California Perspective on High Penetration PV

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California Public Utilities Commission
California Leads the Nation in Installed Solar

- California has 750+ MW installed solar PV at 75,000+ locations
- California is over 2/3rds of the nation’s solar market and the nation’s largest rebate program
- California supports solar self-generation with four interrelated state policies: rebates, net energy metering, interconnection policies, and rate structures (e.g. tiered rates, time of use rates)

Date: January 7, 2011. Data Shown ONLY includes customer-side of the meter self-generation solar. Does not include RPS or wholesale-side solar projects that serve utility load.
Sources: IOU data based on CPUC collected interconnection reports, except 2010 data which is based on CSI Program Data only. POU data based on California Energy Commission data, available through 2009 only.
California Solar Initiative (CSI)

- The CSI Program
  - Budget of $2.167 billion (2007 - 2016) funded by electric ratepayers
  - Goal: 1,940 MW of new solar generation capacity
  - Includes general rebate program, low income programs, RD&D

- The CSI-Thermal program
  - Budget of $250 million (2010 - 2017) funded by gas ratepayers
  - Goal: 200,000 new solar hot water systems (585 million therms)
  - Includes general rebate program and low income program
Context for Funding:
Installed and Growing Renewables Base in California

- Growing amount of PV on the customer-side of meter
- Growing amount of PV on the utility-side of meter
- Regardless of where solar is installed, the future growth of the PV market presents grid integration challenges for planners, utilities, and grid operators

Source: CAISO presentation of ISO Study of Operational Requirements and Market Impacts at 33% RPS – Nov 2010
CPUC established CSI RD&D Program in 2007

- Allocated $50 million for research, development, demonstration and deployment (RD&D) projects to further the overall goals of the CSI Program
- Adopted the “CSI RD&D Plan”

CSI RD&D Plan established:

- Goals and objectives
- Allocation guidelines for project funding
- Criteria for solicitation, selection and project funding

Three Target Areas Established for Program Funding:

- Grid-Integration: 50-65%
- Production Technologies: 10-25%
- Business Development and Deployment: 10-20%

CSI RD&D TimeLine To-Date:

2006
CSI RD&D Program authorized by Legislature

2007
CSI RD&D Adopted by CPUC

2008
CPUC Selected RD&D Program Manager (Itron)

2009
CSI RD&D Program released two solicitations

2010
CPUC authorized 18 grants from two CSI RD&D Program solicitations
Target Area: Grid Integration

Grid-Integration: CSI RD&D Program Plan
Allocates 50-65% of the funding to:

- Identify and address key barriers to the development of PV minigrids or central PV;
- Demonstrate economic viability of new PV system storage technologies
- High value locations for distributed generation (DG) PV on transmission and distribution (T&D) are identified and the impacts/benefits of large concentrations of DG PV in one location on transmission and distribution are assessed.
Sub Areas: Planning and Modeling for High Penetration PV

Needs and issues to help develop better planning and modeling tools:

- Solar resource models should provide capability to forecast solar output at higher PV penetration levels
- Forecast outputs from solar models should be validated by metered PV performance over large system populations
- Solar resource modeling applications should be integrated with utility load or resource forecasting models
- Transmission and Distribution (T&D) models should allow for easy identification for optimal location of high penetration of PV
Sub Areas: Hardware and Software Tools for High Penetration PV

Integrating PV into the utility grid will require robust grid-PV communication, control systems, and operational procedures. These needs include:

- Testing improved monitoring and communications software and systems
- Testing/demonstrating improved control systems and operations
- Integrated subsystems within the distribution system (including mini- or micro-grids)
- Assessing optimal locations within the T&D system
Funded Projects

- Grant to the Lawrence Berkeley National Laboratory, Solar Energy Research Center - $10 million

- Two Grant solicitations conducted to-date
  - 17 projects awarded funding just over $23 million
  - Leveraging over $17 million in match funds
## Target Area 1: Grid Integration: High Penetration PV

<table>
<thead>
<tr>
<th>Project Title</th>
<th>Awardee</th>
<th>CSI Funding</th>
<th>Match Funding</th>
<th>Partners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced Modeling and Verification for High Penetration PV</td>
<td>Clean Power Research</td>
<td>$976,392</td>
<td>$543,000</td>
<td>NREL, State University of New York, New York State Energy Research and Development Authority, SEPA, SMUD, Long Island Power Authority, Salt River Project</td>
</tr>
<tr>
<td>Analysis of High-Penetration Levels of PV into the Distribution Grid in CA</td>
<td>SCE / NREL</td>
<td>$1,600,000</td>
<td>$1,400,000</td>
<td>CPR, Electrical Distribution Design, Satcon, NREL</td>
</tr>
<tr>
<td>Planning and Modeling for High-Penetration PV</td>
<td>SunPower Corporation</td>
<td>$1,000,000</td>
<td>$320,000</td>
<td>KEMA, CAISO AWS Truewind, Sandia National Lab</td>
</tr>
<tr>
<td>Development and Analysis of a Progressively Smarter Distribution System</td>
<td>UC Irvine - APEP</td>
<td>$300,000</td>
<td>$100,000</td>
<td>PG&amp;E</td>
</tr>
<tr>
<td>Improving Economics of Solar Power Through Resource Analysis, Forecasting and Dynamic System Modeling</td>
<td>UC San Diego</td>
<td>$548,148</td>
<td>$140,839</td>
<td>CEC. EPRI, EDSA Power Analytics, CAISO, SDG&amp;E, NREL</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>$6,497,772</strong></td>
<td><strong>$4,127,698</strong></td>
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Target Area 2: Improved Solar Technologies

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<thead>
<tr>
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<th>Match Funding</th>
<th>Partners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved Cost, Reliability, and Grid Integration of High Concentration Photovoltaic Systems</td>
<td>Amonix, Inc.</td>
<td>$2,139,384</td>
<td>$3,157,000</td>
<td>UC Irvine Advanced Power and Energy Program, NREL, SCE</td>
</tr>
<tr>
<td>Improved manufacturing and innovative business models to accelerate commercialization in California of hybrid concentrating photovoltaic/thermal trigeneration (CPV/T-3G) technology</td>
<td>Cogenra</td>
<td>$1,467,125</td>
<td>$2,773,304</td>
<td>Sonoma Wine Company, Patch Engineering, PG&amp;E</td>
</tr>
<tr>
<td>Solaria: Proving Performance of the Lowest Cost PV System</td>
<td>Solaria Corporation</td>
<td>$1,217,500</td>
<td>$1,217,500</td>
<td>PG&amp;E</td>
</tr>
<tr>
<td>PV and Advanced Energy Storage for Demand Reduction</td>
<td>SunPower Corporation</td>
<td>$1,875,000</td>
<td>$937,990</td>
<td>KEMA, Sandia National Laboratories, Target Stores, Prudent Energy, Ice Energy, ZBB Energy, PG&amp;E</td>
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<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>$6,699,009</strong></td>
<td><strong>$8,085,794</strong></td>
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## Target Area 3:
### Innovative Business Models

<table>
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<th>Partners</th>
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</thead>
<tbody>
<tr>
<td>Advanced Grid-Interactive Distributed PV and Storage</td>
<td>Solar City</td>
<td>$1,774,657</td>
<td>$931,187</td>
<td>Tesla Motors, UC Berkeley, PG&amp;E</td>
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<tr>
<td>Engineering and Component Delivery</td>
<td></td>
<td></td>
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<tr>
<td>Innovative Business Models, Rates and Incentives that Promote Integration</td>
<td>Viridity Energy</td>
<td>$1,660,000</td>
<td>$840,000</td>
<td>UC San Diego, Energy &amp; Environmental Economics (E3), SDG&amp;E</td>
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<tr>
<td>of High Penetration PV with Real-Time Management of Customer Sited Distributed Energy Resources</td>
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<td><strong>Total</strong></td>
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<td><strong>$4,430,926</strong></td>
<td><strong>$2,698,218</strong></td>
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## Crosscutting:
Integration of Energy Efficiency, Demand Response and Energy Storage with PV

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<tbody>
<tr>
<td>Low-Cost, Smart-Grid Ready Solar Re-Roof Product Enables Residential Solar Energy Efficiency Results</td>
<td>ConSol</td>
<td>$999,999</td>
<td>$932,500</td>
<td>General Electric, GAF, SDG&amp;E</td>
</tr>
<tr>
<td>Beopt-CA (EX): A Tool for Optimal Integration of EE/DR/ES+PV for California Homes</td>
<td>DEG / NREL</td>
<td>$985,000</td>
<td>$329,416</td>
<td>PG&amp;E, NREL, E3, SunPower, CEC letter of support</td>
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<tr>
<td>Specify, Test and Document an Integrated Energy Project Model</td>
<td>kW Engineering</td>
<td>$942,500</td>
<td>$250,000</td>
<td>Solarnexus, Save Energy 123</td>
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<tr>
<td>West Village Energy Initiative: CSI RD&amp;D Project</td>
<td>UC Davis</td>
<td>$2,500,000</td>
<td>$1,245,000</td>
<td>UC Davis Energy Institute, Chevron Energy Solutions, PG&amp;E</td>
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<td><strong>Total</strong></td>
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<td><strong>$5,427,499</strong></td>
<td><strong>$2,756,916</strong></td>
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CSI RD&D Future Funding Opportunities

- Looking for feedback from Hi Penetration Solar Forum attendees on remaining needs and issues related to grid integration of high penetration PV
- Portfolio Review to identify gaps and remaining needs for Solar RD&D
- Draft solicitation document out for public review and comment in Spring 2011
- Release Third Solicitation in late Spring 2011
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QUESTIONS?