DOE OFFICE OF INDIAN ENERGY

Foundational Courses
Assessing Energy Needs & Resources

Presented by the National Renewable Energy Laboratory

U.S. DEPARTMENT OF ENERGY | Office of Indian Energy

Course Outline

What we will cover…

- About the DOE Office of Indian Energy Education Initiative
- Course Introduction
- Resource Mapping
- Tools to Evaluate Costs and Resources
  - PVWatts; IMBY; SAM; CREST; OpenPV; Solar Prospector
  - OpenEI; Transparent Cost Database; JEDI
- Data Challenges & Solutions: Information Sharing
- Additional Information & Resources

Introduction

The U.S. Department of Energy (DOE) Office of Indian Energy Policy & Programs is responsible for assisting Tribes with energy planning and development, infrastructure, energy costs, and electrification of Indian lands and homes.

As part of this commitment and on behalf of DOE, the Office of Indian Energy is leading *education* and *capacity building* efforts in Indian Country.

Training Program Objective & Approach

Foundational courses were created to give tribal leaders and professionals background information in renewable energy development that:

- *Present foundational information on strategic energy planning, grid basics, and renewable energy technologies;*
- *Break down the components of the project development process on the commercial and community scale; and*
- *Explain how the various financing structures can be practical for projects on tribal lands.*

NREL's Presenter on Energy Needs and Resources is Mr. Nate Blair

Mr. Nate Blair, M.B.A., M.S.

Nate.Blair@nrel.gov

Mr. Nate Blair is the group manager of the Data Analysis and Visualization Group and the Energy Forecasting and Modeling Group in the Strategic Energy Analysis Center at the National Renewable Energy Laboratory (NREL). Mr. Blair has been at NREL for 10 years and has been developing renewable energy and efficiency system modeling for 20 years. He has worked on tools such as TRNSYS, REEDS, WinDS, SAM, PVWatts, and others. Mr. Blair has an M.B.A. and an M.S. in mechanical engineering from the University of Wisconsin-Madison; and a B.A. in physics from Gustavus Adolphus College.

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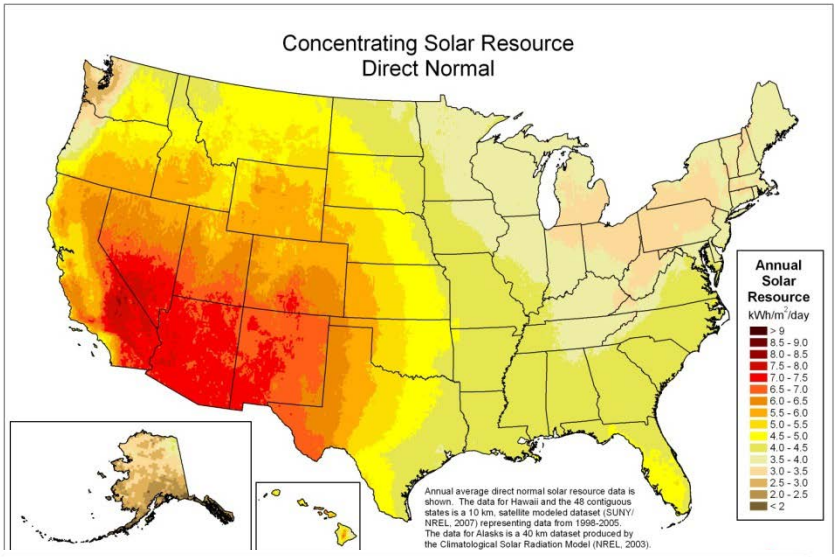
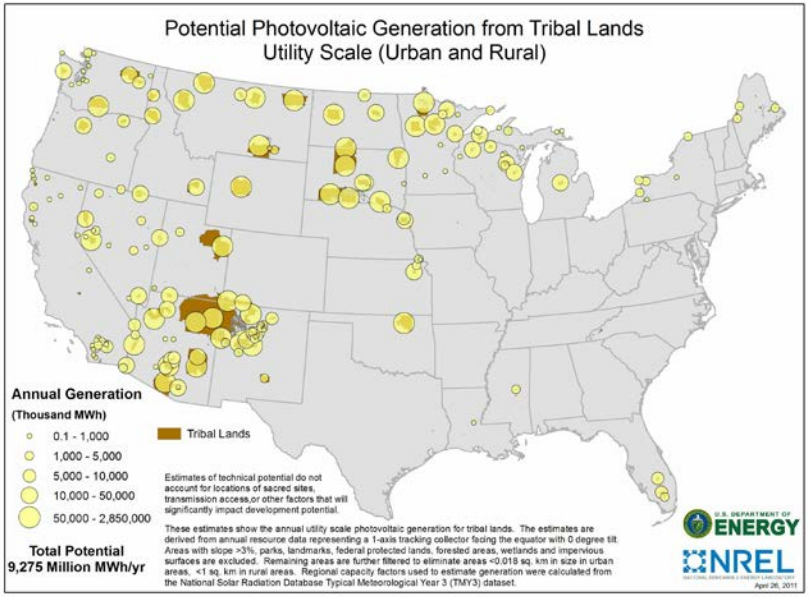
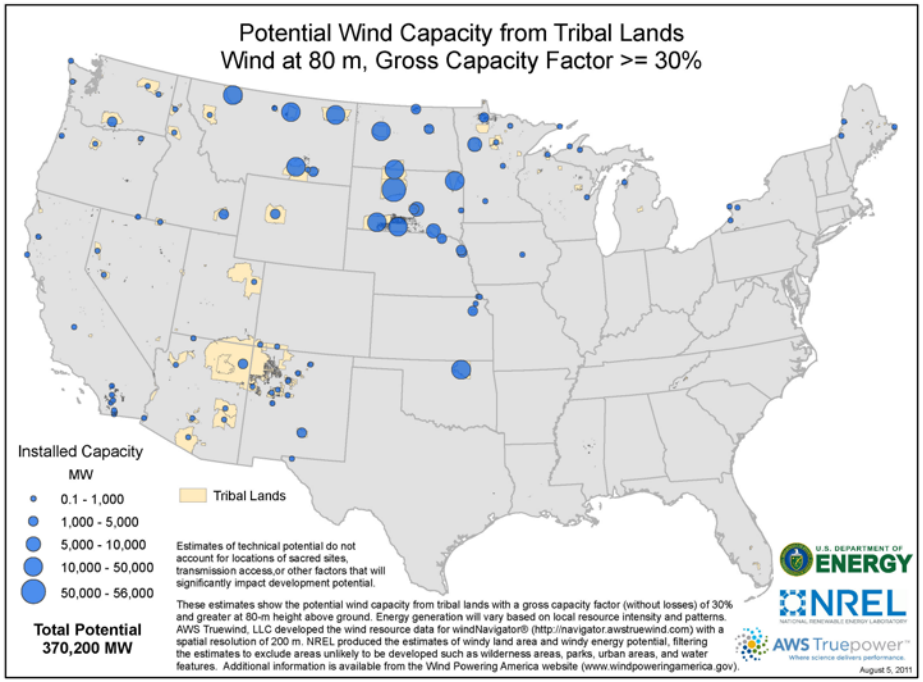
Renewable Energy Resource Mapping (Regional and Tribal)

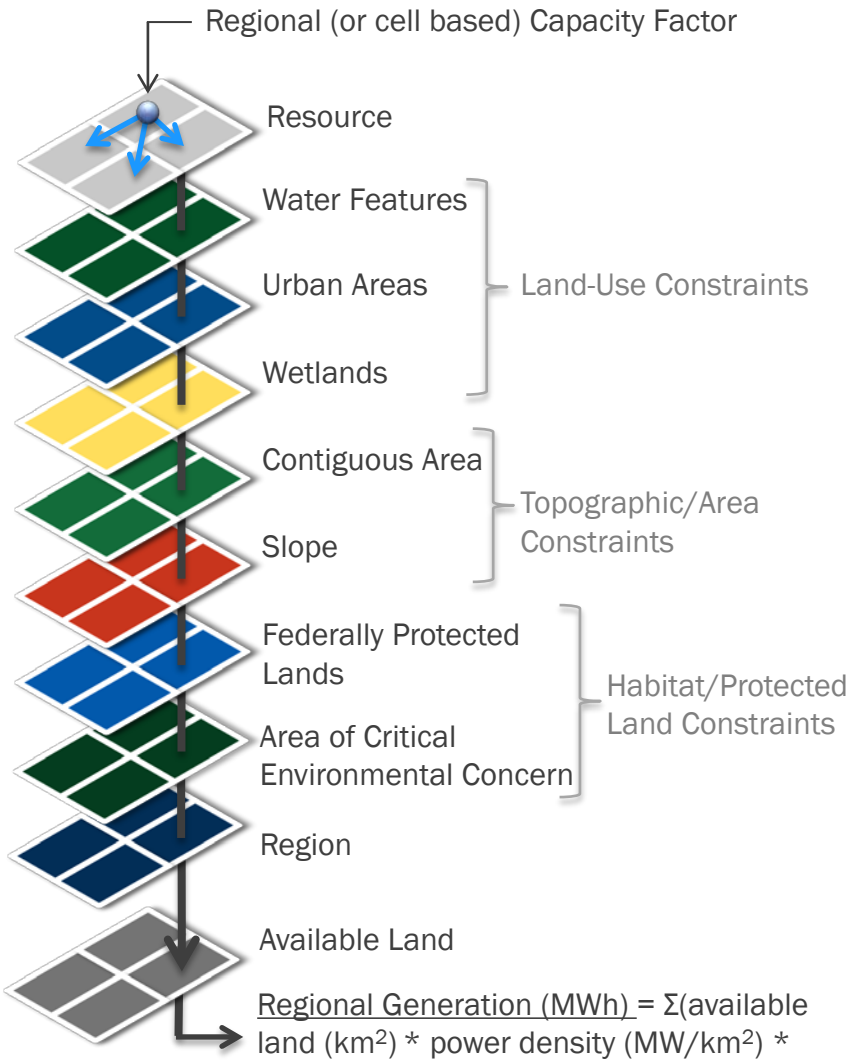




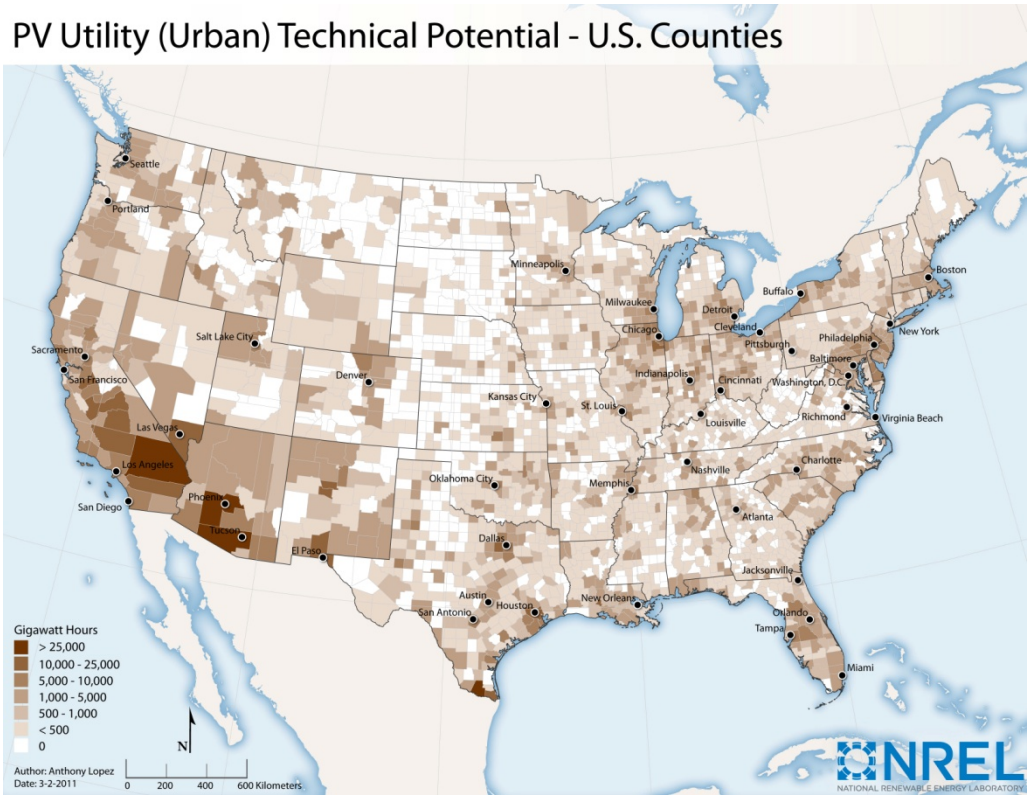


Renewable Resource Characterization & Technical Potential

Layer Stacking



Regional Generation (MWh) = Σ(available land (km^2) * power density (MW/km^2) * capacity factor (%) * 8760 (hours/year))

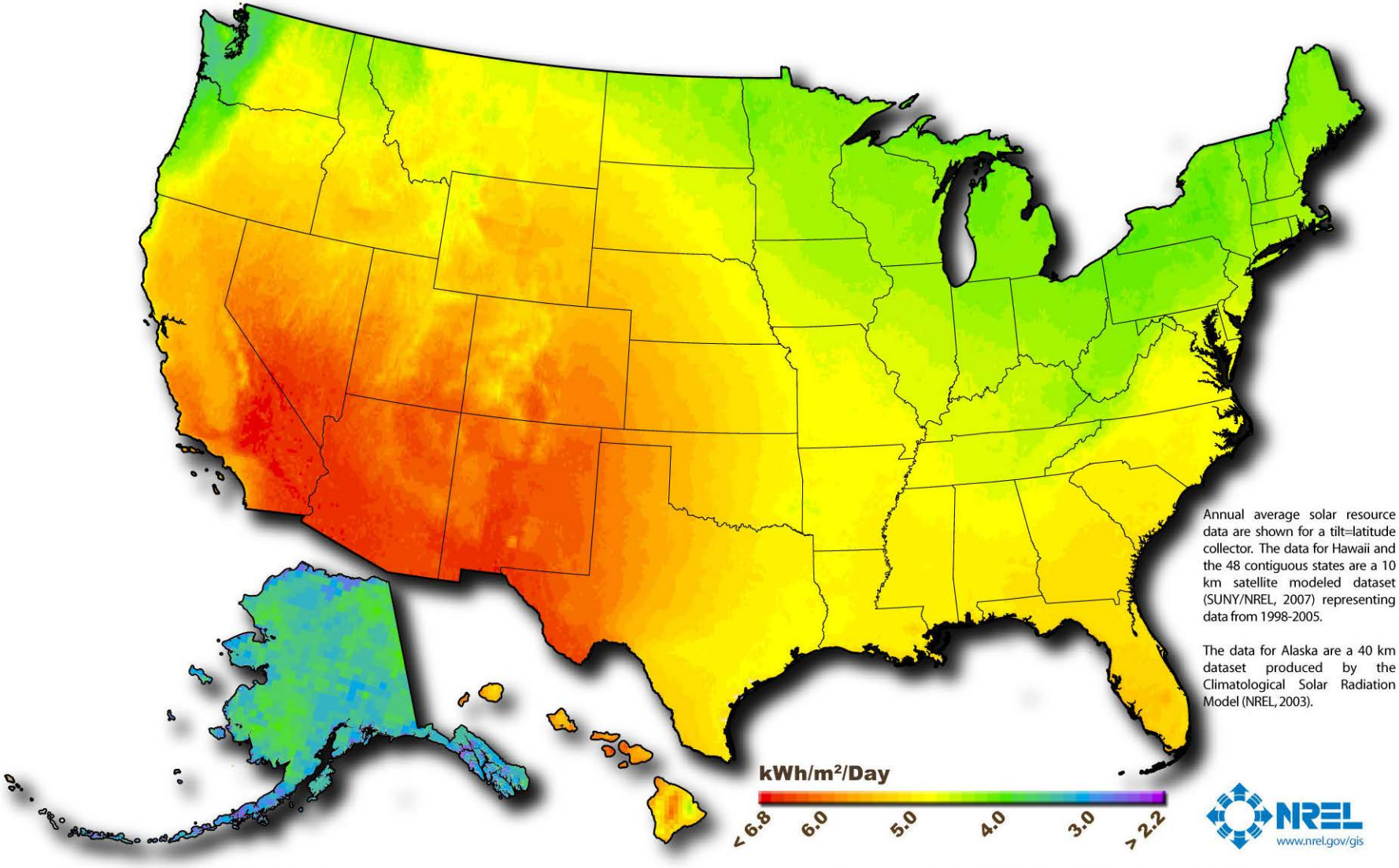


Technical Potentials produced:

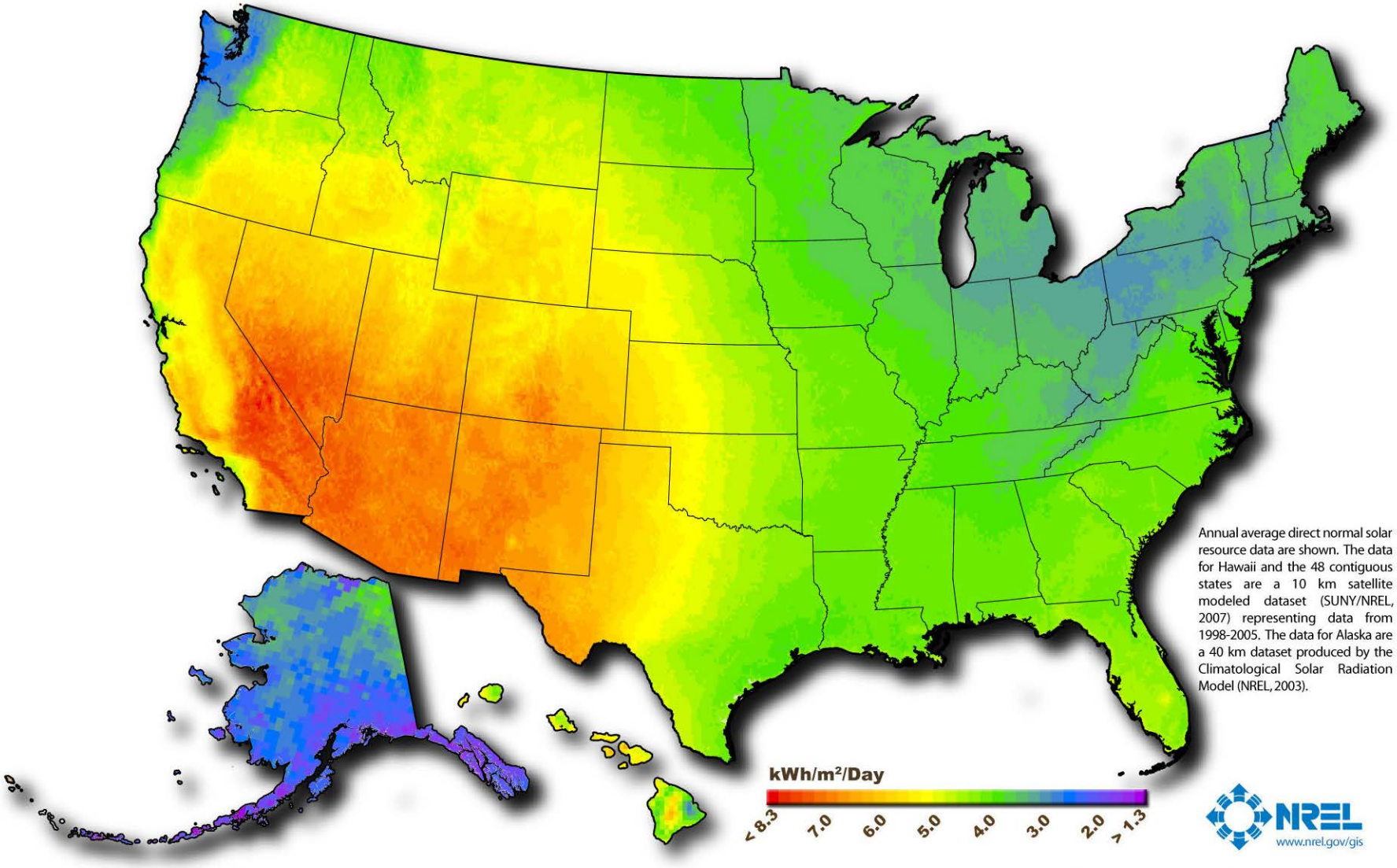
- *Photovoltaic (PV) Utility – Urban & Rural*
- *PV Rooftop*
- *Concentrating Solar Power (CSP)*
- *Onshore Wind*
- *Offshore Wind*
- *Biopower – Gaseous and Solid Biomass*
- *Geothermal*
- *Hydropower*

*See Technical Potential Worksheet for data sources, descriptions, and details

U.S. Photovoltaic Solar Resource



U.S. Concentrating Solar Resource

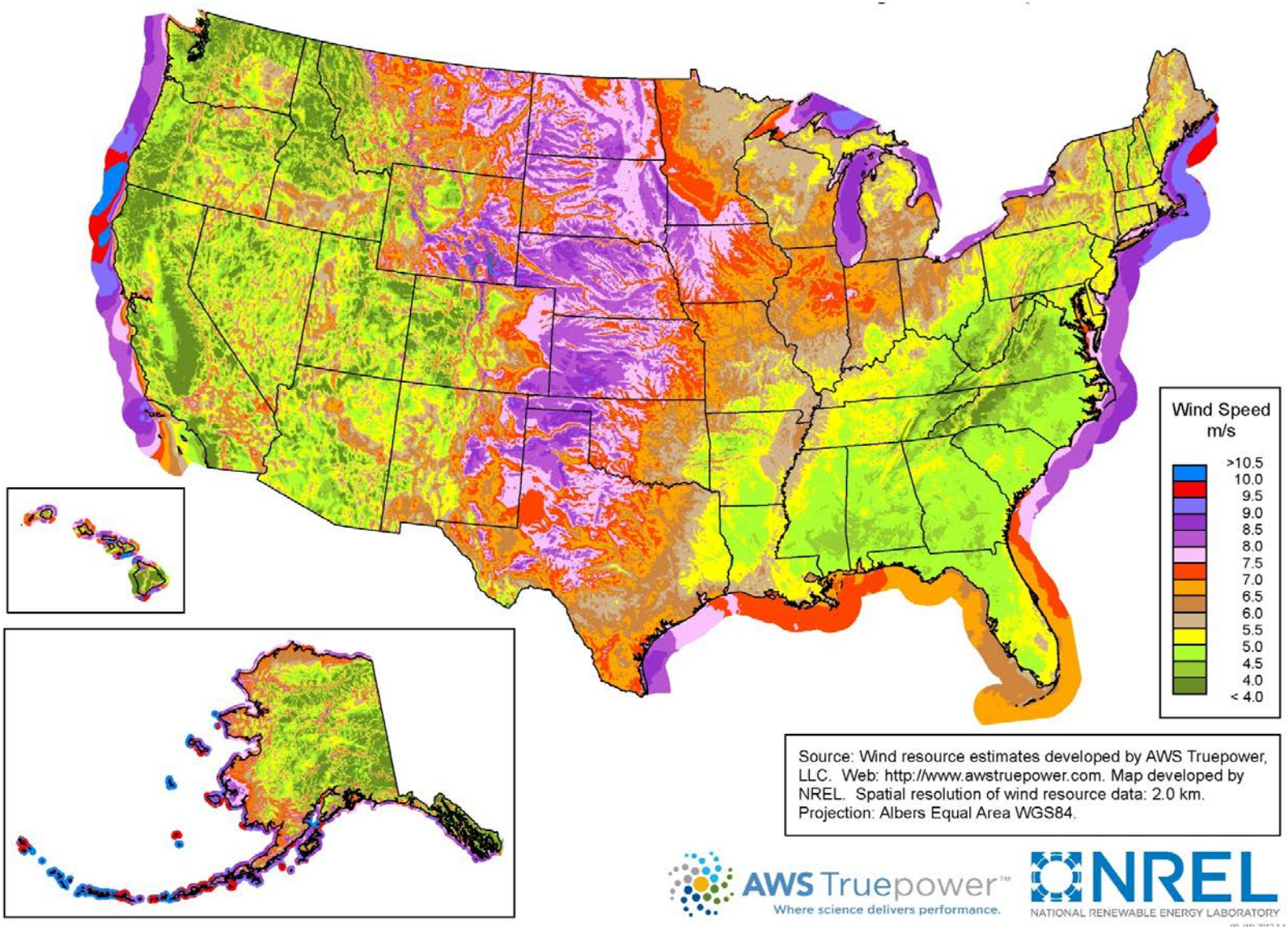


Annual average direct normal solar resource data are shown. The data for Hawaii and the 48 contiguous states are a 10 km satellite modeled dataset (SUNY/NREL, 2007) representing data from 1998-2005. The data for Alaska are a 40 km dataset produced by the Climatological Solar Radiation Model (NREL, 2003).

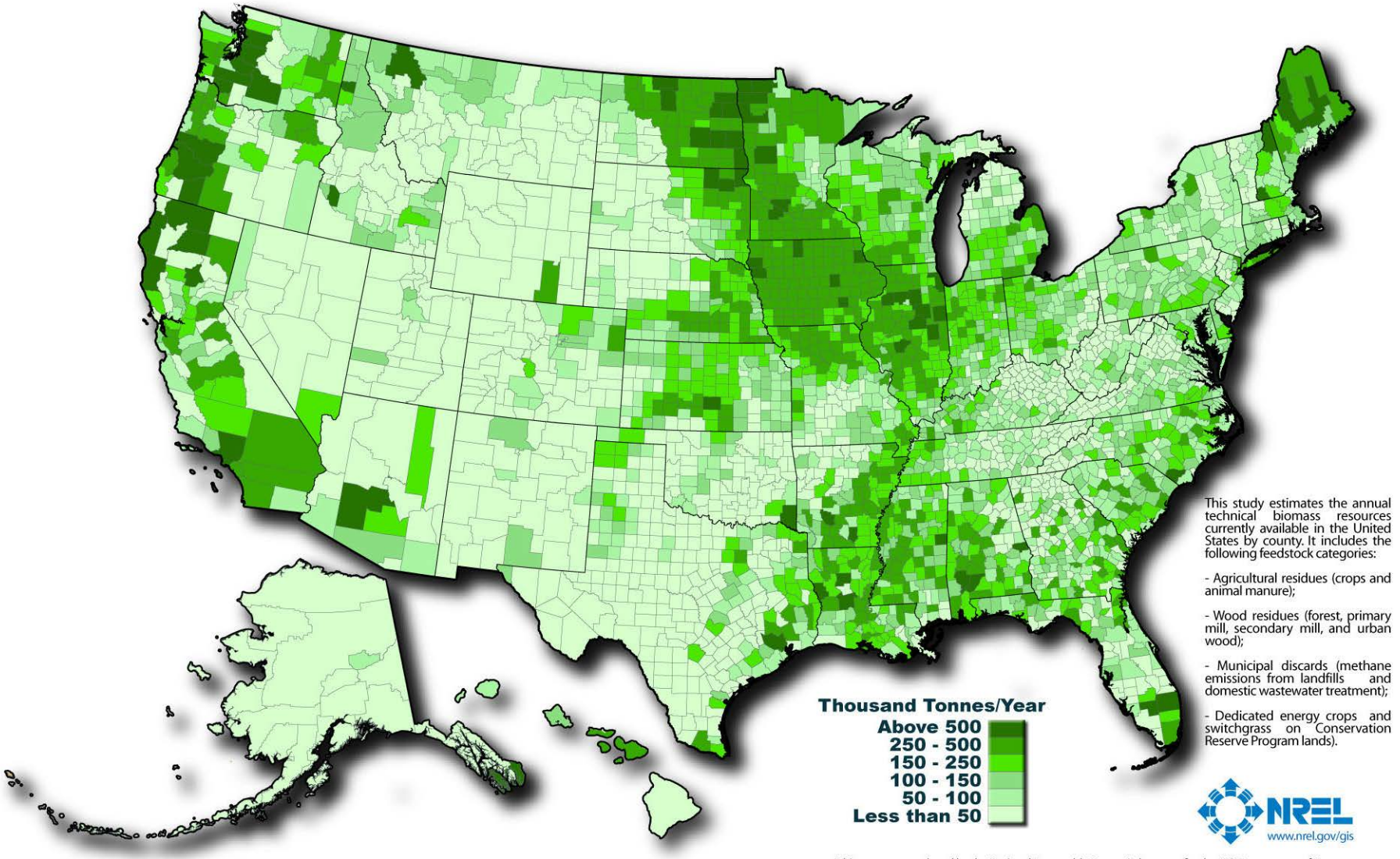
Author : Billy Roberts - October 20, 2008

This map was produced by the National Renewable Energy Laboratory for the U.S. Department of Energy.

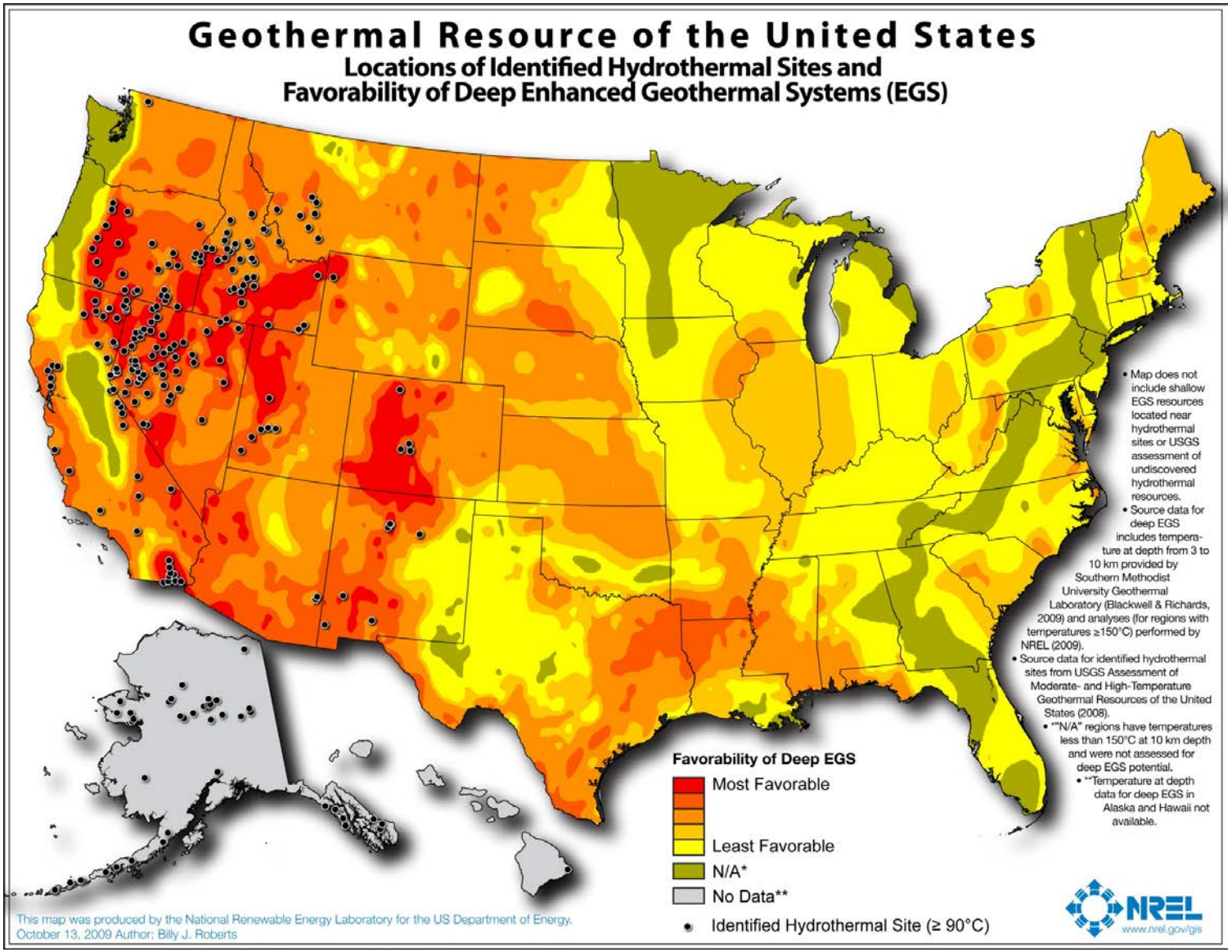
U.S. Wind Resource (at 80 meters)



U.S. Biomass Resource



U.S. Geothermal Resources



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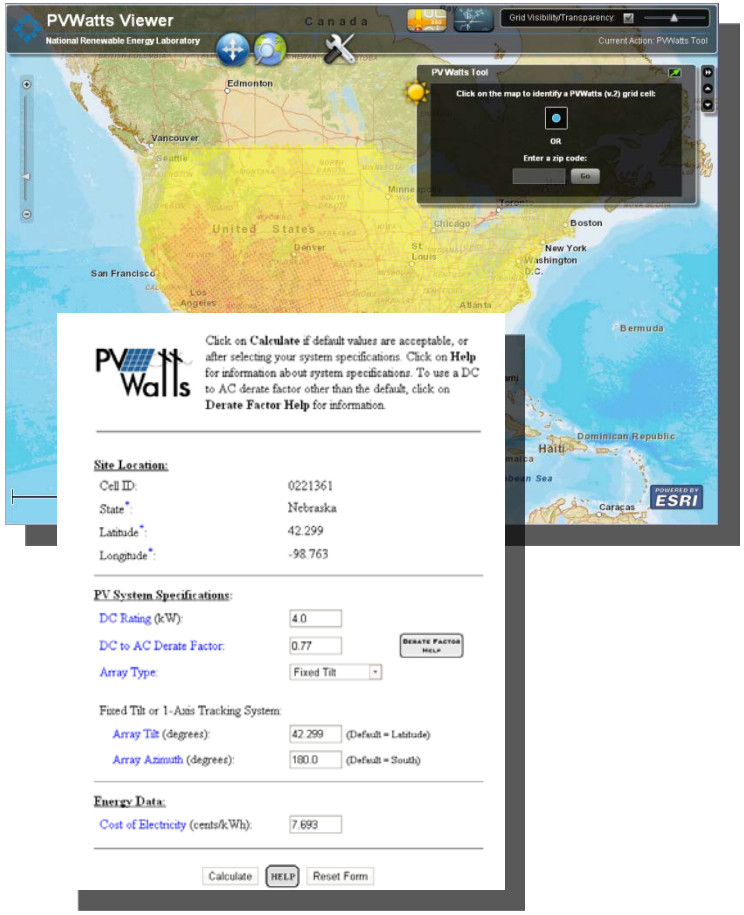
PVWatts

http://maps.nrel.gov/pvwatts

Basic PV Modeling



Project Description

The PVWatts application is an interactive map-based interface to rapidly utilize the PVWatts calculator. The PVWatts calculator is a basic solar modeling tool developed at NREL to allow non-experts to quickly obtain performance estimates for grid-connected PV systems.

Project Impact

This project is focused on providing the general public with a basic solar performance modeling tool and is one of the most heavily visited page on the NREL website. Users can get an estimate of expected monthly and annual solar resource values for any location in the United States.

Users

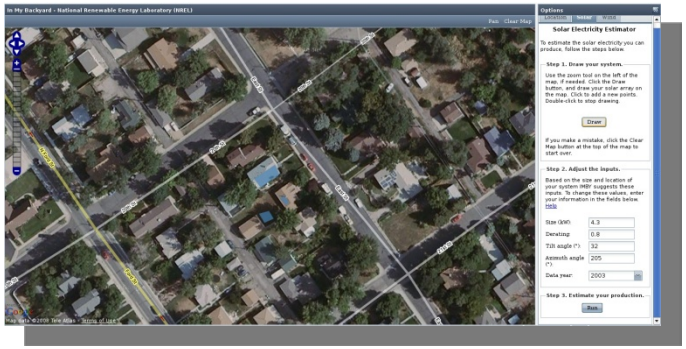
Generally solar installers, but really anyone is able to use this to get a first cut of the potential output. Many national subsidy providers use PVWatts to determine the amount of subsidy a homeowner can receive.

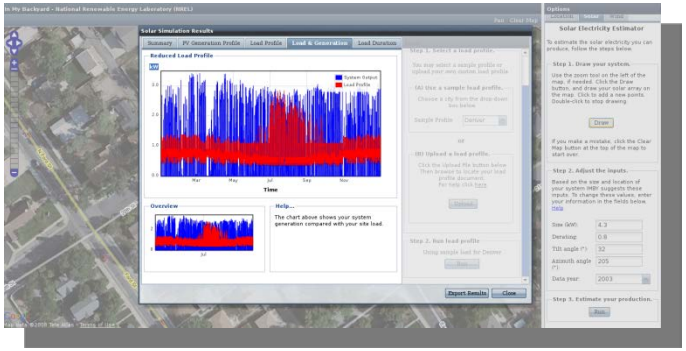
Data Analysis and Visualization Group
Project Lead: Dan Getman
Dan.getman@nrel.gov

In My Backyard (IMBY)

http://mercator.nrel.gov/imby/

Small-Scale PV & Wind





Project Description

In My Backyard, or IMBY, is a small scale PV simulation tool that provides a quick estimation of production potentials and financial implications. Homeowners, business owners, and policy makers can use IMBY get a quick and easy estimate of whether PV makes economic sense at their location. This uses the same PVWatts performance engine.

Project Impact

This project is focused on providing the general public with a tool that provides a slightly more complex analysis than PVWatts, but a more simple analysis than the Solar Advisor Model (SAM). IMBY is currently under active development with several updates and improvements meant to increase the tool's usability and exposure.

Users

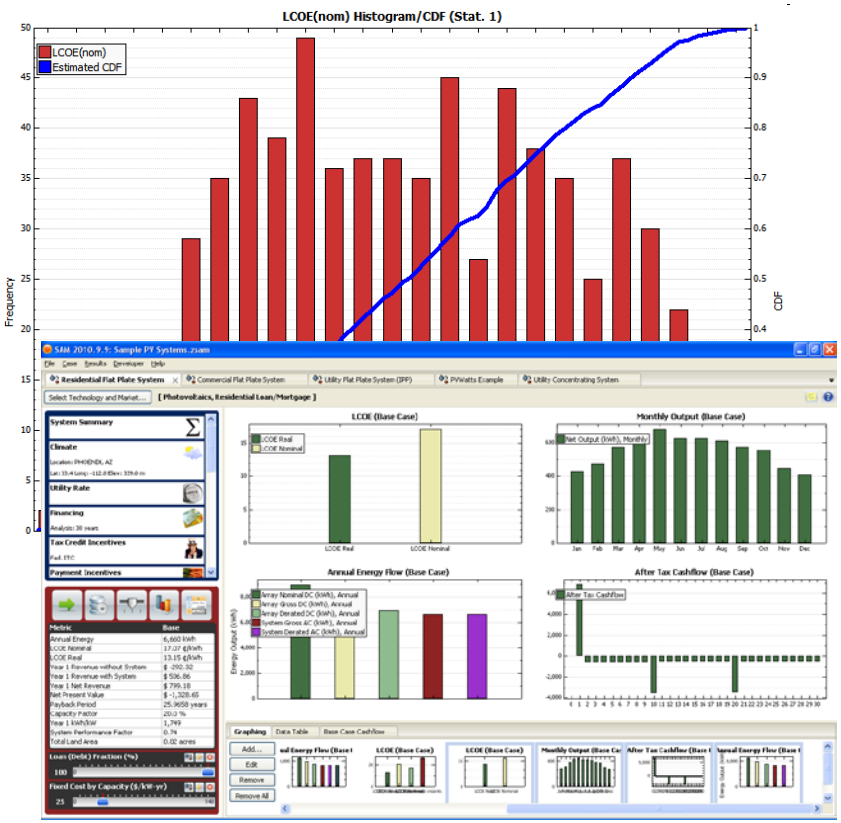
For building owners who want to do a graphical interpretation of the PV options for residential housing stock. This is a step more complex than PVWatts but also more informative.

Data Analysis and Visualization Group
Project Lead: Dan Getman
Dan.getman@nrel.gov

SAM (System Advisor Model)

http://www.nrel.gov/analysis/sam

Complete System Techno-Economic Modeling



Data Analysis and Visualization Group
Project Lead: Nate Blair
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Project Description

The System Advisor Model (SAM) combines detailed performance modeling with detailed finance modeling, cost data, detailed incentive abilities, and a robust user interface to create a full system analysis tool. SAM is significantly more complex than PVWatts or IMBY.

Project Impact

- For the CSP industry to use for performance information
- Robust usage by the PV industry
- 40,000 downloads of software in 2012
- Used for various DOE analyses
- Requires larger learning investment than other online solar tools
- Contains many technologies
- Links to various other NREL datasets and resources

Users

- Plant Developers
- Manufacturers
- Solar Installers
- Utility Planners
- Consultants
- Analysts and Students

Technologies in SAM

Photovoltaics

Concentrating PV

Solar Water Heating

Geothermal

Parabolic Trough

Power Tower

Linear Fresnel

Dish-Stirling

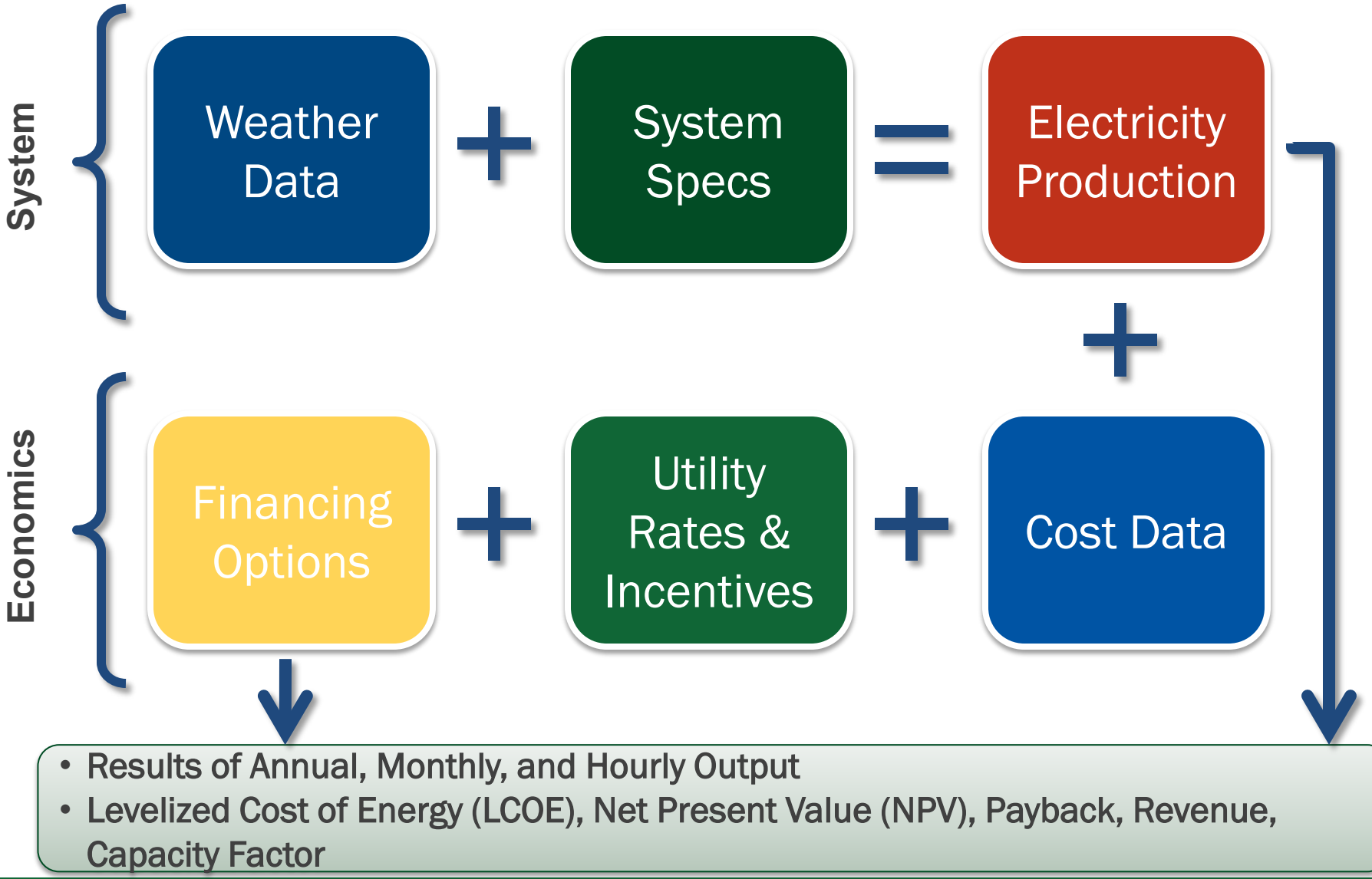
Small Wind

Utility-Scale Wind

Biomass Power

Conventional

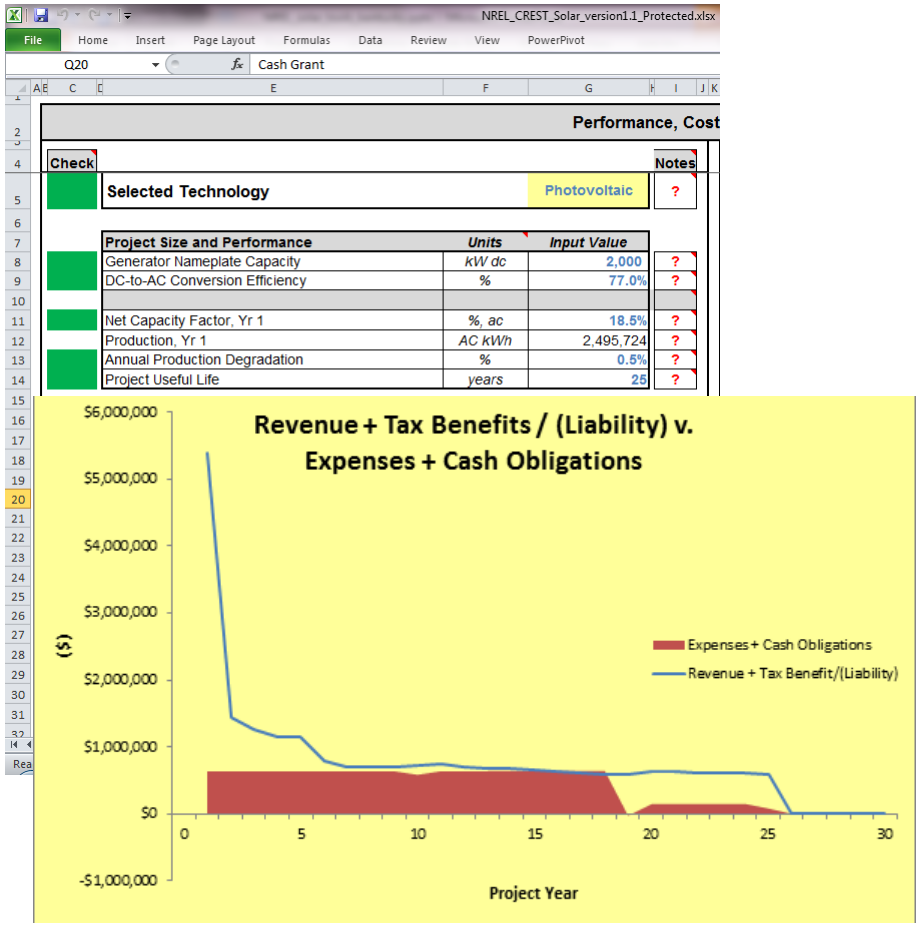
General Modeling Workflow



CREST

http://financere.nrel.gov/finance/content/CREST-model

Project Finance Modeling



Project Description

The Cost of Renewable Energy Spreadsheet Tool (CREST) is an economic cash flow model designed to enable public utility commissions (PUCs) and the renewable energy community to assess projects, design cost-based incentives, such as feed-in tariffs, and evaluate the impact of tax incentives or other support structures. CREST is a suite of three analytic tools for solar (photovoltaic and solar thermal), wind, and geothermal technologies.

Project Impact

Relatively new tool developed in conjunction with various public utility commissions and stakeholders.

Users

Primarily state incentive developers and financial analysts.

Data Analysis and Visualization Group
Project Lead: Michael Mendelsohn
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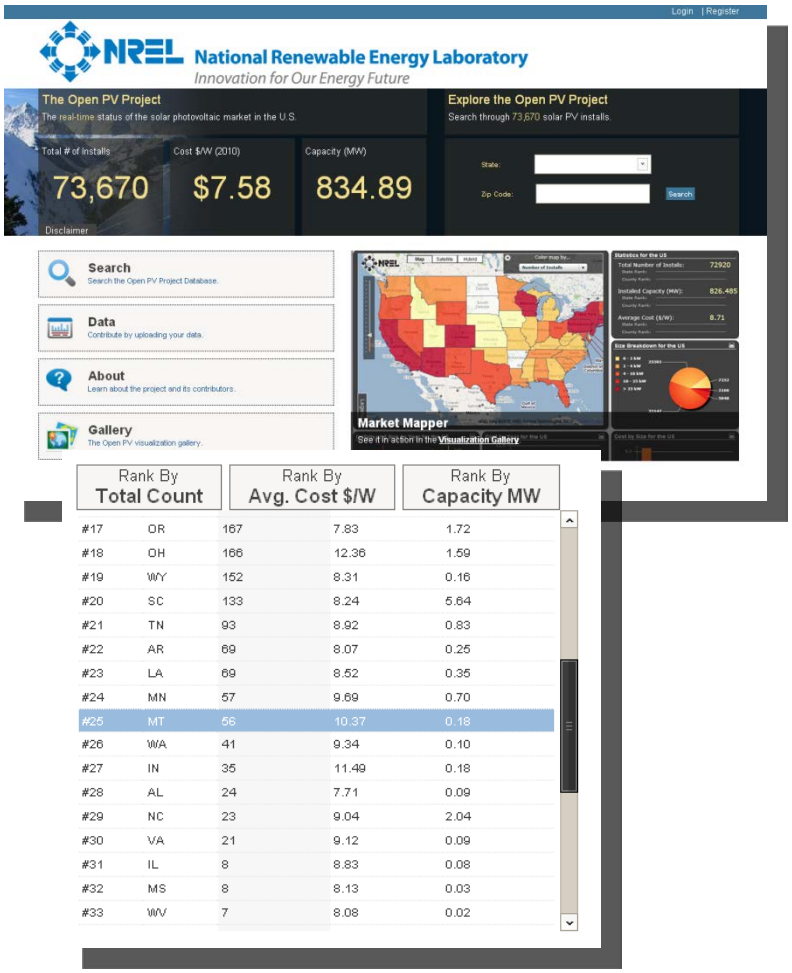
OpenPV

http://openpv.nrel.gov

Tracking PV Market



Project Description

The OpenPV Mapping Project is a collaborative effort between government, industry, and the public that compiles a comprehensive database of PV installation data for the United States. Data for the project is voluntarily contributed from a variety of sources including utilities, installers, and the general public.

Project Impact

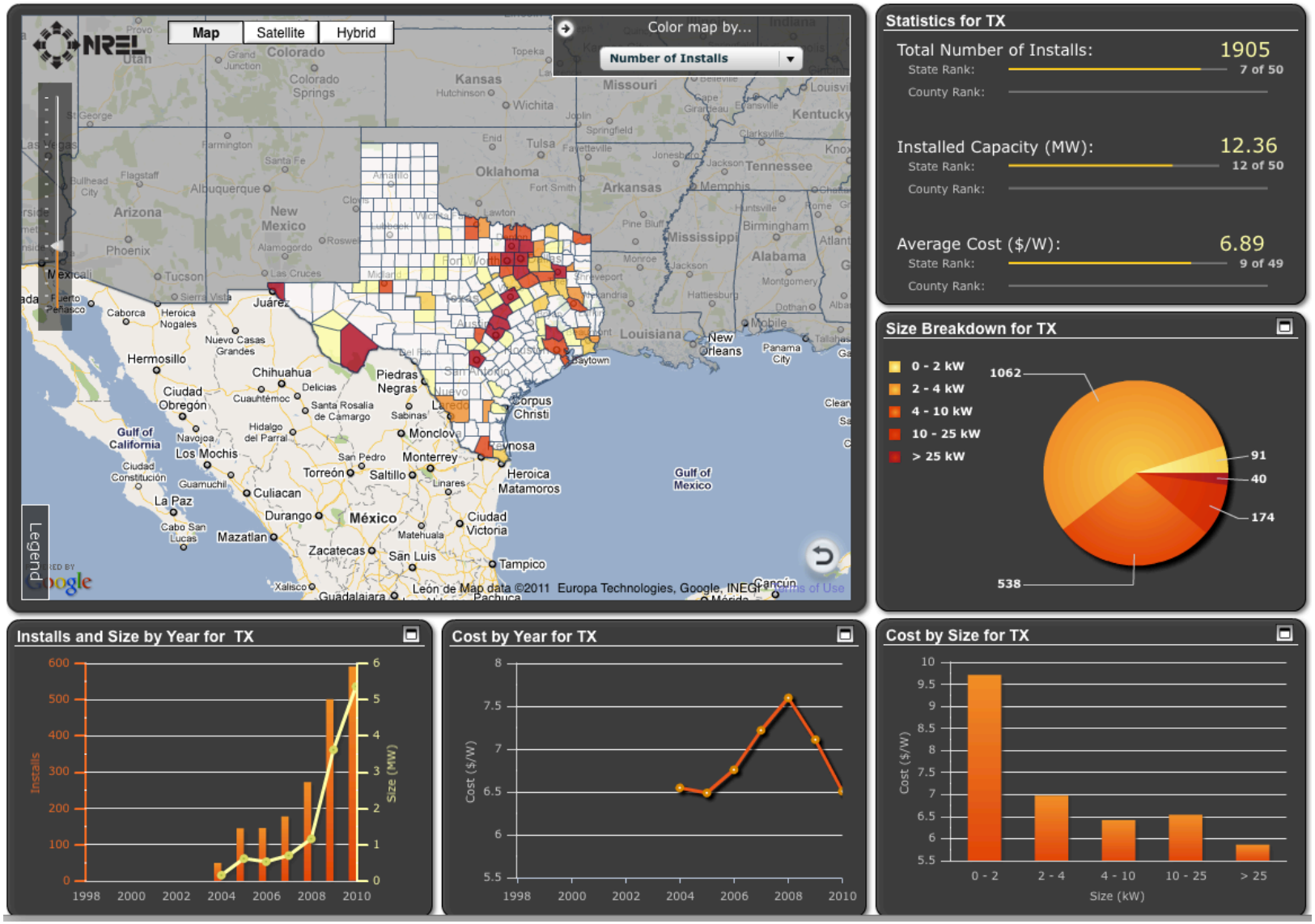
The data collected is actively maintained by the contributors and constantly updated to provide an evolving snapshot of the U.S. solar power market.

Users

- Solar Installers
- PV Industry Business Analysts
- DOE/Lab Market Analysts

Data Analysis and Visualization Group
Project Lead: Ted Quinby
Ted.Quinby@nrel.gov

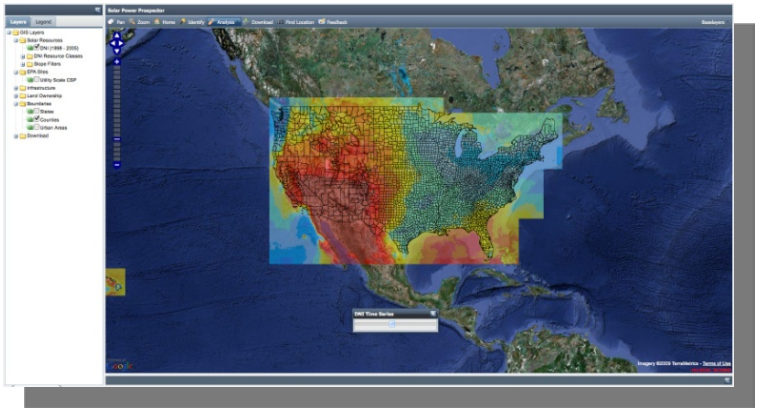
OpenPV: Advanced Visualizations

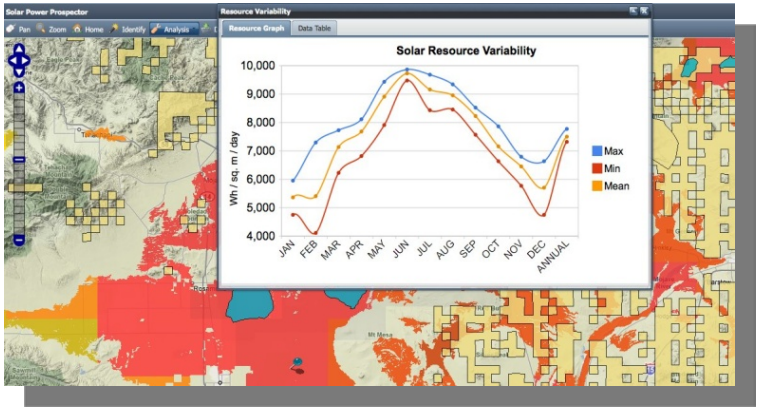


The Solar Prospector

http://maps.nrel.gov/prospector

Citing Utility-Scale CSP





Data Analysis and Visualization Group
Project Lead: Ted Quinby
ted.quinby@nrel.gov

Project Description

The Solar Prospector is a Web-based Geographic Information System (GIS) tool designed to assist industry professionals in the siting of utility-scale solar plants. The tool employs various GIS datasets to help identify areas that may have a high potential for solar plant development. Additionally, the Solar Prospector forms a platform to disseminate all solar related geospatial data to the larger industry and analysis community.

Project Impact

This project provides the location of solar resources, land ownership, and general infrastructure in an easy to use map format. Users can quickly download hourly solar resource data for specific locations and perform temporal analyses for any location in the United States and North Mexico.

Users

- Originally developed for CSP and expanded to PV; the CSP project development industry is a heavy user of the tool
- DOE/Lab analysts
- PV developers interested in information from the federal government

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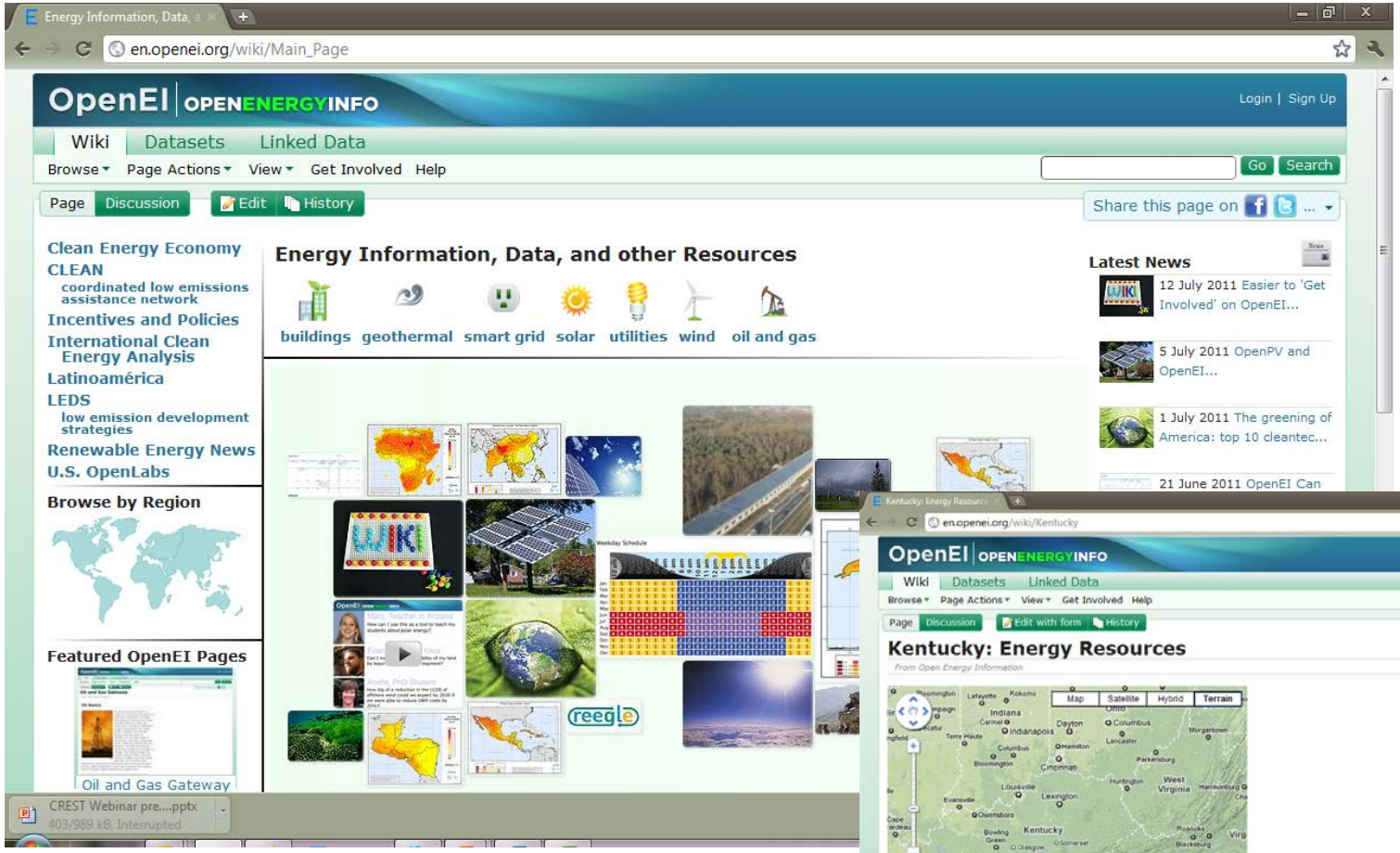
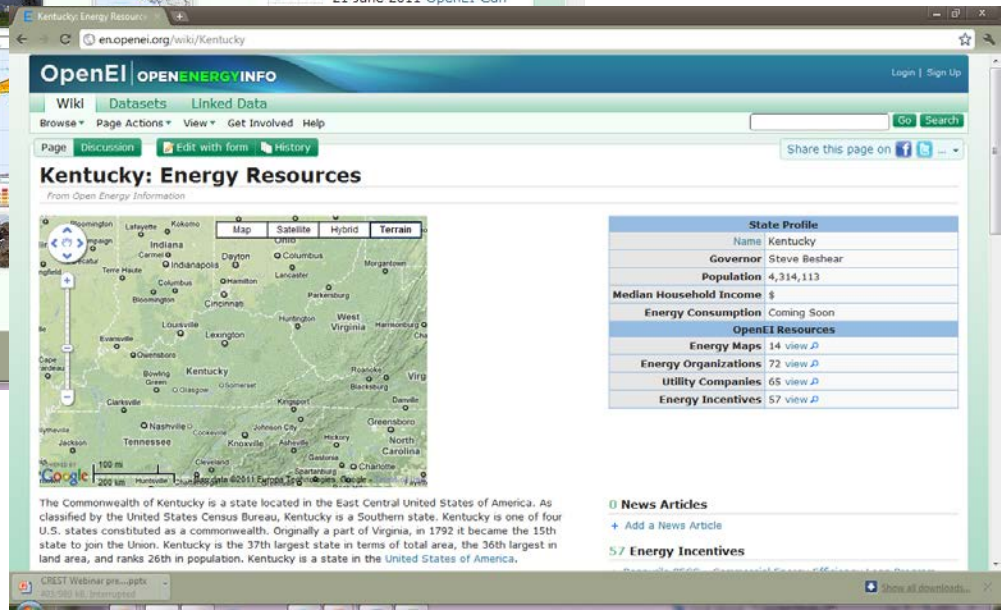
Open Energy Information (OpenEI)

http://openei.org





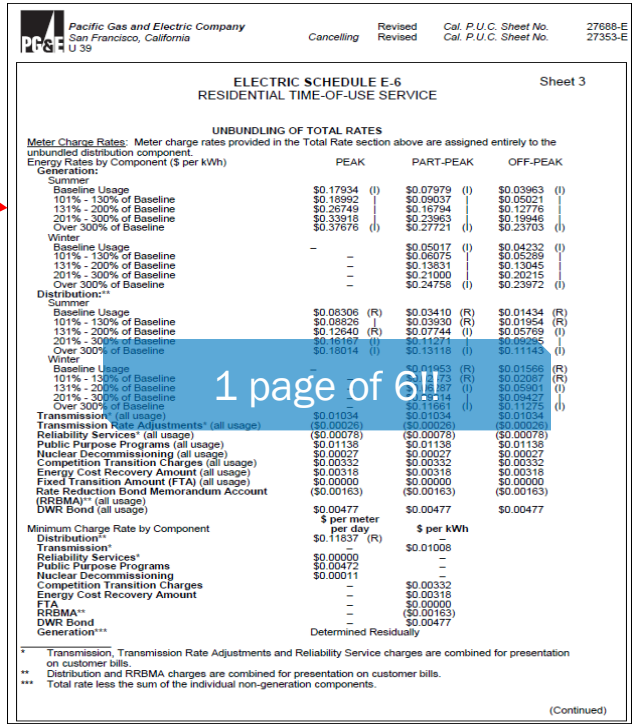
- Growing source of energy information contributed by variety of stakeholders
- Focus is on linked open data

The Problem with Utility Rate Data…

- NREL tools have been using averaged rates from the U.S. Energy Information Administration (EIA), sometimes just state average, and other sources
- This has been a significant limitation, lacking the accuracy to reveal the value of energy efficiency and renewable power
- SAM lead the way with the ability to enter in advanced rate structures, but finding and entering rates is inefficient.

Entity	State	Class of Ownership	Number of Consumers	Revenue (thousand dollars)	Sales (megawatthours)	Average Retail Price (c/kWh)
Florida Power & Light Company	FL	Investor Owned	3,981,453	6,284,178	55,065,086	11.41
Pacific Gas & Electric Co	CA	Investor Owned	4,544,498	4,650,510	30,748,883	15.12
Southern California Edison Co	CA	Investor Owned	4,211,970	4,600,413	29,824,161	15.43
Commonwealth Edison Co	IL	Investor Owned	3,421,075	3,161,083	29,374,282	10.76
Virginia Electric & Power Co	VA	Investor Owned	2,002,884	2,496,677	28,873,227	8.65
Georgia Power Co	GA	Investor Owned	2,015,817	2,442,501	26,840,275	9.10
TXU Energy Retail Co LP	TX	Power Marketer	1,845,167	3,654,106	26,589,947	13.74
Reliant Energy Retail Services	TX	Power Marketer	1,619,371	3,205,646	21,895,312	14.64
Duke Energy Corporation	NC	Investor Owned	1,539,519	1,719,094	20,980,559	8.19
Florida Power Corp	FL	Investor Owned	1,442,854	2,363,142	19,911,884	11.87
Alabama Power Co	AL	Investor Owned	1,202,491	1,833,563	18,874,039	9.71
Detroit Edison Co	MI	Investor Owned	1,967,223	1,680,344	16,146,745	10.41
Carolina Power & Light Co	NC	Investor Owned	1,058,588	1,411,517	15,001,238	9.41
PPL Electric Utilities Corp	PA	Investor Owned	1,211,248	1,388,126	14,568,456	9.53
Union Electric Co	MO	Investor Owned	1,027,668	980,231	14,257,728	6.88
Public Service Elec & Gas Co	NJ	Investor Owned	1,826,039	1,904,724	13,958,115	13.65
Arizona Public Service Co	AZ	Investor Owned	979,138	1,418,315	13,771,481	10.30

EIA data



Pacific Gas and Electric Company
San Francisco, California
U 39

Cancelling Revised Revised

Cal. P.U.C. Sheet No. 27688-E
Cal. P.U.C. Sheet No. 27353-E

ELECTRIC SCHEDULE E-6
RESIDENTIAL TIME-OF-USE SERVICE

Sheet 3

UNBUNDLING OF TOTAL RATES

Meter Charge Rates: Meter charge rates provided in the Total Rate section above are assigned entirely to the unbundled distribution component.

Energy Rates by Component ($ per kWh)	PEAK	PART-PEAK	OFF-PEAK
Generation:			
Summer			
Baseline Usage	$0.17934 (I)	$0.07979 (I)	$0.03963 (I)
101% - 130% of Baseline	$0.18992 |	$0.08037 |	$0.05021 |
131% - 200% of Baseline	$0.26749 |	$0.16794 |	$0.12776 |
201% - 300% of Baseline	$0.33918 |	$0.23963 |	$0.19946 |
Over 300% of Baseline	$0.37676 (I)	$0.27721 (I)	$0.23703 (I)
Winter			
Baseline Usage	–	$0.05017 (I)	$0.04232 (I)
101% - 130% of Baseline	–	$0.06075 |	$0.05289 |
131% - 200% of Baseline	–	$0.13831 |	$0.13045 |
201% - 300% of Baseline	–	$0.21000 |	$0.20215 |
Over 300% of Baseline	–	$0.24758 (I)	$0.23972 (I)
Distribution:**			
Summer			
Baseline Usage	$0.08306 (R)	$0.03410 (R)	$0.01434 (R)
101% - 130% of Baseline	$0.08826 |	$0.03930 (R)	$0.01954 (R)
131% - 200% of Baseline	$0.12640 (R)	$0.07744 (I)	$0.05769 (I)
201% - 300% of Baseline	$0.16167 (I)	$0.11271 |	$0.09295 |
Over 300% of Baseline	$0.18014 (I)	$0.13116 (I)	$0.11143 (I)
Winter			
Baseline Usage		$0.01953 (R)	$0.01566 (R)
101% - 130% of Baseline		$0.02473 (R)	$0.02087 (R)
131% - 200% of Baseline		$0.05337 (I)	$0.05901 (I)
201% - 300% of Baseline		$0.09814 |	$0.09427 |
Over 300% of Baseline	–	$0.11661 (I)	$0.11275 (I)
Transmission* (all usage)	$0.01034	$0.01034	$0.01034
Transmission Rate Adjustments* (all usage)	($0.00078)	($0.00078)	($0.00078)
Reliability Services* (all usage)	($0.00078)	($0.00078)	($0.00078)
Public Purpose Programs (all usage)	$0.01138	$0.01138	$0.01138
Nuclear Decommissioning (all usage)	$0.00027	$0.00027	$0.00027
Competition Transition Charges (all usage)	$0.00332	$0.00332	$0.00332
Energy Cost Recovery Amount (all usage)	$0.00318	$0.00318	$0.00318
Fixed Transition Amount (FTA) (all usage)	$0.00000	$0.00000	$0.00000
Rate Reduction Bond Memorandum Account (RRBMA)** (all usage)	($0.00163)	($0.00163)	($0.00163)
DWR Bond (all usage)	$0.00477	$0.00477	$0.00477
	$ per meter per day	$ per kWh	
Minimum Charge Rate by Component			
Distribution**	$0.11837 (R)	–	
Transmission*	–	$0.01008	
Reliability Services*	$0.00000	–	
Public Purpose Programs	$0.00472	–	
Nuclear Decommissioning	$0.00011	–	
Competition Transition Charges	–	$0.00332	
Energy Cost Recovery Amount	–	$0.00318	
FTA	–	$0.00000	
RRBMA**	–	($0.00163)	
DWR Bond	–	$0.00477	
Generation***	Determined Residually		

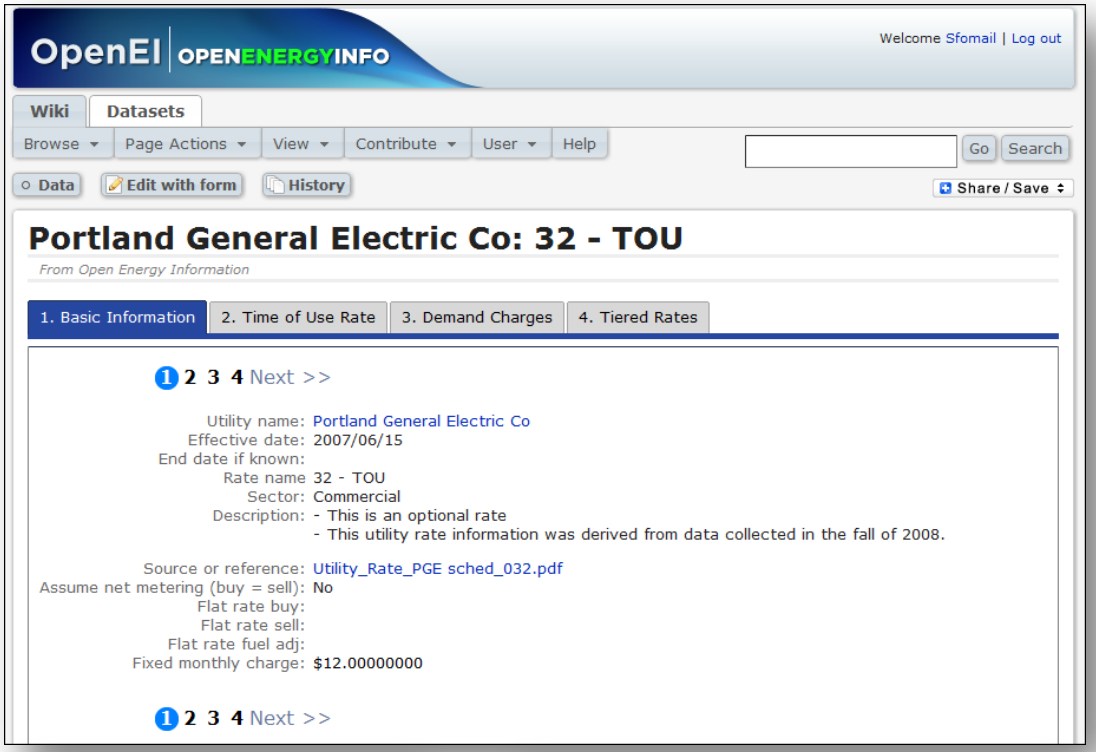
* Transmission, Transmission Rate Adjustments and Reliability Service charges are combined for presentation on customer bills.
** Distribution and RRBMA charges are combined for presentation on customer bills.
*** Total rate less the sum of the individual non-generation components.

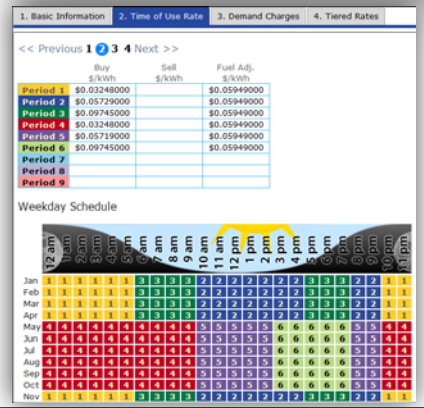
(Continued)

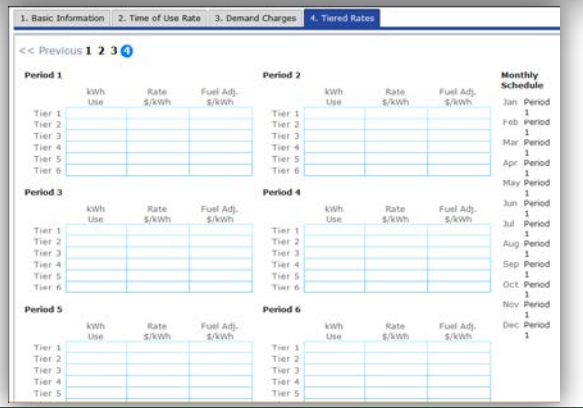
1 page of 6!!

The Solution: The OpenEI Utility Rate Database

- Completely Web based
- 23,000 rates and counting
- Nearly 1000 utilities represented (>80% of US load served)
- Residential and Commercial tariffs
- Can handle a wide variety of rate structures
- Collaboration now with Illinois State University
- Application Programming Interface (API) provided



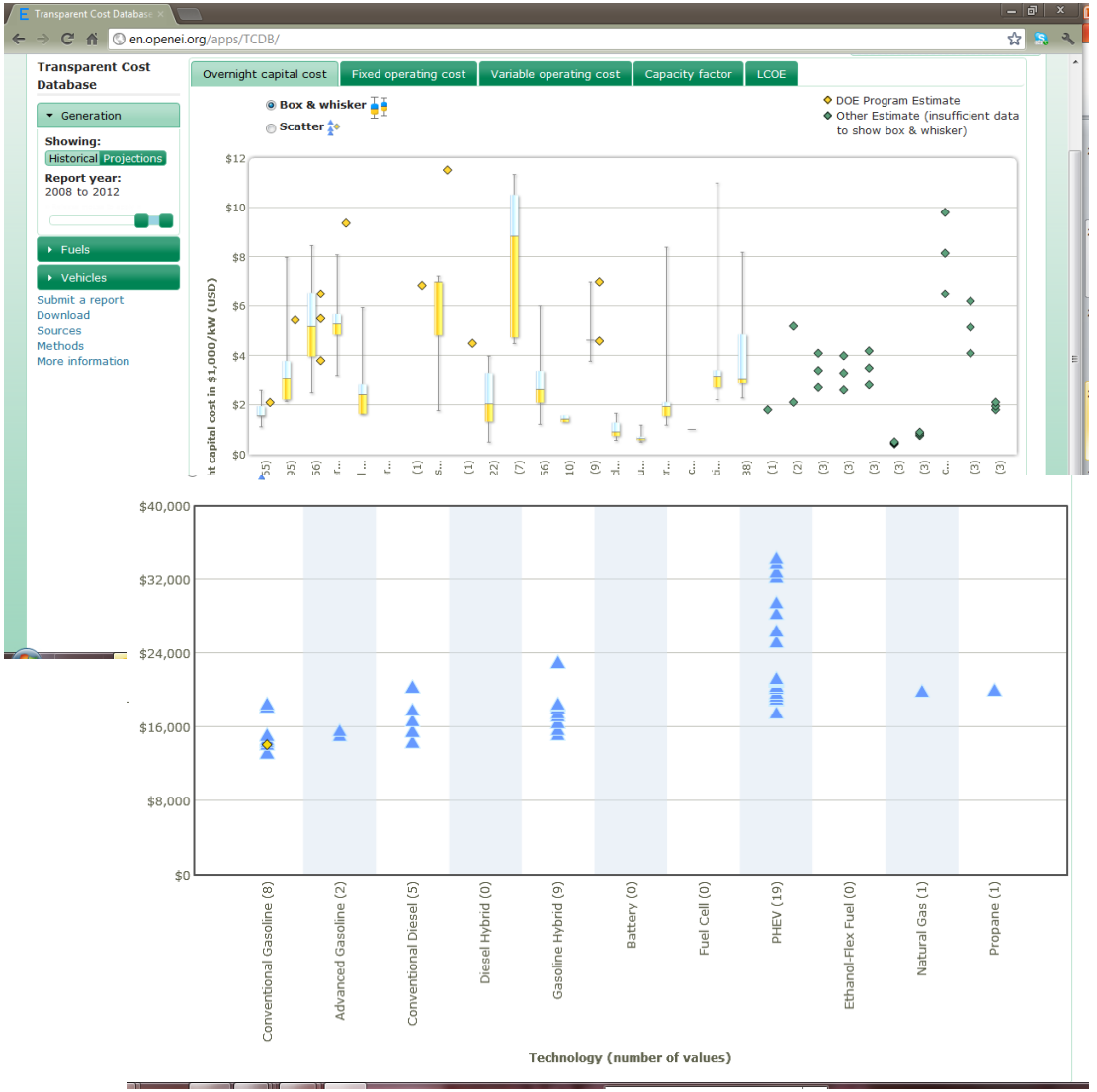




Transparent Cost Database (NEW!)

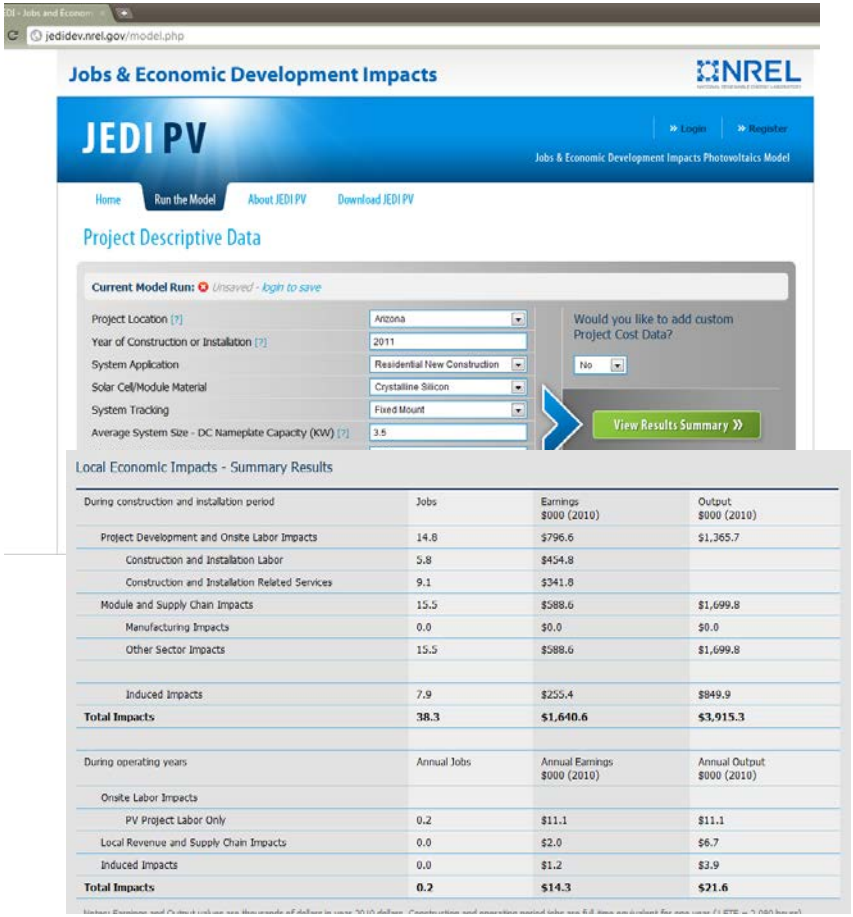
http://en.openei.org/wiki/Transparent_Cost_Database

- Collection of cost data for renewable technologies
- Completely Web based
- Includes literature on technology cost and performance estimates
- Includes vehicles, biofuels, and electricity generation
- All data are downloadable for full transparency



JEDI – Jobs and Economic Development Impact

Renewable Energy Project Economic Impact Calculator



http://www.nrel.gov/analysis/jedi/about_jedi.html

Project Description

The Jobs and Economic Development Impact (JEDI) models are user-friendly tools that estimate the economic impacts of constructing and operating power generation and biofuel plants at the local (usually state) level.

Project Impact

Jobs, earnings, and output are distributed across three categories:

- Project Development and Onsite Labor Impacts
- Local Revenue, Turbine, and Supply Chain Impacts
- Induced Impacts.

Project History and Timeline

JEDI has been developed in Excel for various technologies for over 10 years – constantly being updated and extended to new technologies. Online version of PV JEDI is in beta release.

Data Analysis and Visualization Group
Project Lead: Barry Friedman
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Course Outline

- About the DOE Office of Indian Energy Education Initiative
- Course Introduction
- Resource Mapping
- Applications
  - PVWatts; IMBY; SAM; CREST; OpenPV; Solar Prospector
  - OpenEI; Transparent Cost Database; JEDI
- Data Challenges & Solutions: Information Sharing
- Additional Information & Resources

NREL Tools Links

Map Apps at NREL	http://maps.nrel.gov
MapSearch	http://www.nrel.gov/gis/mapsearch/
REAtlas	http://maps.nrel.gov/reatlas
IMBY	http://mercator.nrel.gov/imby
SAM	http://sam.nrel.gov
HyDRA	http://maps.nrel.gov/hydra
RE_Atlas	http://maps.nrel.gov/re_atlas
Solar Prospector	http://maps.nrel.gov/prospector
OpenPV	http://openpv.nrel.gov/gallery
PVDAQ	http://maps.nrel.gov/pvdaq
LCOE Calculator	http://www.nrel.gov/analysis/tech_lcoe.html
GeoREServ API	http://rpm.nrel.gov/docs/georeserv/
REEDS	http://www.nrel.gov/analysis/reeds/
PV JEDI	http://www.nrel.gov/analysis/jedi/
OpenEI	http://openei.org
Smartgrid.gov	http://smartgrid.gov

Useful Resources

Resource	RE_Atlas:	http://maps.nrel.gov/re_atlas
	Solar Prospector:	http://maps.nrel.gov/prospector
	OpenPV:	http://openpv.nrel.gov/gallery
	PVDAQ:	http://maps.nrel.gov/pvdaq
	GeoREServ API:	http://rpm.nrel.gov/docs/georeserv/
Technology	SAM:	http://sam.nrel.gov
	CREST:	http://financere.nrel.gov/finance/content/CRESTmodel
	LCOE Calculator:	http://www.nrel.gov/analysis/tech_lcoe.html
	PV JEDI:	http://www.nrel.gov/analysis/jedi/
	OpenEI:	http://openei.org
Policy	OpenEI:	http://openei.org
	Utility Rate Database:	http://en.openei.org/wiki/Gateway:Utilities
	Transparent Cost Database:	http://en.openei.org/wiki/Transparent_Cost_Database

Thank You & Contact Information

For Technical Assistance:
IndianEnergy@hq.doe.gov.

DOE Office of Indian Energy Website:
www.energy.gov/indianenergy

NREL Technology Websites:
www.nrel.gov/learning/re_basics.html

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INFORMATION ON THE CURRICULUM PROGRAM & OFFERINGS

Curriculum Structure & Offerings

Foundational Courses

- Overview of foundational information on renewable energy technologies, strategic energy planning, and grid basics

Leadership & Professional Courses

- Covers the components of the project development process and existing project financing structures

Foundational Courses

Energy Basics

- Assessing Energy Needs and Resources
- Electricity Grid Basics
- Strategic Energy Planning

Renewable Energy Technology Options

- Biomass
- Direct Use
- Geothermal
- Hydroelectric
- Solar
- Wind

All courses are presented as 40-minute Webinars online at
www.energy.gov/indianenergy