FEDERAL ENERGY MANAGEMENT PROGRAM

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Project Planning: Determining the Best Renewable Energy Project for Your Site

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FEMP
Federal Energy Management Program

Course Objectives

This course will:

- Introduce the nine steps of a Federal renewable energy project
- Teach you to develop a Site Data Package for renewable energy (RE) studies
- Enable you to perform a preliminary RE screening for your site
  - Tools and resources
- Describe FEMP technical support

Course Overview

- Motivators and drivers for renewable energy
- Nine steps to renewable energy project planning and implementation

[**Planning**]

1. **Determining site characteristics**
2. **Renewable energy studies**

[**Implementation**]

3. Requesting and evaluating RE project proposals
4. Contract
5. Design
6. Build it!
7. Acceptance testing and commissioning
8. Performance Period: O&M and M&V
9. Closeout

- Emphasis on planning steps 1 & 2
- Q&A

FEMP Mission

FEMP
Federal Energy Management Program

Facilitates the Federal Government's implementation of sound, cost-effective energy management and investment practices to enhance the nation's energy security and environmental stewardship

FEMP Structure

Project Transaction Services

Facilitate the use of alternative finance mechanisms

- ESPC, UESC, PPA
- State and Federal incentive programs

Applied Technology Services

Provide technical support services to enable agencies to meet renewable energy and other goals

Decision Support Services

Energy outreach, guidance, training, and education to embrace energy efficiency and renewable energy

- Reporting and guidance for energy legislation and regulations
- Education and training
- Outreach and communication
- Budget and planning

Relevant Courses

- This is the third Webinar in the renewable energy series. Previous sessions include:
  - Introduction to Renewable Energy Technologies
  - Introduction to Federal Renewable Energy Goals and FEMP Services
  - Both available on-demand at: www.femp.energy.gov/technologies/renewable_training.html
- Additional FEMP training opportunities:
  - www.femp.energy.gov/training/

Motivators/Drivers for Federal Renewable Energy Projects

Motivators for Federal RE Projects

Renewable energy benefits include:

- Energy cost savings ($/year), lower life-cycle costs
- Hedge against rate increases (%/year)
- Reduction of price volatility (fuel adjustment charge)
- Job creation
- Benefits to local economy
- Reduction of hazardous waste and emissions of sulfur, heavy metals, particulates, and CO_2
- Avoidance of infrastructure cost (power line extension, upgrade) for off-grid
- LEED points

Motivators for Federal RE Projects

Compliance with requirements

- Federal requirements
- Agency goals
- Greenhouse gas (GHG) goals

Motivators for Federal RE Projects

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Federal Laws and Executive Orders

Source of Requirement	Level…	Agencies
Energy Policy Act of 2005 Federal Use Goal	3% FY07-09 5% FY10-12 7.5% FY13 and beyond On-site generation 2x bonus per EPAct 2005	All
Executive Order 13423	½ of EPAct Federal goal from new* sources	All
DoD National Defense Reauthorization Act of 2007	25% of electricity by 2025	DoD
Executive Order 13514	GHG inventory and goals	All
EISA 2007 SWH Requirement	30% of hot water needs in all new buildings or major renovations if LCC effective	All

** Developed after January 1, 1999.*

View on-demand training for Federal renewable energy goals at:
http://apps1.eere.energy.gov/femp/training/course_detail_ondemand.cfm/CourseId=23

Acronyms

General

- EM - Energy Manager
- EO - Executive Order
- FEMP - Federal Energy Management Program
- GHG - Greenhouse Gas

Renewable Energy

- PV - (Solar) Photovoltaic
- SVP - Solar Ventilation Preheat
- SWH - Solar Water Heating
- RE - Renewable Energy
- REC - Renewable Energy Certificate

Economic

- LCOE - Levelized Cost of Energy
- NPV - Net Present Value
- SIR - Savings to Investment Ratio

The Nine Steps: Federal Renewable Energy Project Planning and Implementation

Steps of a Federal RE Project

1. Facility and energy characteristics
2. Renewable energy studies
3. Requesting and evaluating RE project proposals
4. Contract
5. Design
6. Build it!
7. Acceptance testing and commissioning
8. Performance period
9. Closeout

www.femp.energy.gov/technologies/renewable_projectplanning.html

Planning steps:

1. Facility and energy characteristics
   - Gather site-relevant data to analyze RE project merits
     - Look up energy usage information
     - Identify local incentives from state or utility
2. Renewable energy studies
   - Determine if systems exist that match energy needs, fit well with building or site, and are cost-effective

Implementation steps:

3. Requesting and evaluating RE project proposals
4. Contract
5. Design
6. Build it!
7. Acceptance testing and commissioning
8. Performance period
9. Project closeout

- Steps 3-9 will be covered in detail in a future webinar
- Check FEMP Web site for availability
  - www.femp.energy.gov/training/

Step 1:

Facility and Energy Characteristics

Energy and facility characteristics:

Collect relevant data for renewable energy study

- Energy characteristics
  - Energy usage and cost
- Facility characteristics
  - Physical attributes / Real estate
    - Address, latitude/longitude
    - Characteristics of each building
    - Surrounding grounds
    - What is owned, leased out, or leased by your agency

ENERGY MANAGER IS KEY TO THIS PROCESS

Energy Characteristics

What you need to find out:

- How much energy is being used?
- How much does it cost?
- Where does it go?
  - Which buildings sub-meter data
- What is it used for?
  - Space heating
  - Ventilation rates
  - Lighting
  - Hot water: temperature, gallons/day

Electricity and fuel bills:

- Gather bills (at least 12-24 months)
- Calculate
  - Total annual usage (kWh/yr, therms/yr)
  - Total costs ($)
  - Unit costs ($/kWh, $/therm)
  - Fuel type (electricity, natural gas, propane, oil)
  - Totals by month (seasonal variations)
- Generators
  - Off-grid vs. backup power
  - Fuel costs

Compile monthly electricity and fuel bills

- Locating data
  - Finance department
  - Facilities reports
  - Environmental Management Systems
- What to look for
  - Electricity consumption (kWh) and rates ($/kWh)
  - Natural gas consumption (CCF, Therms, Btu or MMBtu) and rates ($/unit)
  - On-peak and off-peak rates
  - On-peak start time and stop time
  - Utility provider
- Deciphering bills
  - Consult your finance department
  - Contact the utility company

Understanding common charges on utility bills

- **Fixed Monthly Charge:** $/month
- **Demand Charge:** $/kW is highest demand over 15-minute interval in given time period each month
- **Flat Rate:** Per unit price does not change (i.e. $/kWh)
- **Block Charge Rate:** Inclining or declining rate within a set 'block' of unit use
  - With a declining block, the more kW used, the lower the unit price; reverse is true for an inclining rate
- **Ratchet Rate:** Highest monthly demand becomes annual peak, which is used to ratchet the monthly demand peaks for the next 11 months
  - If peak demand for last summer was 500 kW and there is a 50% ratchet, minimum billing would be 250 kW for the following months, regardless of actual low
- **Time of Use Rate:** Based on when the electricity is used (typically broken into day-time and night-time/weekend rates
- **Power Factor Costs:** Utilities usually charge large customers, those with power factors less than about 0.95, additional fee

Determine on-peak and off-peak rates

- On-peak and off-peak times and rates
  - May be labeled Time of Use (TOU) rates, Time Advantage Plans, etc.
- Why it matters
  - RE system may be more cost-effective in TOU plan
    - For example, PV electricity production times often match well with TOU rate structures; value of electricity production may be considerably more than the calculated average cost ($/kWh)

Example outcome: Office building

- Facility square footage: *1,048,588 ft²*
- Energy use intensity (Btu/ft²) = 135,923,899,314 Btu / 1,048,588 ft² = 129,626 Btu/ft²

FY 2007						
Month	**Electricity (kWh)**	**Electricity Cost ($)**	**Natural Gas (MMBtu)**	**Natural Gas Cost ($)**	**Blended Electric Rate ($/kWh)**	**Natural Gas Cost ($/MMbtu)**
Oct	1,702,980	$210,695	2,441	$41,346	$0.124	$16.93
Nov	1,719,187	$180,928	5,625	$95,252	$0.105	$16.93
Dec	1,706,360	$179,405	7,507	$127,129	$0.105	$16.93
Jan	1,647,561	$172,841	8,979	$152,051	$0.105	$16.93
Feb	1,369,987	$148,524	10,613	$179,739	$0.108	$16.94
Mar	1,572,267	$170,241	6,246	$105,777	$0.108	$16.94
Apr	1,627,932	$176,876	4,986	$83,452	$0.109	$16.74
May	1,746,887	$188,993	3,437	$58,219	$0.108	$16.94
Jun	2,224,046	$242,833	3,390	$57,403	$0.109	$16.93
Jul	2,109,209	$286,266	3,862	$65,399	$0.136	$16.94
Aug	2,291,444	$250,055	3,968	$67,191	$0.109	$16.94
Sep	2,120,918	$269,802	334	$5,648	$0.127	$16.94
Totals	***21,838,778***	***$2,477,459***	***61,388***	***$1,038,603***	***$0.113***	***$16.92***

Facility Characteristics

Real estate data for each building

- Owned, leased, or leased out
- Characteristics
  - Location (address, longitude and latitude)
  - Square footage
  - Number of floors
  - Typical number of occupants
  - Function (office, warehouse, dormitory, etc.)
  - Unusual features (pool, chemical storage, etc.)
  - Age, condition of roof
  - Atypical energy needs (high ventilation, etc.)
    - Helps estimate hot water, heated ventilation demands
- Surrounding grounds
  - Size
  - Availability of land for renewable energy installations

Step 2:

Renewable Energy Studies

Step 2: RE Studies

- Goal:
  - Identify which RE technologies fit site needs
  - Determine technical, economic viability
- Vary in complexity, cost, and application
- Consider site energy costs, energy needs, site characteristics, RE resources, and available incentives

Step 2: RE Studies

Financial viability depends on several factors:

- Local renewable resources
  - Solar
  - Wind
  - Biomass (agricultural, forest, industrial)
  - Geothermal
  - Site-generated wastes
- Cost of utility energy, RE systems
- Financial incentives
  - Federal and state tax benefits, captured through alternative financing.
  - Incentives ($/kW or $/kWh) offered by utilities and state

Step 2: RE Studies

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Level		Who / Where	Outcome, usefulness	Tools Used	Other Notes
1	Preliminary Screening	Energy Manager	Reality check. Go/No-Go. Simple Payback. **Possible** SIR, NPV, LCOE*	Maps, rules of thumb, easy to learn on-line tools (IMBY, RETScreen)	Results in a local RE champion and on-site expertise.
2	Screening	RE Expert. No site visit.	Identify dead-ends and ***potential*** opportunities. For RFPs, budgeting engineering studies. **Probable** SIR, NPV, LCOE*	Calculations by hand or sophisticated analysis software (e.g. REO).	High level look. Analysis based on region and site's utility needs and costs. Can be applied across multiple sites or to facilities within a single site.
3	Feasibility Study	RE Expert. Site visit.	Identify dead-ends and ***good*** opportunities. For RFPs, budgeting engineering studies, direct appropriations decisions. **Likely** SIR, NPV, LCOE*	Calculations by hand or sophisticated analysis software (e.g. REO).	On the ground: more detailed and comprehensive, fewer assumptions. Considers RE integration with actual site, building, and system details.

* LCOE – Levelized Cost of Energy, NPV – Net Present Value, SIR – Savings to Investment Ratio

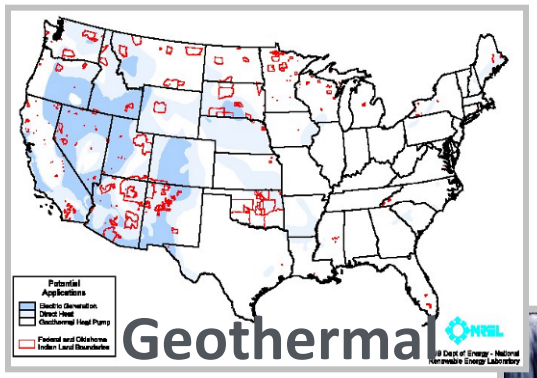
Level 1 Preliminary Screening

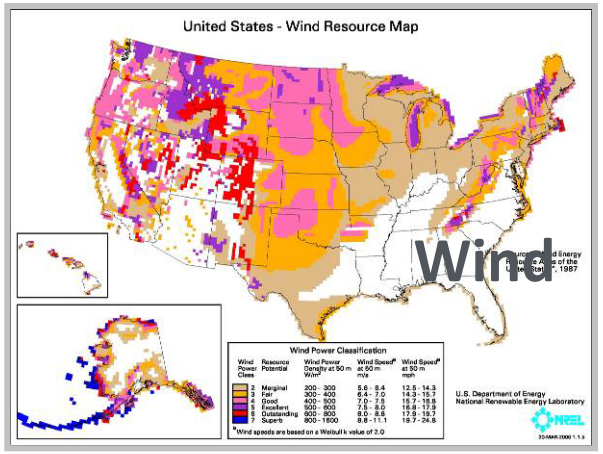
Information sources:

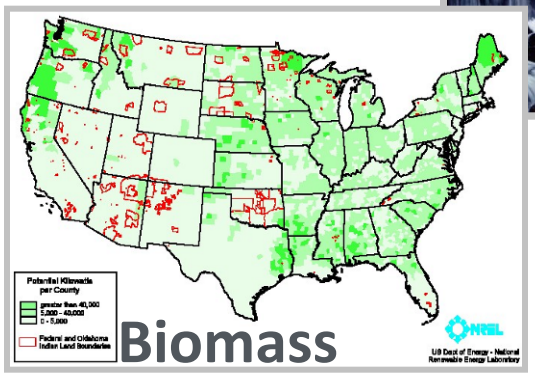
- NREL renewable energy resource maps
- FEMP renewable energy financial analysis maps
  - Technologies:
    - Photovoltaics, solar hot water, solar vent preheat
  - Analyses:
    - Electricity rate needed to produce SIR = 1
    - System cost needed to produce SIR = 1
  - Savings to Investment Ratio (SIR)
    - Measure of project viability
    - SIR > 1, savings exceed costs, good investment
    - SIR < 1, costs exceed savings, poor investment

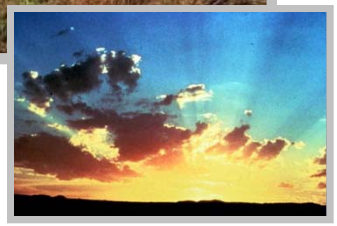
http://www.nrel.gov/gis/femp.html

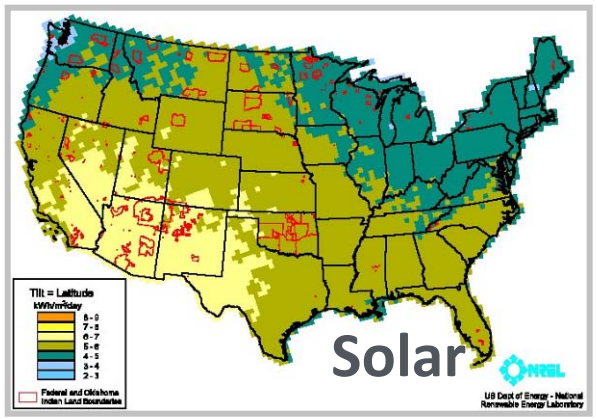
Resources Maps











Renewable resources maps accessible at:
www.eere.energy.gov/maps_data/renewable_resources.html

FEMP RE Financial Analysis Maps

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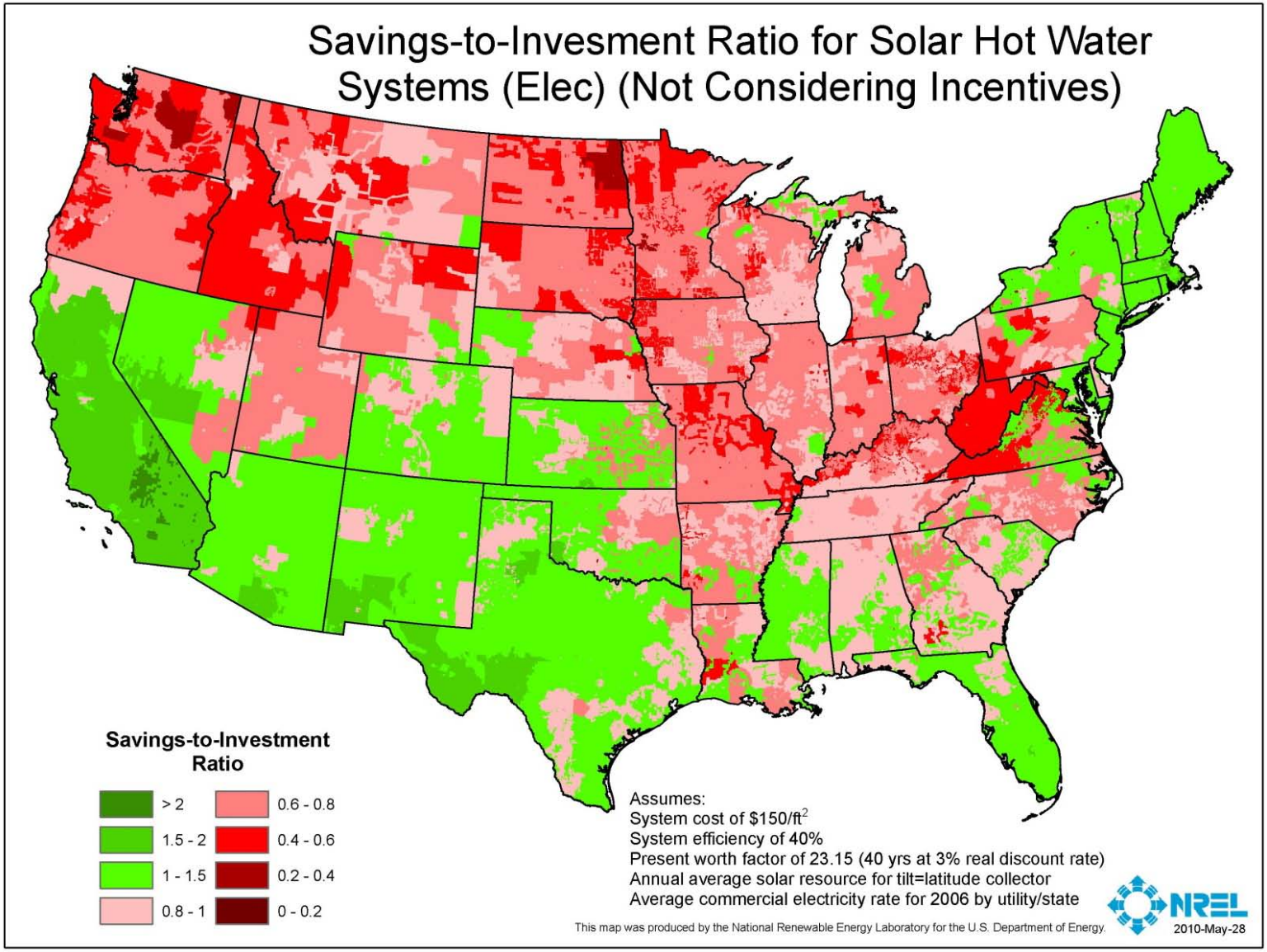
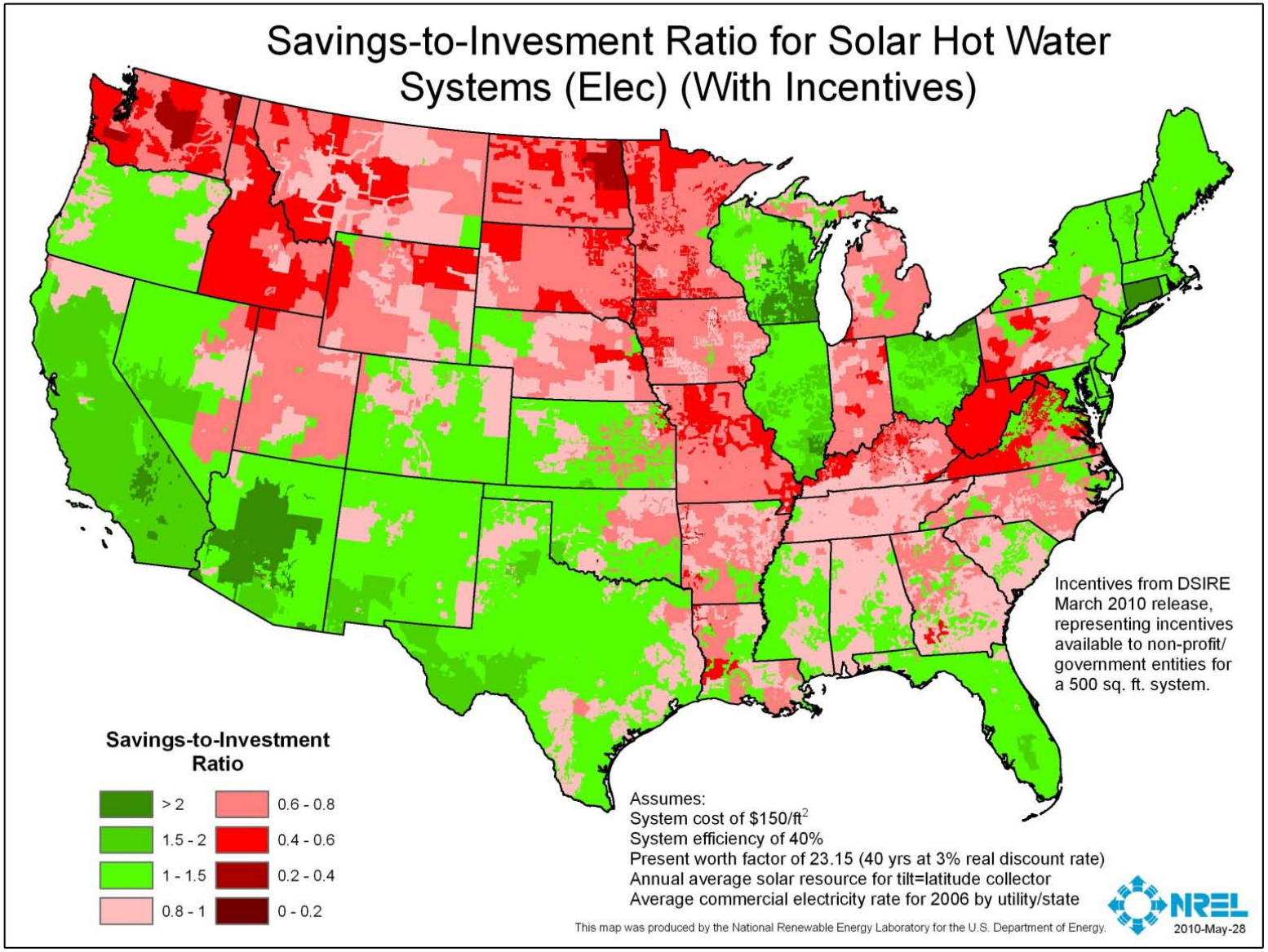


FEMP RE Financial Analysis Maps



Free online assessment tools

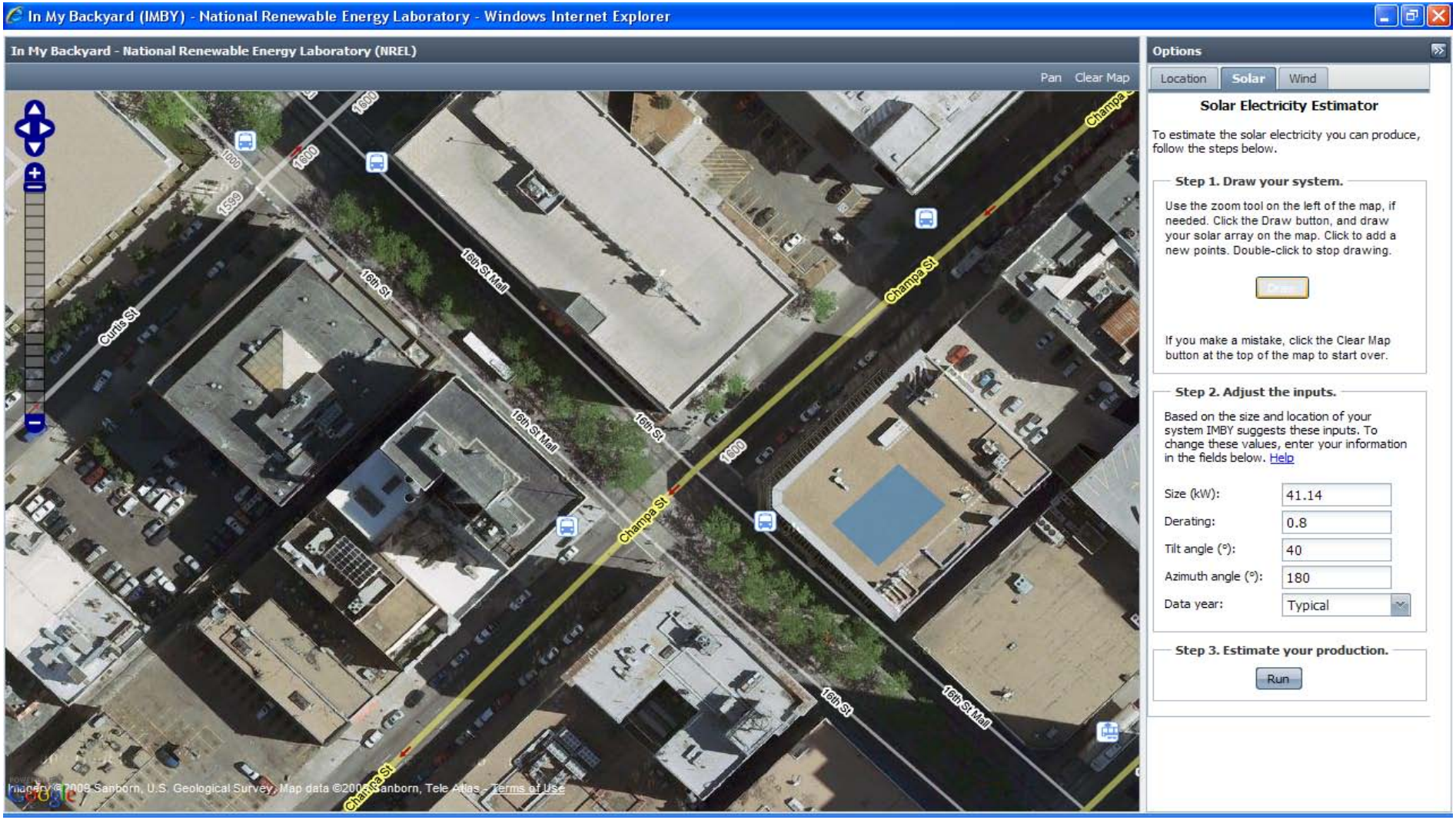
- In My Back Yard (IMBY)
  - Web-based software tool that estimates electricity produced by a photovoltaic array and wind turbines
- RETScreen
  - RE and energy efficiency technologies
  - Training opportunities
  - www.retscreen.net/ang/home.php
- Other tools:
  - www.nrel.gov/analysis/analysis_tools.html

In My Back Yard

- Google Maps Web interface
- Estimates PV system size suitable for roof or open space, based on user-drawn boundaries
- Easy to learn
- PV system output plus simple payback
- Wind system kWh output only
  - Works for only 30 US states with available data

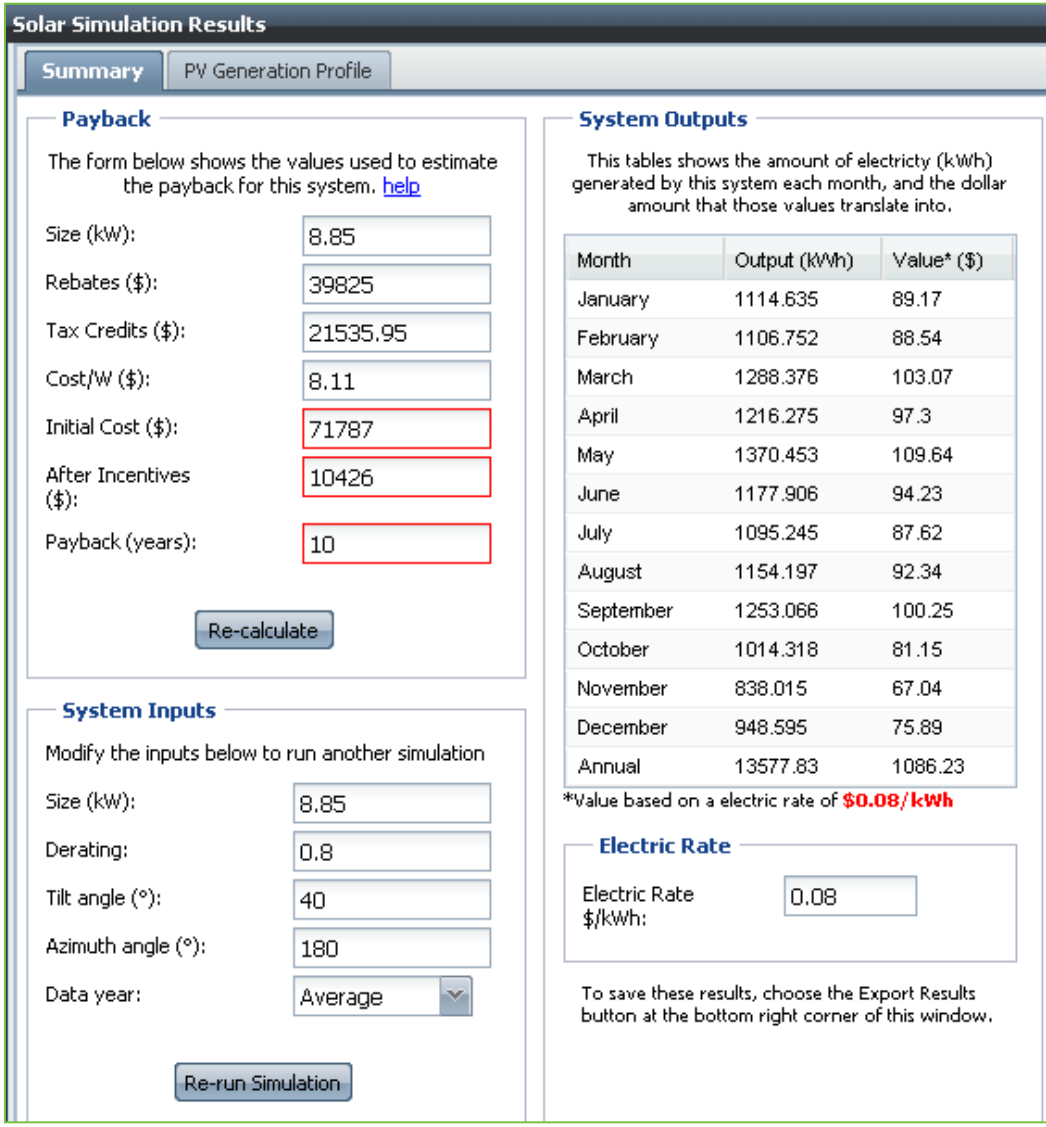
www.nrel.gov/eis/imby/

IMBY Interface



Outputs

- Estimate of power production, value, and simple payback
- Rebates, tax incentives pulled from DSIRE database
- Easy to adjust system inputs and costs for "what-if" analysis
  - For example, tilt angle



Level 1 Considerations: Site

RE in open space

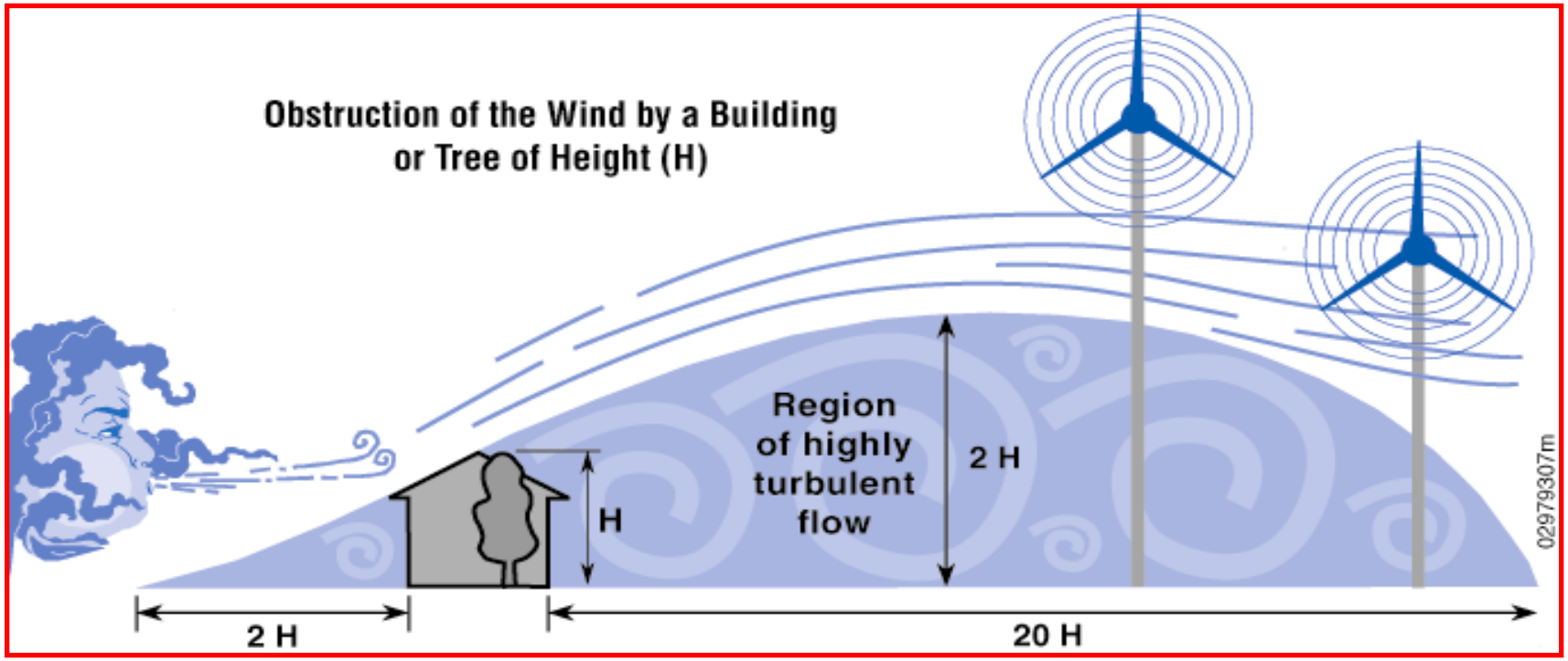
- Ground-mounted PV
- Wind turbines
- Ground source heat pump wells
- Central plant: Biomass, solar thermal, geothermal power

RE for buildings

- Rooftop PV
- Solar water heat
- Solar ventilation preheat
- Daylighting

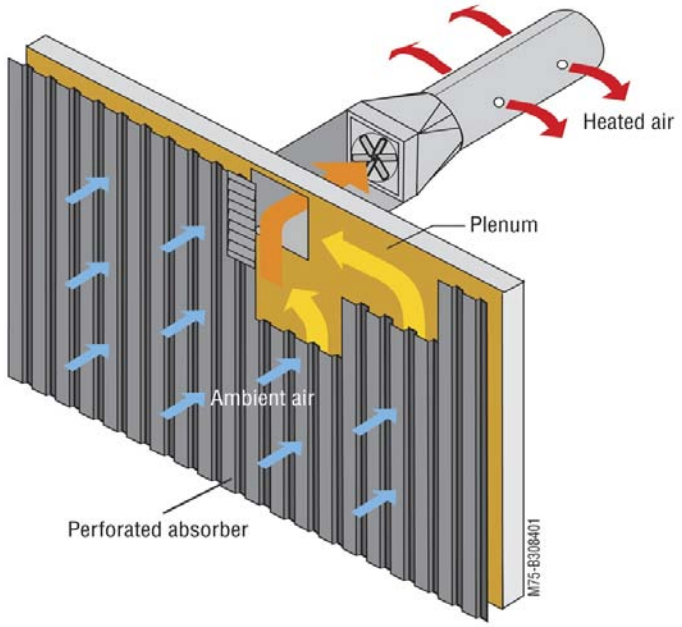
Level 1 Considerations: Wind Turbines

- Turbines need to stand out
- Wind resource far more site-specific than solar
- For larger turbines, 30 meters or taller meteorological (MET) towers erected to determine site's resource
- MET studies often one year or longer



Level 1 Considerations: Solar Ventilation Preheat (SVP)

- Applications that require space heating and outside air ventilation
- South wall, solar exposure
- Fits aesthetically with shops, recreation centers, warehouses, office buildings
- Easier/cheaper to install if intake vents are on or close to south wall
- ~4CFM/ft2
- Relatively short payback
- Easy analysis with RETScreen
  - www.retscreen.net/ang/home.php



Level 1 Considerations: Rooftop PV and SWH

- Open/unshaded "view" to southern sky
- 20 to 30-year life expectancy; roof condition, age, and warranty are important
- PV particularly sensitive to shading
  - Open roof areas free of large HVAC equipment, away from parapet wall, shadowing from adjacent buildings, etc.
  - For PV, 8 to10 Watts/ft2

Level 1 Considerations: Daylighting

- Can be more cost-effective in industrial buildings/warehouse
  - Open ceilings
- Includes light sensors and lighting controls
  - Consider in conjunction with lighting upgrades for improved economics
- Skylights, windows, translucent wall panels

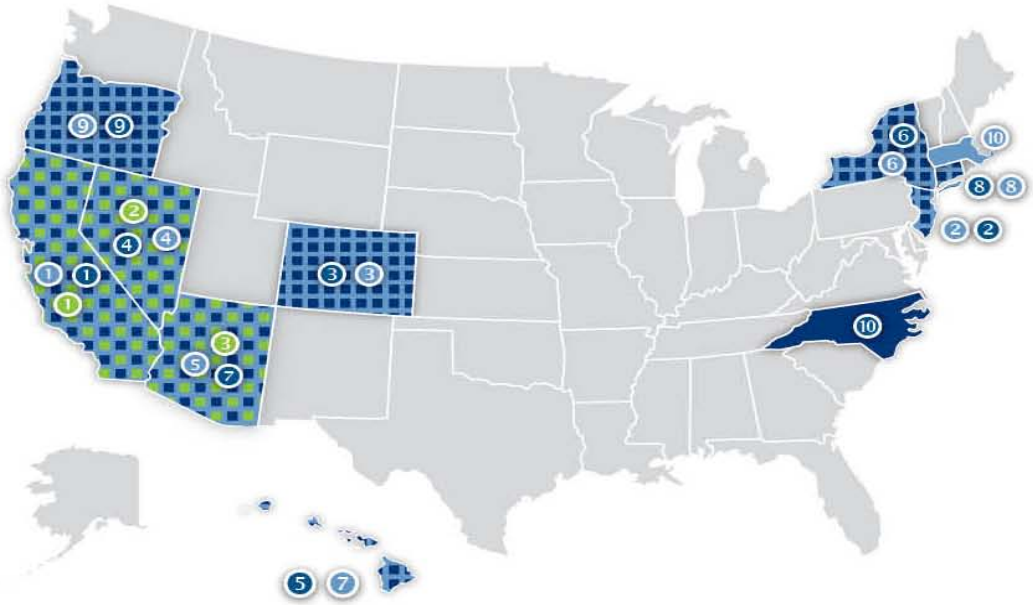
Level 1 Considerations: Practical

- Per unit of energy, electricity is a considerably more expensive heating source than fuels
- Per unit of energy, propane is considerably more expensive than natural gas
- Where electricity or propane is used for space heating or water heating, SVP and SWH payback is much faster
- Due to economy of scale, buildings with higher hot water usage have improved payback for SWH
- Think RE when replacing equipment, remodeling, or planning new construction
  - EISA 2007: 30% of water heating load to be met by SWH
  - Incremental cost of RE more cost-effective than replacement costs for equipment that still has useful life
- Operation and maintenance (O&M) costs

Significant impact of incentives

- States with greatest resources do not necessarily lead in RE development

States Leading Solar Energy Development

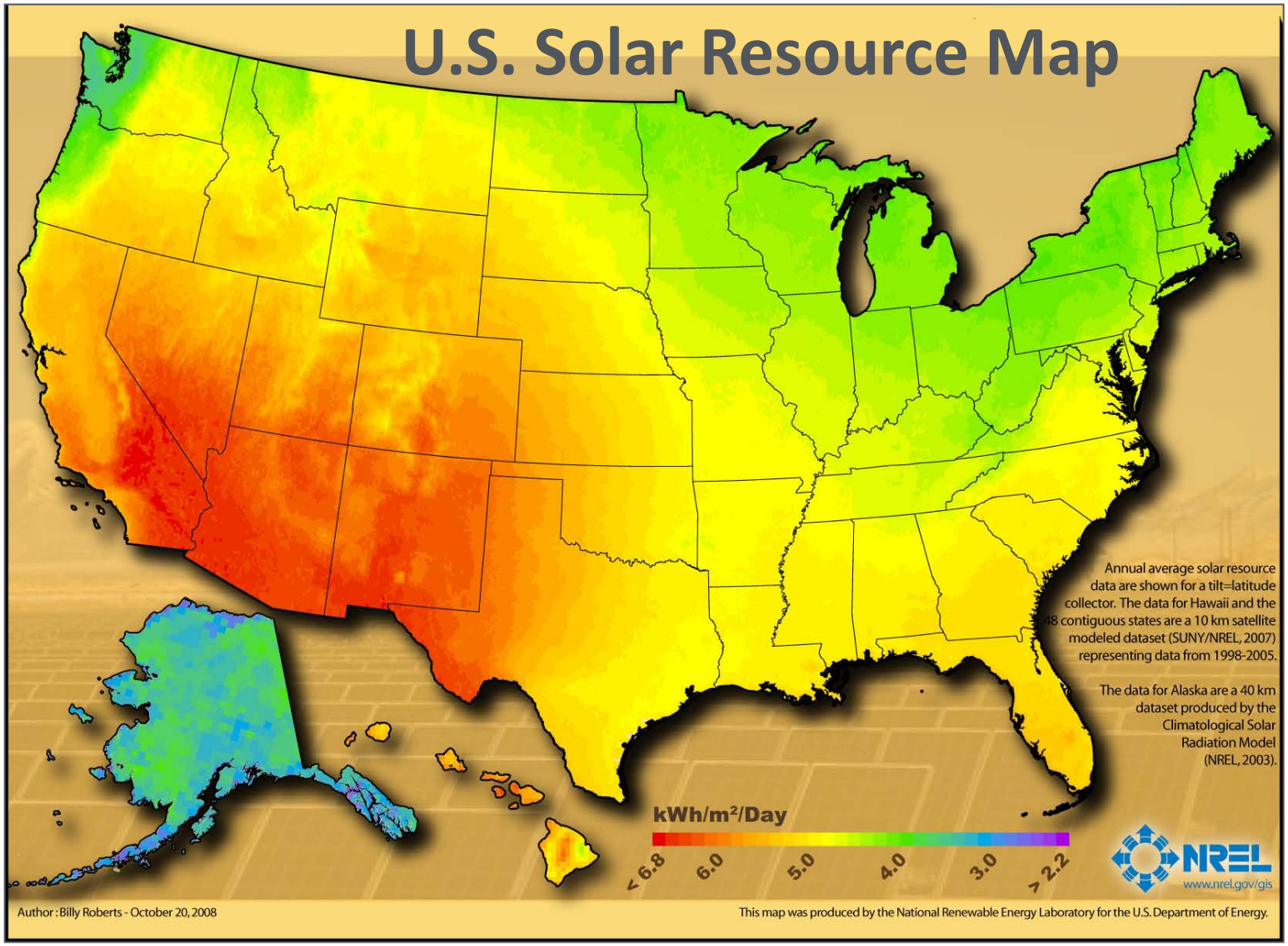


PV Cumulative Capacity (2008, MW)	
1 California	528.3
2 New Jersey	70.2
3 Colorado	35.7
4 Nevada	34.2
5 Arizona	25.3
6 New York	21.9
7 Hawaii	13.5
8 Connecticut	8.8
9 Oregon	7.7
10 Massachusetts	7.5

PV Annual Capacity Additions (2008, MW)	
1 California	178.7
2 New Jersey	22.5
3 Colorado	21.7
4 Nevada	14.9
5 Hawaii	8.6
6 New York	7.0
7 Arizona	6.4
8 Connecticut	5.3
9 Oregon	4.8
10 North Carolina	4.0

CSP Cumulative Capacity (2008, MW)	
1 California	354
2 Nevada	64
3 Arizona	1

Level 1 Considerations: Financial Incentives



Level 1 Considerations: Financial Incentives

Database for State Incentives for Renewables and Efficiency (DSIRE)

- www.dsireusa.org
- Types of incentives: Federal, state, local, utility
  - Corporate, personal income, sales, and property tax incentives
  - Grant programs
  - Industry recruitment incentives
  - Leasing/lease purchase programs
  - Loan programs
  - Production incentives
  - Rebate programs
  - Renewable energy certificates (RECs) sales

Existing vs. planned sites

- For existing sites, consider present cost of power and future project costs
- For planned site, consider cost to add power, extend grid, etc.
- For off-grid site, consider costs of transporting fuel, security, and environmental safety risks, etc.

Level 2 Screening

Screening:

- Identifies dead ends and ***potential*** opportunities
- Is conducted by a renewable energy expert
- Uses calculations and/or sophisticated analysis software to identify likeliest opportunities
- Does not usually involve a site visit
- Results used in RFPs, budgeting, engineering studies

Level 2: Finding Technical Support

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- FEMP
  - Energy/facility managers can apply for screening through FEMP
- GSA Blanket Purchase Agreement (<$3,000)
- RE vendors, consultants
- Some utility providers

www.femp.energy.gov

Level 3 Feasibility Study

Level 3 Feasibility Study

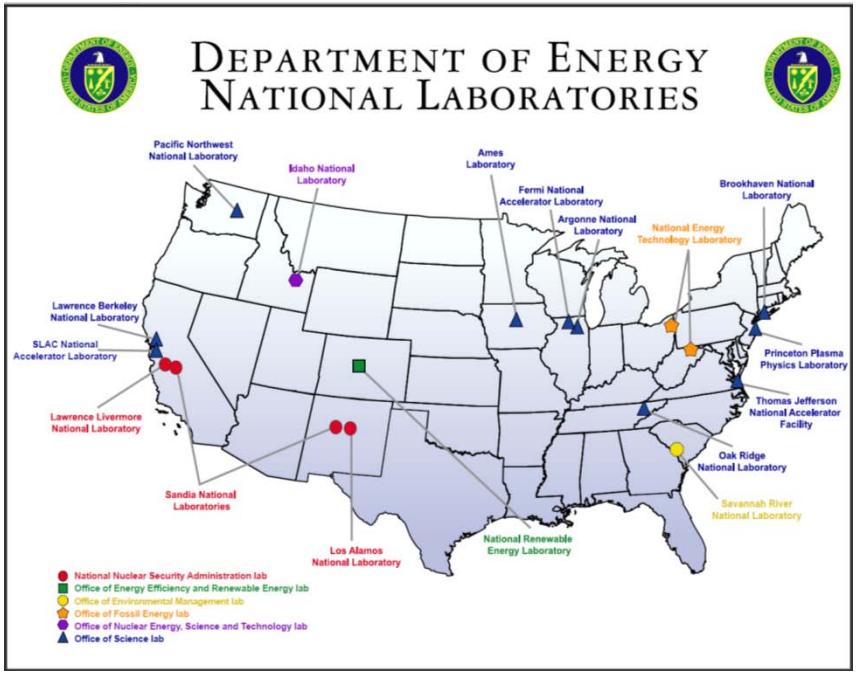
Feasibility study:

- Conducted for site(s) after screening reveals high potential
- Involves expert who conducts detailed technical and economic study, including environmental and other constraints, for each opportunity
- Usually requires site visit
- Results in recommendations of technologies and project financing mechanisms to pursue

Level 3: Finding Technical Support

Sources:

- FEMP, through limited funding and occasional Call for Projects
- GSA BPA
- RE vendors, consultants
- Some utility providers
- National labs through Work for Others agreements



Blanket Purchase Agreements (BPAs)

- GSA's Comprehensive Professional Energy Services (CPES) BPA program maintains list of pre-qualified providers who can assist Federal agencies with RE screening and assessment
- Use a credit card for $3,000 or less
- Providers guaranteed to have capabilities and rates suitable for screening or other work
- For more information:
  - www.gsa.gov/Portal/gsa/ep/channelView.do?pageTypeId=17110&channelPage=%252Fep%252Fchannel%252FgsaOverview.jsp&channelId=-26649
  - www.femp.energy.gov/news/news_detail.html?news_id=15826

RE Project Implementation

Steps 3 - 9

Recap: Nine Steps of Federal RE Project

Planning

1. Facility and energy characteristics
2. Renewable energy studies

Implementation

3. Requesting and evaluating RE project proposals
4. Contract
5. Design
6. Build it!
7. Acceptance testing and commissioning
8. Performance period
9. Closeout

www.femp.energy.gov/technologies/renewable_projectplanning.html

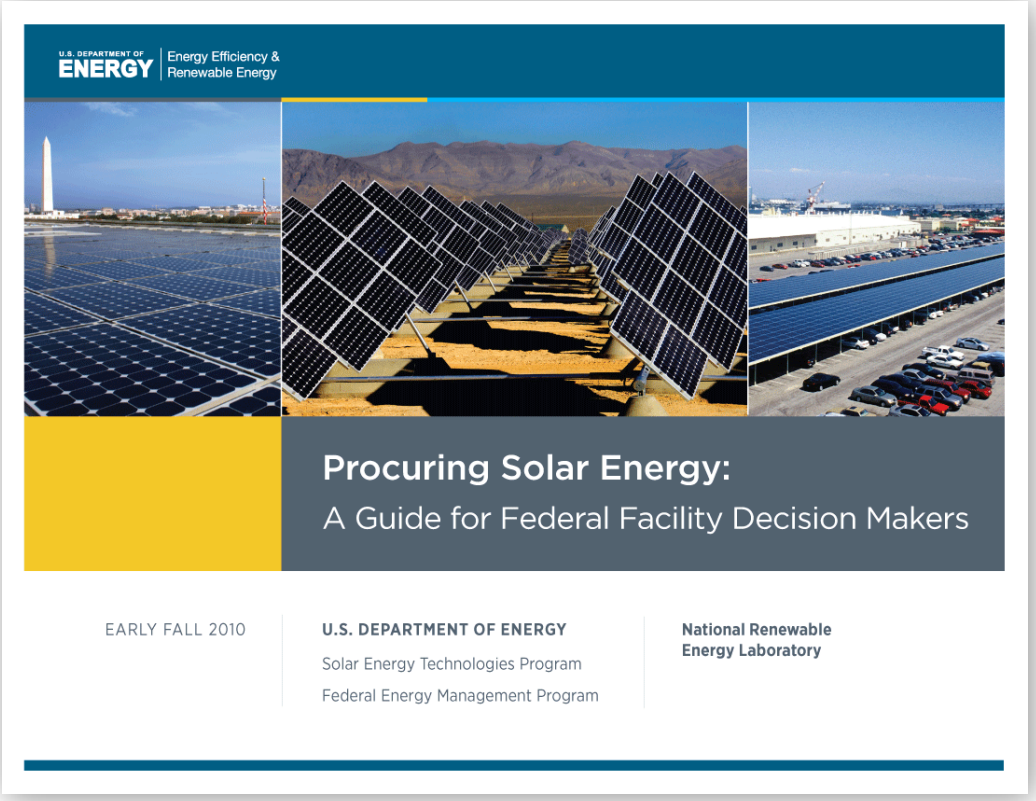
In Conclusion

- It has never been easier to learn about renewable energy and perform preliminary screenings.
- Jump in, ask questions, get informed.
- As on-site expert and champion, you can make projects happen.
- Capitalize on FEMP's excellent resources available to the Federal sector.
- www.femp.energy.gov

Resource Information

Audience and purpose

- Designed for building, energy, and project decision makers
- Describes importance of solar projects and preliminary solar site screenings
- Guides you through planning and execution steps of solar projects on a federal site – from identifying needs and goals through project closeout



www.solar.energy.gov/fed_facility_guide.html

Additional Resources

- Federal Energy Management Program (FEMP): www.femp.energy.gov
- FEMP Renewable Energy: www.femp.energy.gov/technologies/renewable_energy.html
- FEMP Renewable Energy Contacts: www.femp.energy.gov/technologies/renewable_contacts.html
- Other FEMP Contacts and Customer Service Representatives: www.femp.energy.gov/about/contacts.html
- Training Database: www.femp.energy.gov/training
- Database of State Incentives for Renewables and Efficiency: www.dsireusa.org/