



Nebraska
Wind & Solar
CONFERENCE & EXHIBITION

Consumer Webinar for Residential / Small Business Solar

Thursday, August 26th
10:00 AM

Featured Presenters:



Ron Rose
Nebraska
Public
Power
District



John Hay
UNL
Biosystems
Engineering
Department



Marc
Shkolnick
Lincoln
Electric
System



Kirk Estee
Omaha
Public
Power
District



David Rich
Nebraska
Public
Power
District



Nebraska Wind and Solar Conference

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- Ron Rose - NPPD
- John Hay - UNL
- Marc Shkolnick - LES
- Kirk Estee – OPPD
- Dave Rich - NPPD



Net Metering

- (2009) LB 436 mandated net metering
 - Encourage customer-owned renewable energy
 - Stimulate the economy
 - Encourage diversification of energy generation
 - Maintain low-cost, reliable electric service



Net Metering, continued

- (2009) LB 436 -
 - Customer must generate electricity on the customer side of the meter
 - Interconnection agreement with their local utility
 - Net Excess Generation is the amount of energy, if any, that exceeds the total consumption during a billing period
 - Credit a customer-generator at the applicable retail rate up to the total requirement



Net Metering, continued

- (2009) LB 436 -
 - Qualified Facility
 - Methane, Wind, Solar, Biomass, hydropower, or geothermal
 - Controlled by the customer-generator and located on their property
 - Does not provide credits to another location
 - Rated capacity of 25kW or less
 - Inspected by City Electrical Inspector or
 - State Electrical Division



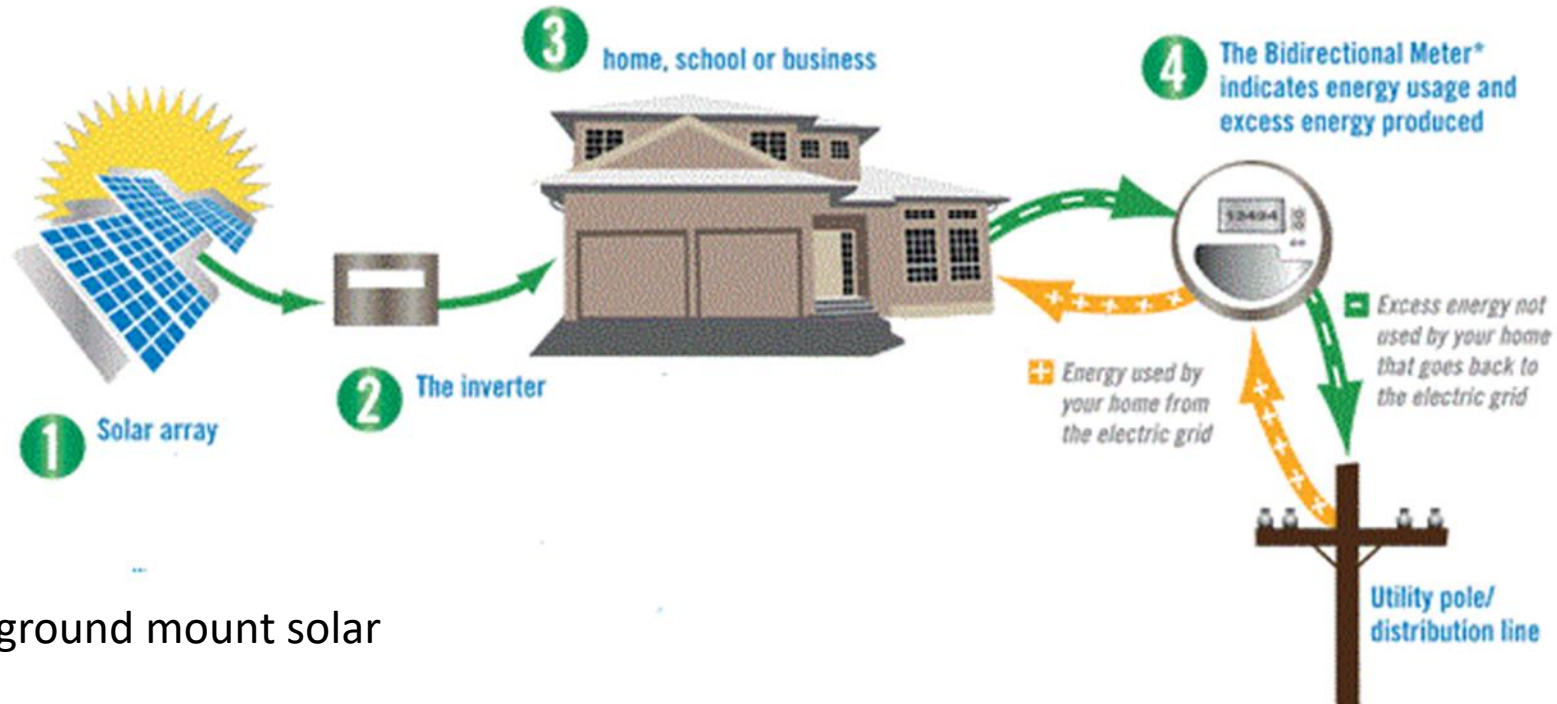
Net Metering, continued

- (2009) LB 436 -
 - Equipment shall meet UL and IEEE standards
 - Equipment is to automatically isolate in a power outage
 - Utility shall provide bi-directional meter
 - No additional costs to the customer using the existing infrastructure
 - Net Excess Generation is paid at utility avoided cost
 - Utility is not required to provide net-metering once the total of capacity of all customer's qualified generators reaches 1% of avg. monthly peak demand



Net Metering, continued

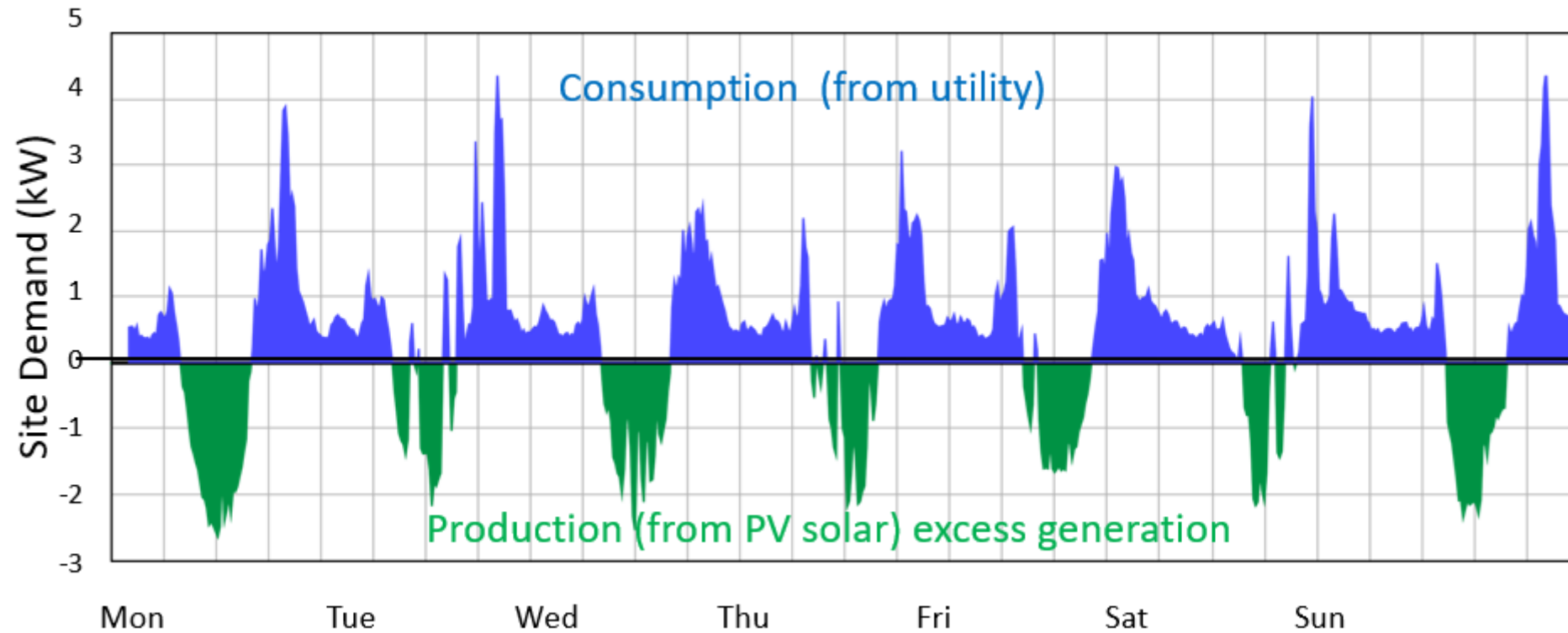
Solar Photovoltaic Array Example



Roof or ground mount solar



Net Metering, continued



Net Metering Example for York, NE

- Billing example (NPPD)
- What we typically see before net metering:
 - Energy received (from your public power utility):
2000 kWh

A. Customer Charge	\$ 22.50
B. Energy and Delivery Charges	\$ 200.00
C. Production Cost Adjustment	\$ 5.82 CR
D. Other Fees and Taxes	<u>\$ 64.92</u>
	\$ 281.60



$$$/kWh = \$281.60/2000 = \$0.14/kWh$$

$$$/kWh =$$

$$(\$200 - \$5.82 + 58.31) =$$

$$\$252.49/2000 = \$0.1262/kWh \text{ (summer)}$$

$$\$180.59/2000 = \$0.0903/kWh \text{ (winter)}$$

Net Metering Example for York, NE, continued

- Billing example (NPPD)
 - Net Excess generation (NEG) = 0

Energy received (from your public power utility): 2000 kWh
Energy delivered (to your public power utility): -- 500 kWh
Billed Net 1500kWh

Customer Charge	\$ 22.50
Energy and Delivery Charges	\$ 150.00
Production Cost Adjustment	\$ 4.36 CR
Other Fees and Taxes	<u>\$ 51.00</u>
	\$ 219.14



Net Metering Example for York, NE, continued

- Billing Example (NPPD)
 - Net Excess generation (NEG) = 500 kWh

Energy received (from your public power utility): 1500 kWh
Energy delivered (to your public power utility): -- 2000 kWh
Billed Net -500 kWh

Customer Charge	\$ 22.50
Net Excess Generation	\$ 44.70 CR
Lease Payment	\$ 3.25
Gross Revenue Tax	<u>\$ 1.36</u>
	\$17.59 CR

Credit is applied to customer account to future billing. Any excess credits shall be paid out to coincide with the last bill of an annualized period or within 60 days of customer terminating service.



PV Solar (without storage battery) is not backup generation during an outage

- Large misconception that PV Solar can be used during an outage as backup power
- PV Solar disconnects from the grid during an outage to protect utility linemen
- Safety feature of all UL and CSA approved inverters
- During an outage, the PV Solar inverter must disconnect within 0.1 seconds



Residential Battery Storage

- Net Metering will largely reduce the economic benefit of battery storage
- Net Metering (Battery Storage kW + PV Solar kW \leq 25kW)
- Pros
 - A few hours of automatic backup to critical loads during a utility outage
 - Offset on-peak energy (kWh) if on a TOU (time of use) rate
- Cons
 - Cost
 - Operation and Maintenance, programming, scheduling



Social & Environmental Benefits of PV Solar

- Positive social impacts from decreased electric bills for low-income individuals
- Job creation
- Reduces Greenhouse Gas Emissions
- Reduces Dependence On Nonrenewable Energy Sources
- Improves Humanity's Health In The Long-run.



Financing options for PV Solar

Residential, Commercial, and Ag Production customers

- 26% Federal ITC (Investment Tax Credit) must have tax liability to claim the credit.
- <https://www.energy.gov/eere/solar/downloads/residential-and-commercial-itc-factsheets>
- NDEE (Nebraska Dept of Environment and Energy)
Dollar and Energy Savings loan
 - This is a low interest 10-year loan from your local bank supported by NDEE
- <https://neo.ne.gov/programs/loans/loans.html#:~:text=Most%20financial%20institution s%20in%20Nebraska%20offer%20Dollar%20and%20Energy%20Saving%20Loans.&text=T he%20lender%20will%20approve%20your,to%20proceed%20with%20your%20project>



Financing options for PV Solar

Commercial and Agriculture Production customers only

- Federal & State Tax MACRS (Modified Accelerated Cost Recovery System) depreciation information for Solar
- <https://www.energy.gov/sites/prod/files/2020/01/f70/Guide%20to%20Federal%20Tax%20Credit%20for%20Residential%20Solar%20PV.pdf>
- USDA Rural Development REAP grant program for energy efficiency and renewable energy.
- <https://www.rd.usda.gov/programs-services/rural-energy-america-program-renewable-energy-systems-energy-efficiency/ne>



Solar Economic Analysis

- Costs
- Production
 - Shading
 - Tilt/Azimuth
- Incentives
- Assumptions
 - Inflation/escalation
 - Maintenance
 - Insurance
- Process and picking an installer
- Resources



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Why Solar?

Residential or Business System

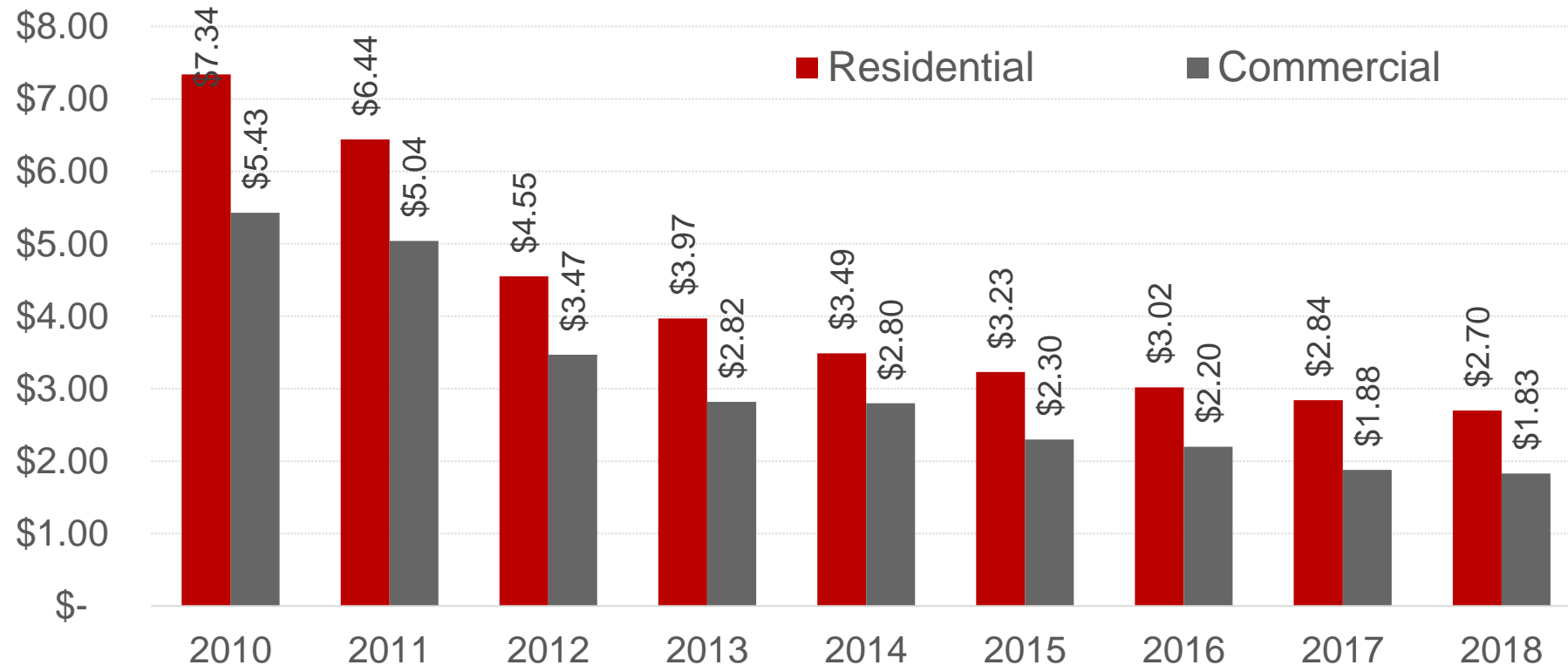
- Pros:
 - Green energy
 - Tax credit
 - Attached to your home or business
 - Depreciation (businesses)
 - Marketing
 - Ongoing savings
- Cons:
 - Initial cost of system
 - O&M
 - May not regain investment if you move

Community Solar Purchase

- Pros:
 - Green energy
 - Can participate even without place to install
 - Sell it back if you move
 - No O&M
 - Little to no risk
- Cons:
 - No tax credit (maybe)
 - No depreciation
 - Not at your location for marketing purposes

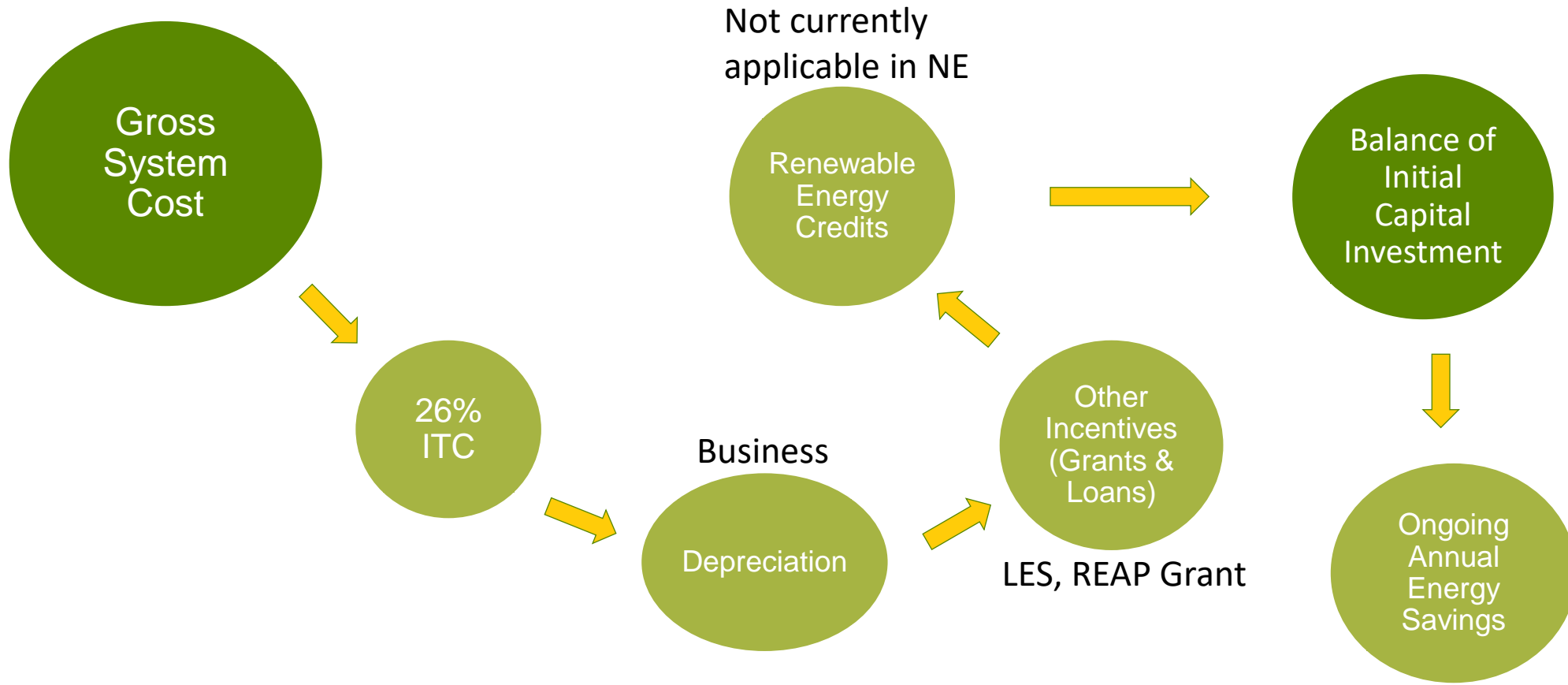


NREL Solar System Installation Cost \$ Per DC/Watt (Inflation Adjusted), Q4 2010–Q1 2018



Cash Flow Mechanics of Investing in PV Solar

How will you get your money back and what are the assumptions?



Incentives: Federal

The Federal Business Energy Investment Tax Credit (ITC) Schedule for Photovoltaic Solar

12/31/19	30%
12/31/20	26%
12/31/21	26%
12/31/22	26%
12/31/23	22%
12/31/24	10%
Future Years	10%

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12/31/19	30%
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12/31/21	26%
12/31/22	26%
12/31/23	22%
12/31/24	10%
Future Years	0%

USDA Rural Energy for America Program (REAP) Grant

25% of total costs
-Rural or Agricultural to Qualify

Considerations for Good Financial Analysis

- **Assumptions:**

- Solar electricity generation
 - Degradation ←
 - Shading ←
- Value of the electricity generated ←
 - Net excess generation ←
- Inflation ←
- Discount rate
- Tax implications of incentives
 - Tax Credit
 - Depreciation
 - Utility incentives
- Insurance ←
- O&M ←

Financial Metrics

- Payback ← Good
 - Simple
 - Discounted
- Net Present Value ← Best
- Levelized cost of electricity
- Electricity bill with and without system

Payback (Nebraska 2021)


- Using conservative assumptions
 - Residential 12-16 years
 - Commercial/Agricultural 9-14 years

NOTE: system economics are unique the numbers here are only estimates

Residential Example – Eastern NE – Using System Advisor Model – National Renewable Energy Lab

6 kW solar (roof mount) <ul style="list-style-type: none"> House load: 10,500 kWh per year \$2.50 per Watt (total cost) Finance: 100% at 2.5% Insurance and O&M 1.5% energy cost escalation 	No net metering	Conservative Assumptions (O&M, Insurance, normal inflation)	Back of the envelope calculations (no other ongoing costs)	6% escalation of electrical prices (no other ongoing costs) 
Payback	18.6 years	14.6 years	13.5 years	10.5 years
Net Present Value (6% discount Rate) (25 years)	-\$1,387	\$740		\$7,456

Small Commercial Example – Eastern NE – Using System Advisor Model – National Renewable Energy Lab

25 kW solar (ground mount) <ul style="list-style-type: none"> Business load: 55,000 kWh per year Non demand rate schedule \$2.20 per Watt (total cost) Finance: 100% at 2.5% Insurance and O&M 1.5% energy cost escalation 100% bonus depreciation 	No net metering	Conservative Assumptions (O&M, Insurance, normal inflation)	All back of the envelope Calculations (no other ongoing costs)	6% escalation of electrical prices (no other ongoing costs) 
Payback	16.5	13.8 years	10.2 years	9.5 years
Net Present Value (6% discount Rate) (25 year)	\$2,945	\$7,359		\$28,036

System Price Sensitivity

Residential 6 kW		
System Total Cost (\$ /Watt)	Payback (years)	Net Present Value (6% discount rate)
\$2.00	12.16	\$2,244
\$2.25	13.42	\$1,492
\$2.50	14.64	\$740
\$2.75	15.82	-\$12
\$3.00	16.97	-\$764
\$3.25	18.08	-\$1,516
\$3.50	19.15	-\$2,268
\$3.75	20.20	-\$3,021
\$4.00	21.22	-\$3,773

Small Commercial 25 kW		
System Total Cost (\$ /Watt)	Payback (years)	Net Present Value (6% discount rate)
\$2.00	12.65	\$8,851
\$2.25	14.03	\$6,987
\$2.50	15.38	\$5,122
\$2.75	16.70	\$3,258
\$3.00	17.99	\$1,394
\$3.25	19.25	-\$470
\$3.50	20.49	-\$2,334
\$3.75	21.70	-\$4,198
\$4.00	22.88	-\$6,062



System Owner

Installer and Electrician

Utility is involved.

Steps in Solar PV Process

(Process for a Customer Owned Grid Connect Solar Electric System)

1. Study electric bills, efficiency
2. Solar homework, goals,
3. Get quotes, talk to multiple installers
4. Contact utility (Owner and Installer)
5. Design
6. Order solar modules, inverter, mounting
7. Building permit
8. Structure
9. Solar rail mounting
10. Solar module (panel) installation

11. Electrical permit
12. DC wiring and grounding
13. Inverter installation
14. AC wiring
15. Electrical inspection
16. Install safety labeling
17. Utility agreement
18. New meter (Utility site inspection)
19. Turn it on! (owner and installer)
20. Monitoring (owner and installer)



Picking an installer

- How many systems have you installed?
 - Where? How many years? Have you worked with my utility?
 - Can I see one? (straight lines, no hanging wires, good dirt work and good concrete work)
- What is estimated production of a system at my location?
 - Compare to PV Watts (pvwatts.nrel.gov)
 - Or your Utility's Solar Calculator
- Does my system need rapid shutdown?
 - (A good installer should know about this and explain it in a way you can understand)
- **Nebraskans for Solar** has list of installers on-line



Solar Electric Investment Analysis – bioenergy.unl.edu



Assessing System Cost

The average installed price of electricity in the U.S. increased from 7.2¢ per kilowatt-hour in 2005 to 10.1¢ per kilowatt-hour in 2012. Forecasting a PV solar system is essentially looking up the average system cost. However, production from a system will depend on the amount of solar resource available. A better understanding of how to calculate energy savings will allow a more accurate analysis, allowing investors to make better decisions.

The factors that affect the value of a PV system include:

- System size
- System type
- System location
- System orientation
- System tilt
- System shading
- System efficiency
- System degradation
- System maintenance
- System financing
- System incentives
- System risk
- System return

UNDERSTANDING YOUR RATE STRUCTURE

There are two main rate structures in the U.S. and an understanding of each is essential. Most electric consumers are on a flat rate, where the rate is the same regardless of how much electricity is used. However, some consumers are on a time-of-use (TOU) rate, where the rate varies throughout the day. This is often the case for businesses and large residential users. Understanding your rate structure is essential for making a good investment decision.

HOW ARE YOU CHARGED FOR ELECTRICITY?

Although the components of a utility bill vary, the following charges are generally included:

- **Fixed monthly charge:** This fee is a flat dollar amount that is charged to all customers, regardless of usage.
- **Energy charge:** This charge is based on the amount of electricity used, measured in kilowatt-hours (kWh).
- **Demand charge:** This charge is based on the maximum amount of electricity used during a specific period of time, usually 15 minutes.
- **Transmission and distribution (T&D) charge:** This charge is based on the amount of electricity used, measured in kWh.
- **Other charges:** These charges include things like meter rental, line loss, and other miscellaneous fees.

U.S. Energy Information Administration Electricity Data Browser

Forecasting the Value of Electricity

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Estimating System Production

Producing renewable energy is much like gambling or farming – the quantity produced and the cost vary with the production conditions. For solar power, weather, solar resource, and the amount of solar panels installed are the main factors that affect production. For example, a system in a high solar resource area will produce more energy than a system in a low solar resource area. Similarly, a system with more solar panels will produce more energy than a system with fewer solar panels.

The amount of solar energy produced by a system is determined by the amount of solar resource available, the amount of solar panels installed, and the efficiency of the solar panels. The amount of solar resource available is determined by the amount of solar radiation that reaches the solar panels, which is determined by the amount of solar radiation that reaches the Earth's surface, the amount of solar radiation that is reflected by the Earth's surface, and the amount of solar radiation that is absorbed by the solar panels.

KEY SITE-SPECIFIC DATA REQUIREMENTS

Key site-specific data requirements include:

- **Solar resource:** The amount of solar radiation that reaches the solar panels, measured in kilowatt-hours per square meter per day (kWh/m²/day).
- **System orientation:** The angle of the solar panels relative to the horizontal plane, measured in degrees.
- **System tilt:** The angle of the solar panels relative to the vertical plane, measured in degrees.
- **System shading:** The amount of solar radiation that is blocked by shadows from other objects, measured in kilowatt-hours per square meter per day (kWh/m²/day).
- **System efficiency:** The amount of solar energy that is converted into electricity, measured in percent.
- **System degradation:** The amount of solar energy that is lost due to system wear and tear, measured in percent per year.
- **System maintenance:** The amount of solar energy that is lost due to system maintenance, measured in percent per year.
- **System financing:** The amount of solar energy that is lost due to system financing, measured in percent per year.
- **System incentives:** The amount of solar energy that is lost due to system incentives, measured in percent per year.
- **System risk:** The amount of solar energy that is lost due to system risk, measured in percent per year.
- **System return:** The amount of solar energy that is lost due to system return, measured in percent per year.

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Understanding Incentives

Understanding a PV solar project requires significant up-front capital investment. To help the investor understand the value of a PV system, it is essential to understand the incentives that are available. These incentives include:

- **Investment Tax Credit (ITC):** A federal tax credit that allows investors to deduct a percentage of the cost of a PV system from their federal income taxes.
- **State incentives:** Many states offer their own incentives, such as property tax exemptions, sales tax exemptions, and net metering.
- **Local incentives:** Some local governments offer their own incentives, such as property tax exemptions and net metering.
- **Net metering:** A billing arrangement that allows a PV system to generate credit for the electricity it produces, which can be used to offset the electricity that is consumed from the grid.
- **Net billing:** A billing arrangement that allows a PV system to generate credit for the electricity it produces, which can be used to offset the electricity that is consumed from the grid.
- **Feed-in tariffs:** A policy that guarantees a fixed price for the electricity generated by a PV system.
- **Renewable Portfolio Standards (RPS):** A policy that requires utilities to generate a certain amount of renewable energy.
- **Renewable Energy Certificates (RECs):** A certificate that represents the environmental attributes of a unit of renewable energy.
- **Green bonds:** A type of bond that is used to finance green projects.
- **Green loans:** A type of loan that is used to finance green projects.
- **Green leases:** A type of lease that is used to finance green projects.
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KEY ESSENTIAL INCENTIVES

Although there are many incentives available, the following are the most important:

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Conducting a Financial Analysis

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THE IMPORTANCE OF FIN-TAX AND HOUS-TAX

Another key consideration is to make sure the project accounts for the tax benefits and any tax incentives that are available. These incentives include:

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PV Solar Example

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USING THE SAM MODEL

The National Renewable Energy Laboratory, which is funded by the U.S. Department of Energy, has developed the System Advisor Model (SAM) as a software tool for analyzing the financial performance of renewable energy projects. SAM is a comprehensive financial model that includes everything from system design and production to system cost, operation and maintenance, financial factors, project revenues, tax implications, and the value of electricity generated by the system. It includes a detailed cash flow view of the system's lifetime. The SAM model estimates the likelihood of a project and simulates a detailed cash flow analysis throughout the system's lifetime, including the payback period, net present value, levelized cost of energy, electricity savings, and electricity cost, and allows a renewable energy system. SAM is available for download at <http://www.nrel.gov/sam/>.

PV SOLAR OHIO EXAMPLES

To illustrate the implications of aggressive assumptions and the benefits of having a flexible cash flow analysis, the following examples are provided. The first example is a 100 kW residential solar project. The second example is a 1 MW commercial solar project. The third example is a 10 MW utility-scale solar project. The fourth example is a 100 MW utility-scale solar project. The fifth example is a 1 GW utility-scale solar project. The sixth example is a 10 GW utility-scale solar project. The seventh example is a 100 GW utility-scale solar project. The eighth example is a 1000 GW utility-scale solar project. The ninth example is a 10000 GW utility-scale solar project. The tenth example is a 100000 GW utility-scale solar project. The eleventh example is a 1000000 GW utility-scale solar project. The twelfth example is a 10000000 GW utility-scale solar project. The thirteenth example is a 100000000 GW utility-scale solar project. 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Contact me for Questions

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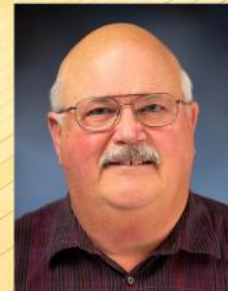
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