Streamlined and Standardized Permitting and Interconnection Processes for Rooftop PV in Puerto Rico

Puerto Rico Energy Affairs Administration
University of Puerto Rico-Mayaguez (ECE Department)

UPRM Team: Efraín O'Neill-Carrillo, Agustín Irizarry, Eduardo Ortiz
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Agenda

9:30 am	Resumen del proyecto "Rooftop Solar Challenge"
10:00 am	Reformas al proceso de permisos de PV en PR
10:30 am	Recomendaciones de reformas a estándares de interconexión y net metering
11:15 am	Recomendaciones de reformas en financiamiento y de zonificación
12m	ALMUERZO
1:00pm	Estructuras para viabilizar las reformas en PV
2:00pm	Discusión de acciones y seguimiento
2:30pm	Evaluación de la actividad
3:00pm	Clausura

Rooftop PV System

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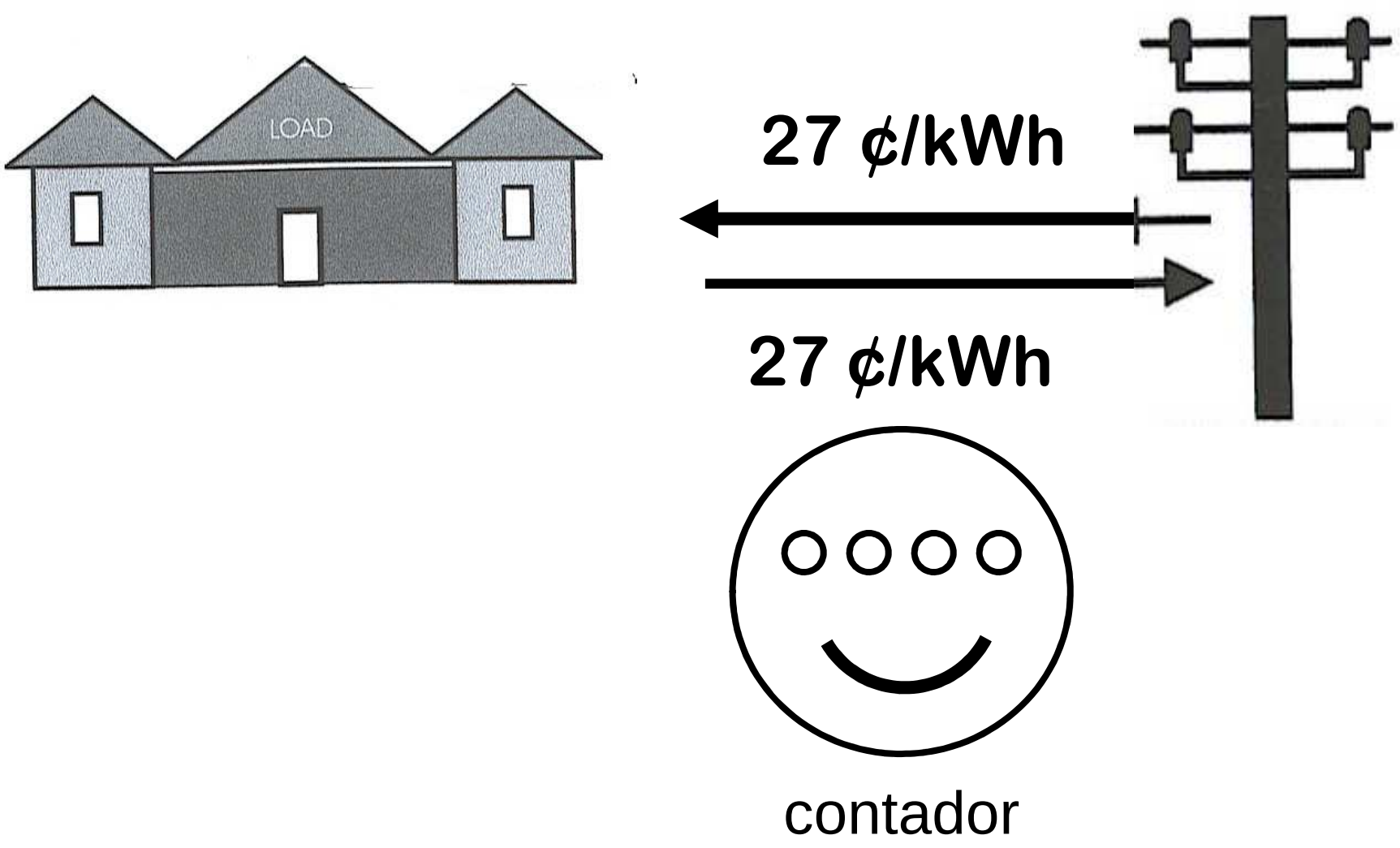
Medida Neta



Brief and recent history of PV

1987	Juana Diaz
1993	PR's Energy Policy
1996	Mona Island's PV System
2001	DOE Million Solar Roofs
2002	First DG Studies (UPRM)
2003	First DG CIAPR seminars (UPRM)
2004	Net metering in PR? No way!
2007	ITEAS founded (energy policy at UPRM)
2007	Net metering law

Brief and recent history of PV

2008 Mesa de Diálogo (energy policy)

2008 Net metering and interconnection standards (UPRM in public hearings)

2008 ACONER founded

2008/09 ARET (UPRM project funded by PREAA)

2011 DOE SunShot Initiative

2012 Rooftop PV Challenge

(UPRM-led proposal in collaboration with PREAA)

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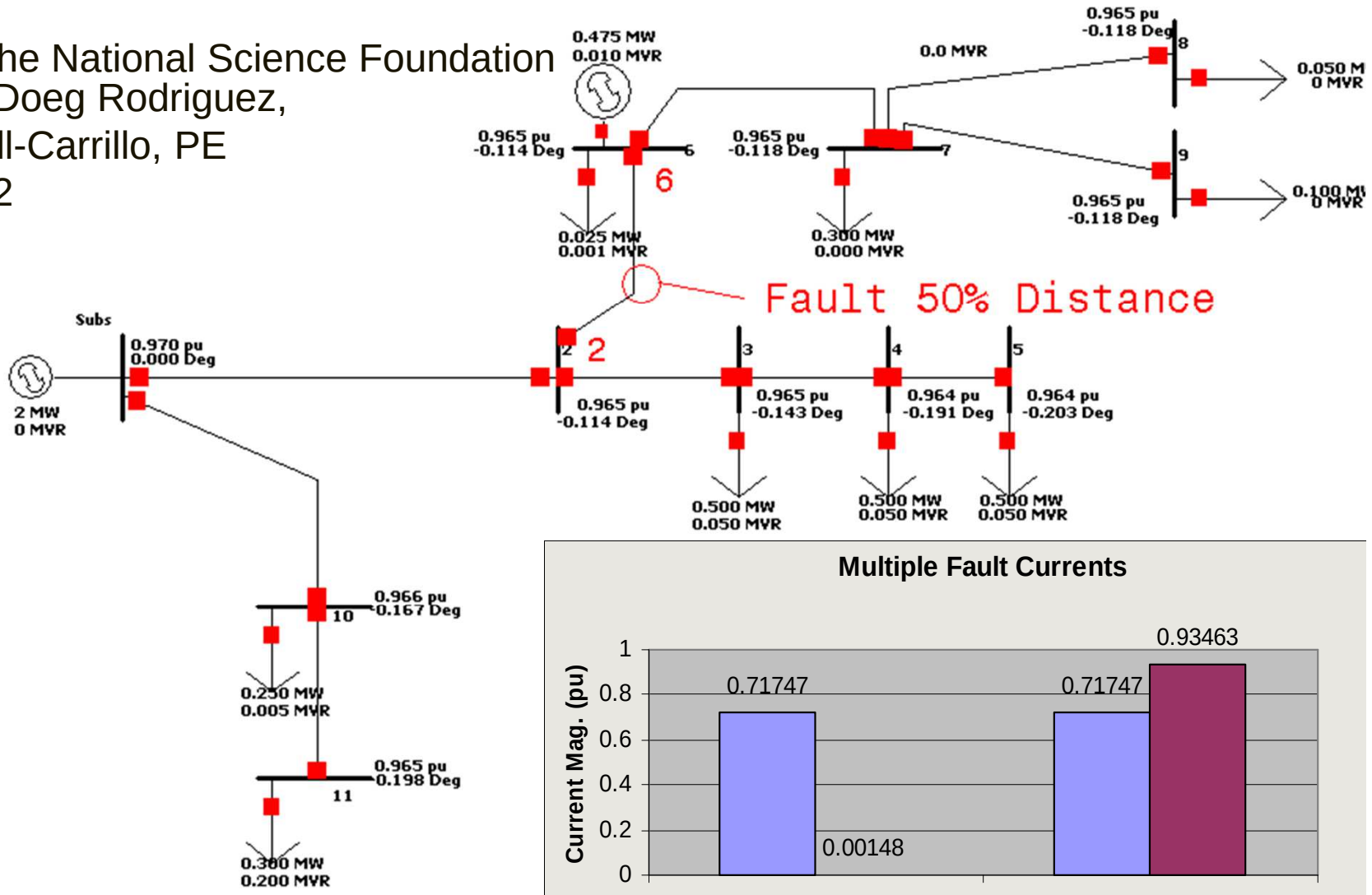
First Distributed Generation Studies in PR
DG in Rural Distribution Feeder - 13.2kV

Funded by the National Science Foundation
Reference: Doeg Rodriguez,
Dr. E. O'Neill-Carrillo, PE
UPRM, 2002



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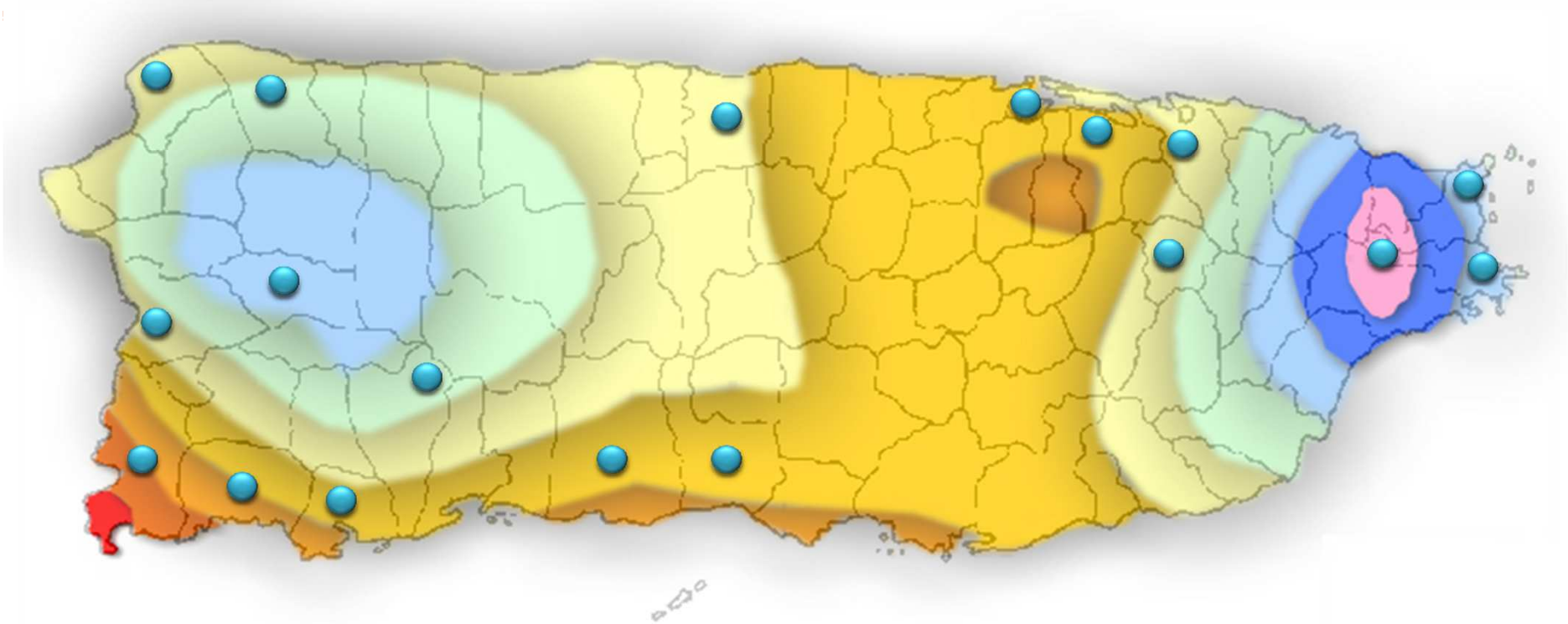
Average Insolation in Puerto Rico, kWh/m^2 per year



1419 – 1572	1876 – 2028	2332 – 2484
1267 – 1419	1724 – 1876	2180 – 2332
1115 – 1267	1572 – 1724	2028 – 2180

Funded by the PREAA, 2008-2009.

Population Distribution

- ~50% → >18.5 MJ/m^2/day
- ~20% → 17-18.5 MJ/m^2/day
- ~30% → <17 MJ/m^2/day

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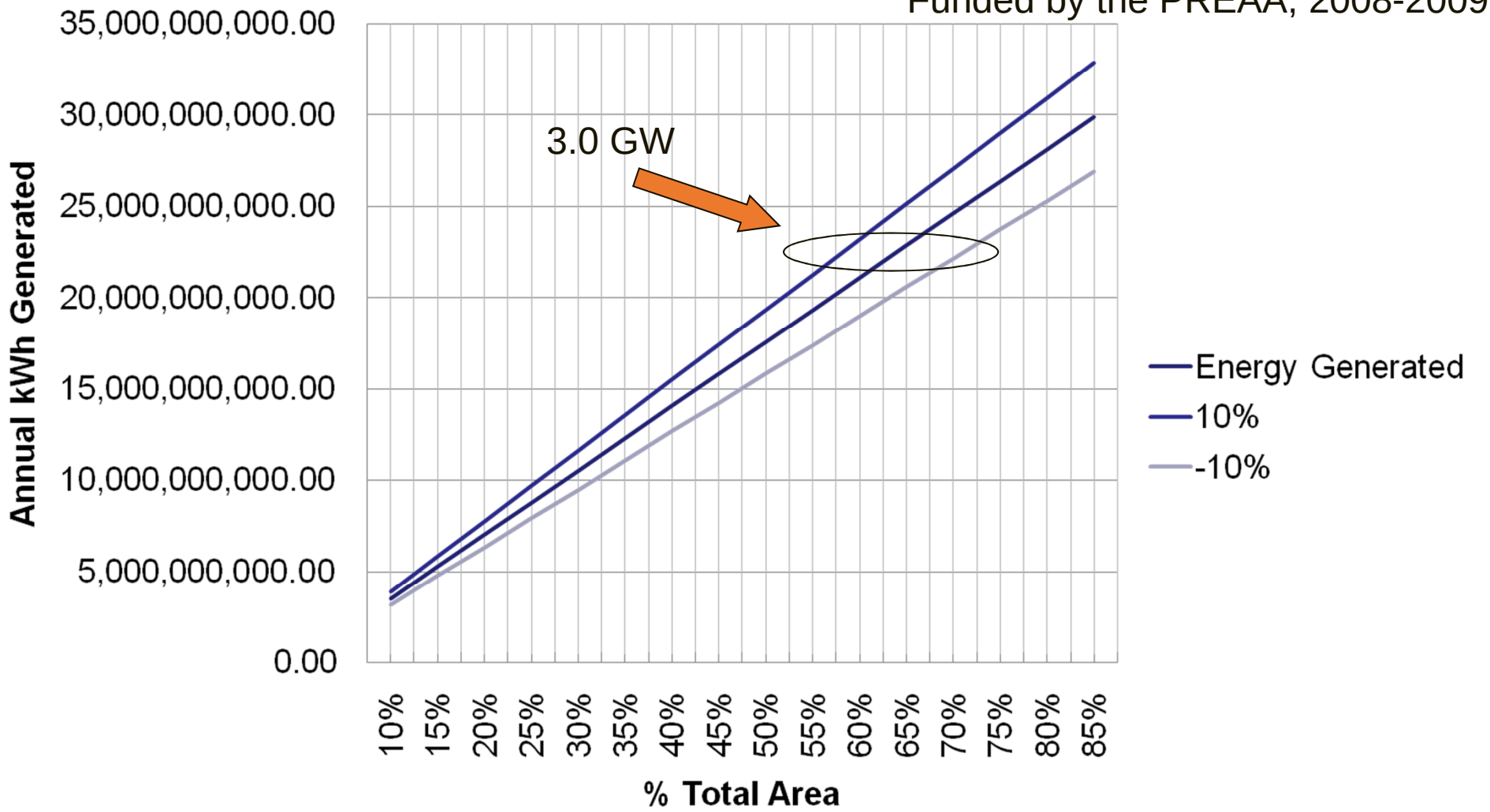
Estimate of potential electric energy residential contribution

Funded by the PREAA, 2008-2009



Design of PV Systems using K_t Distributions (accounting for sun variations to reduce impact to the power grid)

H.Ladner, M.S. Thesis, December 2008, UPRM

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PR's "Roof Resource"

- Residential Area→180,814,184m^2
- Commercial→ 7,300,000m^2
- Industrial→ 2,702,545.45m^2

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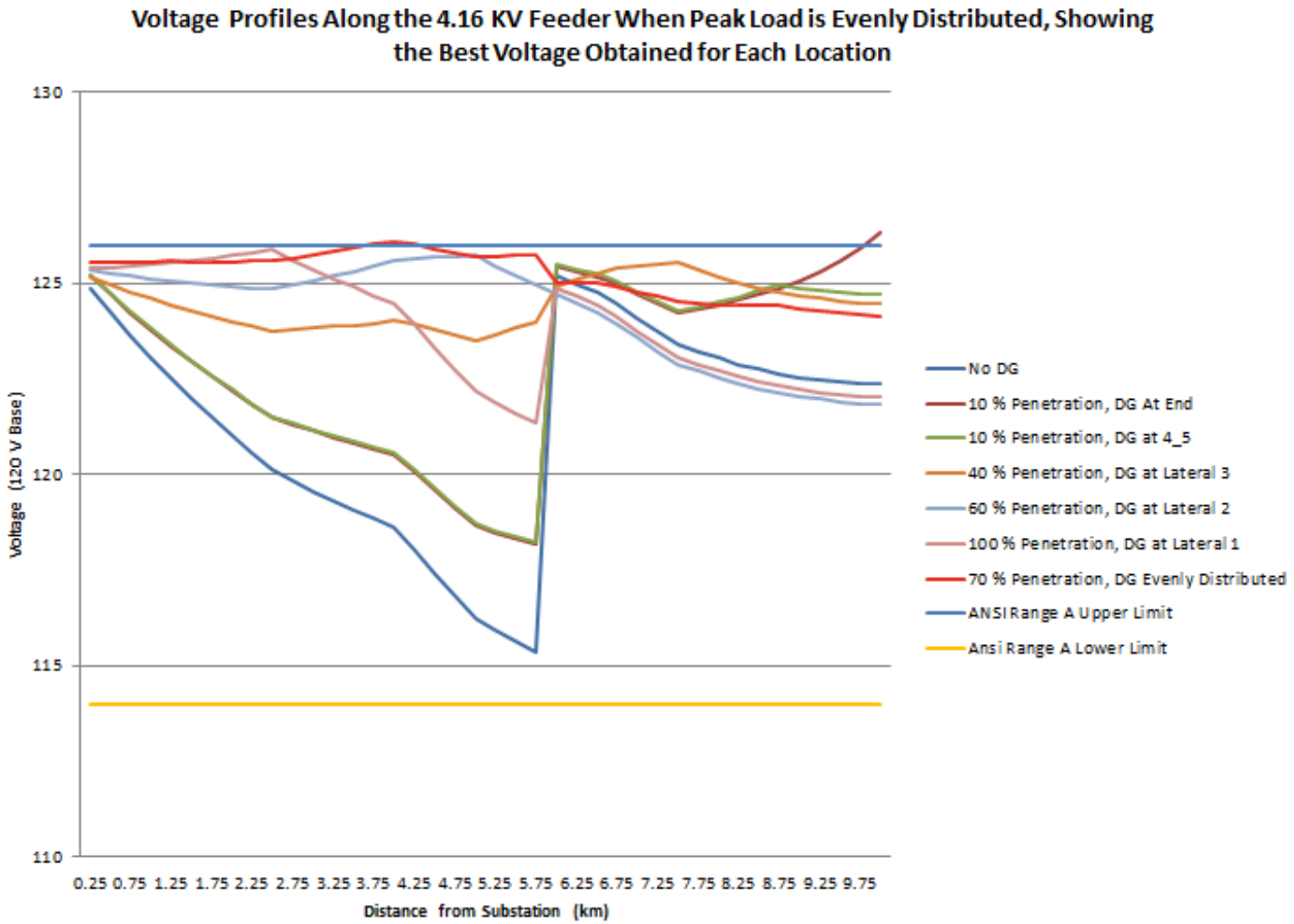
Actual DG projects

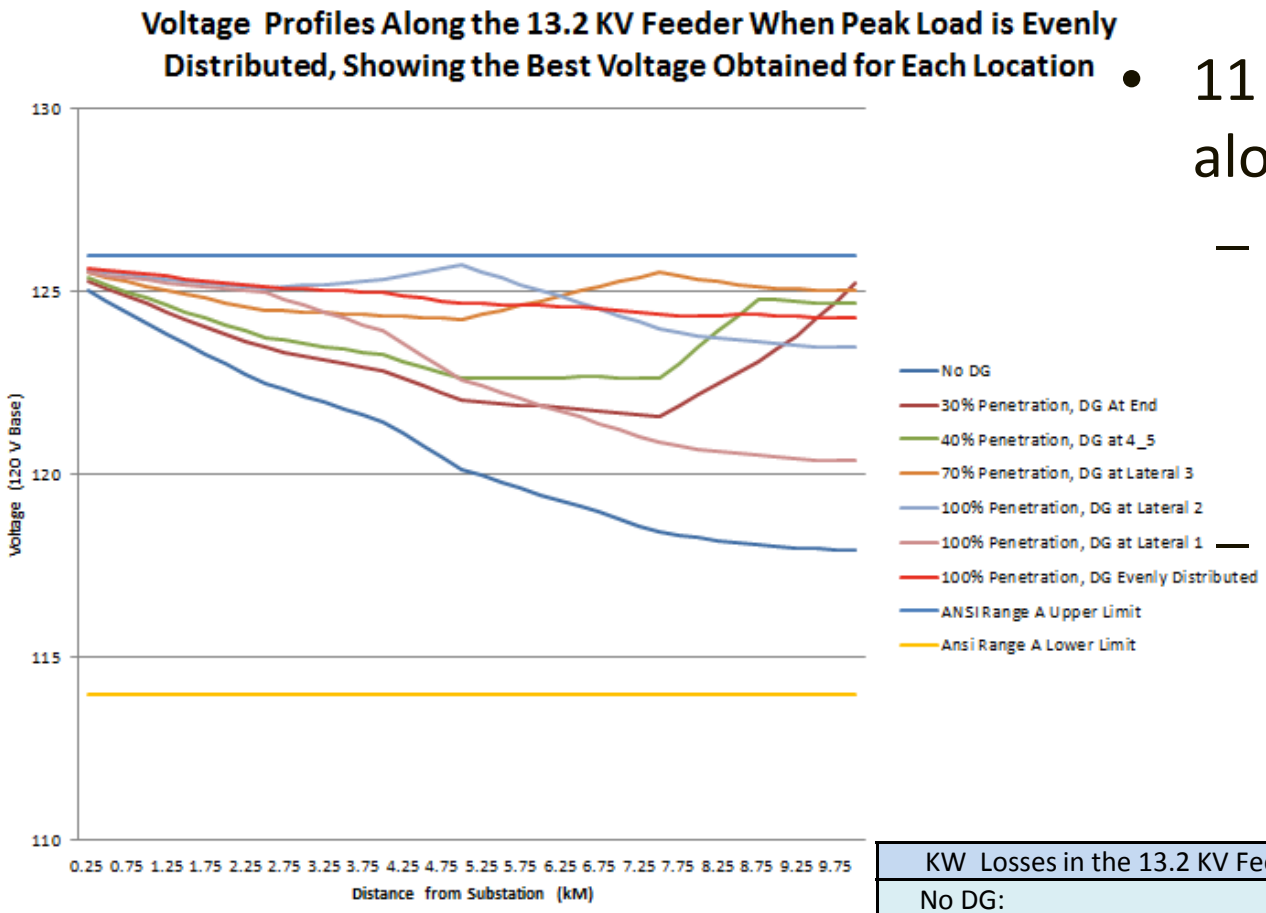
Rooftop PV Projects in the City of Caguas.

Casa Pueblo-UPRM Solar Laboratory: First net-metered system, 2008. Outstanding Electrical Engineering Project, CIAPR 2009 (Casa Pueblo, UPRM, Solartek)

587 kW grid-tied PV system, City of Bayamon



- 2.5 MVA load: Even distribution along the feeder allows high DG capacity (70% of feeder load)
  - Least DG capacity could be installed at the end of the feeder (10% penetration).
  - Most DG capacity could be installed when located close to the substation.



- 11 MVA load distributed along a 13.2 kV feeder
  - Higher voltages allow more DG capacity to be interconnected at all locations.
  - Higher voltages can achieve higher DG penetration than lower voltages.
  - Best voltage profile and loss reductions when DG is distributed along the feeder.

KW Losses in the 13.2 KV Feeder with Load Distributed Evenly - Peak Demand						
No DG:	357					
DG Penetration	KW Losses Depending on DG Location					
	End	Section 4_5	Lateral 3	Lateral 2	Lateral 1	Evenly Distributed
10%	275	269	269	292	324	290
20%	237	213	199	237	294	231
30%	239	184	147	191	269	179
40%	*	181	112	154	247	135
50%	*	*	93	126	229	98
60%	*	*	89	108	214	68
70%	*	*	100	97	204	44
80%	*	*	*	95	197	28
90%	*	*	*	102	193	17
100%	*	*	*	116	194	13

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M. Irizarry Silvestrini, Masters Thesis, May 2011, University of Puerto Rico – Mayaguez Campus

Puerto Rico's Solar Challenge

- If we have the experience, technical resources, track record… why are we not using more solar energy in Puerto Rico?
  - NOT a purely technical problem…
  - Emphasis on generation, while conservation and efficiency are mostly forgotten
  - PV costs, processes, interconnection, planning and zoning issues
  - Dominant energy model
    - Central, hierarchical, little (if any) public participation

AEE	2006	2007	2008	2009	2010	2011
Capacidad instalada (MW)	5,388	5,388	5,402	5,898	5,898	5,898
Demanda Pico (MW)	3,685	3,604	3,546	3,351	3,404	3,406
Energía neta generada (MWh)	23,754	24,062	22,924	21,763	22,559	21,639
Energía perdida (MWh)	3,134	3,390	3,322	3,247	3,324	3,138
Energía vendida (MWh)	20,620	20,672	19,602	18,516	19,235	18,501
Cobrado tarifa básica (Millones)	$1,166	$1,184	$1,132	$1,072	$1,121	$1,087
Compra de combustible (M)	$1,868	$1,778	$2,473	$2,162	$2,256	$2,579
Compra de energía (M)	$674	$708.906	$745.753	$752.61	$777.52	$740.26
Ingresos Totales (M)	$3,732	$3,687	$4,369	$4,007	$4,173	$4,411
Gastos totales (M)	$3,034	$3,015	$3,688	$3,378	$3,427	$3,705
Ingresos netos (M)	$698	$672	$681	$629	$746	$706
Bonos: Intereses + Principal (M)	$449	$455	$420	$435	$398	$480

Rooftop Solar Challenge

- ***Partnerships among relevant stakeholders*** to improve market conditions for rooftop PV in major regions of the USA.
- Focus on grid-connected rooftop PV in the residential and commercial sectors
- Emphasis on streamlined and standardized permitting and interconnection processes.
- ***Encourage participation*** to ensure meaningful, measurable results.

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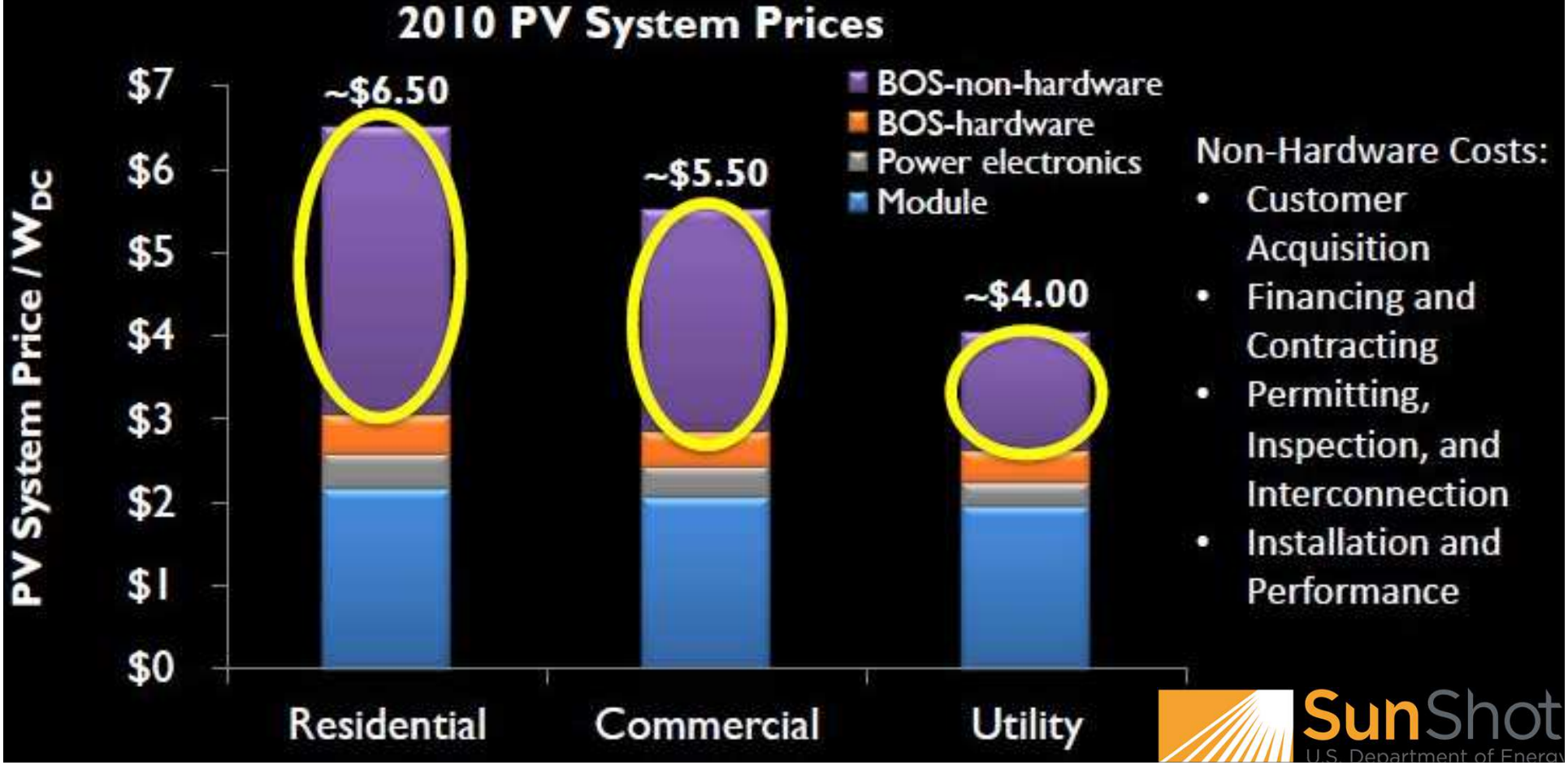
Source: Funding Opportunity Announcement DE-FOA-0000549

The Issue:

"Even if you paid nothing for the hardware, you'd still pay thousands of dollars to install a residential solar power system" - Secretary Chu



But Why So Pricey?

- Complicated and confusing process
- Process is different for every locale
- Unnecessarily high permit fees

  In-person application submission and inspection

- Long wait times for inspection and approval

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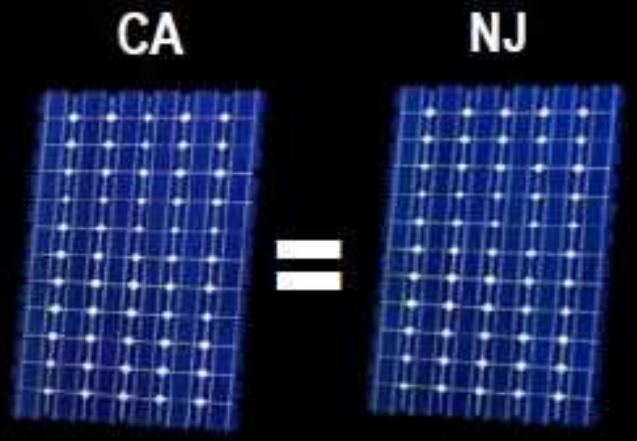
Rooftop Solar Challenge

The Problem

- **18,000+** local jurisdictions with different PV permitting requirements
- **5,000+** utilities implementing interconnection standards and net metering programs
- 50 states developing interconnection standards and net metering rules

The Solution

The Challenge invests in **22** teams comprised of jurisdictions, utilities, and local stakeholders to develop the same requirements and processes across large geographic areas (500,000+ population). The Challenge also measures each team's progress to identify approaches that work.



Uniform processes

Source: SunShot - DOE

Germany's Success

As long as housing structure is built to code, no permits filed for residential PV in Germany

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Time Requirements to Complete Interconnection Application Process in Germany

PV Legal's survey found that residential systems (up to 5 kWp) and roof-mounted commercial and industrial systems (up to 50 kWp) averaged 2 and 4 person-hours of legal-administrative labor, respectively, to complete the grid connection process.

System Category	Min.	Avg.	Max.
Residential (up to 5 kWp)	1	2	3
Roof-Mounted Commercial and Industrial (up to 50 kWp)	2	4	6
Ground-Mounted (up to 5 MWp)	6	25	46

Source: PV Legal 2011b, PV Legal 2011g, PV Legal 2011h

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Key findings: German Utilities

- **Renewable electricity output has priority in grid management** – the system operator manages non-renewable units around the integration of renewable electricity, which has priority in the system integration.
- Customer satisfaction is important and **"customers want utilities to embrace renewables, not just accept them**."
- German utilities must interconnect all renewables to the grid and **the rules are very clear**.
- External disconnects and system inspections are not necessary.

More Key findings: German Utilities

- Ease of integration is inherent to the less litigious nature of Germany and the assignment of **no-fault as long as the specific rules were followed**.
- **Clarity and transparency** – there are no surprises or uncertainly and therefore they can plan accordingly.
- **German utilities used to require external disconnect switches** but do not any longer. Since there are so many PV systems on their grid, it would be a burden to the utility to utilize and manage them all.
- **German utilities want PV to stay on the grid during disturbances to provide grid support**.
- Large ground mount systems are a relatively small and decreasing part of the overall German solar market.
- **Theft of panels has become a problem in Europe**.
- – Recycling, LCA studies

MIT Energy Conference 2012

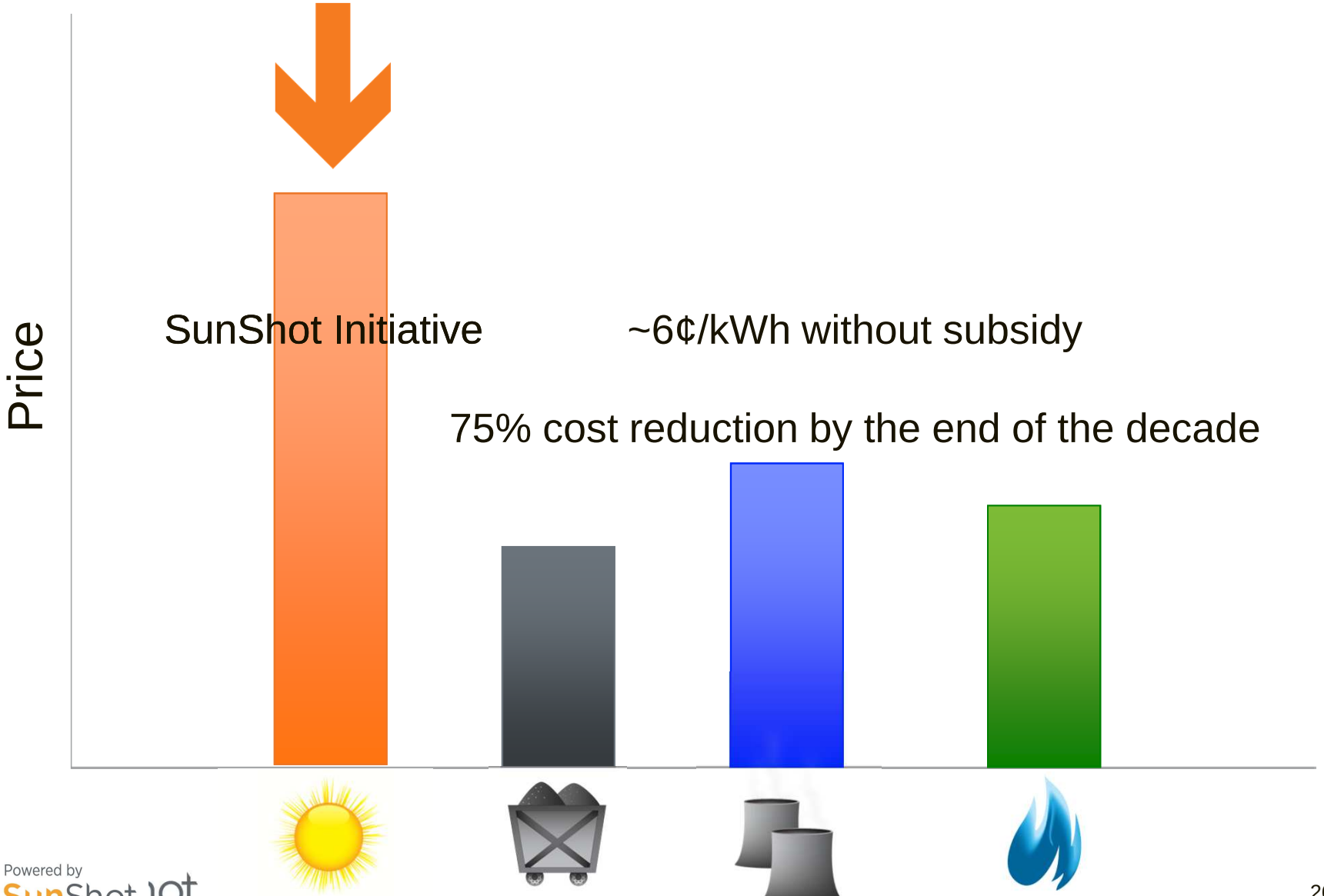
"Unlike physics, where we can fundamentally figure out the upper limit for the efficiency of solar cells, there is no such limit to bureaucracy"

Minh Le, Acting Deputy Program Manager

DOE's Solar Technologies Program

http://www.greentechmedia.com/articles/read/Bold-Words-From-the-DOE-on-Solars-Future

Why we're here: Big Picture



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Source: DOE

Market Evaluation Points

ACTION AREA	POINTS
Permitting Process	**460**
Application	110
Information Access	60
Process Time	110
Fee	30
Model Process	30
Inspection	80
Communication w/ Utility	40
Interconnection Process	**110**
Application	40
Information Access	20
Process Time	20
Inspection	30

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Source: Funding Opportunity Announcement DE-FOA-0000549

Market Evaluation Points (cntd)

Interconnection Standard	**100**
Net Metering Standard	**100**
Financing Options	**150**
Third Party Ownership (or equivalent)	90
Direct Finance Options	25
Community Solar	15
Other	20
Planning and Zoning	**80**
Solar Rights and Access	54
Zoning	20
New Construction	6
TOTAL POINTS POSSIBLE	**1000**

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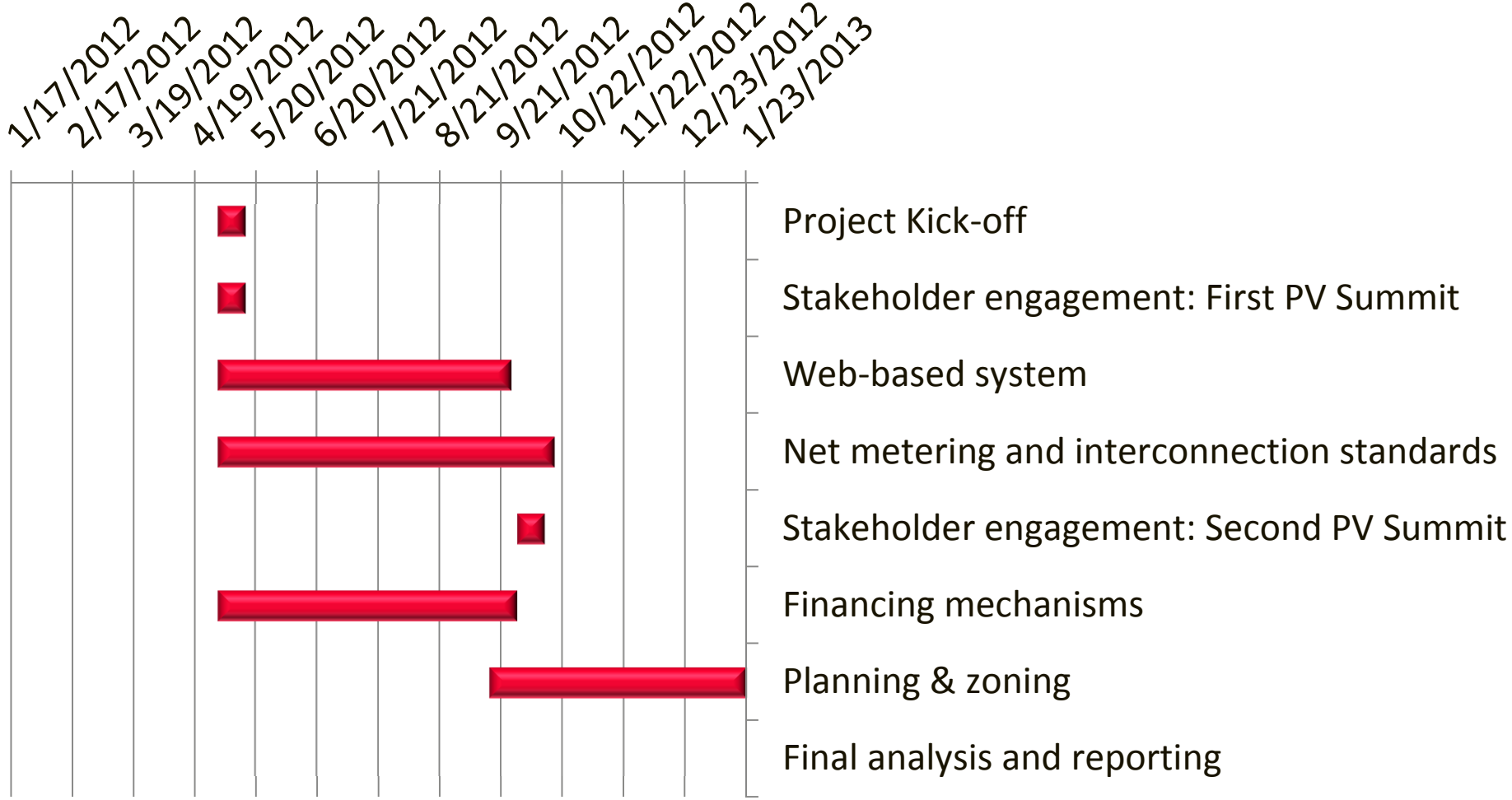
Source: Funding Opportunity Announcement DE-FOA-0000549

Timeline


1/17/2012
2/17/2012
3/19/2012
4/19/2012
5/20/2012
6/20/2012
7/21/2012
8/21/2012
9/21/2012
10/22/2012
11/22/2012
12/23/2012
1/23/2013
Project Kick-off
Stakeholder engagement: First PV Summit
Web-based system
Net metering and interconnection standards
Stakeholder engagement: Second PV Summit
Financing mechanisms
Planning & zoning
Final analysis and reporting

Why are we here?

- Stakeholder summits (one in the eastern side of the Island, and another in the western side).
- Include not only industry, government and other typical market participants but also community and environmental groups to ensure a strong base support for the policy changes.
- Ownership of the rooftop PV framework among stakeholders
- Create trust and transparency.
- Island-wide "PV community" to ease the transition towards implementation

Task 1.0 Stakeholder Engagement

- Create best practices with active participations of PV stakeholders
- Kick-off activities of the project
  - May 2nd, 2012, PREAA; May 8th, 2012, Mayaguez
- Focus group meetings on processes and standards
  - May 31st, June 19th PREAA; May 30th, June 20th UPRM
- Small group meetings on processes and standards
  - July 12th, 2012, Mayaguez; July 13th, 2012, PREAA
- Focus group meetings on financing
  - July 18th, 2012, August 28th, 2012, Mayaguez
  - July 19th, 2012, PREAA
- Small group meetings on financing
  - September 24th, 2012, Mayaguez; September 25th, 2012, PREAA
- Focus group meetings on planning and zoning
  - September 18th, 2012, Mayaguez; September 19th, 2012, PREAA

PV Summits October 2012:

Rincon (18) and Caguas (30)

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Stakeholder engagement is vital

- Dynamic, non-linear process
- Need multi-sector collaborations: Government, industry, NGOs, communities.
  - From distrust to a lasting commitment with PR's social, environmental and economic welfare and a different energy future
- Changes needed to improve Rooftop PV market in PR require a multi-sector approach
  - Puerto Rico Solar: PV Community
- Stakeholder references
  - Peter Senge, *The Necessary Revolution: How Individuals and Organizations are Working Together to Create a Sustainable World,* Doubleday, 2008.
  - Venkat Ramaswamy, *The Power of Co-Creation*, Free Press, 2010.

Stakeholder Engagement

- Peter Senge argues that the deep problems we face today are the result of a way of thinking whose time has passed or is near its end.
- Do we protect the ways of the past or join in creating a different future?
- Seeing the *deeper pattern that connects many different problems* is crucial if we are to move beyond piecemeal reactions and create lasting change for PV systems.
- Many collaborative initiatives can be frustrating because they produce lots of talk and little action.
- *Groups might not have exactly the same set of objectives, but there was enough of a common ground to work together*
- We have been following this, with a clear focus (rooftop PV under 300 kW).

Stakeholder Engagement

- Dr. Ramaswamy argues in favor of co-creation, developing systems, products or services through collaboration
- *Co-creation involves democratization and decentralization of value-creation*, moving it from concentration inside a few to interactions with stakeholders.
- Dr. Ramaswamy goes on to describe "social eco-systems" an environment with free flow of information, which engages people better and enable richer, fuller stakeholder interactions than traditional outreach strategies.
- For our project, the use of focus and small group meetings are the key engagement platforms supported by electronic and phone conversations with key stakeholders. It is our objective to expand those engagement platforms in ***the creation of a PV Community in Puerto Rico.***

Sharing Success Emerging Approaches to Efficient Rooftop Solar Permitting (IREC)

- Realistic and effective ways to improve solar permitting
- ***The responsibility for change should be shared***
  - Utility: Processes and requirements
  - PV Industry: complete and accurate applications
- ***Need commitment from both groups to be effective.***

Sharing Success Emerging Approaches to Efficient Rooftop Solar Permitting (IREC)

- Changes to permitting policies should benefit all involved
  - Understand PREPA's operations and services
  - Understand PV industry's challenges
- The economic conditions faced by both groups are critical
- ***The best solutions are those that benefit the broader community.***

Rules of Engagement

- Development of best practices
  - Aspirational: a vision of where the rooftop PV market could be
- Practical considerations
  - Identify low hanging fruit, e.g., clarifications of grey areas
- Respectful dialogue
  - We will not agree on everything, but at least, try to listen and understand the other sector's perspective
- What's the value-added for my sector?

Constant Collaborators

- Cooperativas del Oeste
- Gerardo Cosme, Solartek
- Rafael Fernandez Sein, RUM (ret.)
- Iliana Garay, OGPE
- Harry Mendez, Basora Group Communications
- Sonia Miranda & Miguel Irizarry, PREPA
- Edison Pares
- Ernesto Rivera, ACONER
- Daniel Rosell, DRS
- Maximo Torres, Green Solar
- Angel Zayas, AZT Engineering

Other stakeholder engagement

- Webpage development
  - http://prsolar.ece.uprm.edu/
- Email
  - PuertoRicoSolar2012@hotmail.com

Task 2.0 Web-based system to improve processes

1. PERMITTING AND INTERCONNECTION PROCESSES

   Develop and implement a transparent, consistent, and expedient permitting and interconnection process for residential (less than approximately 10kW) and small commercial (less than approximately 300kW) rooftop PV systems, throughout all participating jurisdictions.

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Source: Funding Opportunity Announcement DE-FOA-0000549

Why should the installation of a PV system on your roof be handled like the installation of a gas water heater?

Source: DOE

Residential PV in Germany costs ~$2.50/W

Residential PV in the U.S. costs ~$6/W

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Key Reference

Solar ABCS

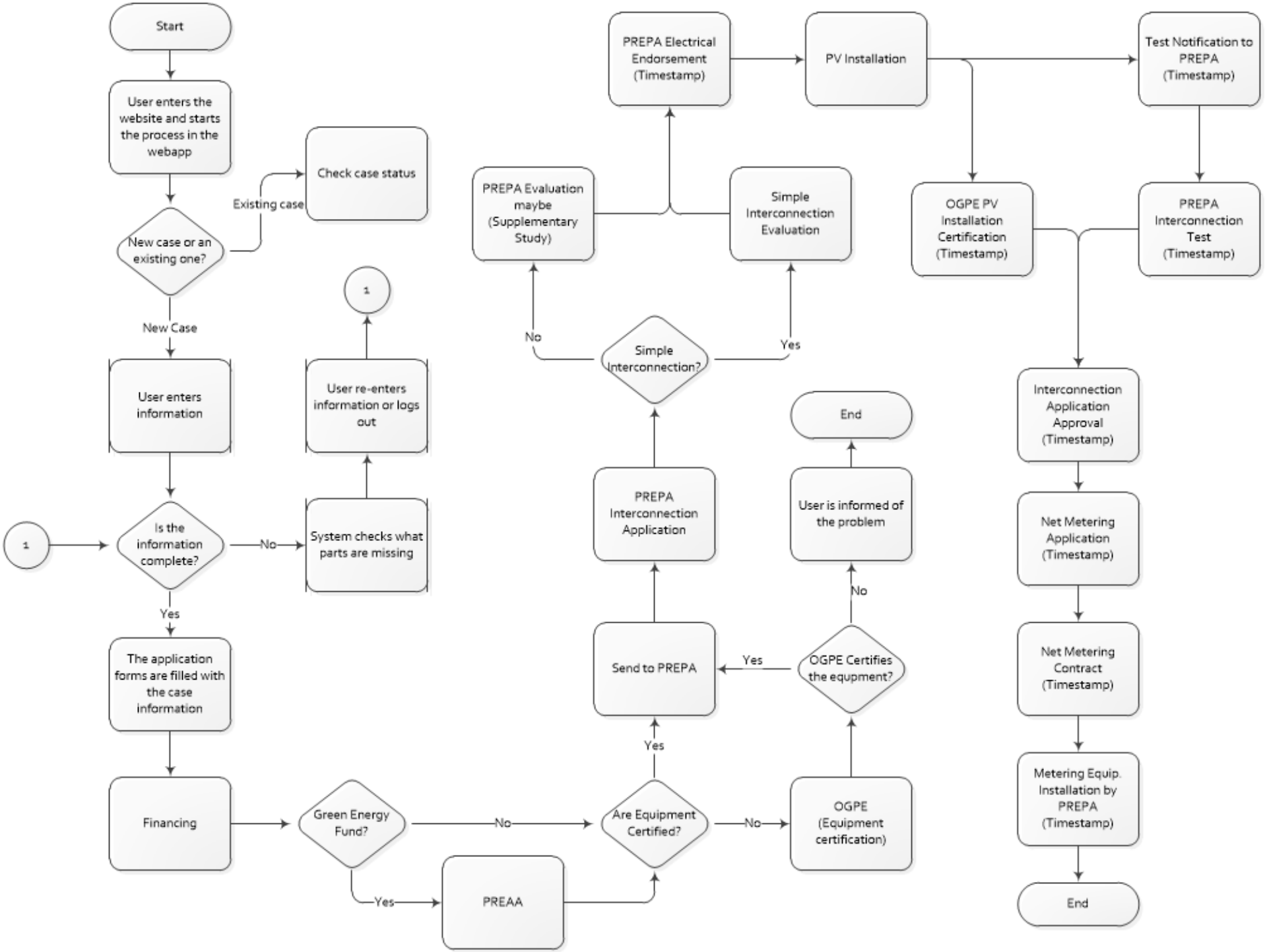
- Report from the Solar America Board for Codes and Standards (Solar ABCs). The full report documents legal issues for solar access and solar rights. The report provides model statutes for use by state and local governments.

Main Task for Processes

- An on-line framework is a key improvement strategy that will save time and money to all involved.
- Two approaches
  - Best practice: An Integrated Web-based Framework for Rooftop PV Systems
  - Near term: PREAA-based functions to complement processes at OGPE and PREPA

Main Task for Processes (cont.)

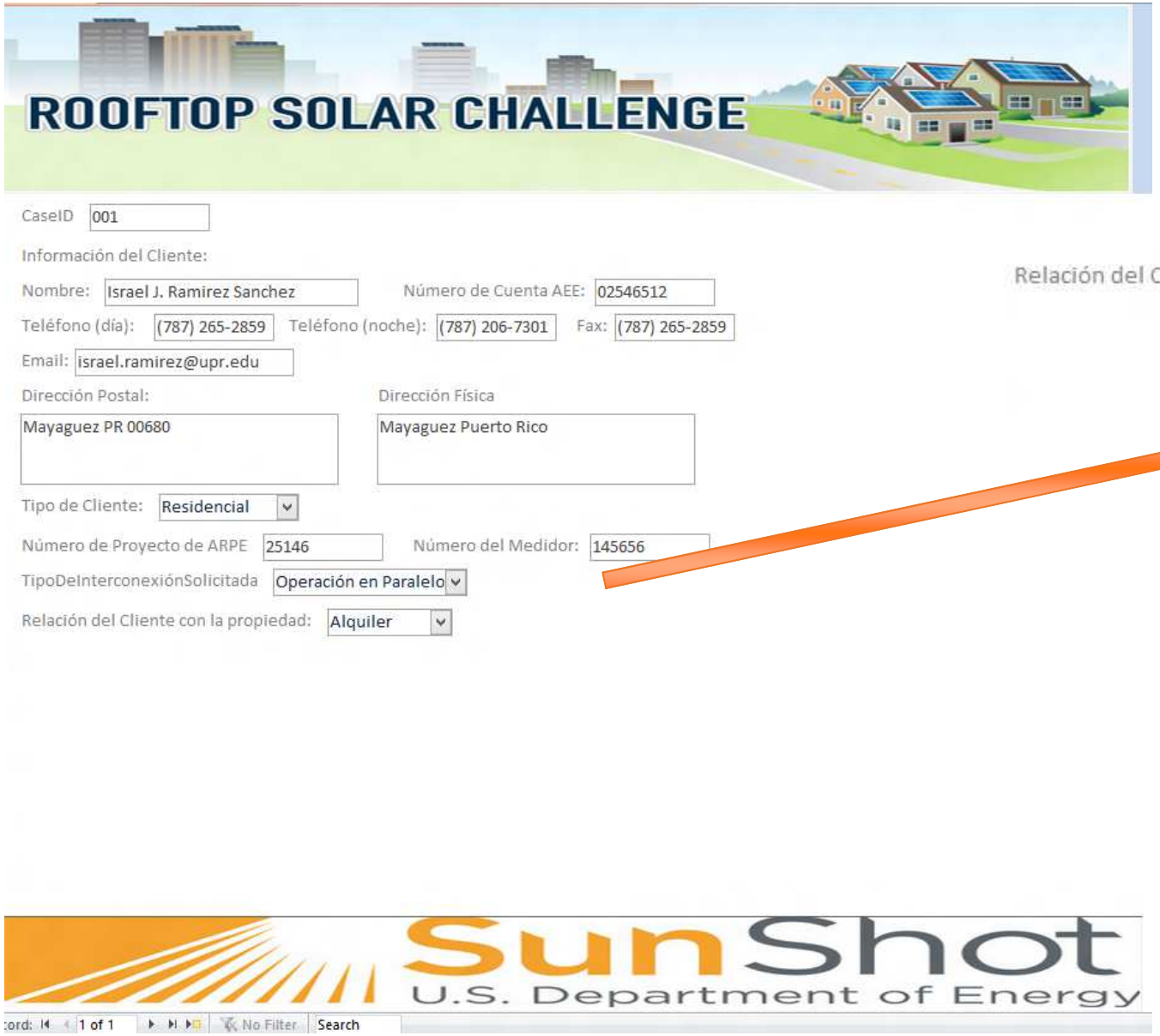
- Structure
  - General Information of rooftop PV in PR
  - Access to the Integrated System for Permitting and Deployment
  - The Puerto Rico Solar interface (PV Community)
  - Document Templates and Examples.
- Vision for the PV permitting functions
  - Software tools that become a one-stop shop for the PV market.
  - User inputs all the data for the proposed rooftop PV installation in once place
  - The system will automatically complete and electronically submit all forms
  - The objective is to speed up processing of rooftop PV cases to attain the recommended practice of less than a month for the whole process.


Start
User enters the website and starts the process in the webapp
New case or an existing one?
Existing case
Check case status
New Case
User enters information
1
Is the information complete?
No
System checks what parts are missing
User re-enters information or logs out
1
Yes
The application forms are filled with the case information
Financing
Green Energy Fund?
No
Yes
PREAA
Are Equipment Certified?
No
OGPE (Equipment certification)
Yes
Send to PREPA
PREPA Interconnection Application
Simple Interconnection?
No
PREPA Evaluation maybe (Supplementary Study)
Yes
Simple Interconnection Evaluation
PREPA Electrical Endorsement (Timestamp)
PV Installation
OGPE Certifies the equpment?
Yes
No
User is informed of the problem
End
Test Notification to PREPA (Timestamp)
OGPE PV Installation Certification (Timestamp)
PREPA Interconnection Test (Timestamp)
Interconnection Application Approval (Timestamp)
Net Metering Application (Timestamp)
Net Metering Contract (Timestamp)
Metering Equip. Installation by PREPA (Timestamp)
End

Initial Tasks

- User logs in to the website.

Interface Model



- If the Relationship of the Client with the property is set as owner, it will ask for the owner information (see next slide).

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Property Owner Information

- User enters new case information.

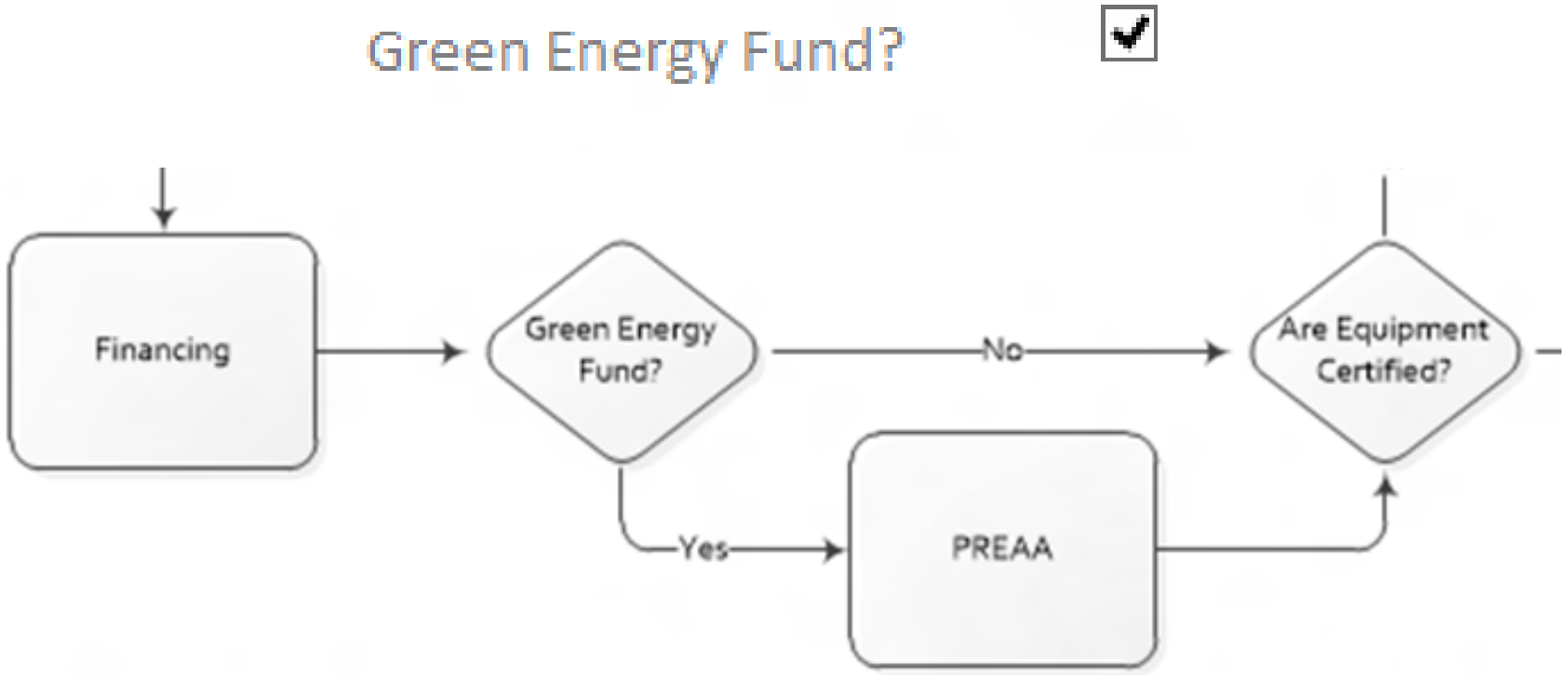
SharePoint site (web app)

- PREAA, PREPA and OGPE will have accounts in the SharePoint Site.

- Daily e-mails reminders until case is opened.
- Upload approved case or negative evaluation
- Through the process the installer/user will receive e-mails about the status of the process.

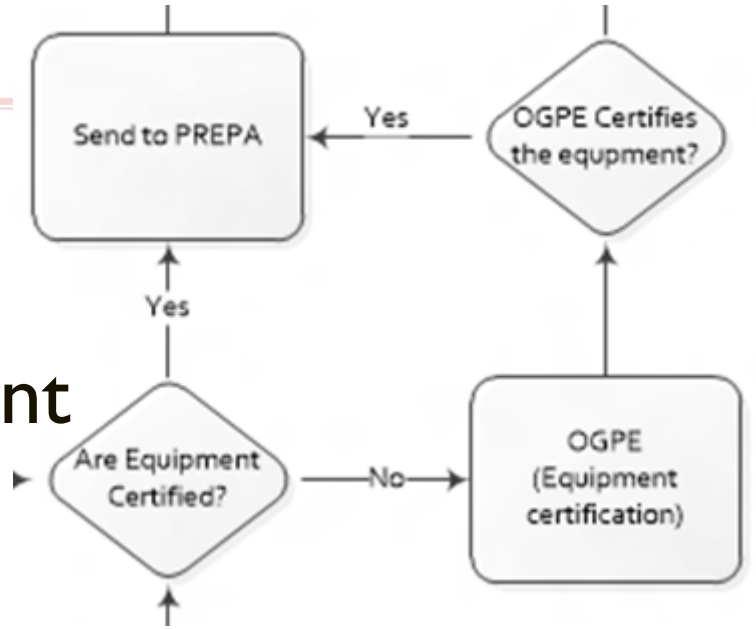
Financing options

- Financing work on-going
- If user selects Green Energy Fund, information will be given about needed steps.



Equipment

Are Equipment Certified? ☑

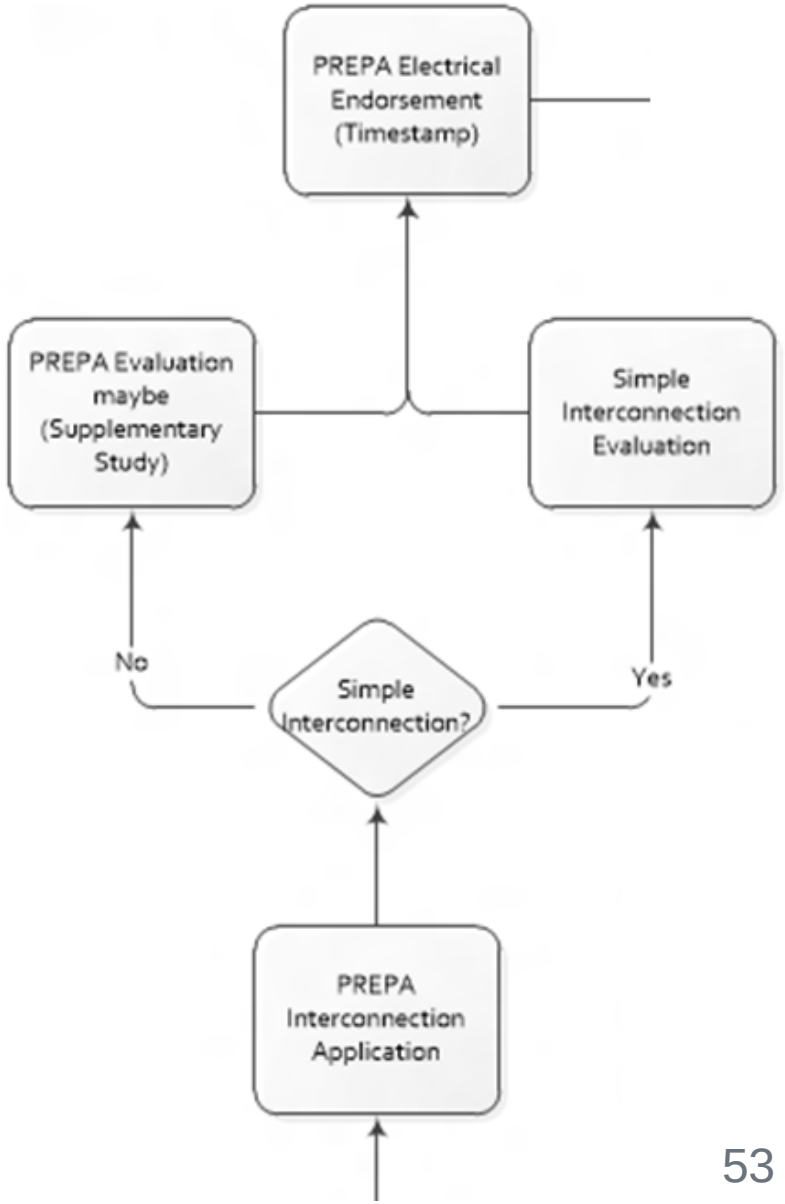


- User is taken to Database of Certified Equipment
- Else, user is taken to a screen for uncertified devices
  - OGPE certification process
  - User selects certified devices
- Once all certifications and applications are complete, case is sent to PREPA

Interconnection application

Simple Interconnection? ☐

- System checks if the installation complies with requirements for simple interconnection.
- If it is simple, the Simple Interconnection Evaluation process begins (PREPA confirms info).
- Else, PREPA evaluation process begins (check if study is needed).
- PREPA Electrical Endorsement
  - Goal: Develop an on-line tool to upload all documents and/or do as much as possible on-line



AEE _____

ESTADO LIBRE ASOCIADO DE PUERTO RICO
AUTORIDAD DE ENERGÍA ELÉCTRICA DE PUERTO RICO

SOLICITUD DE EVALUACIÓN PARA LA INTERCONEXIÓN DE GENERADOR DISTRIBUIDO (GD) AL SISTEMA DE DISTRIBUCIÓN ELÉCTRICA

Nota: Esta solicitud no aplica para generadores que operen aislados del sistema de distribución de la Autoridad.

A - Información del Solicitante

Nombre: Israel J. Ramirez Sanchez

Teléfono (día): (787) 265-2859 Teléfono (noche): (787) 206-7301

Fax: (787) 265-2859 Email: israel.ramirez@upr.edu

Dirección Postal: Mayaguez PR 00680

B - Relación del Colicitante con la propiedad donde se instalaráa el GD:

Relación del Colicitante con la propiedad donde se instalaráa el GD: Alquiler

C - Información del Dueño

Nombre: Israel Ramirez

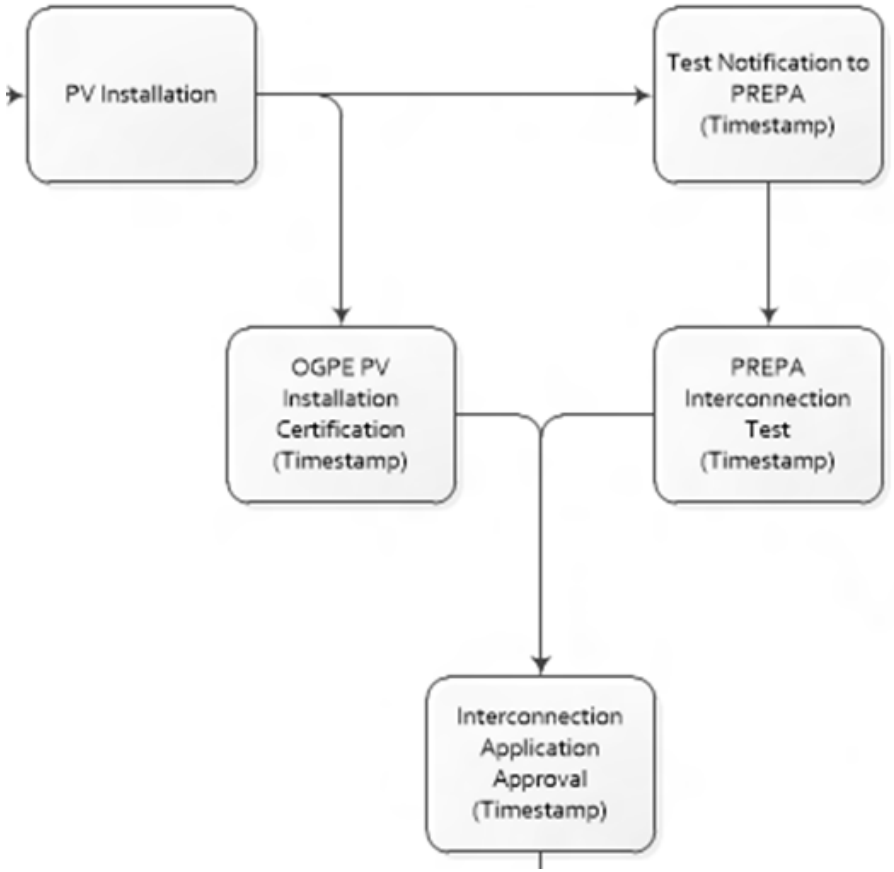
Teléfono (día): (787) 956-4656 Teléfono (noche): (979) 654-6546

Fax: Email: irsrony@gmail.com

DirecciónPostalDueno Mayaguez 00682

Installation and tests

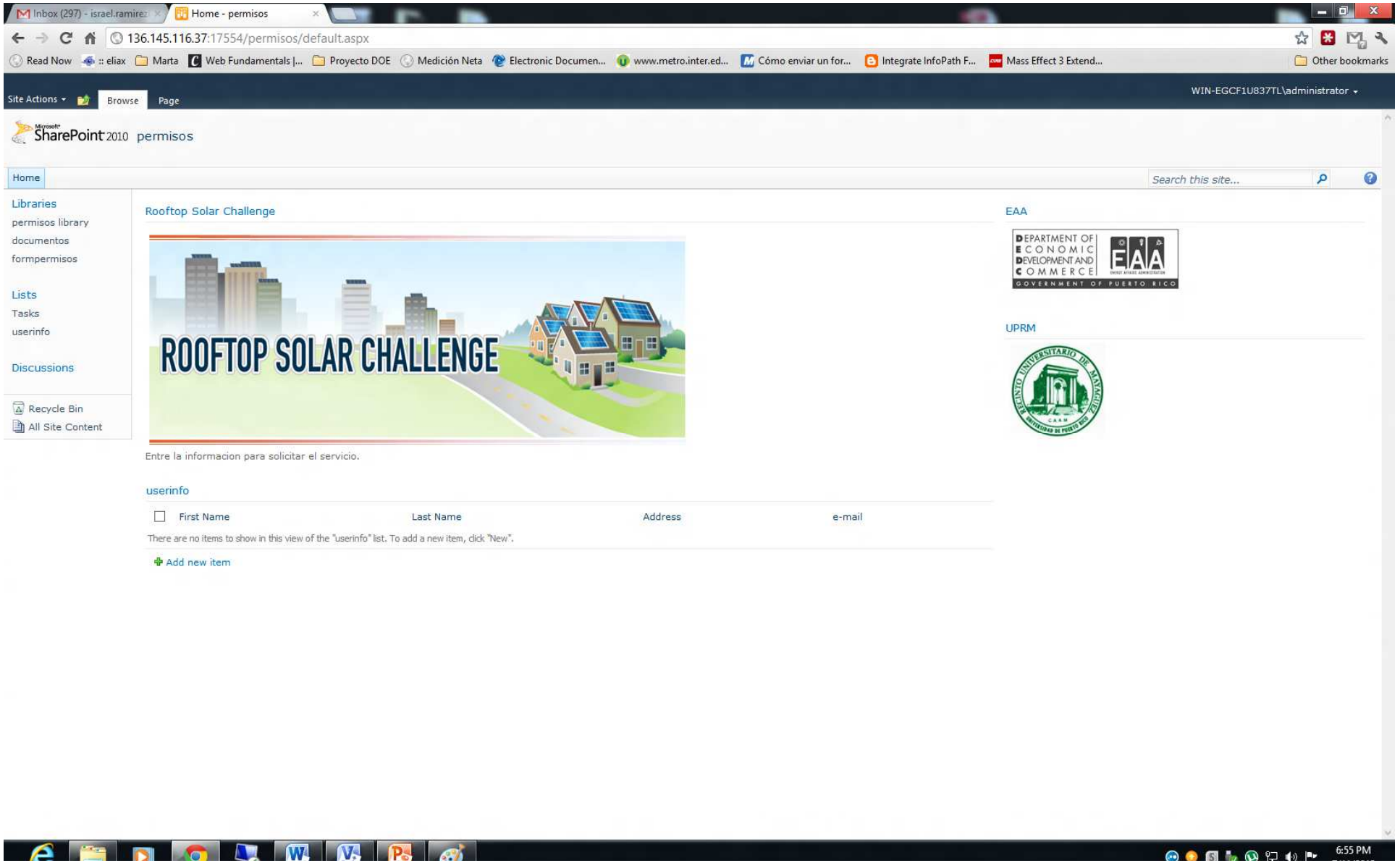
- PV Installation
- Notification of test sent to PREPA
- PREPA confirms attendance to test and inspection
- Tests performed
- Submission to OGPE for installation certification
  - Goal: On-line process should speed up response
- Interconnection Application Approval.



Net Metering

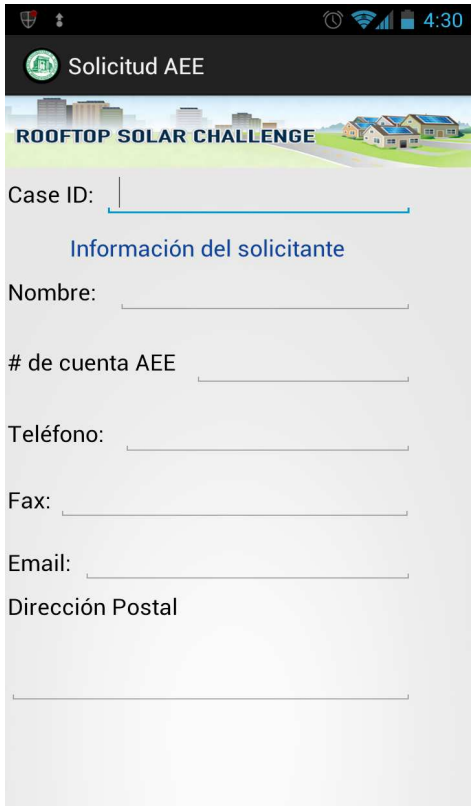
- Submission of application
- PREPA evaluation
  - Goal: Evaluation and decision made on-line
- User signs contract on-line
- Automatic generation of PREPA actions

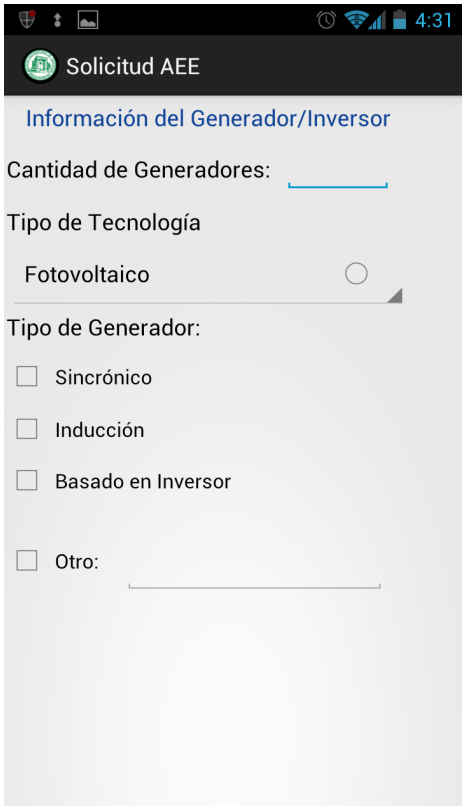
Case Database



Android Application

- Android application as a tool to improve the application process of PV systems in Puerto Rico





http://prsolar.ece.uprm.edu/resources.html

Task 3.0 Net metering and interconnection standards

2. NET METERING AND INTERCONNECTION STANDARDS

Improve interconnection and net metering standards, as evaluated by the Network for New Energy Choices grading scheme, for the primary load-serving utility in each participating jurisdiction.

SunShot U.S. Department of Energy

Source: Funding Opportunity Announcement DE-FOA-0000549

Key Reference

Network for New Energy Choices

- Network for New Energy Choices promotes environmentally responsible energy policies and technologies through in-depth reports and web content.

- Freeing the Grid (2011) - Best Practices in State Net Metering Policies and Interconnection Procedures.

- Performed detailed analyses of best practices from NNEC. May 2012 (*Freeing the Grid* report)

What is the Freeing the Grid Report?

- *Freeing the Grid* report explains in details all the best and worst practices in PV systems.
- The report shows PV systems practices in two types: 1) *net metering* and 2) *interconnection*.
- This two type of practices are graded with different letters such as A, B, C, D, and F where A is the best and F is bad practice.
- Finally, the report provide recommendations to the States to improve their practices.

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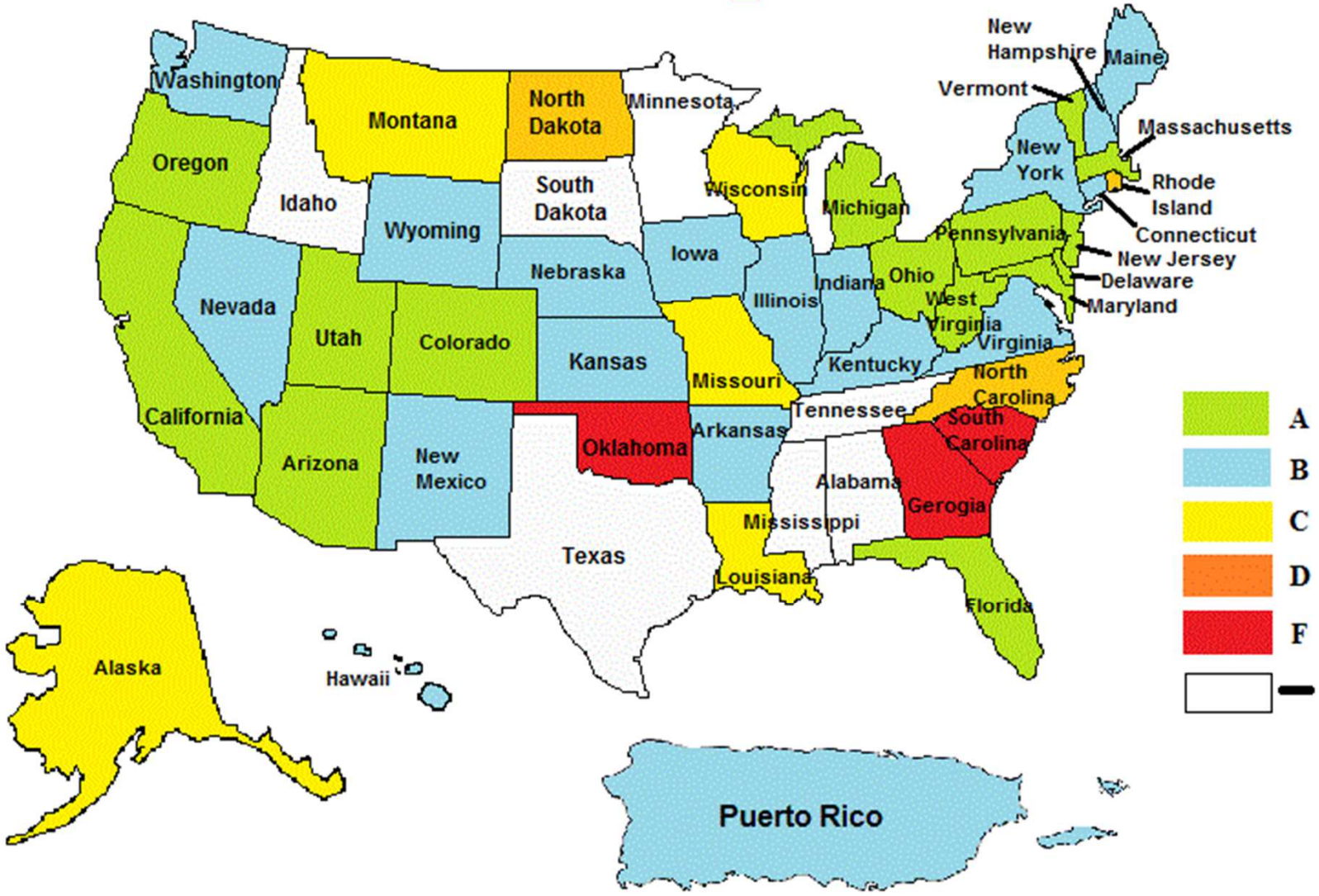
Common mistakes: net metering and interconnection

- Limiting program eligibility based on the size of individual renewable energy systems.
  - Potential solution for Puerto Rico: The size of a system should be determined only by a customer's load and by the nature of the grid (the point of interconnection).
- Capping the total combined capacity of all customer-sited generators.
  - Potential solution for Puerto Rico: Limit must be set based on engineering criteria in a way that does not affect the grid's reliability.
- Requiring unreasonable, opaque or redundant safety measures, such as an external disconnect switch.
  - Potential solution for Puerto Rico: Do not require external disconnect for inverter-based systems.

Common mistakes: net metering and interconnection

- Creating an excessively prolonged or arbitrary process for system approval.
  - Potential solution for Puerto Rico: Create a mechanism to ensure the interconnection application takes the least amount of time possible.
- Failing to promote the program to eligible customers.
  - Potential solution for Puerto Rico: Encourage rooftop PV among residential customers

Which States have the best practices? *Net Metering*



Net-Metering: Map of United States including Puerto Rico .
Courtesy of Ms. Vivian Rodriguez, UPRM ECE Undergraduate Student

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Best Net Metering Practices (for all States)

1. adopt safe harbor language to protect customers-generators from extra unanticipated fees,
2. remove systems size limitations to allow customers to meet all on-site energy needs,
3. increase overall enrollment to at least 5% of peak capacity,
4. specify that customers-generators own their RECs, and more others.

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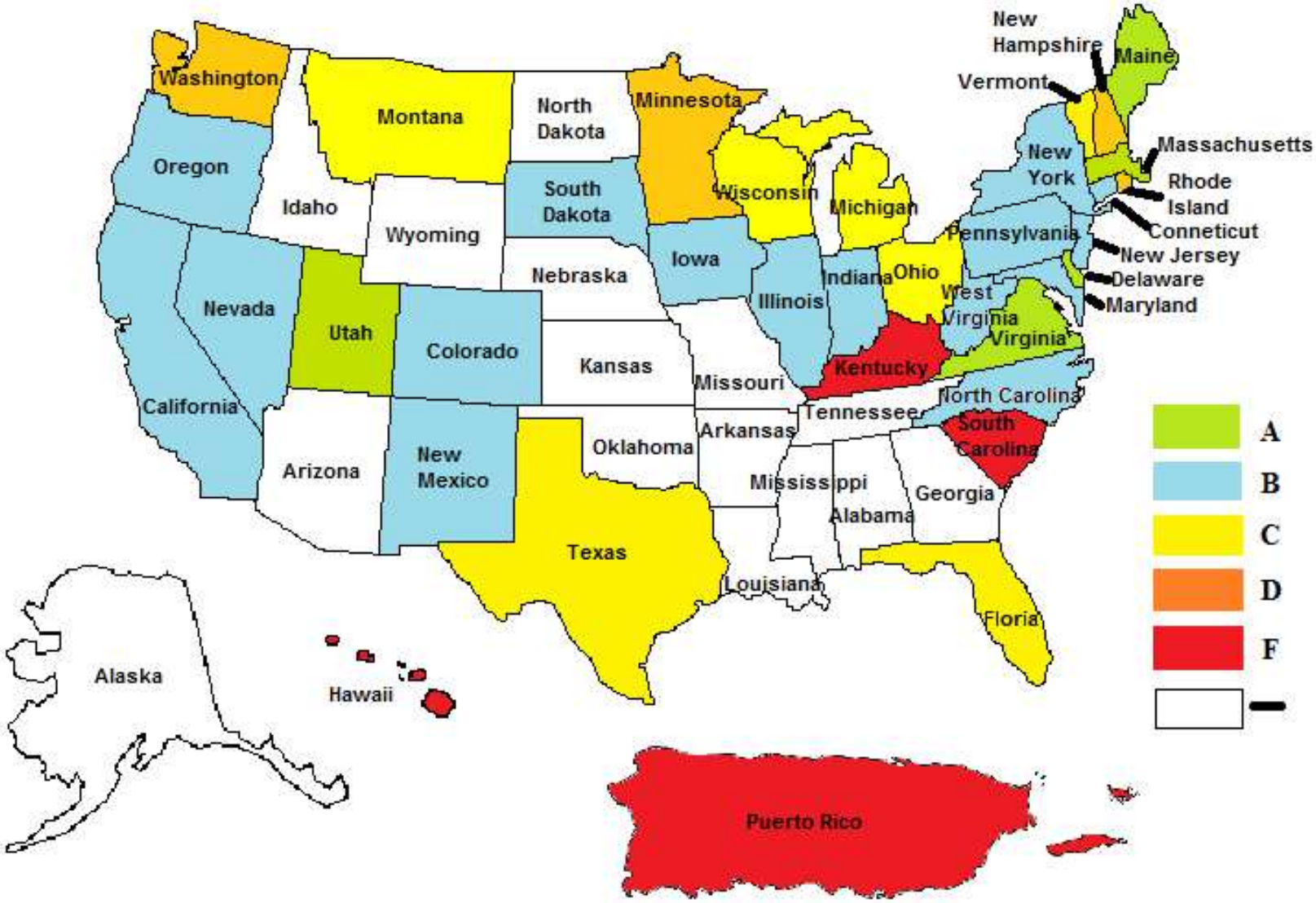
Revise net metering using *Freeing the Grid* 2010

- Allow net metering system size limits to cover large commercial and industrial customers' loads as systems at the 2 MW level are no longer uncommon.
  - Best practice: Increase size allowed to 2 MW for systems connected to 13 kV feeders
  - Near term: Preliminary study of potential users of 1-2 MW systems at 13 kV
- Do not arbitrarily limit net metering as a percent of a utility's peak demand.
  - Best practice: Change standard to include language more flexible on capacity limit
  - Near term: Determine rational limits (nowadays for simple interconnection, 15% of feeder's peak capacity, 1% of distribution demand)

Revise net metering using *Freeing the Grid* 2010

- Allow monthly carryover of excess electricity at the utility's full retail rate (unlimited).
  - Work in progress (Financing)
- Allow customer-sited generators to retain all renewable energy credits for energy they produce.
  - Work in progress (Financing)
- Protect customer-sited generators from unnecessary and burdensome red tape and special fees.
  - Best practice: Web-based system implemented will help reduce red tape.
  - Near term: Clarify all gray areas. Strict compliance with Law 114.

Which States have the best practices? *Interconnection*



Interconnection: Map of United States including Puerto Rico .
Courtesy of Ms. Vivian Rodriguez, UPRM ECE Undergraduate Student

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Best Interconnection Practices (for all States)

1. remove system size limitations to allow customers to meet all on-site energy needs,
2. provide more clarification on the dispute resolution process, prohibit the use of redundant external disconnect switch,
3. prohibit requirements for additional insurance,
4. prohibit external disconnect switch requirements for all inverter-based system.

Revise Interconnection Procedures using *Freeing the Grid*

- Set fair fees that are proportional to a project's size.
  - Best practice: No fees for processes done on-line. Begin an Island-wide effort to characterize feeders, so that number of supplementary studies are minimized (begin with 13 kV feeders?).
  - Near term: OGPE/PREAA making available a certification database (no charge for on-line copies), accept National Labs certification for new equipment with minimum evaluation (no charge or minimum). PREPA should publish details and costs of needed studies.
- Ensure that policies are transparent, uniform, detailed and public
  - Best practice: Web-based system will strive to comply with these characteristics

Revise Interconnection Procedures using *Freeing the Grid*

- Prohibit requirements for extraneous devices, such as redundant disconnect switches. Apply existing relevant technical standards, such as IEEE 1547 and UL 1741.
  - Best practice: Do not require external disconnect for all rooftop PV Systems below 300 kW
  - Near term: Do not require external disconnect for systems below 25 kW (including small commercial systems)

Revise Interconnection Procedures using *Freeing the Grid*

- Do not require additional insurance.
  - Best practice: Do not require for all residential systems and small commercial systems (XX kW)
  - Near term: Ensure the existing order is included in the PREPA regulation
- Process applications quickly; a determination should occur within a few days. Standardize and simplify forms.
  - Best practice: Web-based system will be developed to this end. Ideally everything should occur within a month (interconnection & net metering).
  - Near term: PREAA-based system, OGPE and PREPA use tools

Revise Interconnection Procedures using *Freeing the Grid*

- Screen applications by degree of complexity and adopt plug-and-play rules for residential- scale systems and expedited procedures for other systems.
- Best practice: Four levels listed for interconnection:
  - Level 1 Screening Criteria and Process for Inverter-Based Generating Facilities Not Greater than 25 kW
    - Plug-and-play rules for residential-scale systems below 10 kW
    - PREPA, OGPE and OIGPE
  - Level 2 Screening Criteria and Process for Generating Facilities Not Greater than 2 MW
  - ~~Level 3 Screening Criteria and Process for Non-Exporting Generating Facilities Not Greater than 10 MW~~
  - ~~Level 4 Process for All Other Generating Facilities~~

Source: *Model Interconnection Procedures* and *Model Net-Metering Rules, IREC*

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Agenda

9:30 am Resumen del proyecto "Rooftop Solar Challenge"

10:00 am Reformas al proceso de permisos de PV en PR

10:30 am Recomendaciones de reformas a estándares de interconexión y net metering

11:00 am Recomendaciones de reformas en financiamiento y de zonificación

12m ALMUERZO

1:00pm Estructuras para viabilizar las reformas en PV

2:00pm Discusión de acciones y seguimiento

2:30pm Evaluación de la actividad

3:00pm Clausura

Task 4.0 Financing Options

Increase distributed PV market activity in models other than self-financed ownership by enabling direct financing options, community solar programs, and/or utility-owned distributed generation and resolving legal issues around third party ownership models.

Source: Funding Opportunity Announcement DE-FOA-0000549

Costo estimado sistema PV, 1 kW

Elemento del sistema/trabajo	**($/W)**
Paneles	1.10
Invertidor	0.75
Materiales eléctricos, cajas, herrajes	0.75
Instalación	0.60
Diseño, certificación, permisos	0.55
Total estimado (sept 2012)	**3.75**

Costo estimado sistema PV>30 kW?, 3 $/W

(sept 2012)

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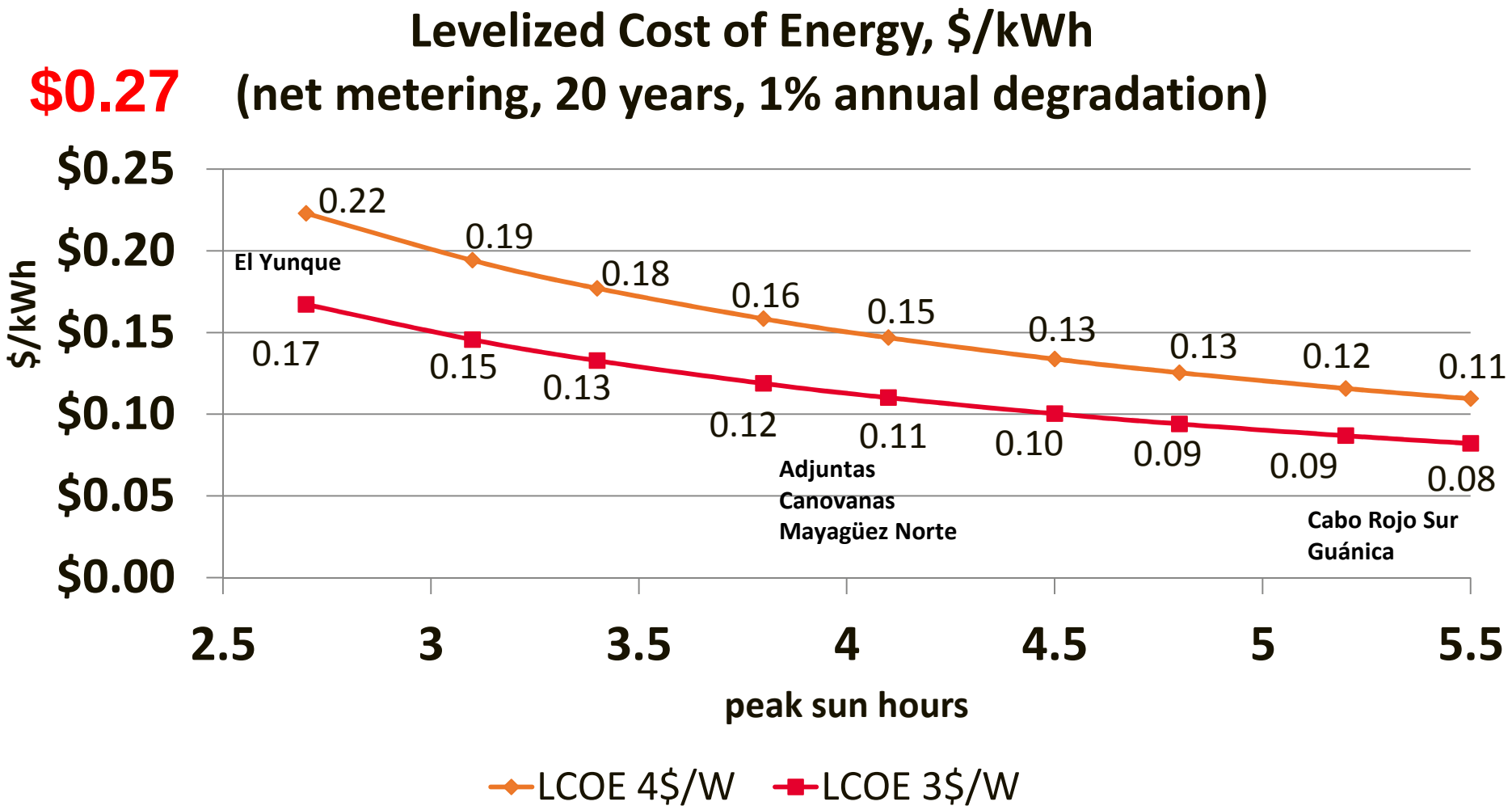
Estimated average insolation in Puerto Rico, kWh/m^2 per year

1495 → 3.4 h	1952 → 4.5 h	2408 → 5.5 h
1343 → 3.1 h	1800 → 4.1 h	2256 → 5.2 h
1191 → 2.7 h	1648 → 3.8 h	2104 → 4.8 h

Rooftop Solar Challenge to Induce Market Transformation in Puerto Rico



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Rooftop Solar Challenge to Induce Market Transformation in Puerto Rico

Y si es tan barata esa energía ¿Por que no hay sistemas PV en todos los techos? **Costo inicial (desconocimiento, trámites)**

- 500 kWh/mes con 4 horas sol pico (Mayagüez)
  - 500/30 = 16.7 kWh/dia
  - 16.7 (kWh/dia)/(4 h/dia) = 4.2 kW, digamos 4 kW
- 4 kW = 4,000 W, 4,000 W x $3.5/W = $14,000

Toyota Yaris
$16,200 a $19,400
(julio 2012)

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Rooftop Solar Challenge to Induce Market Transformation in Puerto Rico

Costo inicial – ¿como financiar un sistema PV, residencial?

- 500 kWh/mes = $135 @ $0.27/kWh (AEE)
- 500 kWh/mes = $ 65 @ $0.13/kWh (PV 4 horas/dia)
- $1,000 de pronto, $13,000 a financiar, 5.25% a 15 años son $104.5/mes – Financiamiento propio

Toyota Yaris
$16,200 a $19,400
(julio 2012)

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Rooftop Solar Challenge to Induce Market Transformation in Puerto Rico

Costo inicial – ¿como financiar un sistema PV, comercial?

- 6,000 kWh/mes = $1,800 @ $0.30/kWh (AEE)
- 6,000 kWh/mes = $ 660 @ $0.11/kWh (PV 4 horas/dia)
- 50 kW @ $3/W = $150,000
- $135,000 a financiar, (90%) 5.25% a 15 años son $1,085.23/mes – Financiamiento propio

Reacción comunidad de finanzas y seguros

Financing Options	150
Third Party Ownership (or equivalent)	90
Direct Finance Options	25
Community Solar	15
Other	20

- Coops – nuevo producto (adaptado) de financiamiento con garantía propia ¿a 10 años?
- Bancos – indican que poseen varios productos (préstamo personal …)

RIESGO = seguros, reposesión (mercado secundario),garantías de financiamiento (**clientes con haberes**), tasación, límites (medición neta), incentivos (mercado REC's, otros)

Reacción a financiamiento propio:
comunidad de finanzas y seguros - SEGUROS

Preocupación de Cooperativas	Respuesta aseguradora
instalador (garantía instalación, perforación de techos, riesgo obrero-patronal)	Seguro de contratista, registro n DACO (*ACONER está trabajando registro en DACO*)
Propiedad (dueño del equipo y sobre el equipo, "double-interest?", robo, huracán, …)	NO aseguran los equipos, prefieren asegurar la propiedad • ¿póliza vigente? – crear endoso ajustando valor • Deducible (actualmente es común 5% terremoto, 2% huracán, $250 robo o vandalismo) • Peligros nombrados

Reacción a financiamiento propio:
comunidad de finanzas y seguros - SEGUROS

Preocupación de Cooperativas	Respuesta aseguradora
Cubierta a terceros (viento tumba panel y cae en casa del vecino …)	Cubierta responsabilidad pública ("personal package")
Mantenimiento del equipo (si no produce no se paga)	Incluir el mantenimiento en el financiamiento
Tasación	Aseguradoras no piden tasación si es un añadido a cubierta de propiedad

TODAS las pólizas tienen exclusiones. Las condiciones del préstamo (incluyendo cubiertas mínimas de póliza) las pone el que financia. ¿COSTO?

Reacción a financiamiento propio:
comunidad de finanzas y seguros - SEGUROS

Posibles requisitos mínimos:

- Financiamiento al dueño de la propiedad
- Instaladores certificados, con póliza de contratista y registrados en DACO
- Equipos certificados
- Seguro de propiedad y responsabilidad pública

Reacción comunidad de finanzas: otros riesgos (reposesión, tasación, límites)

Reposesión – la falta de un mercado secundario

- Una oportunidad de negocios: ¿identificar mercado existente?, ¿re-venta fuera de PR?, ¿almacén común?, ¿manejado por cooperativa de instaladores?

Tasación – sistema PV produce $$$

- Tasación en base a “comparadas”
- Tasación ¿incluyendo el valor de la energía? **pendiente**

Límites – AEE limita clientes con medición neta

- Revisión ley medición neta, revisión tarifa básica **pendiente**

Reacción comunidad de finanzas: otros garantías (clientes con haberes), incentivos

Financing Options	150
Third Party Ownership (or equivalent)	90
Direct Finance Options	25
Community Solar	15
Other	20

Construir una comunidad solar de financiamiento

- Identificar posibles clientes (miembros de la coop, negocios)
- Llamado a Propuestas (CFP) a instaladores ($/W, requisitos mínimos (garantías, seguros, equipos),)
- Negociar la venta de REC's (AEE, AES, ecoelectrica, otro mercado)
- Usar los beneficios de venta de RECs y economía de escala para viabilizar un financiamiento atractivo

Comunidades solares

- **¿Auspiciado por la AEE?**, la corporación pública construye y maneja un proyecto en el que participan, voluntariamente, los abonados. (15% de los ciudadanos de los EEUU reciben electricidad de una corporación pública)

- **Una entidad con propósito especial (SPE)**, desarrolladores privados desarrollan un proyecto solar comunitario.

  ✓ De tipo “compra consertada” para beneficiarse por economías de escala y venta de RECs
  ✓ Todavía con financiamiento individual

- **Sin fines de lucro,** donantes contribuyen para lograr una instalación para una entidad sin fines de lucro.

Financiamiento de terceros

- **Desarrollador de Servicios Solares,** una empresa privada que diseña, financia, instala, mantiene, opera y vende energía solar en los predios del cliente.

  Existe un acuerdo de compra de energía durante un período de tiempo largo (10 – 20 años)

  No hay costo de instalación al cliente, quizás tiene la opción de comprar el sistema al final del contrato.

  ✓ Quizás la Banca industrial se interese
  ✓ ¿interés de las Coop?

Financiamiento de terceros ó comunidad solar

- **Desarrollo de finca solar (el techo puede ser de uso común, como una cancha o del Municipio, como un cementerio)**

  - ✓ Los clientes compran “parcelas” solares (2 kW, 5 kW, 20 kW)
  - ✓ **Hace falta cambios en ley y reglamentos de interconexión y medición neta (medición neta virtual)**
  - ✓ El financiamiento puede ser comunitario o del desarrollador y luego individual (como las viviendas; casa o apartamentos) o público (programas PACE)
  - ✓ Los Municipios Autónomos son los más preparados para iniciar programas PACE (y la AEE …)

Financing Mechanisms Recap

Financing Option	Cash	Home Equity Loan	Other Loan	Leasing	PPA
Upfront Cost	High	Low	Low	Low	Low
System's Owner	Homeowner	Homeowner	Homeowner	Homeowner	Homeowner
Ongoing payments	None	Yes	Yes	Yes	Yes
System's maintenance	Homeowner	Homeowner	Homeowner	Solar Cooperative	Solar Cooperative
Federal Credit	Yes	Yes	Yes	No	No
Tax deductions	N/A	Interest on loan	No	N/A	N/A
Term	N/A	5-30 years	Up to 20 years	Up to 20 years	10-20 years

Table: Financing Options (Summary); Adapted from [1]

Financing Modeling: Results

Financing Metric	Residential and Commercial PV System's Financing Structures			
	Residential		Solar Community (Per Homeowner)	
	Personal Loan	*Third Party Lease**	*Personal Loan*	*Third Party Lease**
Payback Period	8	N/A (Down Payment=0)	6	N/A (Down Payment=0)
Approximate Monthly Electric Bill	$165	$3**	$165	$3**
Approximate Monthly Loan Payment	$114	$132	$82	$132
Approximate Monthly Savings (During Loan)	$51	$33	$83	$33
Approximate Monthly Savings (After Loan)	$165	$33	$165	$33

* Third party Leasing includes a yearly insurance fee of .5% of the total installed PV system cost

** Fixed residential customers fee in Puerto Rico

Key References

- Solar Photovoltaic Financing: Residential Sector Deployment, NREL
- "The Resale Market Value of Residential Solar Photovoltaics: A summary of literature and insight into current value perceptions"
- Technology Roadmap Solar photovoltaic energy, NREL
- Solar PV Project Financing: Regulatory and Legislative Challenges for Third-Party PPA System Owners, NREL

Action Areas

PLANNING AND ZONING

Remove siting restrictions and incorporate favorable provisions in state and local codes and land use policies in every participating jurisdiction to maximize PV siting options.

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Source: Funding Opportunity Announcement DE-FOA-0000549

Solar Rights

- NO state or local law, or fixed process, that provides for solar easements to protect access to sunlight (solar access) and there is no enforcement mechanism to support solar rights.
- There is NO state or local process for a PV system to be registered in order to protect solar access since there is no law provision recognizing said solar rights. So far there have been no cases argued in a Court of Law regarding solar rights.

Solar Rights

- "Servidumbre de Luces y Vista"
- No one has conducted and published a review of any local ordinances to determine if there might be barriers to solar rights provisions and make recommendations for updating, if necessary, any such ordinances.

Solar Rights Proposal

- We will use Solar Rights Acts of New Mexico, Wyoming and other locations to develop models and amendments to said laws, and then write a proposal for a Solar Rights Act for Puerto Rico. Our goal will be to avoid ambiguous statutory language that may result in litigation that discourages the development of domestic solar energy. The extent and limitations of Solar Rights will be clear to avoid conflicts between solar users and adjacent property owners.

2009 International Energy Conservation Code of Puerto Rico

- *Section 406 – Renewable Energy Systems* of this Code provides some construction standards for new construction to facilitate future solar deployments.
  - *A* 2 pole, 60A breaker for connection of the future renewable source of energy, a 5"x5"x2 ½" junction box connected to the main meter box by a 1" PVC empty conduit, a 1" PVC empty conduit from the 5"x5"x2 ½" junction box to roof level at location where renewal energy system could be located. Low income housing units are not required to have these provisions.

Code Review Proposal

- Study, and encourage construction standards for new construction to reduce barriers to solar deployment.
- Use of east-west street and building orientation, other solar-ready construction guidelines, solar easements for new construction and others adopted in other jurisdiction to identify best practices.
- Recommendations for rooftop layout.
  - "Fachada al cielo" (Dr. Abruña)
- Best practices for these standards and propose a plan to allow all or the best suitable combination.

Other Proposals

- Review local ordinances to identify any potential barriers to maximize solar use
- Revision of the Planning Board's limit for all PV rooftop mounted systems (1 MW)
- Develop Preferred PV Zones – (suggested by Gerardo Cosme, PE).
  - Identify focus zones for increased penetration of PV: Connection to 13 kV, public buildings, government installations were billing is difficult. Economically-strained communities.
- Issues in historic zones
- Could replicate in regions with similar climate.

Rooftop Solar Challenge to Induce Market Transformation in Puerto Rico

- Contact Info:
  - maviles@aae.gobierno.pr
    - Mariely Aviles Rios, Esq.
  - PuertoRicoSolar2012@hotmail.com
    - Efrain O'Neill – Project's Principal Investigator

- We invite you to visit the following websites for more info:
  - www.eere.energy.gov/solar/sunshot/rooftop_challenge.html
  - **http://prsolar.ece.uprm.edu/**

Agenda

9:30 am	Resumen del proyecto "Rooftop Solar Challenge"
10:00 am	Reformas al proceso de permisos de PV en PR
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11:15 am	Recomendaciones de reformas en financiamiento y de zonificación
12m	ALMUERZO
1:00pm	**Estructuras para viabilizar las reformas en PV**
2:00pm	**Discusión de acciones y seguimiento**
2:30pm	**Evaluación de la actividad**
3:00pm	**Clausura**

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Why are we here?

- Stakeholder summits (one in the eastern side of the Island, and another in the western side).
- Include not only industry, government and other typical market participants but also community and environmental groups to ensure a strong base support for the policy changes.
- Ownership of the rooftop PV framework among stakeholders
- Create trust and transparency.
- Island-wide "PV community" to ease the transition towards implementation

Sharing Success Emerging Approaches to Efficient Rooftop Solar Permitting (IREC)

- Realistic and effective ways to improve solar permitting
- ***The responsibility for change should be shared***
  - Utility: Processes and requirements
  - PV Industry: complete and accurate applications
- ***Need commitment from both groups to be effective.***

Sharing Success Emerging Approaches to Efficient Rooftop Solar Permitting (IREC)

- Changes to permitting policies should benefit all involved
  - Understand PREPA's operations and services
  - Understand PV industry's challenges
- The economic conditions faced by both groups are critical
- ***The best solutions are those that benefit the broader community.***

Rules of Engagement

- Development of best practices
  - Aspirational: a vision of where the rooftop PV market could be
- Practical considerations
  - Identify low hanging fruit, e.g., clarifications of grey areas
- Respectful dialogue
  - We will not agree on everything, but at least, try to listen and understand the other sector's perspective
- What's the value-added for my sector?

Stakeholder engagement is vital

- Dynamic, non-linear process
- Need multi-sector collaborations: Government, industry, NGOs, communities.
  - From distrust to a lasting commitment with PR's social, environmental and economic welfare and a different energy future

Stakeholder engagement is vital

- Changes needed to improve Rooftop PV market in PR require a multi-sector approach
  - Puerto Rico Solar: PV Community
- Stakeholder references
  - Peter Senge, *The Necessary Revolution: How Individuals and Organizations are Working Together to Create a Sustainable World*, Doubleday, 2008.
  - Venkat Ramaswamy, *The Power of Co-Creation*, Free Press, 2010.

Stakeholder Engagement

- Peter Senge argues that the deep problems we face today are the result of a way of thinking whose time has passed or is near its end.
- Do we protect the ways of the past or join in creating a different future?
- Seeing the *deeper pattern that connects many different problems* is crucial if we are to move beyond piecemeal reactions and create lasting change for PV systems.

Stakeholder Engagement

- Many collaborative initiatives can be frustrating because they produce lots of talk and little action.
- *Groups might not have exactly the same set of objectives, but there was enough of a common ground to work together*
- We have been following this, with a clear focus (rooftop PV under 300 kW).

Stakeholder Engagement

- Dr. Ramaswamy argues in favor of co-creation, developing systems, products or services through collaboration
- *Co-creation involves democratization and decentralization of value-creation*, moving it from concentration inside a few to interactions with stakeholders.
- He describes "social eco-systems": environments with free flow of information, which engages people better and enable richer, fuller stakeholder interactions than traditional outreach strategies.

Stakeholder Engagement

- For our project, the use of focus and small group meetings are the key engagement platforms supported by electronic and phone conversations with key stakeholders. It is our objective to expand those engagement platforms in ***the creation of a PV Community in Puerto Rico.***

Solar PV Facts

- "The high upfront cost of residential and commercial PV systems are mostly due to non-technical factors" –NREL
- The break-even price (PV_{Rate}=$Utility_{Rate}$) of residential PV varies by more than a factor of 10 in the United States, mostly due by the differences in incentives and financing structures
- *Puerto Rico is already in "grid-parity"*
- *We need a strong, reliable electric grid*

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AEE	2006	2007	2008	2009	2010	2011
Capacidad instalada (MW)	5,388	5,388	5,402	5,898	5,898	5,898
Demanda Pico (MW)	3,685	3,604	3,546	3,351	3,404	3,406
Energía neta generada (MWh)	23,754	24,062	22,924	21,763	22,559	21,639
Energía perdida (MWh)	3,134	3,390	3,322	3,247	3,324	3,138
Energía vendida (MWh)	20,620	20,672	19,602	18,516	19,235	18,501
Cobrado tarifa básica (Millones)	$1,166	$1,184	$1,132	$1,072	$1,121	$1,087
Compra de combustible (M)	$1,868	$1,778	$2,473	$2,162	$2,256	$2,579
Compra de energía (M)	$674	$708.906	$745.753	$752.61	$777.52	$740.26
Ingresos Totales (M)	$3,732	$3,687	$4,369	$4,007	$4,173	$4,411
Gastos totales (M)	$3,034	$3,015	$3,688	$3,378	$3,427	$3,705
Ingresos netos (M)	$698	$672	$681	$629	$746	$706
Bonos: Intereses + Principal (M)	$449	$455	$420	$435	$398	$480

PR's "Roof Resource"

- Residential Area→180,814,184m^2
- Commercial→ 7,300,000m^2
- Industrial→ 2,702,545.45m^2
- We have an excellent solar resource, there is a need to incorporate explicit favorable provisions in state and local codes regarding use of our Solar Resource.

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Time for change, time for collaborations

- Dominant energy model
  - Need to re-think ***OUR*** electric system and consumption
  - Envision a new grid and a new way to design and operate it
- The Sun is a different energy source
  - Renewable is not the same as sustainable

Time for change, time for collaborations

- Collaborations among sectors: government, industrial, commercial and residential
  - Going from an adversarial to a collaborative relationship
  - Going from mutual distrust, to a serious and lasting commitment for the public good, for the social, environmental and economic welfare of Puerto Rico.

Puerto Rico Solar

- Región Oeste
  - Efraín O'Neill (UPR-Mayaguez)
  - Ernesto Rivera (presidente ACONER)

- Región Este
  - Fernando Abruña (Abruña & Musgrave)
  - Jose Maeso (PREC)

Comunidad Puerto Rico Solar

- Iniciar un diálogo multi-sectorial, que sea regional y a nivel de Puerto Rico, para maximizar el uso de energía fotovoltaica en techos en Puerto Rico a nivel residencial y comercial (hasta 300 kW)
- Coordinadores por región para FACILITAR el intercambio de ideas y las acciones concretas para apoyar y mover las recomendaciones de este proyecto

Comunidad Puerto Rico Solar

- Región Oeste
  - Efraín O'Neill (UPR-Mayaguez)
  - Ernesto Rivera (presidente ACONER)
- Región Este
  - Fernando Abruña (Abruña & Musgrave)
  - Jose Maeso (PREC)

Agenda

9:30 am	Resumen del proyecto "Rooftop Solar Challenge"
10:00 am	Reformas al proceso de permisos de PV en PR
10:30 am	Recomendaciones de reformas a estándares de interconexión y net metering
11:15 am	Recomendaciones de reformas en financiamiento y de zonificación
12m	ALMUERZO
1:00pm	Estructuras para viabilizar las reformas en PV
2:00pm	**Discusión de acciones y seguimiento**
2:30pm	**Evaluación de la actividad**
3:00pm	**Clausura**

GRACIAS

- Equipo IRISE: Maribel Feliciano, Evelyn Guzman, Soliris Maldonado, Victor Asencio.
- Estudiantes Graduados: Armando Figueroa, Israel Ramírez, Luis de Jesús, Ezequiel Vassallo.
- Estudiantes Subgraduados: colaboradores: Vivian Rodríguez, Kidany Berrios, Arnold X. Irizarry.
- Webmaster – Luis Lugo

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SunShot U.S. Department of Energy

Rooftop Solar Challenge to Induce Market Transformation in Puerto Rico

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    - Mariely Aviles Rios
  - PuertoRicoSolar2012@hotmail.com
    - Efrain O'Neill – Project's Principal Investigator

- We invite you to visit the following websites for more info:
  - www.eere.energy.gov/solar/sunshot/rooftop_challenge.html
  - **http://prsolar.ece.uprm.edu/**