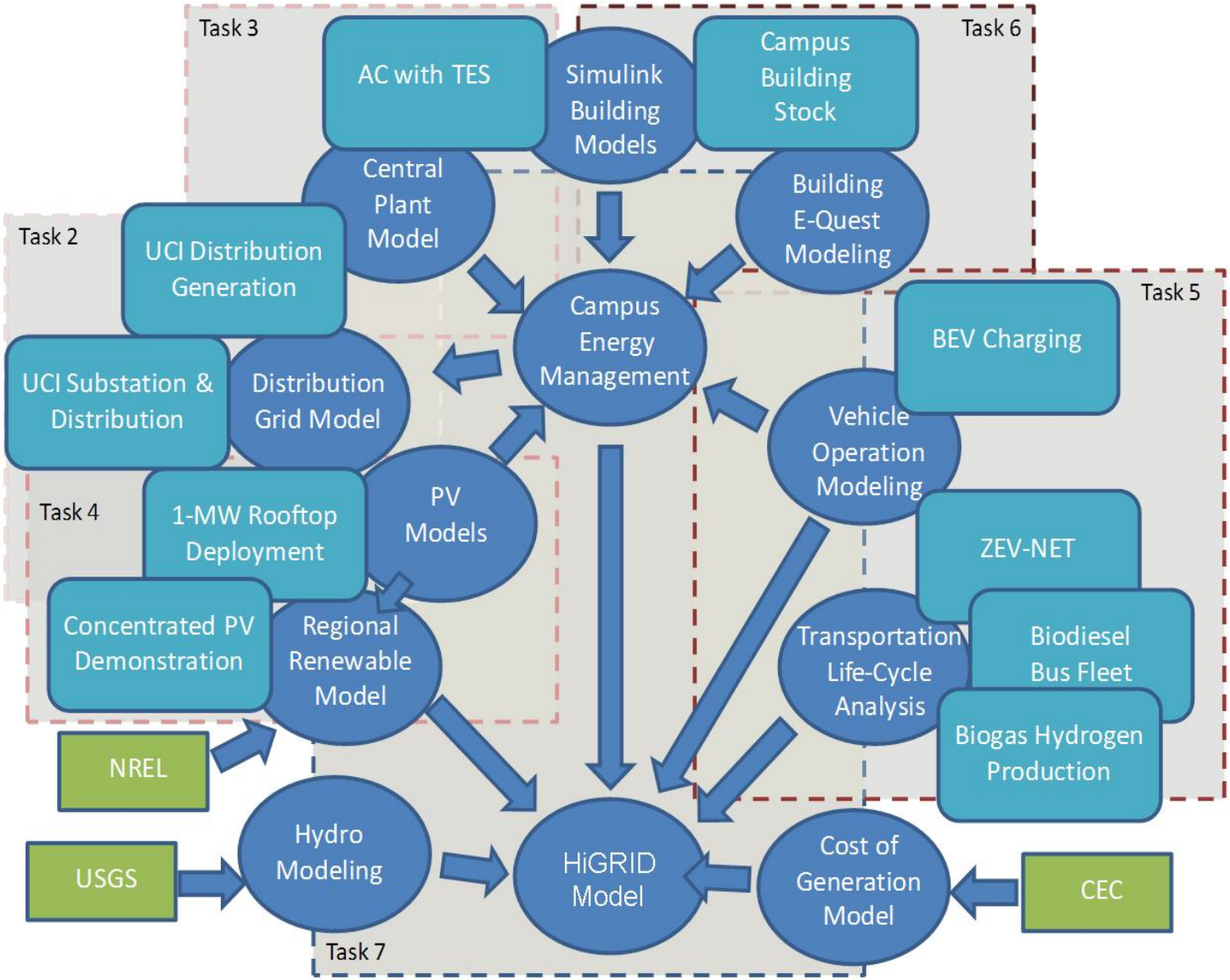
Methodology



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UCI Microgrid

- Comprehensive Research University
- $330 Million Sponsored Research
- Top Public U.S. University 50 Years Old or Younger
- 20+ LEED Buildings
- 7.5 Million Square Feet
- 8–24 MW Load

- **Major Goal: Net zero carbon by 2025**

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UCI Microgrid

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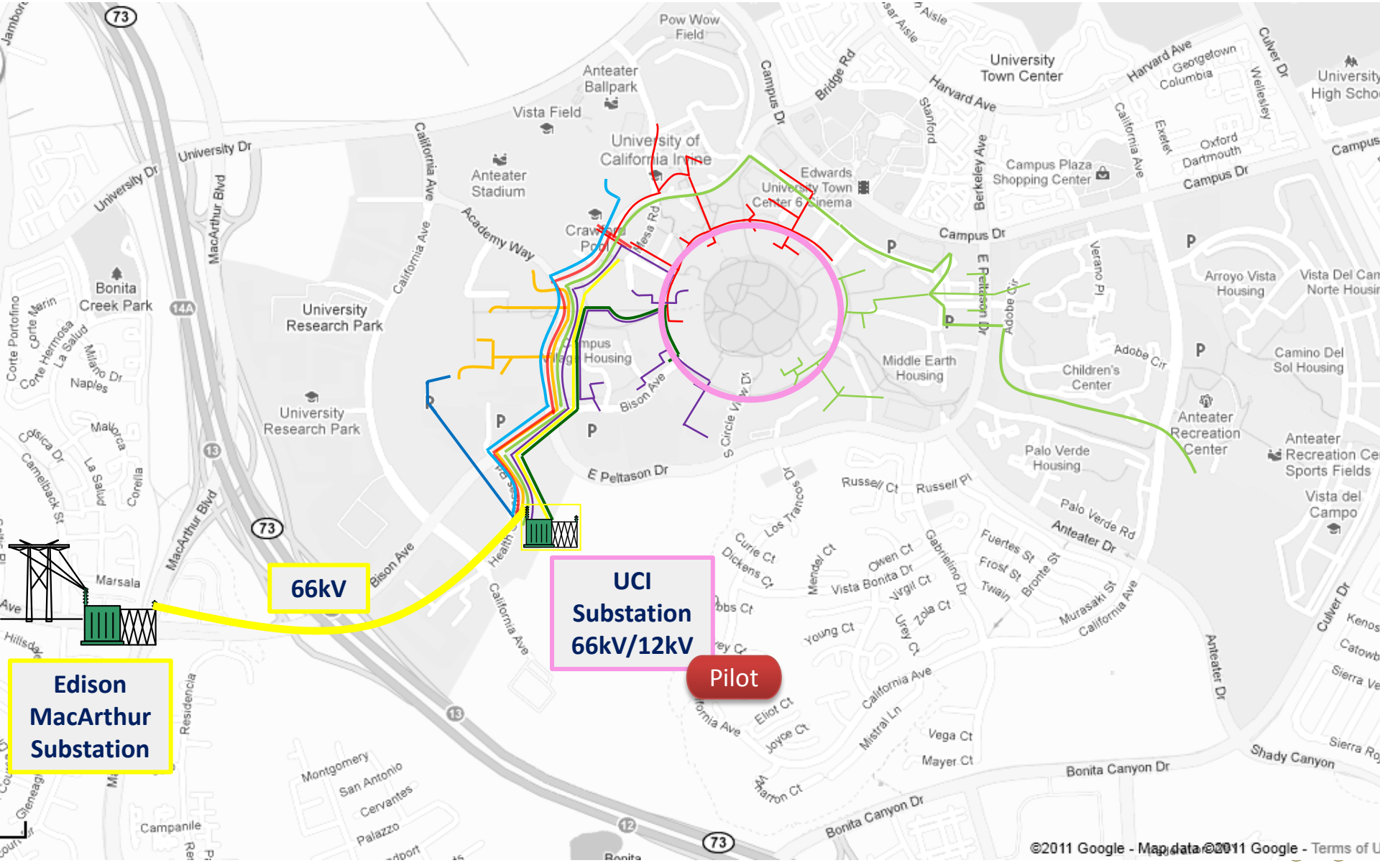
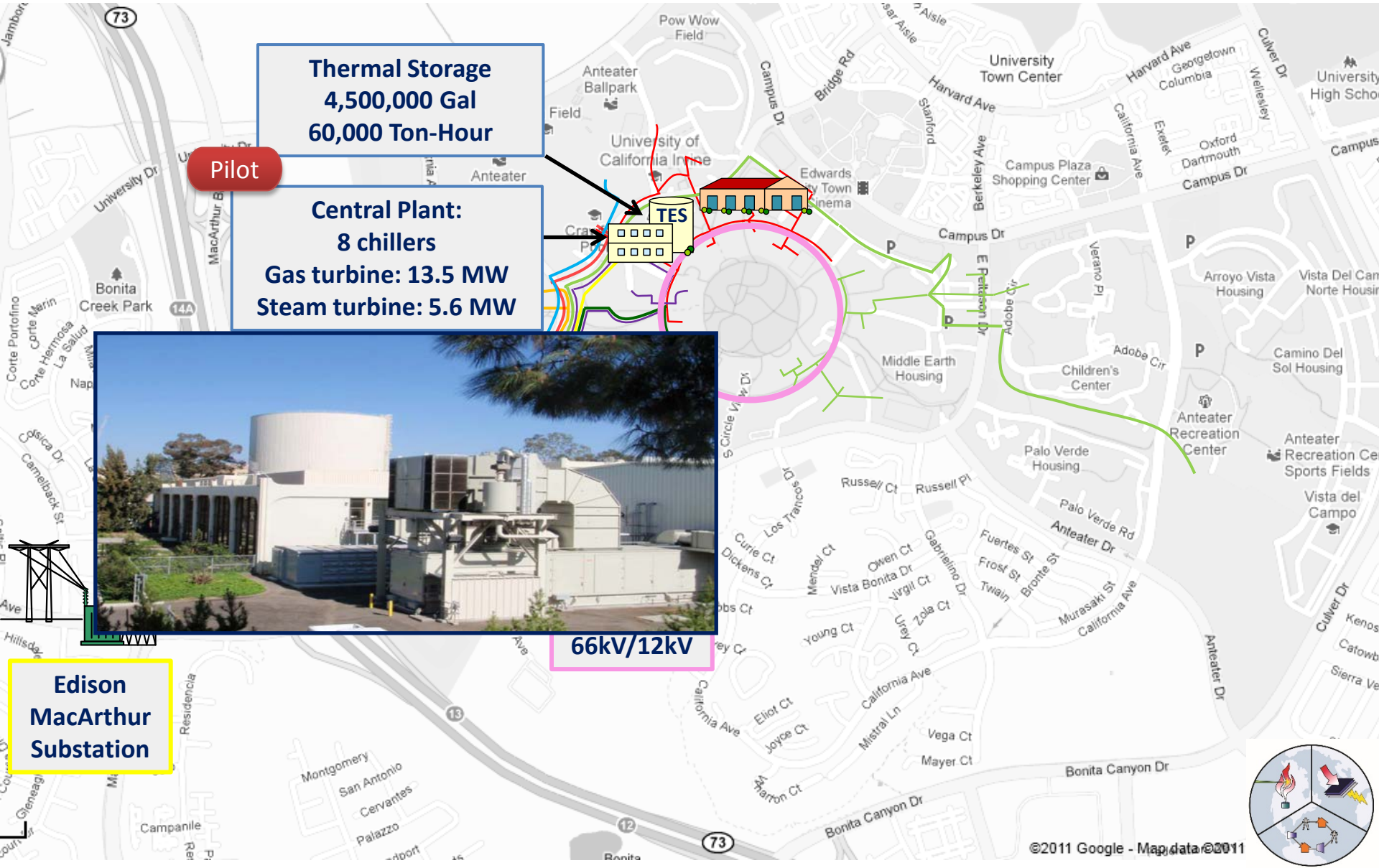
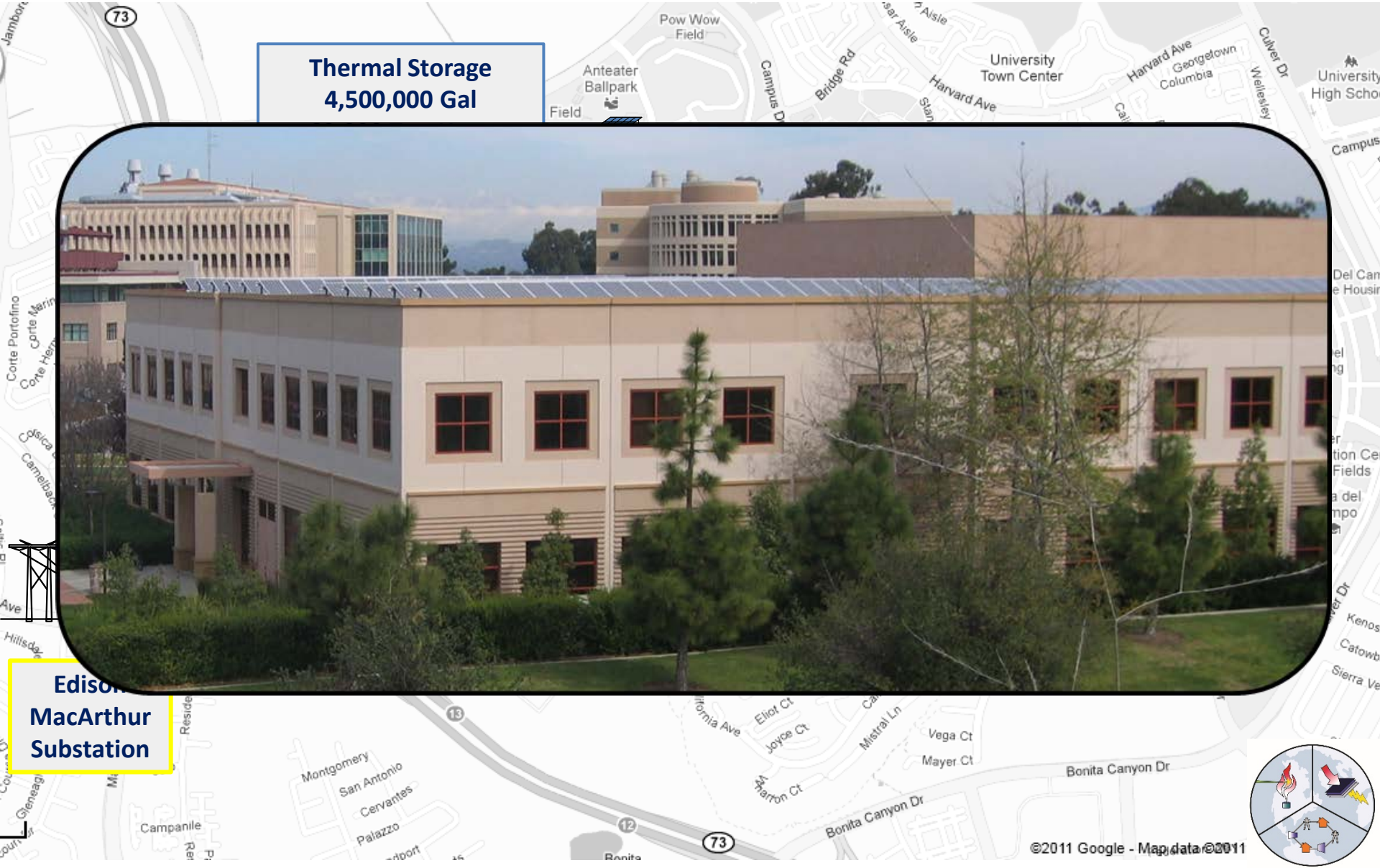
UCI Microgrid



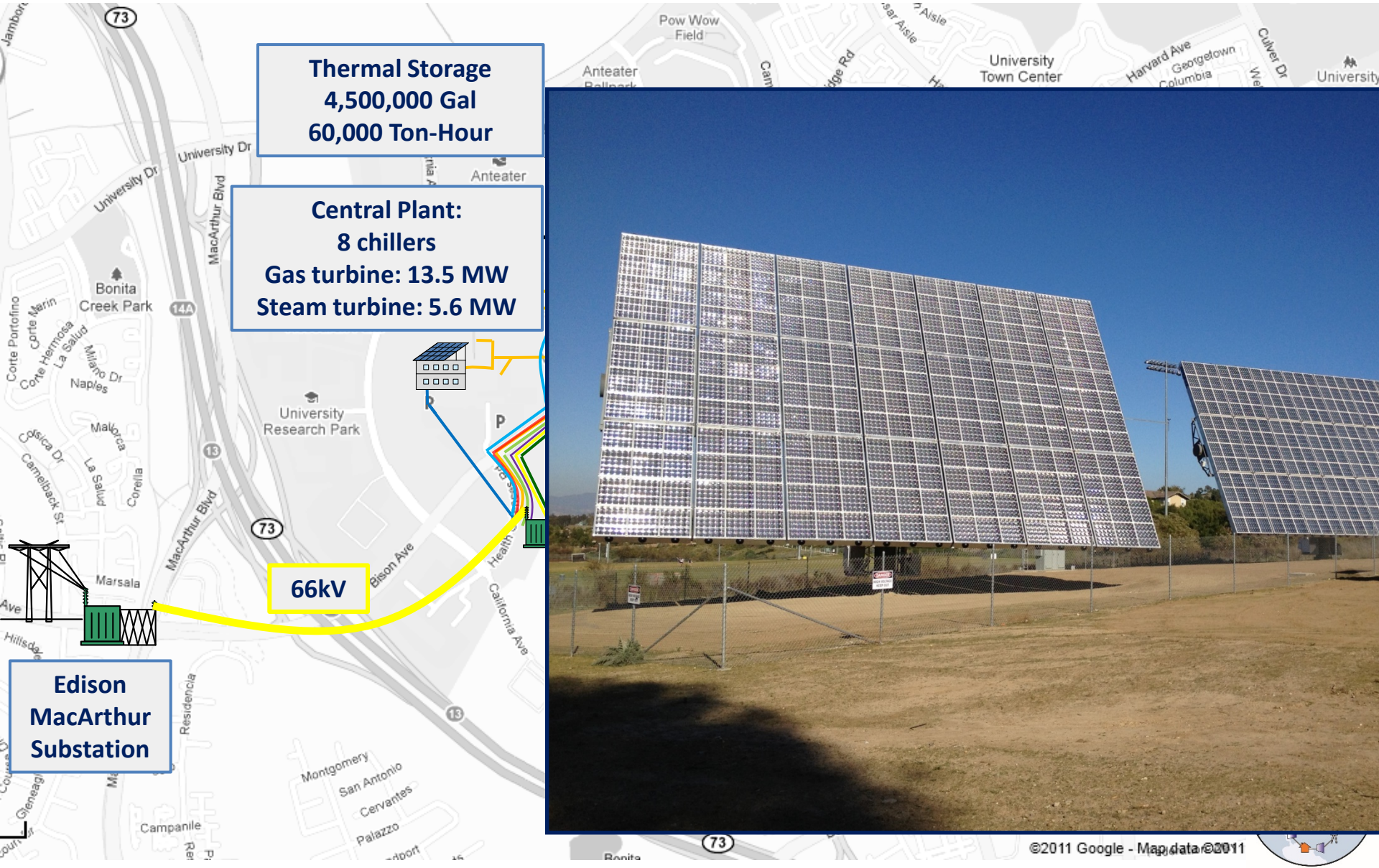
UCI Microgrid



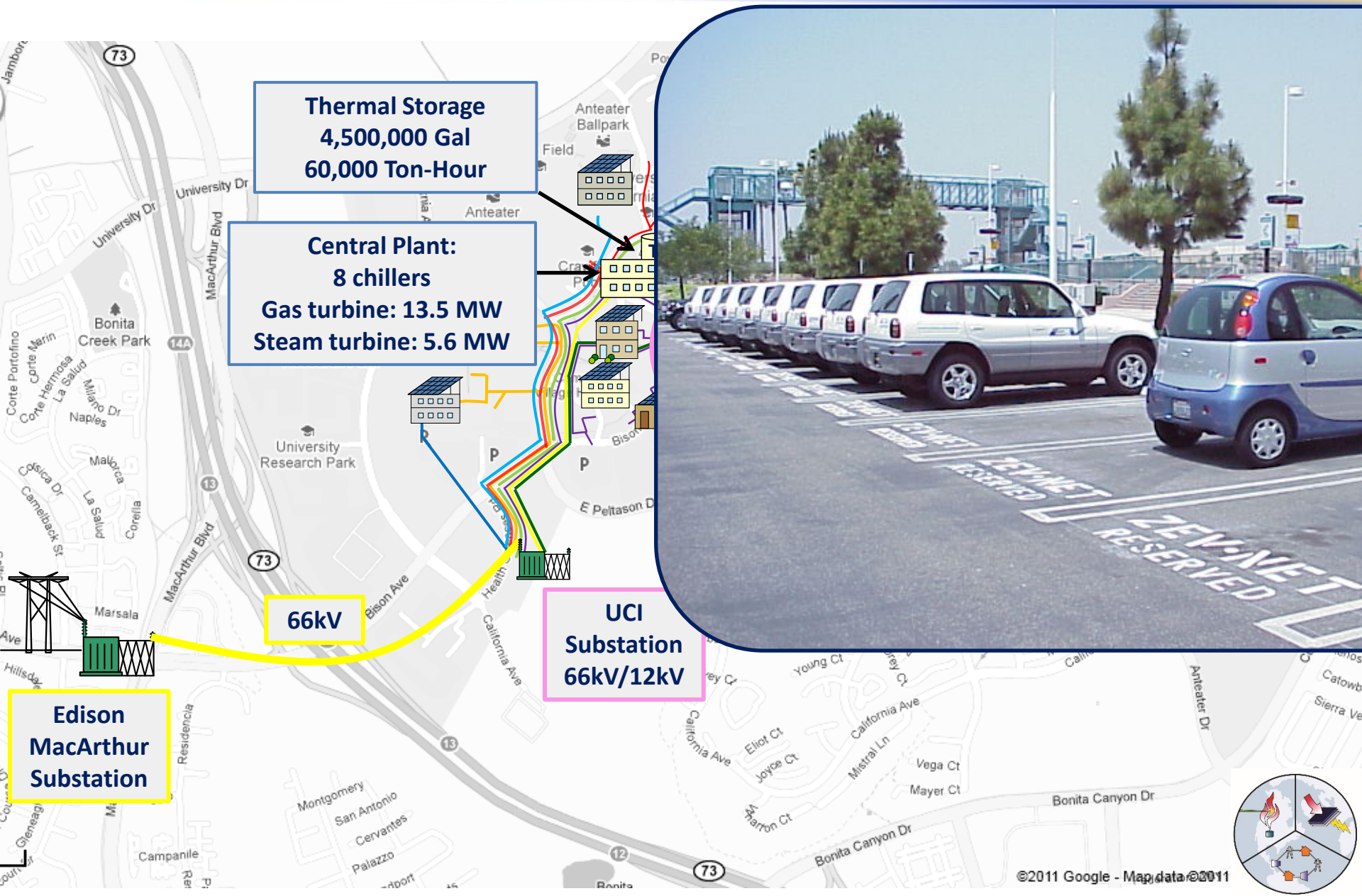
UCI Microgrid



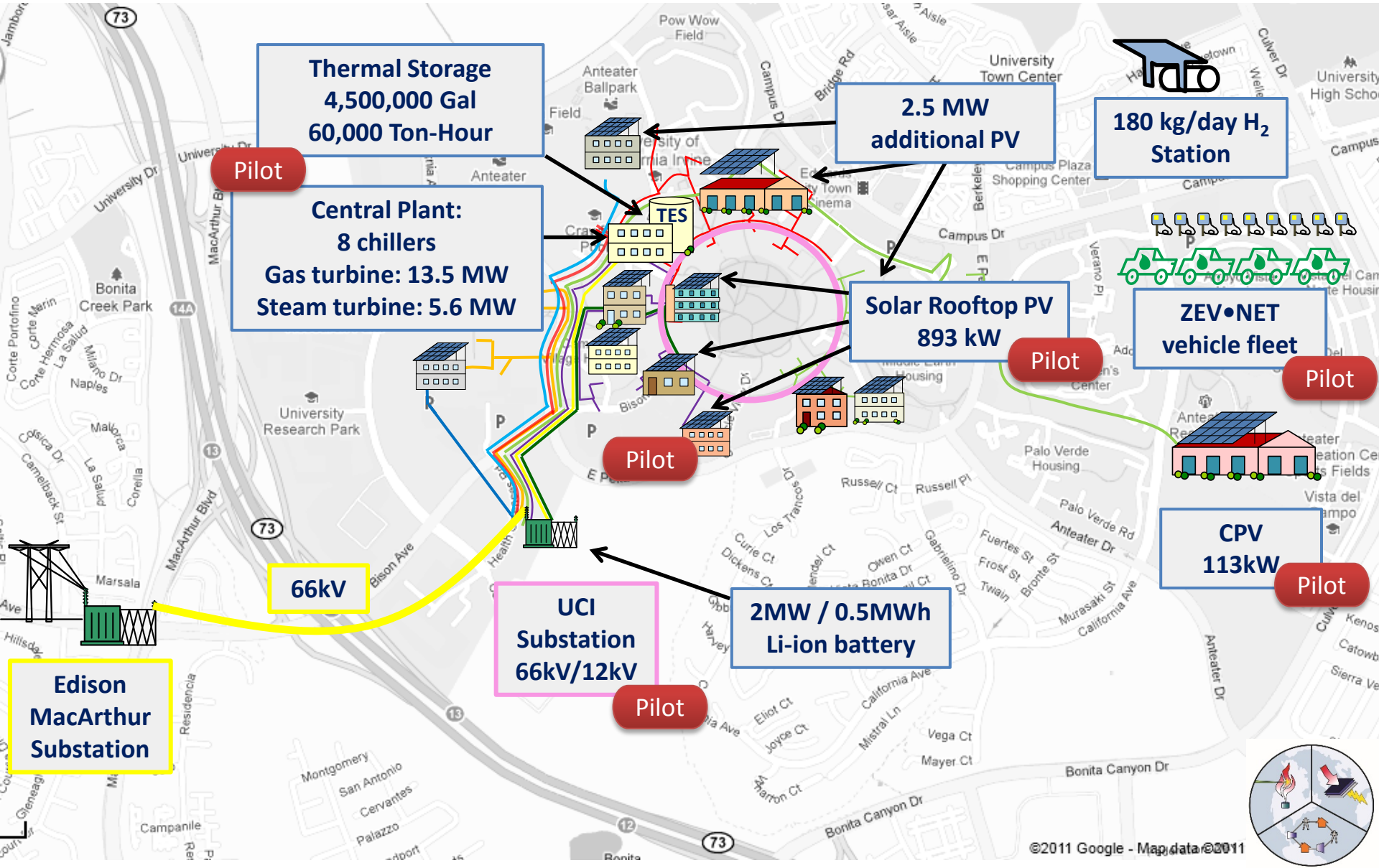
UCI Microgrid



UCI Microgrid

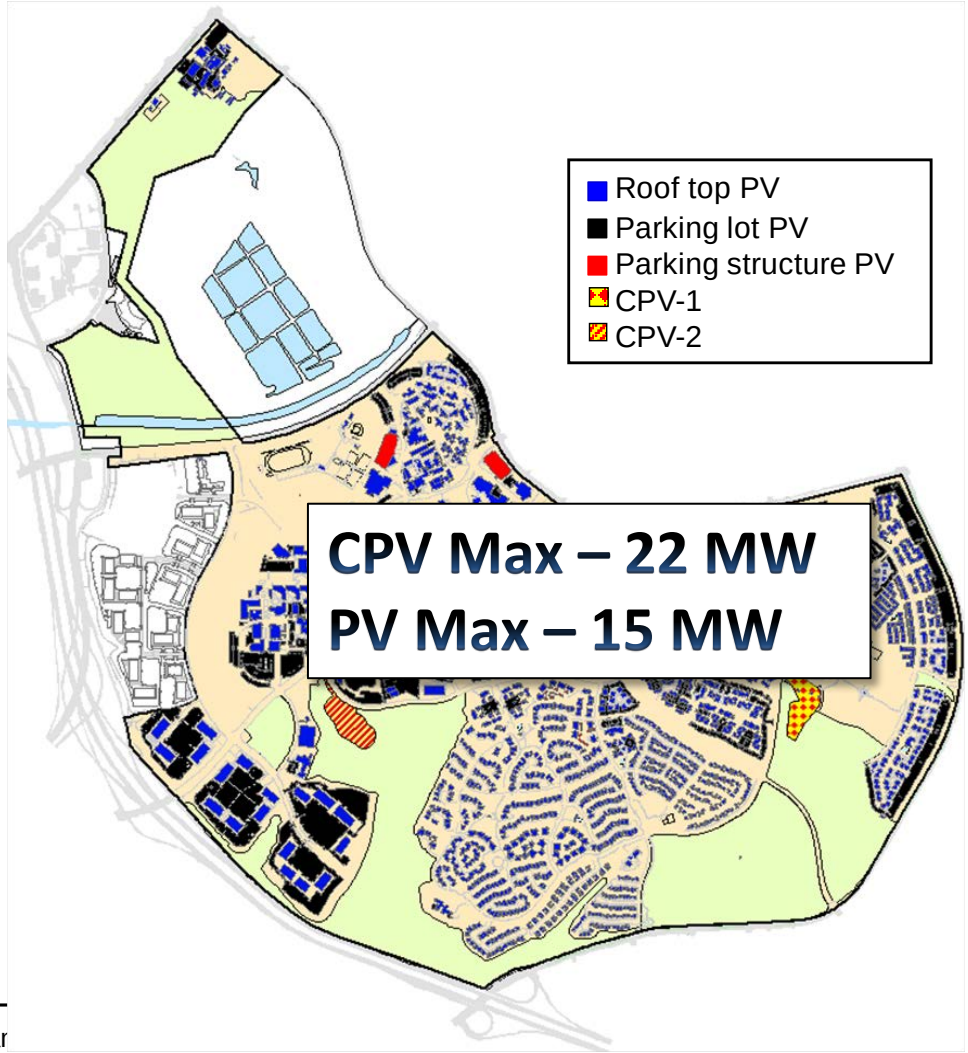


UCI Microgrid



On-site Renewables

- **Fixed PV**
  - Building rooftops (20%), ground level parking lots - car shade (15%), and parking structure terraces (70%)
  - 15 Watts/m^2
- **Dual-axis CPV**
  - Exposed ground
  - 40 Watts/m^2



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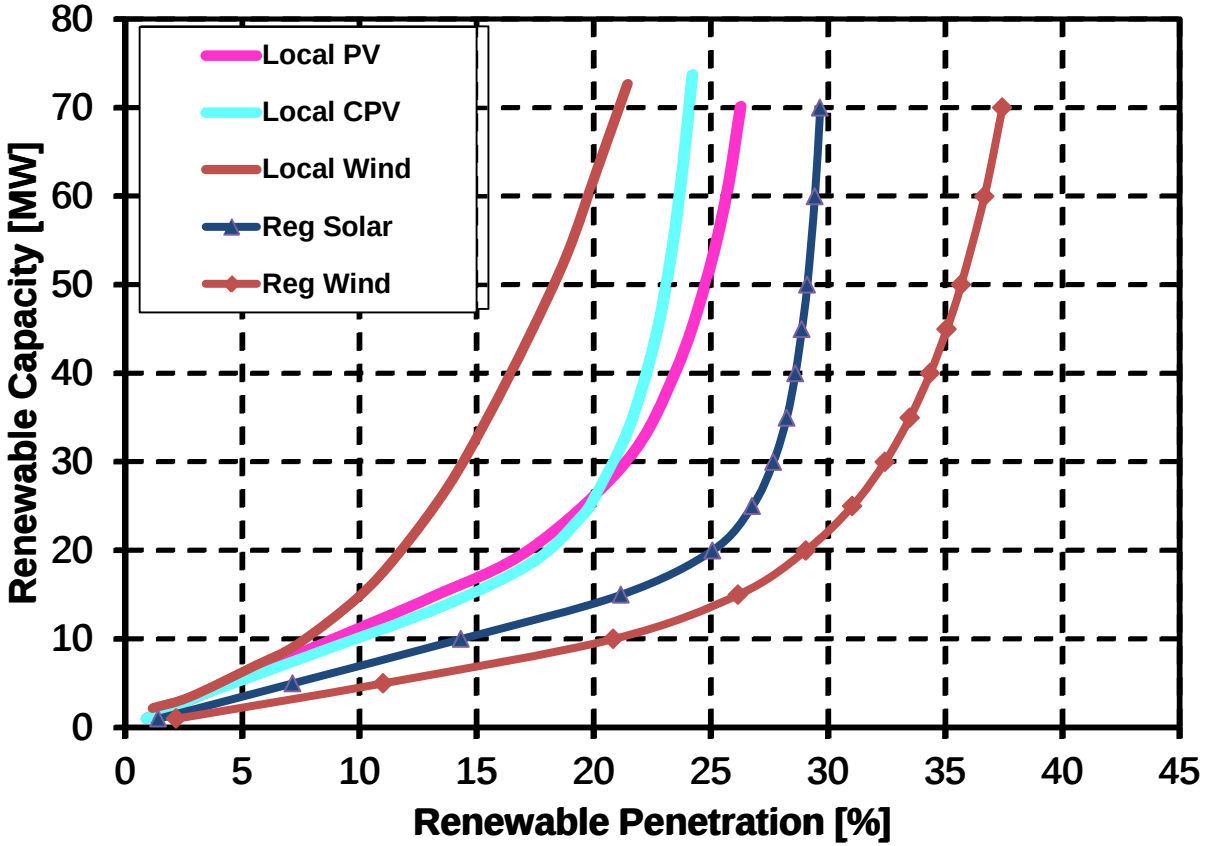
HiGRID Community Scale

- Renewable Deployment on the UCI Microgrid



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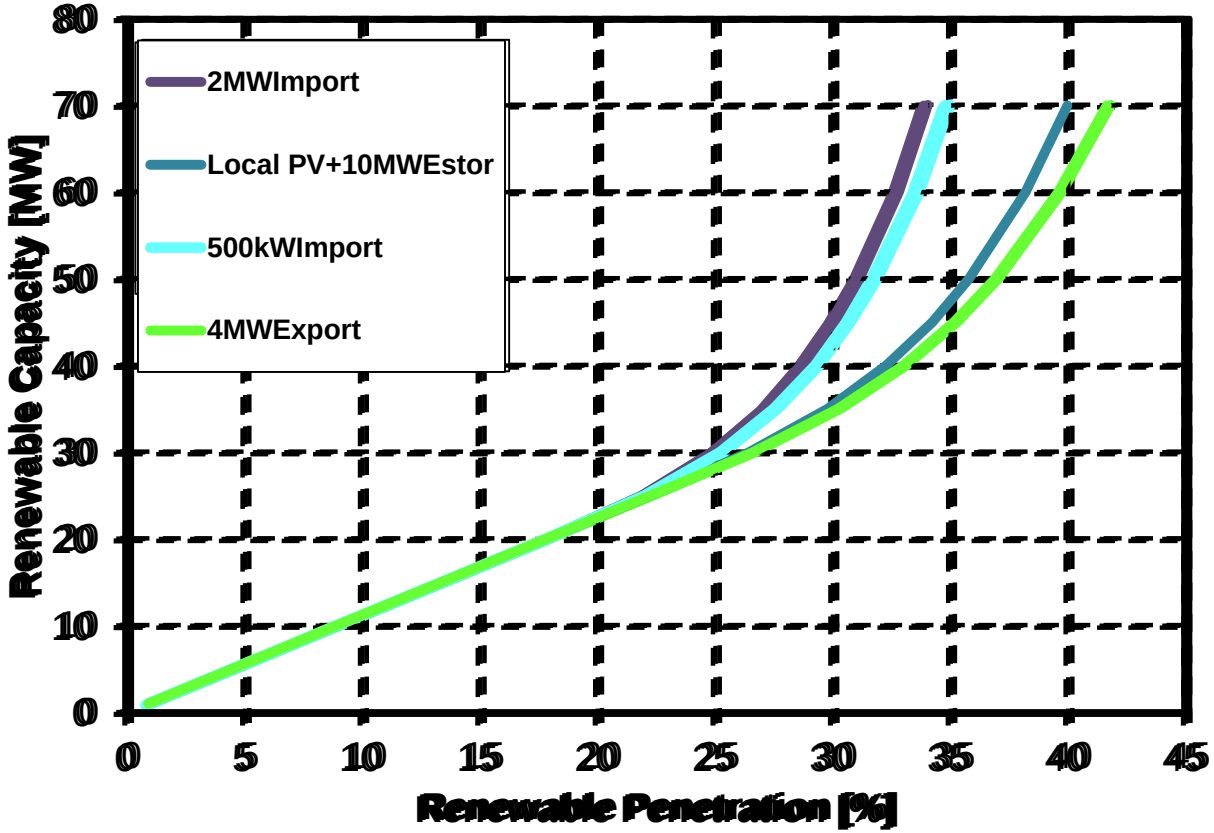
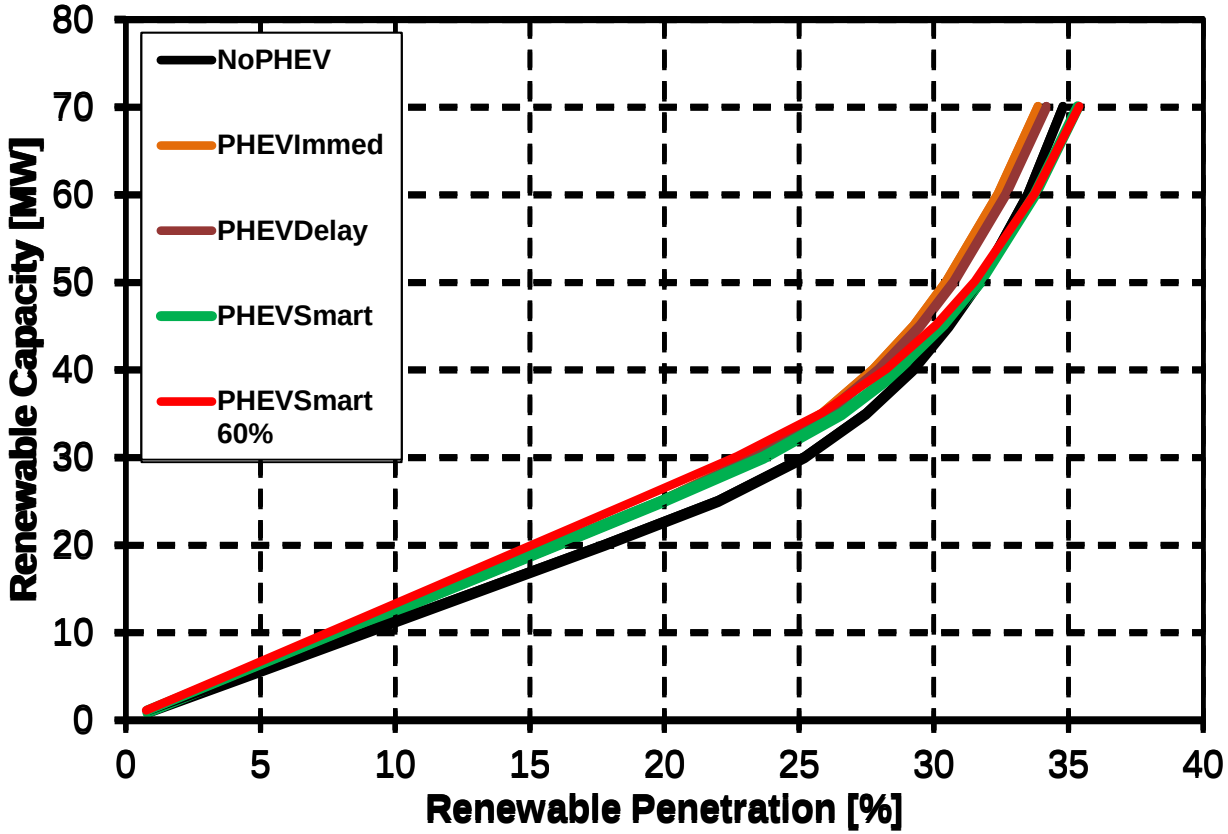
HiGRID Community Scale

- Inadvertent Export



HiGRID Community Scale

- Electric Vehicles (40% VMT penetration)
  - AER = 35 mi ; 0.34 kWh/mile ; 3.3kW charging



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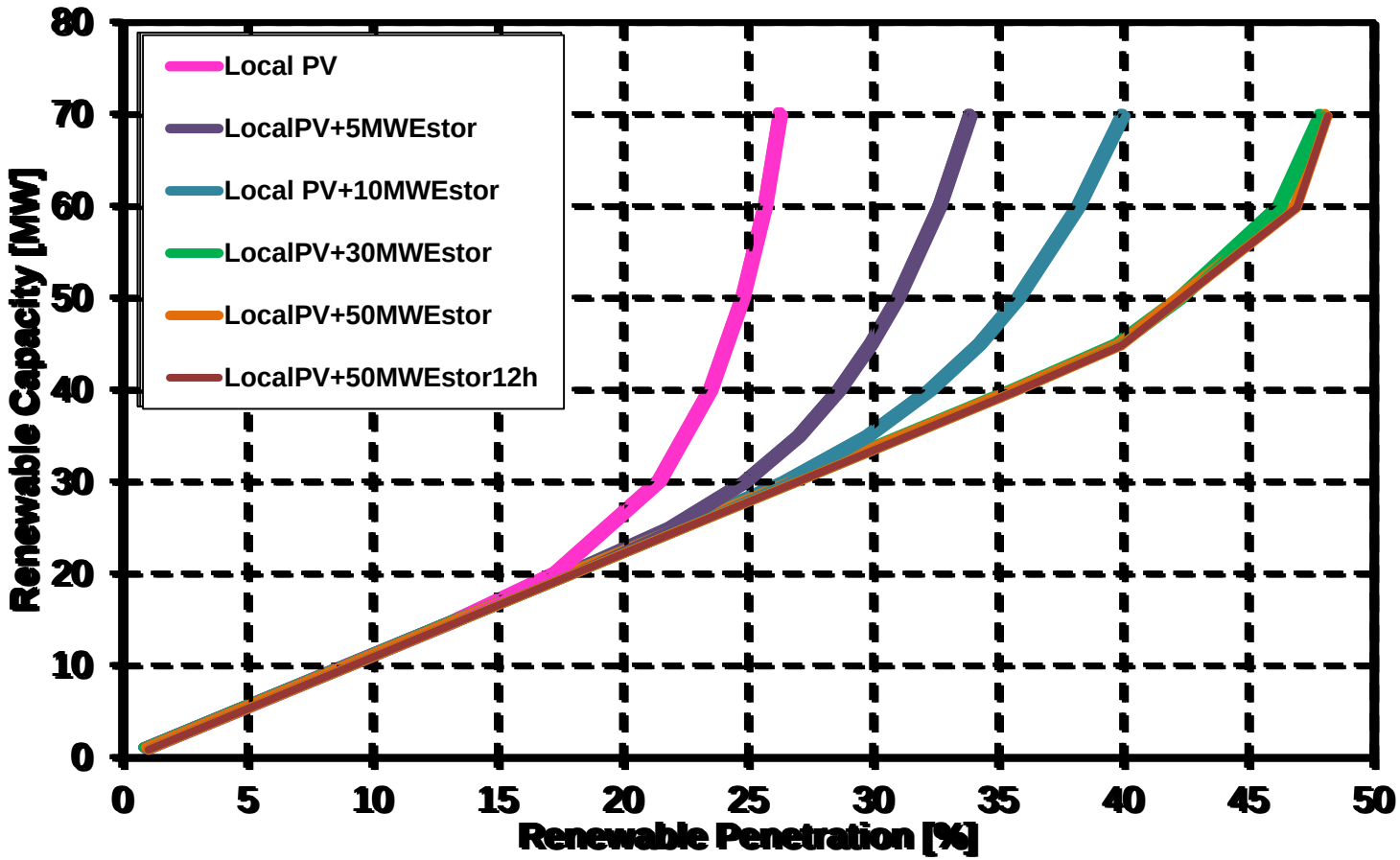
HiGRID Community Scale

- Energy Storage – Battery



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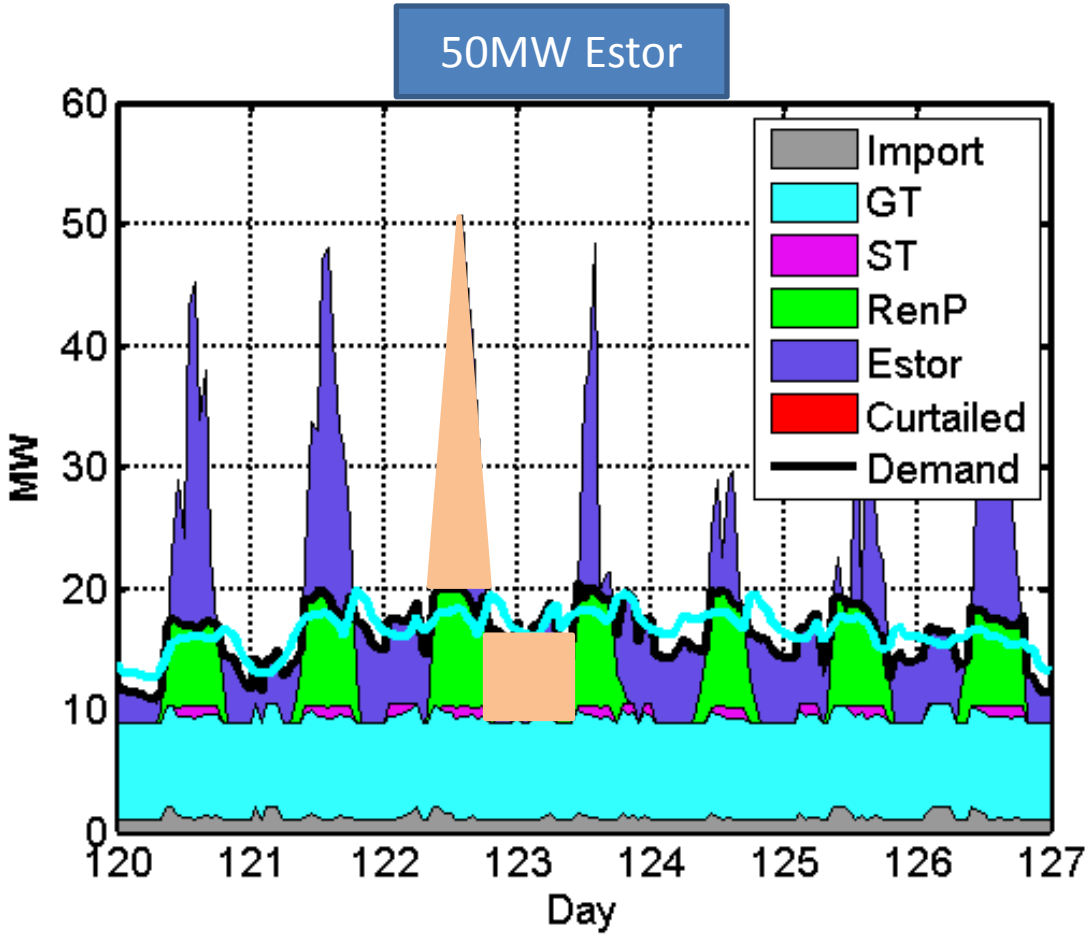
HiGRID Community Scale

- Energy Storage



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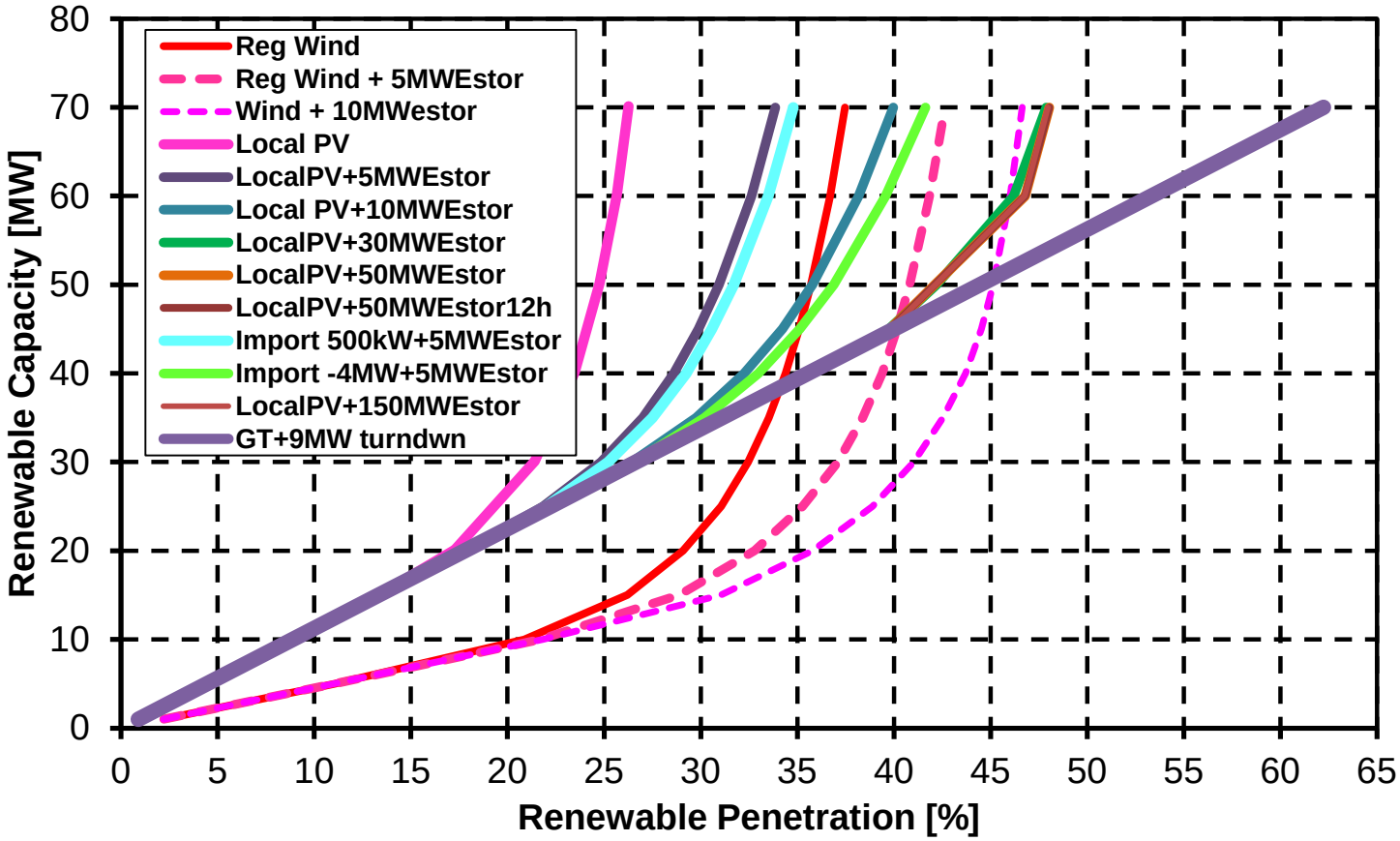
HiGRID Community Scale

- GT Turndown



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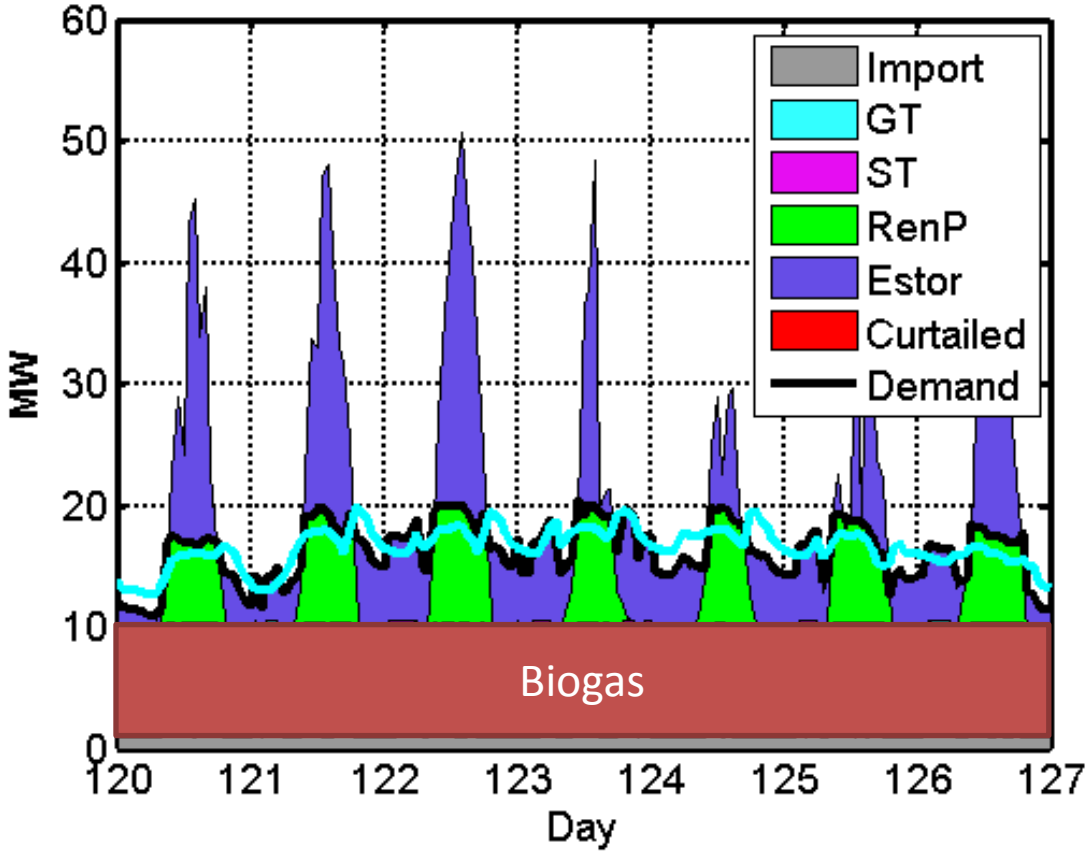
HiGRID Community Scale

- Energy Storage



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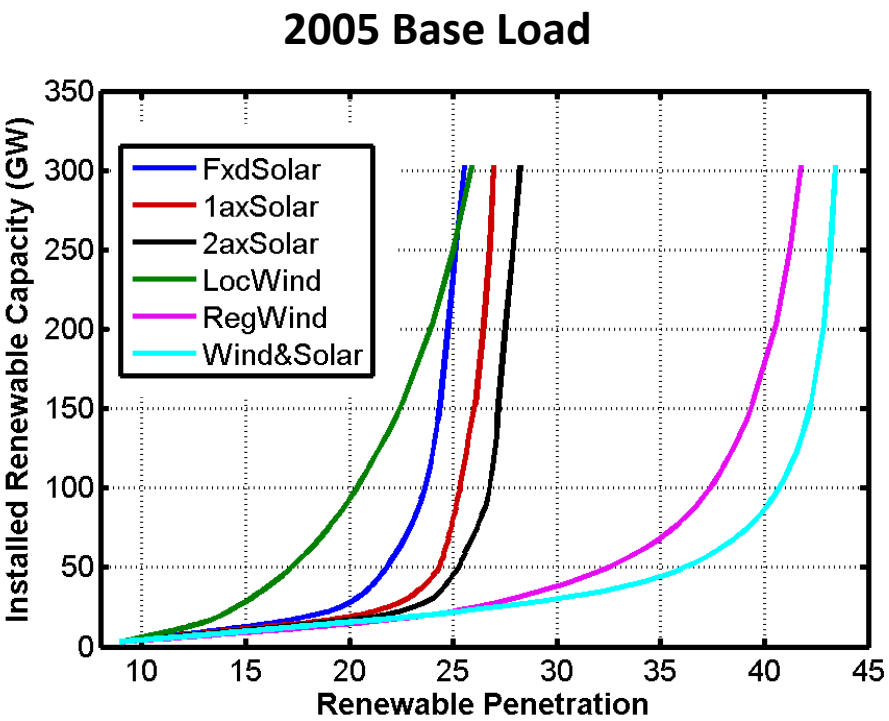
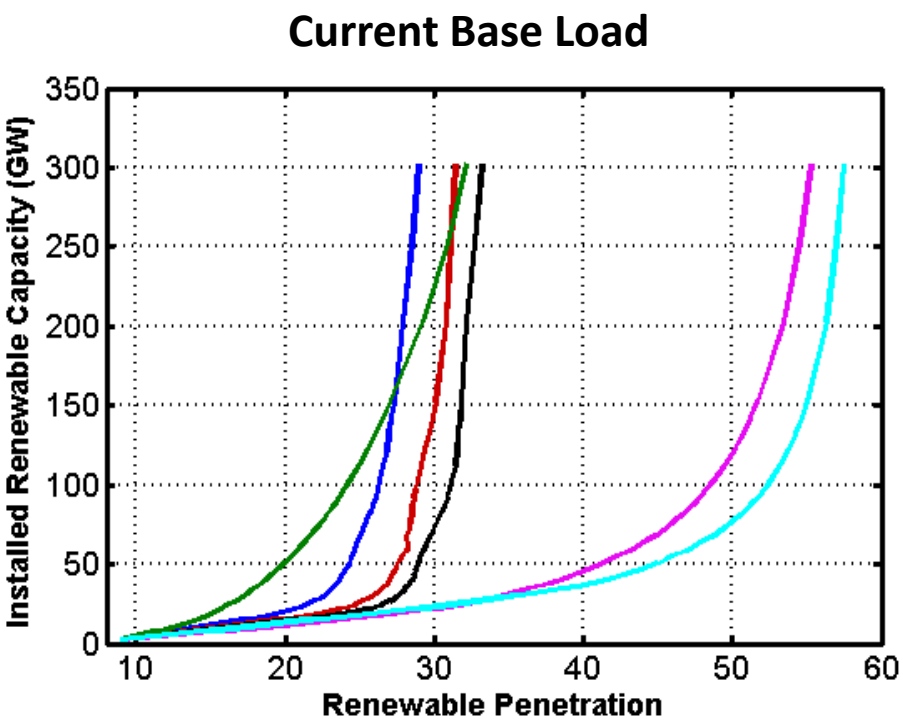
HiGRID CA Grid Scale

- Renewable Spanning





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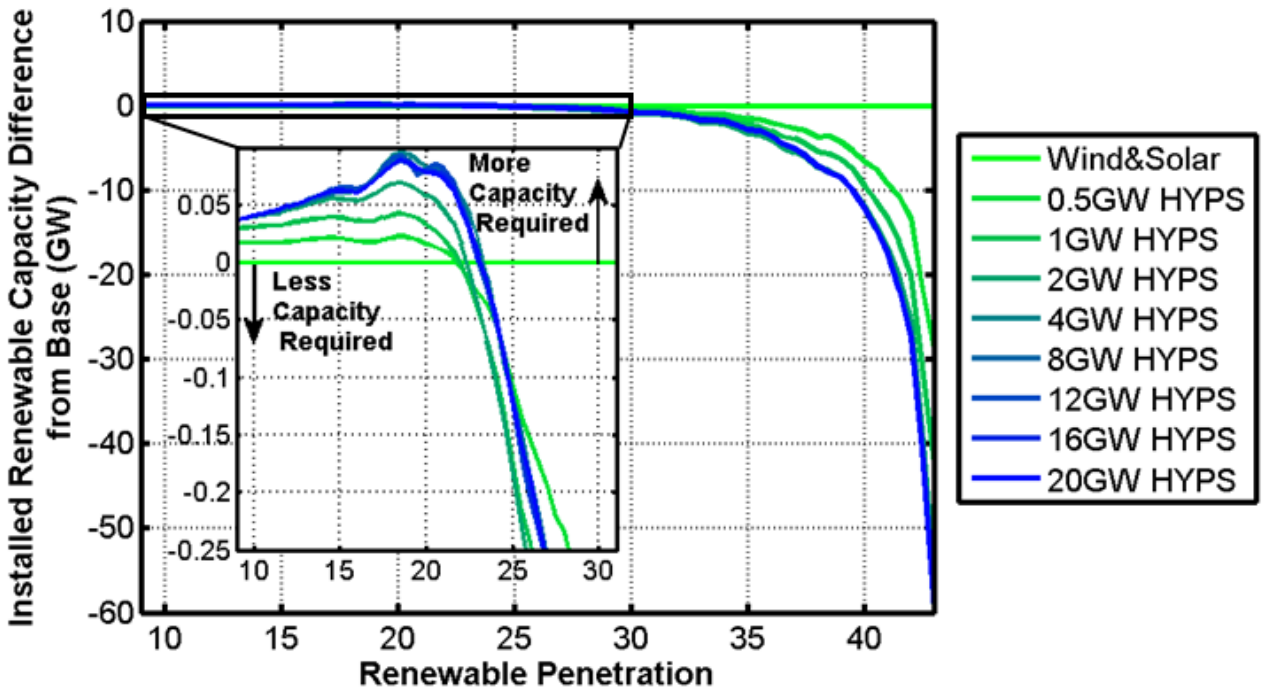
HiGRID CA Grid Scale

- Energy Storage – Pumped Hydro
  - Dispatched to smooth net load profile



Tradeoff between energy penalty and ability to use of curtailed renewables

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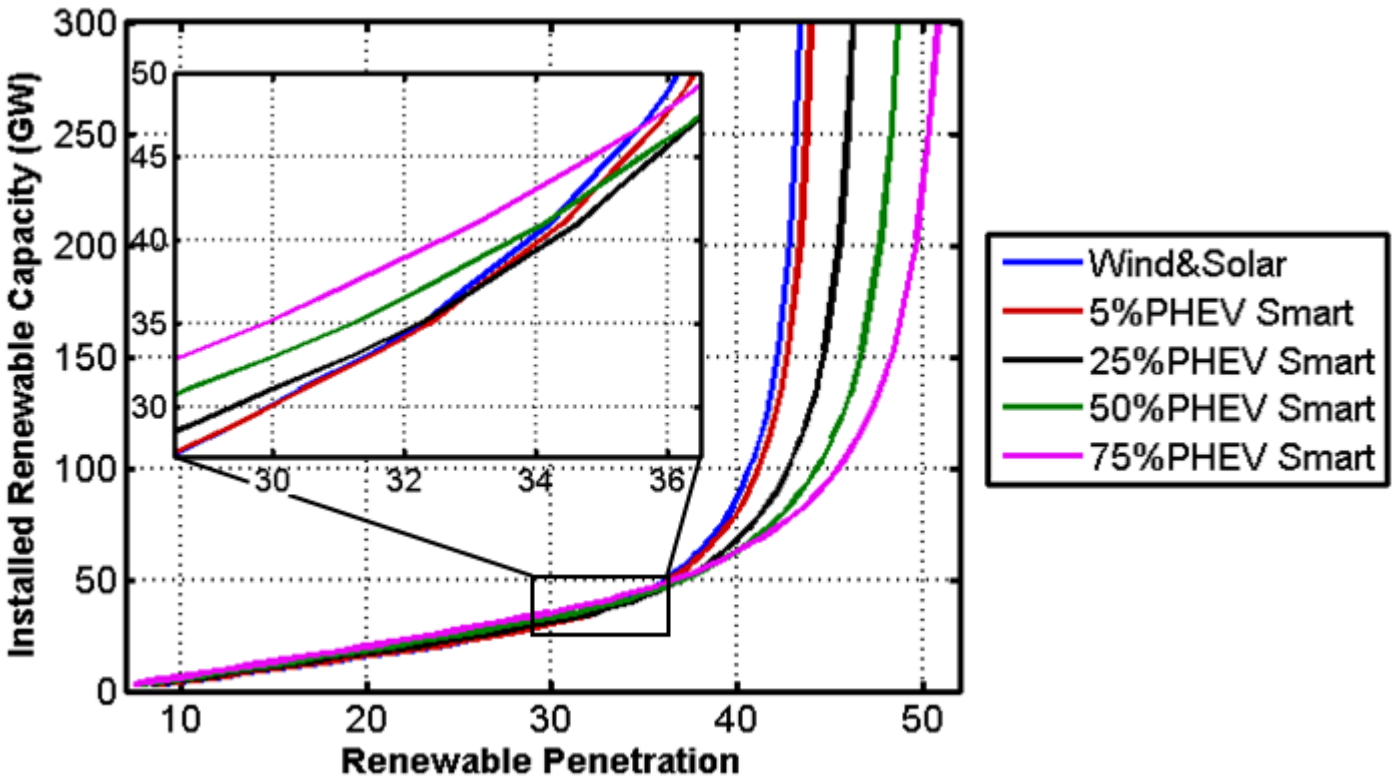
HiGRID CA Grid Scale

- Three Charging Strategies
  - ASAP: Charge as soon as cars arrive at residences
  - Delayed: Start charging a few hours after cars arrive at residences
  - Smart: Grid-responsive control of charging profile



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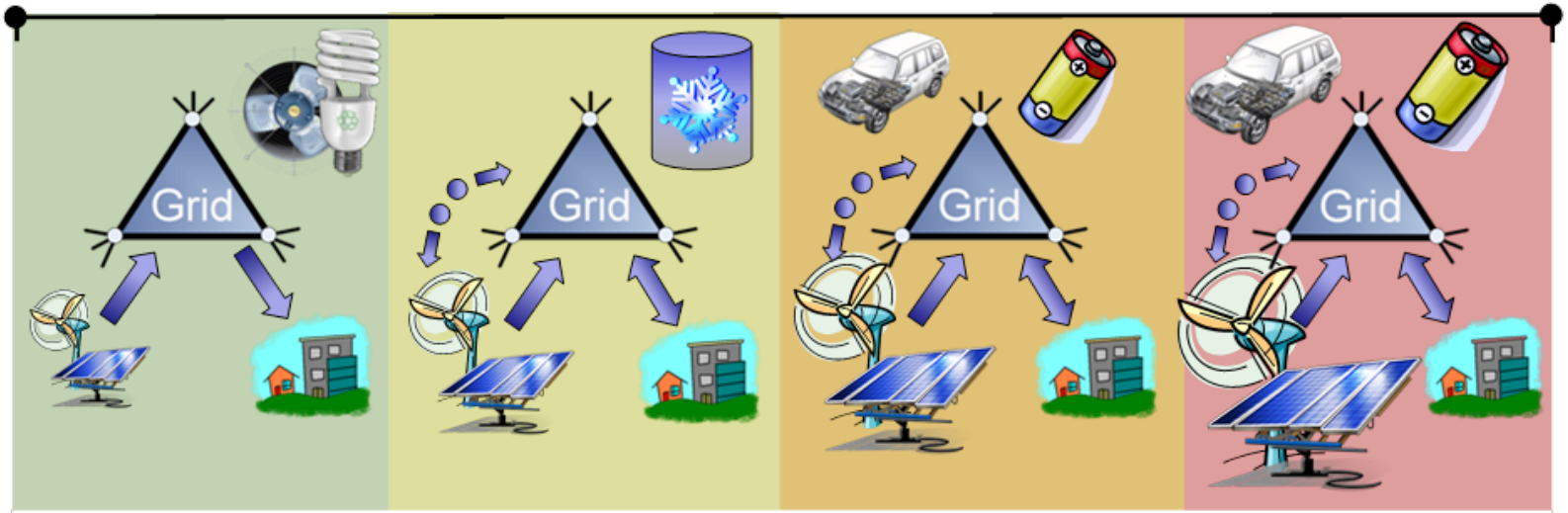
UCI Community Roadmap

0% → Renewable Penetration → 100%



Techs	Energy Efficiency Local Renewables	Demand Response Dynamic Chiller Dispatch Regional Renewables	Energy Storage Generator Flexibility Alternative Transportation	All Complementary Techs., Renewable Dispatchability
Paradigm	Minimal Effects, System operation is ***nearly transparent***	Coordination **required** between community energy resources	Coordination required between community resources and grid, Dispatchable generation **critical** to avoid excess generation	Full dispatchability of energy supply and demand, scientific advances

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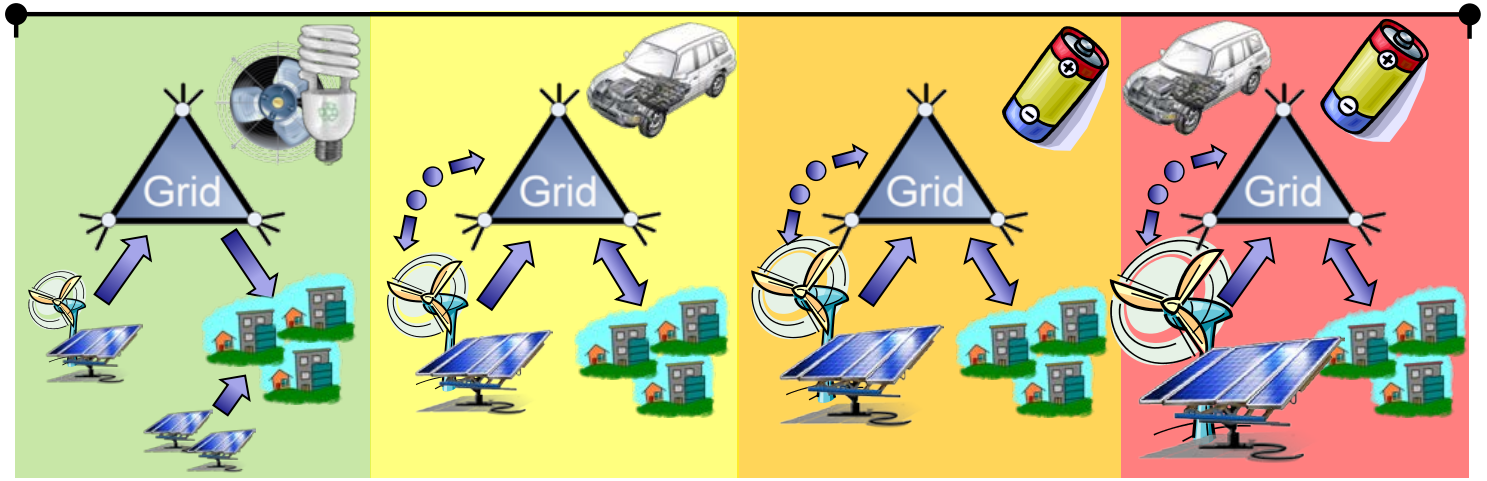
Generic Community Roadmap

0% → Renewable Penetration → 100%



Techs	Local Renewables until Regional are available Energy Efficiency	Regional Renewables Demand Response Alternative Transportation	Energy Storage Generator Flexibility	All Complementary Techs., Renewable Dispatchability
Paradigm	Minimal Effects, Grid operation and transportation are ***nearly transparent***	Generation and Portfolio Management, Feedback **required** from communities and generation	Resource selection, integration, and management, Dispatchable generation **critical** to avoid excess generation	Dispatchability of energy supply and demand, scientific advances

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RESCO Impacts

- RESCO results led to direct partnership with UCI Business Administration in developing plans for carbon neutrality

- Follow-on Projects
  - California Solar Initiative
    - Partners: Amonix, NREL
  - DOE Microgrid (DE-FOA-0000997)

Major Findings 1/2

1. **Communities must contribute to, communicate and coordinate with other utilities and the system operator or other communities to achieve a high-penetration of renewables.**

2. **New economic mechanisms such as dynamic rate structures must be developed to incentivize dispatch of community resources in response to the behavior of the larger electric grid.**

3. **Integration of electricity generation and transportation load provides synergistic benefits at both the community and regional level through:**

    - **Plug-in Electric Vehicle (PEV) charging**
    - **H2 production for Fuel Cell Electric Vehicles (FCEVs)**

4. **Reducing the capacity of carbon-fueled inflexible (base load) generation must be prioritized for meeting renewable utilization goals**

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Major Findings 2/2

5. **Avoiding curtailment of renewable generation is critical for reaching renewable utilization goals in a cost-effective manner**

6. **Complementary technologies such as energy storage and demand response are required to meet renewable utilization goals, but their preferred operation will change with renewable penetration**

7. **Significant cost, energy, and greenhouse gas savings are available through the widespread implementation of energy efficiency measures, but their impact on demand response potential must be considered**

8. **To support and complement a planning roadmap, a pragmatic planning and design tool is required for community planners and policy makers**

9. **A planning roadmap is desirable for community planners to determine the options for their specific community to qualify as a RESCO**

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