

A close-up photograph of several fresh green zucchinis in a dark-colored basket. The zucchinis are vibrant green with some yellow at the stems. The background is slightly blurred, focusing on the vegetables in the foreground.

Cheaper, Better, and Faster to 100% **

Why solar, wind, and electric cars are a perfect match

** or darn close

Ken Regelson

March, 2020

Image: pixabay.com

A close-up photograph of several fresh green zucchinis in a dark-colored basket. The zucchinis are vibrant green with some yellow at the stems. The background is slightly blurred, focusing on the vegetables in the foreground.

**Lots of ECars lower electricity costs for
EVERYONE!**

**Lots of renewables lower charging costs
for Ecars.**

Image: pixabay.com

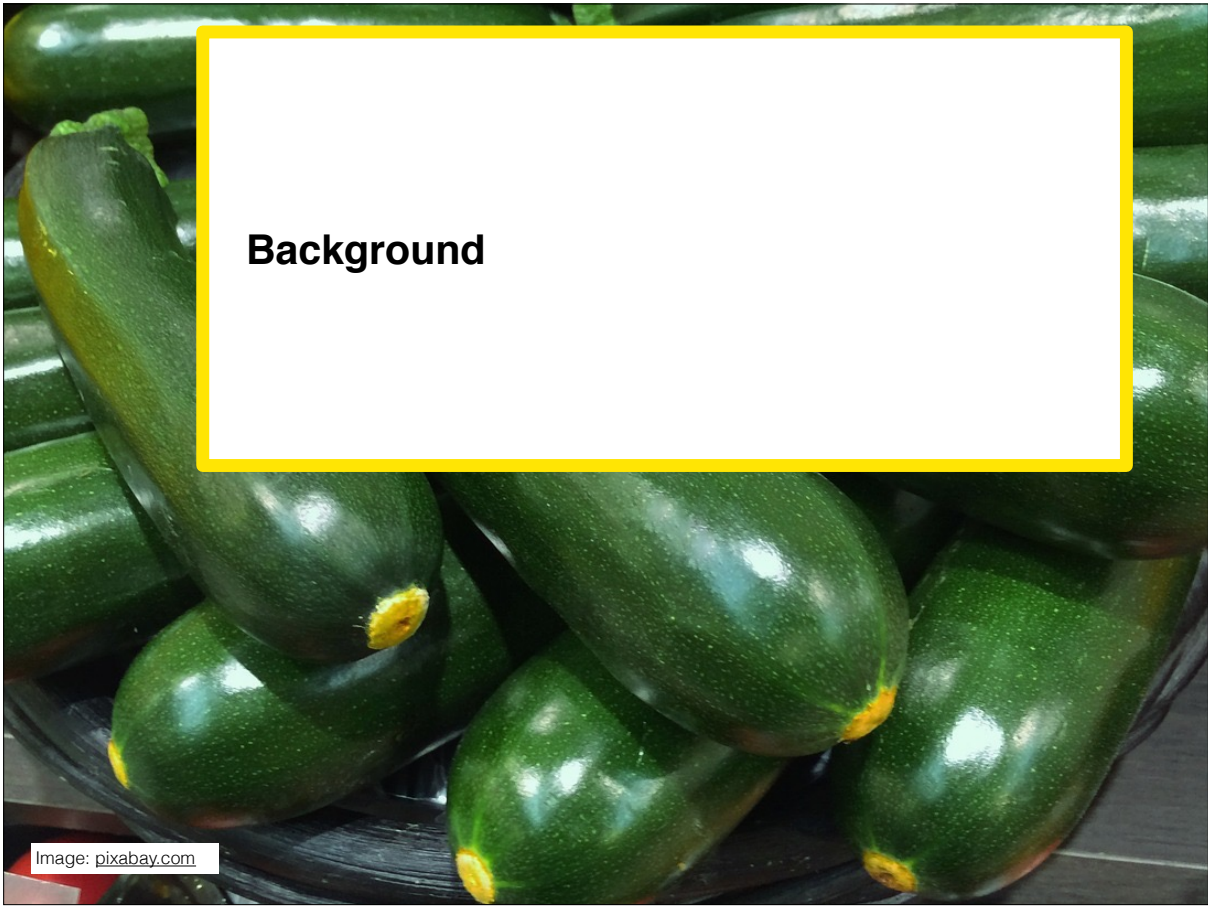


Image: pixabay.com

My Daughter Bakes Really Great Cakes!

Like most bakers, she follows a recipe.



Colorado Energy Recipe

- 1 part 100% Renewable Electricity
- 1 part *Electrify All* - Everything Else

Just Colorado - Annual

	Colorado Climate Impact	Electricity or Fuel Cost Now Billions	Increase in electricity to <i>Electrify All</i>	Electricity Cost to <i>Electrify All</i> 10 ¢ / kWh
Electricity coal + fossil gas to make electricity	1/3	\$5.5 B	<i>No Change</i>	\$5.5 B 95% renewable
Transportation gasoline diesel	1/3	\$6.5 B	30%	\$1.8 B
Comfort Heat Buildings & Water fossil gas NOT used for electricity	1/3	\$1.5 B	20%	\$1.2 B
Total		\$13.5 B	50%	\$8.5 B

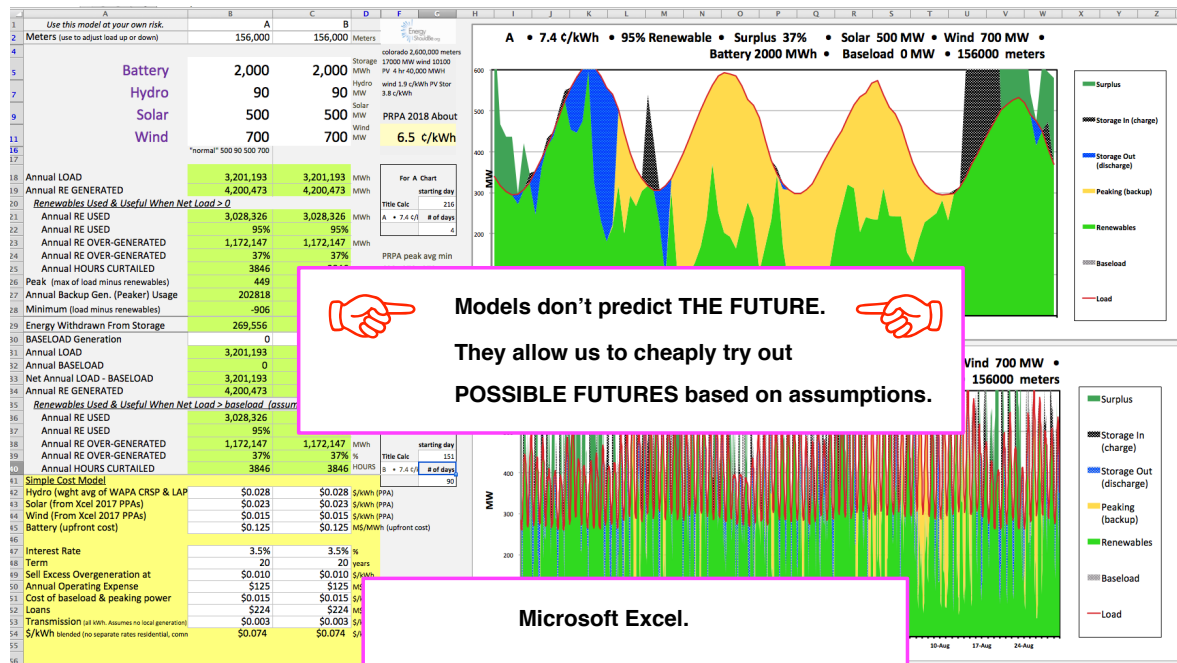
\$5 Billion Savings per year!

Notes: Most of data from 2016 EIA with analysis by EnergyShouldBe.org. The electricity use to electrify transportation is conservative. 10 cents per kWh is the blended cost of Colorado electricity. Divide EIA Table 10 all Colorado revenue by MWh Sales. The climate impact is a rough estimate based on actual CO2 output and a guess at the impact of methane leakage. The most speculative number is the electricity to electrify nat. gas use. This is based on using heat pumps with a COP of 3. Air source heat pumps are available now (2019) for Colorado at that COP.

Modeling Renewables & Reliability

Image: pixabay.com

Modeling Electric Grids and Renewables - PRPA Data



Models don't predict THE FUTURE.

They allow us to cheaply try out POSSIBLE FUTURES based on assumptions.

Microsoft Excel.

Email Ken for a free copy



The Data Came From...


Cost:

Xcel Colorado
 Platte River Power Authority - PRPA
 EIA (DOE)

Annual Use (Load) and Generation From PRPA:

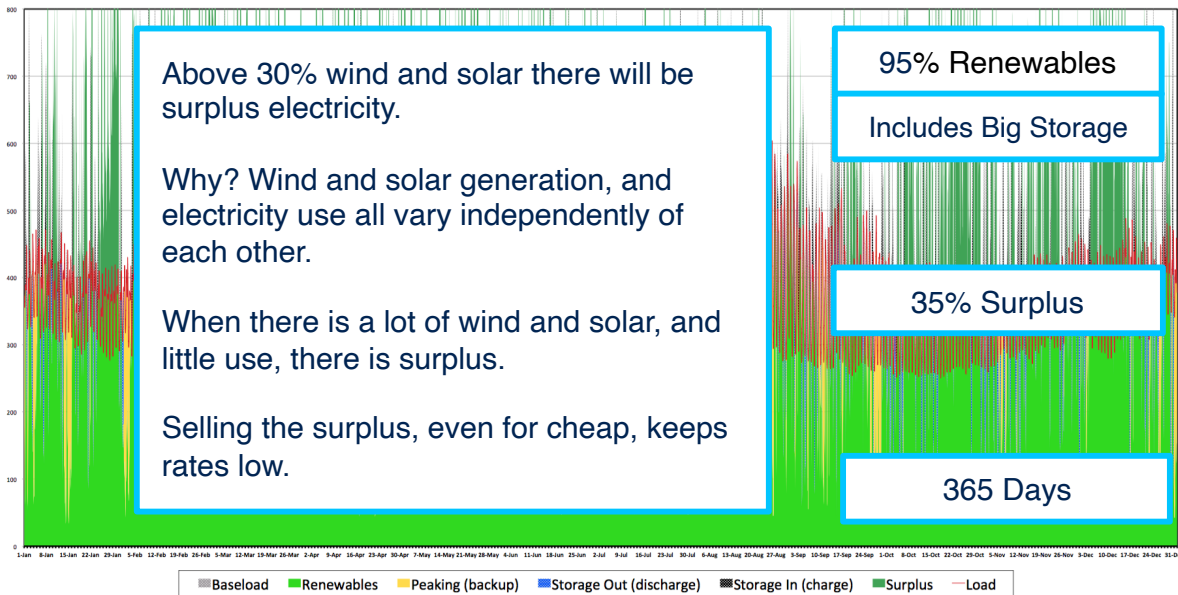


Compare For and Non-Profit Self-Generators. Colorado.

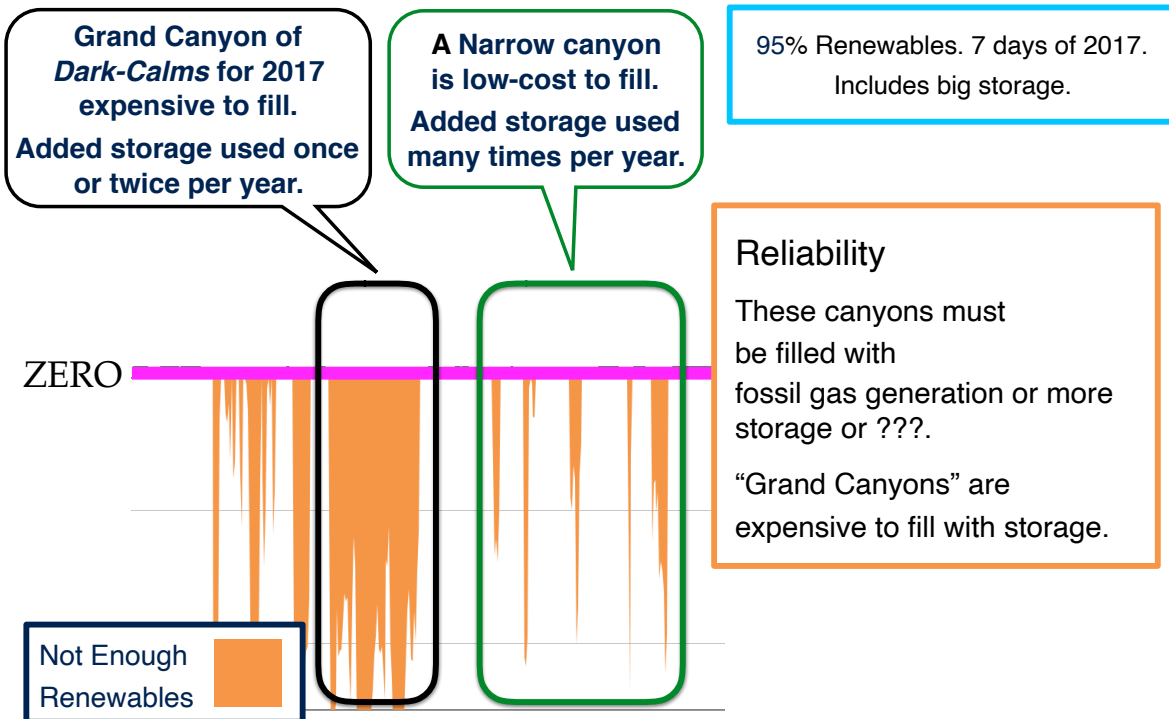
	Long Term Goal	100% Renewables	% Colorado Served Retail	Blended Rate (cents/kWh)	
PRPA non-profit	100% non-carbon	2030	6%	8.0	Lowest Rates in CO. Excellent Reliability.
Xcel for profit	100% reduction in carbon dioxide	2050	54%	9.5	If Xcel charged PRPA's rates we would save About \$400 Million per year on electricity. Bigger is not better. 
Tri-State non-profit	100% Clean Energy	2040	15%	11.0	
Colorado Springs Muni non-profit	(none)		9%	9.2	
IREA non-profit	(none)		6%	12.4	
Black Hills for profit	(none)		4%	12.8	

Source: EIA Table 10 2015 retail sales by utility. Blended rate for Tri-State and PRPA are a weighted average for Colorado retail utilities by MWh sales. % Colorado served is by number of customers (meters). Number of customers turns out to track well with MWh sales. "?" means data not available.

Solar Wind Hydro & Storage



Reliability During “Dark-Calms” at OK Cost



Reliability: Filling in With Gas

95% Renewable Hourly.

PRPA's Rawhide Station

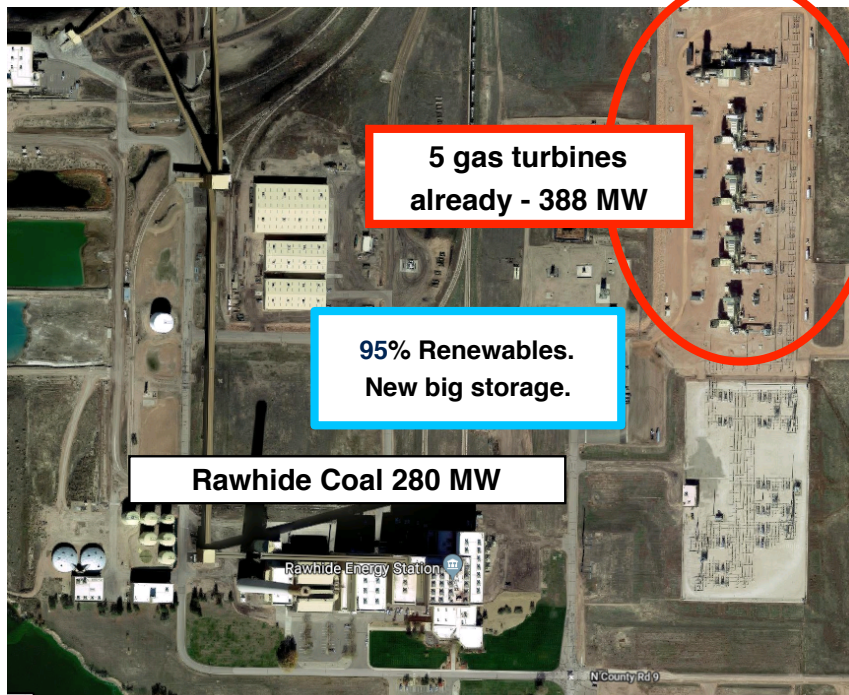
5 gas turbines
already - 388 MW

95% Renewables.
New big storage.

Craig
Coal 154 MW

Rawhide Coal 280 MW

Image: Google
Satellite View



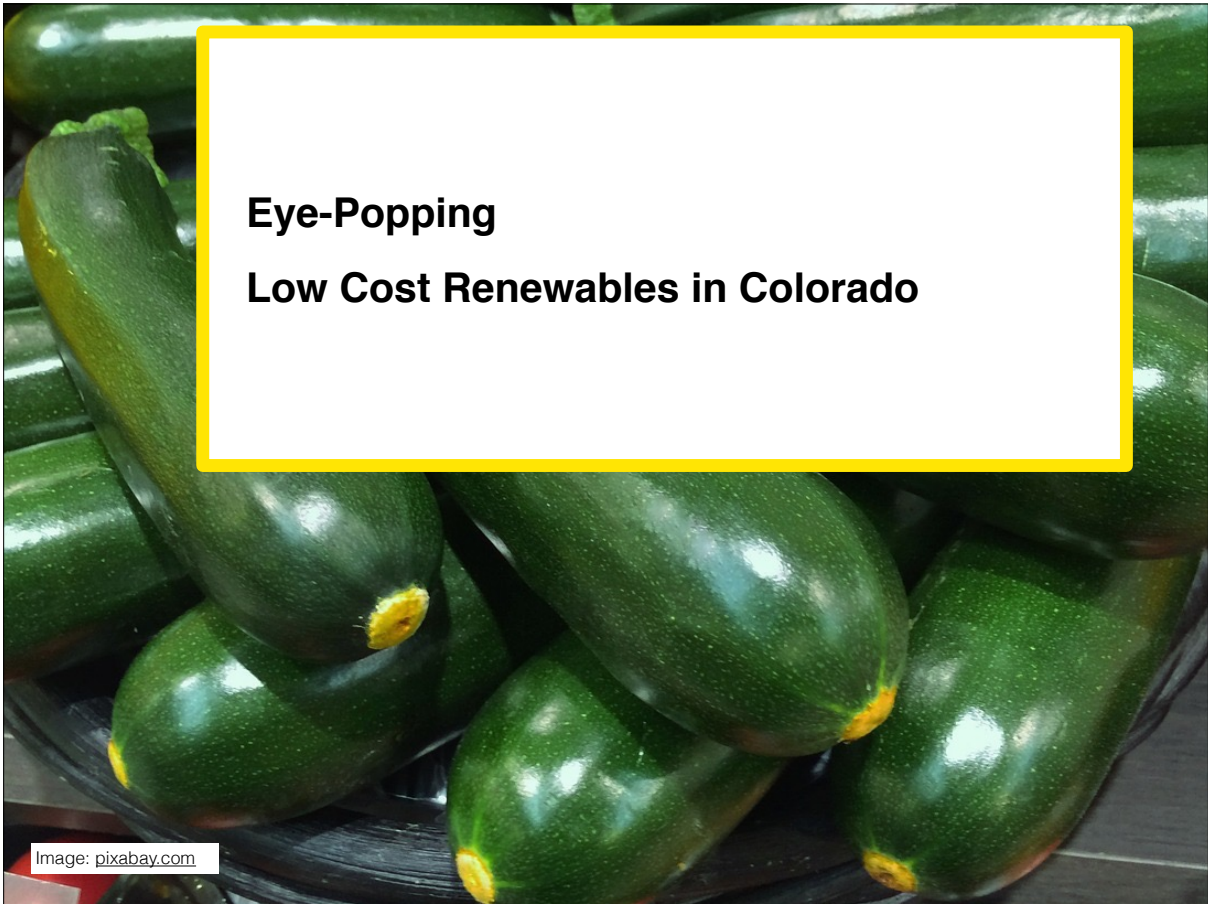
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PRPA Short Term Storage Utilization

	Renewable %	Surplus %	Storage (MWh)	Storage used (annual discharge / total storage) (times per year)
Solar Wind Hydro no storage	85%	45%	0	n/a
Solar Wind Hydro small storage	90%	40%	500	500
Solar Wind Hydro big storage	95%	35%	2,000	500 500 500
Solar Wind Hydro very big storage	99%	31%	13,000	500 500 500 500 500 500 500 500 500 500 500 500 500 500 500
Solar Wind Hydro ginormous storage	100%	30%	47,000	500 500

Sweet spot?

Long Term Storage? Surplus Electricity to "natural" gas or liquid fuel? or, super cheap used EV batteries?



Eye-Popping Low Cost Renewables in Colorado

Image: pixabay.com

Xcel 2017 RFP for Colorado Renewables & Other Resources

PUBLIC VERSION Updated Attachment A

RFP Responses by Technology

Generation Technology	# of		# of Projects	Project MW	Median Bid	
	Bids	Bid MW			Price or Equivalent	Pricing Units
Combustion Turbine/IC Engines	29	6,365	19	4,436	\$ 5.08	\$/kW-mo
Combustion Turbine with Battery Storage	7	804	3	476	6.21	\$/kW-mo
Gas-Fired Combined Cycles	3	873	3	873	█	\$/kW-mo
Stand-alone Battery Storage	28	2,144	24	1,945	10.53	\$/kW-mo
Compressed Air Energy Storage	1	317	1	317	█	\$/kW-mo
Wind	96	41,915	42	16,949	\$ 19.30	\$/MWh
Wind and Solar	5	2,601	4	2,151	19.96	\$/MWh
Wind with Battery Storage	11	5,700	5	2,700	20.63	\$/MWh
Solar (PV)	148	28,382	78	14,085	30.96	\$/MWh
Wind and Solar and Battery Storage	7	4,048	7	4,048	30.41	\$/MWh
Solar (PV) with Battery Storage	79	14,980	57	10,098	38.30	\$/MWh
IC Engine with Solar	1	5	1	5	█	\$/MWh
Waste Heat	2	21	1	11	█	\$/MWh
Biomass	1	9	1	9	█	\$/MWh
Total	418	108,163	246	58,101		

“The (plan) includes **unprecedented** low pricing across a range of generation technologies including wind at levelized pricing between \$11-18/MWh, solar between \$23-\$27/MWh, solar with storage between \$30-\$32/MWh...”

- Xcel

In 2022, Xcel Colorado 55% Renewables

 **Left 95% of bids on the table.**

Xcel Energy (bottom P 51) <https://www.documentcloud.org/documents/4546891-Xcel-Energy-Electric-Resource-Plan-120-Day-Report.html>

Eye-Poppingly

“The (plan) includes **unprecedented** low pricing

Even if you could build a new coal or gas generator for FREE, all-in new wind and solar electricity costs less.

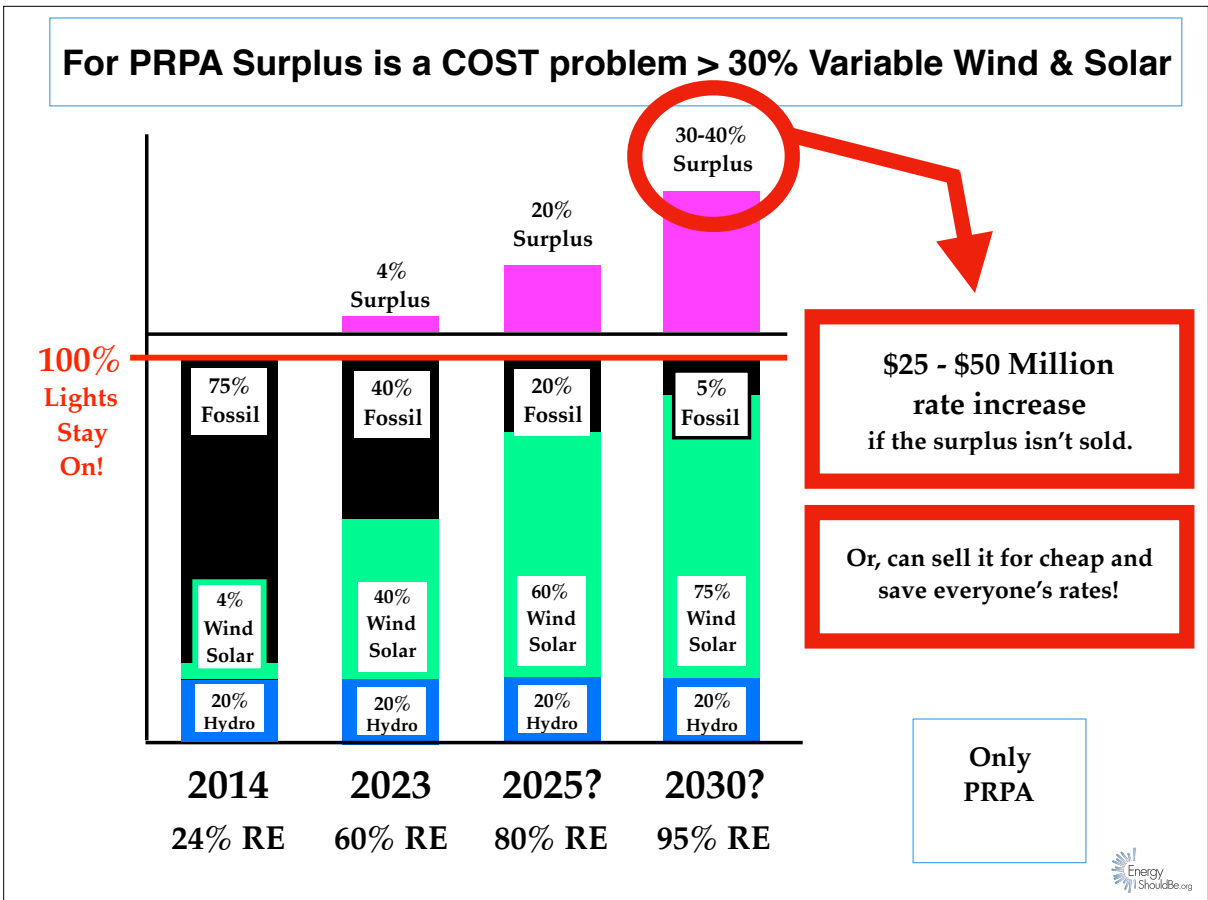
Even existing fossil plants cost more for operations, maintenance, and fuel, than all-in new wind & solar costs.

Xcel Energy (bottom P 51) <https://www.documentcloud.org/documents/4546891-Xcel-Energy-Electric-Resource-Plan-120-Day-Report.html>



Selling Surplus Lowers Everyone's Cost

Image: pixabay.com



Surplus is a COST problem > 30% Variable Wind & Solar

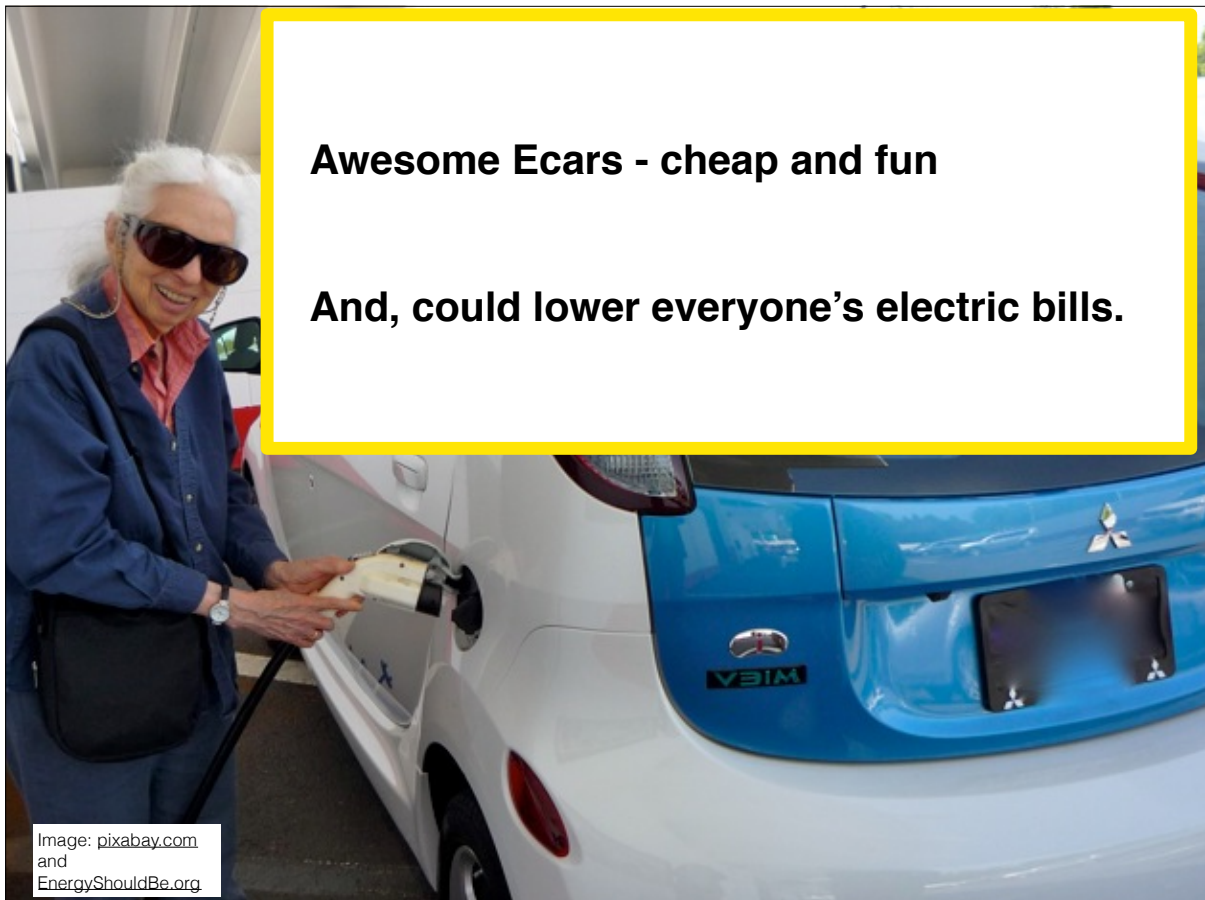
**\$25 - \$50 Million
rate increase
if the surplus isn't sold.**

Called "curtailment".
Turning off wind & solar.

**Or, can sell it for cheap and
save everyone's rates!**

"Sell for cheap" to who??

- Other utilities.
Energy Imbalance Market
- Existing customers.
 - Business
 - Residential



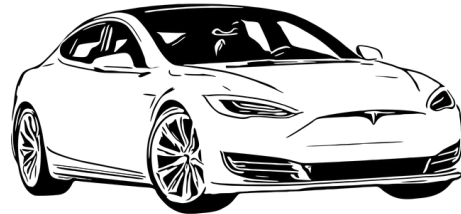
Awesome Ecars - cheap and fun

And, could lower everyone's electric bills.

2015 Two Practical Electric Cars



Leaf: realistic 80 mile range



Tesla Model S

Images: EnergyShouldBe.org and pixabay.com Tesla Image by Susrut Mishra from pixabay.com



2019 Five ECars at Lower Cost - 220 Miles Range or More



Kia Niro EV



Tesla Model 3



Hyundai Kona

Nissan Leaf

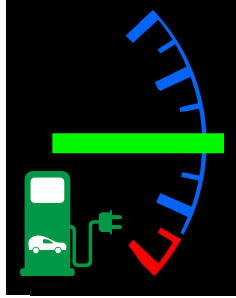
Chevy Bolt

Images: EnergyShouldBe.org and pixabay.com Kona Image by mikenr1 from Pixabay

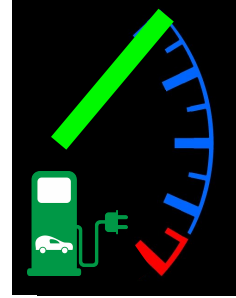


Ecar Charging - Most Current ECars have > 240 miles of Range
“Cheap 2 Charge from Surplus” Program

Always Wake to
120 Miles (50%)



Cheap 2 Charge
“Fill Er Up!”
240 Miles (100%)



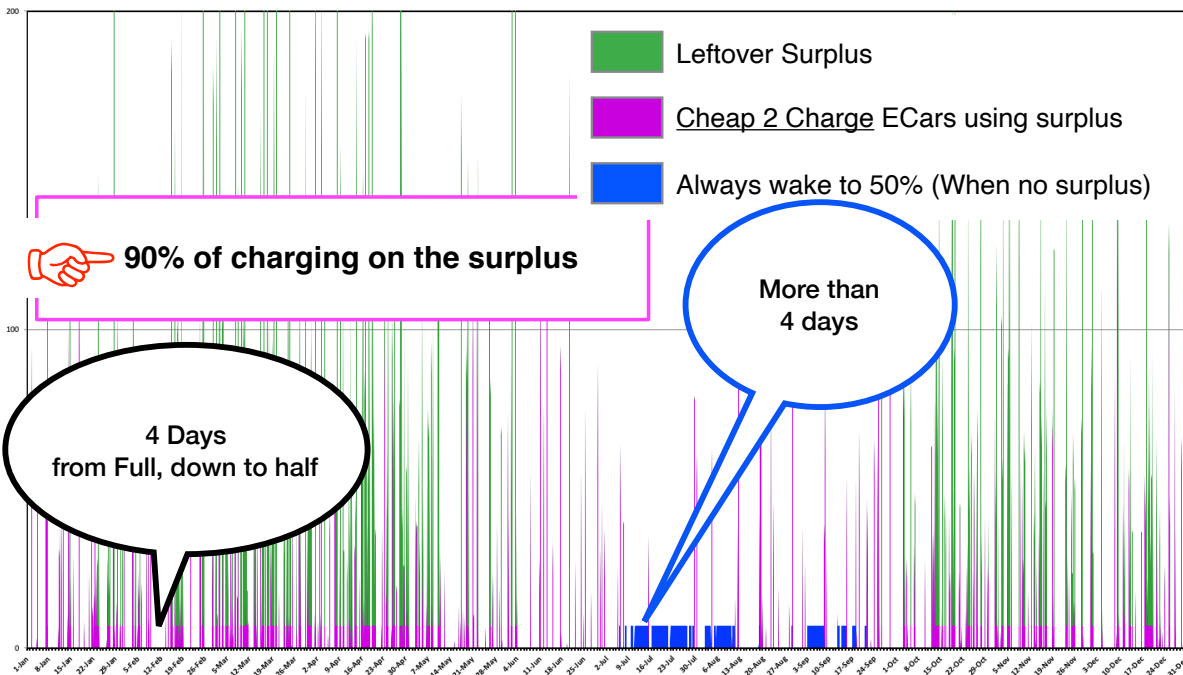
120 miles of additional range when full
 4 days from Full to Half at 30 miles per day

Images: pixabay.com



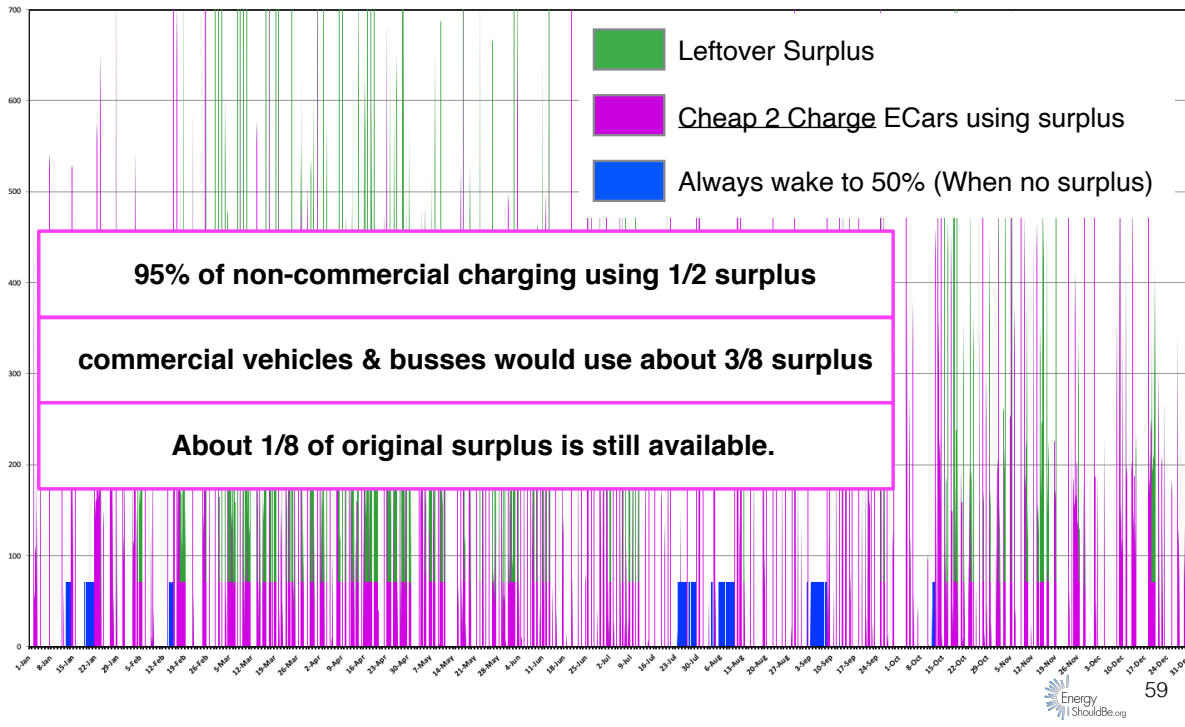
Rewarding Flexible Use of Surplus

Every hour of an entire year. Wind & solar PRPA 2023. **60%** Renewable.
20,000 Plug-ins.



Rewarding Flexible Use of Surplus

Every hour of an entire Year. Wind & solar PRPA 2030. **95%** Renewable.
200,000 **non-commercial** Plug-ins.



Do Ecar chargers exist today that allow charging when the sun is shining or wind blowing?

When surplus electricity?

Cheap 2 Charge?


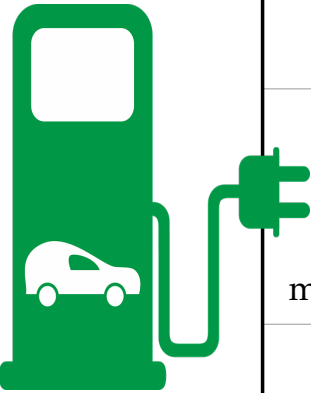
Yes

Almost

No



Ecar Fuel Savings per Year

	Cost per mile	15,000 miles per year	Savings per year
	10 ¢	\$1,500	-
	US residential rate 3.5 ¢	\$500	\$1,000
	On Surplus <i>Cheap 2 Charge</i> 1 ¢ most of year, then 3.5 ¢	\$200	\$1,300
	FREE	FREE	\$1,500

Images: pixabay.com

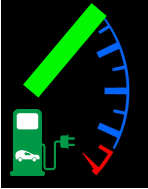


10¢ per mile gasoline is at \$3.00 / gallon and 30 MPG.

Electricity at national average 12 ¢ per kWh and an Ecar at 3.5 miles per kWh. 1 ¢ per mile is about 3 ¢ per kWh electricity.



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Using the Surplus - With Storage. Just PRPA.

	How Used <i>Storage lasts...</i>	Energy Use per day per car...	Impact per year
	Electric car 4 days.	30 miles about 9 kWh/day	270,000 vehicles. Roughly 30% of total electricity use all transportation - commercial and residential.
	Hot water heater. 1 - 2 days.	3 people 6/kWh/day for electric resistance. Heat pumps use less - about half to a third.	110,000 homes. Roughly 8% of total electricity use.
	Pre heat/cool home or business. A few hours.	TBD	TBD

Images: pixabay.com



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Not Just Us Saying Cheap 2 Charge is Good For ALL



New Report Shows Electric Vehicles = Lower Bills for All

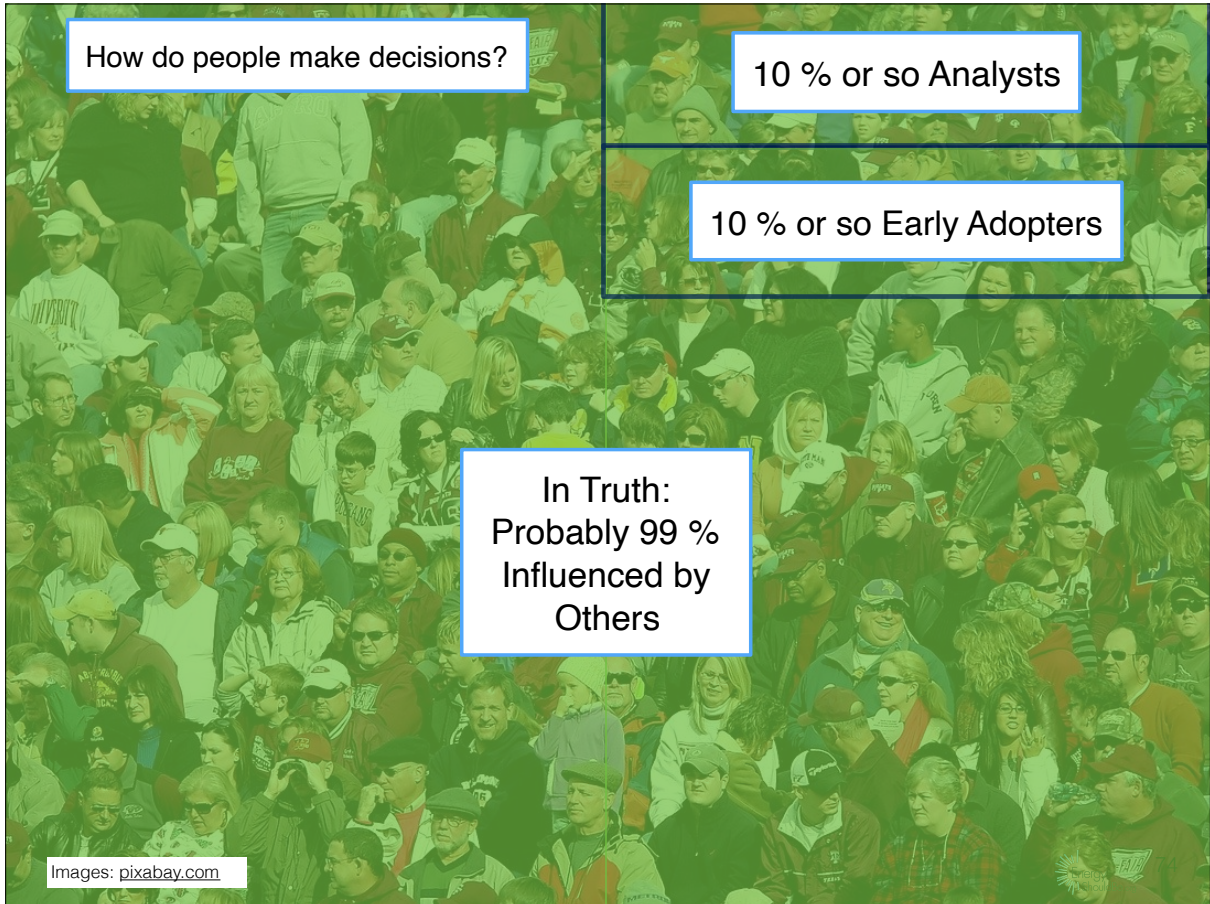
By Fresh Energy | November 25, 2019

⋮
The report shows that ... rate policies ... maximizing **off-peak** vehicle charging... residential utility customers in Minnesota could save as much as **\$71 per year** on their electricity bills.

 **Our modeling shows “off-peak” is good.**
“On surplus” is better.

Our emphasis added. <https://fresh-energy.org/new-report-shows-electric-vehicles-lower-bills-for-all/>





Hyundai Kona's available for sale in Colorado.

Which one gasoline? Which is an Ecar?



Removable adhesive bumper stickers or magnets.



Poll: Single Choice

Will you want a bumper sticker?


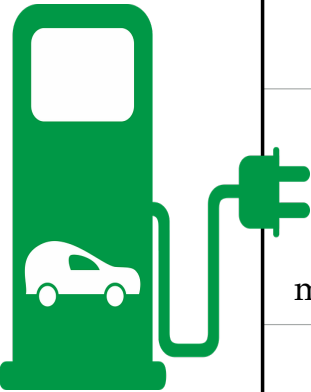
Poll: Multiple Choice

Which ones do you like?

A few short topics.

E Bus Savings

Transit Bus Fuel Savings per Year


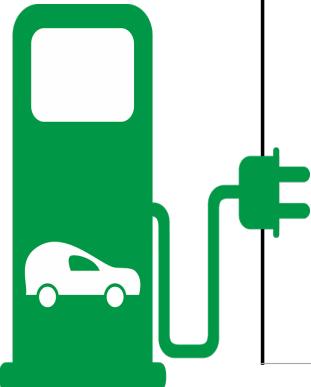
	Cost per mile	34,000 miles per year	Savings per year
	46 ¢	\$16,000	-
	13 ¢	\$4,500	\$11,500
	On Surplus <i>Charge 4 Cheap</i> 4 ¢ most of year, then 13 ¢	\$2,000	\$14,000
	FREE	FREE	\$16,000

Images: pixabay.com

46¢, 13¢ from <http://swenergy.org/new-xcel-energy-rate-could-speed-rtd's-purchase-of-electric-buses- using Xcel's proposed rate for 13¢. 34,000 miles per year from> <https://afdc.energy.gov/data/10309>



Transit Bus Maintenance Savings per Year

	Cost per mile	34,000 miles per year	Savings per year
	\$1.53	\$52,000	-
	\$0.55	\$19,000	\$33,000

Images: pixabay.com

\$1.53 and \$0.55 from <https://www.publicpower.org/periodical/article/electric-buses-mass-transit-seen-cost-effective> 34,000 miles per year from <https://afdc.energy.gov/data/10309>



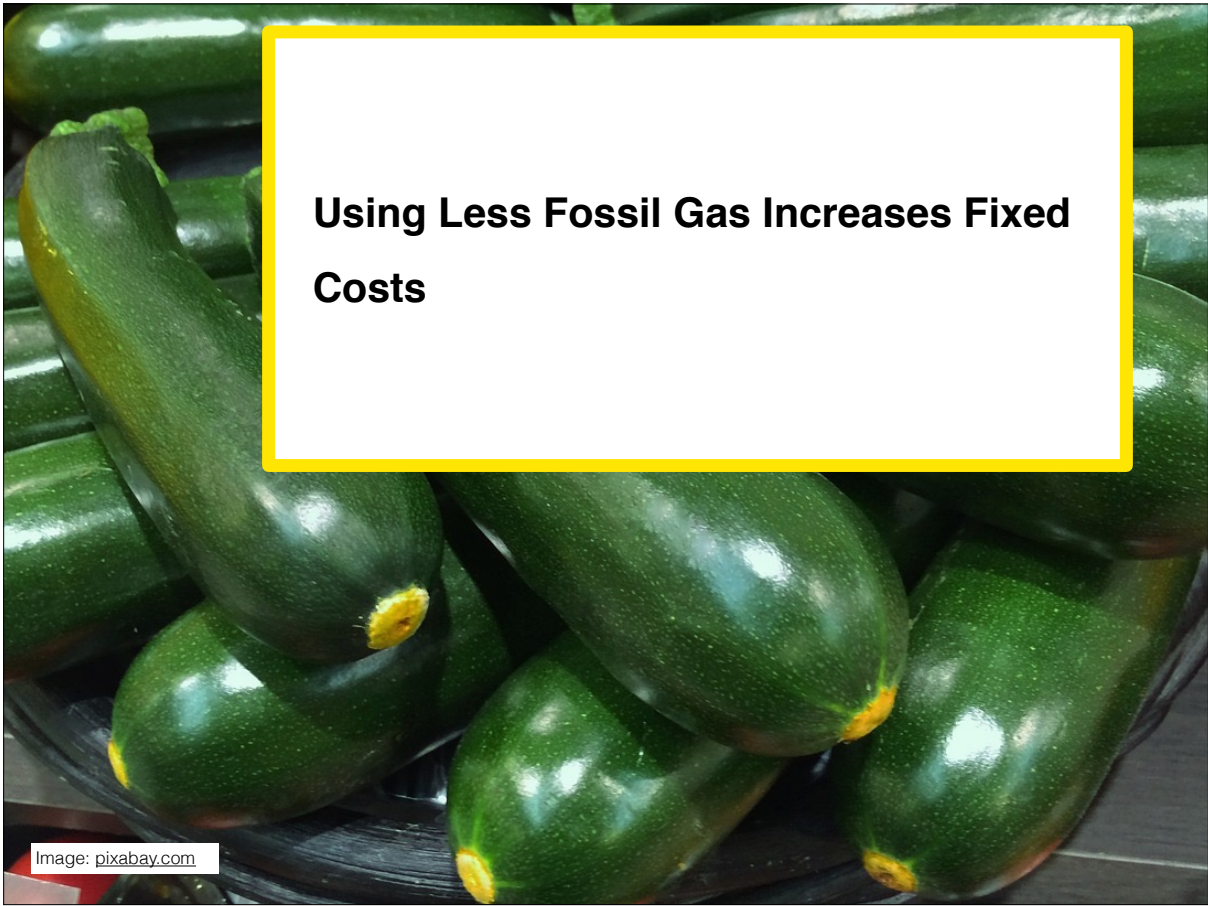
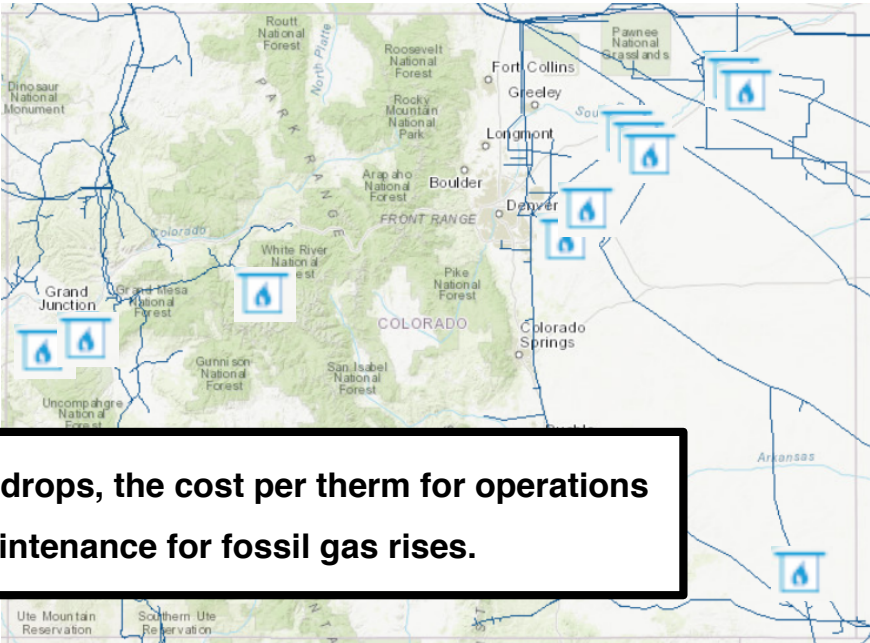



Image: pixabay.com

As we use less and less...
What happen\$ to fossil ga\$ pipeline\$ and \$torage Costs?

Storage



 **As use drops, the cost per therm for operations and maintenance for fossil gas rises.**

Source: EIA map <https://www.eia.gov/state/maps.php?v=Natural%20Gas>

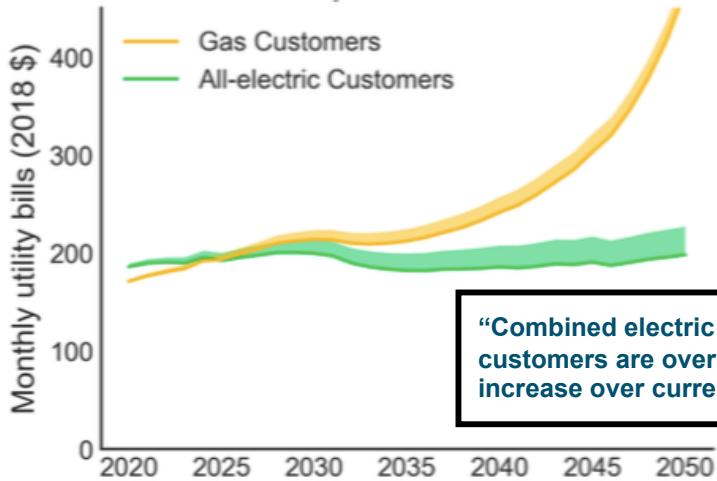
California Gas Future Study



Energy+Environmental Economics

Draft Results: Future of Natural Gas Distribution in California

High Building Electrification Scenario: Bill Impacts with targeted gas pipeline retirements



“Combined electric and gas bills for remaining gas customers are over \$490/month in 2050, a 2.5X increase over current bills “



Enough Wrench Ready Renewables For All Colorado?

For ALL Colorado: Is There Enough Renewables?

PUBLIC VERSION Updated Attachment A

RFP Responses by Technology

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Solar (PV) with Battery Storage	79	14,980	57	10,098	38.30	\$/MWh



Using Only “Wind” & “PV + storage” -->
All Colorado: 95% Renewable. 60% Surplus.

Xcel Energy (bottom P 51) <https://www.documentcloud.org/documents/4546891-Xcel-Energy-Electric-Resource-Plan-120-Day-Report.html>



Energy Imbalance Markets Will Not Work All the Time

Surplus is a COST problem > 50% Renewables

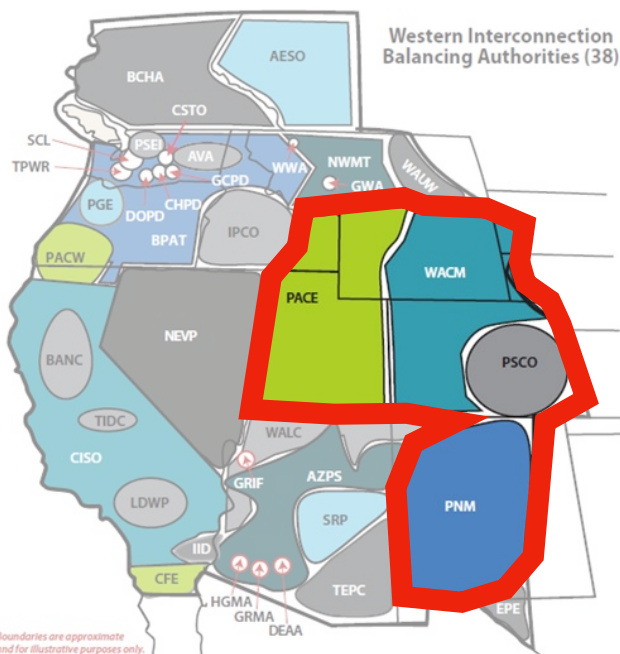
**\$25 - \$50 Million
rate increase
if the surplus isn't sold.**

**Or, can sell it for cheap and
save everyone's rates!**

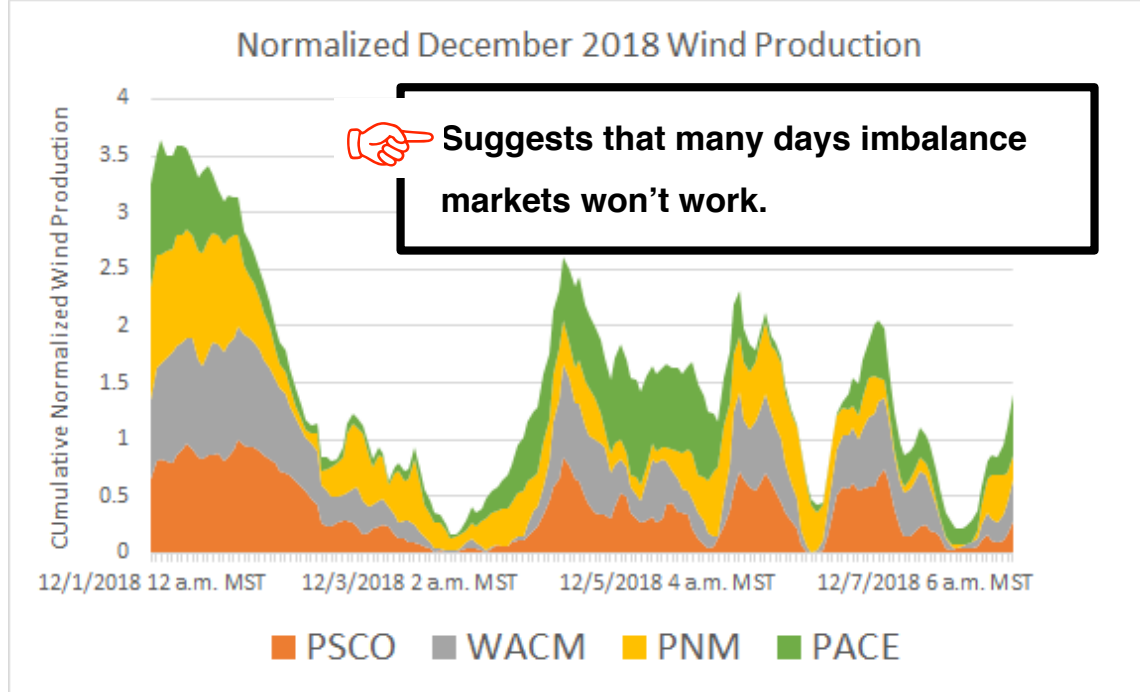
“Sell for cheap” to who??

- Other utilities.
- **Energy Imbalance Market**
- Existing customers.

4 Neighboring Balancing Authorities



7 Days. Just Wind. 4 Neighboring Balancing Authorities



Surplus is a COST problem > 30% Variable Wind & Solar

Or, can sell it for cheap and save everyone's rates!

“Sell for cheap” to who??

- Other utilities.
Energy Imbalance Market
- Existing customers.



Which one? Probably “Do Both!”

And.

Be extremely skeptical of high cost projects to implement either.
(e.g. New Transmission)



**Lots of ECars lower electricity costs for
EVERYONE!**

**Lots of renewables lower charging costs
for Ecars.**

Image: pixabay.com



Questions?

regelson at [mac.com](mailto:regelson@mac.com)

Image: pixabay.com