



# Boosting Profits with Wind Power Savings

How commercial operations in the dairy, farming, and industrial industries benefit from making their own electricity with the wind



## **Why Wind Power?**

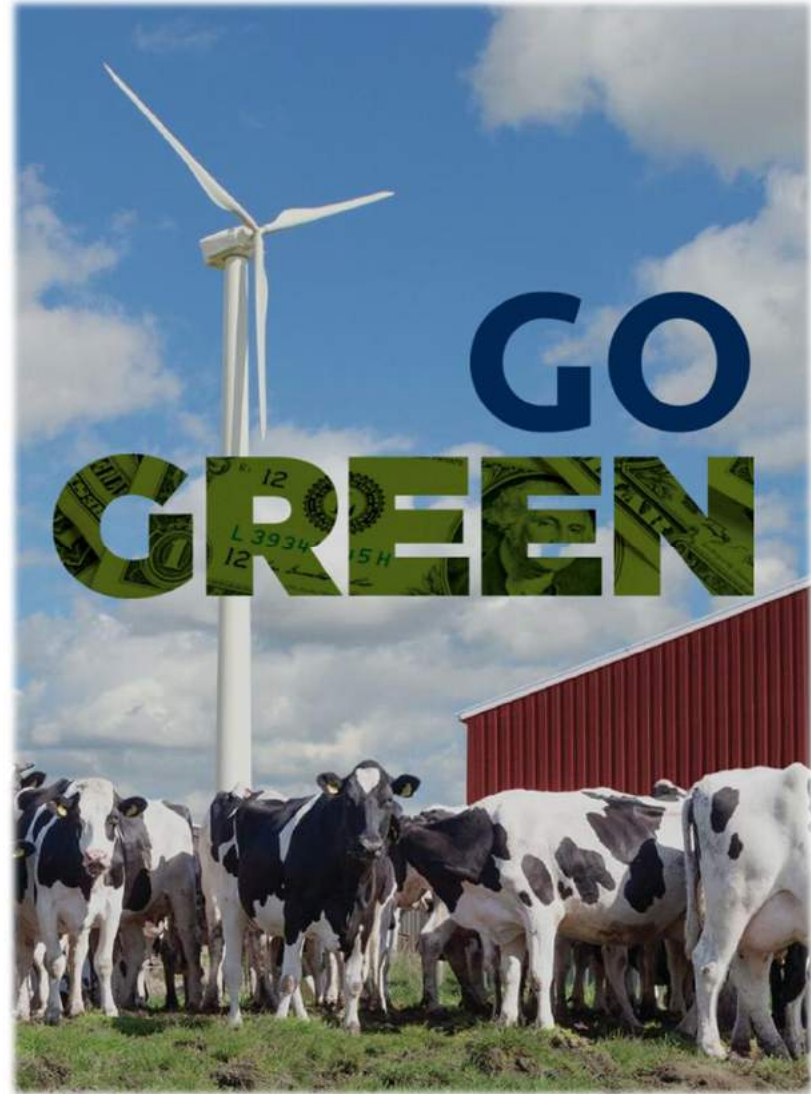
# Saving Money with Wind Power

If a business is in a site with good wind, investing in a turbine is a smart idea.

For an NPS 100 wind turbine, this means:

- ❖ Immediate **tax credit** opportunity:
  - almost \$100K over 1-5 years
- ❖ **Savings** from electricity bill every year:
  - depending on wind and utility rates, savings range from \$15,000 to \$37,000 per year (year 1 value)

**50% lifetime savings  
directly boost profits**



*Note: 10% no-money-down savings also available*



# Non-financial Benefits of Wind Power

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- ❖ Stable and more predictable cost of power
- ❖ Energy independence / Self Reliance
- ❖ Small Footprint
- ❖ “Green” Values Made Visible – marketing value
- ❖ Educational value – local kids and communities learn about renewables





# Why Wind Now? (from 10 years ago)

- ❖ NPS 100 Reduced Installed Cost (TIC)
  - \$500,000+ → as low as \$350,000\*
  - 30%-40% reduction in cost
- ❖ NPS 100 Increased Production (AEP)
  - 21 meter rotor → 24 meter rotor
  - 183,000 kWh/yr → 240,000 kWh/yr\*\*
  - Over 30% improvement in performance

**With these powerful cost and productivity improvements, wind power makes economic sense, even with reduced incentives...**



*\* Based on grouping 8-10 turbine installations*

*\*\* Based on 5.5 m/s wind regime*





## **About Northern Power**

# Northern Power Systems – Company Overview

Providing distributed energy & renewable solutions globally for over 40 years

Based in Barre, Vermont, USA

Offices in:  
Boston ▪ Italy ▪ United Kingdom ▪ Switzerland

## Distributed Wind Turbines



100 kW, 60 kW  
700+ plus  
turbines with  
over 16 million  
run hours  
98% availability

## MW Scale Wind Technology



Partnered with  
WEG  
Over 100MW  
installed

## Integrated design and controls



For microgrid  
applications  
>25 projects  
globally

## Power Converter Systems



500 kVA – 2.5  
MVA units  
FlexPhase™  
technology

## Turnkey Energy Storage



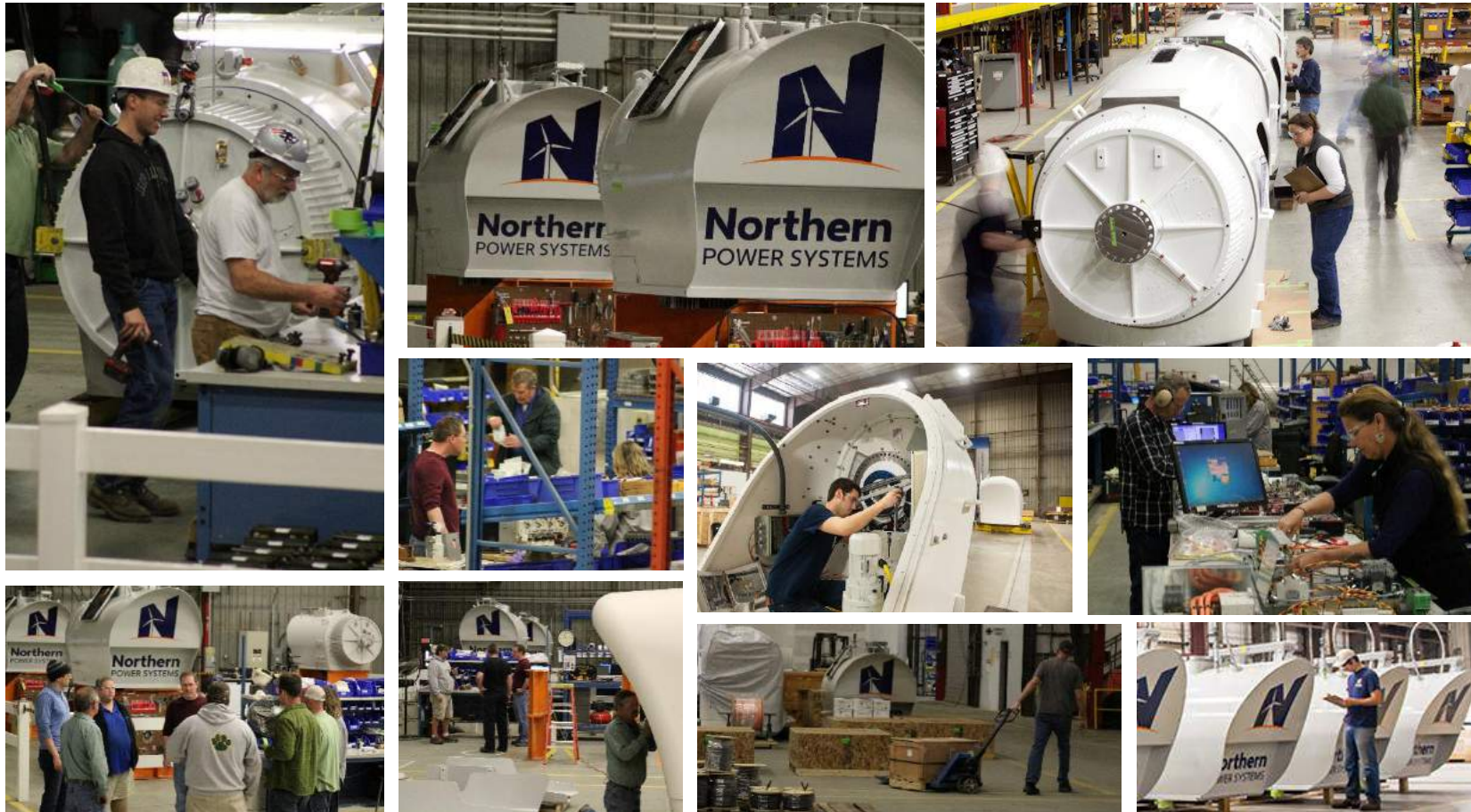
ESS site  
controller  
BMS integration  
Monitoring &  
data acquisition

Business  
core

Leveraging history into distributed solutions



# Why Northern Power?



***Proven Track-Record of Performance and Safety***  
***Engineered and assembled in America***



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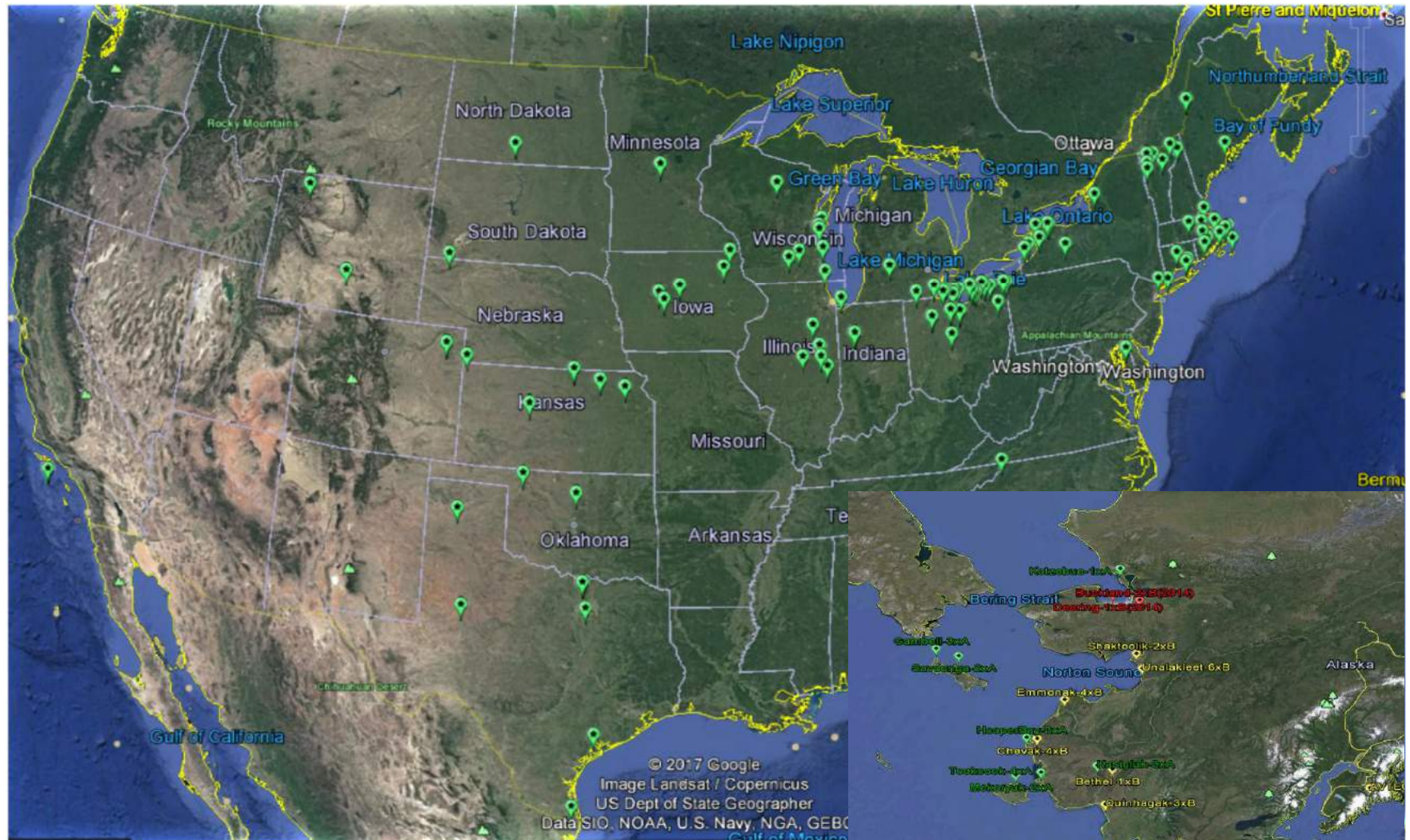
# NPS Global Footprint

Over 700 units operational w/24/7 monitoring, another 200 in development.....

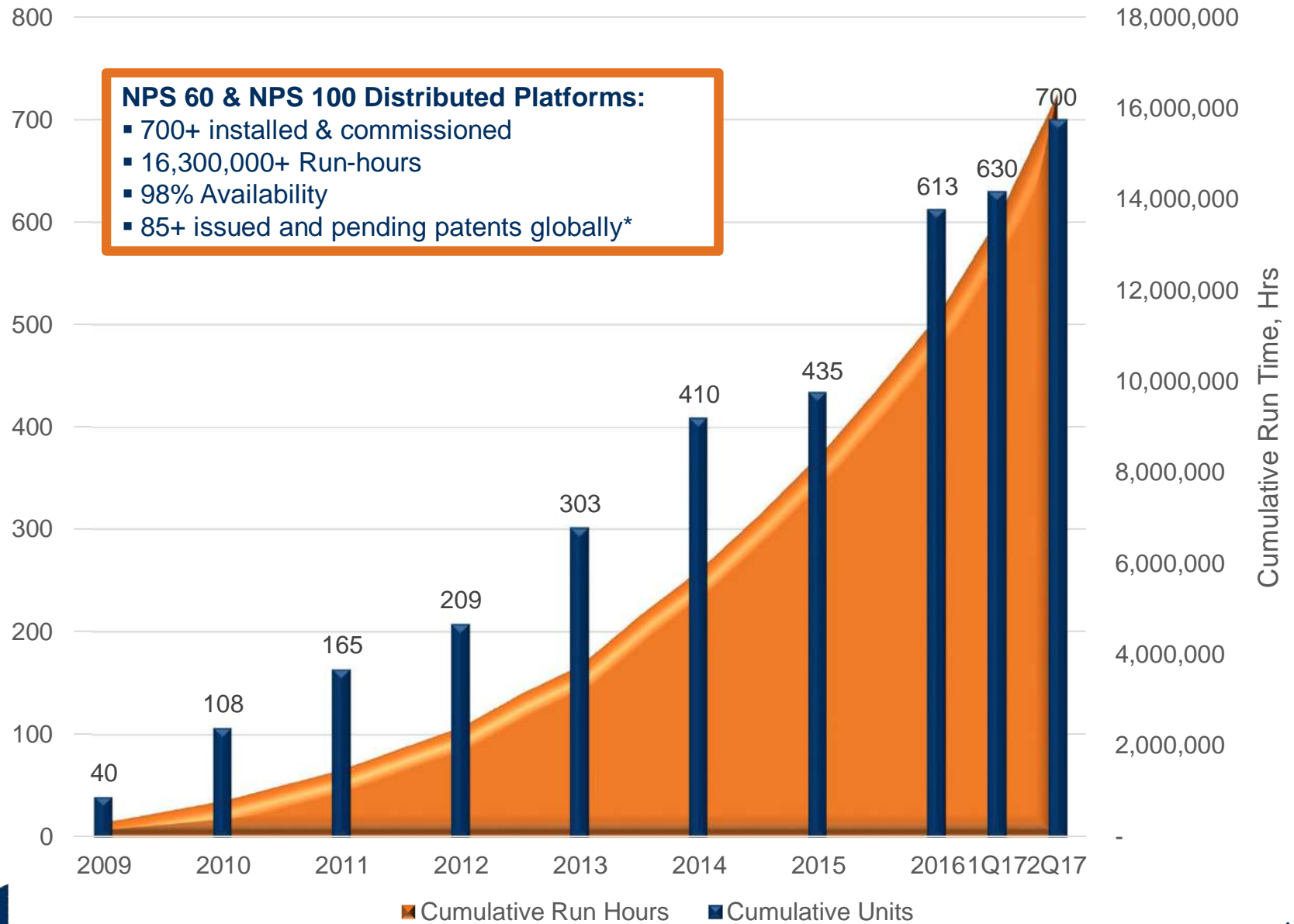




# 100's of NPS 100 in the United States



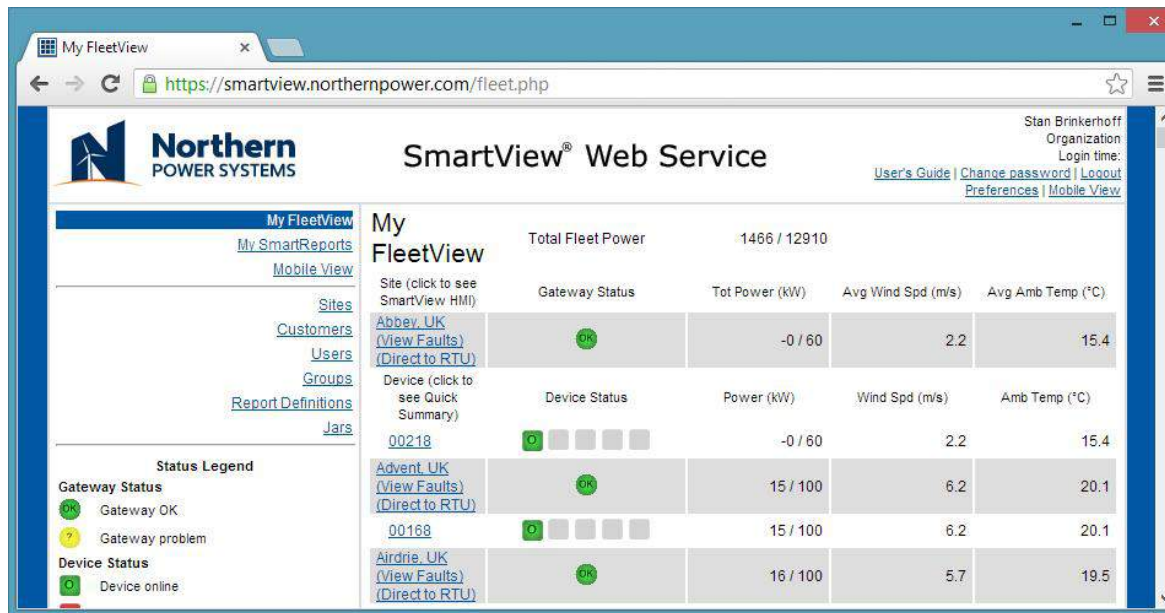
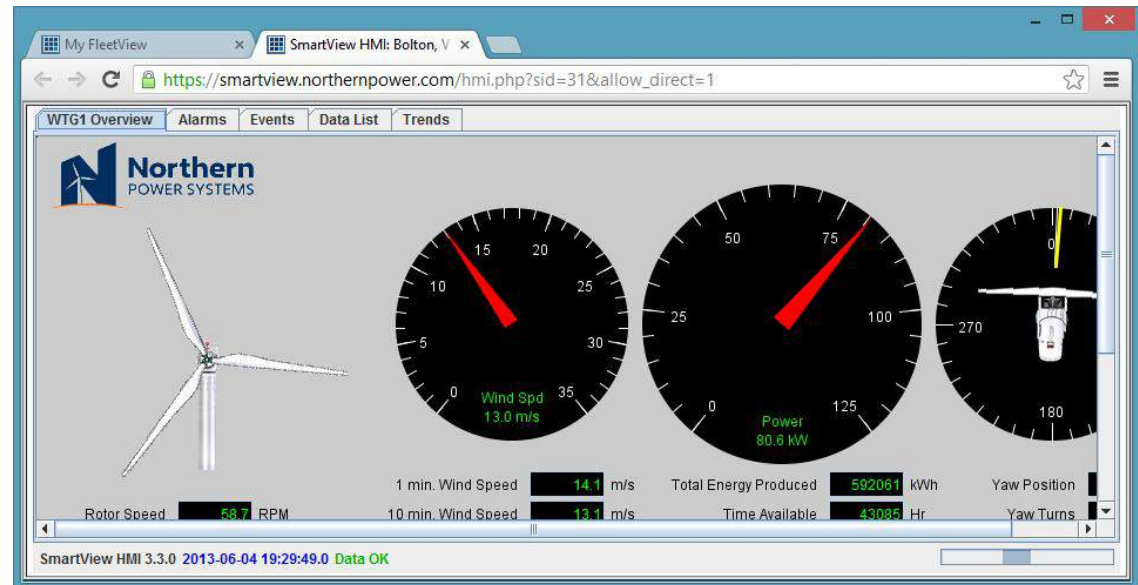
# NPS Wind Turbine Deployment & Run Hours



# SmartView: FleetView

## Monitoring and Remote Access

- ❖ Customer and internal facing fleet performance overview.
- ❖ Central web platform 24/7/365
- ❖ Encrypted Cloud based architecture.



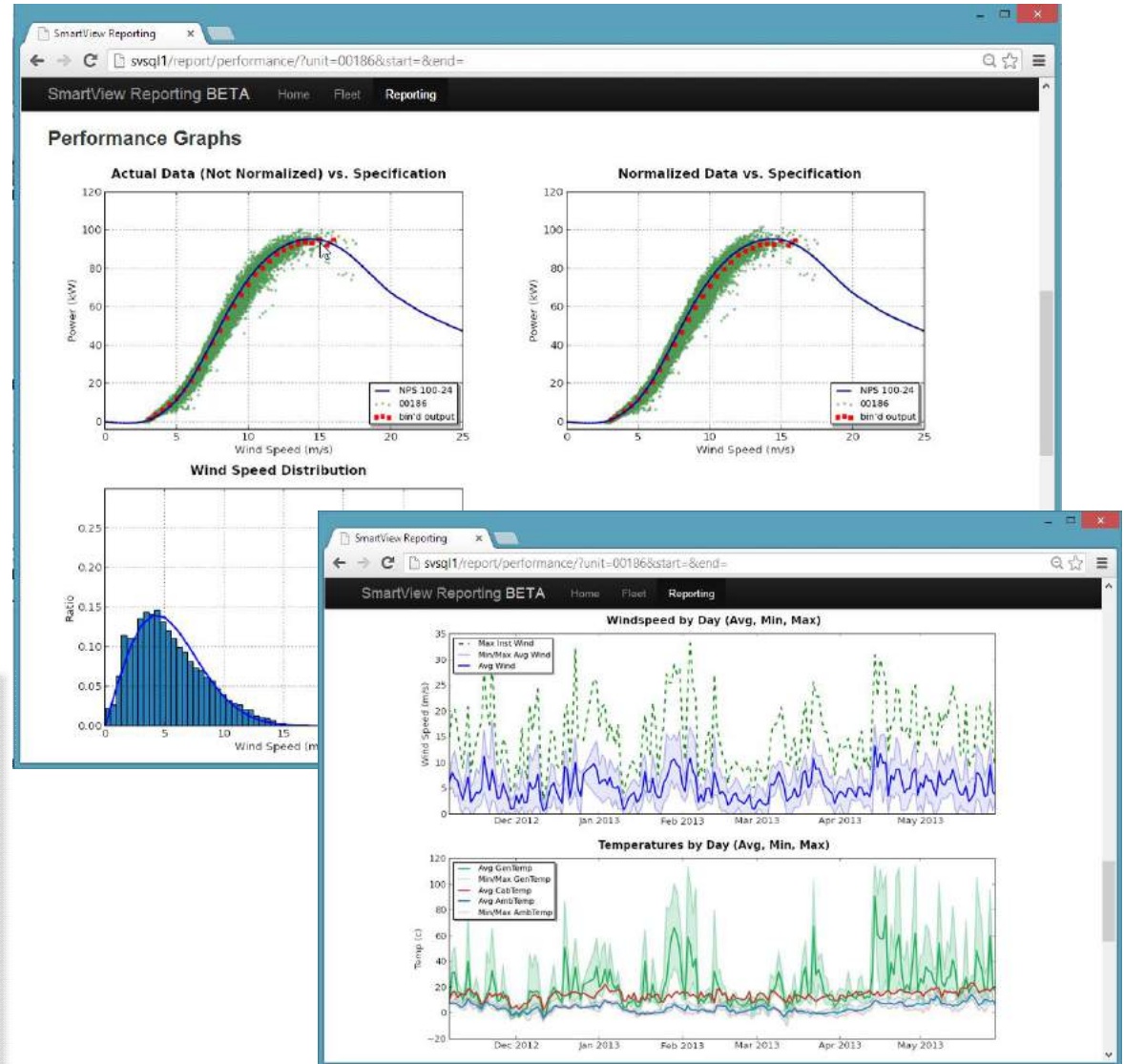


# SmartView: Performance Analytics

- ❖ Dynamic single unit and aggregate fleet performance toolset.
- ❖ Customizable and scalable.
- ❖ Integrated with ERP, Fleet Management, and other databases.

95% of customers have rated the Northern Service Team as either “Very Knowledgeable” or “Extremely Knowledgeable”

*Source: Jan 2017 NPS customer survey*



# Distributed Wind Power – not just for Big Wind Farms

## Commercial & Industrial



Phoenix Press  
Connecticut, USA



Bolton Valley  
Vermont, USA



Hyannis Country Gardens  
Mass. USA



Triad Recycling & Energy  
New York, USA

## Municipalities



Village of Cascade Water  
Treatment Facility  
Wisconsin, USA



Energy Park, Hempstead  
New York, USA

## Schools and Universities



Medford High School  
Mass. USA



Cloud County Community  
College, Kansas, USA



Camden Hills HS  
Maine, USA



Alfred State College  
New York, USA





# Wind Power – Isolated Village Electrification

## Island & Micro-Grids



## Water Pumping



## W/D Village (AK)





## **Large Ag, Commercial and Industrial Applications**

# Large Ag / Commercial & Industrial Applications

## ❖ Large / Commercial Agriculture

- Dairy farms with **500+ head**
- Hog & Chicken Farms
- Dairy processing facilities
- Meat Processing
- Feed Lots
- Farms with large electricity-based processes (e.g. drying)
- Vineyards
- Nursery businesses



## ❖ Commercial & Industrial Applications

- Telecommunications Companies
- Recycling Facilities
- Printing Operations
- Utility
- Manufacturing





# Farm-based 100kW turbines



*Arends  
Brothers  
John Deere  
Sales, IL*



*Blairmains Farms, Scotland*

**Northern Power has over  
200 farm/ag-based  
turbines worldwide**

- ❖ ~100 in the UK
- ❖ ~100 in Italy
- ❖ ~20 in the US



*Burco Farms, IA*



*Audets / Blue Spruce Farm, VT*



# KS Installations Statistics

- ❖ 6x NPS 100kW Turbines (Ag, Educational, C&I, WWTF)
- ❖ More than 5,200,000 kW-Hrs. (total lifetime) delivered to the customers load
- ❖ More than 260,000 accumulated Run Time Hours
- ❖ 93%-94% Availability
- ❖ 3x in 2010
- ❖ 1x in 2012
- ❖ 1x in 2014
- ❖ 1x in 2016
- ❖ 32%-36% Capacity Factor (CF) in some locations





# CASE STUDY: GBT Communications (Rush Ctr.- KS)

## Location

Rush Center, KS

## Project

distributed wind generation system at a commercial business, net metered on a monthly basis

## Model

NPS 100-21 wind turbine, 37 meter tower

## Year Commissioned:

2014

## Average wind speed

6.26 m/s

## Annual Energy

### Production

257,000 kWh (2016)

## Annual Carbon Offset

Saved carbon emissions equivalent to burning 209,000 lbs of coal

Source: <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>

**Electricity is critical** to Golden Belt's business **operations**. The central office and TV head-end distribute services 24 hours a day, 7 days a week. All of these electronics generate so much heat that air conditioners are required to keep the systems and surrounding office cool. **Electricity also represents a major expense item, impacting bottom line profits every month.**

## Performance:

### ❖ Monthly bills:

\$4,000-5,000 to as low at **\$1,100 now!**

### ❖ 1st half 2017 = 145,500 kilowatt-hours

over **\$19,000** worth of energy (valued at 13.6 cents)

### ❖ Yearly savings: approx. **\$30,000** per year in utility bill savings

## Hedging against rising costs

### ❖ 2014 rate: 11.3 cents/kWh

### ❖ 2016 rate: 13.6 cents/kWh **(20%)**

**"The reason we built the turbine was to save on expenses, but also take advantage of the very predictable wind patterns in Kansas."**



Beau Rebel  
Golden Belt Communications



# CASE STUDY: KS / CO Ag and Dairy Business

## Location

Yuma, CO (2 units)  
St. Francis, KS (1 unit)

## Project

Net metered distributed  
wind generation system at  
two farm locations

## Model

3 NPS 100-24 wind  
turbines, 37 meter tower

## Year Commissioned:

2016

## Average wind speed

6.38 m/s (14.3 mph)  
6.49 m/s (14.5 mph)  
5.92 m/s (13.24 mph)

## Annual Energy Production

750,000+ kWh  
(extrapolated from 1<sup>st</sup> half  
of 2017 data)

## Annual Carbon Offset

Saved carbon emissions  
equivalent to burning over  
298,000 lbs. of coal

Source:

<https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>

An agricultural businessman with dairy and cattle operations in two locations.

**Electricity** is one of the elements that make a difference to the **bottom line**.

Wind power was particularly attractive as a renewable energy choice because it **required minimal land** (cattle can graze immediately around the 8' Diameter foundation pad, and because wind turbines do not need regular cleaning – which requires the use of scarce and valuable water – **to keep producing at efficient levels**.

## Performance:

- ❖ 1st half 2017 =  
395,000 kilowatt-hours  
/ approx. **\$40,000**  
worth of energy  
(valued at 10 cents)
- ❖ **Yearly savings:**  
approx. **\$80,000** per  
year in utility bill  
savings

**“Dairies work 24 hours a day,  
and they use energy that  
whole time.”**

Owner, Confidential Client



# CASE STUDY: Miller Sonshine Acres Dairy Farm (NY)

## Location

Corfu, NY

## Project

Net metered distributed wind generation system at a farm

## Model

2 NPS 100-24 wind turbines, 37-meter towers

## Year Commissioned:

2014 and 2016

## Average wind speed

5.02 m/s (11.3 mph) and 5.44 m/s (12.2 mph)

## Annual Energy Production

360,000+ kWh

## Annual Carbon Offset

Saved carbon emissions equivalent to burning 270,000 lbs. of coal

Source:

<https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>

When Dan Miller installed his first 100kW turbine, Miller Sonshine Acres Farm was a bustling dairy operation with over **2,800 milking cows**. His electricity bills were \$6,000 per month. He knew that if he wanted his business to be sustainable, he would have to find a way to control costs now and well into the future.

## Performance:

- ❖ Monthly bills: from \$6,000+ to approx. **\$2,000**
- ❖ 1st half 2017 = 180,00 kilowatt-hours / over \$35,000 worth of energy (valued at 10 cents)
- ❖ Yearly savings: approx. **\$35,000** per year in utility bill savings

"I'm concerned about climate change and see the value in renewable energy, but the bottom line is, I thought I could save some money. This has proven to be a great way to do that."

Dan Miller, Owner, Sonshine Acres Farm



# Energy on a Dairy Farm

*A typical dairy farm consumes between 800 and 1,200 kilowatt hours (kWh) per cow every year.*

“With the energy cost savings that result from the use of these [renewable] technologies... farmers will then be able to sustain and expand their agricultural operations over the long term, and have confidence in handing it off to the next generation.”

**Renewable Energy World Magazine**

July 6, 2017, “Congress Introduces Bill to Catalyze Economic Development for Rural and Agricultural Communities through Energy Investment”

***Electricity helps dairy farms be more productive:***

- Milk cooling
- Water heating
- Vacuum pumps
- Ventilation



# Match the Rotor to the Load

- ❖ Once you know the value is there, it is important to “match” the electric load with the correct turbine size
  - Make sure amount of electricity that is used (**Demand**) on a regular basis is **more** than what a turbine will Generate.
  - **Why?** excess power is generally not credited at a retail rate

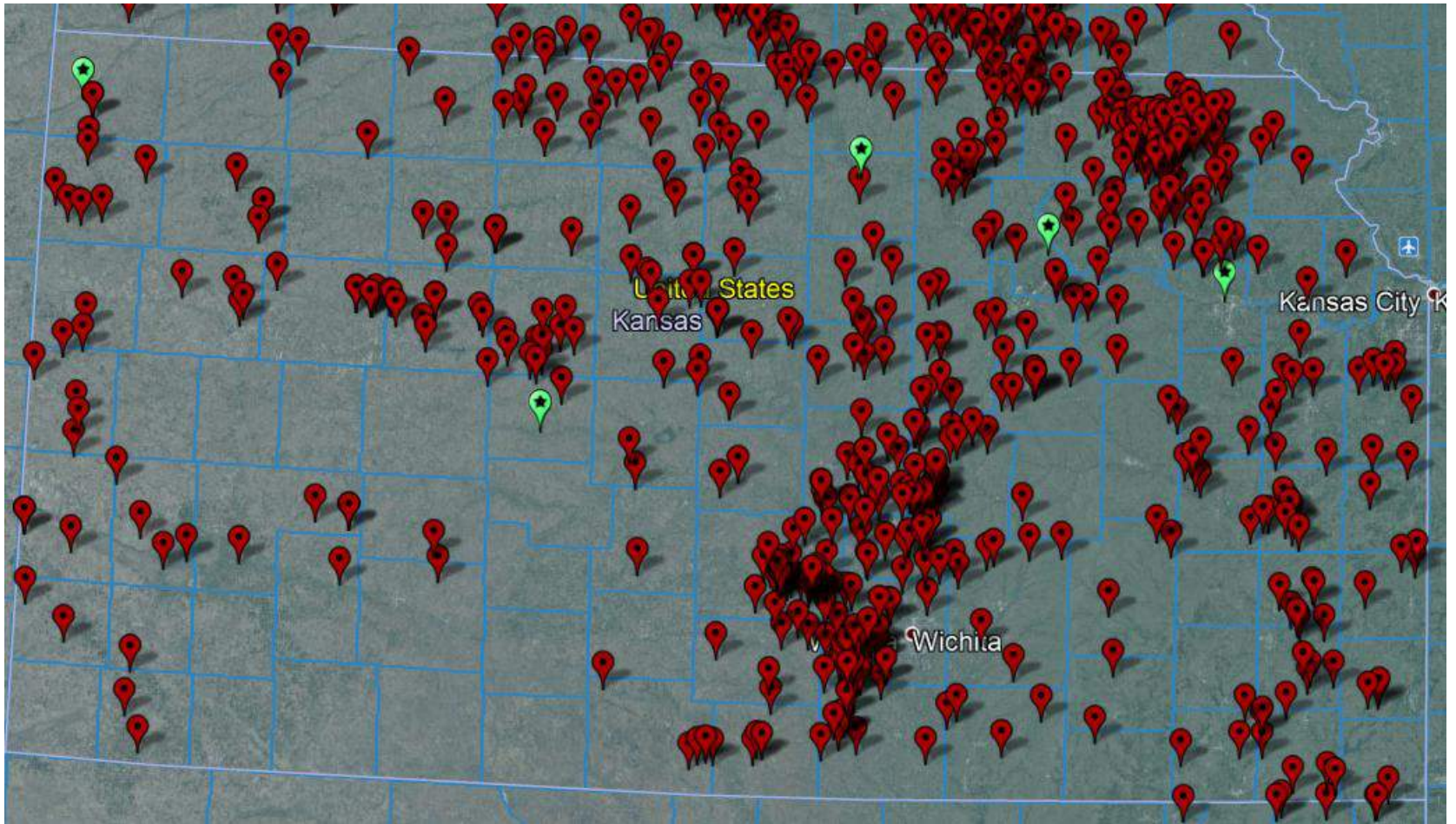
Turbine size	Dairy Herd Size	Electricity Bill range	Reference point: How many homes?	Notes
2-10 kW	<100 head	<\$350/month	1	
25 kW	100 – 500 head	\$350/month - \$1,000/month	5-10	Very easy almost everywhere!
100 kW	500 – 3,000+ head	>\$1,000/month	20-30	Depends on utility NET Meter Caps.
MW-scale	>3000 head	>\$10,000/month	100++	Be aware of Permitting considerations





# Many Opportunities in Kansas

- ❖ From a purchased list of dairy-related businesses, over 500 showed good economic returns.
- ❖ Additional opportunities in business/industrial sector





## **Wind Power Economics Overview**

# What Makes a Good Wind Project?

## ❖ Project Economics depend upon:

### ➤ Wind Resource

- How much wind is there at your site?
- The higher the wind, the more you can make

### ➤ Energy Cost (Utility Rates)

- How much is wind-generated energy worth?
- The higher your current cost, the greater the value of the energy you can make on your own

### ➤ Incentives

- **Federal 24% (ITC) Investment Tax Credit, KS-SEO, USDA-REAP**



## ❖ The quick math

- Up front cost = **\$250K** or **less** up front cost (**after tax credits/incentives**)
- The turbine can make **\$15k-\$40k** worth of electricity in a year. \*

**Same approach for all turbine sizes**



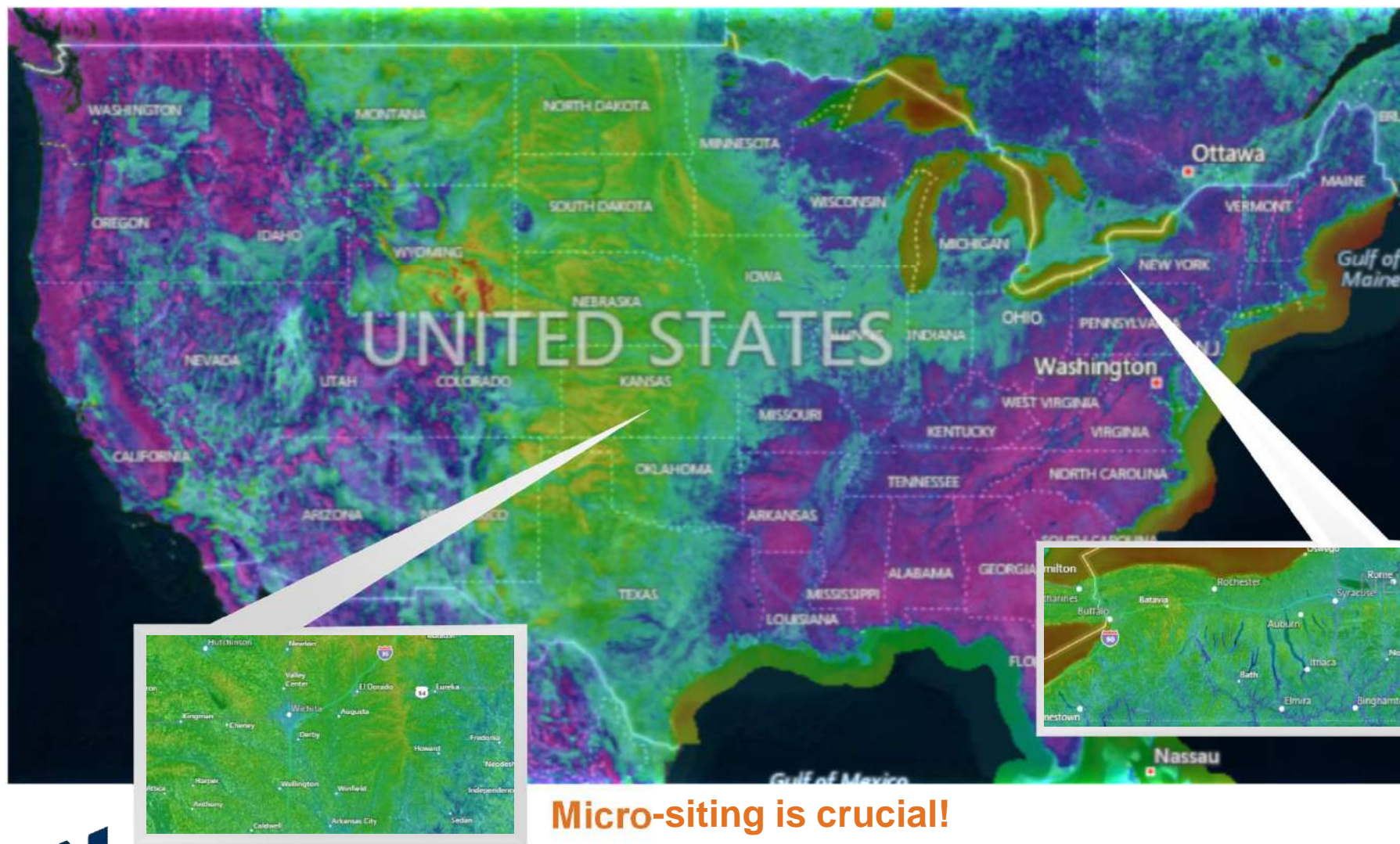
*\* Production value depends on your wind and utility price*

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# Wind in the United States

- ❖ Light blue / green / yellow / red are high quality wind regimes



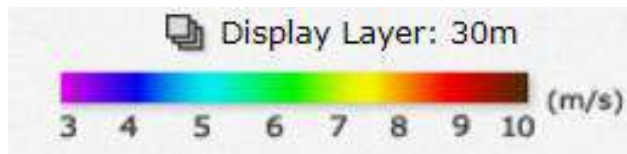
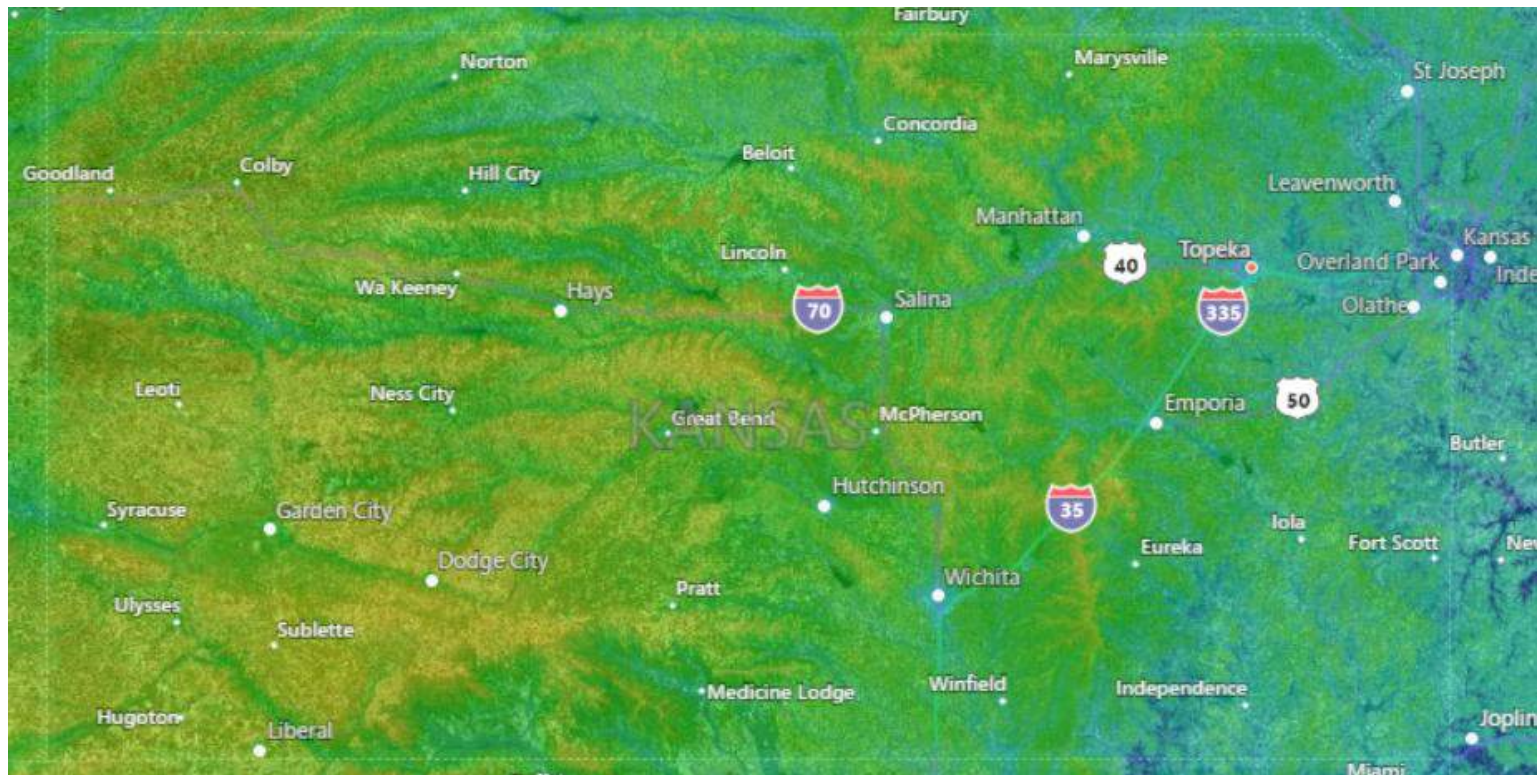
**Micro-siting is crucial!**



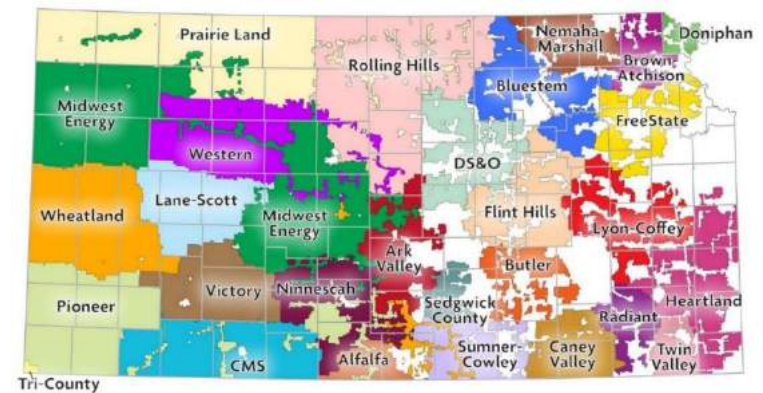


# Kansas

*Excellent Wind Resource In Most Locations!*



*Many Utilities, but fairly uniform net metering programs*



# Energy Costs

- ❖ Electricity Rates can be complex
  - Commercial Rates
  - Ag Rates
  - Every bill is different – the one at the right is actually pretty simple!
- ❖ Good resources to estimate rates for economic analysis, including:



BILLING PERIOD: Jun 26, 2017 to Jul 27, 2017 PAGE 2 of 4

ACCOUNT NUMBER: 12637-94119 **PLEASE PAY BY** Aug 20, 2017 **AMOUNT DUE** \$ 3,775.09

**DETAIL OF CURRENT CHARGES**

**Delivery Services**

Service Period	No. of days	Current Reading	Previous Reading	=	Total Usage
Jun 26 - Jul 27	31	51562	35926	Actual	15654 kWh

METER NUMBER: 35154860 NEXT SCHEDULED READ DATE ON OR ABOUT: Aug 29

RATE: Electric SC1 T&D Non Heat

Basic Service (not including usage)					17.00
Delivery	0.04758874	x	15654 kWh		744.96
Consolidated Billing Credit					-1.24
Res Agricultural Discount	-0.005193	x	15654 kWh		-804.37
RCM	0.00084	x	15654 kWh		13.15
Incr State Assessment	0.00007969	x	15654 kWh		1.25
SBC	0.007948	x	15654 kWh		124.42
Legacy Transition Chrg	0.001128	x	15654 kWh		17.66
Transmission Rev Adj	-0.00338	x	15654 kWh		-52.91
Tariff Surcharge	2.04082 %				9.59
<b>Total Delivery Services</b>					<b>\$ 479.51</b>

**Supply Services**

SUPPLIER: Hudson Energy Services LLC  
4 Executive Blvd  
Suite 301  
Suffern, NY 10901  
PHONE: 1-877-Hudson 9 ACCOUNT NO: 242792

Electricity Supply	0.06212115	x	15654 kWh		972.44
Sales Tax	11.0 %				106.97
<b>Total Supply Services</b>					<b>\$ 1,079.41</b>







## **Wind Power Savings Report – What's it to you?**

# *What's it to you?*

*Analyzing Wind Speed,  
Energy Production, &  
Utility Rates at Precise  
Locations*

**Northern Power will run this  
report for your specific location**






Wind Power Savings Report for:  
John Smith  
123 Dairy Lane  
Dairyland, KS 12046

Thank you for requesting a Wind Power Savings Report from Northern Power Systems. According to the site-specific data we pulled for your site, you could **SAVE OVER 60%** on your long term energy costs – or get a **GUARANTEED IMMEDIATE 10%** with no money-down. Turn the page to explore your savings potential...



# Wind Power Savings Report

- ❖ Visual Meters for
  - Wind speed
  - Electricity Rate
  - Lifetime savings
- ❖ Wind speed
- ❖ Utility rate
- ❖ Annual production
- ❖ Translate above to
  - Current year equivalent savings
  - Value 10 years from now
- ❖ Initial project Cost
- ❖ Financing Options

Assessment of wind at your site Based on estimated wind speed. Key: 4-4.9 m/s = poor; 5-5.5 m/s = good (yellow); 5.5-6.0 m/s = great (green); over 6 m/s = excellent (dark green) <small>m/s = meters per second (1 m/s = 2.2 mph)</small>	
Value of the electricity you could make using an NPS100 Based on current utility cost. Key: less than 8 cents/kWh = poor (red); 8-10 cents/kWh = good (yellow); 10-12 cents/kWh = great (green); Over 12 cents/kWh = excellent (dark green)	
Long term value of producing electricity from the wind using an NPS100 Based on long term savings, straight purchase scenario, page 4) Key: less than 20% = poor (red); 20-49% = good (yellow); 50-60% = great (green); Over 60% = fantastic (dark green)	



**Northern**  
POWER SYSTEMS  
HOME GROWN IN AMERICA

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# Flexible Financing Options



# Flexible Financing Options

	POWER PURCHASE PROGRAM	LEASE-TO- OWN OPTION	LOAN OPTION	STRAIGHT PURCHASE
<b>Key financing feature</b>	Immediate savings on current costs (10%)	Own the turbine after 7-9 years of lease payments	Own the turbine with financing by your local lender	
<b>Predictable and stable energy costs</b>	✓	✓	✓	✓
<b>3<sup>rd</sup> party monetizes tax benefits and passes savings to you</b>	✓	✓		
<b>You monetize 100% of tax benefits directly (MACRS and ITC)</b>			✓	✓
<b>Own the asset and its value</b>		✓	✓	✓





**Trevor Atkinson**  
**Northern Power Systems**

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**802-461-2847 Office**  
**[tatkinson@northernpower.com](mailto:tatkinson@northernpower.com)**



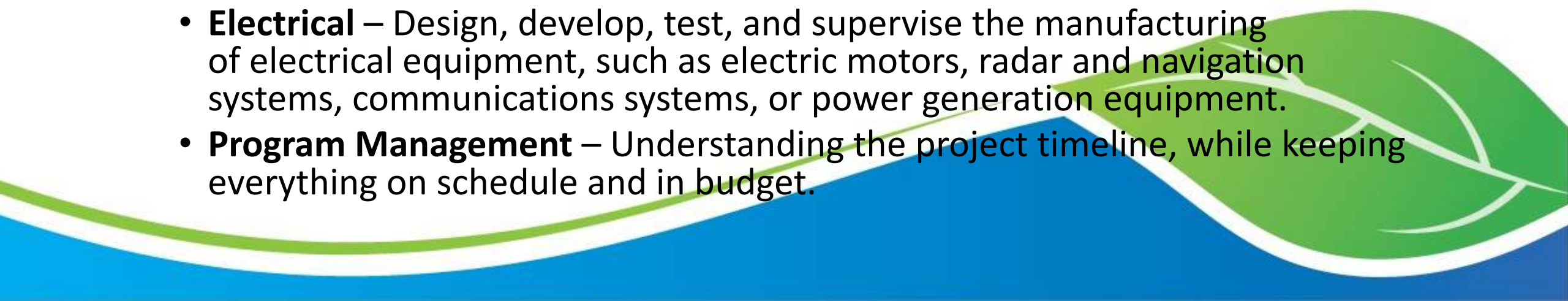


**EthosDistributed**  
Solutions

## O&M and Engineering: DG Wind and Solar

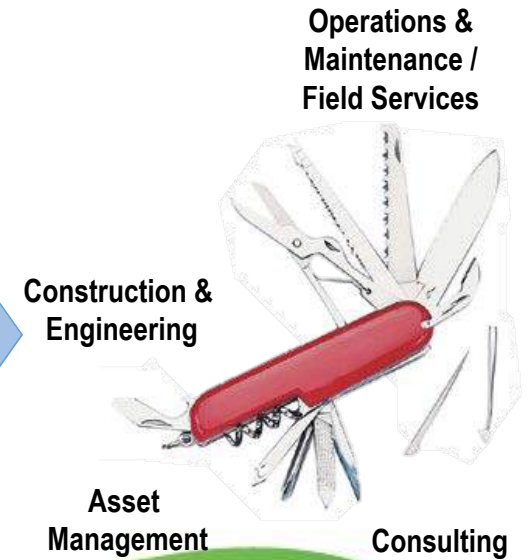


# Definitions

- What is O&M
    - Operations – Management of the system from day to day actions all the way to spare parts.
    - Maintenance – Preventative maintenance, major and minor corrective, and project work.
  - What is engineering
    - Civil – Design, build, supervise, operate, and maintain construction projects and systems in the public and private sector, including roads, buildings, airports, tunnels, dams, bridges, and systems for water supply and sewage treatment.
    - **Electrical** – Design, develop, test, and supervise the manufacturing of electrical equipment, such as electric motors, radar and navigation systems, communications systems, or power generation equipment.
    - **Program Management** – Understanding the project timeline, while keeping everything on schedule and in budget.
- 

# Who is Ethos

- Ethos Distributed Solutions is based in Denver, Colorado and provides wind, solar and telecommunications services nationally.
- Presently Ethos is working on over 300 distributed energy projects covering 32 states, including Alaska, and in the Bahamas on a US military installation.
- Our team of experienced professionals customize high-quality and cost-effective solutions to address each client's specific requirements across the entire life cycle of a capital project.
- Service offerings: Consulting, Development, Construction, Operations & Maintenance (field services), and Asset Management.
- Provide ongoing operations and maintenance support to 28 different turbine types ranging from 50 kW to 2.3 MW.
- Perform construction QA services – to date we have completed these inspections on over 1900 MW of utility-scale wind projects.
- New site construction services for telecommunications towers, telecommunications roof top installations, solar and wind projects.
- Over 12 MW of solar under operations & maintenance contracts. Projects range in size from 250 kW to 5 MW.
- Full time, on site staffing solutions and traveling solutions, depending on project.





# Wind vs Solar Maintenance

- Solar
  - TYCO connectors, ants, broken modules, fuses, switches, home-runs, soiling, inverter control panels, and weather stations.
- Wind
  - Blades, towers, generators, connectors, cables, PLC's, gearboxes, fuses, and weather stations.





# Atypical Defect



# Cost of Time

- 2 MW and 2500 kV switchgear goes down
  - 10 cents kWh you are losing \$1000's of dollars a day
- If it is a string, you are losing pennies a day
- Owner needs to be an active partner
- Local resets vs. Owner resets





# Routing is Important





# Ways Ethos increased Output

- Took over sites from previous O&M provider.
- Have fully trained technicians in 28 different turbine types.
- Hired guys out of Greensburg.
- Utilized local resets where it made financial sense.



# Asset management

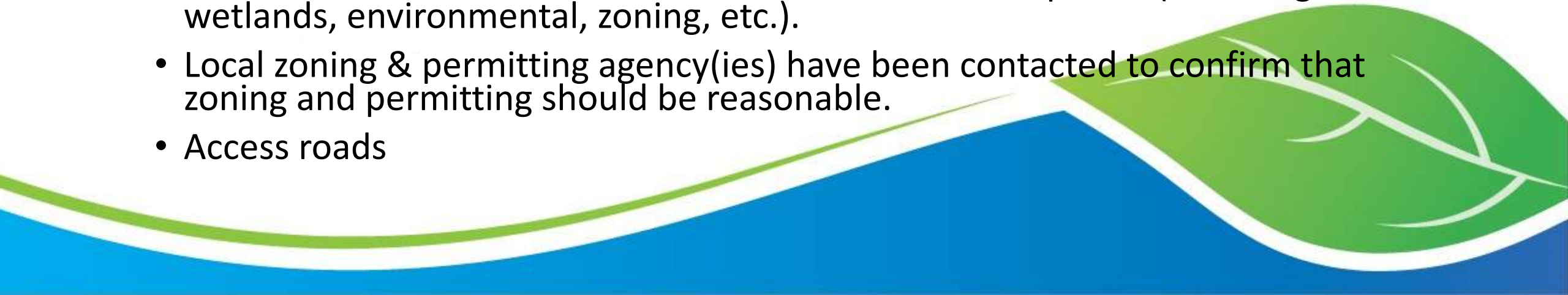
- Spare parts available
- Spare parts inventory
- Consumable inventory
- Reporting – are you getting what you think your getting.
  - Type of report
  - Actual Production vs. Perceived Production



# First Steps to a New Construction Project

Ethos envisions a relationship where the customers are qualified prior to Ethos beginning work on the development phase of the project. The customer qualification should include:

- Project vetted financially – customer is happy with all economics and Vendor is satisfied with customer's ability to complete a project.
- Utility bill is examined and it is determined that demand charges and net metering issues will not stop the project. Local utility has been contacted and the process for interconnection & net metering is understood and looks viable.
- “Quick-kill” issues have been reviewed and found acceptable (including wetlands, environmental, zoning, etc.).
- Local zoning & permitting agency(ies) have been contacted to confirm that zoning and permitting should be reasonable.
- Access roads





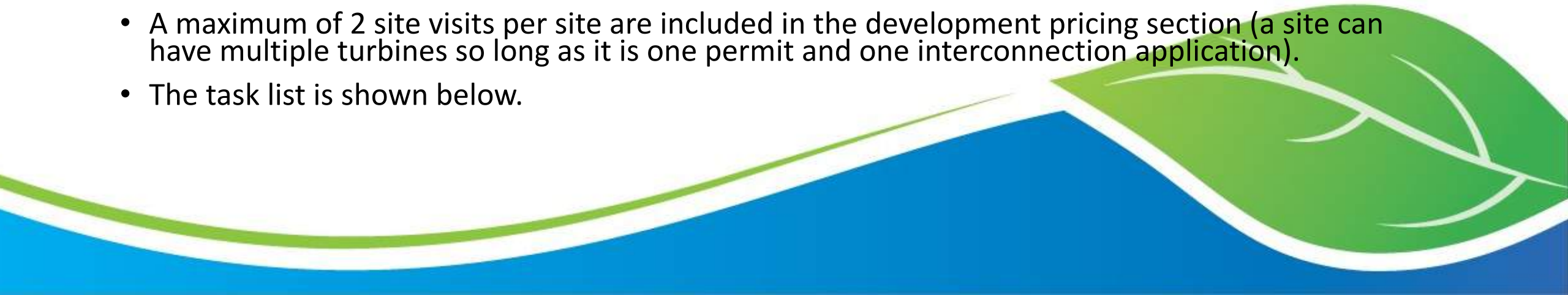
# Indicative Pricing Model

Ethos has produced an indicative pricing model that includes 3 pricing points. The first is the initial on-site meeting, the second is for the remaining development, and last is for full construction.

**Pricing is not final until engineering is complete. Things that can drive pricing are**

Our indicative pricing is based on a sample project with the following assumptions:

- Distance from the correct resources.
- Foundation type.
- Soil Conditions.
- Electrical interconnection run from interconnection point to tower, and includes a minimal amount of rework to existing infrastructure, as described below.
- Copper vs. Aluminum
- A maximum of 2 site visits per site are included in the development pricing section (a site can have multiple turbines so long as it is one permit and one interconnection application).
- The task list is shown below.



# Ethos introduced to Project

Initial site meeting, vetting & design (move to front)

- Site walk
- Design electrical connection
- Meet zoning & utility planners
- Look for local vendors for Geotech, concrete, and crane
- Confirm that turbine location, existing infrastructure, and local vendors meet standard pricing model
- Note: among the items to complete on this site walk are any final “quick-kill” checks – if there are items that could stop the project we must make certain that they are identified here.

Project timeline – develop based on site meetings

## Regulatory

- FAA review & submission as required
- Zoning

## Engineering

- Geotech - One boring per turbine
- Zoning drawings
- Electrical Construction drawings - One-line and drawings sufficient for permitting
- Foundation design drawings



## Permit

- Electrical, building
- Submit applications and receive approval

## Interconnection & net metering

- Submit applications and receive approval

## Inclusions / exclusions

- No physical survey being performed or required





# Scope of Work for Construction

- Starting point of construction phase:
  - All required permits issued
  - Drawing package complete and stamped as required, including:
    - Foundation
    - Electrical
    - Zoning / site
  - All required equipment is ordered with a committed delivery date.



# Construction Deliverables

## Electrical

- Electrical install pricing consists of the following scope:
  - 200 amp breaker to turbine coming off existing panel
  - 200 amp 480 V NEMA 3R fusible disconnect
  - Revenue grade production meter (Excluded from base price and actual need is TBD)
  - Existing service at sites will vary so the scope varies at each site based on the existing configuration; our pricing is based on the above assumptions.





Foundation – cure time, testing, rebar meets spec, tied in appropriate fashion.

This is a custom designed foundation and the companies engineer came out to watch us build it.

- Assume anchor bolts, anchor bolt embedment plate, and spacing template provided by tower manufacturer.

## Controls & Communication

- Internet connection from existing internet connection to turbine (assuming 200' run in conduit of CAT5e cable)



# Erection

- Crane operators need to be certified
- Everyone on site is certified for the tasks they are completing.
- Assume ? crane days for erection.





## Commissioning

- Commissioning to be performed by 3<sup>rd</sup> party
- Wind vs. Solar
  - Typically a manufacturer is involved with the project for wind.
  - For solar, there is typically a GC that is putting the pieces together.
- Example pricing assumes 1 technician for 1 day for commissioning support



AE



# About Alternative Electric, LLC



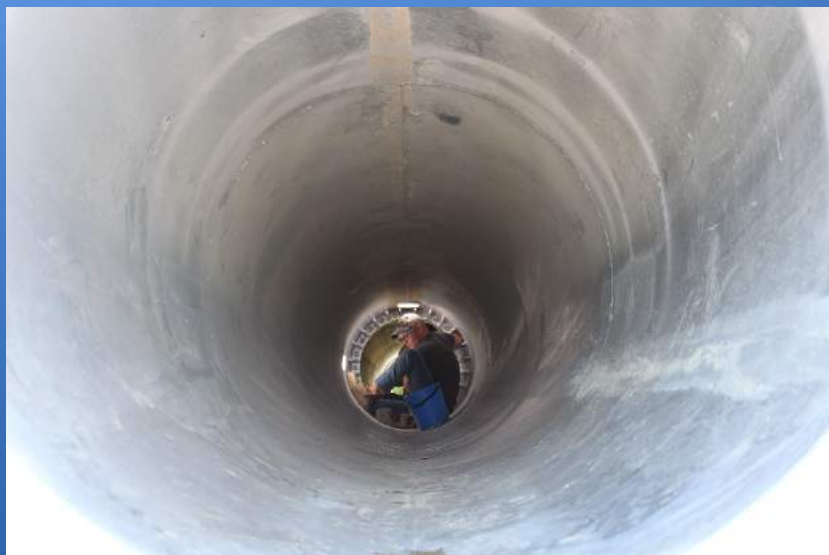
**Alternative Electric, LLC**  
**Matt Pascal, Owner**  
**316.461.8225**  
**[www.altelectricllc.com](http://www.altelectricllc.com)**



eocycle 

# Recent Wind Turbine Project in Kansas





















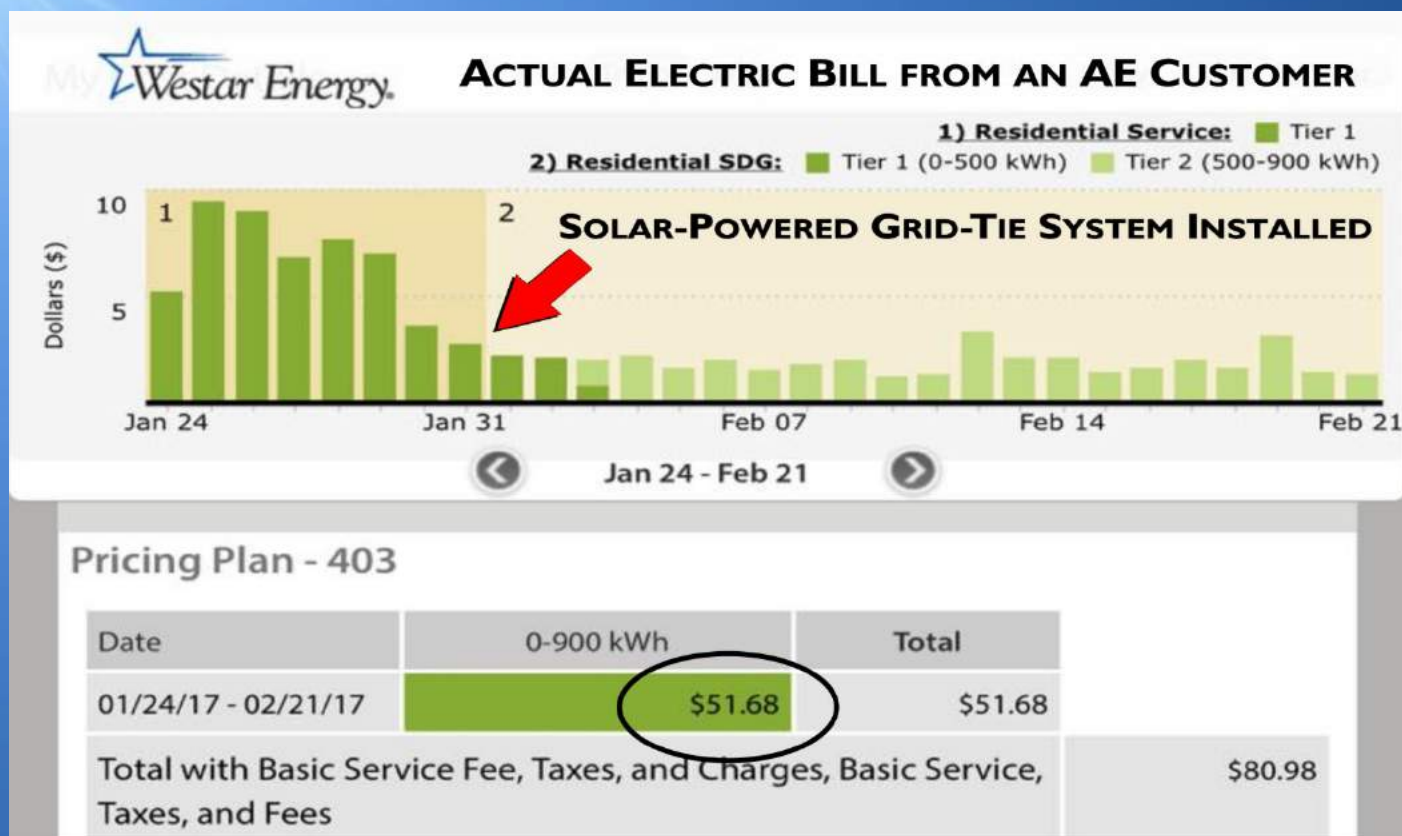
## Solar Array Projects







## Benefits of Solar







# Introducing the Storeedge System



## There's an App for that...





# Cost of Wind vs. Solar

harnessing

# RENEWABLE ENERGY

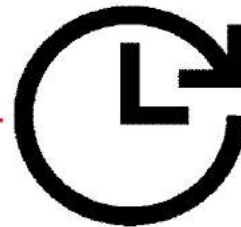
for your



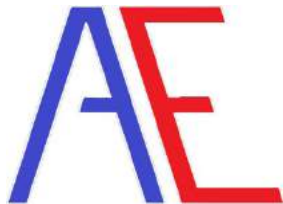
home



planet



future



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Time lapse video of installation:  
[Click here](#)

# GREENSBURG KANSAS



THE SMALL TOWN REIMAGINED





















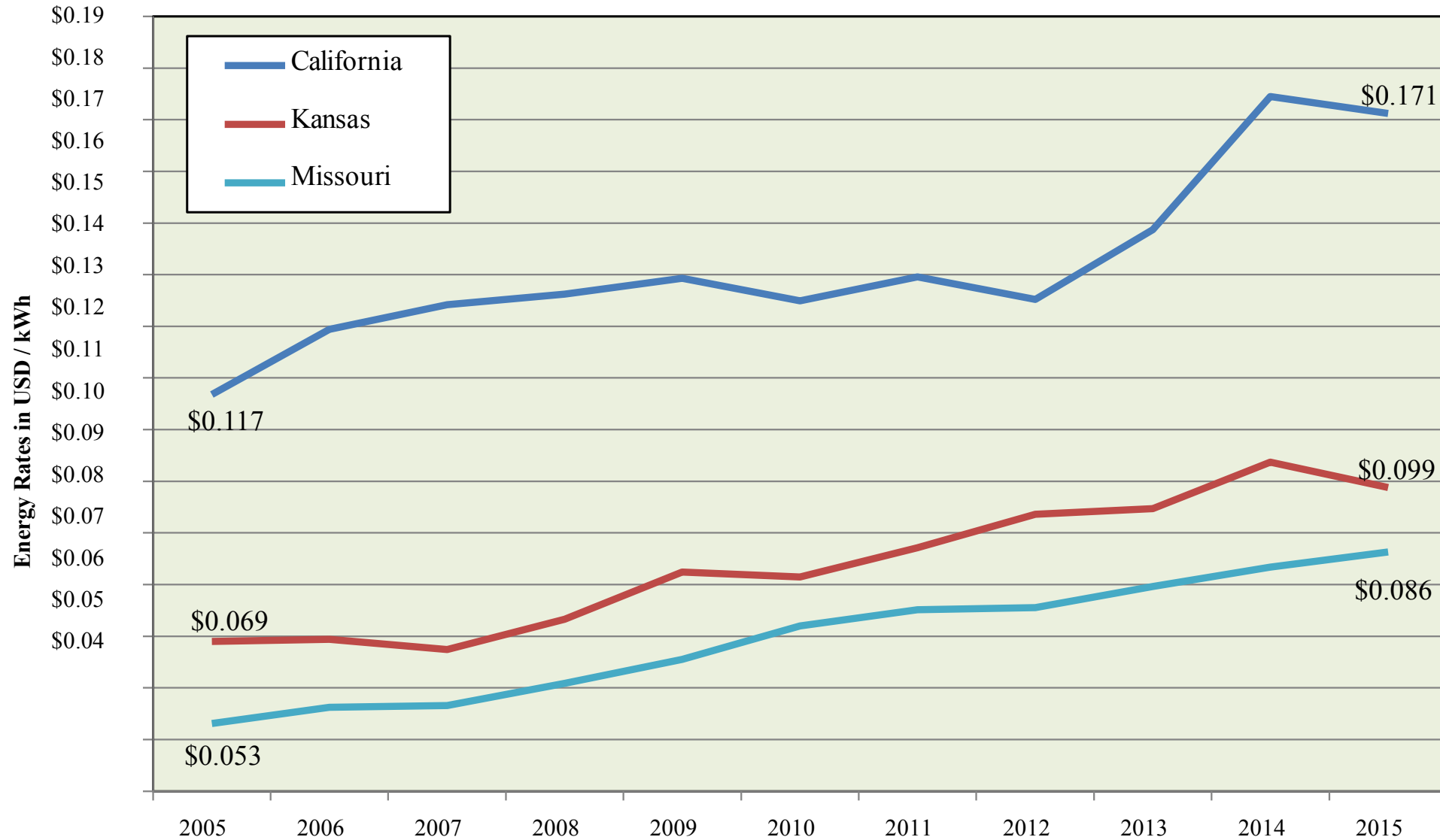
# Why Solar?

Representative Boyd Orr  
Fowler Feeders



# Power Rate Growth & Solar Grid Parity

## The Rise in Commercial Energy Rates

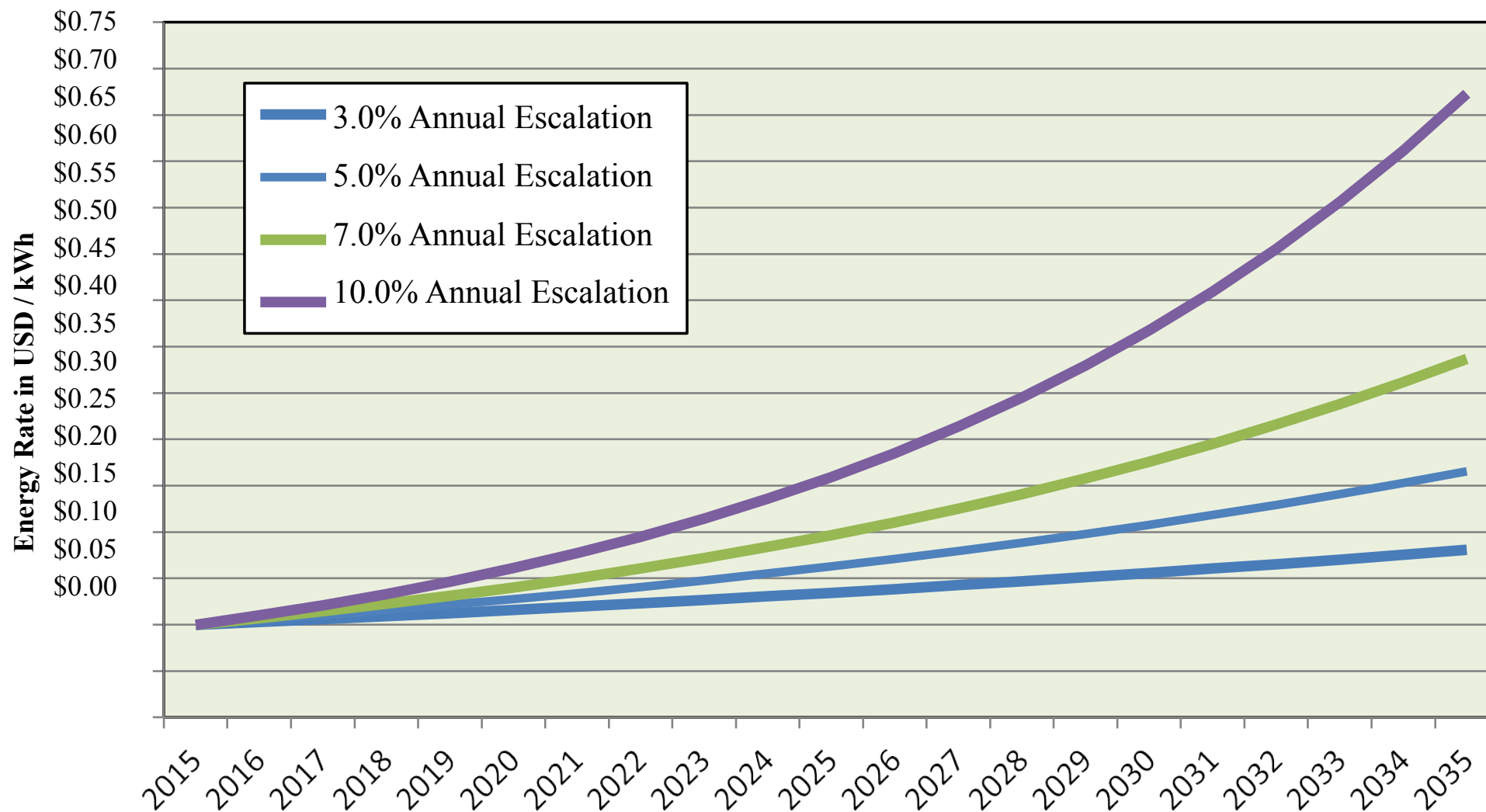






# Power Rate Growth & Solar Grid Parity

## Impact of Rising Power Costs













# Previous Projects

## 415 kW Project: Cattle Feedlot - Fowler, Kansas





Midwest Energy's 1MW Community Solar Array,  
Colby, Kansas



# Community Solar: Choices, Challenges, Results



# Why Did MWE Do This?

- Economical: Cost of PV solar dropped 60% since 2009
- Pull: 40% of customers expressed interest (2012-2013)
- Opportunity: Learn more about production values
- Positioning: Become a “we” participant in DisGen discussion

## Finding a Partner

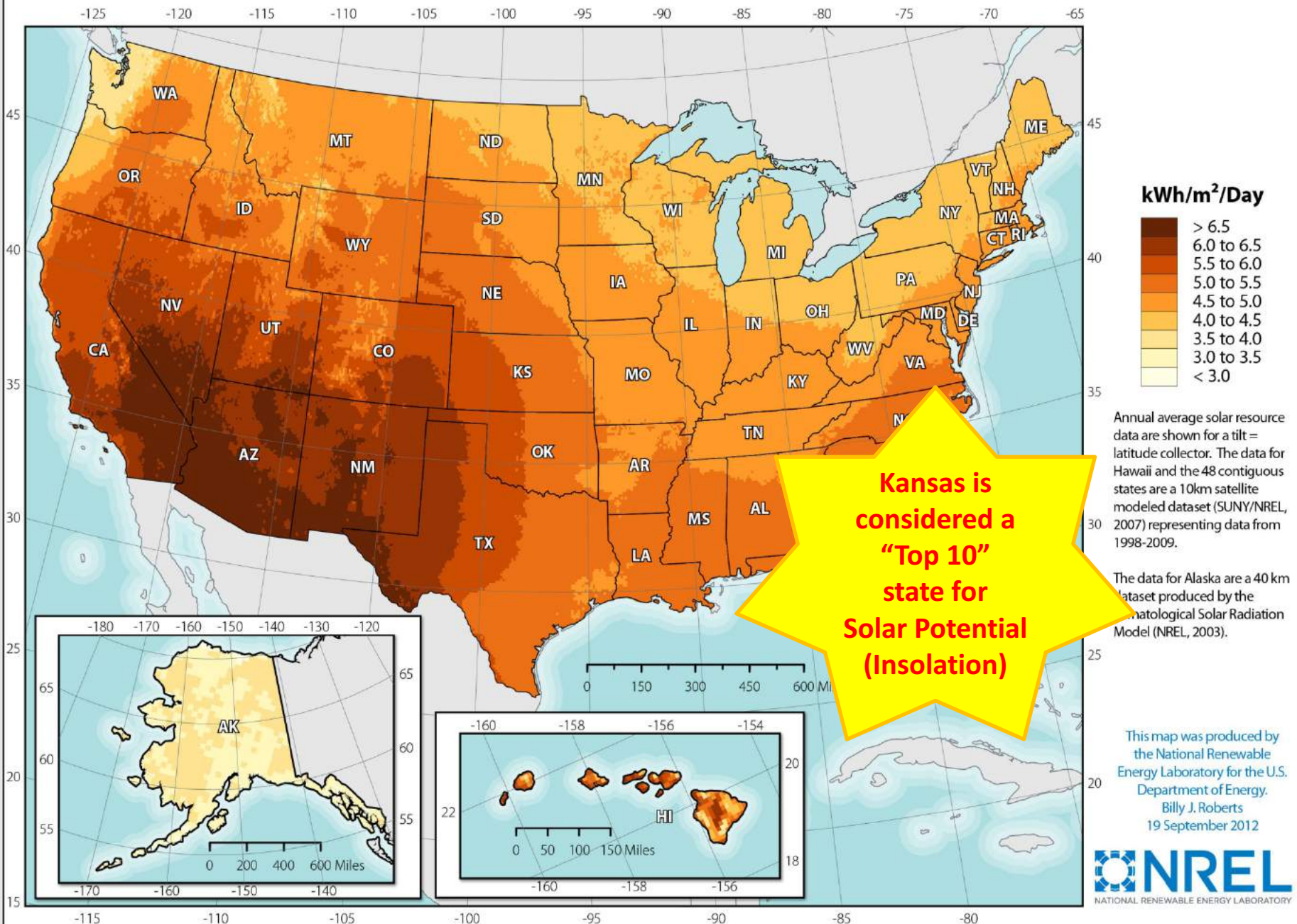
- Experience: CEC had completed dozens of utility-scale projects in 6 states since 2009
- Regional: Based in Boulder, Colo.
- Willing: Flexibility on certain terms of PPA



# MWE's Community Solar Array

- Members purchase solar panels in array
- One-time, all-in cost (\$891/panel or **\$2.92/Watt**)
- Monthly bill credit for power produced
- 25-year PPA between MWE and CEC
- Federal tax incentives 'buy down' panel cost
- CEC handles siting, const., marketing, operations
- Purchase up to 8kW residential (26 panels), up to 75kW commercial (250 panels)

# Photovoltaic Solar Resource of the United States





✓ Array is **100% sold as of Mar. 2016**

✓ Panels were \$891 each, with a payback of approx. \$57/year over 25 years (6.4%)



MIDWEST ENERGY INC  
PO BOX 898  
HAYS KS 67601  
800-222-3121  
www.mwenergy.com

ACCOUNT NUMBER: 1916  
MICHAEL W MORLEY

BILL DATE: 9/20/2017

SERVICE ADDRESS: 1408 W 46TH ST, HAYS

Electric Service									
Rate	Meter Number	Previous Read Date	Current Read Date	Number of Days	Previous Reading	Current Reading	Meter Multiplier	kWh Used	Billing Demand
RES	2000000086	8/15/2017	9/12/2017	28	9002	10366	1	1364	0
Electric Customer Charge								\$14.00	
Electric Energy Charge								\$142.92	
Transmission Delivery Charge								\$11.95	
Total Electric - Residential								\$168.87	

Gas Service									
Rate	Meter Number	Previous Read Date	Current Read Date	Number of Days	Previous Reading	Current Reading	Therm Factor	Therms Used	
RGTS	10027854	8/15/2017	9/19/2017	35	2044	2044	1.0057	0	
Gas Customer Charge								\$18.00	
Gas Infrastructure Rider								\$0.37	
Total Gas - Residential								\$18.37	

Adjustment									
Solar Credit								\$73.34	CR
Total Adjutment								\$73.34	CR

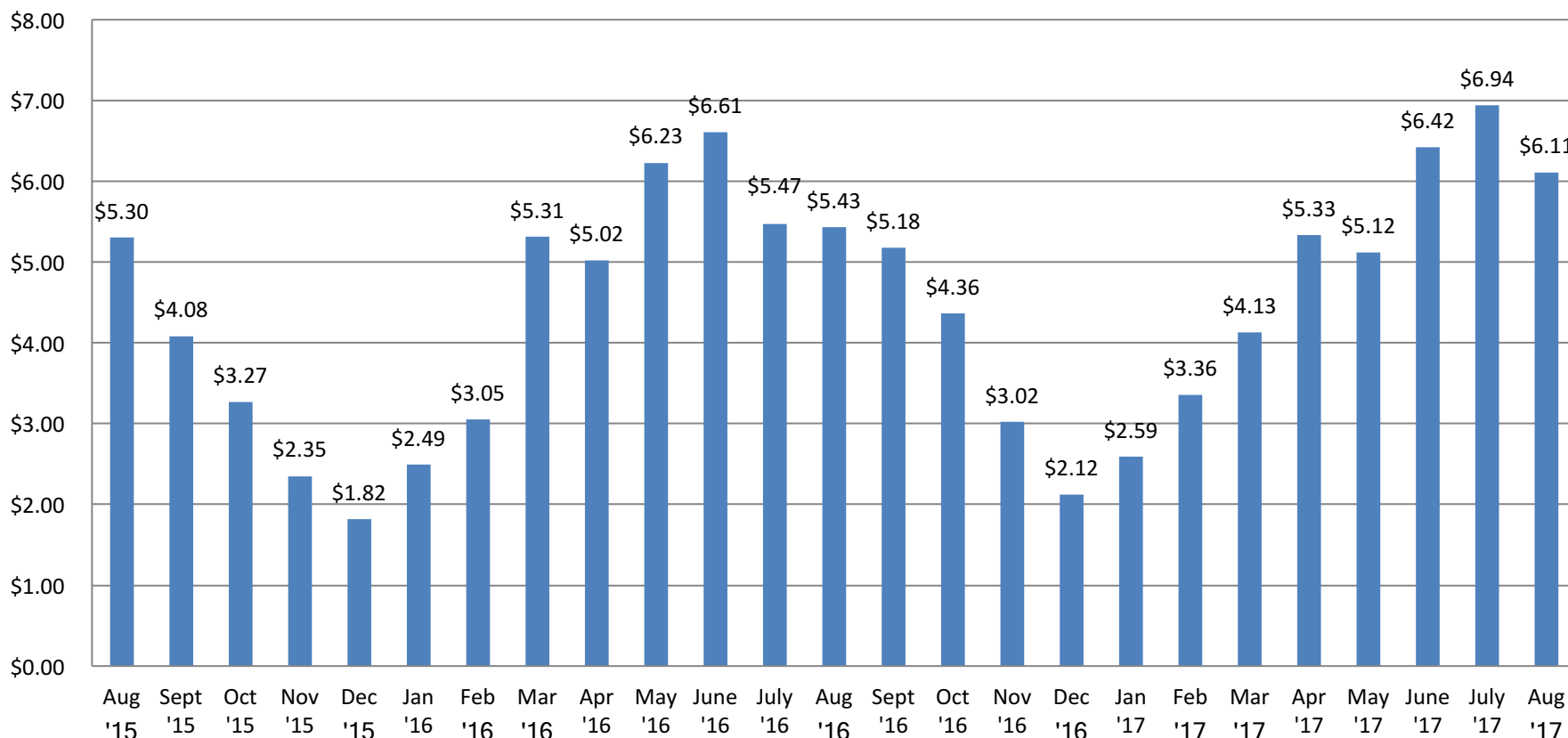
Donation									
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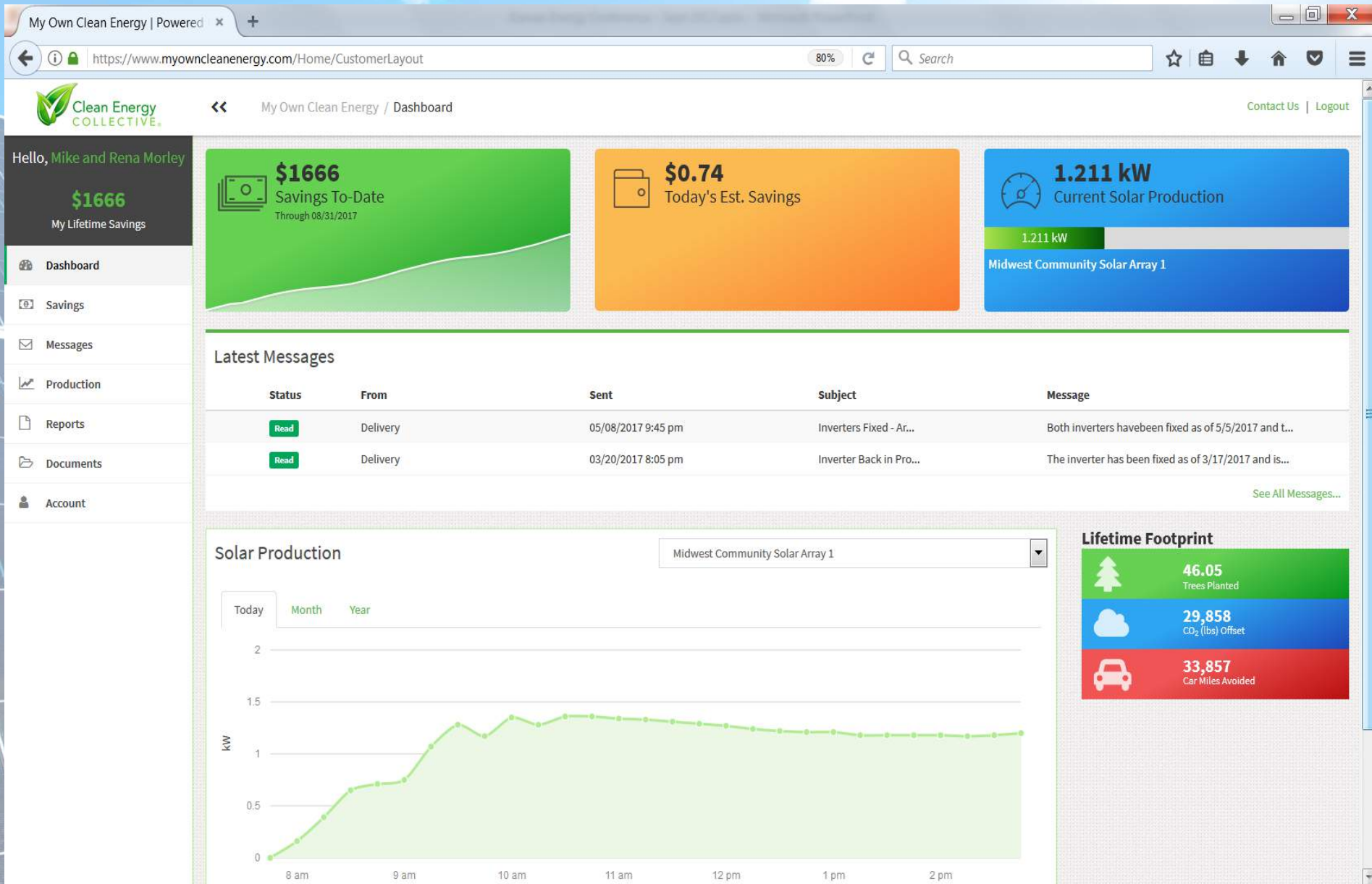
# Actual Production: 24 Months

Credits for one panel



**Realized: \$111.11 (vs. \$57/yr, \$114/2 yr predicted)**  
**6.2% Rate of Return over 24 mos.**

# Online Customer Portal





# Maintenance: Minimal





# How Do Customers Like It?

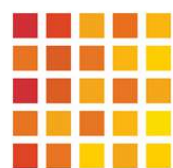


**Smart Electric  
Power Alliance**

First national survey of  
Community Solar participants, 2016

	<u>POPULATION</u>	<u>MIDWEST</u>
Count of respondents	639	<b>26</b>
Respondents satisfied or very satisfied with the program (%)	92%	<b>88%</b>
Respondents who would definitely recommend or probably recommend the program (%)	92%	<b>92%</b>
Respondents who believe that program was explained clearly (%)	91%	<b>88%</b>
Percent of electric bill covered by participant subscription (%)	39%	<b>33%</b>

# How Do Customers Like It?



**Smart Electric  
Power Alliance**

First national survey of  
Community Solar participants, 2016

	POPULATION	MIDWEST
Top 3 ways how subscriber learned of program with percent respondents who selected the reason.	Bill (45%) Mail / Email (23%) Word of mouth (8%)	Bill (50%) Mail / Email (12%) Radio (12%)
Top 3 reasons listed for joining program with percent respondents who selected the reason.	Environmental (53%) Financial benefits (40%) No roof installation (27%)	Financial benefits (58%) Environmental (54%) No roof installation (50%)
Top 3 reasons for selecting community solar over rooftop solar with percent respondents who selected the reason.	Don't want to deal w/ maintenance (40%) Liked economies of scale of central array (24%) Rooftop not ideal for solar (20%)	Don't want to deal w/ maintenance (62%) Liked economies of scale of central array (31%) Don't want to penetrate roof (62%)
How participation has affected respondents relationship with their utility (% more satisfied   % no change   % less satisfied)	37% more 1% less	35% more 0% less
Respondents very satisfied or somewhat satisfied with the electricity production data available (%)	81% satisfied 5% dissatisfied	92% satisfied 4% dissatisfied
Respondents stating billing and crediting process is clear and consistent with expectations (%)	85%	88%



Midwest Energy's 1MW Community Solar Array,  
Colby, Kansas



# Questions?





# Flint Hills Renewable Energy & Efficiency Cooperative

In Manhattan, we've begun buying in bulk, splitting the cost and helping each other put the system up on each other's homes. Usually we all meet on a Saturday morning and have a pot luck like an old fashioned "barn raising" where you invite us over to help you. The ground crew mounts inverters to panels while the crew on the roof mounts rails. 6 people is a sufficient crew but sometimes we get 25.





# Micro Inverters & AC Modules

- Each module has its own inverter so shading only blocks production from that module and they can face various directions...South being best
- No work involving DC or high voltage
- Each module has its own monitoring so trouble- shooting is very much easier
- Arrays are expandable in steps of one module
- Don't have to find matching module replacements in case one is broken
- All connectors are touch safe. All are plug and play so any homeowner who is reasonably comfortable on a roof can safely install them.

- **The New Inverters have only two wires: L1 & L2 so it would take effort to screw up the wiring.**



**Disadvantage: Rooftop mounting exposes electronics to high temperatures. But these are warrantied for 25 years.**



## Canadian Solar 340W, All Hardware, Wholesale 2017

System Size		With Monitor	- 30% Tax Credit	Wp	\$/Wp	Yrly Return *	ROI
# Panels	3	\$ 2,835.46	\$ 1,985	870	\$ 2.28	\$ 144.55	7.3%
	4	\$ 3,418.62	\$ 2,393	1160	\$ 2.06	\$ 192.74	8.1%
	5	\$ 4,001.77	\$ 2,801	1450	\$ 1.93	\$ 240.92	8.6%
	6	\$ 4,584.92	\$ 3,209	1740	\$ 1.84	\$ 289.11	9.0%
	7	\$ 5,168.08	\$ 3,618	2030	\$ 1.78	\$ 337.29	9.3%
	8	\$ 5,751.23	\$ 4,026	2320	\$ 1.74	\$ 385.48	9.6%
	9	\$ 6,334.38	\$ 4,434	2610	\$ 1.70	\$ 433.66	9.8%
	10	\$ 6,917.54	\$ 4,842	2900	\$ 1.67	\$ 481.85	10.0%
	11	\$ 7,500.69	\$ 5,250	3190	\$ 1.65	\$ 530.03	10.1%
	12	\$ 8,083.85	\$ 5,659	3480	\$ 1.63	\$ 578.22	10.2%
1 Branch	13	\$ 8,667.00	\$ 6,067	3770	\$ 1.61	\$ 626.40	10.3%
	14	\$ 9,250.15	\$ 6,475	4060	\$ 1.59	\$ 674.58	10.4%
	15	\$ 9,833.31	\$ 6,883	4350	\$ 1.58	\$ 722.77	10.5%
	16	\$ 10,416.46	\$ 7,292	4640	\$ 1.57	\$ 770.95	10.6%
	17	\$ 10,999.62	\$ 7,700	4930	\$ 1.56	\$ 819.14	10.6%
	18	\$ 11,582.77	\$ 8,108	5220	\$ 1.55	\$ 867.32	10.7%
	19	\$ 12,165.92	\$ 8,516	5510	\$ 1.55	\$ 915.51	10.8%
	20	\$ 12,749.08	\$ 8,924	5800	\$ 1.54	\$ 963.69	10.8%

\* Commercial Installers charge by the "Name Plate Array Capacity" instead of the actual capacity

Fees and Permits will run approximately \$115

Electrician will typically charge \$300-\$400 to run back to your breaker panel.

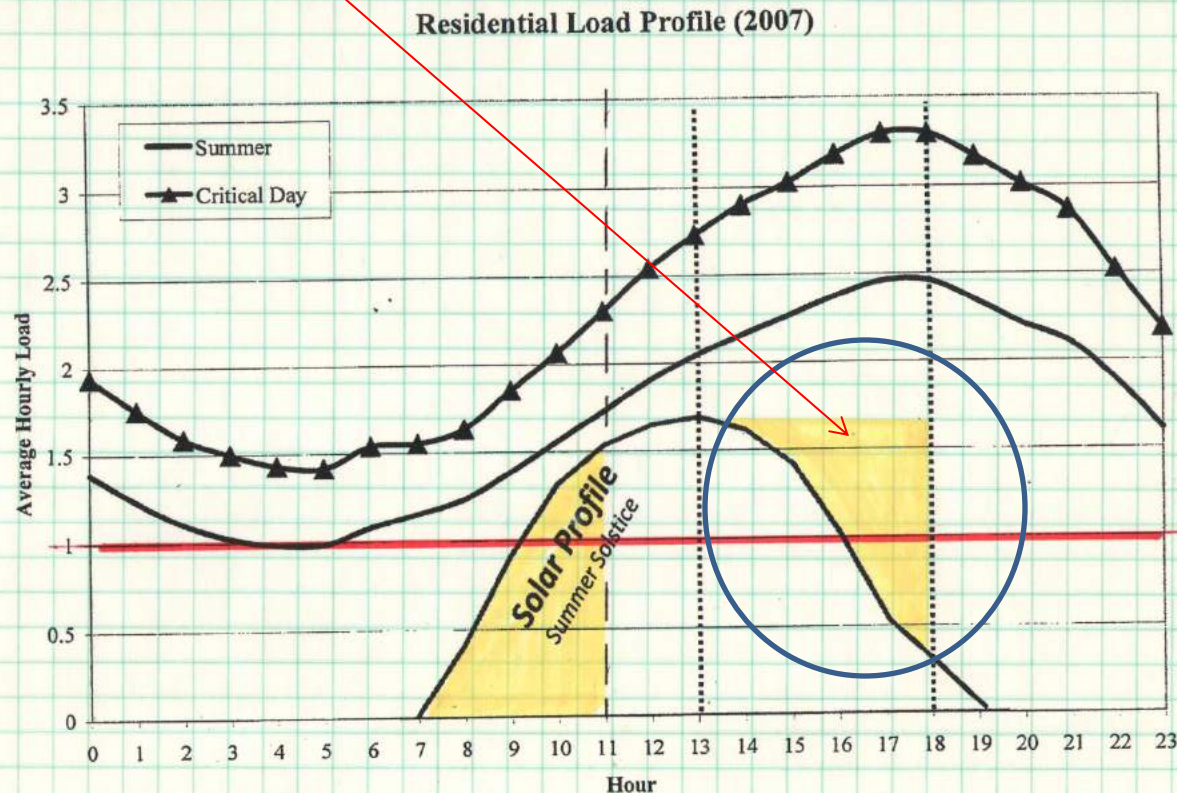
\*\* Yearly Return based on not exporting anything back to the utility

### One Branch, 13 Panel, 3,770W (actual capacity) PV System, Sept. 2017

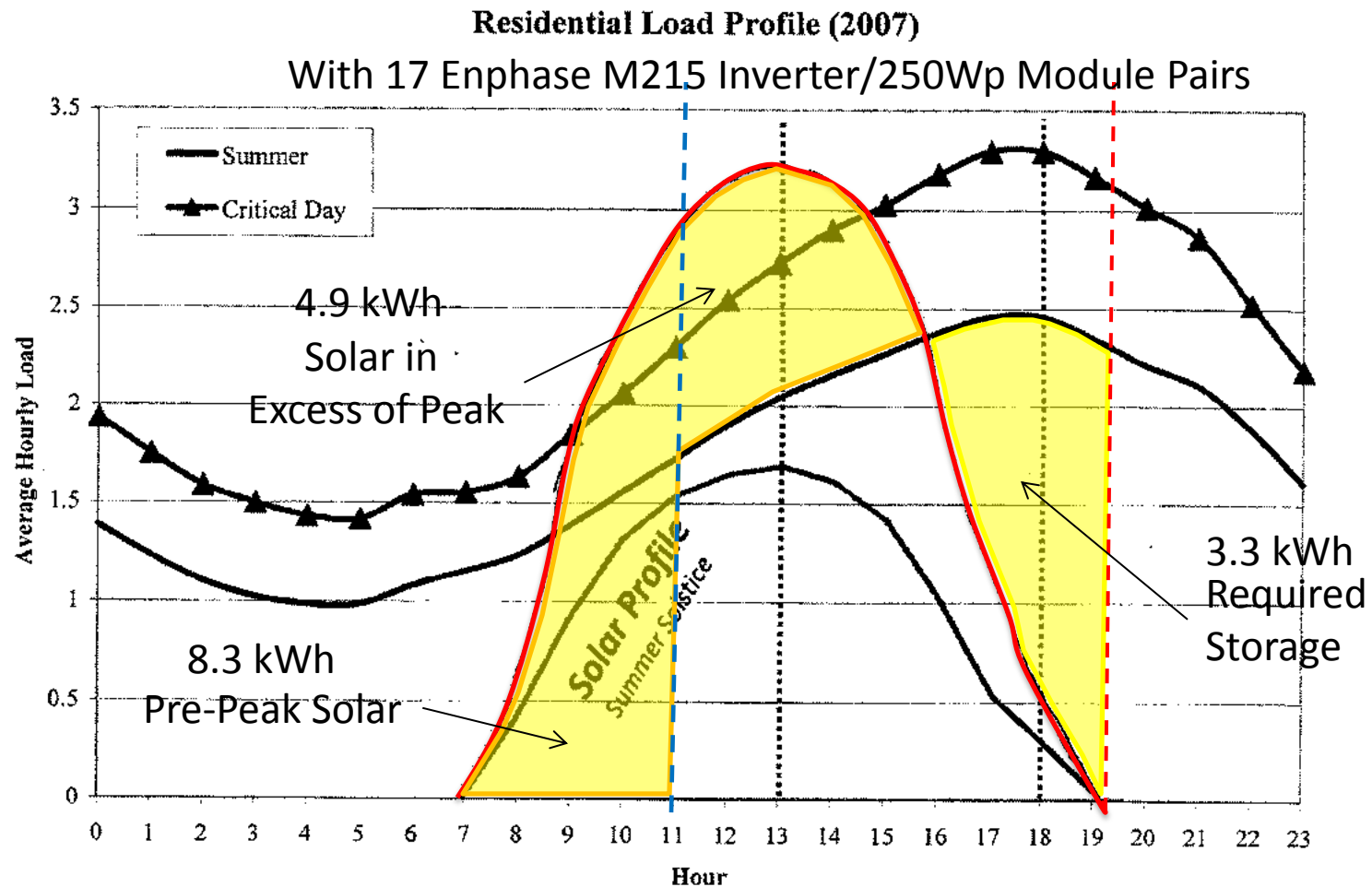
Costs which vary by the number of panels		\$ 7,581
Plus Fixed Costs (i.e.disconnect, system monitor)		\$ 1,086
Total Costs		\$ 8,667

At this moment when the sun goes down but people are still watching TV in the air conditioning, utilities still have to run their generators, and deliver the peak power to our homes.

## The residential class peaks slightly later than the system

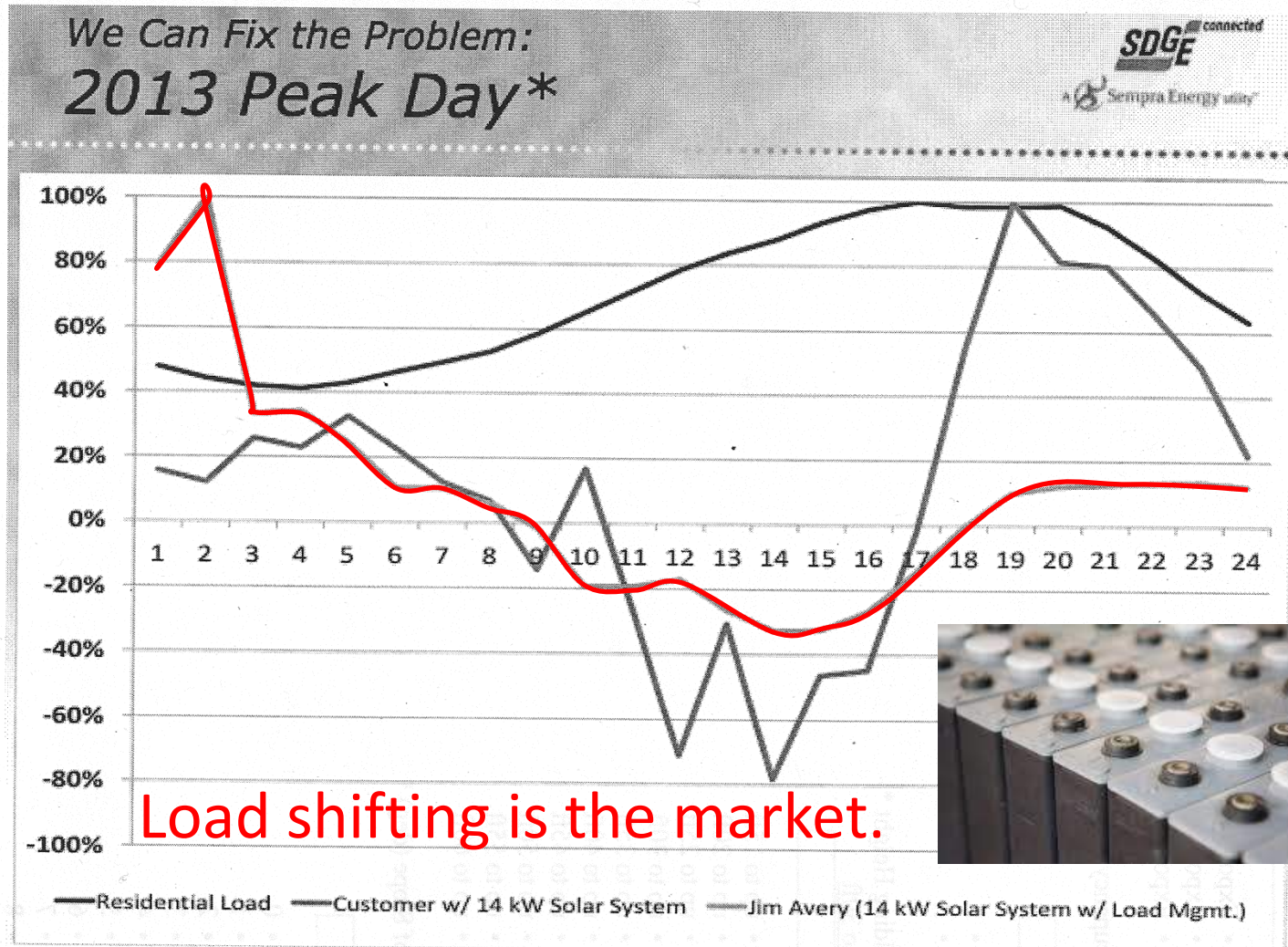


# The residential class peaks slightly later than the system





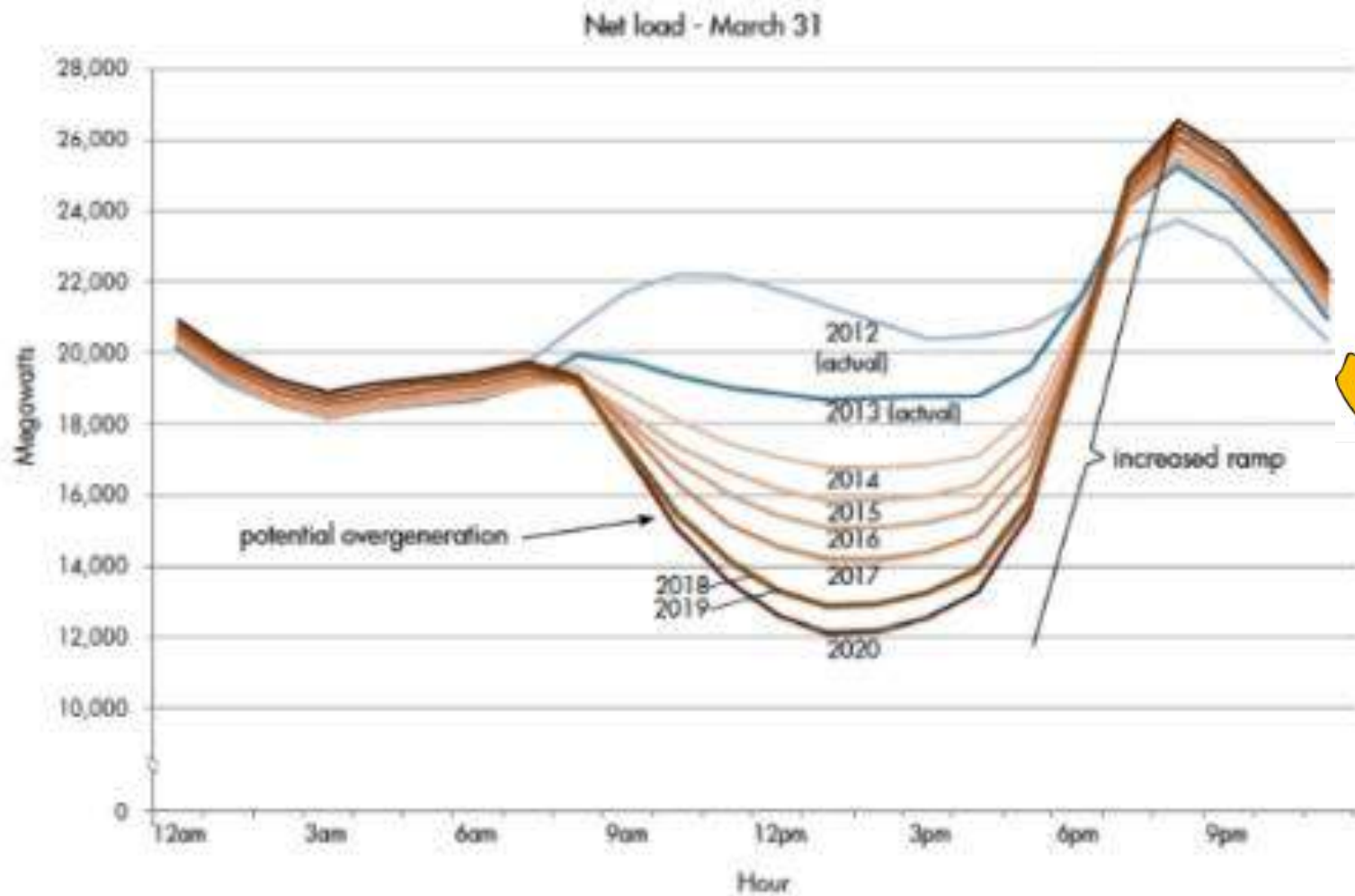
# Solar With Today's Storage



\*4,604 MWs August 30<sup>th</sup> 2013 at 4pm

Credit to Matt Lehrman, Rocky Mountain Institute

# Let's think of the “Duck Curve” in Kansas



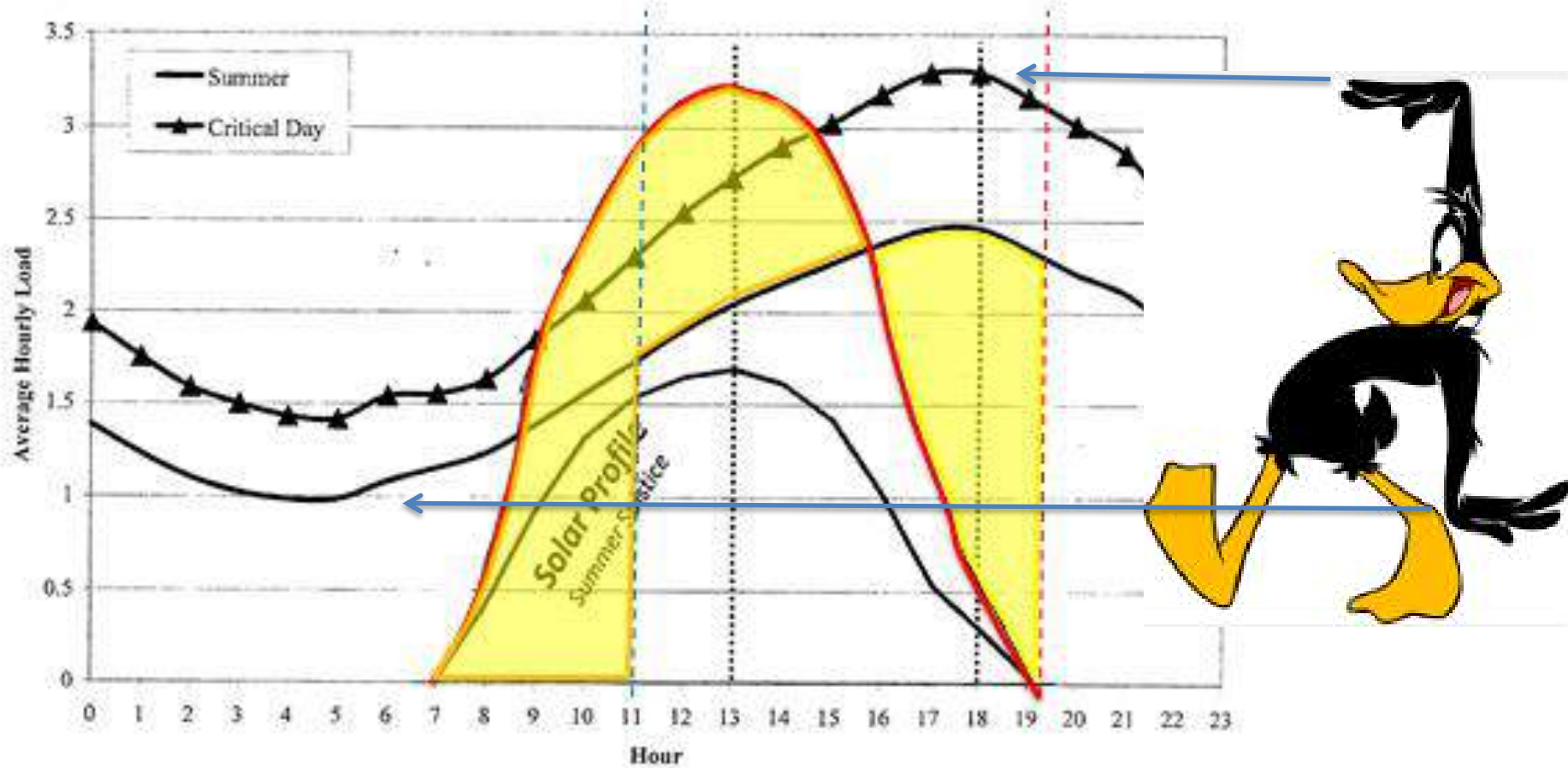
# Solar Potential in Kansas: Jan 2012 to Dec 2016

CLR	no clouds		3434 Total Solar Hours over 100 degrees F.			
SKC	~no clouds	93.7%	3216 CLR	93.65%	no clouds	
FEW	12 - 25% cloudy	4.3%	146 SCT	4.25%		
SCT	37 - 50% Cloudy	1.9%	64 BKN	1.86%	63 -88% Cloudy	
BKN	63 -88% Cloudy	0.2%	8 OVC	0.23%	100% Coudy	
OVC	100% Coudy		SCT = 3/8-4/8, BKN = 5/8-7/8, OVC = 8/8			
94%	Of Critical Peak days are cloudless					
98%	Have less than 50% Cloud Cover		97.90%	with fewer	37 - 50% Cloudy	

The same amount of sun shines on two panels whether it is on my roof or in a centralized array. They both have the same efficiency except that on my roof it doesn't have to travel as far on hot cables. They fit exactly the same way in Westar's generation profile.

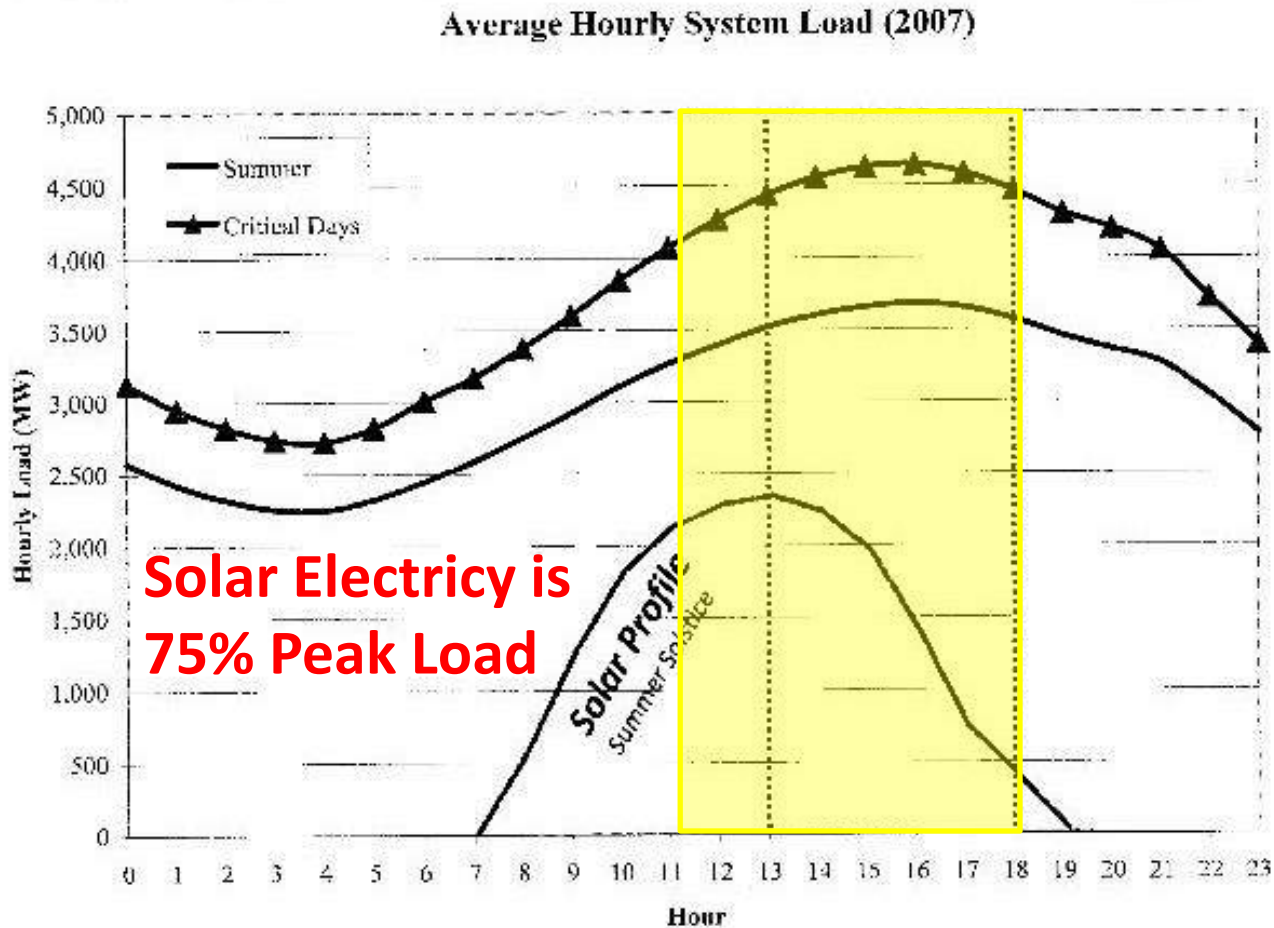


Historically utilities can't leave customers sweltering (or dying) on the 15 Critical Peak Days. This is the dimension of the intermediate and peak load designed into Westar's infrastructure, both generation and **distribution** ...2.5 X baseload. This is a huge opportunity for saving all ratepayers.

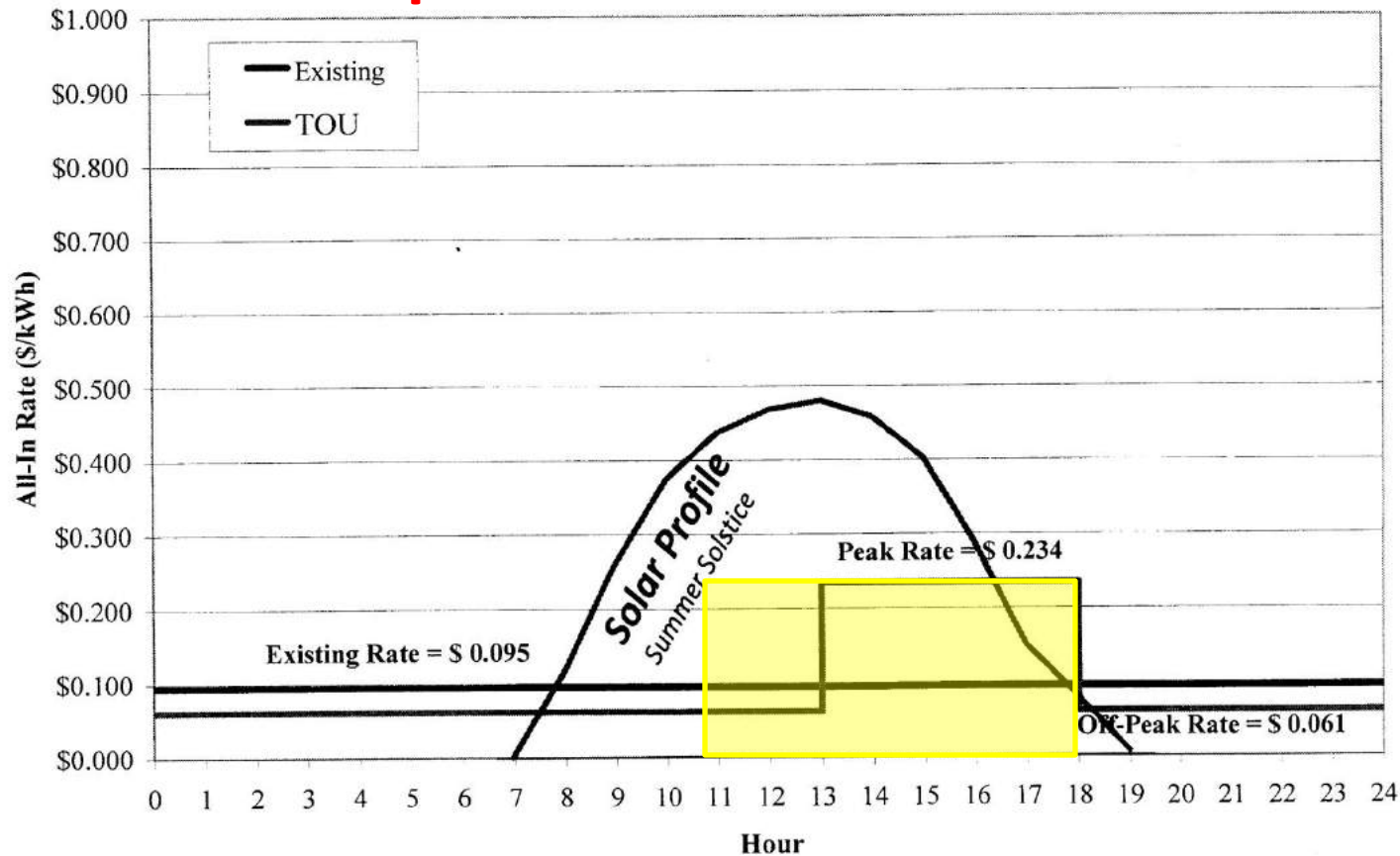


## ***The Sun's energy is a close match to when we need it most.***

*Our Peak Use Period is from the time we get ready for work to the time we come home, turn on the air conditioning and cook supper.*



Like advertising at the SuperBowl or airplane tickets on Christmas Eve, these minutes of high demand are expensive...almost 4x for utilities to generate and distribute as off-peak.





# ***Peak Load Distribution***

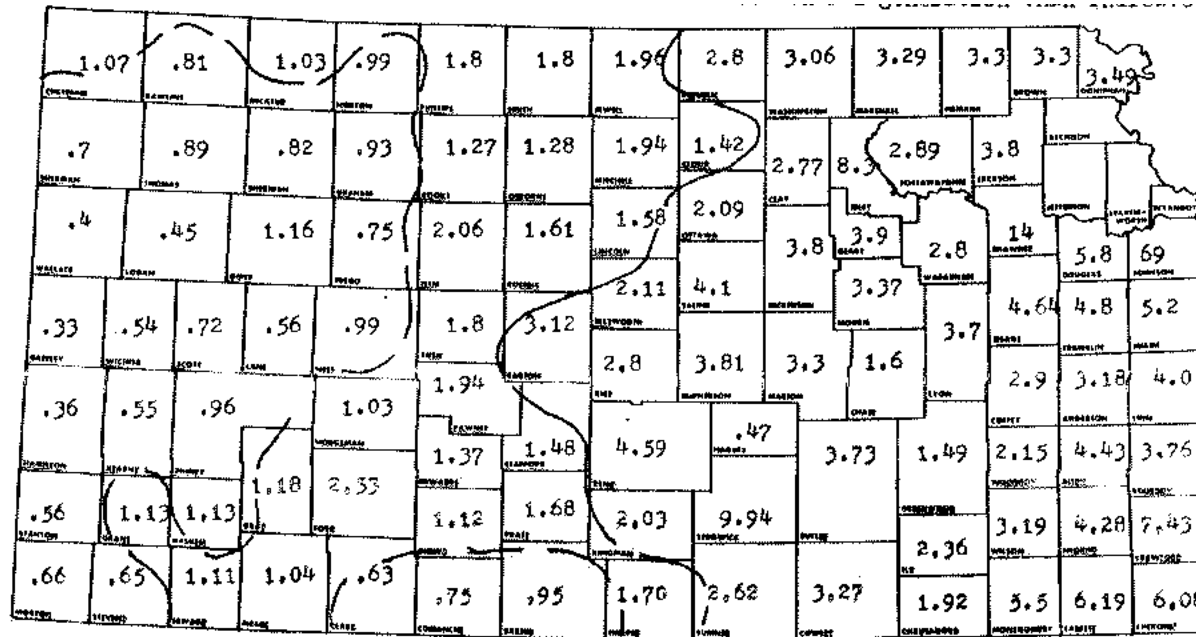
- Pacific Gas & Electric's typical feeder is used over **50% of capacity ...only 40% of the time**. There is a lot of investment that is not being used. Westar appears to have much the same.
- For a typical urban utility, 60% of their fixed assets are in transmission and distribution.

**If much of the peak can be generated where the electricity is used, what savings might be made for all rate payers?**

# How about Rural Electric Cooperative's?

- If municipal utilities have 60-70 customers/mile of distribution line, this map will indicate the relative costs of reconstructing and maintaining the REC distribution system.

KEC Customers/mile of line, avg = 3.2



Kansas Rural Electric Cooperatives (and municipal utilities) should already buy their base load wholesale and encourage/finance their members to generate their own peaks. It would add reliability, provide voltage support and might save their members on cost in restringing their lines.

If utilities are to use distributed generation to reduce the size required of their distribution systems, we need to provide enough storage to cover the worst days.

July 29, 2012 wasn't a historical worst case but it is instructive of how much storage will be required.

This is eight hours over 100F...after sun down.

7/29/2012

is one of the most extreme days since 2012

2012 was a year of a very high number of days when temperature reached 100F or above.

Of these "critical peak" days, the time of highest temperatures were mostly after sundown.

Coffeyville10 hours 4:00 to 2:00 AM above 100F

WBAN	YR--MODAHRMN	DIR	SPD	SKC	TEMP	DEWP		
93967	201207290652	170	3	CLR	83	59		
93967	201207290752	180	5	CLR	80	61		
93967	201207290852	180	6	CLR	81	62		
93967	201207290952	190	7	CLR	82	61		
93967	201207291052	170	6	CLR	79	61		
93967	201207291152	170	6	CLR	80	61		
93967	201207291252	160	6	CLR	82	61		
93967	201207291352	200	8	CLR	89	62		
93967	201207291452	240	11	CLR	97	61		
93967	201207291552	240	16	CLR	102	60	4:00 PM	
93967	201207291652	240	16	CLR	105	60		
93967	201207291752	270	16	CLR	107	58		
93967	201207291852	240	9	CLR	108	56		
93967	201207291952	230	8	CLR	108	57		
93967	201207292052	210	14	SCT	109	56		
93967	201207292152	240	6	CLR	109	54		
93967	201207292252	240	11	CLR	109	53		
93967	201207292352	240	9	CLR	108	53		
93967	201207300052	200	8	CLR	105	55		
93967	201207300152	200	9	CLR	100	58	2:00 AM	
93967	201207300252	190	8	CLR	95	59		
93967	201207300352	190	8	CLR	94	57		
93967	201207300452	200	8	CLR	90	57		
93967	201207300552	190	8	CLR	88	56		
93967	201207300559	***	***	***	****	****		
93967	201207300652	210	9	CLR	91	56		
93967	201207300752	220	10	CLR	90	56		
93967	201207300852	220	8	CLR	89	55		
93967	201207300952	220	6	CLR	89	55		
93967	201207301052	200	8	CLR	88	55		
93967	201207301152	160	6	CLR	82	57		



# Energy Sentry

## Residential (& Business) Controllers

Energy Sentry Residential Demand Controllers manage your non-essential electric loads to reduce peak demand and improve energy efficiency. What does this mean?

The Energy Sentry will stabilize your home's electric use **by managing equipment with thermal storage such as water heaters, air conditioners, hot tubs etc.** Electric loads like these can be turned off for small periods of time without effecting overall comfort or convenience.

Loads such as lighting, televisions, computers and other plug loads are not managed by the Energy Sentry. By controlling large electric loads with thermal storage the Energy Sentry will make your home more energy efficient, reduce your electric bills, and save you money!



Every electrical device has a unique electronic signature – its own voice. There is a noisy conversation happening inside your home as every device that's turned on is talking. All at once.

# *Energy Storage*

## **Electrical Storage**

- We learned that electricity is very high quality energy, and expensive to store.
- It should be used for services that can only use electricity, lighting, data processing...
- Cars need expensive light weight of  $\text{LiFePO}_2$ , houses do not. Minimize those.

## **Thermal Storage**

- Providing low grade temperature changes whether heating or cooling with high value electricity is a wasteful mismatch.
- Chilled water in a tank is much less costly than chemical batteries for what we need for peak in Kansas.

---

**Except in rare district heating,  
thermal storage lends itself only to distributed generation**

# Jeffery Energy Center:



***Burns up to 36,000 tons of coal per day  
And uses 24,000 gallons of water per minute***

*Westar Website*



**Risks? Sure, but there are greater risks in waiting for more Harveys and Irmias.**

Whether it's the carrot or the stick that gets you moving, there is no justification for waiting.

