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)

# Rincón, Thursday October 18, 2012. Caguas, Tuesday October 30, 2012. UPRM Team: Efraín O'Neill-Carrillo, Agustín Irizarry, Eduardo Ortiz Students: Armando Figueroa, Israel Ramírez, Luis de Jesús, Vivian Rodríguez, Ezequiel Vassallo, Arnold X. Irizarry, Kidany Berrios.



### 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
- II:15 am Recomendaciones de reformas en financiamiento y de zonificación
- I 2m ALMUERZO
- I: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**



DC 🚳 AC







### Medida Neta





Autor: Dr. Gerson Beauchamp

### 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)



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



#### Average Insolation in Puerto Rico, kWh/m<sup>2</sup> per year



# **Population Distribution**

- ~50% → >18.5 MJ/m<sup>2</sup>/day
- ~20% → 17-18.5 MJ/m<sup>2</sup>/day
- $\sim 30\% \rightarrow <17 \text{ MJ/m}^2/\text{day}$



# Estimate of potential electric energy residential contribution



Design of PV Systems using K<sub>t</sub> Distributions (accounting for sun variations to reduce impact to the power grid)



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

# PR's "Roof Resource"

- Residential Area  $\rightarrow$  180,814,184m<sup>2</sup>
- Commercial  $\rightarrow$  7,300,000m<sup>2</sup>
- Industrial → 2,702,545.45m<sup>2</sup>



### **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



#### Voltage Profiles Along the 4.16 KV Feeder When Peak Load is Evenly Distributed, Showing the Best Voltage Obtained for Each Location



- 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.

SunShot U.S. Department of Energy M. Irizarry Silvestrini, Masters Thesis, May 2011, University of Puerto Rico – Mayaguez Campus



#### Voltage Profiles Along the 13.2 KV Feeder When Peak Load is Evenly Distributed, Showing the Best Voltage Obtained for Each Location

- 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.

SunShot

KW Losse	Losses in the 13.2 KV Feeder with Load Distributed Evenly - Peak Demand					
No DG:	_			357		
DG Penetration	End	KV Section 4_5	V Losses Der Lateral 3	pending on E Lateral 2	OG Location 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

nt of Energy 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)	<u>3,685</u>	3,604	3,546	3,351	3,404	3,406
Energía neta generada (MWh)	23,754	<u>24,062</u>	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	<u>19,602</u>	<u>18,516</u>	19,235	<u>18,501</u>
Cobrado tarifa básica (Millones)	\$1,166	\$1,184	<u>\$1,132</u>	<u>\$1,072</u>	\$1,121	<u>\$1,087</u>
Compra de combustible (M)	\$1,868	\$1,778	<u>\$2,473</u>	<u>\$2,162</u>	\$2,256	<u>\$2,579</u>
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	<u>\$4,411</u>
Gastos totales (M)	\$3,034	\$3 <i>,</i> 015	\$3,688	\$3,378	\$3,427	<u>\$3,705</u>
Ingresos netos (M)	\$698	\$672	\$681	\$629	\$746	<u>\$706</u>
Bonos: Intereses + Principal (M)	\$449	\$455	\$420	\$435	\$398	<u>\$480</u>

### **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.



### 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







### **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



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

### 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	Min.	Avg.	Max.
Category			
Residential (up	1	2	3
to 5 kWp)			
Roof-Mounted			
Commercial	2	4	6
and Industrial			
(up to 50 kWp)			
Ground-	6	25	46
Mounted (up			
to 5 MWp)	Source: PV Legal 2	2011b. PV Legal 201	1g. PV Legal 2011h



### 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. SunShot U.S. Department of Energy 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-Fromthe-DOE-on-Solars-Future



# Why we're here: Big Picture SunShot Initiative ~6¢/kWh without subsidy Price 75% cost reduction by the end of the decade Powered by SunShot Source: DOE U.S. Department of Energy

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### **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



Source: Funding Opportunity Announcement DE-FOA-0000549 27

# Market Evaluation Points (cntd)

Interconnection Standard	100
Net Metering Standard	100
Financing Options	150
Third Party Ownership (or equiva	alent) 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
SunShot	Source: Funding Opportunity Annou DE-FOA-0000549

### Timeline





### 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 I.0 Stakeholder Engagement

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

**PV Summits October 2012:** 



Rincon (18) and Caguas (30)

# 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 valuecreation, 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 <u>the creation of a</u> <u>PV Community in Puerto Rico.</u>



### 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
- <u>Need commitment from both groups to be</u> <u>effective.</u>



### 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
  - <u>http://prsolar.ece.uprm.edu/</u>
- Email
  - PuertoRicoSolar2012@hotmail.com



# Task 2.0 Web-based system to improve processes

I. 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.



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

### **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.





### **Initial Tasks**

User logs in to the website.





### **Interface Model**

ROOFTOP S	OLAR CHALLENGE		
CaseID 001 Información del Cliente: Nombre: Israel J. Ramirez Sanchez Teléfono (día): (787) 265-2859 Tele Email: israel.ramirez@upr.edu	Número de Cuenta AEE: 02546512 éfono (noche): (787) 206-7301 Fax: (787) 265-2859	Relación del Cliente con la propiedad:	Alquiler Dueño Co-dueño Alquiler
Mayaguez PR 00680 Tipo de Cliente: Residencial Número de Proyecto de ARPE 25146 TipoDeInterconexiónSolicitada Oper. Relación del Cliente con la propiedad:	Mayaguez Puerto Rico         Número del Medidor:         145656         ación en Paralelo v         Alquiler	<ul> <li>If the Relation Client with the is set as own for the owned information (</li> </ul>	Otro: nship of the he property er, it will ask r (see next



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_	Nuevo	Caso						
	Nombre:		Nur	nero de Cuenta AEE:				
	Telefono (dia):	No.	Telefono (noche):					
	Fax: Direction Postal:	Email:	-					
	Direccion Postal.							
	Direccion fisica:							
	Tipo de Cliente:		-					
	Numero de Proyecto	ARPE:						
	Numero de Medido	r:						
	Tipo de Interconexi	on Solicitada:		•				
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#### User enters new case information.



# SharePoint site (web app)

PREAA, PREPA and OGPE will have accounts

in the SharePoint Site.

ithenticatio	on Required	
2	Enter username and password for http://	/localho
Jser Name:	OGPE	
Password:		

- 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



# **Financing options**

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



#### Equipment Yes OGPE Certifies Send to PREPA Are Equipment Certified? the equpment? User is taken to Yes Database of Certified Equipment OGPE Are Equipment (Equipment Certified? Else, user is taken to a screen certification) 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







#### 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 0068	0				

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 online
- 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

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Información del solicita	inte	Tipo de Tecnología	
Nombre:		Fotovoltaico	$\bigcirc$
		Tipo de Generador:	
# de cuenta AEE		Sincrónico	
Teléfono:			
Fax:		Basado en Inversor	
Email:		Otro:	
Dirección Postal			
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#### 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.



### **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: I) 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.



# 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.

SunShot U.S. Department of Energy Courtesy of Ms. Vivian Rodriguez, UPRM ECE Undergraduate Student

# Best Net Metering Practices (for all States)

- 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.



# 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 I-2 MW systems at I3 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 .

SunShot Courtesy of Ms. Vivian Rodriguez, UPRM ECE Undergraduate Student

# Best Interconnection Practices (for all States)

- I. 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 plugand-play rules for residential- scale systems and expedited procedures for other systems.
- Best practice: Four levels listed for interconnection:
  - Level I 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,



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



# Costo estimado sistema PV, 1 kW

Elemento del sistema/trabajo	( <b>\$/W</b> )
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)



#### Estimated average insolation in Puerto Rico, kWh/m<sup>2</sup> per year





→ LCOE 4\$/W → LCOE 3\$/W



- 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
- $4 \text{ kW} = 4,000 \text{ W}, 4,000 \text{ W} \times \$3.5/\text{W} = \$14,000 \text{ W}$



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





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)





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,)	<ul> <li>NO aseguran los equipos, prefieren asegurar la propiedad</li> <li>¿póliza vigente? – crear endoso ajustando valor</li> <li>Deducible (actualmente es común 5% terremoto, 2% huracán, \$250 robo o vandalismo)</li> <li>Peligros nombrados</li> </ul>



#### 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
ſ	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

Option		Equity Loan	Other Loan	<u>Leasing</u>	<u>PPA</u>
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
<i>Term</i>	N/A Table: Financin	5-30 years <del>g Options (Summar</del>	Up to 20 years <del>y); Adapted from [1</del>	Up to 20 years	10-20 years

# Financing Modeling: Results

	Residential and Commercial PV System's Financing Structures			
Financing Metric	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.



# 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 (I 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.



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  - <u>PuertoRicoSolar2012@hotmail.com</u>
    - 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
  - <u>http://prsolar.ece.uprm.edu/</u>



SunShot U.S. Department of Energy

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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
- <u>Need commitment from both groups to be</u> <u>effective.</u>



#### 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.


- 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).



- 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.



 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 <u>the creation of a PV</u> <u>Community in Puerto Rico.</u>



#### Solar PV Facts

- "The high upfront cost of residential and commercial PV systems are mostly due to <u>non-technical</u> factors" –NREL
- The break-even price (PV<sub>Rate</sub>=Utility<sub>Rate</sub>) 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



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)	<u>3,685</u>	3,604	3,546	3,351	3,404	3,406
Energía neta generada (GWh)	23,754	<u>24,062</u>	22,924	21,763	22,559	21,639
Energía perdida (GWh)	3,134	3,390	3,322	3,247	3,324	3,138
Energía vendida (GWh)	20,620	20,672	<u>19,602</u>	<u>18,516</u>	19,235	<u>18,501</u>
Cobrado tarifa básica (Millones)	\$1,166	\$1,184	<u>\$1,132</u>	<u>\$1,072</u>	\$1,121	<u>\$1,087</u>
Compra de combustible (M)	\$1,868	\$1,778	<u>\$2,473</u>	<u>\$2,162</u>	\$2,256	<u>\$2,579</u>
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	<u>\$4,411</u>
Gastos totales (M)	\$3,034	\$3,015	\$3,688	\$3,378	\$3,427	<u>\$3,705</u>
Ingresos netos (M)	\$698	\$672	\$681	\$629	\$746	<u>\$706</u>
Bonos: Intereses + Principal (M)	\$449	\$455	\$420	\$435	\$398	<u>\$480</u>

# PR's "Roof Resource"

- Residential Area  $\rightarrow$  180,814,184m<sup>2</sup>
- Commercial  $\rightarrow$  7,300,000m<sup>2</sup>
- Industrial  $\rightarrow$  2,702,545.45m<sup>2</sup>
- 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.



#### Time for change, time for collaborations

- Dominant energy model
  - -Need to re-think <u>OUR</u> 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**

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- Efraín O'Neill (UPR-Mayaguez)
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# 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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#### Rooftop Solar Challenge to Induce Market Transformation in Puerto Rico

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    - Efrain O'Neill Project's Principal Investigator
- We invite you to visit the following websites for more info:
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  - <u>http://prsolar.ece.uprm.edu/</u>



SunShot U.S. Department of Energy