Renewable Energy and Energy Efficiency for Tribal Community and Project Development

Basic Energy and Market Terms

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Overview

- Provide background terminology and information to course participants
- Discuss terminology related to the following:
  - Fundamental energy terminology
  - Electrical system
  - Financial
  - Renewable energy markets
  - Renewable energy policies

Basic energy terms

Voltage - (Volts) (V) = Difference of electrical potential across two points, or electromotive force behind the flow of electricity. This is the amount of potential energy in a circuit. Like the pressure in a pipe from a pump or the height of a waterfall. Sources of voltage include batteries, photovoltaic cells, and generators.

Current - (Ampere, Amp) (I) = Current is the amount of electricity flowing in a circuit past a given point. Like the flow of water in a pipe or the amount of water going over the falls each second.

Resistance – (R, ohms) is a measure of the degree to which an object opposes an electric current through it. Increased resistance results in a decrease in the amount of current that will flow through the wire.

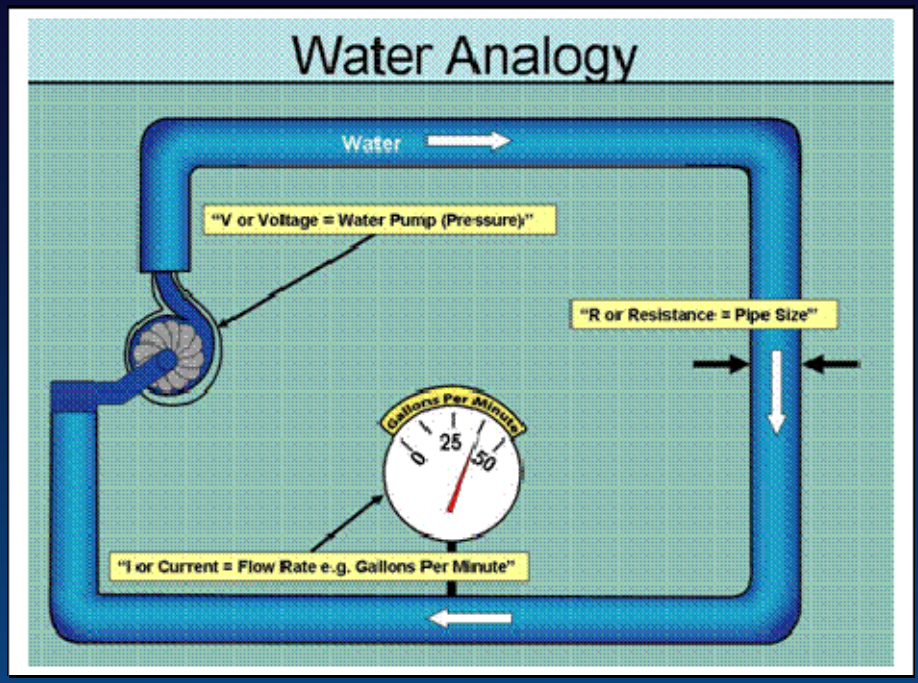
Appliances, lights, power tools can all be thought of as resisters.

$$R = V/I$$

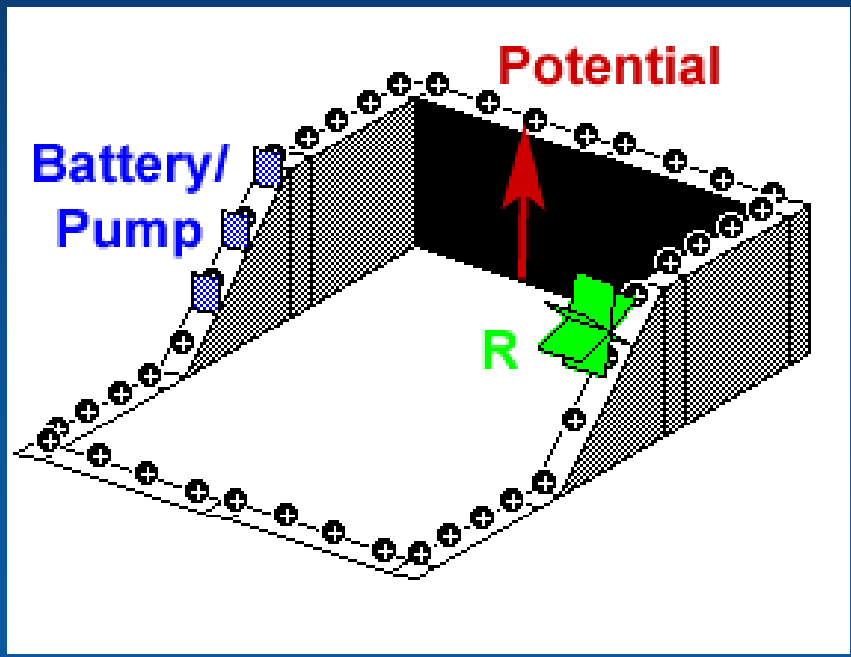
Basic terms

Power - (Watt, W) (P) = current x voltage; P=I*V. Rate at which work is done. This is an instantaneous measure at a given point in time.

- kW – kilowatt = 1000 watts,
- MW – Megawatt = 1 million watts = 1,000 kW
- GW – Gigawatt = 1 billion watts = 1,000 MW



If you increase the pressure (voltage) of the water coming out of the pump, it hits the waterwheel with a lot more force and the wheel turns faster, generating more power. If you increase the flow rate (current), the waterwheel turns faster because of the weight of the extra water hitting it.



Electrical system terms

Energy – the ability to do work (Joules, Btu or kWh)

Electrical Energy: The generation or use of electric power (W) over a period of time (h), often expressed in kilowatt-hours (kWh), megawatt-hours (MWh) or gigawatt-hours (GWh).

- For example:
  - A 100 watt light bulb burns for 10 hours. Consumes 100 watts x 10 hours, or 1000 watt hours of energy (1 kWh).
  - A 100 kW gasifier runs for 8 hours, producing 800 kWh
  - A 20 MW power plant runs for 7000 hours per year. So it produces 20 x 7000 = 140,000 MWh (140 GWh) per year.

Electrical system terms

Demand - Electric demand (load) is the amount of electricity you require at an instantaneous point in time. When you turn on an electric appliance, a "demand" for power is created. This instantaneous amount of electricity demand is measured in kiloWatts (kW).

- Appliances are rated either in Watts or amps.
  - If your appliance is measured in amps, calculate using current x voltage (e.g. 2.5 amps x 120 volts = 300 watts)
- The sum of all appliances that are on at any one time is your demand. Peak demand is your maximum demand in a given time period (e.g. one month)

An electric utility must match the customer demand on its system to its generation capacity (plus line losses and mandatory reserve requirements)

Thermal energy terms

Btu - The British thermal unit (BTU or Btu) is a unit of heat energy used in the U.S. In most other areas, it has been replaced by the SI unit, the Joule (J).

- A Btu is defined as the amount of heat required to raise the temperature of one pound of water by 1 degree Fahrenheit.
- In the energy world, we typically discuss energy content in terms of Million Btu, or MMBtu
- For example, a biomass feedstock may have a heating value of 16 MMBtu/ton on a dry basis, or 8 MMBtu/ton as received

Therm - used to measure natural gas usage is 100,000 Btu, so 10 therms = 1 MMBtu

Mcf – Thousand cubic feet of natural gas. More or less = 1 MMBtu

Xcel Energy®

PUBLIC SERVICE COMPANY OF COLORADO *
P O BOX 840
DENVER, CO. 80201
(800) 895-4999

Customer Name	Service Address	Due Date	Account No.	Amount Due
	LAKEWOOD, CO 80215-7047	Dec 26, 2007	53-3706880-3	$131.66

Account Activity

Date of Bill	Dec 10, 2007	Previous Balance	$97.47
Number of Payments Received	1	Total Payments	($97.62)
Number of Days in Billing Period	31	Balance Forward	($0.15)
Statement Number	135238923	+ Current Bill	$131.81
Premise Number	301800776	Current Balance	$131.66

Electric Service - Account Summary

Invoice Number	0202159357			Residential General	$37.15
Meter No.	0000D1198414			GRSA	$4.71
Rate	R	Residential General		Air Quality Imp	$0.83
Current Reading	63000	Actual	12/07/2007	Elec Commodity Adj	$27.57
Previous Reading	62020	Actual	11/06/2007	Demand Side Mgmt Cost	$1.27
Kilowatt-Hours Used	980			Purch Cap Cost Adj	$13.36
				Renew. Energy Std Adj	$0.51
				Franchise Fee	$2.56
				Sales Tax	$3.08
				Subtotal	$91.04

Gas Service - Account Summary

Invoice Number	0096361486			Residential			
Meter No.	00000A214691			Usage Charge	41.00 x	0.08868	$3.64
Rate	RG-T	Residential		Interstate Pipeline	41.00 x	0.06110	$2.51
Current Reading	515	Actual	12/07/2007	Natural Gas - Dec	9.57 x	0.59370	$5.68
Previous Reading	468	Actual	11/06/2007	Natural Gas - Nov	31.43 x	0.48350	$15.20
Measured Usage	47			Service & Facility			$11.20
Therm Multiplier	0.8628			Franchise Fee			$1.15
Therms Used	41.00			Sales Tax			$1.39
				Subtotal			$40.77

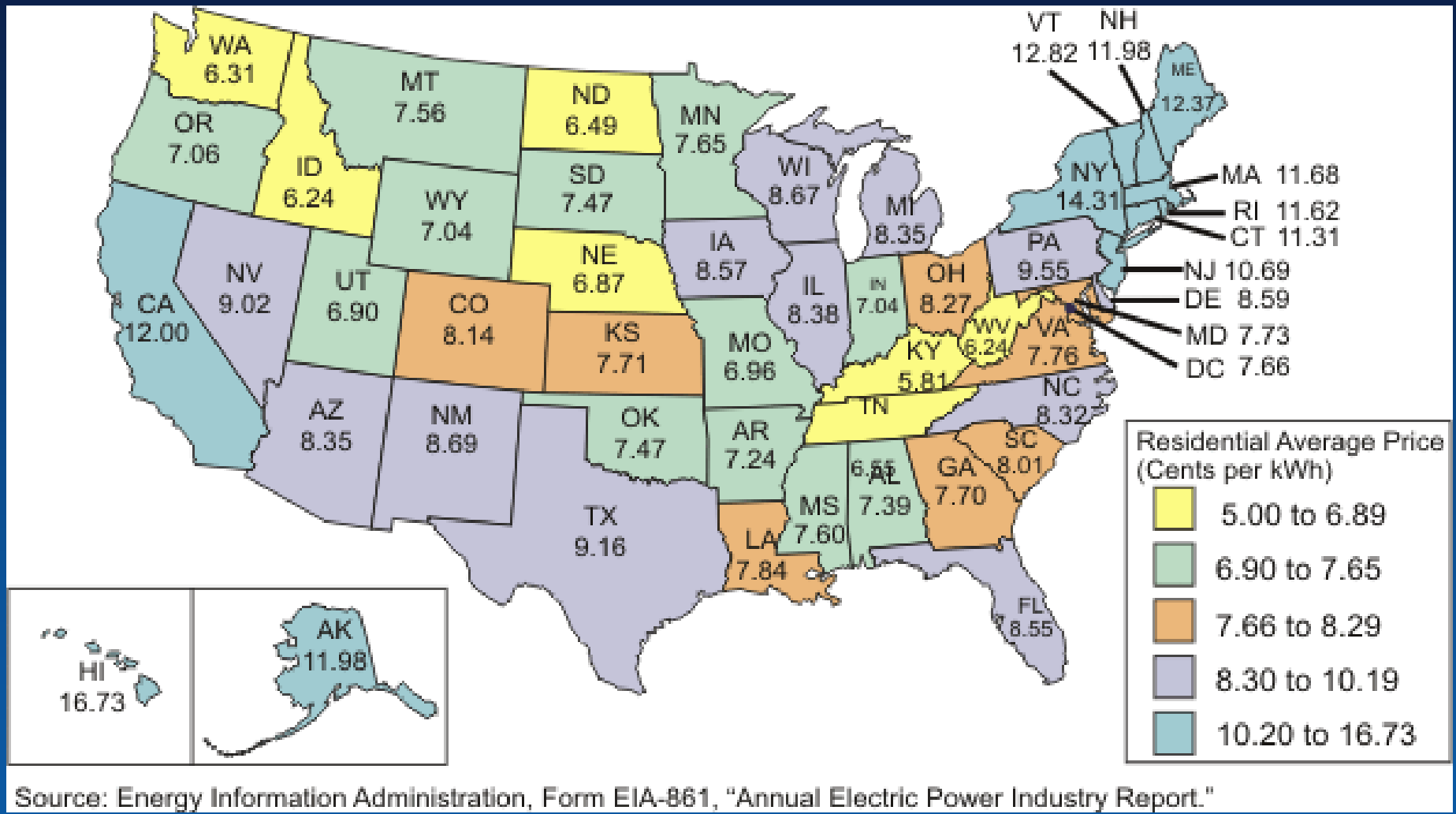
Comparison Information

			Billing Period	Kwh Usage/Month	Therm Usage	Avg. Daily Temp.
Gas	$40.77 per month	$1.32 per day	This Year	980	41	41°
Electric	$91.04 per month	$2.94 per day	Last Year	965	97	39°

Average rate for electrical energy = $91.04/980 kWh = 9.3 cents/kWh

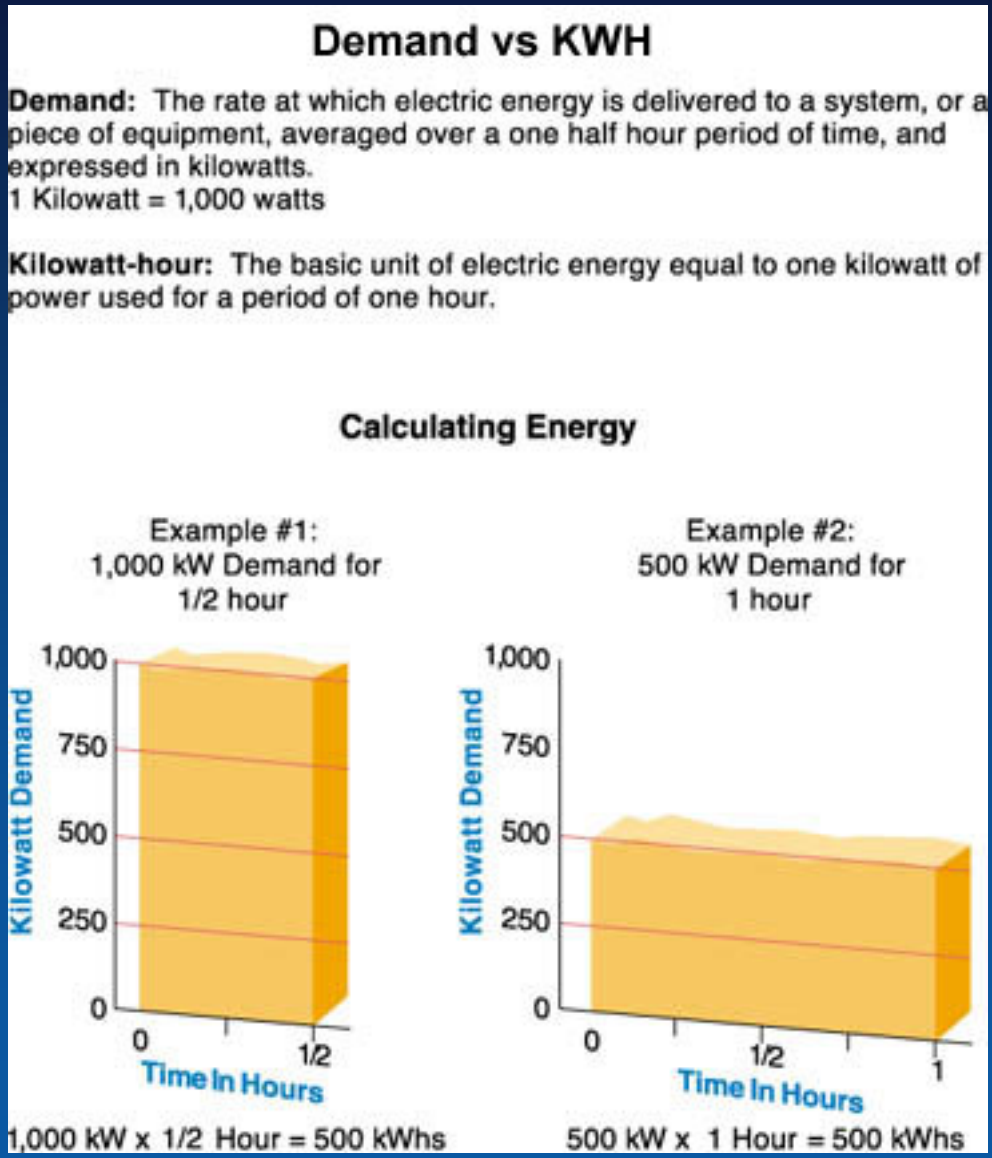
Average rate for thermal energy = $40.77/41 therms = 99 cents/therm = $9.90/MMbtu

Average 2006 costs of electricity



Source: Energy Information Administration, Form EIA-861, "Annual Electric Power Industry Report."

Other utility bill issues



Demand charge - Some utility companies also impose an additional charge based on the maximum amount of power you draw at any one time. This is called a demand charge. In the chart, it costs the utility more to serve example #1 then example #2.

If your utility company has a demand charge (ask them), then you can save money by spreading out your electrical use. For example, run a washing machine and dryer one after the other rather than at the same time. And better yet, run them when you're not using much electricity for other purposes (such as at night when the air conditioner is off).

Demand Side Management – utility programs to reduce customer demand

Utility terms

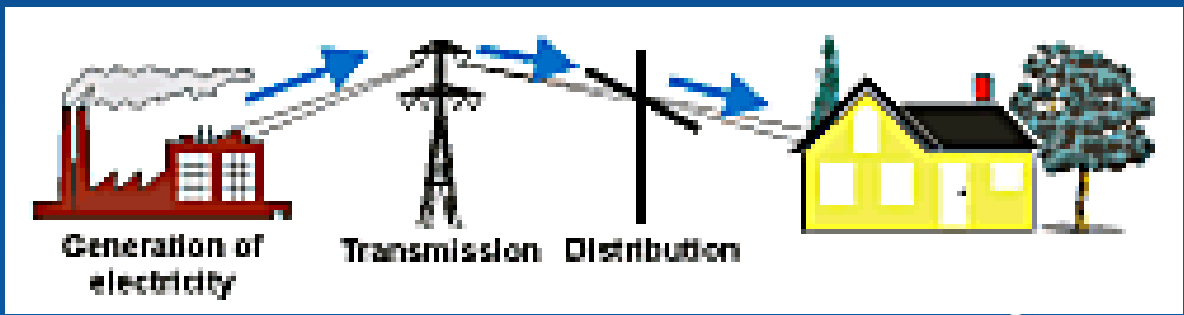
Generating Station – a power plant. Can be owned by just about anybody including utilities and non-utilities. Central station vs. distributed.

DG – Distributed Generation – Small-scale power generation systems typically located on a customer site. Typically 3 kW – 10 MW in scale. Can be stand alone or grid connected.

Cogeneration – the sequential production and use of heat and power from a power plant.

Transmission system - An interconnected group of lines and equipment for the movement or transfer of bulk electric energy between points of supply and points at which it is transformed for delivery to customers or is delivered to other electric systems. Typically 69,000 volts (69 kV) and higher.

Distribution system - The poles, wire and transformers used to deliver electric energy from a bulk power supplier to the consumer.



Electric utility types

IOU – Investor Owned Utility (e.g SCE, PG&E, SDG&E). Owned by investors or stockholders. Generates, transmits and distributes electricity to consumers and other utilities. Regulated by FERC, EPA and state Public Utilities Commissions. Monopoly service territories.

Co-op – A cooperative electric utility, usually based in rural areas. Plumas-Sierra is an example. Owned by the members (customers).

Muni – A municipally owned utility. Examples are Alameda, Roseville, SMUD.

Federally owned utility – Non profit entity that is owned by the federal government and primarily sells bulk power to other public power entities. The Tennessee Valley Authority is an example. Federal power marketing administrations (PMAs) often transmit the power (e.g. WAPA). Primarily produce and distribute hydropower.

Generation and Transmission Co-op (G&T) – Bulk producer and transmitter of electricity. Usually, co-ops and munis are "all requirements" customers of a G&T. NCPA (Northern California Power Agency) is an example.

Market terms

IPP – Independent Power Producer. Also called a Non-utility Generator (**NUG**). A power plant owned not by a utility but by an investor or some other entity (Tribe, company, city, military base).

QF - Qualifying facilities are a distinct class of energy producer which consists of either small-scale producers of commercial energy who normally self-generate energy for their own needs but may have occasional or frequent surplus energy, or incidental producers who happen to generate saleable electric energy as a byproduct of other activities. When a facility of this type meets the Federal Energy Regulatory Commission's requirements for ownership, size and efficiency, utility companies are obliged to purchase energy from these facilities based on a pricing structure referred to as avoided cost rates. Qualifying facilities were first classified in 1978 with the establishment of the Public Utility Regulatory Policies Act (PURPA), a piece of legislation which was intended to encourage more efficient and environmentally friendly energy production in the United States.

Avoided cost - the cost a utility would incur to generate its next unit of energy or power. Avoided cost rates have historically been used as the power purchase price utilities offer Qualifying Facilities.

Power generation terms

Heat Rate – (Btu/kWh) A measure of the efficiency of a power plant. The amount of energy it takes to produce a unit of electricity. The conversion factor of a 100% efficient plant (electric heater) is:

3,413 Btu = 1 kWh

The lower the heat rate, the better.

- Natural gas – 7,000 – 10,000 Btu/kWh
- Coal – 8,000 -11,000 Btu/kWh
- Biomass – 12,000 – 24,000 Btu/kWh

Power generation terms

Capacity – The amount of power that a generator can produce at a point in time, usually reported in MW. The maximum capacity is the amount of power that can be output when the plant is running "full out." For example, a 10 MW biomass power plant when running at its maximum level will produce 10 MW of power.

Capacity Factor – Ratio of the actual output of a power plant over a period of time and its output if it had operated at full capacity in that time period. This is calculated by totaling the energy the plant actually produced and dividing it by the energy it would have produced if running the entire time at full capacity.

- Biomass power plants typically have a 80-92% CF
- Wind is typically 25-40% CF
- Solar is typically 20%

So a 20 MW power plant with an 80% capacity factor will produce 20 MW * 8760 hours/year * .8 = 140,160 MWh/yr

Exercise

- Question 1 - A 2 MW wind turbine produced 432 MWh over a 30 day period. What is the capacity factor?

- Question 2 – A 10 kW PV plant has a capacity factor of 25%. How much energy does it produce over a year?

Answers

- Question 1
  - Maximum energy generation over the 30 days:
    - 2 MW * 30 days * 24 hrs/day = 1,440 MWh
    - So the capacity factor is 432/1440 = .30 or 30%
- Question 2
  - 25 kW * 365 days * 24 hrs/day * .25 = 54,750 kWh

Basic financial terms

Installed capital costs (ICC) – The total up-front costs of hardware, design, development, engineering, construction associated with building an energy system.

Sometimes defined in terms of $/MW of capacity, or $/gallon of capacity for liquid fuels

Basic financial terms

LCOE – Levelized Cost of Energy. Also referred to as life-cycle cost of energy. Used by utilities, developers and planners to compare the average costs of various energy options. Often expressed in terms of $/MWh or cents/kWh.

Thermal energy projects would be expressed in terms of $/MMBtu.

- Total lifetime costs (discounted) ÷ total lifetime energy generation of the project

Energy market terms

PPA – Power Purchase Agreement. A legal contract between a utility and an IPP or QF for the purchase of energy, power or both. PPAs typically are 10-20 years in duration.

PTC – Production tax credit. The federal government currently offers a production tax credit of 2 cents/kWh for electricity produced from wind, closed loop biomass and geothermal and 1 cent/kWh for open loop biomass.

The PTC is not an outright payment for the production of renewable energy. It can only be used to reduce the amount of taxes a firm owes. So, if a firm produces 1,000,000 kilowatt-hours of energy from a wind turbine, that firm could reduce the amount of taxes it owes to the federal government by $20,000 ($0.020 x 1,000,000).

Energy market terms

RPS – Renewable Portfolio Standard. Regulations that mandate that a certain portion of an electric utility's generation capacity must come from eligible renewable energy resources. Primarily state-based, and primarily targeted at IOUs.

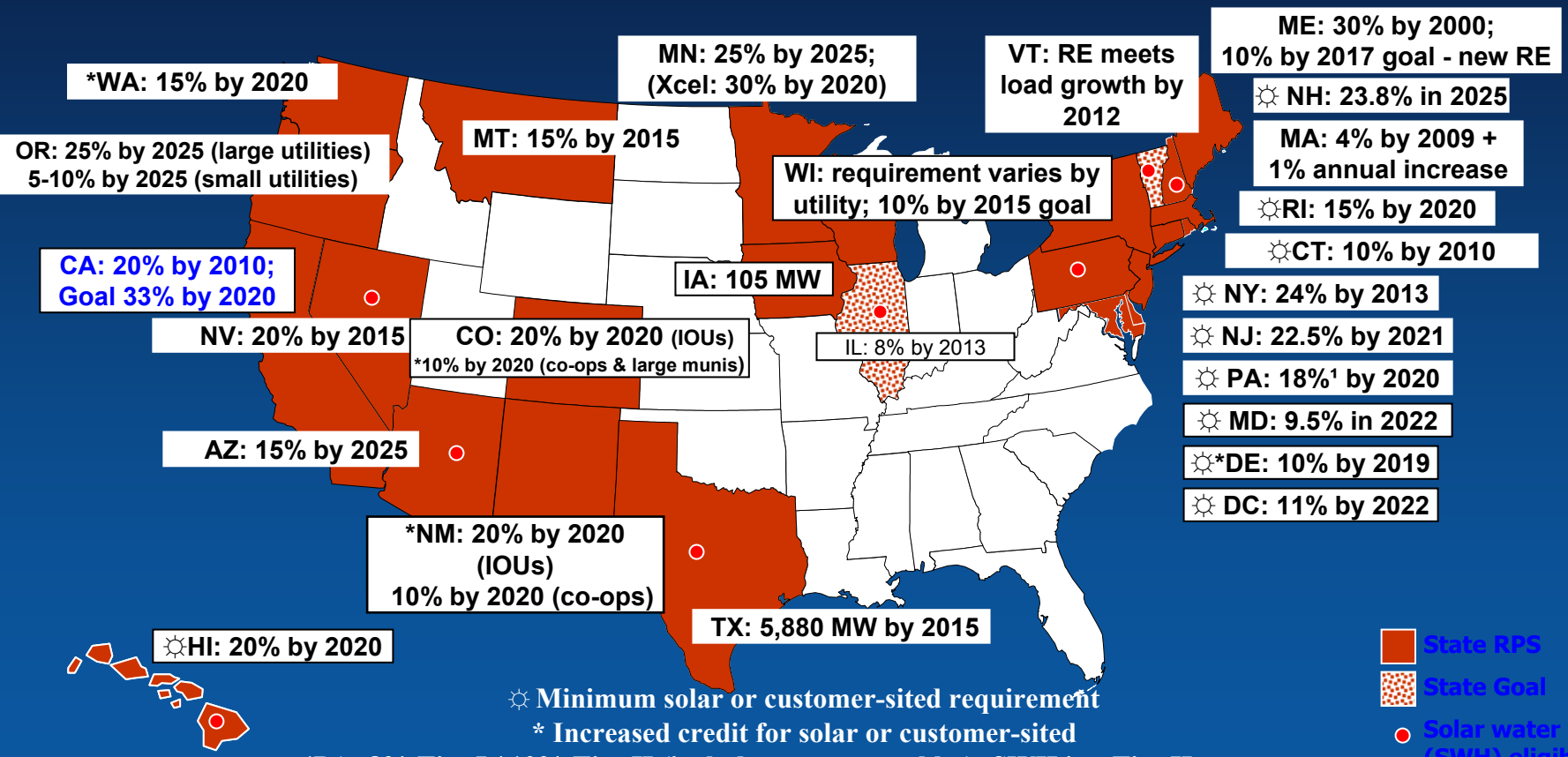
Green power - Electricity produced by sources that are less harmful to the environment than fossil fuels. Generally includes solar, wind, geothermal, biomass, and small hydroelectric. Often sold through a utility Green Pricing Program.

Green pricing – a utility based program whereby renewable energy is sold to consumers or other utilities at a premium. Xcel's WindSource Program is an example. This is usually a voluntary program.

Current Renewable Portfolio Standards (National RPS on the way?)

DSIRE: www.dsireusa.org

Jan 2008



☼ Minimum solar or customer-sited requirement

* Increased credit for solar or customer-sited

¹PA: 8% Tier I / 10% Tier II (includes non-renewables); SWH is a Tier II resource

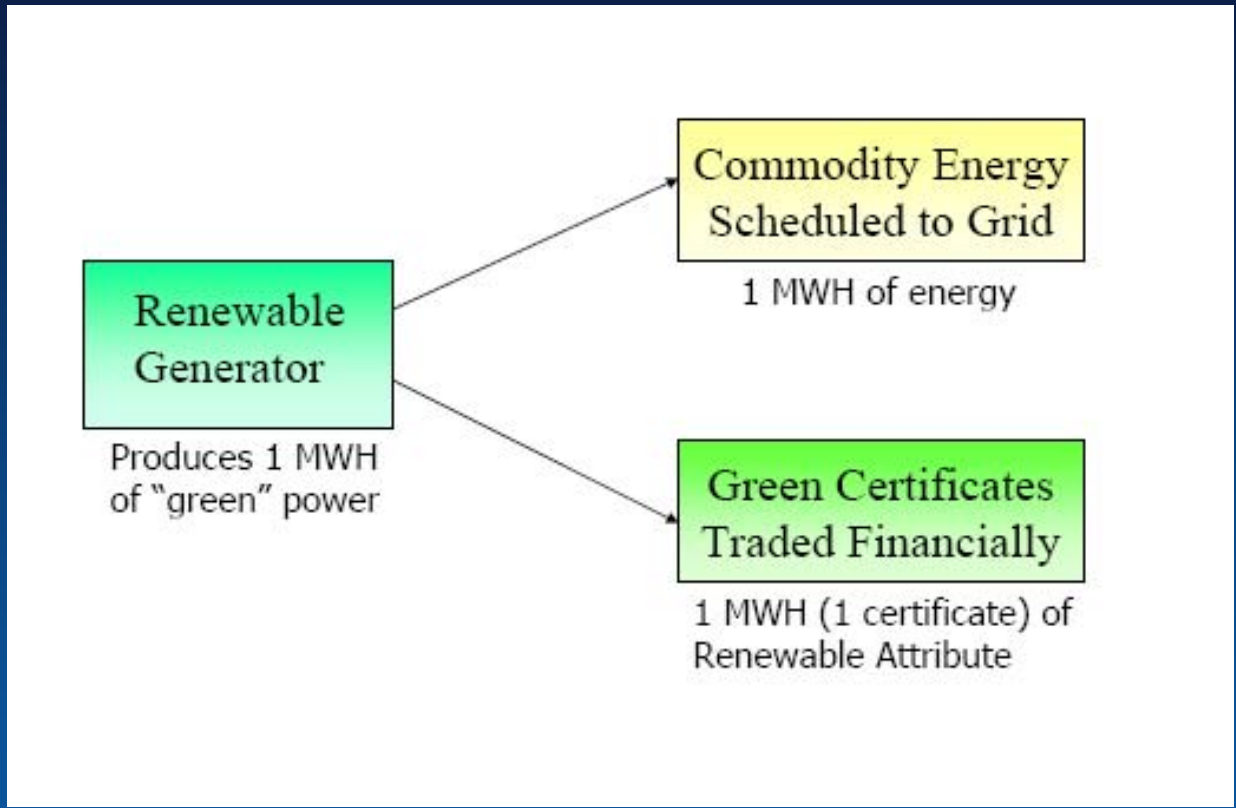
(Source: Database of State Incentives for Renewable Energy. 2006. "Renewables Portfolio Standards." NC State University. NC Solar Center. Available online at: http://www.dsireusa.org/documents/SummaryMaps/RPS_Map.ppt)

Energy market terms

RECs – Renewable Energy Certificates. Also called Green Tags, Renewable Energy Credits, or Tradable Renewable Certificates (TRC). Tradable environmental commodities that represent proof that 1 MWh of electricity was generated by an eligible renewable energy resource. RECs represent the environmental attributes of the renewable power, not the commodity electricity.

RECs are bought and sold on the open market. For example, Whole Foods buys RECs to meet its requirements for "providing" 100% of its power needs from renewables.

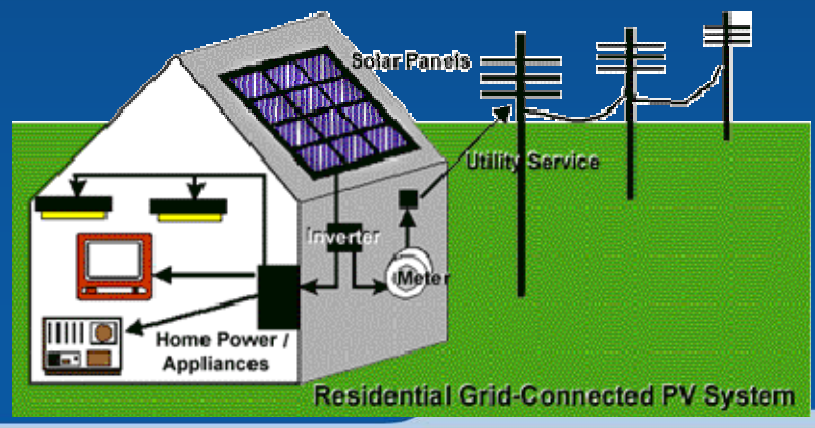
REC transactions



Transactions must be registered and tracked to avoid double sales

Market terms

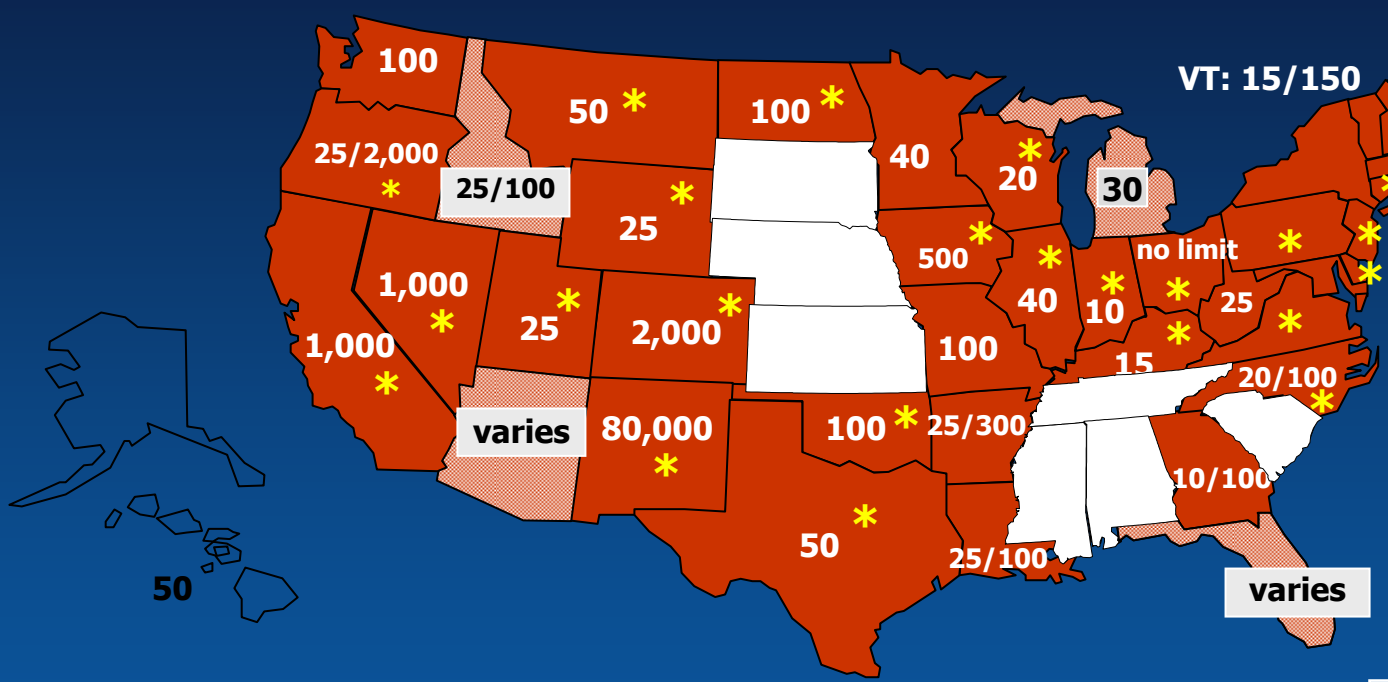
Net metering - Net metering is a policy for consumers who own, small, renewable energy facilities, such as wind or solar. "Net", in this context, is used in the sense of meaning "what remains after deductions" -- in this case, the deduction of any energy outflows from metered energy inflows. Under net metering, a system owner receives retail credit for at least a portion of the electricity they generate. The ideal has your existing electrical meter spinning backwards, effectively banking excess electricity production for future credit. In reality, the rules vary significantly by utility; if net metering is available, if and how long you can keep your banked credits, how much the credits are worth (retail/wholesale), etc. *(Source: Wikipedia)*



Net Metering

Source: DSIRE: www.dsireusa.org

December 2007



NH: 100
MA: 60
RI: 1,000/1,650*
CT: 2,000*
NY: 10/25/125/400
PA: 50/3,000/5,000*
NJ: 2,000*
DE: 25/500/2,000
MD: 2,000
DC: 100
VA: 10/500*

State-wide net metering for all utility types

State-wide net metering for certain utility types (e.g., investor-owned utilities only)

Net metering offered by one or more individual utilities

Net metering is available in 42 states + D.C.

(Numbers indicate individual system size limit in kilowatts. Some states' limits vary by customer type and/or technology as shown)

Existing IRP and RPS Renewable additions