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Charting a Course to Energy Independence

Providence, RI
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Assessing Renewable Energy Opportunities

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Agenda

- Renewable Energy Sources Assessment Approach
  - Biomass/Waste-to-Energy
  - Wind
  - Solar
  - Ground Source Heat Pumps
  - Geothermal
- Renewable Project Economics
  - Incentives & tax credits
  - Fort Carson example
  - Financial Analysis Tool

Renewable Energy Assessment
Technical Approach

- Energy characterization
  - Demand and electricity consumption
  - Electric rate - $/kWh and blended rate
  - Significant changes to future consumption
- Resource availability on and near site
- Development costs
  - What technologies, if any, are economic?
- Financing options
- Implementation suggestions

Biomass/WTE - Resource

- Agricultural
  - Crop residues
  - Animal waste
  - Dedicated energy crops
- Forest
  - Thinnings
  - Logging slash
- Industrial
  - Mill residue
  - Other industry waste
- Waste
  - Municipal solid waste (MSW)
  - Construction and demolition (C&D) waste
  - Landfill gas
  - Biogas or biosolids from wastewater treatment plants

Biomass/WTE - Approach

- Find amount of each resource available within 60 miles of site (considering collectability and competing markets)
- Calculate how much electricity could be generated
- If >1 MW, use spreadsheet tool to estimate levelized cost of electricity produced for each technology and resource
  - Feedstock cost (collection, transportation, tipping fees, etc.)
  - Plant development costs
  - Size of plant
- Detailed economic analysis for feasible resources (consider incentives, taxes, financing)

Municipal Solid Waste Example

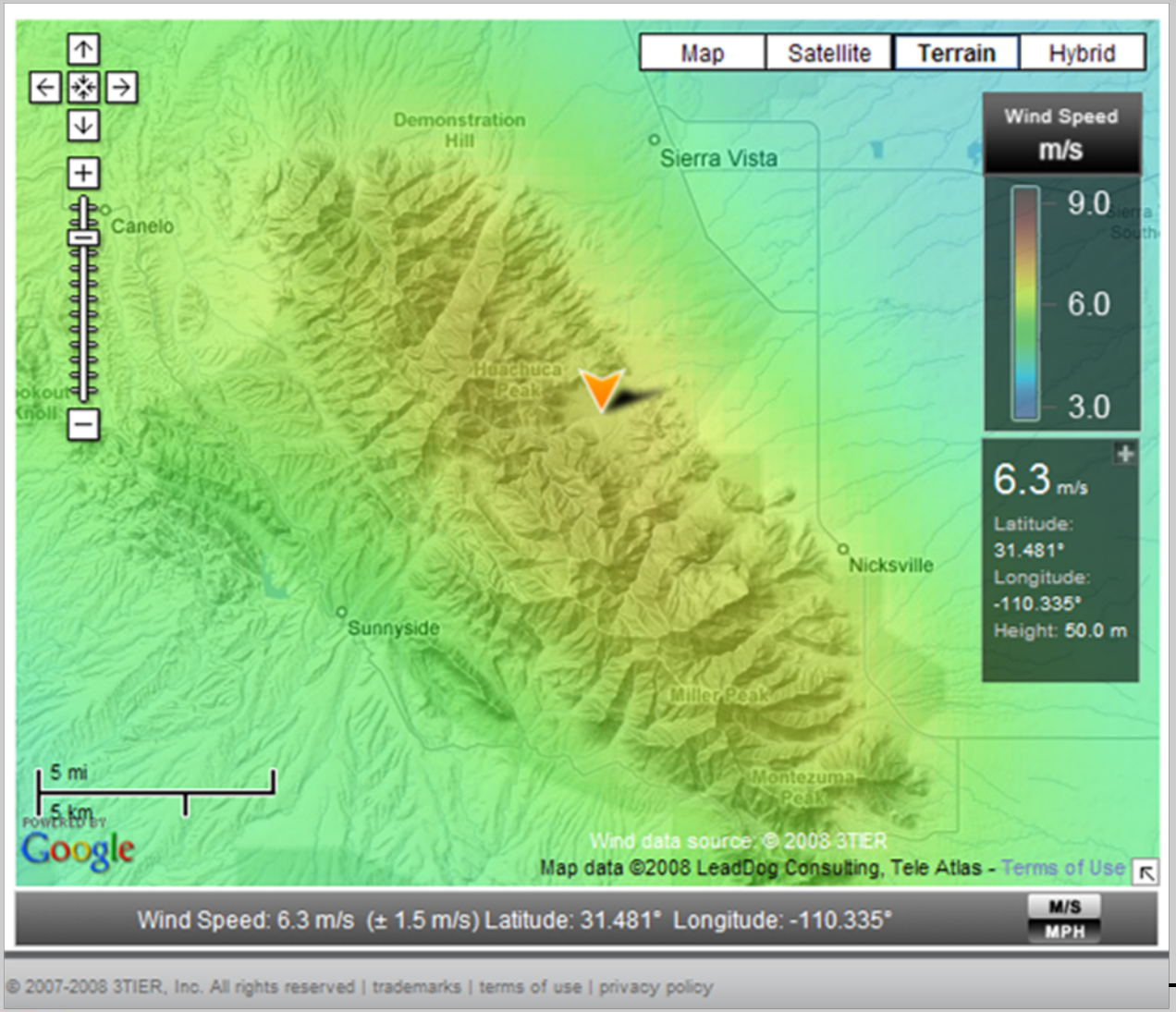
Site	Collection Location	Miles from Fort	Tipping Fee ($)	Assumed Cost Savings ($)	Available MSW (tons/year)	Potential Electricity Generation (MW)
Fort XXXXX	Fort XXXX	0	$42	$27	10,000	1.1
City Landfill	City	1	$35	$20	31,874	3.5
Cochise County Western Regional Landfill	Whetstone	3	$45.50	$30.50	87,509	9.6
Elgin Landfill	Sonoita	20	$36	$21	1,508	0.2
Rio Rico Landfill	Rio Rico	30	$36	$21	42,237	4.6
Sahuarita Landfill	Sahuarita	45	$23.50	$8.50	61,922	6.8
Speedway C&D Landfill	Tucson	55	$25	$10	24,345	2.7
Los Reales Landfill	Tucson	55	$23	$8	515,321	56.5
Sierra Vista Transfer Station	Sierra Vista	1	$45.50	$30.50	29,112	3.2
Benson Transfer Station	Benson	25	$45.50	$30.50	9,319	1.0
Bisbee Transfer Station	Bisbee	25	$45.50	$30.50	7,151	0.8
				TOTAL	**764,716**	**83.8***

Wind - Resource

- Need minimum of a Class 3 wind resource with average annual winds of at least 6.4 m/s (14.3 mph)
- Methods used to characterize wind resource:
  - Meteorological (Met) tower @ 50 m height with 1 yr data (minimum requirements for project development)
    - Sodar and Lidar are new methods being used to compliment met tower data collection
  - Nearby wind data with similar elevation
  - Wind mapping tools: clickable maps that give annual average wind speed at difference levels of resolution
    - Wind Navigator from AWS Truswind (2.5 km)
    - First Look from 3TIER (5 km)
  - NASA Atmospheric Science Data Center surface meteorology data set is used to determine atmospheric conditions (temperature, pressure, wind direction at different times, and corollary wind data)

Photo credit: Jennifer States

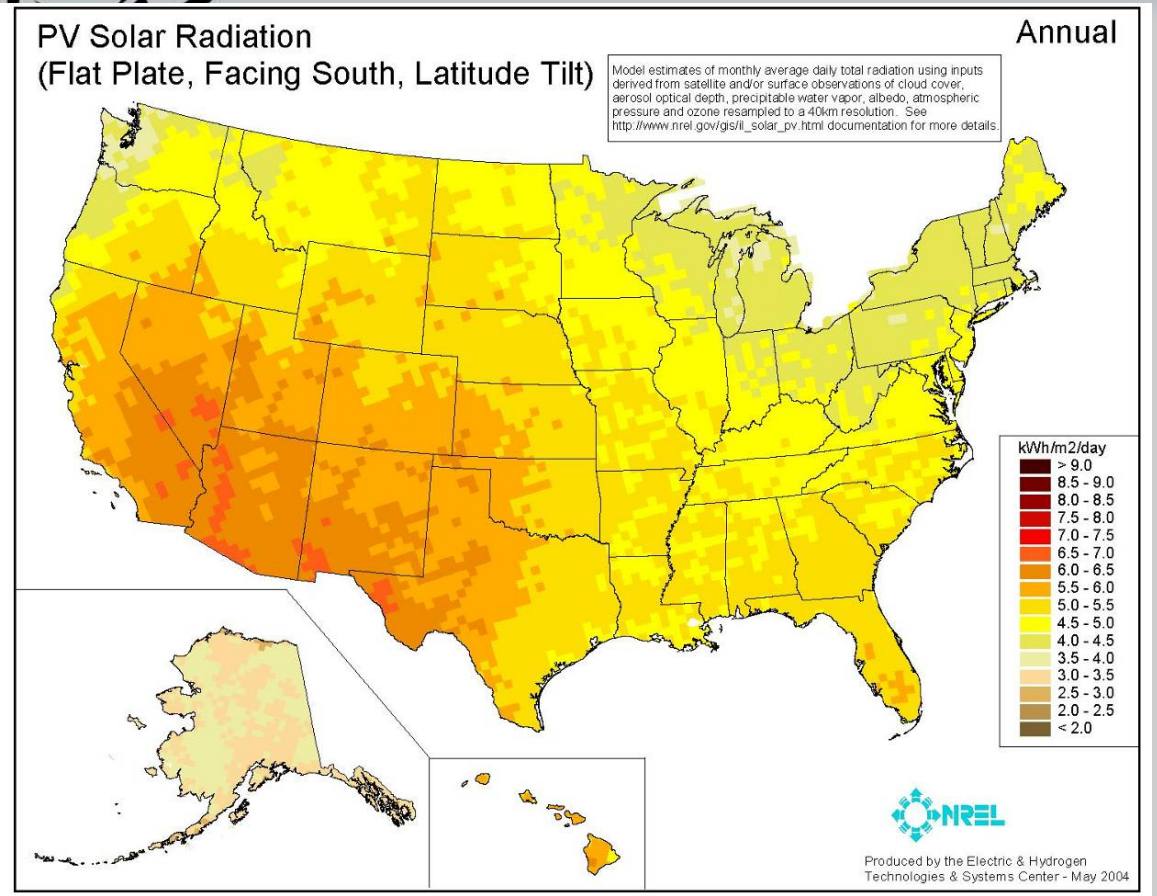
3TIER FirstLook Map



Wind - Approach

- Find best sources available for wind data to determine if sufficient wind resource exists.
- Review maps of land use and transmission lines to determine if potential interconnection location exists near high wind area.
- Utilize land and IC information, along with energy use estimates provided by the site, to estimate potential project size.
- Calculate potential capacity factor and energy output per turbine
- Estimate total project costs including project development, generation equipment, balance of plant construction, IC and transmission, O&M, available incentives, and taxes.
- Run detailed economic analysis to determine if project is economically viable (consider both IPP and ECIP financing scenarios).

Solar - Resource



- U.S. DOE Solar energy maps
  - Flat plate collector
  - Single axis tracking
  - Double axis tracking
- National Resources Canada
  - RETscreen solar energy model
- NASA
  - Surface meteorology and Solar Energy

Maxwell, E, R. George, and S. Wilcox, "A Climatological Solar Radiation Model," Proceedings of the 1998 Annual Conference, American Solar Energy Society, Albuquerque NM.

Marion, William and Stephen Wilcox, 1994: "Solar Radiation Data Manual for Flat-plate and Concentrating Collectors." NREL/TP-463-5607, National Renewable Energy Laboratory, 1617 Cole Boulevard, Golden, CO 80401.

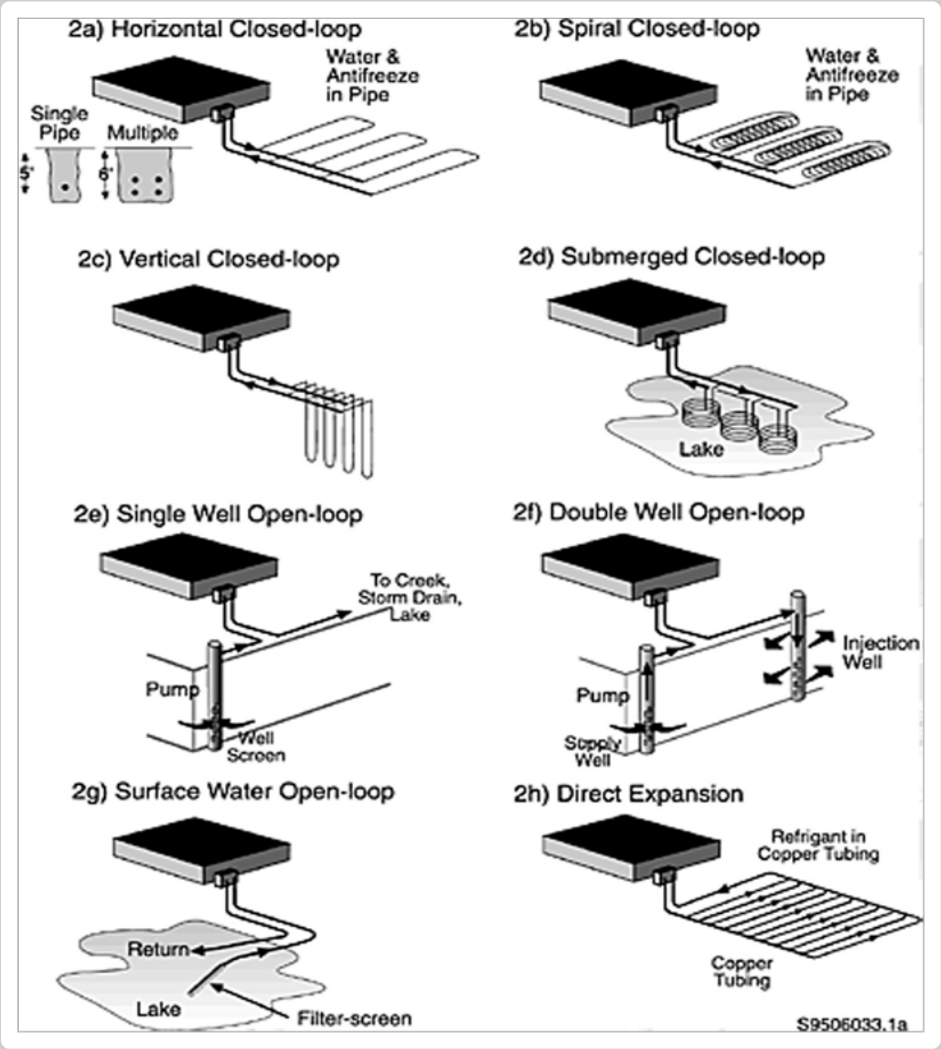
Solar - Approach

- Identify solar potential
  - Determine seasonal and annual solar radiation from existing sources
- Identify potential development areas
  - Installation-specific sites
  - Potential users of generated energy (on-site or off-site)
  - Existing electrical transmission system
  - Potential users of waste thermal energy (building, process, central energy plants)
- Based on site-specific inputs, determine applicable solar technology

Ft. Carson Solar PV project

Ground Source Heat Pumps - Technology

- Open-Loop
  - Need water source and sink (1.5-3.0 gpm/ton)
  - Regulatory issues?
- Closed-Loop
  - Horizontal
    - Need ~4-5x building floor area
  - Vertical
    - Need ~1/2x building floor area

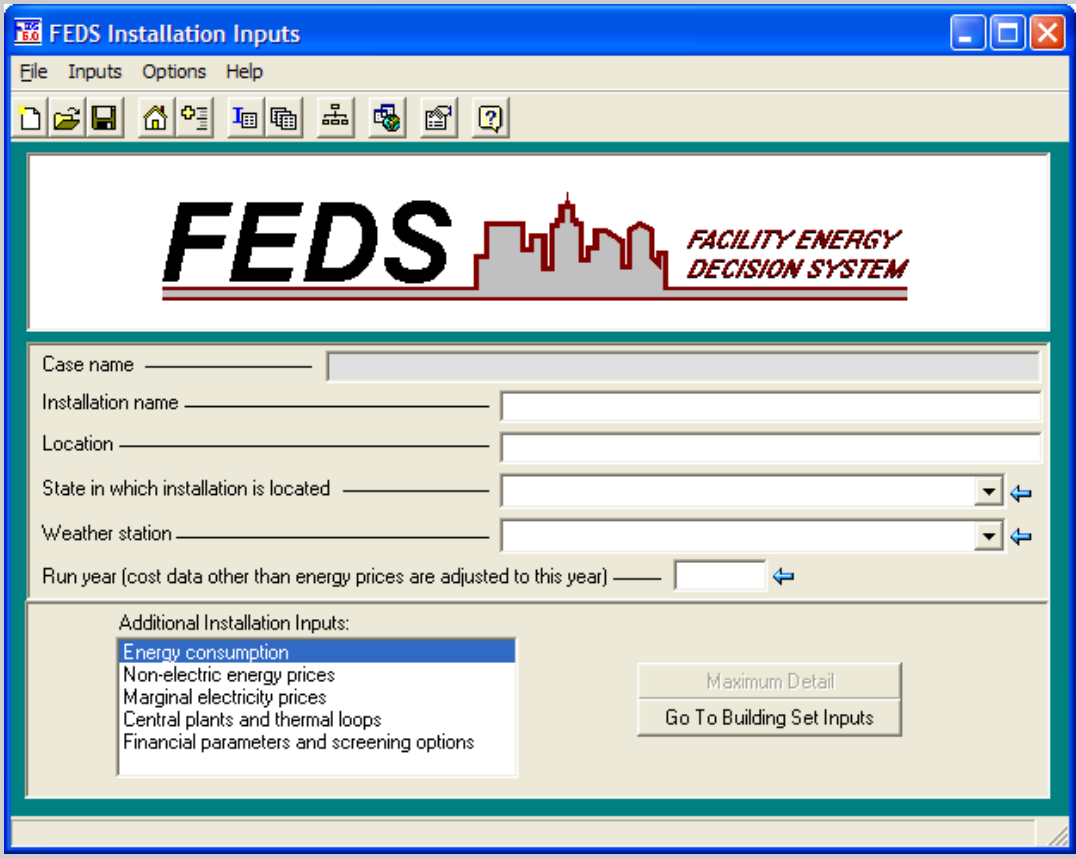


Ground Source Heat Pumps - Resource

- Thermal energy not electricity generation
- Will work anywhere, but some conditions are cost-prohibitive
  - Deep groundwater – expensive open-loop wells
  - Rocky surface – expensive trenching
  - Dry, sandy soil – low thermal conductivity
  - Mild climate – less significant savings
- Retrofit or new construction

Ground Source Heat Pumps - Approach

- Optimizes building & site energy costs
- Restricted to GSHP retrofits only
- Uses site-specific:
  - Building data
  - Weather
  - Ground/soil characteristics
  - Energy costs



Geothermal - Approach

- Utilize information available from previous DoD study, plus new additional sources, to determine if the following conditions exist to demonstrate potential:
  - Existing power plant operation or developer activity
  - One or more wells tested with temperatures in excess of 100°C (212°F) logged downhole (at depths less than 3,000 m)
  - Demonstrated high fluid flow rates on the order of 1,000 gallons per minute per MW
  - Heat flow rates greater than 80 mW/m2 (milliWatts per square meter)
  - Other exploration data and information available
- Utilize best available geothermal resource information, along with energy use estimates provided by the site, to estimate potential project size.

Geothermal – Approach (cont.)

- Estimate total project costs including development, infrastructure, well field drilling, steam and brine gathering system, balance of plant construction, IC and transmission, O&M, available incentive and taxes.
  - Well fields may consist of 10-100 wells with each well costing $1 million to $4 million to drill
- Run detailed economic analysis (taking into account incentives, taxes) to determine if project is economically viable (consider both IPP and ECIP financing scenarios).

Renewable Project Economics

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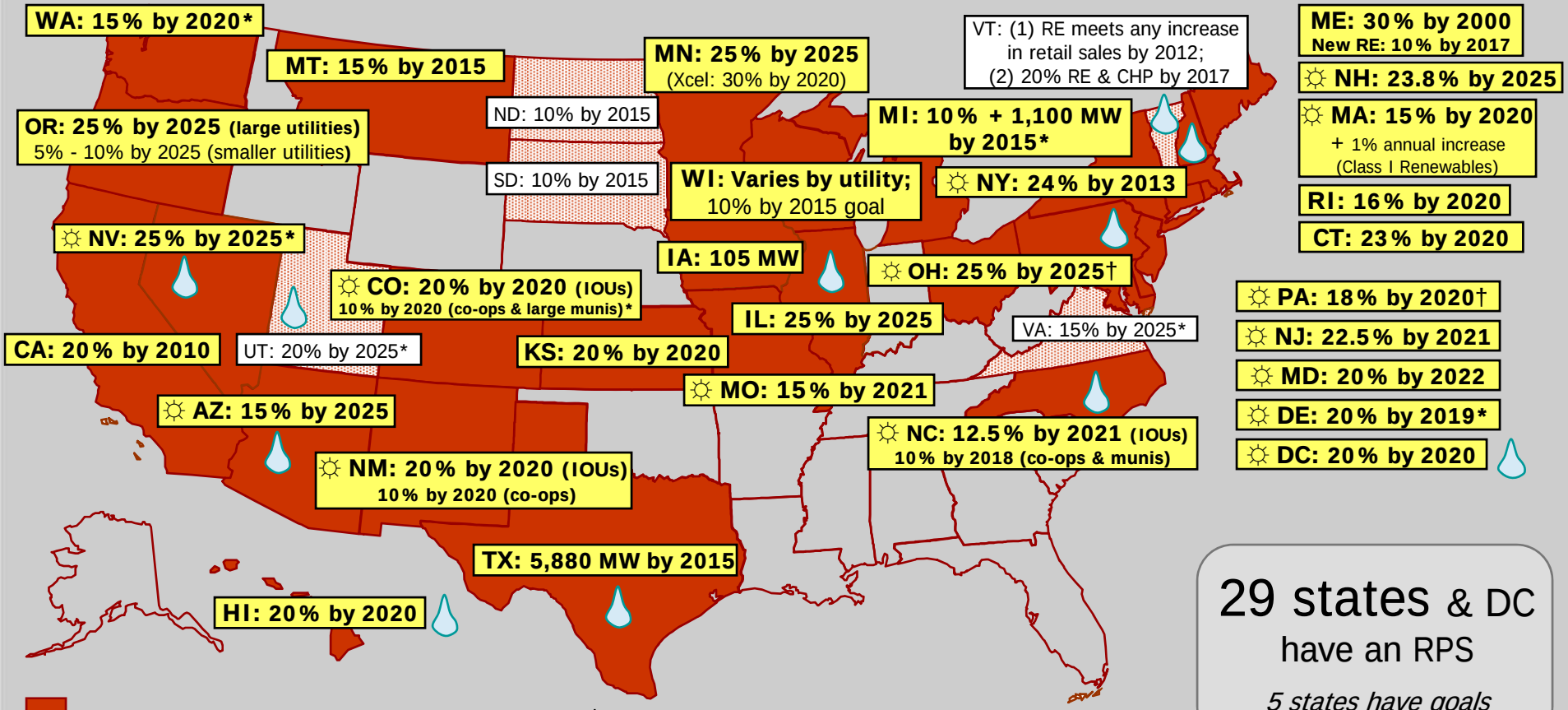
Renewable Energy Financial Incentives

- State
  - Sales, income, and/or property tax exemptions
  - Investment tax credits
  - Production tax credits
  - Rebates
  - Renewable portfolio standards (RPS)/Renewable energy certificates (RECs)
  - Varies for each resource and sometimes technology used
- Federal
  - Investment tax credits
  - Accelerated depreciation of equipment
  - Production tax credits
- Source: Database of State Incentives for Renewables and Efficiency (DSIRE) http://www.dsireusa.org/

Renewable Portfolio Standards

www.dsireusa.org / July 2009



29 states & DC have an RPS

5 states have goals

State renewable portfolio standard

State renewable portfolio goal

Solar water heating eligible

Minimum solar or customer-sited requirement

* Extra credit for solar or customer-sited renewables

† Includes separate tier of non-renewable alternative resources

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RPS Policies with Solar/DG Provisions

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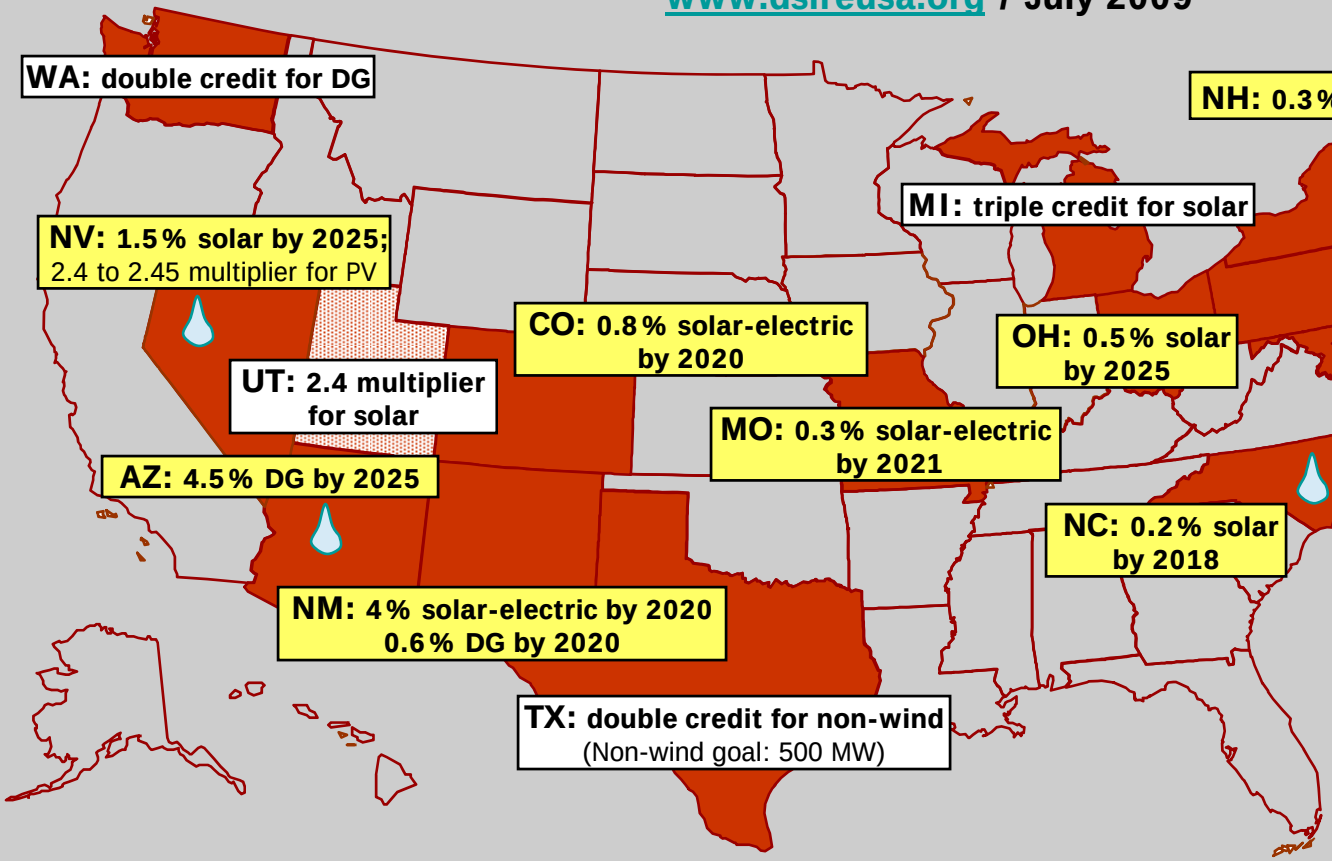

14 states & DC have an RPS with solar/DG provisions

State renewable portfolio standard with solar / distributed generation (DG) provision

State renewable portfolio goal with solar / distributed generation provision

Solar water heating counts toward solar provision

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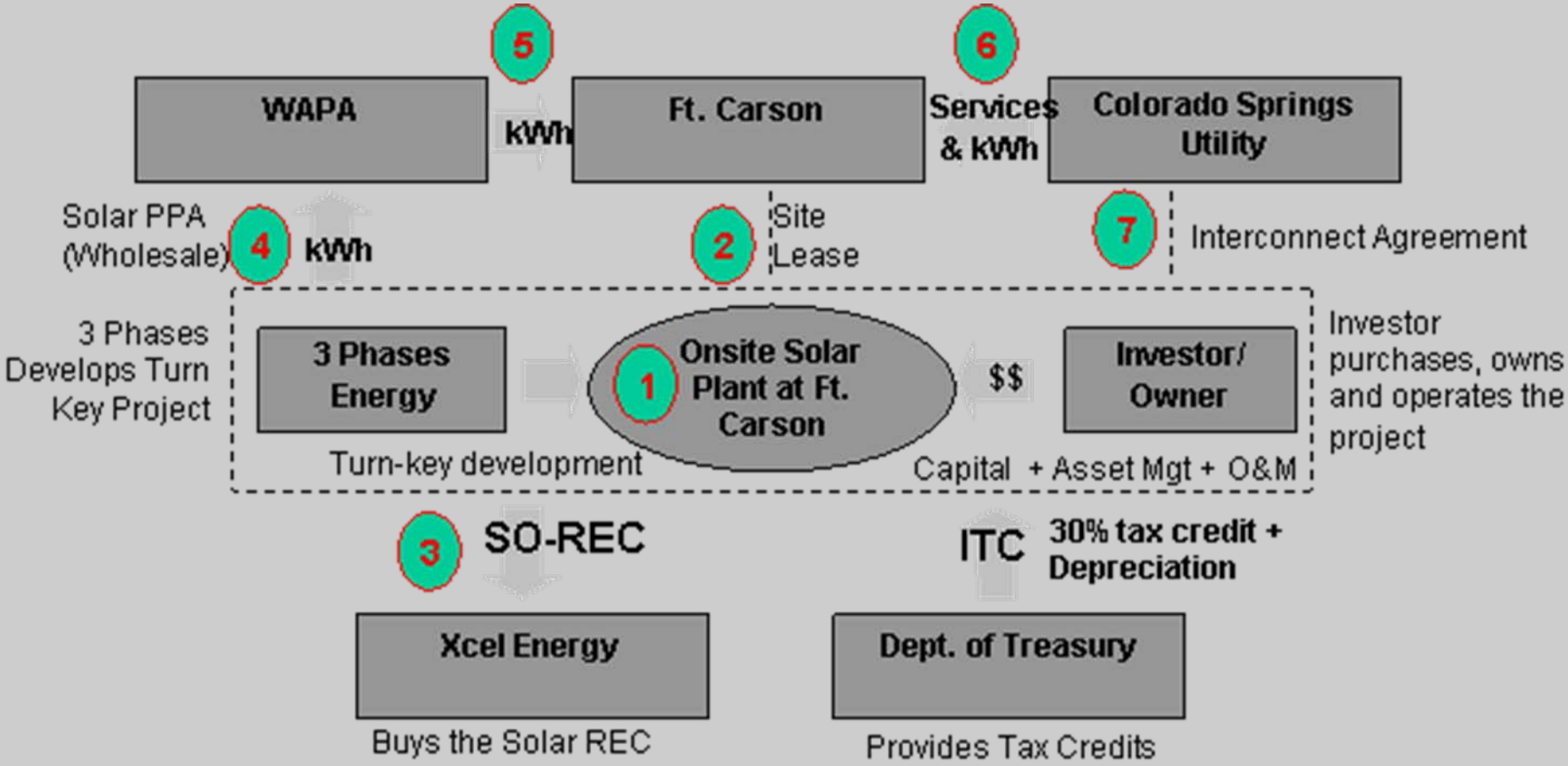
Federal Renewable Energy Projects

- Incentives are essential to achieving a cost effective project
- Many incentives are not directly available to federal customers, but use of third party contracts should provide the benefit indirectly
- RECs can be sold by federal customers or third parties to reduce the capital costs of renewable energy projects

Fort Carson Solar Example



Financial Analysis Tool for Electric Energy Projects (FATE2-P)

- Developed by Princeton Economic Research, Inc. and the National Renewable Energy Laboratory for the U.S. Department of Energy
- Private ownership rate of return module
- Develops an annual after-tax cash flow based on:
  - the revenues defined in the power purchase contract, and
  - costs associated with constructing and operating the renewable generation facility
- Includes all state and federal incentives for renewable energy technologies
- PNNL required at least a 10% internal rate of return (IRR) after tax for project to "work"
- PNNL modified to include MILCON Energy Conservation Investment Program module with NIST Building Life-Cycle Cost (BLCC) methodology

Economic Evaluation Criteria

- For "firm" or dispatchable resources: avoided retail power costs, i.e. average avoided retail rate (includes all retail rate elements, including demand charges)

- For "intermittent" resources = avoided "energy" component of power costs, i.e. only energy component of retail rate

Summary

- A resource assessment provides an estimate of the relative cost-effectiveness of the various renewable energy technologies
- Financial attractiveness of the RE technologies can change significantly with modifications to state and federal incentives
- Third party investment/ownership is key to obtaining the most attractive project for federal customers
- Long term contracts are required to allow an adequate return on investment

Questions?

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