



The Parker Ranch installation in Hawaii

Power Electronics: Grid Integration and System Performance

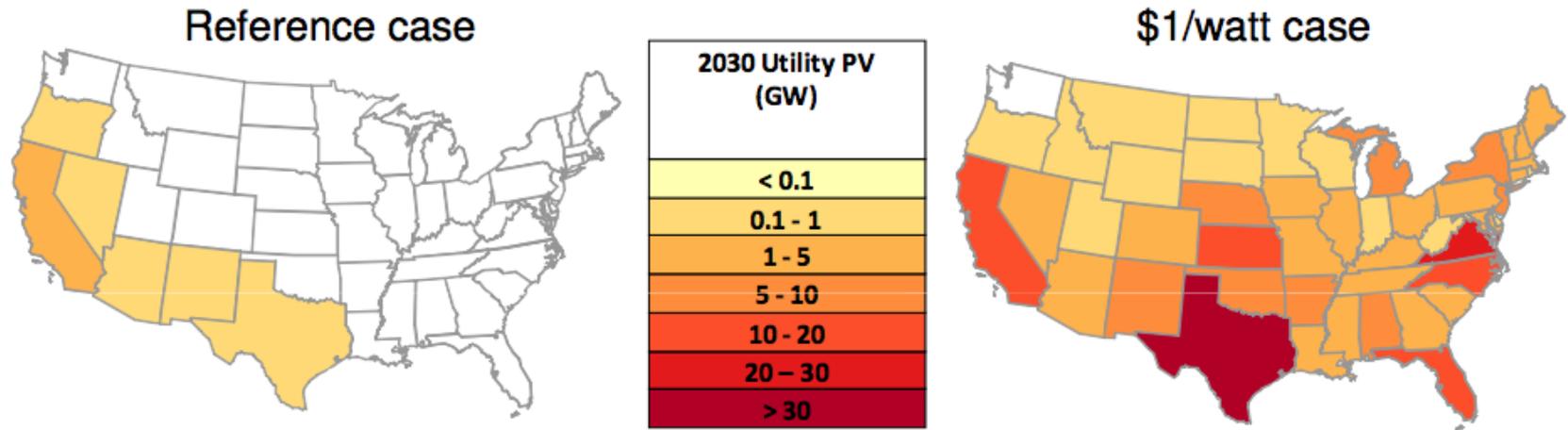
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Kevin Lynn

Kevin.Lynn@ee.doe.gov

(202) 586-1044

A \$1/watt fully installed photovoltaic solar energy system – equivalent to 5-6 cents/kWh – would be a game-changer



NREL: At \$1/watt, PV would be 14% of U.S. electricity by 2030, with minimal need for storage or additional transmission

Solar Energy Technologies Program

HOME

ABOUT

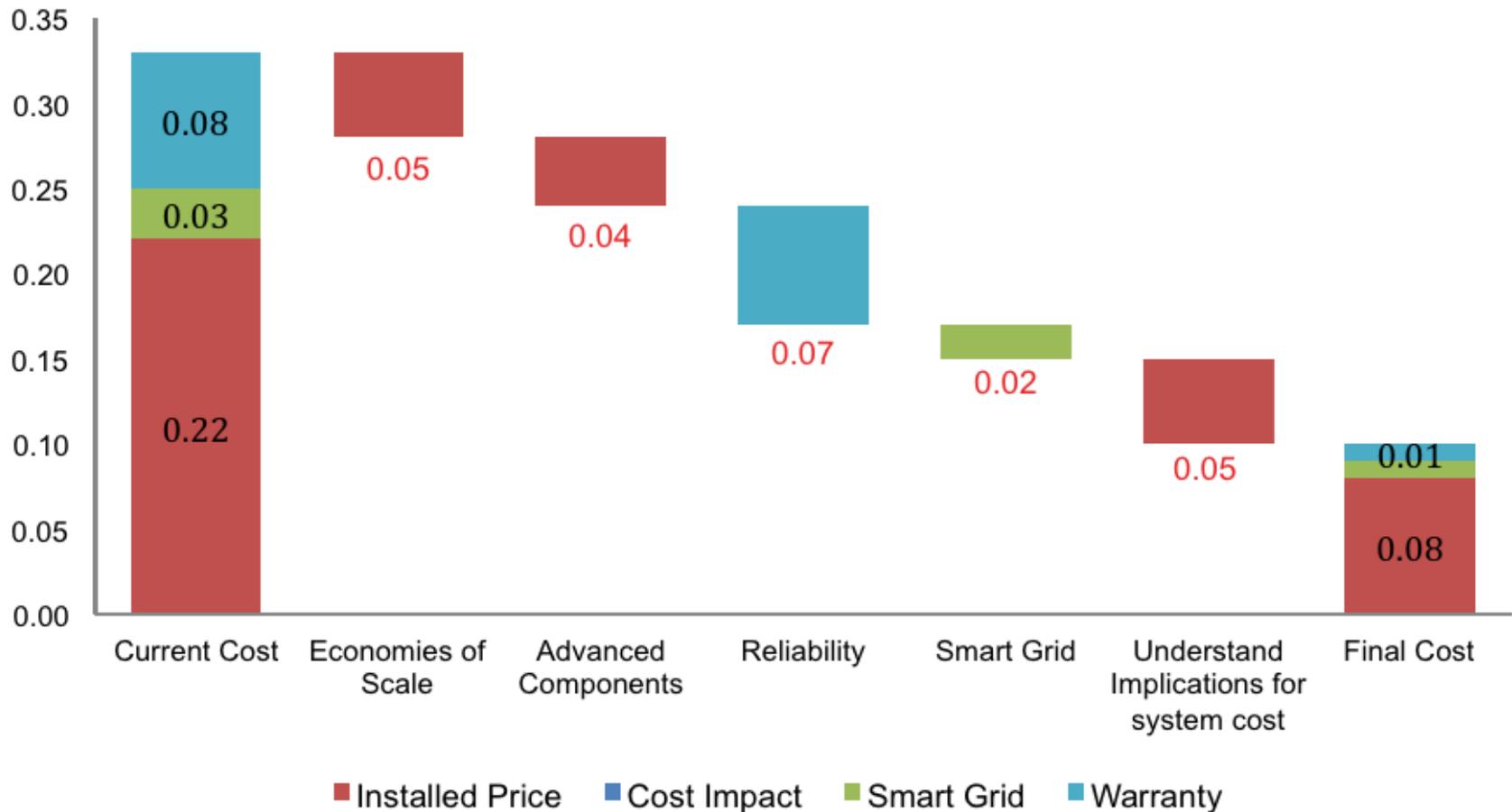
RESEARCH &
DEVELOPMENT

MARKET
TRANSFORMATION

FINANCIAL
OPPORTUNITIES

- **\$1/W Photovoltaic Systems**
 - Balance of Systems (BOS): DOE is requesting information on Building Integrated Photovoltaic (BIPV) concepts, roof and ground mount innovations, software design tools, and BOS transformational concepts.
 - Due: January 31, 2011
 - Solar Energy Grid Integration Systems – Advanced Concepts: DOE is requesting information on new inverter technologies and demonstration projects that can reduce inverter costs and enhance greater penetration of solar technologies on the grid.
 - Due: February 4, 2011

Centralized Inverter (\$/W)



- *Smart-Grid Functionality:* As PV technologies become more ubiquitous, these systems may potentially impact grid reliability on both the distribution (e.g. voltage fluctuation) and transmission systems (e.g. variability). This may cause utilities to severely limit PV installations or severely increase integration and interconnection costs. Awardees will develop cost-effective technologies to mitigate these issues using reactive power, storage, utility communication protocols, etc.

Phase 1 Functions:

- Connect/Disconnect – Non Islanding
- Max Generation Level Control
- Smart VAR Management and PF
- Storage Management
- State/Status Monitoring
- Event Logging
- Time Adjustment

Phase 2 Proposed Functions:

- Voltage Sag Ride-Through
- Autonomous Watt-Voltage Management (transient and steady-state)
- Autonomous Watt-Frequency Management
- Islanding
- Additions to State/Status Monitoring

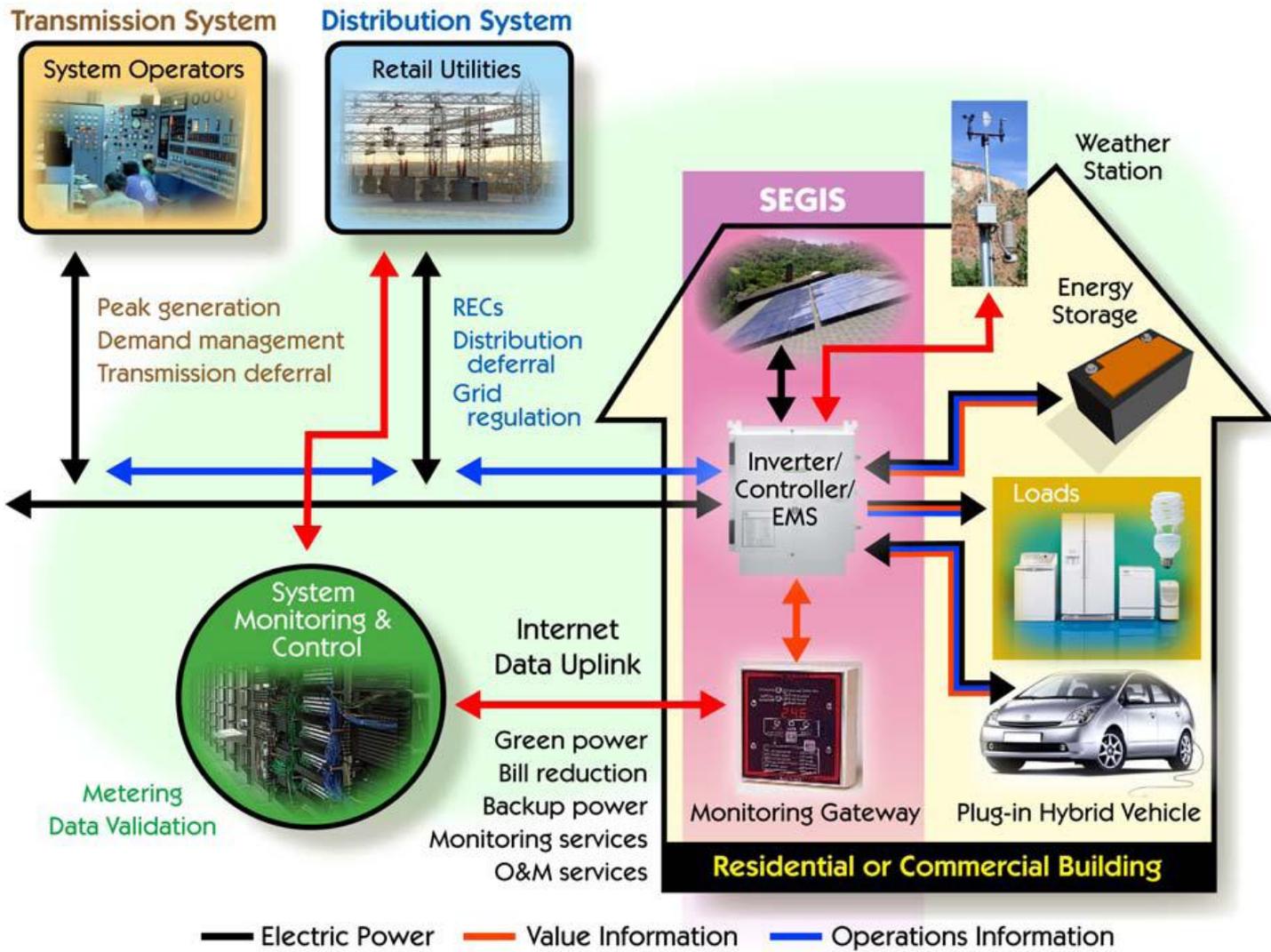
Table 3: Applications for Storage-integrated PV

Residential			
Homeowner-owned Systems		Utility-owned Systems	
<p>Current:</p> <ul style="list-style-type: none"> • Save solar energy for evening use in TOU operations • Back-up power (UPS) 	<p>Future:</p> <ul style="list-style-type: none"> • With time of day residential rates, load shifting • Lower cost than utility • Smart grid interface 	<p>Current:</p> <ul style="list-style-type: none"> • Solar community – ride-through during cloud cover • Distributed generation • Congestion reduction 	<p>Future:</p> <ul style="list-style-type: none"> • Smart grid applications (e.g., distributed energy management, microgrid islanding, peak shaving/shifting.) • High penetration ramp control (short-term spinning reserve) • Emission reduction, carbon credits (with high penetration)
Commercial			
Business-owned Systems		Utility-owned Systems	
<p>Current:</p> <ul style="list-style-type: none"> • Peak shaving to reduce TOU and/or demand charges • Power quality and UPS 	<p>Future:</p> <ul style="list-style-type: none"> • Carbon credits • Microgrid generation and islanding • Smart grid/building management interfaces 	<p>Current:</p> <ul style="list-style-type: none"> • Distributed generation • Congestion reduction • Improved power quality 	<p>Future:</p> <ul style="list-style-type: none"> • Microgrid generation and islanding • Emission reduction, carbon credits (with high penetration)

- *Using Power Electronics to Address Balance of System Costs:* Power electronics can be used to harness more energy from the sun effectively reducing the need for PV modules or BOS equipment. They may also be used to enhance safety. Awardees will develop new ways to harness more energy through MPPT algorithms or by mitigating the effects of issues like PV module mismatch, shading, etc. Awardees may also develop new ways to reduce the amount of copper wiring in the system using high-voltage techniques. Awardees should develop monitoring equipment to be integrated into the power electronics equipment that is inexpensive, accurate, and easily integrated into existing energy management systems. Awardees may also consider using technologies to mitigate fire hazards and *enhance safety in general (e.g. arc-fault detection)*.

Solar Energy Grid Integrations Systems (SEGIS)

• /



— Electric Power — Value Information — Operations Information



SCE
MW scale
rooftop
installation

- SCE is installing 500MW of commercial rooftop PV systems over the next 5 years
- 250MW utility owned, 250MW IPP
- Interconnected at distribution circuit level

Specific Issues:

- Unsure of interconnection process for circuits with over 15% PV (Peak PV/Peak Load)
- Need to develop quick study process for penetrations >15%
- Issues include: voltage regulation, circuit ratings, circuit protection coordination, cloud variability

SI Communications High Penetration Solar Portal

A New Destination for
High Pen Solar Information
From The U.S. Department of Energy
Solar Energy Technologies Program

The High Penetration Solar Portal

This winter, the Systems Integration subprogram is launching a Web site for the U.S. utility community and DOE's High Pen Solar Deployment Awardees.

The High Penetration Solar Portal will allow DOE's awardees and the utility community to share results, information, and expertise in order to increase and expand newly designed distribution and transmission circuits in the electrical grid and help expand the utility solar market.

Join the Conversation!

Visit www.solar.energy.gov/high_pen/ to register for news and notifications.

The screenshot shows the 'High Penetration Solar Portal' website. At the top, there is a navigation bar with the U.S. Department of Energy logo and the text 'Energy Efficiency & Renewable Energy'. Below this, the page title 'High Penetration Solar Portal' is displayed. A search bar is located in the top right corner. The main content area is divided into several sections: 'About the site' with a large image of solar panels, 'Featured Article' with a smaller image of solar panels, 'News' with a list of recent news items, 'Events' with a list of upcoming events, and 'High Penetration Project Awardees' with a map of the United States. At the bottom, there is a 'Partner Organizations' section with a grid of placeholder logos. The footer contains contact information and a copyright notice.