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PLUG & PLAY SOLAR PV FOR AMERICAN HOMES

Fraunhofer Plug & Play Solar PV Team

New SunShot project, 5 years, started February 1, 2013



City of Rutland, Vermont

VERMONT LAW SCHOOL



High Penetration

2013

Feb 13-14, San Diego, CA

Problem Statement

- Complexity and unpredictability of permitting and interconnection processes
 - > Schedule uncertainty
 - Average BOS soft and hardware cost for residential rooftop installations 3x compared to Germany
 - > Cost not only high, but also highly variable
 - PV systems are complex, many custom parts
 - > Installation labor and expertise required is high
 - Today, it takes a die-hard solar fan to take on the obstacles to install rooftop PV
- PV for every American rooftop needs to be much simpler!

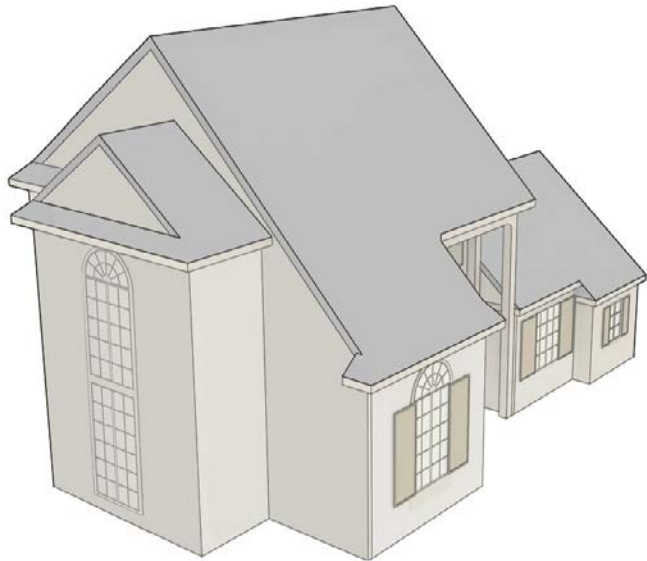
5 Year Project Objectives

- Demonstrate complete plug-and-play photovoltaic system
- Single electrical listing for complete plug-and-play photovoltaic systems
- Automation or elimination of electrical permitting and inspection processes
- Reduction or elimination of structural review and permitting for PV systems
- Remote utility reporting and grid interconnection
- \$1.50/Watt installed cost for a typical residential system
- Successful demonstration of the field installation, commissioning, and interconnection
- Seed Plug-and-play PV industry standard
- Appealing to residential homeowners and installers

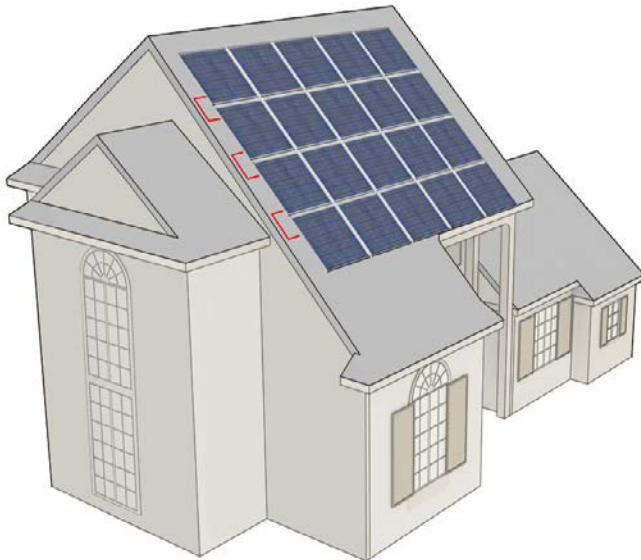
The Plug and Play Vision

- Simple configuration for purchase
- Eliminate virtually all permitting, use technology to simplify and streamline remaining processes
- Installation by home owner or handyperson
 - modules, inverters, wiring, obtain local building permits, obtain interconnection agreement, commission system –
 - in less than 10 hours
- Very high degree of safety
- As easy as buying and installing a washer/dryer combo

Technical Approach



Technical Approach: PV modules and structural



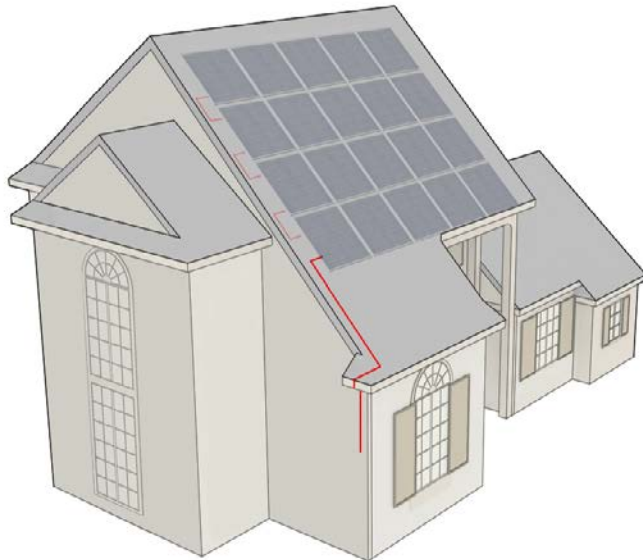
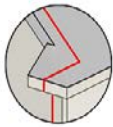
Candidates:

1. Peel & stick modules
 - > Advanced adhesives
 - > Lightweight substrate
2. Rack mount solution
 - > Self-sealing roof mounts
 - > Visual safe installation feedback

Guiding attributes:

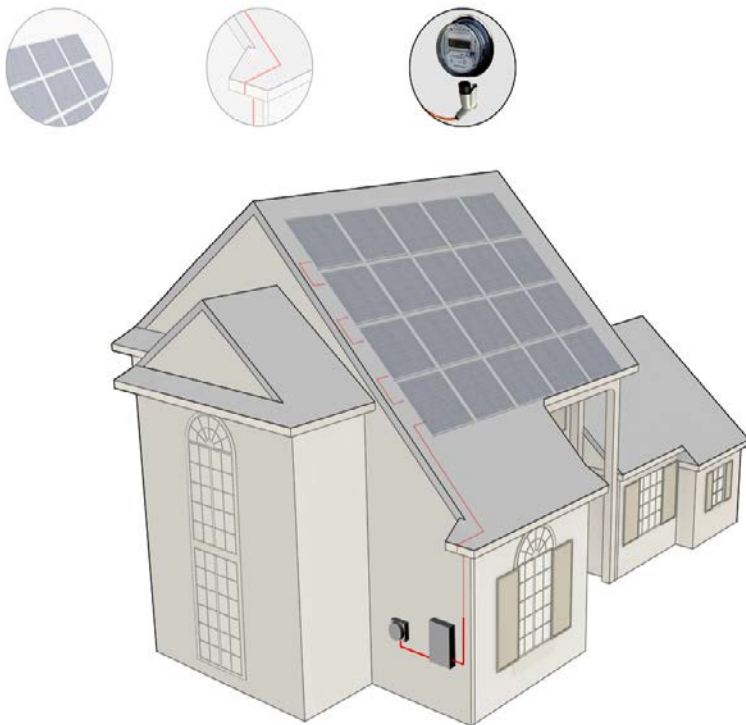
- Fire safety
- Integrated power electronics

Technical Approach: Wiring



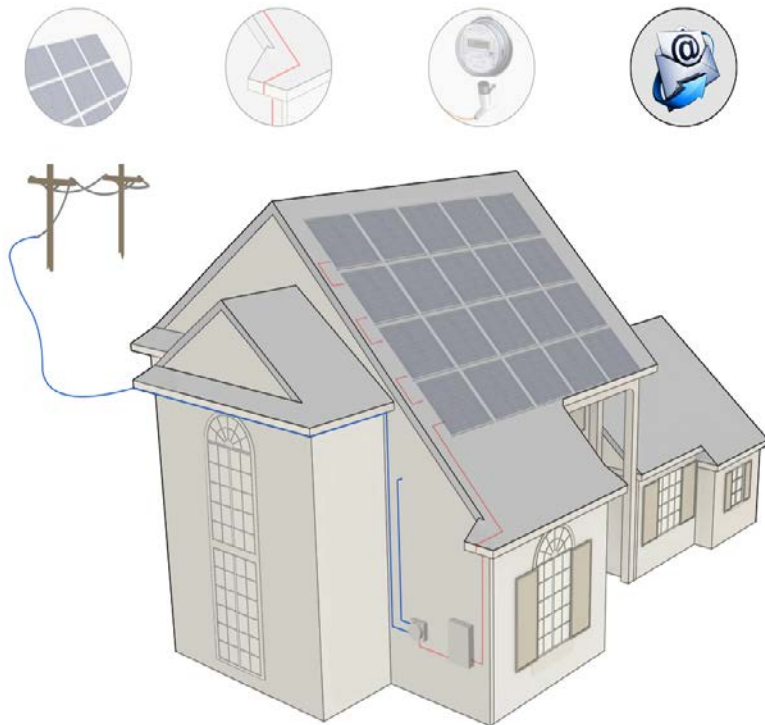
- Outside of building envelope
- Prefabricated cables with connectors
- Integrated power and communication
- Peel & stick cable management
- Integrated grounding
- Self-test for wiring integrity and ground faults

Technical Approach: Grid connection



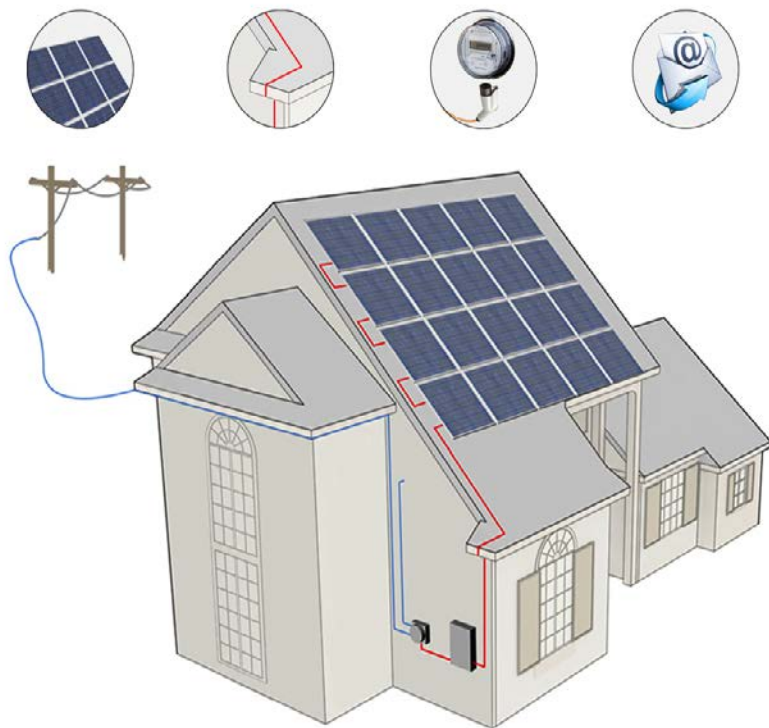
- PV-ready meter or smart meter
- Grid-tie on utility or residential side
- Smart “PV ready” connector
- Self test of grid-tie integrity
- Compatible with net-metering and other business models

Technical Approach: Commissioning



- Automatic registration with jurisdiction
 - > Email protocol
 - > Option for post-commission inspection
- Automatic interconnection with participating utility
 - > Email based interconnection process
 - > Smart grid integration

Technical Approach



**10 Hours
later:**

Ready !



Key Deliverables Year 1 (1)

- Selection of power conversion topologies and safety features
 - > Determined by comparison of cost, ease of integration of safety features, power conversion efficiency
 - > Micro-inverters, dc-dc optimizers, string inverters
 - > Potential for integrated ground fault and arc detection
- Determine design trade-offs for reduction or elimination of roof penetrations
 - > Determine requirements and specifications for adhesive based zero penetration approach
 - > Determine requirements and specifications for “safe” roof mount
- Demonstration of 50 kg/kW light weight PV module, roadmap for further reductions
 - > Light weight and durable modules
 - > Technologies investigated include Si, thin film, others

Key Deliverables Year 1 (2)

- Roadmap for automated interconnection process
 - > Implementation plan for low penetration scenario, incl. back office infrastructure
 - > Determine roadmap for high-penetration scenarios
- Draft outline of Plug and Play standards suite
 - > Electrical, structural, interconnect
 - > Determine required code changes
- Plug and Play scorecard – to measure project progress
- System demonstrations
 - > Baseline system on residential rooftop
 - > Year 1 system with advanced modules and power electronics on roof in solar test field

Fraunhofer Center for Sustainable Energy Systems

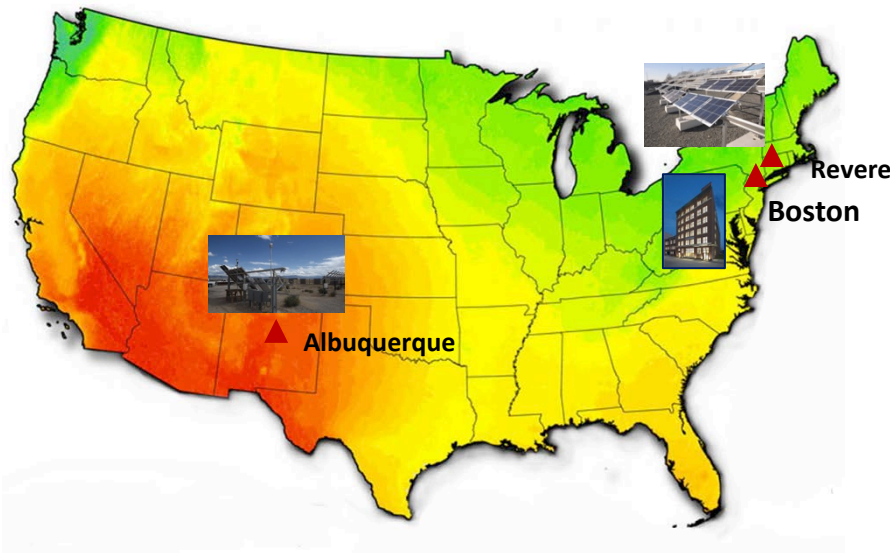
Mission

Foster economic development ...
... through the commercialization of
clean energy technologies ...
... for the benefit of society



How we work

- > Research initiatives and consortia to promote the technical leadership of U.S. industry
- > Contract research
- > Third-party technology validation
- > Technology commercialization assistance for cleantech start-ups
- > Standards development



Fraunhofer CSE R&D Groups Target Critical Areas for the Clean Energy Transition

Photovoltaic Technologies

Design
Modeling
Manufacturing
Durability



Building Energy Efficiency

Building Enclosures
Energy Management
Monitoring
Technology Assessment



Distributed Electrical Energy Systems

Grid Impact of High PV Penetration
PV System Performance
E-Mobility



Fraunhofer TechBridge

Supporting early-stage cleantech companies with R&D services

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Q & A AND DISCUSSION