Feasibility Study of Economics and Performance of Solar Photovoltaics In Puerto Rico

A Study Prepared in Partnership with the Environmental Protection Agency
For the RE-Powering America's Land Initiative: Siting Renewable Energy on Potentially Contaminated Land and Mine Sites
&
For the Department of Energy's Technical Assistance Program

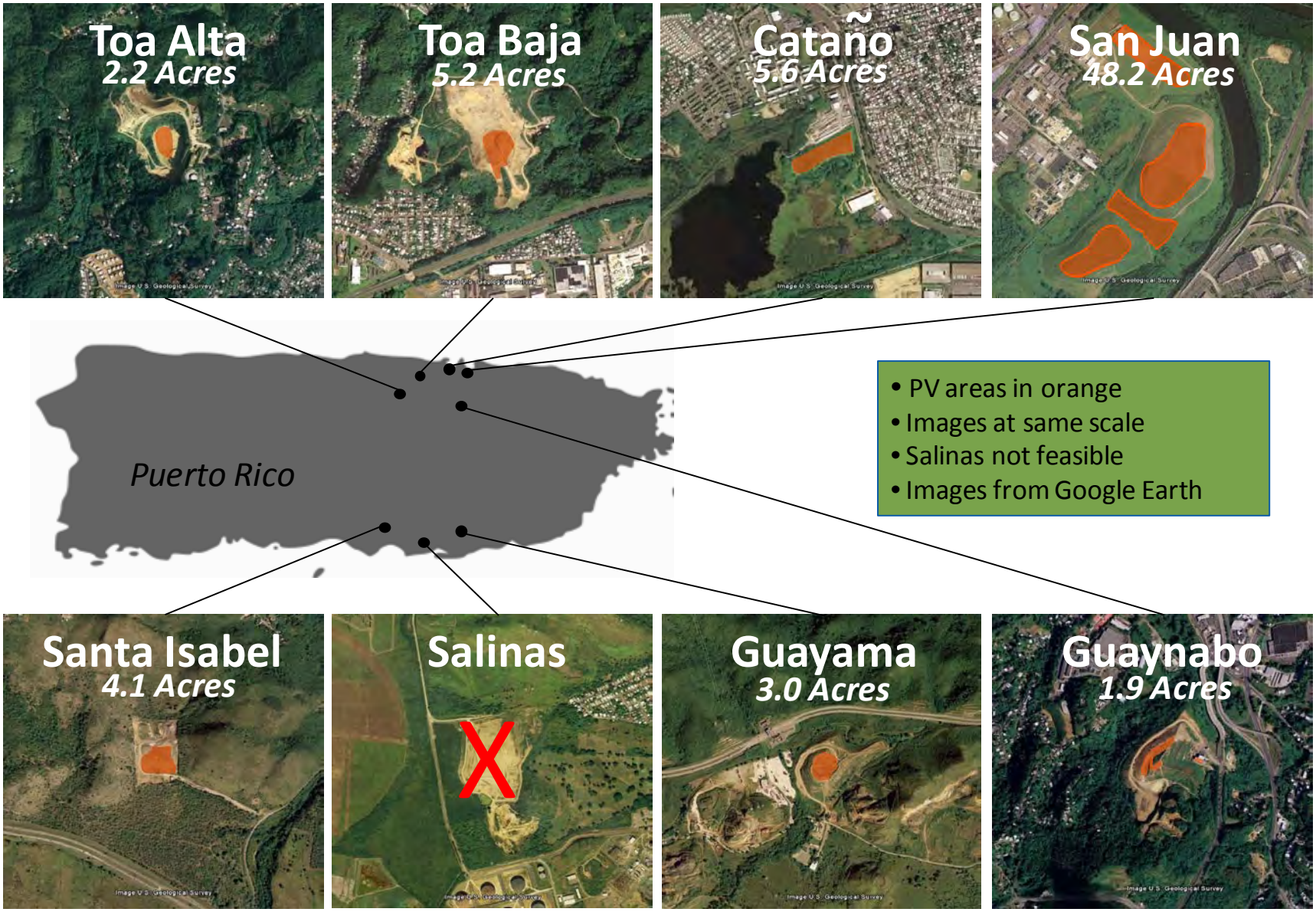
Gail Mosey, NREL
Jimmy Salasovich, NREL

November 1st, 2011

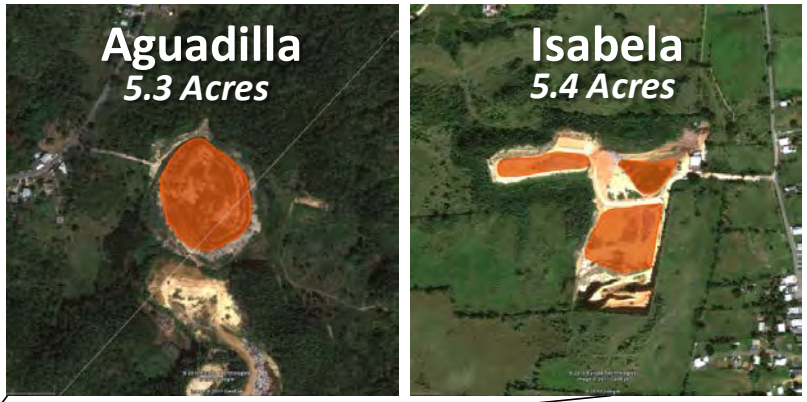
Background

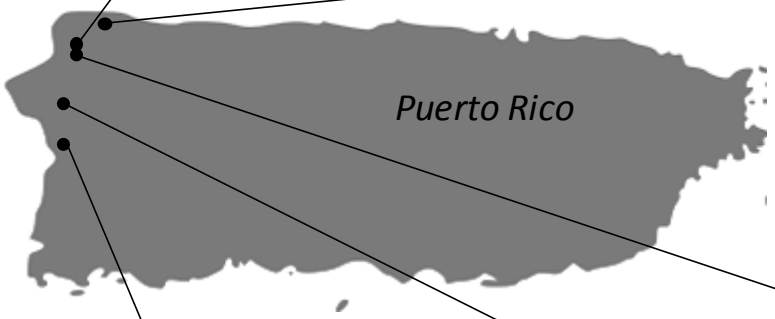
- Gail Mosey – NREL's project lead
- Jimmy Salasovich – NREL's technical lead
- NREL's effort was funded through: EPA's RE-Powering America's Lands Initiative and DOE's Technical Assistance Program (TAP)
- NREL held three site visits
- Two feasibility study reports of solar on landfills in Puerto Rico now available for download at NREL.gov

First Site Visit



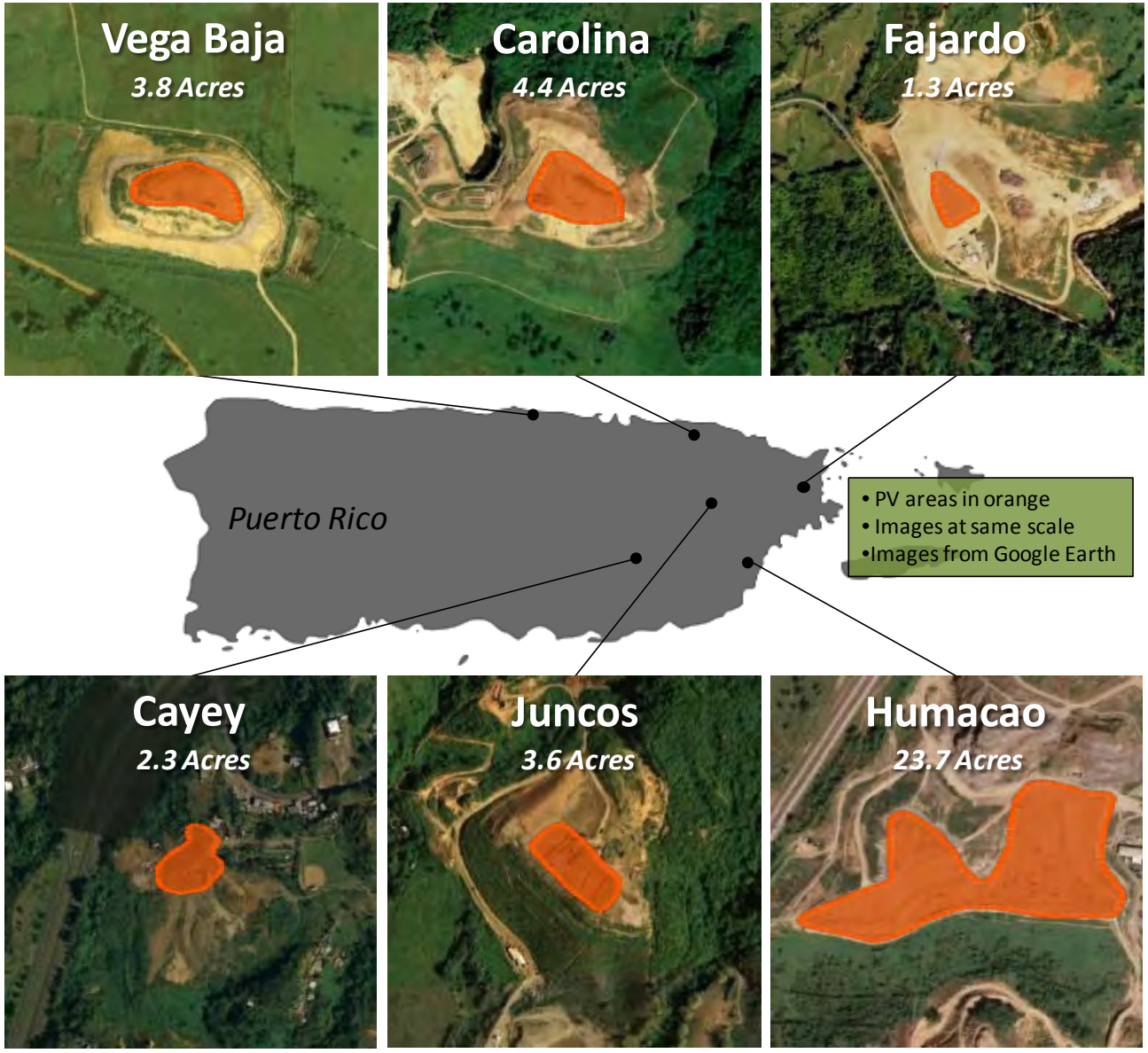
Second Site Visit



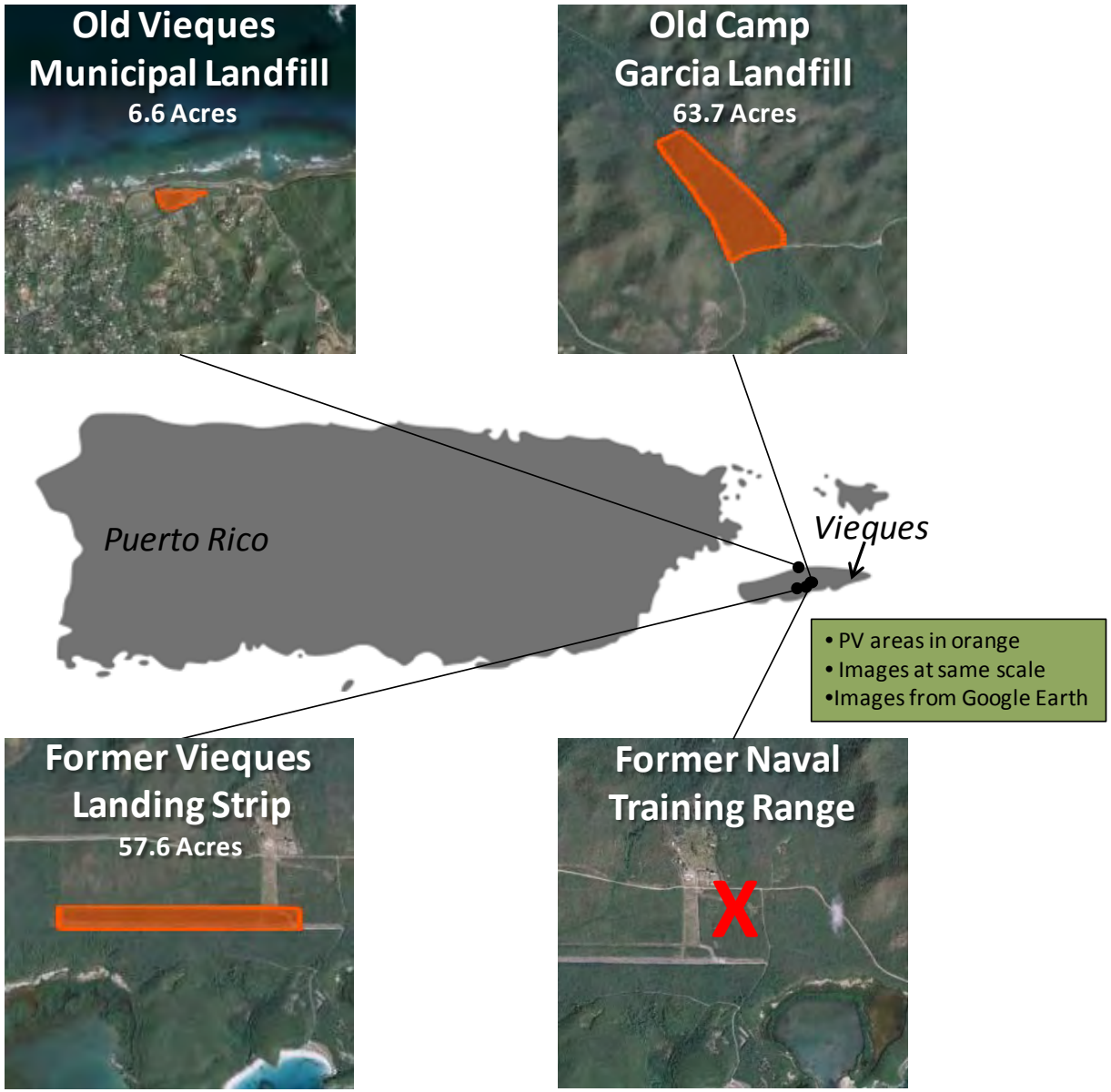


- PV areas in orange
- Images at same scale
- Images from Google Earth

Third Site Visit



‘Desktop’ Analysis for Vieques



Photovoltaics

- Photovoltaics (PV) are semiconductor devices
- PV panels convert sunlight directly into electricity
  - No moving parts
  - No noise
  - No pollution

Ground Mounted PV Suitable for Landfills

Amorphous (Thin Film)

Ballasted Fixed Tilt

- Lower first cost
- Lower O&M cost
- 6-8% efficient
- Lower energy output
- Panels can be flexible

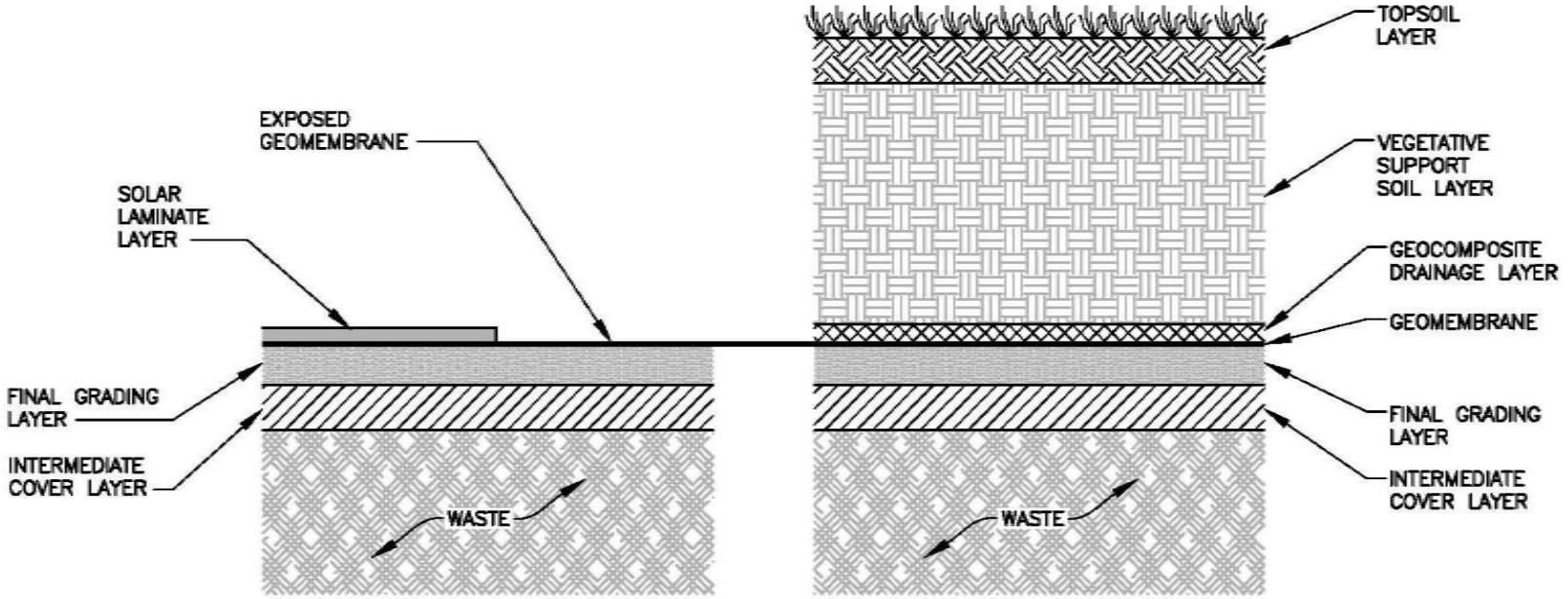
Crystalline-Silicon

Ballasted Single-Axis Tracking

- Higher first cost
- Higher O&M cost
- 17% efficient
- Higher energy output

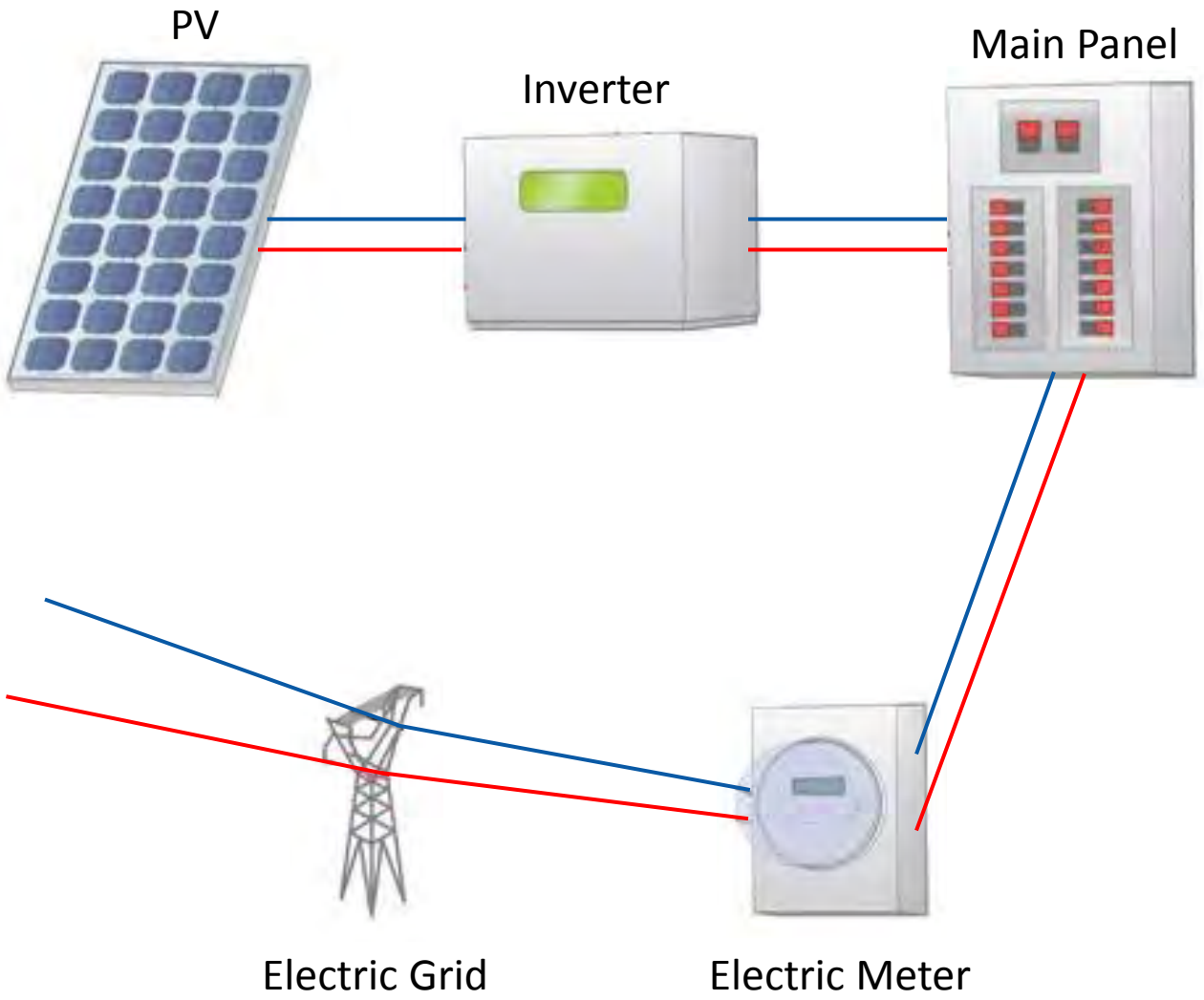
PV Integrated into the Landfill Cap

Composite system that integrates both flexible photovoltaic laminates with an enhanced geomembrane liner system to create a dual-purpose closure system



**Not investigated for this study*

Grid Tied PV System Components



Considerations for Siting PV on Landfills

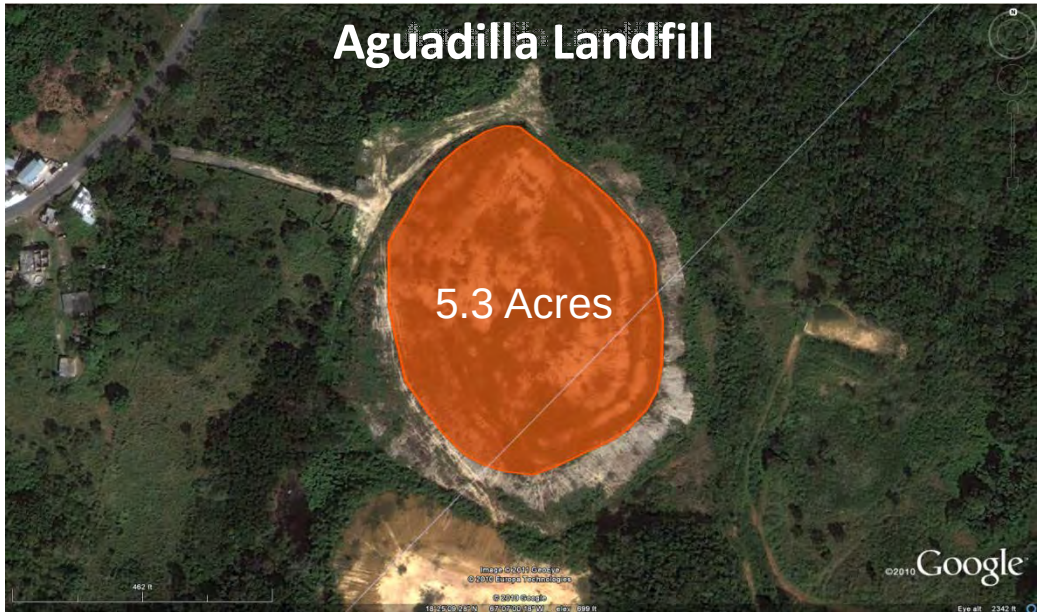
- ✓ Closure status
- ✓ Cap characteristics
  - Type
  - Age
  - Institutional controls
  - Long-term maintenance requirements
- ✓ Slope
- ✓ Settlement
- ✓ Erosion control and vegetative cover
- ✓ Control of leachate and gas
- ✓ Stormwater management
- ✓ Solar resource availability
- ✓ Acreage of the site
- ✓ Distance to graded roads
- ✓ Distance to transmission lines
- ✓ Interconnection
- ✓ Environmental review and permitting
- ✓ Economic factors

Representative Landfill for PV - Aguadilla

Aguadilla PV System – Crystalline Fixed Tilt

						System Cost Estimates with Incentives ($)		Simple Payback Estimates (years)	
Description	**Potential System Size (kW)**	**Annual Energy Output (kWh)**	**Number of Households Powered***	**Annual Cost Savings ($)**	**Annual O&M ($)**	**Assuming $3.50/Watt**	**Assuming $7.00/Watt**	**Assuming $3.50/Watt**	**Assuming $7.00/Watt**
Aguadilla Landfill	800	1,281,600	134	$166,608	$4,760	$1,860,000	$3,820,000	11	24

*Assume the average household in Puerto Rico uses 800 kWh/month as per Ruth Dones from PREPA.



Success Stories






Solar PV on Former Landfill in Fort Carson

PROJECT OVERVIEW

Location: Colorado
Completed: December 2007
Site type: Former landfill
Installation Type: Ground mounted, fixed system
System Size: ~2 MW, about 2% of Ft Carson load
Covered Area: 12 acres
Project Cost: $13 million
First Solar Thin Film, 25 year warranty
Homes Powered: 540

Governor Ritter at Fort Carson, CO Landfill Project

Solar PV on Former Landfill on Nellis AFB, NV

Photos courtesy of SunPower Corporation

PROJECT OVERVIEW

Location: Nevada
Completed: December 2007
Property Type: Former landfill
Installation Type: Ground mounted, single axis
System Size: ~15 MW
Covered Area: 140 acres including former landfill
Number of Panels: 70,000
SunPower® T20 Tracker

Geomembrane Solar PV Hickory Ridge Landfill

Photos courtesy of Carlisle Energy

PROJECT OVERVIEW

Location: Georgia
Completed: December 2011
Property Type: Former landfill
Installation Type: Geomembrane with PV laminate
System Size: ~1 MW
Covered Area: 48 acres
Uni-Solar thin film laminate
Largest PV system in Georgia
Largest geomembrane solar cap in the world