Foundational Courses
Assessing Energy Needs & Resources

Presented by the National Renewable Energy Laboratory
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
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.
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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 (or cell based) Capacity Factor

Resource
Water Features
Urban Areas
Wetlands
Contiguous Area
Slope
Federally Protected Lands
Area of Critical Environmental Concern
Region
Available Land

Regional Generation (MWh) = Σ(available land (km²) * power density (MW/km²) * capacity factor (%) * 8760 (hours/year))

 PV Utility (Urban) Technical Potential - U.S. Counties

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

Annual average solar resource data are shown for a tilt–latitude collector. 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. 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)


AWS Truepower
Where science delivers performance.

NREL
NATIONAL RENEWABLE ENERGY LABORATORY
This study estimates the annual technical biomass resources currently available in the United States by county. It includes the following feedstock categories:

- Agricultural residues (crops and animal manure);
- Wood residues (forest, primary mill, secondary mill, and urban wood);
- Municipal discards (methane emissions from landfills and domestic wastewater treatment);
- Dedicated energy crops and switchgrass on Conservation Reserve Program lands.

This map was produced by the National Renewable Energy Laboratory for the U.S. Department of Energy. See additional documentation for more information at [http://www.nrel.gov/](http://www.nrel.gov/).
U.S. Geothermal Resources

**Geothermal Resource of the United States**

Locations of Identified Hydrothermal Sites and Favorability of Deep Enhanced Geothermal Systems (EGS)

- Map does not include shallow EGS resources located near hydrothermal sites or USGS assessment of undiscovered hydrothermal resources.
- Source data for deep EGS includes temperature at depth from 3 to 10 km provided by Southern Methodist University Geothermal Laboratory (Blackwell & Richards, 2009) and analyses (for regions with temperatures ≥ 150°C) performed by NREL (2009).
- Source data for identified hydrothermal sites from USGS Assessment of Moderate- and High-Temperature Geothermal Resources of the United States (2008).
- “N/A” regions have temperatures less than 150°C at 10 km depth and were not assessed for deep EGS potential.
- **Temperature at Depth** data for deep EGS in Alaska and Hawaiʻi not available.

*Identified Hydrothermal Site (≥ 90°C)*

This map was produced by the National Renewable Energy Laboratory for the US Department of Energy, October 13, 2009. Author: Billy J. Recknagel.
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PVWatts

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 pages 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
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http://maps.nrel.gov/pvwatts

Basic PV Modeling
In My Backyard (IMBY)

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
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http://mercator.nrel.gov/imby/
**SAM (System Advisor Model)**

**Complete System Techno-Economic Modeling**

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

**Data Analysis and Visualization Group**
Project Lead: Nate Blair
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[Link to SAM website](http://www.nrel.gov/analysis/sam)
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

- Weather Data + System Specs = Electricity Production
- Financing Options + Utility Rates & Incentives + Cost Data = Results of Annual, Monthly, and Hourly Output
  - Levelized Cost of Energy (LCOE), Net Present Value (NPV), Payback, Revenue, Capacity Factor
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
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OpenPV: Advanced Visualizations
The Solar Prospector

Citing Utility-Scale CSP

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

Data Analysis and Visualization Group
Project Lead: Ted Quinby
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http://maps.nrel.gov/prospector
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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.

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EIA data
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!)

- 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

http://en.openei.org/wiki/Transparent_Cost_Database
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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**NREL Tools Links**

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<td>OpenEI</td>
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<tr>
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# Useful Resources

## Resource

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## Technology

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<tr>
<td>CREST:</td>
<td><a href="http://financere.nrel.gov/finance/content/CRESTmodel">http://financere.nrel.gov/finance/content/CRESTmodel</a></td>
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## Policy

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Thank You & Contact Information

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

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


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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