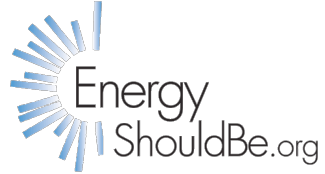


Image:EnergyShouldBe.org

## What is Driving the Energy Transition?

Climate. Cost. Competition. Rapid Transition. Texas.



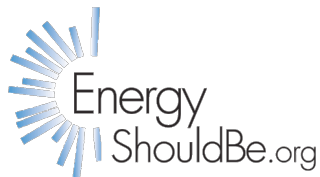
Ken Regelson  
April 15, 2021



***I skate to where the puck is going to be,  
not where it has been.***

- Wayne Gretzky

**Don't Believe Everything You Think.**



**Drive a rapid transition to a reliable,  
reasonable cost, renewable energy  
future based on data driven actions.**



Image:EnergyShouldBe.org



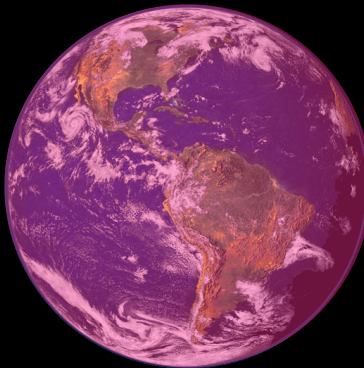
3

**Past  
Goldilocks Zone  
(just right)**



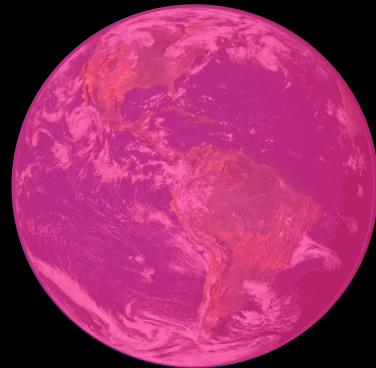
**280 PPM CO2  
Prior to  
Industrial  
Revolution**

**Rapid Transition to  
renewables  
Goldilocks Zone?  
(nearly too hot)**



**417 PPM CO2  
Today  
Effect of CO2 for  
100s of years**

**Keep Burning stuff.  
Too hot!**



**??? PPM CO2**

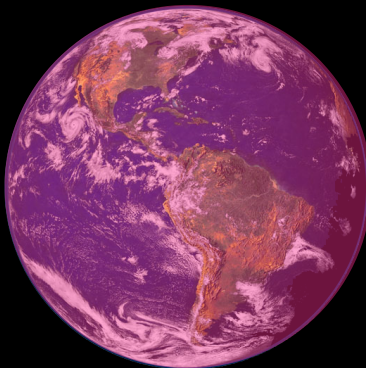
Image: Blue Marble NASA



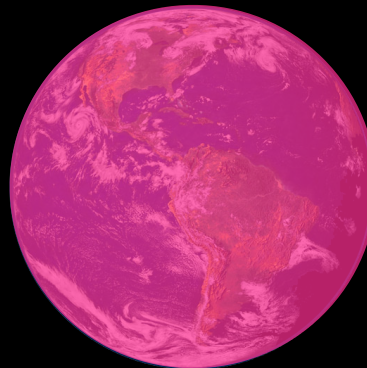
**Past  
Goldilocks Zone  
(just right)**



**Rapid Transition to  
renewables  
Goldilocks Zone?  
(nearly too hot)**



**Keep Burning stuff.  
Too hot!**



Ghost of Climate Past,  
the Ghost of Climate Baked In,  
and the Ghost of Climate Yet to Come.  
*With apologies to Charles Dickens' A Christmas Carol.*

Image: Blue Marble NASA

**Not actionable.  
No data.**

**Climate Change is not going  
to be even planetary  
heating.**



**Increased catastrophic:**

- ◆ Drought
- ◆ Heat Waves
- ◆ Fires
- ◆ Floods
- ◆ Cold Snaps
- ◆ Hurricanes

...

Image: Blue Marble NASA

## **Electric Reliability Council of Texas (ERCOT):**

**33,000 megawatts still offline**

**"Just like maintaining your car, generators must be maintained to keep them running smoothly. ERCOT must balance these necessary outages with serving load during the spring and fall months, especially given increased weather volatility."**

- **Woody Rickerson,**  
ERCOT's vice president of grid planning and operations.

**Quoted in Austin-American Statesman. 4/14/21**

<https://www.statesman.com/story/news/2021/04/14/ercot-power-grid-remains-strained-but-no-blackouts-expected/7224993002/>

## **Driving Action**



**Tesla Model Y**



## Ford 2019 Electric Car Poll

**“three in four  
say they’d prefer to date  
an electric vehicle owner. “**

Poll: <https://media.ford.com/content/fordmedia/fna/us/en/news/2020/02/13/spark-a-new-romance-with-all-electric-mustang-mach-e.html>  
Image: EnergyShouldBe.org



## What People Say About Electric Cars



### What drives people to action?

**Fear      Climate Change**

**\$s      Cost**

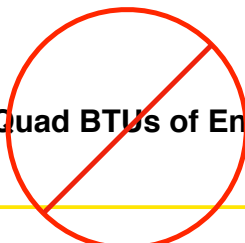
**Fun      Competition**

**Hope**

**Stories      True and Useful**

**Humor**

**Quad BTUs of Energy?**



## Which argument is most likely to lead to action?

### Gasoline vs Electric Vehicle

#### Light Duty Transportation

##### BTU

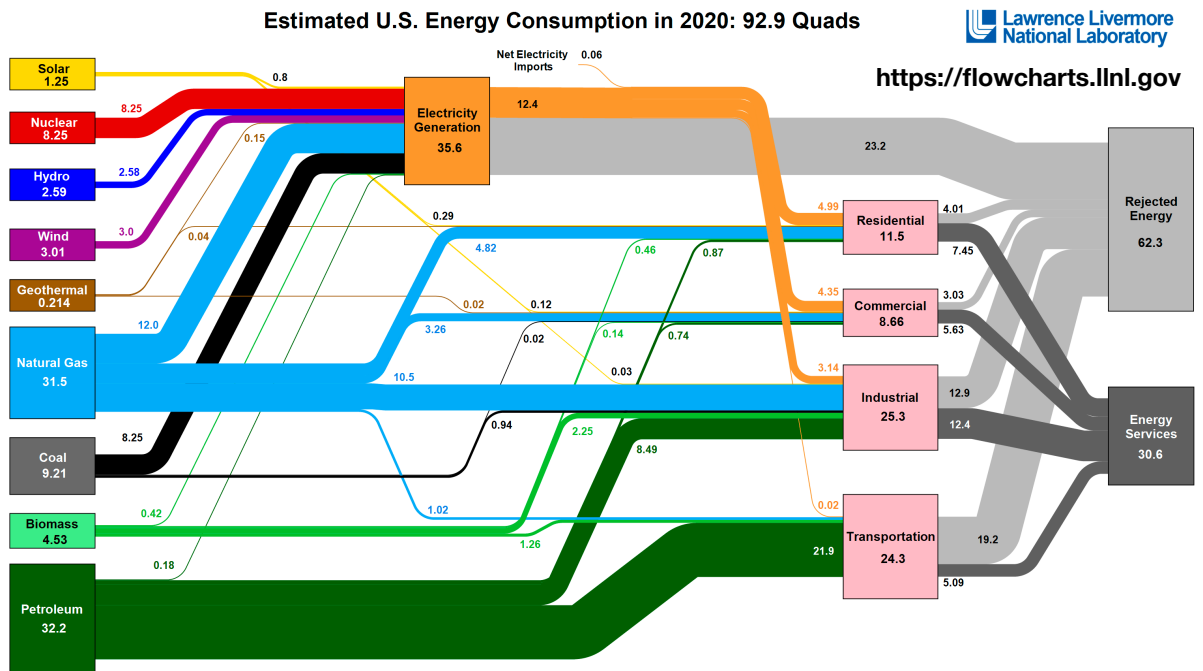
**gasoline** 120,000 BTU / gallon / 30 MPG = **4,000 BTU / mile**

**electricity** 3,214 BTU / kWh / 3.5 miles/kWh = **920 BTU / mile**

##### Fuel Cost

**gasoline** \$3 / gallon / 30 MPG = **\$0.10 / mile**

**electricity** \$0.12 / kWh / 3.5 miles / kWh = **\$0.034 / mile**

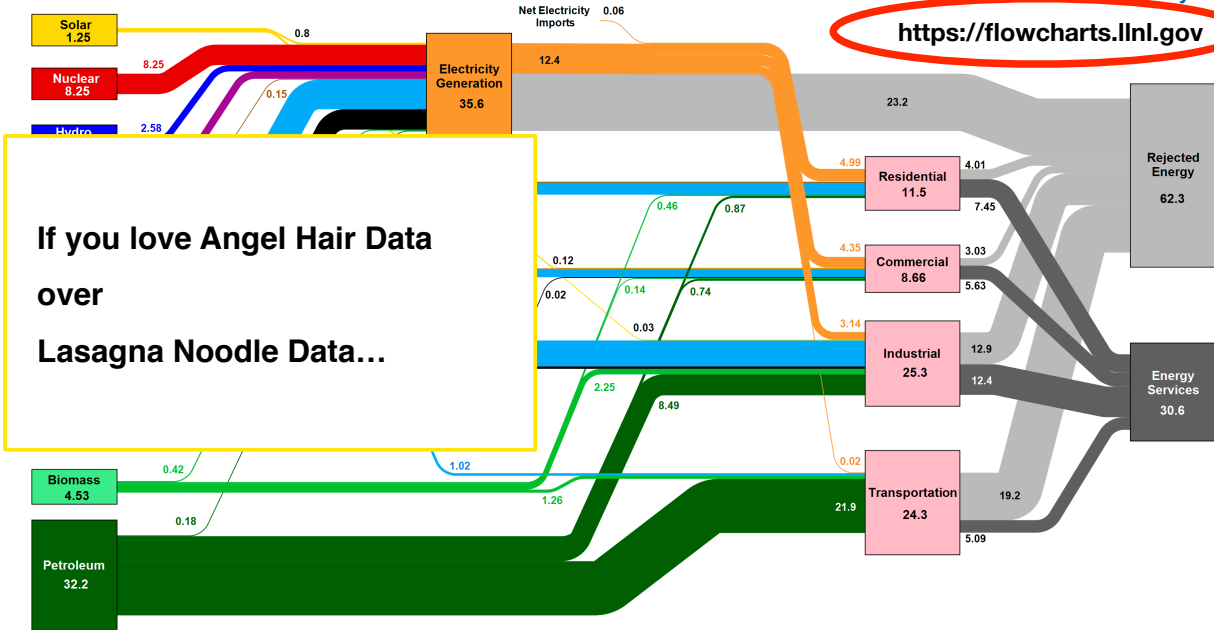


Source: LLNL March, 2021. Data is based on DOE/EIA MEB (2020). If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports consumption of renewable resources (i.e., hydro, wind, geothermal and solar) for electricity in BTU-equivalent values by assuming a typical fossil fuel plant heat rate. The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 65% for the residential sector, 65% for the commercial sector, 21% for the transportation sector and 49% for the industrial sector, which was updated in 2017 to reflect DOE's analysis of manufacturing. Totals may not equal sum of components due to independent rounding. LLNL-MI-410027

## Estimated U.S. Energy Consumption in 2020: 92.9 Quads

Lawrence Livermore  
National Laboratory

<https://flowcharts.llnl.gov>



If you love Angel Hair Data  
over  
Lasagna Noodle Data...

Source: LLNL March, 2021. Data is based on DOE/EIA MEB (2020). If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports consumption of renewable resources (i.e., hydro, wind, geothermal and solar) for electricity in BTU-equivalent values by assuming a typical fossil fuel plant heat rate. The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 65% for the residential sector, 65% for the commercial sector, 21% for the transportation sector and 49% for the industrial sector, which was updated in 2017 to reflect DOE's analysis of manufacturing. Totals may not equal sum of components due to independent rounding. LLNL-MI-410527

Image: Lawrence Livermore National Laboratory and the US Department of Energy  
<https://flowcharts.llnl.gov>

Very Detailed Energy Sankey  
<http://energyliteracy.com>

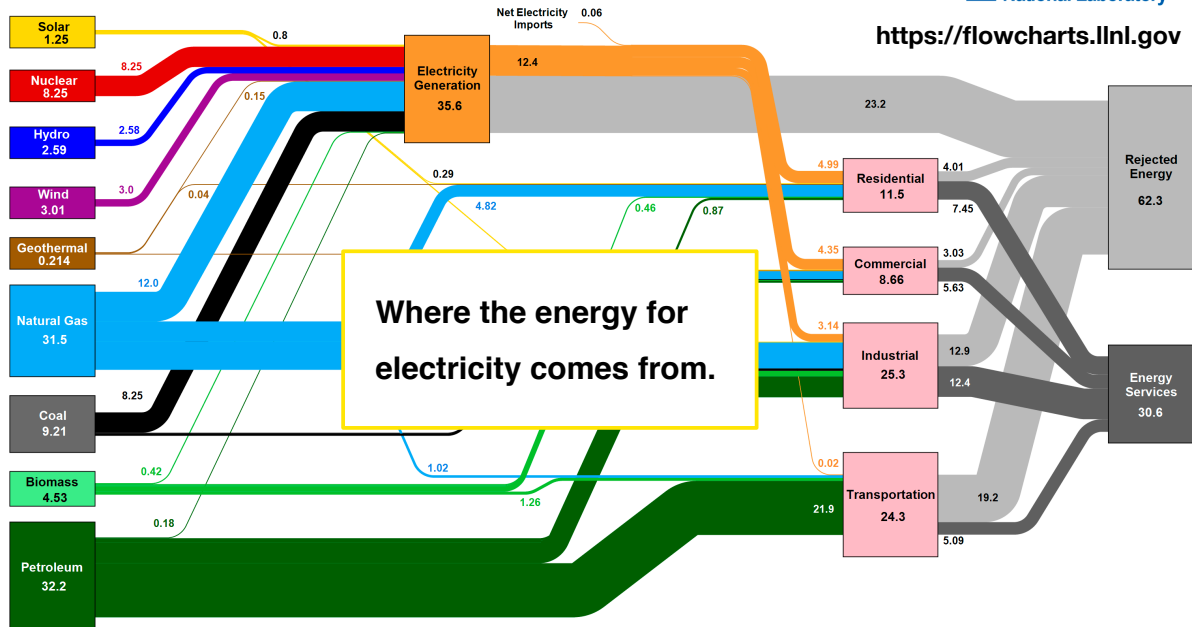
Energy  
I Should Be.org

13

## Estimated U.S. Energy Consumption in 2020: 92.9 Quads

Lawrence Livermore  
National Laboratory

<https://flowcharts.llnl.gov>



Where the energy for  
electricity comes from.

Source: LLNL March, 2021. Data is based on DOE/EIA MEB (2020). If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports consumption of renewable resources (i.e., hydro, wind, geothermal and solar) for electricity in BTU-equivalent values by assuming a typical fossil fuel plant heat rate. The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 65% for the residential sector, 65% for the commercial sector, 21% for the transportation sector and 49% for the industrial sector, which was updated in 2017 to reflect DOE's analysis of manufacturing. Totals may not equal sum of components due to independent rounding. LLNL-MI-410527

Image: Lawrence Livermore National Laboratory and the US Department of Energy  
<https://flowcharts.llnl.gov>

Very Detailed Energy Sankey  
<http://energyliteracy.com>

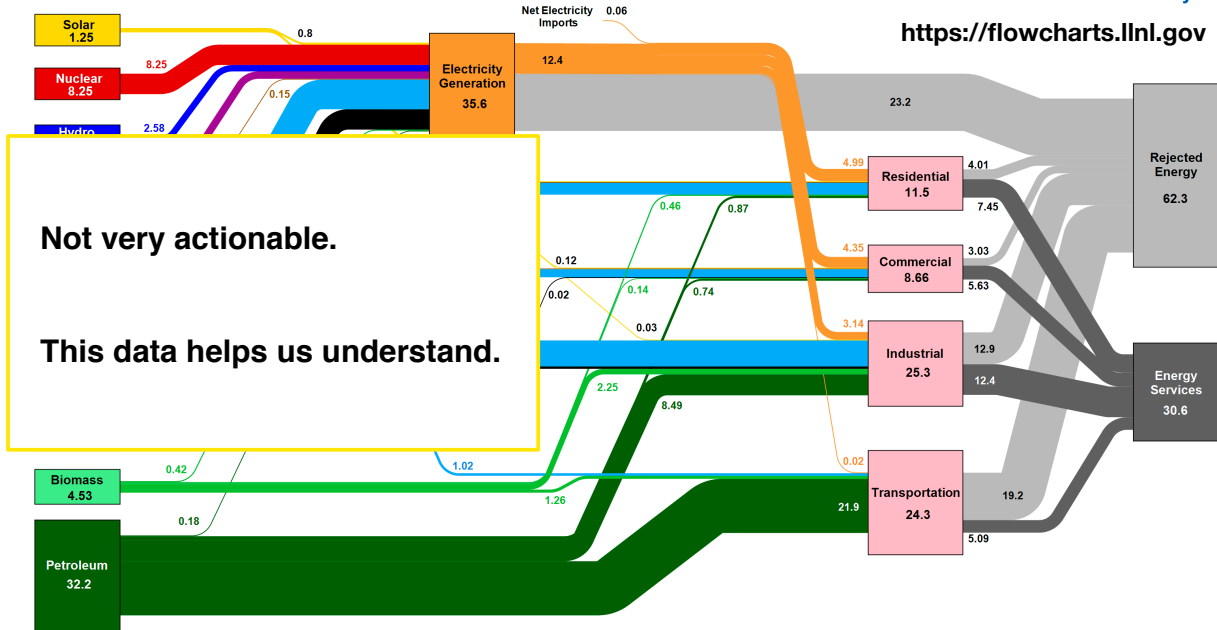
Energy  
I Should Be.org

14



# Estimated U.S. Energy Consumption in 2020: 92.9 Quads

<https://flowcharts.llnl.gov>



Source: LLNL March, 2021. Data is based on DOE/EIA MEB (2020). If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports consumption of renewable resources (i.e., hydro, wind, geothermal and solar) for electricity in BTU-equivalent values by assuming a typical fossil fuel plant heat rate. The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 65% for the residential sector, 65% for the commercial sector, 21% for the transportation sector and 49% for the industrial sector, which was updated in 2017 to reflect DOE's analysis of manufacturing. Totals may not equal sum of components due to independent rounding. LLNL-MF-515557

Image: Lawrence Livermore National Laboratory and the US Department of Energy  
<https://flowcharts.llnl.gov>

**Very Detailed Energy Sankey**  
<http://energyliteracy.com>

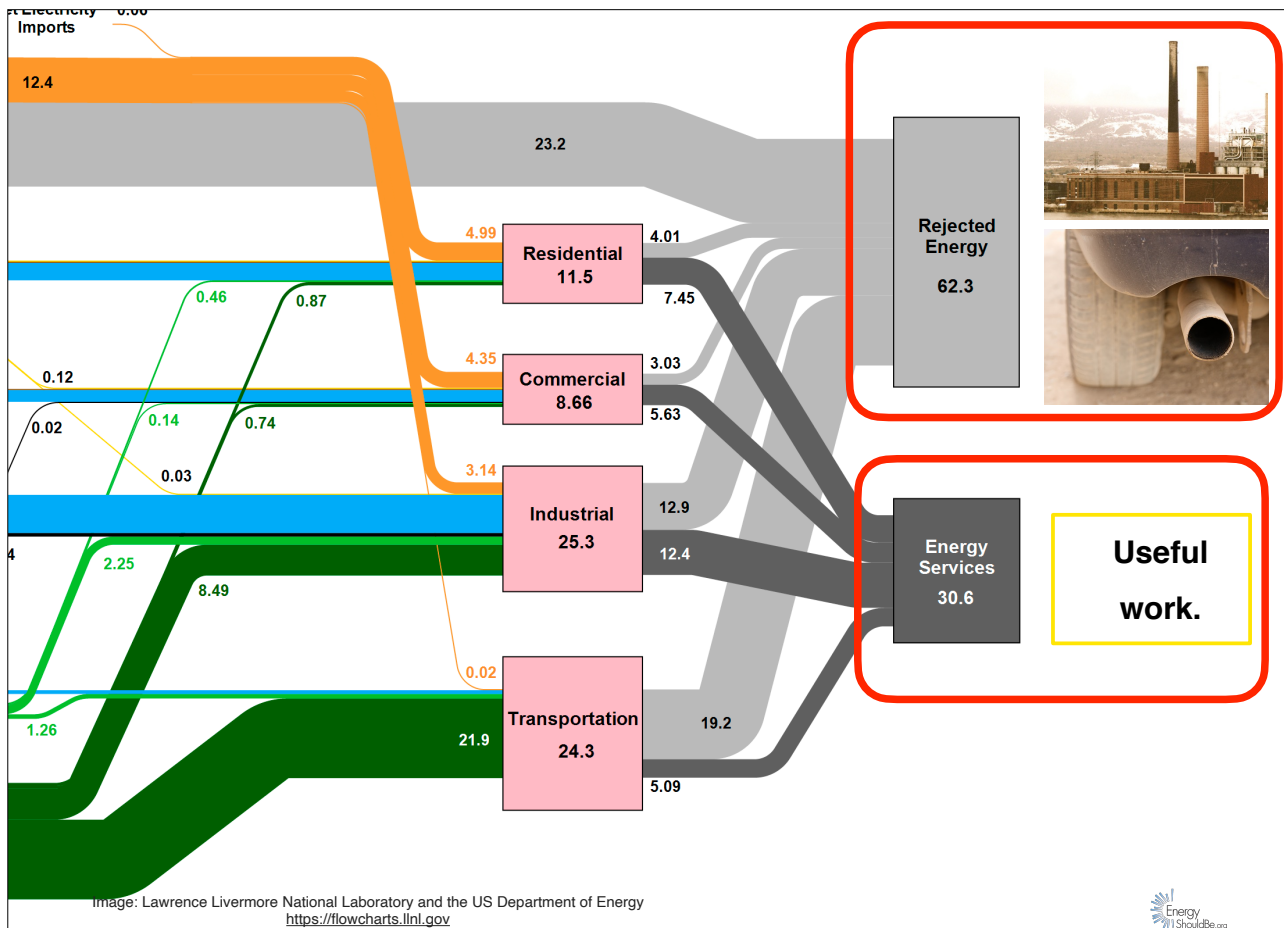


Image: Lawrence Livermore National Laboratory and the US Department of Energy  
<https://flowcharts.llnl.gov>

**Develop a Plan based  
on cost and GHG  
emission data.**



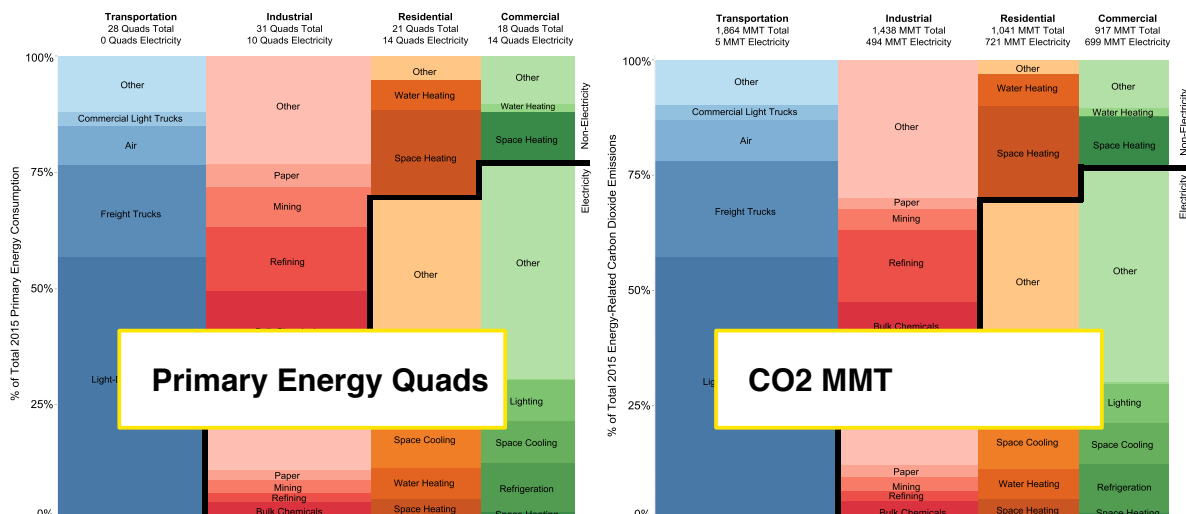
**Tesla Model 3**

Image: [EnergyShouldBe.org](http://EnergyShouldBe.org)



17

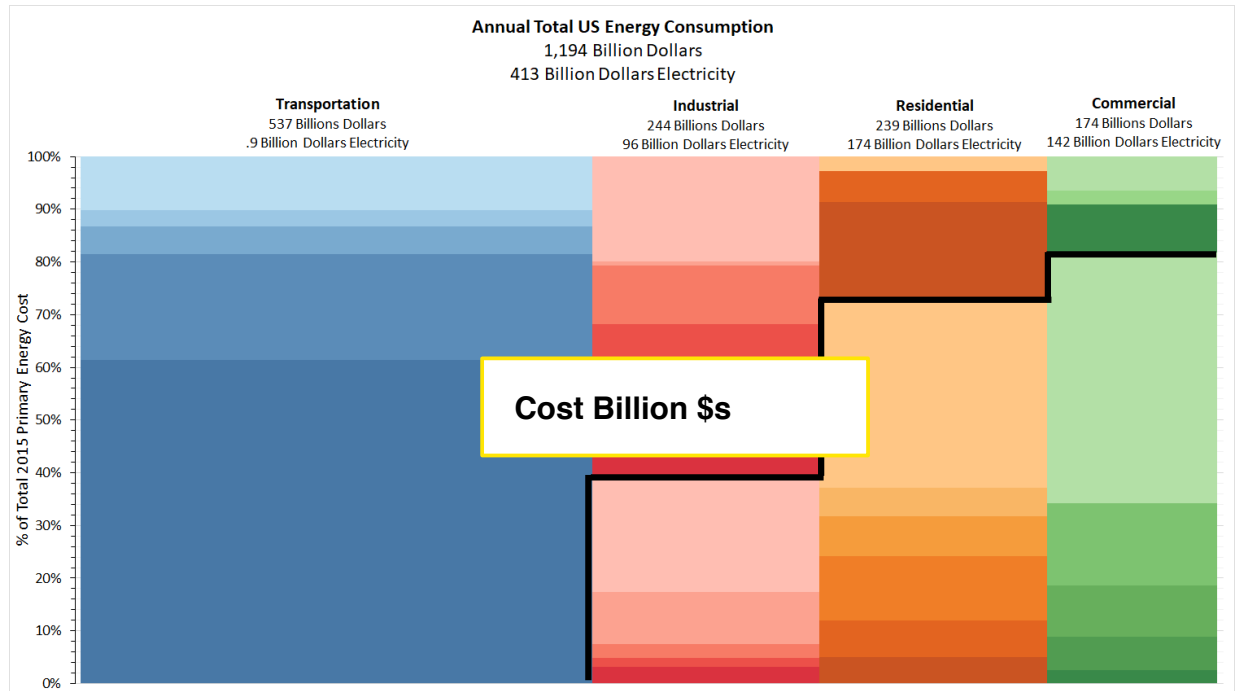
## Subsector primary energy consumption and energy-related carbon dioxide emissions 2015



**The Money???**

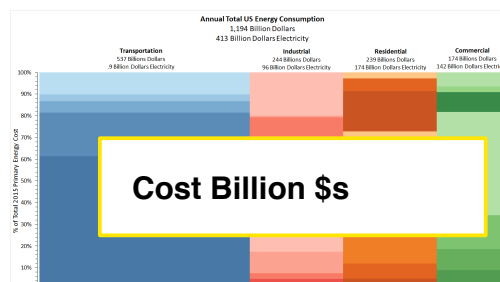
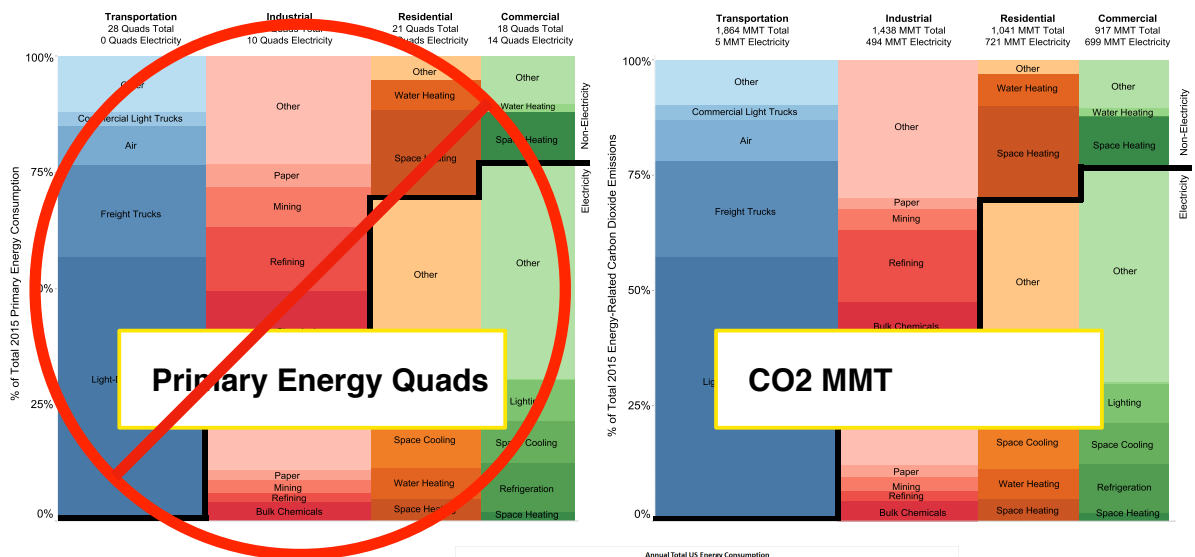
Source NREL. <https://www.nrel.gov/docs/fy18osti/70485.pdf> page 18. Based on 2015 data from EIA.

\$ draft



Draft from [EnergyShouldBe.org](http://EnergyShouldBe.org) based on 2015 EIA data

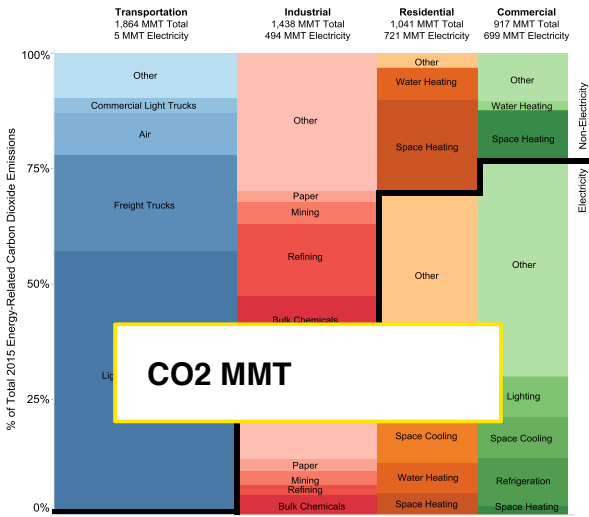
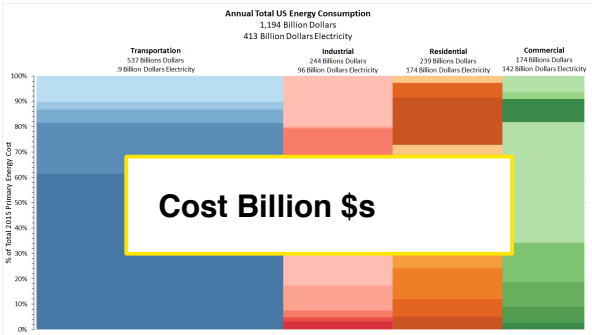
### Subsector primary energy consumption and energy-related carbon dioxide emissions 2015



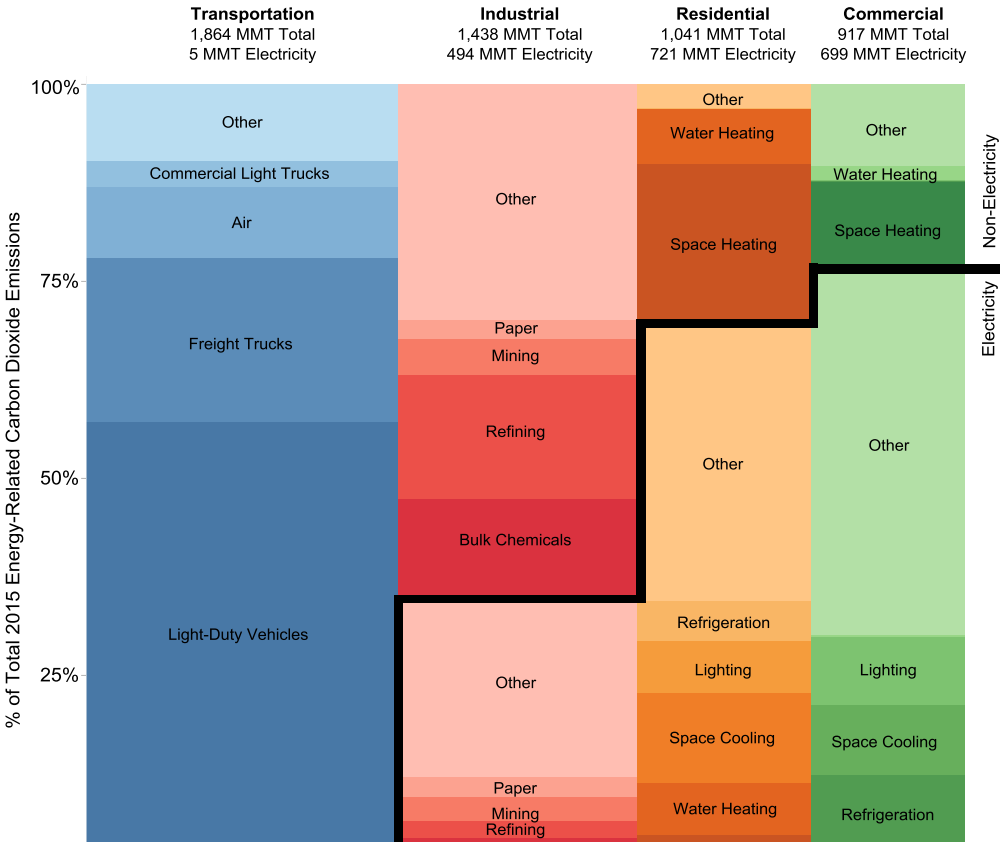


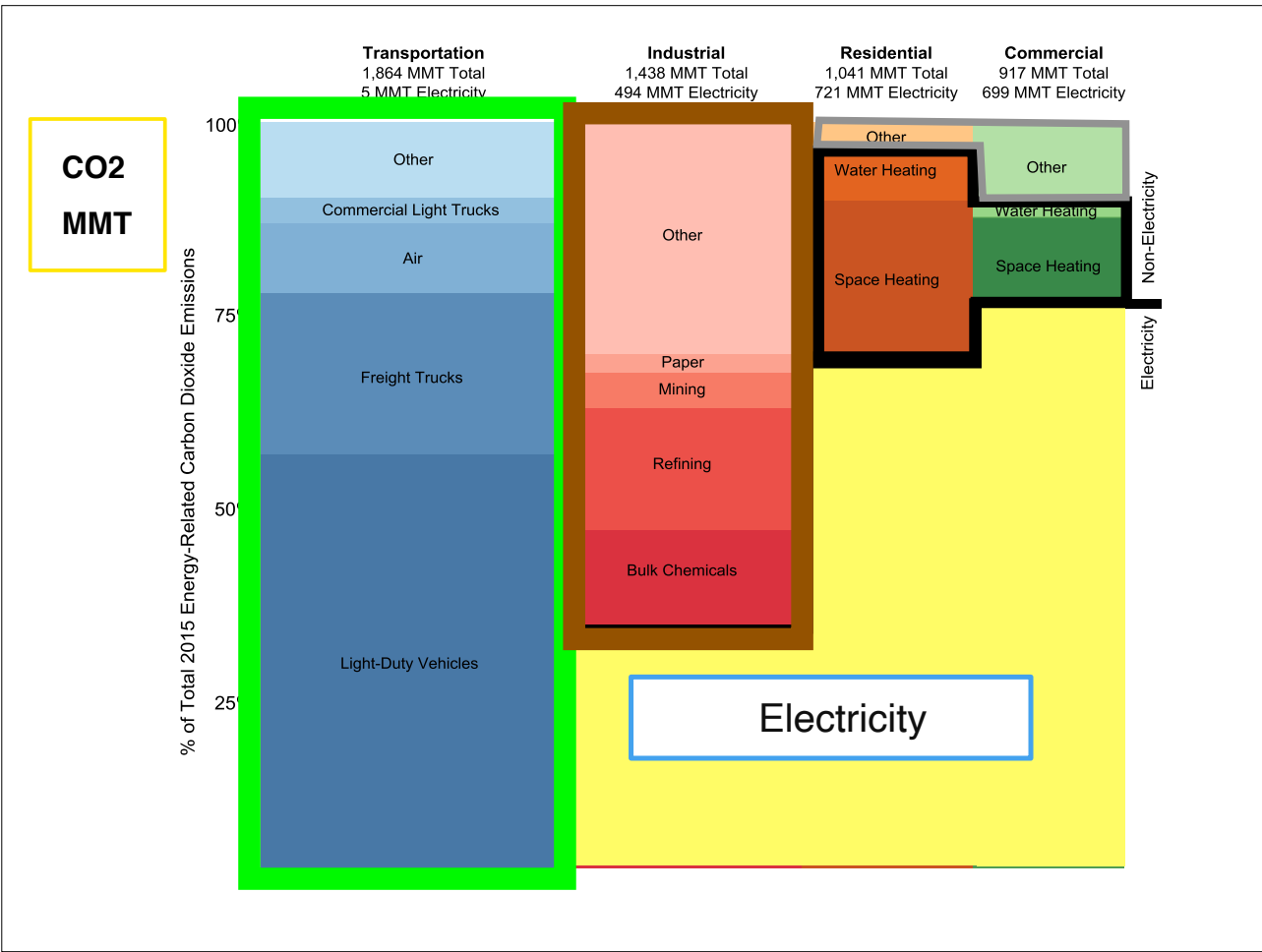
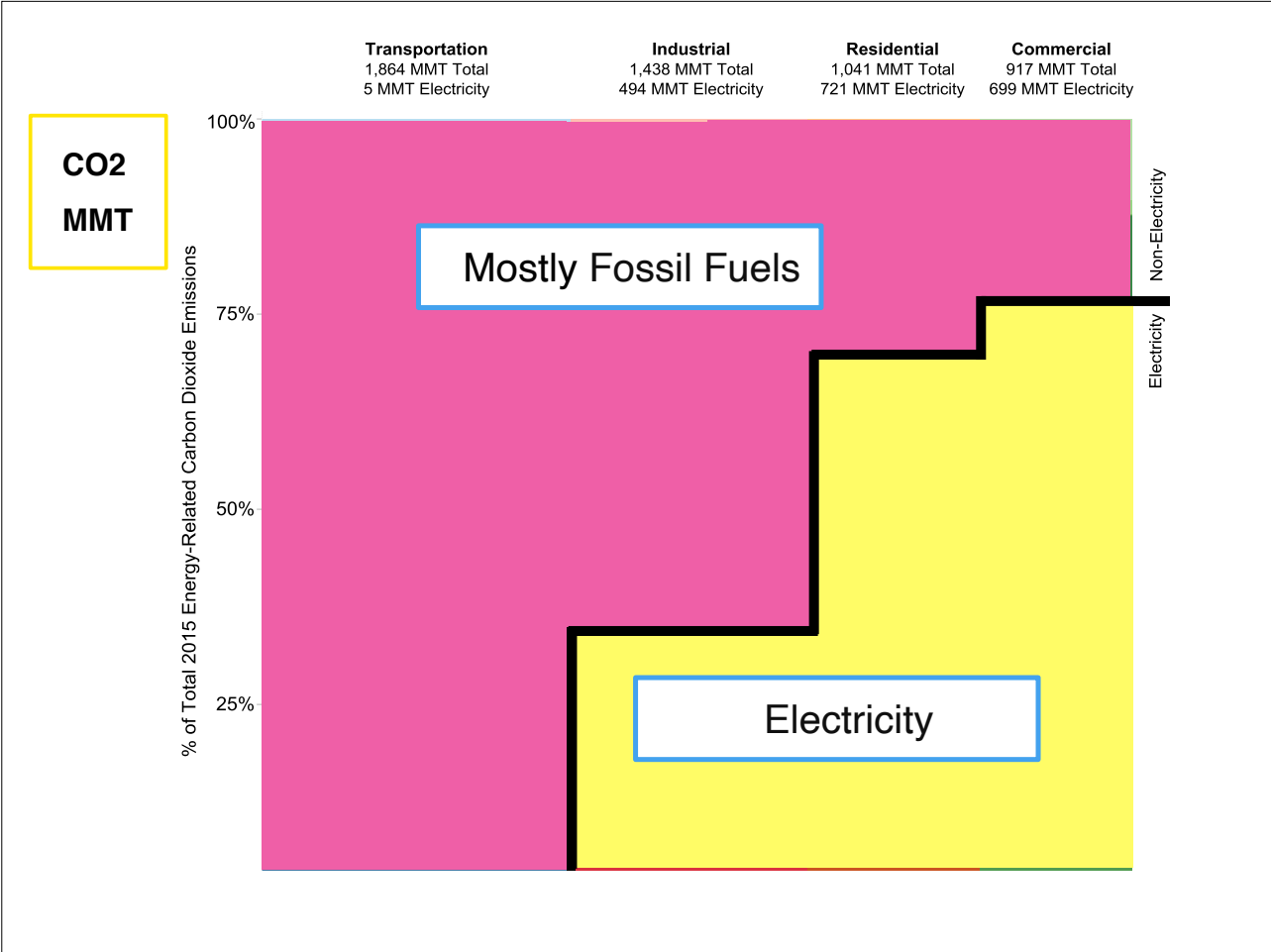
Subsector primary energy consumption and energy-related carbon dioxide emissions 2015

Actionable.  
Interesting data.  
Hard for most to understand.



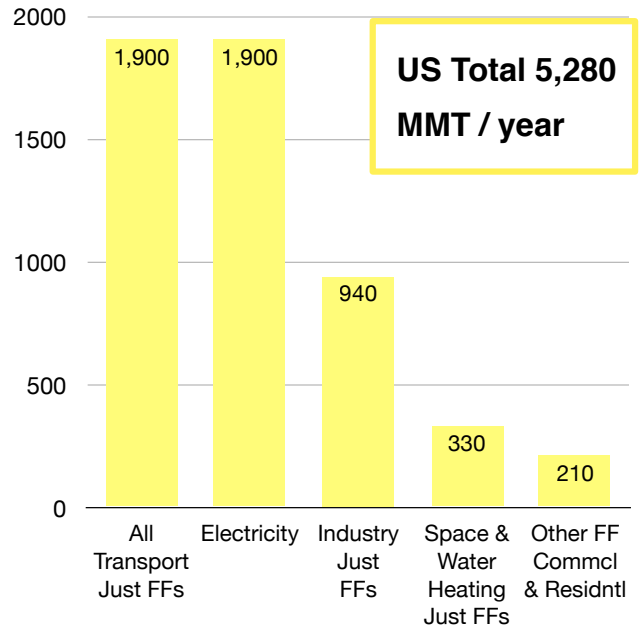
CO2  
MMT





2015

US - GHGs  
Million MT CO<sub>2</sub>e



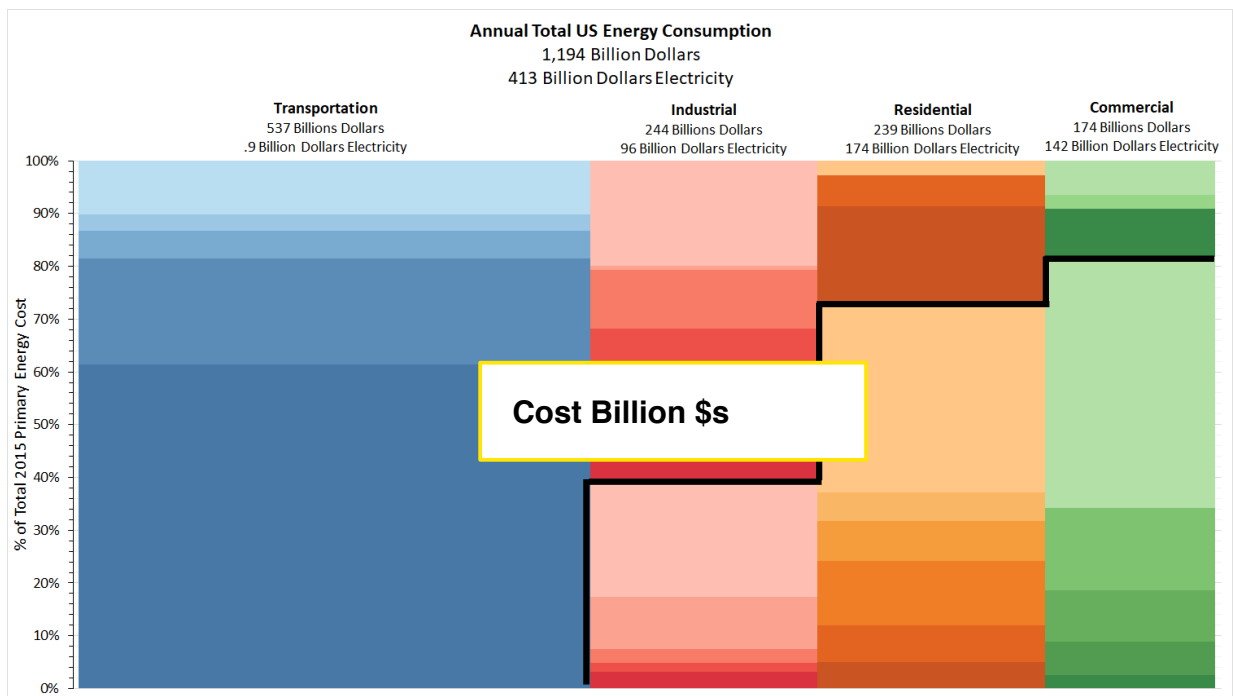
Images: [EnergyShouldBe.org](http://EnergyShouldBe.org)

Data analysis [EnergyShouldBe.org](http://EnergyShouldBe.org)  
based on EIA 2015 US data. Space  
heating includes water heating.



25

\$ draft



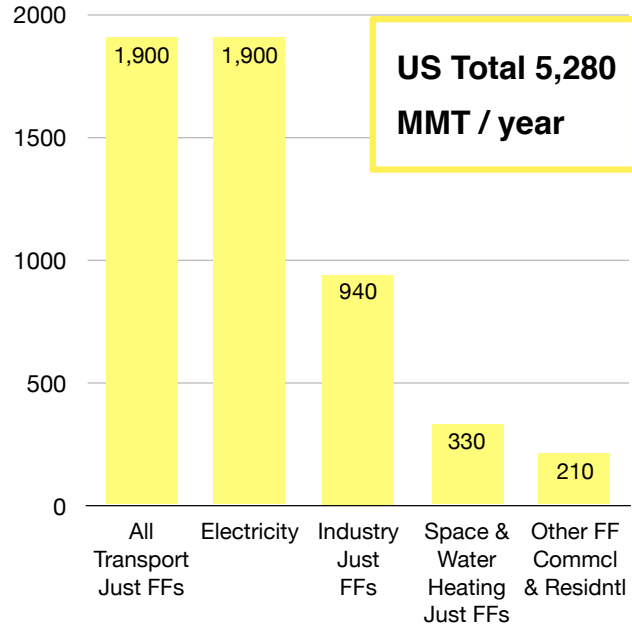
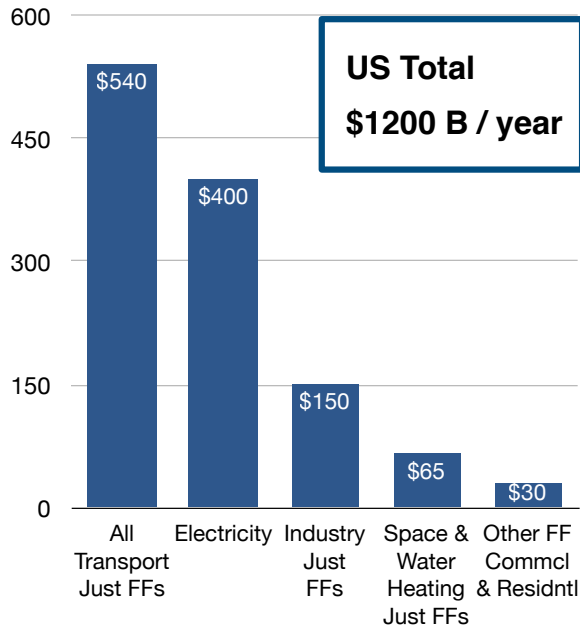
Draft from [EnergyShouldBe.org](http://EnergyShouldBe.org) based on 2015 EIA data



## US Energy Cost Billion \$ Per Year

2015

## US - GHGs Million MT CO<sub>2</sub>e



Images: [EnergyShouldBe.org](http://EnergyShouldBe.org)

Data analysis [EnergyShouldBe.org](http://EnergyShouldBe.org)  
based on EIA 2015 US data. Space heating includes water heating.

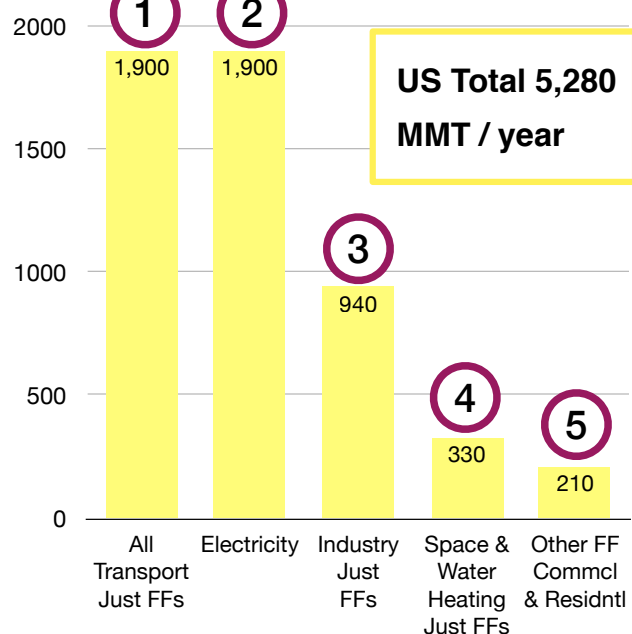
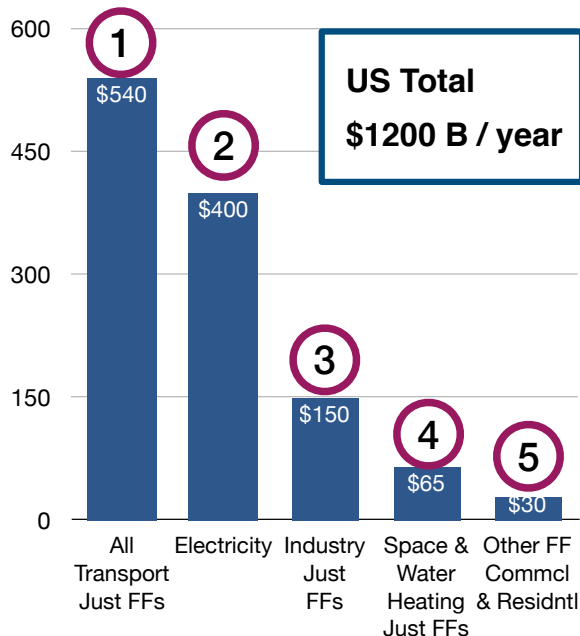


27

## US Energy Cost Billion \$ Per Year

2015

## US - GHGs Million MT CO<sub>2</sub>e



Images: [EnergyShouldBe.org](http://EnergyShouldBe.org)

Data analysis [EnergyShouldBe.org](http://EnergyShouldBe.org)  
based on EIA 2015 US data. Space heating includes water heating.

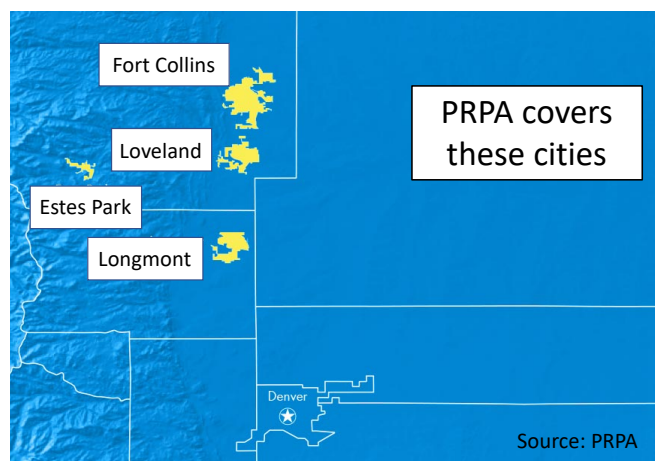


28

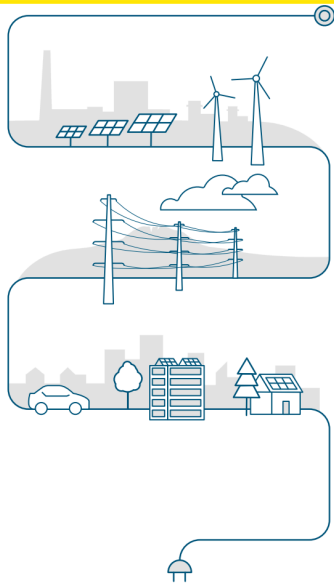
## Actions

### 2. 90% Renewable Electricity

Platte River Power Authority (PRPA) is a leader in transitioning to renewable electricity



**PRPA - Lowest cost and highest reliability in Colorado.**

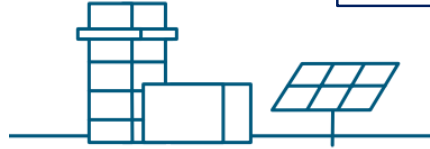


**2020 Integrated Resource Plan**

**In 2014, ~ 20% renewables.  
If you told them 50% by 2020...  
In 2020, 50% renewables.**



Approved by  
PRPA Board of  
Directors



## **Portfolio 2: zero coal**

**85% Renewables,  
90% carbon  
reduction,  
by 2030!**

**Includes big  
storage.**

## **Platte River Power Authority**

**North Colorado**

**85% Renewable Electricity by 2030**

**2035Report.com UC Berkeley**

**Every US State**

**“90% clean,  
carbon-free electricity nationwide by 2035,  
dependably,  
at no extra cost to consumers,  
and without new fossil fuel plants.”**

**Xcel Energy Colorado**

**90% carbon free 2030. ERP just released 4/2021.**

**Etc.**



## **Platte River Power Authority**

North Colorado

85% Renewable Electricity by 2030

**2035Report.com** UC Berkeley

Yesterday. 2035Report.com 2nd report.

“ with the right policy, it is technically and economically feasible for all new car and truck sales to be electric by 2035, saving lives, cutting transportation costs, and creating millions of jobs.

... would prevent 150,000 premature deaths and avoid \$1.3 trillion in environmental and health costs through 2050

... would save consumers \$2.7 trillion by 2050, ...

and would support a net increase of over 2 million jobs in 2035

Etc.

## **Platte River Power Authority**

North Colorado

85% Renewable Electricity by 2030

**2035Report.com**

Every US State 90%  
Renewable Electricity by 2035

And

Every new car & truck sold  
by 2035 Electric.

**Xcel Energy Colorado**

90% carbon free 2030. ERP just released 4/2021.

Etc.

**Why?**

**Solar and wind  
electricity are now  
cheaper than operations,  
maintenance and fuel of  
many fossil fuel  
generators.**

**Why?**

## These Make the Same Amount of Electricity per year

Competition and  
Mass Production  
always means  
costs go down!

1



425



13,000,000



Number of wind turbine and solar panel calculations by [EnergyShouldBe.org](http://EnergyShouldBe.org) from common data sources for Colorado.

## These Make the Same Amount of Electricity per year

Competition and  
Mass Production  
always means  
costs go down!

1



**Billions**  
of batteries for  
Electric Vehicles



425



13,000,000



In 2015 in California,  
new battery storage  
beat gas generation for  
peaking needs.

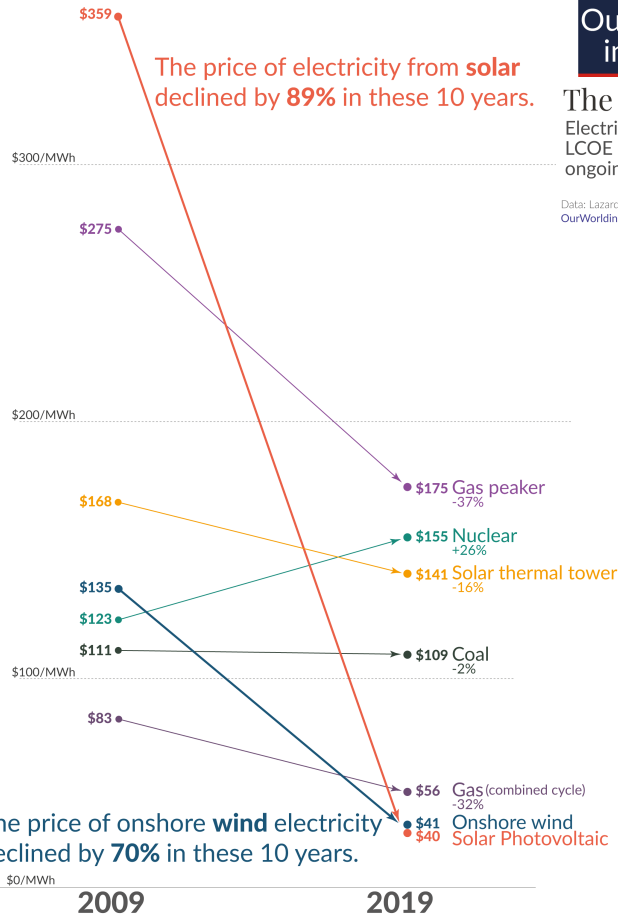
Number of wind turbine and solar panel calculations by [EnergyShouldBe.org](http://EnergyShouldBe.org) from common data sources for Colorado.

The price of electricity from solar declined by **89%** in these 10 years.

The price of electricity from new power plants  
Electricity prices are expressed in 'levelized costs of energy' (LCOE). LCOE captures the cost of building the power plant itself as well as the ongoing costs for fuel and operating the power plant over its lifetime.

Data: Lazard Levelized Cost of Energy Analysis, Version 13.0  
OurWorldinData.org - Research and data to make progress against the world's largest problems.

Licensed under CC-BY  
by the author Max Roser.



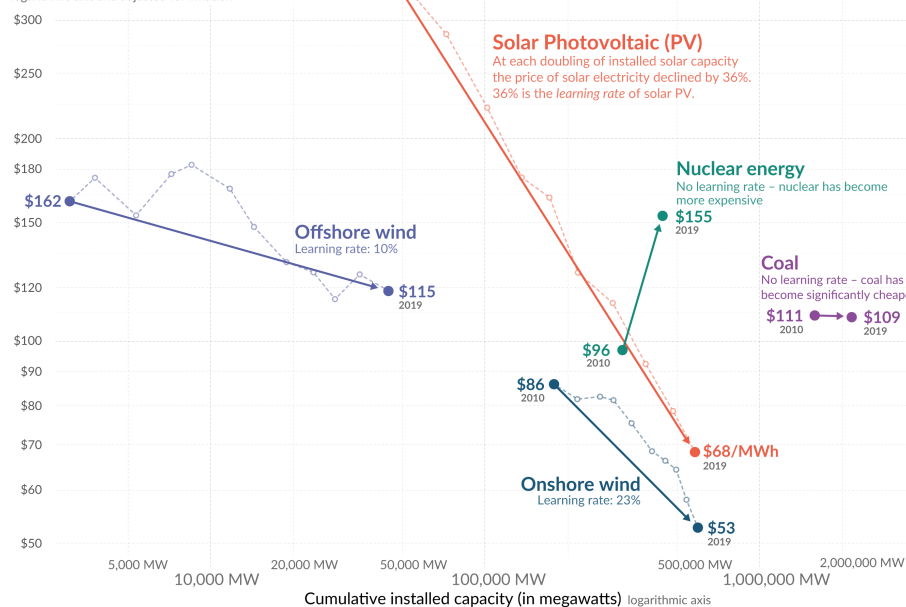
Henry Hub Natural Gas Spot Price (Dollars per Million Btu)					
Decade	Year-5	Year-6	Year-7	Year-8	Year-9
1990's			2.49	2.09	2.37
2000's	8.69	6.73	6.97	8.86	3.94
2010's	2.62	2.52	2.99	3.15	2.56

<https://ourworldindata.org/cheap-renewables-growth>  
<https://www.eia.gov/dnav/ng/hist/rngwhhdA.htm>

## Electricity from renewables became cheaper as we increased capacity – electricity from nuclear and coal did not

Unsubsidized

Price per megawatt hour of electricity  
This is the global weighted-average of the levelized costs of energy (LCOE), without subsidies  
logarithmic axis and adjusted for inflation



Source: IRENA 2020 for all data on renewable sources; Lazard for the price of electricity from nuclear and coal – IAEA for nuclear capacity and Global Energy Monitor for coal capacity. Gas is not shown because the price between gas peaker and combined cycles differs significantly, and global data on the capacity of each of these sources is not available. The price of electricity from gas has fallen over this decade, but over the longer run it is not following a learning curve.

OurWorldinData.org - Research and data to make progress against the world's largest problems.

Licensed under CC-BY  
by the author Max Roser

<https://ourworldindata.org/cheap-renewables-growth>

Gas Peaker & Combined Cycle: Lazard 2020 <https://www.lazard.com/media/451419/lazards-levelized-cost-of-energy-version-140.pdf>

The world's best solar power schemes now offer the  
“cheapest...electricity in history”

...cheaper than coal and gas in most major countries.  
... International Energy Agency...

<https://www.carbonbrief.org/solar-is-now-cheapest-electricity-in-history-confirms-iea>

90% Renewable Electricity = rapid transition.

Need to Scale to Everyone.

Get close to 100%.

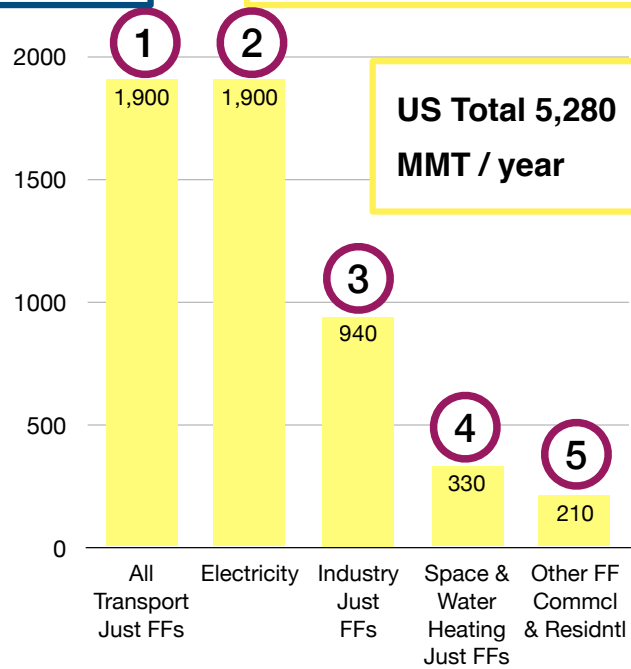
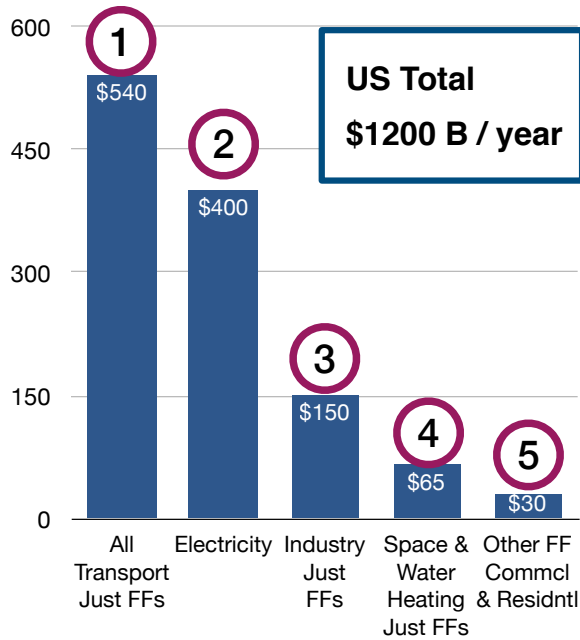
Surplus - Cost Issue

Dark Calms - Reliability and Cost

## US Energy Cost Billion \$ Per Year

2015

## US - GHGs Million MT CO<sub>2</sub>e



Images: [EnergyShouldBe.org](http://EnergyShouldBe.org)

Data analysis [EnergyShouldBe.org](http://EnergyShouldBe.org)  
based on EIA 2015 US data. Space  
heating includes water heating.

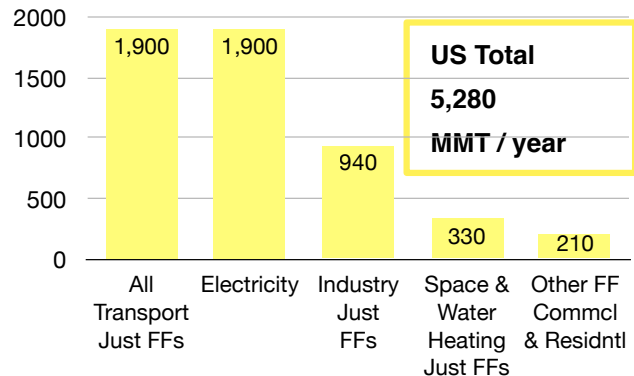
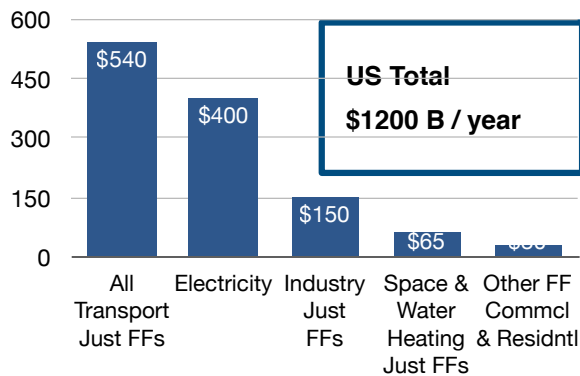


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## US Energy Cost Billion \$ Per Year

2015

## US Energy GHGs Million MT CO<sub>2</sub>e



Images: [EnergyShouldBe.org](http://EnergyShouldBe.org) Data analysis [EnergyShouldBe.org](http://EnergyShouldBe.org) based on EIA 2015 US data.



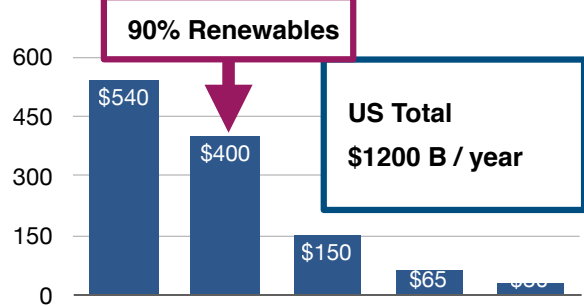
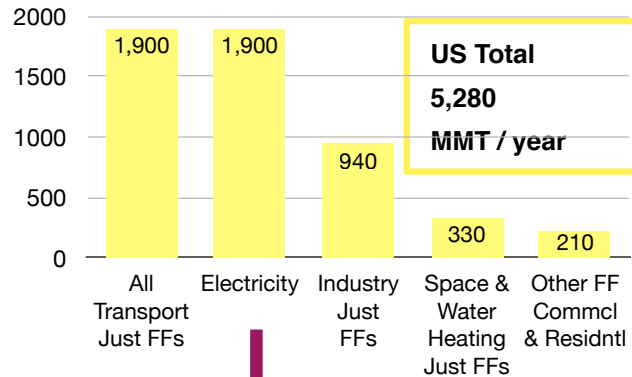
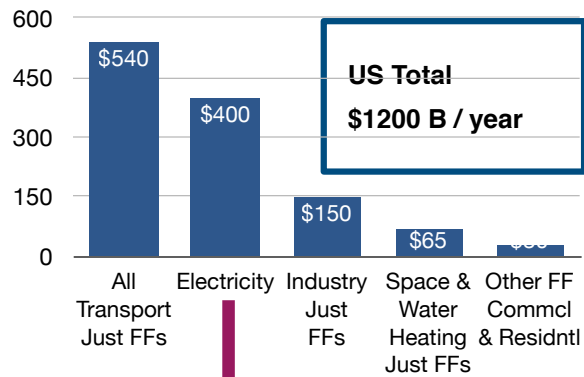
42



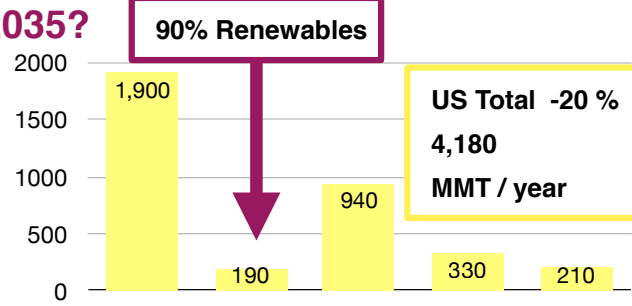
## US Energy Cost Billion \$ Per Year

2015

## US Energy GHGs Million MT CO<sub>2</sub>e



2035?



Images: EnergyShouldBe.org. Data analysis EnergyShouldBe.org based on EIA 2015 US data.



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## Actions

### 2. 90% Renewable Electricity



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### Light Duty Transportation

#### Fuel Cost

gasoline \$3 / gallon / 30 MPG = \$0.10 / mile  
electricity \$0.12 / kWh / 3.5 miles / kWh = \$0.034 / mile

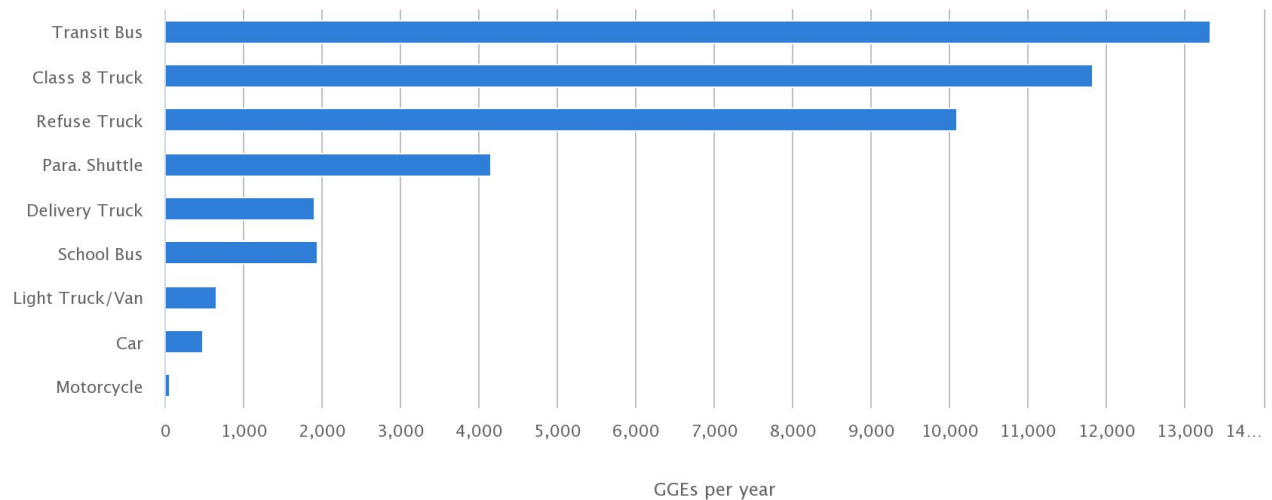
**For a Rapid Transition of Transportation, how would you rank these?**

**Fuel Used.**

**Miles Driven for each vehicle class.**

**# of vehicles converted.**

Average Annual Fuel Use by Vehicle Type



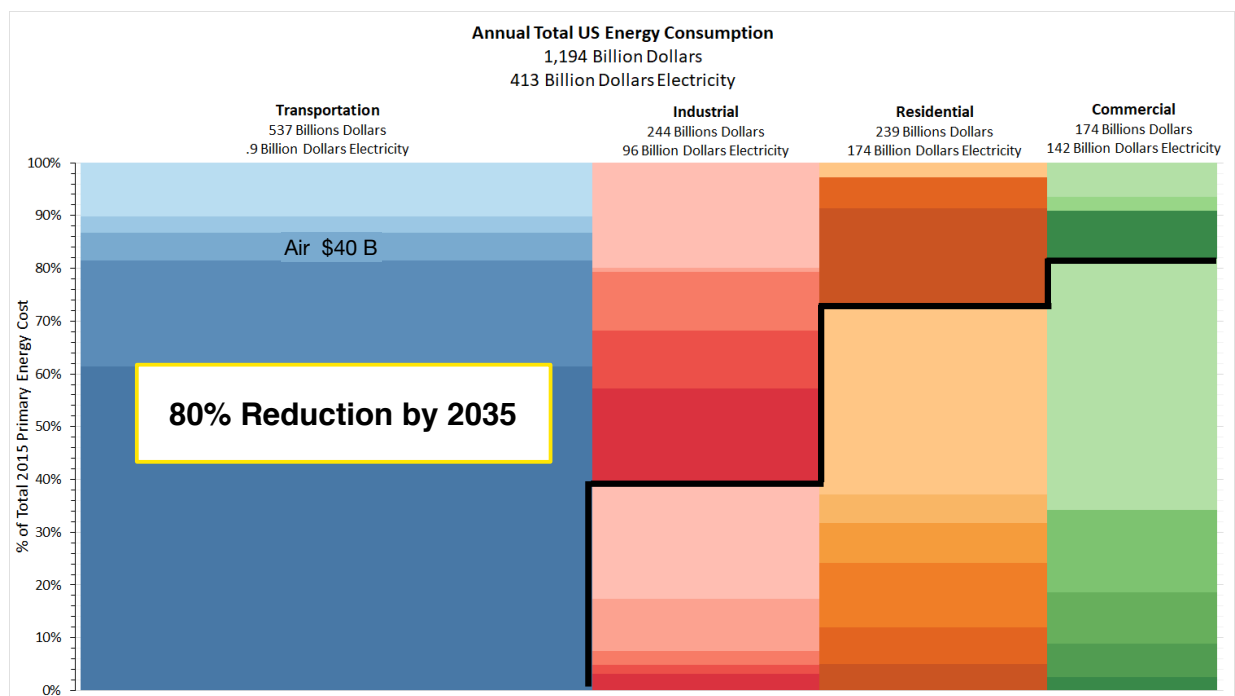
Last updated: February 2020  
Printed on: April 12

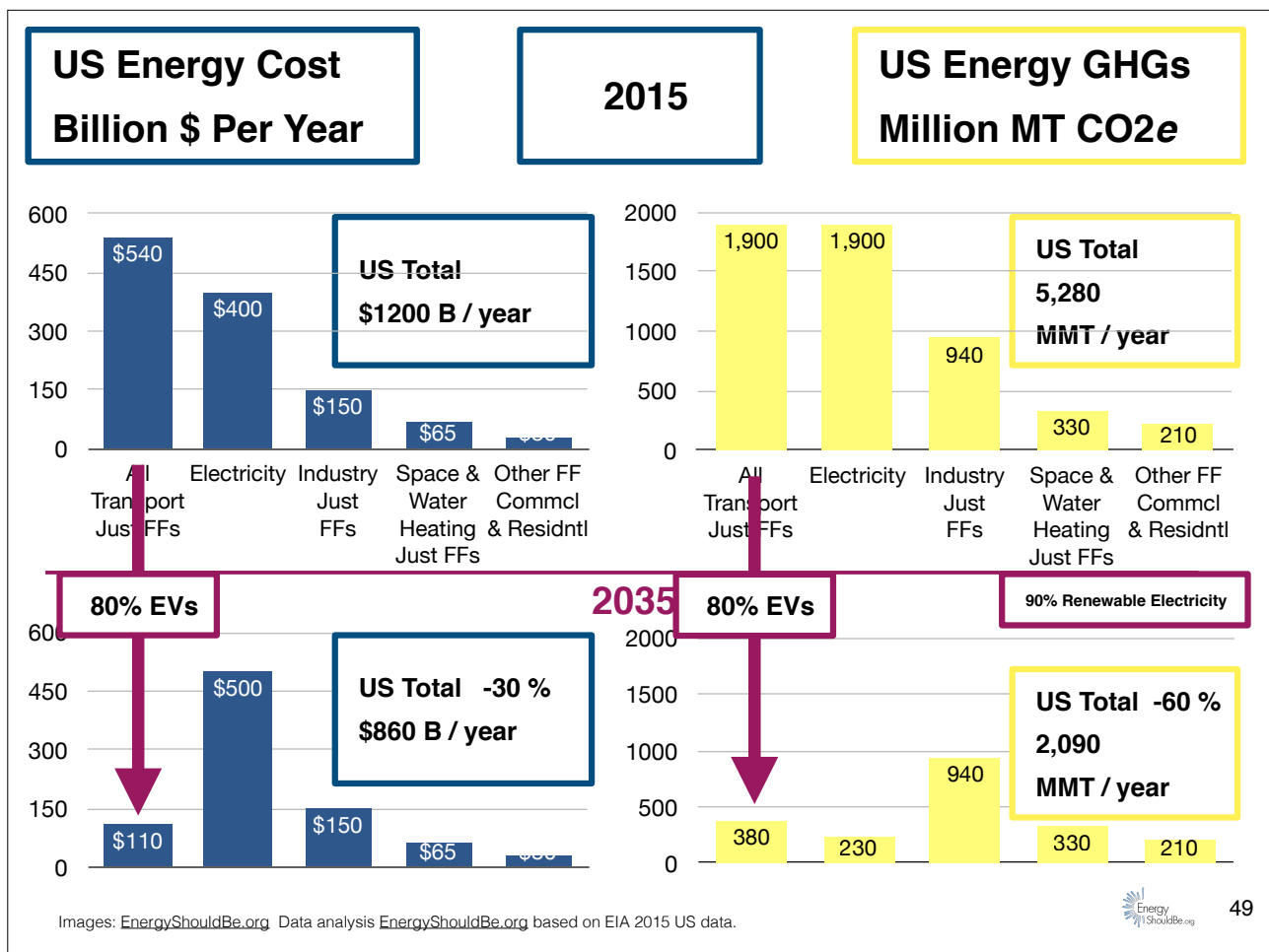
GGE Gasoline Gallon Equivalents <https://afdc.energy.gov/data/10308>

## Actions

1. Electrify 80% of transportation.  
Start with light duty, high mileage,  
and high energy use vehicles.
2. 90% Renewable Electricity

\$ draft





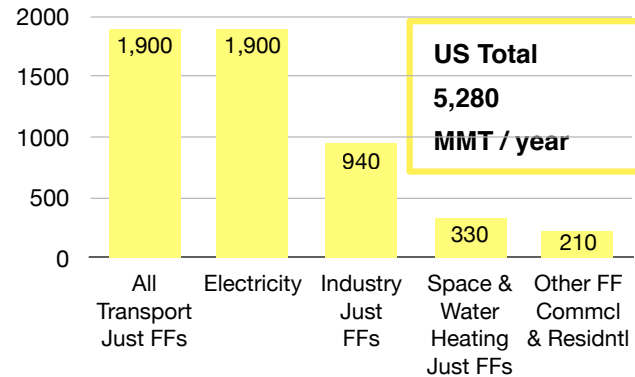
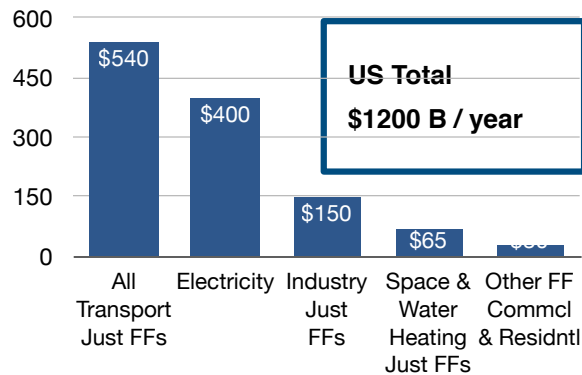
### Actions Now for 2035

1. **Electrify 80% of transportation.**  
Start with light duty, high mileage, and high energy use vehicles.
2. **90% Renewable Electricity**
3. **50% electrification of FF industry.**  
Hydrogen generated onsite?
4. **50% electrification of FF heating.**  
Heat pumps.

## US Energy Cost Billion \$ Per Year

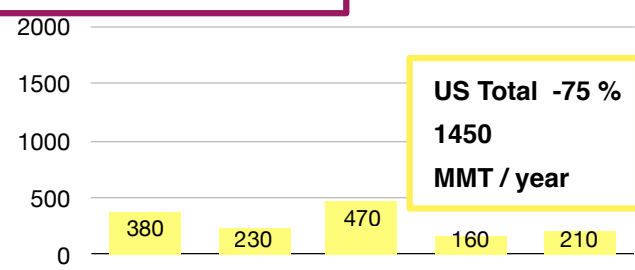
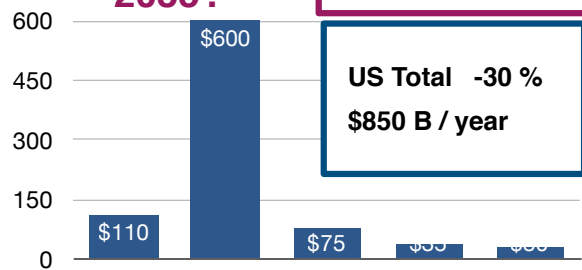
2015

## US Energy GHGs Million MT CO<sub>2</sub>e



2035?

90% Renewable Electricity. 80% EVs. Electrify 50% of industry and Heating.



Images: EnergyShouldBe.org. Data analysis EnergyShouldBe.org based on EIA 2015 US data.



51

## Actions Now for 2035

1. Electrify 80% of transportation.  
Start with light duty, high mileage, and high energy use vehicles.
2. 90% Renewable Electricity
3. 50% electrification of industry.  
Hydrogen generated onsite?
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Heat pumps.

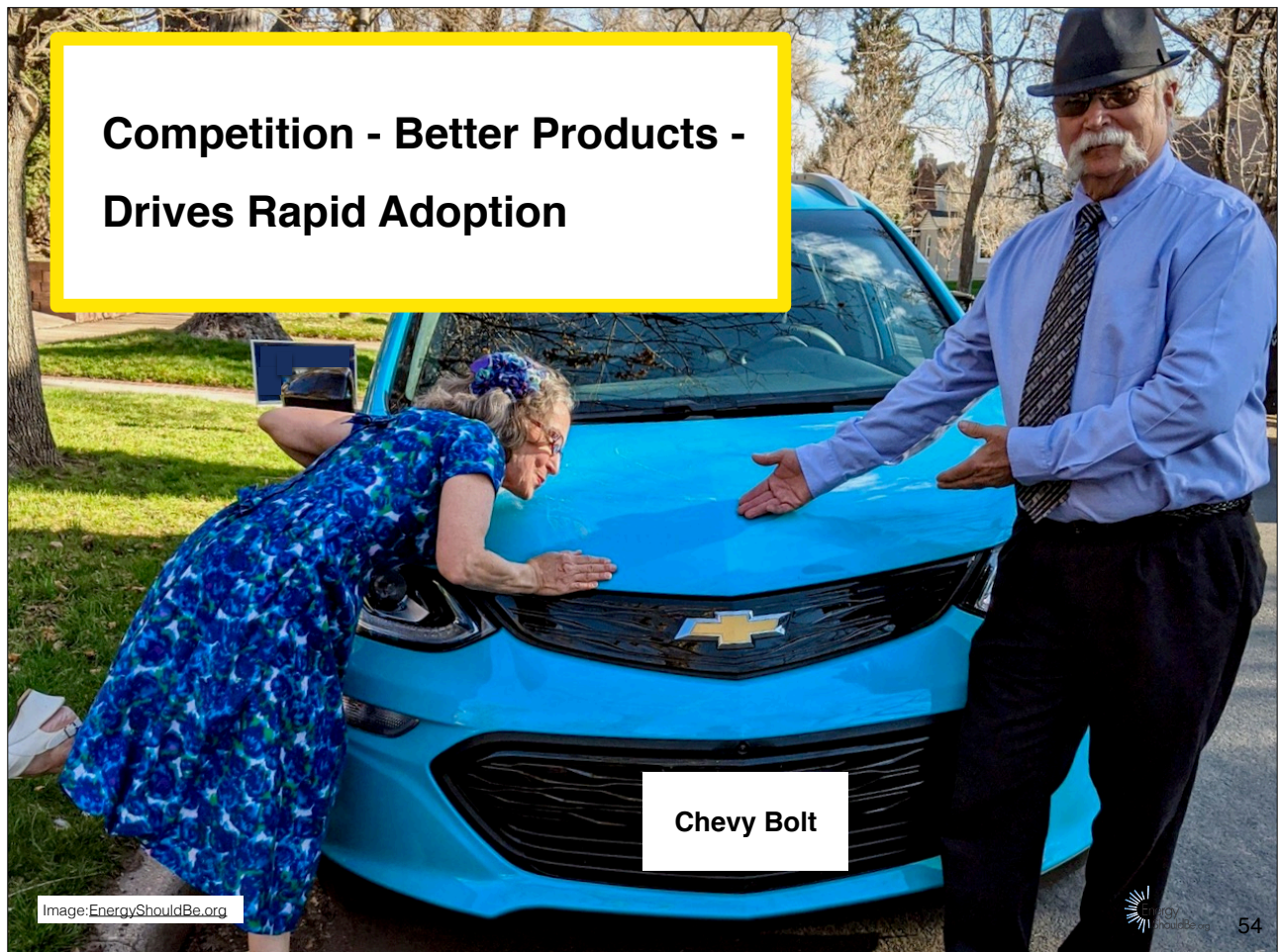
How much heat must a heat pump pump if a heat pump must pump cold.



52

**Air vs. Ground Source Heat Pump  
Impact on the Grid  
in Cold Climates**

**How much heat must a heat pump  
pump if a heat pump must pump  
cold.**





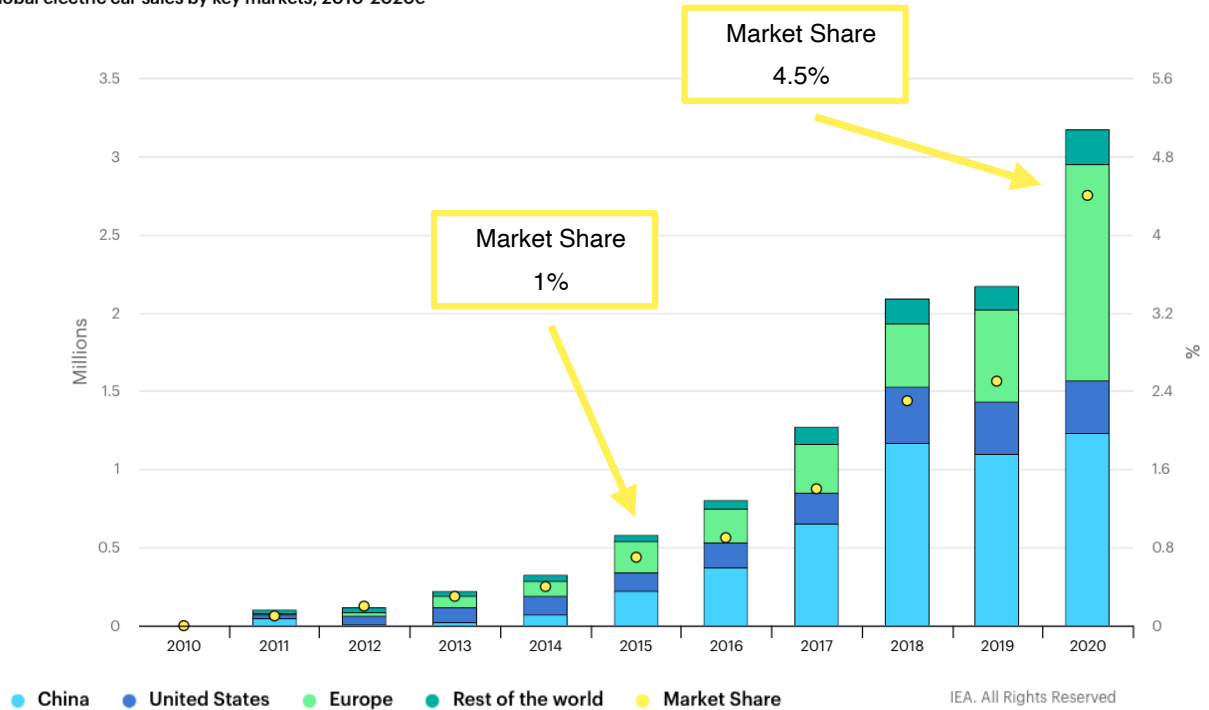
The dribble of EV and plug-in launches has turned into an avalanche of news about accelerated EV timelines and emissions-reduction goals.

- Car & Driver 2/20/21

<https://www.caranddriver.com/news/g35562831/ev-plans-automakers-timeline/>

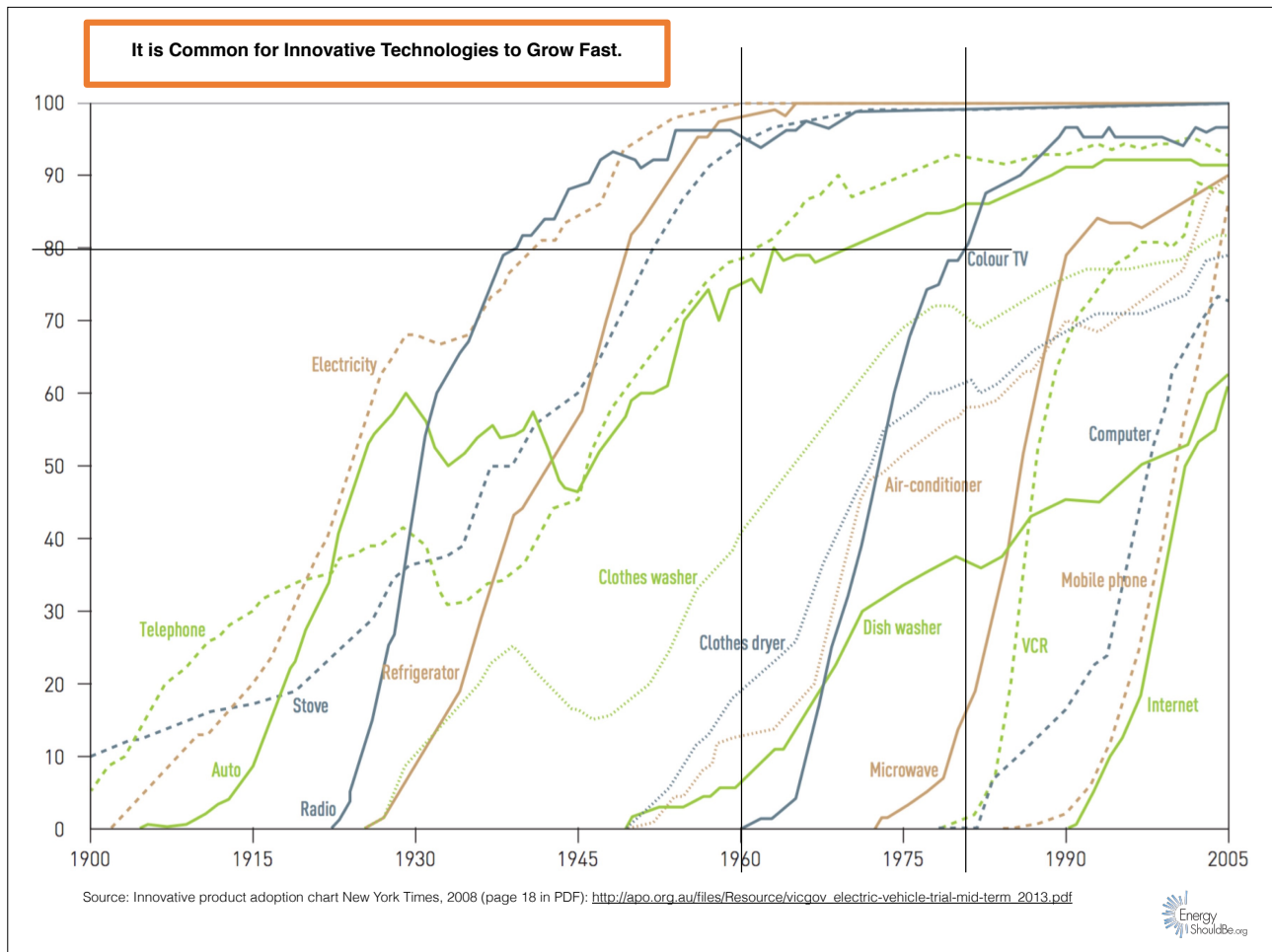


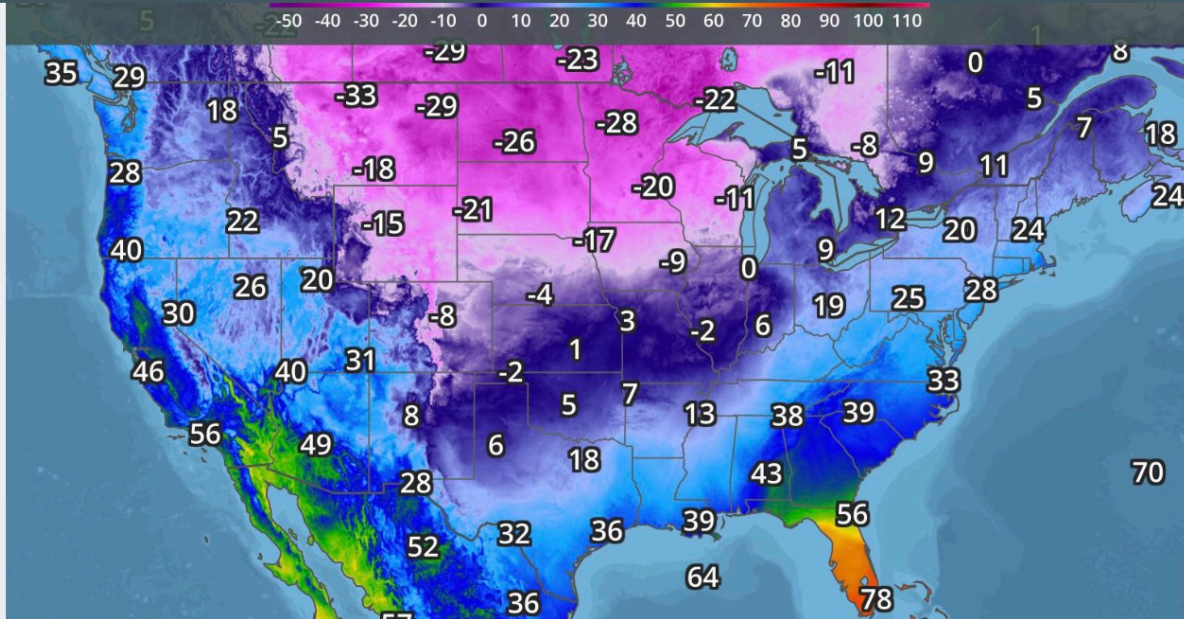
Global electric car sales by key markets, 2010-2020e



Source: IEA, Global electric car sales by key markets, 2010-2020e, IEA, Paris <https://www.iea.org/data-and-statistics/charts/global-electric-car-sales-by-key-markets-2010-2020e>







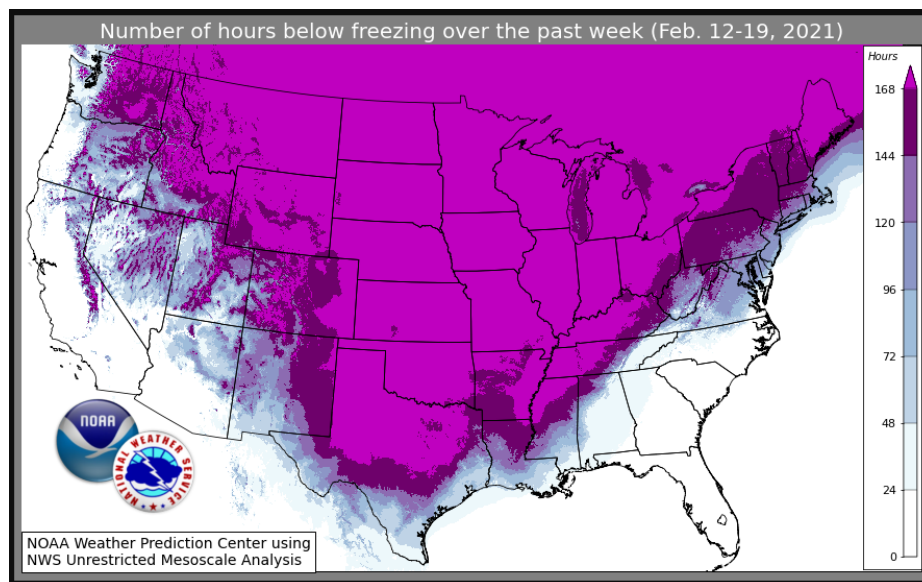
2/14/21 about 7 AM

Entire Front Range Impacted - 5 Million of Colorado's 5.5 Million people

"We couldn't help Texas..." - Jason Frisbie. PRPA General Manager & CEO, at 2/25/21 Board Meeting



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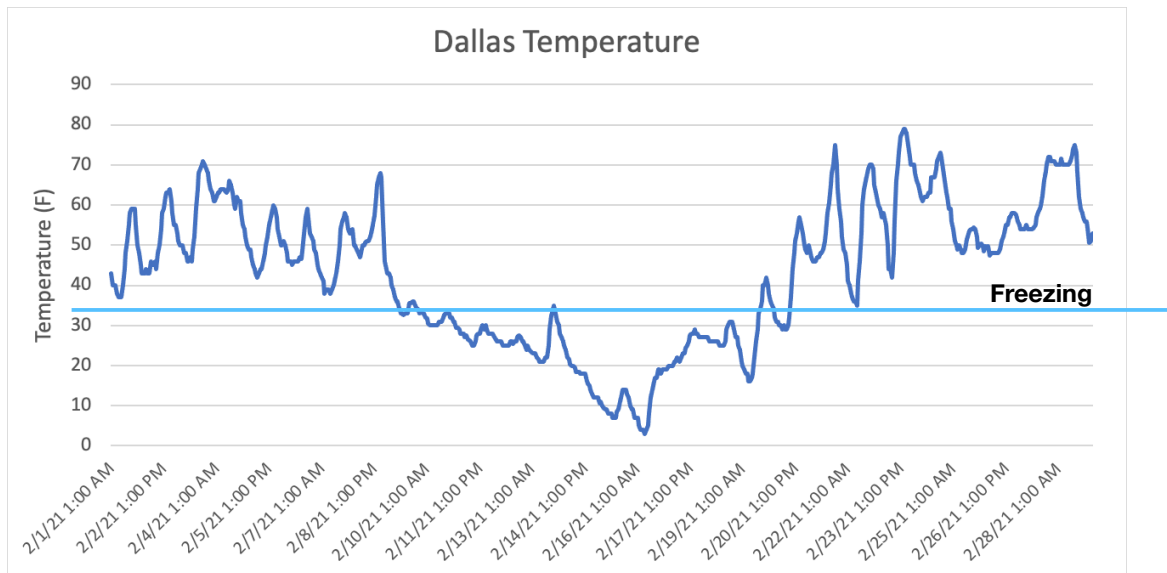
... cold snap was historic... it wasn't completely unprecedented. 1899, surpassed it in severity.  
... this winter weather event ... is expected to be on the list of most expensive U.S. natural disasters of 2021...

The Washington Post 2/24/21



60





EnergyShouldBe.org



61

**111 people died mostly of hypothermia**

**About 60% of Texas homes heat with electricity.**

**Roughly 1/4 of Texas generation was offline for annual maintenance.**

**3/16/21**

Griddy is the third Texas energy provider to file for bankruptcy since the storm. Brazos Electric Power Cooperative, ... filed for Chapter 11 after accumulating \$2.1 billion in bills.

Just Energy Group also filed for bankruptcy

Lisa Khoury, said Griddy charged her \$9,546 between February 1 and 19. That amount is 40 times more than her typical bill

CBS

**3/17/21**

Houston-based Brilliant Energy LLC filed for bankruptcy

The Dallas Morning News

Gas wells froze.  
Pipelines froze.  
Cooling systems for power plants, compressors, etc froze.  
Some wind and solar iced up, though not all that much wind & solar in winter in Texas.

March futures for natural gas are selling for \$3 per million BTUs in Oklahoma, he said, but the spot price hit \$600 over the weekend.

The Washington Post

<https://www.cbsnews.com/news/griddy-energy-texas-files-bankruptcy/>  
<https://www.dallasnews.com/business/energy/2021/03/17/another-texas-electricity-seller-files-for-bankruptcy-in-wake-of-winter-freeze/>  
<https://www.washingtonpost.com/business/2021/02/16/ercot-texas-electric-grid-failure/>



62

111 people died mostly of hypothermia

About 60% of Texas homes heat with electricity.

Roughly 1/4 of Texas generation was offline for annual maintenance.

**Massive market and mechanical failure of both the gas and electric grids. - many people**

**Texas' competitive gas & electric markets worked. - some people**

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<https://www.washingtonpost.com/business/2021/02/16/ercot-texas-electric-grid-failure/>



63

111 people died mostly of hypothermia

About 60% of Texas homes heat with electricity.

Roughly 1/4 of Texas generation was offline for annual maintenance.

**Were the markets manipulated?**

Lisa Khoury, said Griddy charged her \$9,546 between February 1 and 19. That amount is 40 times more than her typical bill  
CBS

3/17/21

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<https://www.washingtonpost.com/business/2021/02/16/ercot-texas-electric-grid-failure/>



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## 2011 vs. 2021 Event Comparison

	2011	2021
Maximum generation capacity forced out at any given time (MW)	14,702	52,277
Generation forced out one hour before start of EEA3 (MW)	1,182	2,489
Cumulative generation capacity forced out throughout the event (MW)	29,729	46,249*
Cumulative number of generators outaged throughout the event	193	356
Cumulative gas generation de-rated due to supply issues	1,282	9,323
Lowest frequency	59.58	59.30
Maximum load shed requested (MW)	4,000	20,000
Duration load shed request (hours)	7.5	70.5
Estimated peak load (without load shed)	59,000	76,819

\*Note: "Cumulative" values for 2021 were calculated using NERC 2011 report methodology. Cumulative amount for 2021 starts at 00:01 on February 14, 2021

UBLIC

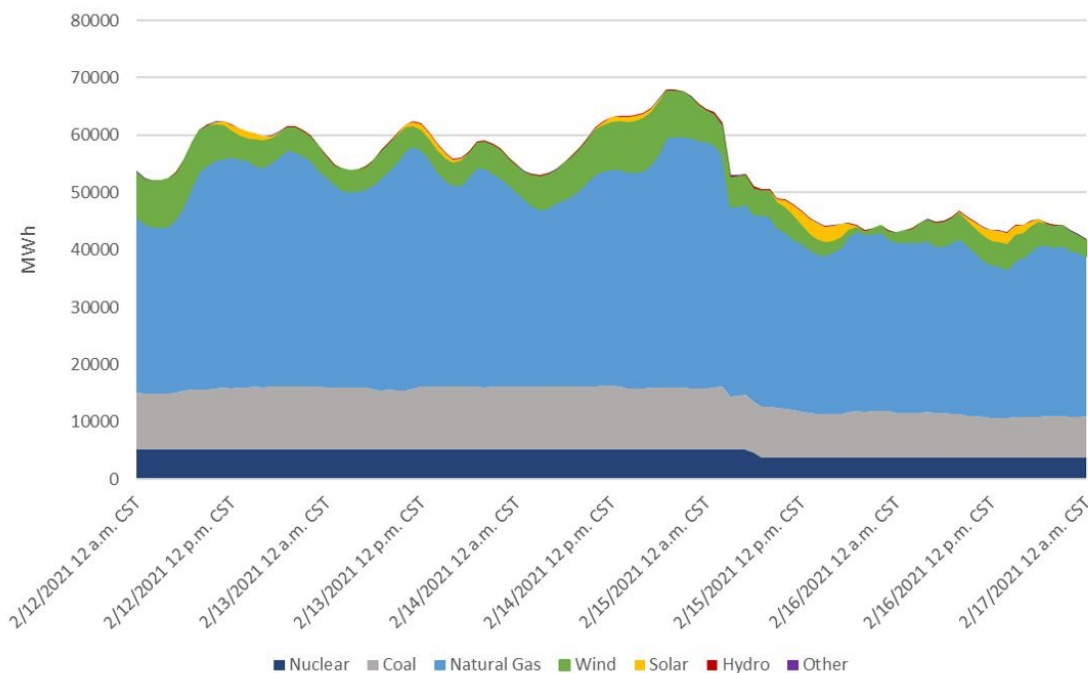


**Electric Reliability Council of Texas**



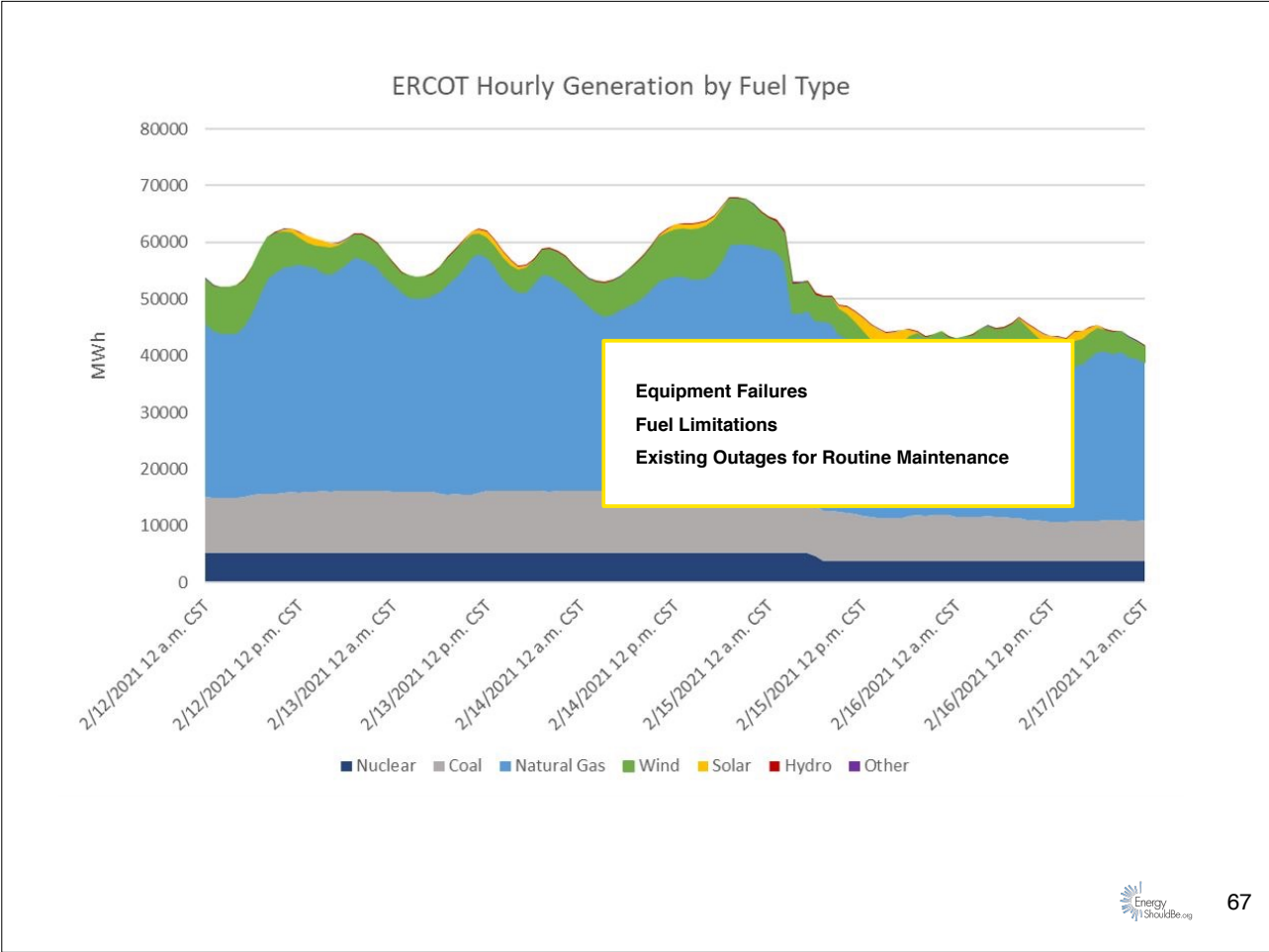
65

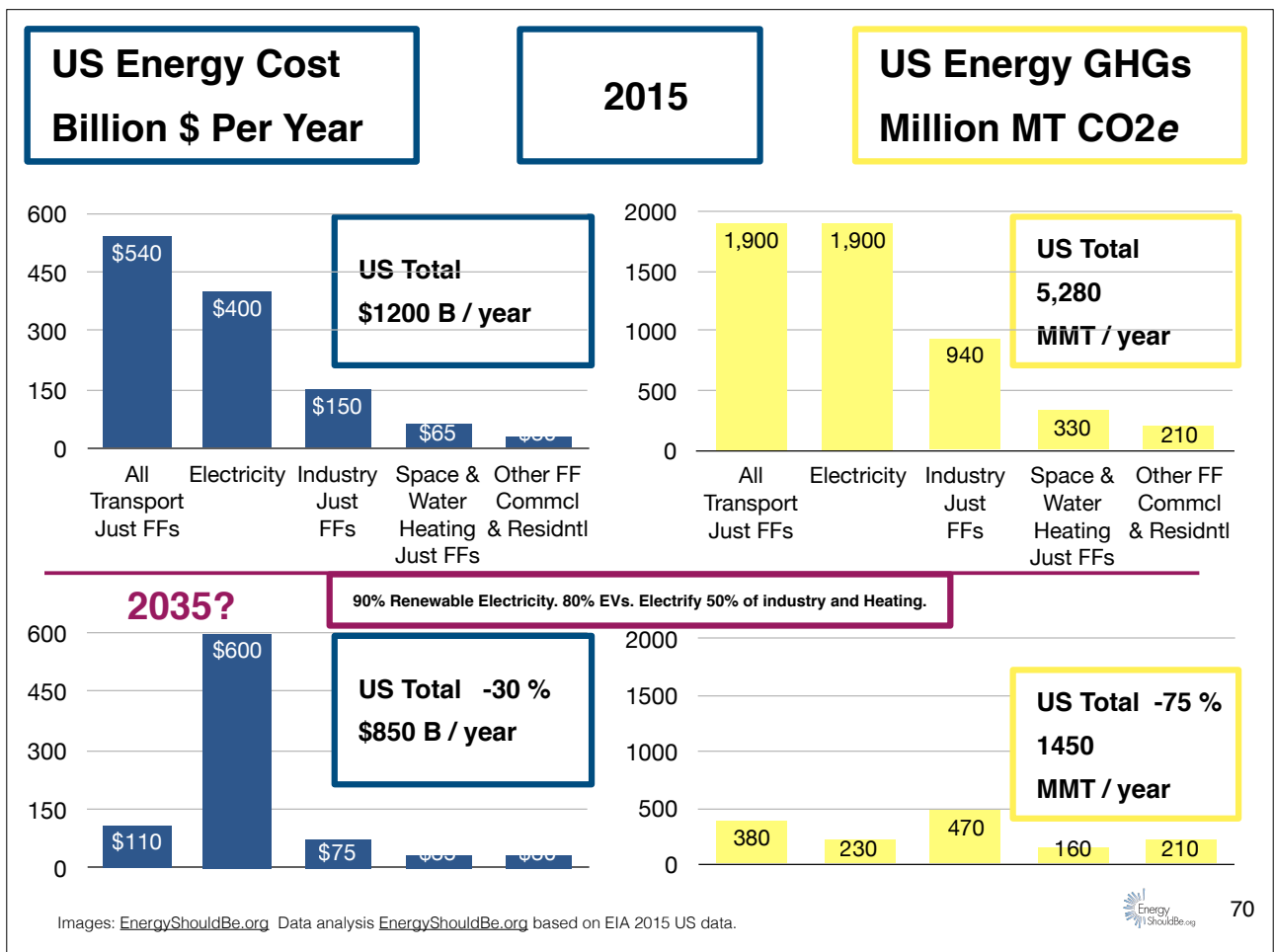
ERCOT Hourly Generation by Fuel Type

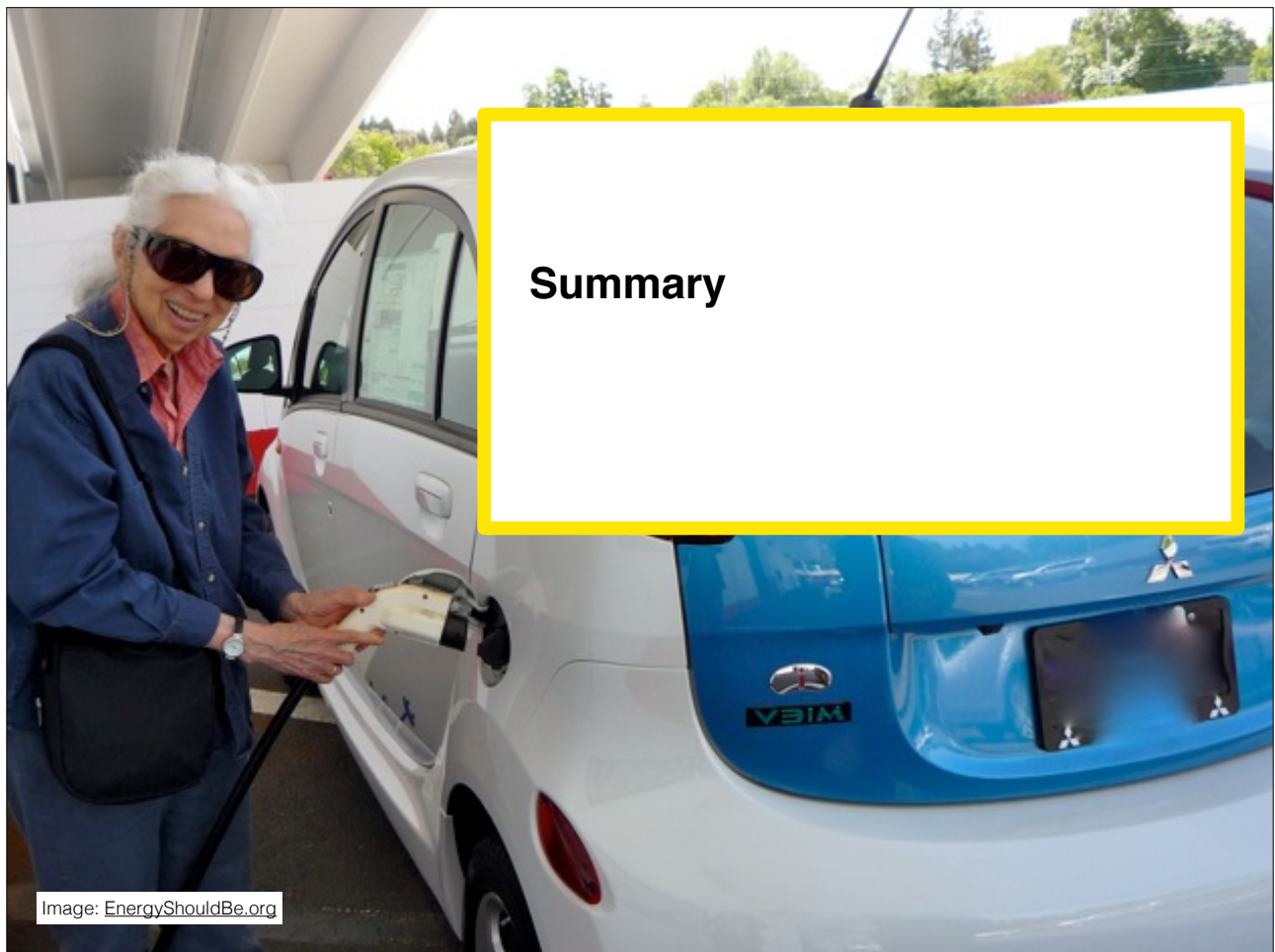


66







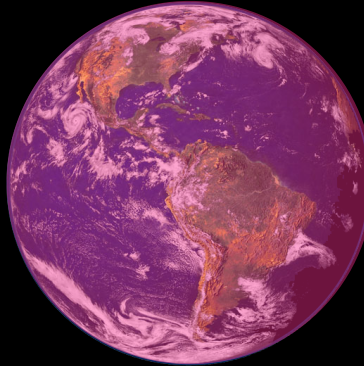




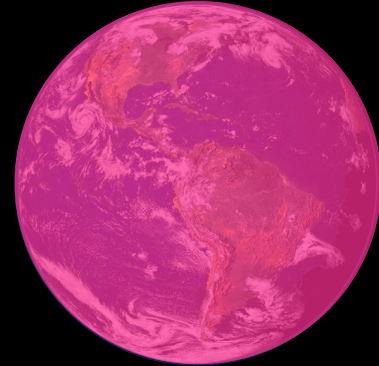
**Past  
Goldilocks Zone  
(just right)**



**Rapid Transition  
Goldilocks Zone?  
(nearly too hot)**



**Keep Burning stuff.  
Too hot!**



Ghost of Climate Past,  
the Ghost of Climate Baked In,  
and the Ghost of Climate Yet to Come.  
*With apologies to Charles Dickens' A Christmas Carol.*

Image: Blue Marble NASA

**Not actionable.  
No data.**

**Climate Change is not going  
to be even planetary  
heating.**

**Increased catastrophic:**

- ◆ Drought
- ◆ Heat Waves
- ◆ Fires
- ◆ Floods
- ◆ Cold Snaps
- ◆ Hurricanes

...



Image: Blue Marble NASA

## What drives people to action?

Fear      Climate Change

\$s      Cost

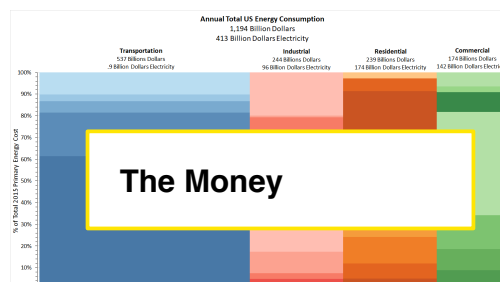
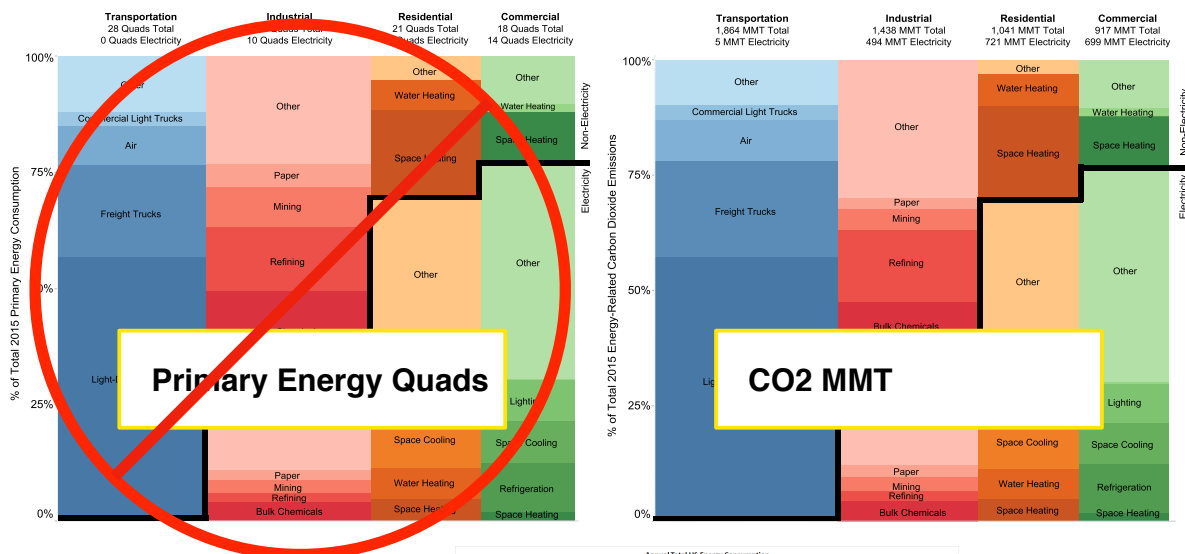
Fun      Competition

Hope

Stories      True and Useful

Quad BTUs of Energy?

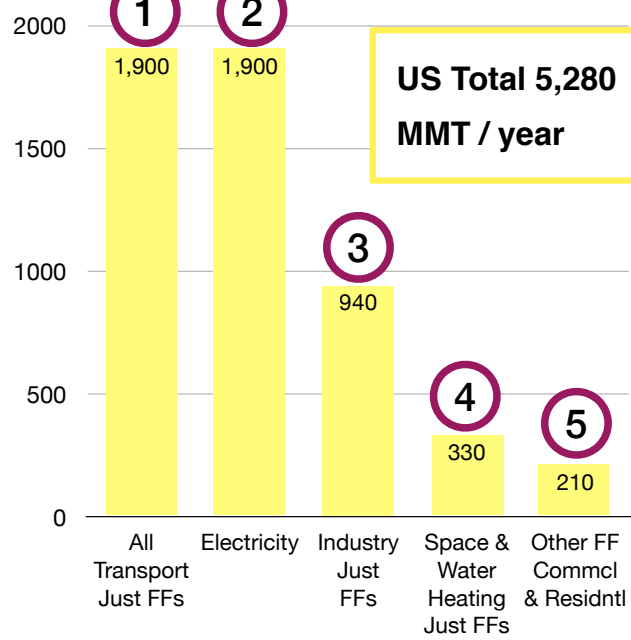
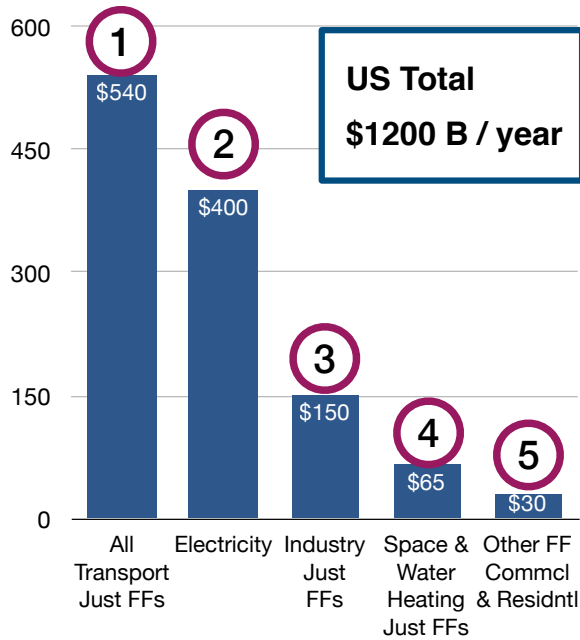
## Subsector primary energy consumption and energy-related carbon dioxide emissions 2015



## US Energy Cost Billion \$ Per Year

2015

## US - GHGs Million MT CO<sub>2</sub>e



Images: [EnergyShouldBe.org](http://EnergyShouldBe.org)

Data analysis [EnergyShouldBe.org](http://EnergyShouldBe.org)  
based on EIA 2015 US data. Space heating includes water heating.



77

## These Make the Same Amount of Electricity per year

Competition and Mass Production always means costs go down!

1



**Billions**  
of batteries for  
Electric Vehicles

425



13,000,000



In 2015 in California, new battery storage beat gas generation for peaking needs.

Number of wind turbine and solar panel calculations by [EnergyShouldBe.org](http://EnergyShouldBe.org) from common data sources for Colorado.



## Platte River Power Authority

North Colorado

85% Renewable Electricity by 2030

### 2035Report.com

Every US State 90%  
Renewable Electricity by 2035

And

Every new car & truck sold  
by 2035 Electric.

### Xcel Energy Colorado

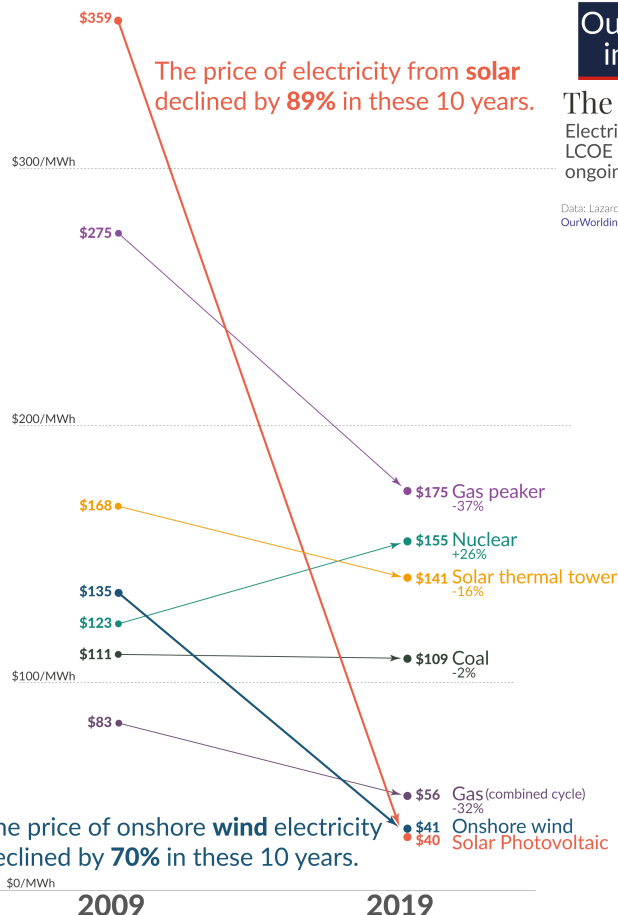
90% carbon free 2030. ERP just released 4/2021.

Etc.

### Why?

**Solar and wind  
electricity are now  
cheaper than operations,  
maintenance and fuel of  
many fossil fuel  
generators.**

### Why?



### Our World in Data

The price of electricity from new power plants

Electricity prices are expressed in 'levelized costs of energy' (LCOE). LCOE captures the cost of building the power plant itself as well as the ongoing costs for fuel and operating the power plant over its lifetime.

Data: Lazard Levelized Cost of Energy Analysis, Version 13.0

OurWorldInData.org - Research and data to make progress against the world's largest problems. by the author Max Roser.

Henry Hub Natural Gas Spot Price (Dollars per Million Btu)

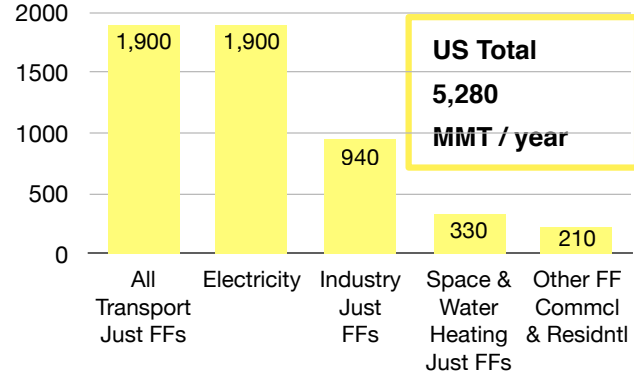
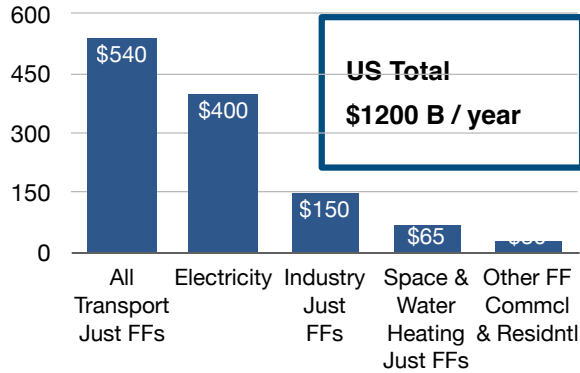
Decade	Year-5	Year-6	Year-7	Year-8	Year-9
1990's			2.49	2.09	2.37
2000's	8.69	6.73	6.97	8.86	3.94
2010's	2.62	2.52	2.99	3.15	2.56

<https://ourworldindata.org/cheap-renewables-growth>  
<https://www.eia.gov/dnav/ng/hist/ngwhhdA.htm>

## US Energy Cost Billion \$ Per Year

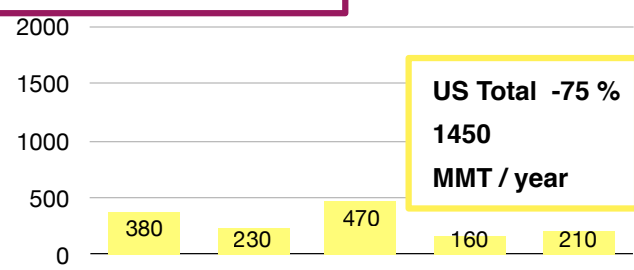
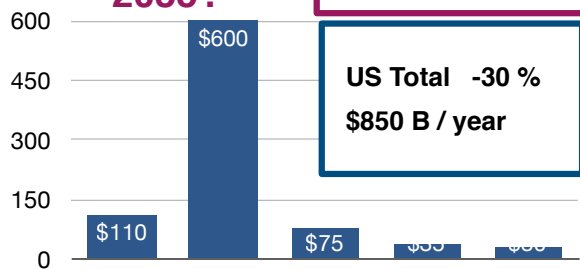
2015

## US Energy GHGs Million MT CO<sub>2</sub>e



2035?

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Images: EnergyShouldBe.org Data analysis EnergyShouldBe.org based on EIA 2015 US data.



81

## Actions Now for 2035

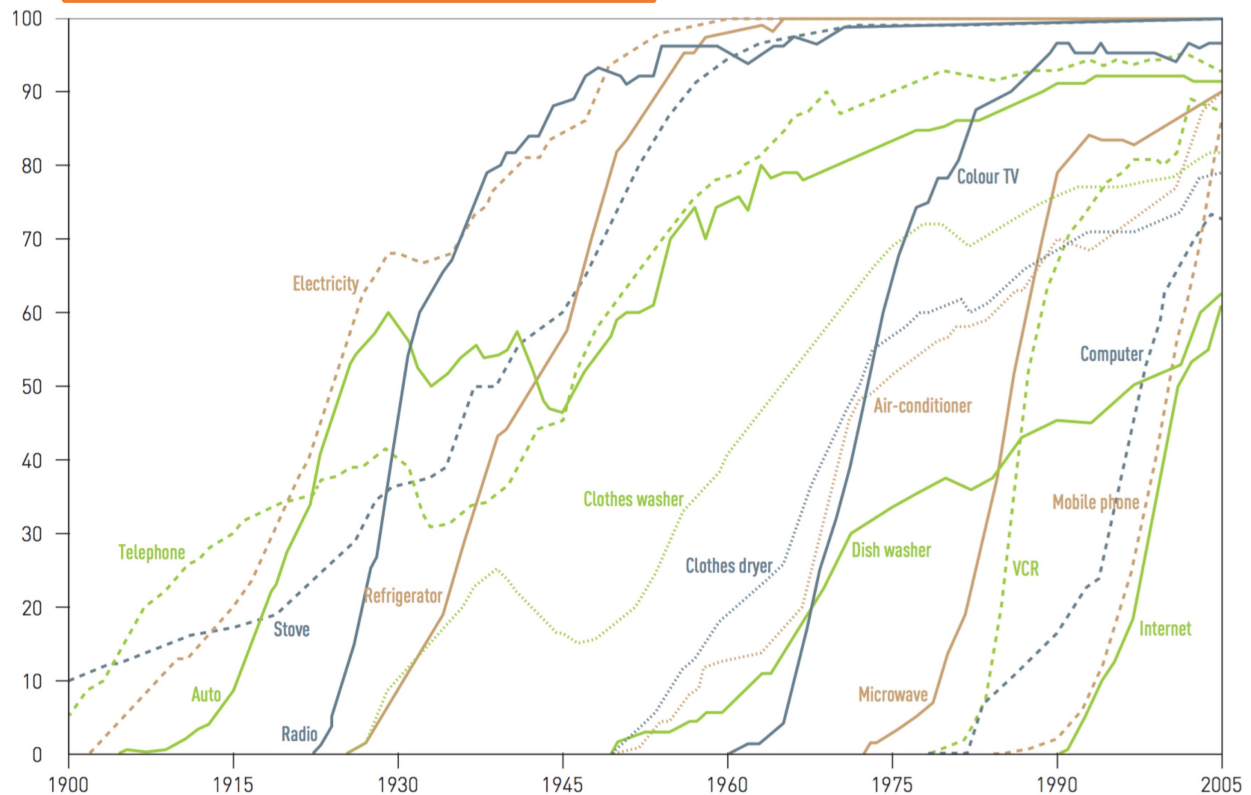
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Heat pumps.

How much heat must a heat pump pump if a heat pump must pump cold.



82

It is Common for Innovative Technologies to Grow Fast.



Source: Innovative product adoption chart New York Times, 2008 (page 18 in PDF): [http://apo.org.au/files/Resource/vicgov\\_electric-vehicle-trial-mid-term\\_2013.pdf](http://apo.org.au/files/Resource/vicgov_electric-vehicle-trial-mid-term_2013.pdf)



## Ford 2019 Electric Car Poll

“three in four say they’d prefer to date an electric vehicle owner. “

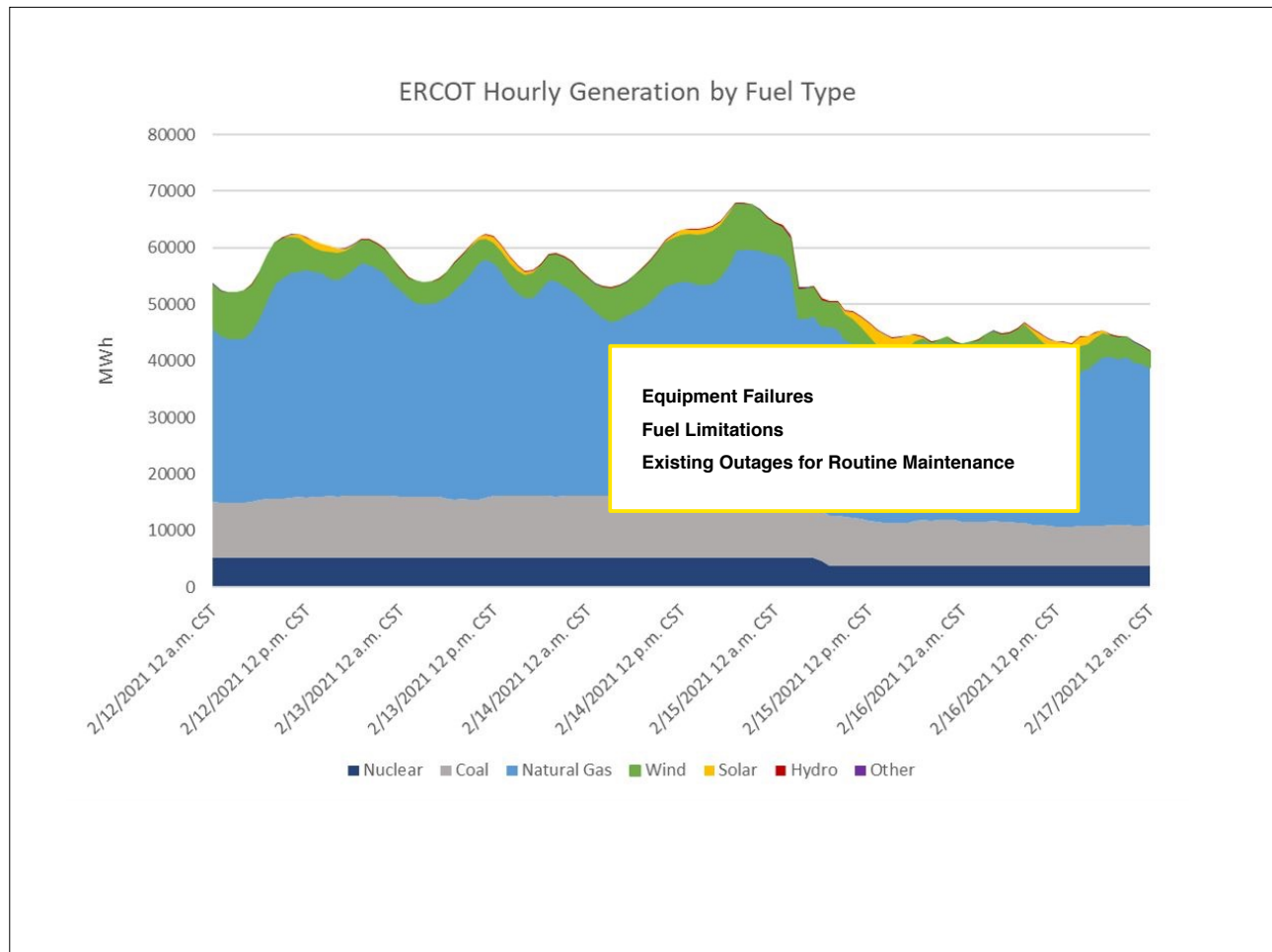
Poll: <https://media.ford.com/content/fordmedia/fna/us/en/news/2020/02/13/spark-a-new-romance-with-all-electric-mustang-mach-e.html>  
Image: [EnergyShouldBe.org](https://www.energyshouldbe.org/)



Tesla Model 3 all electric

## 6. What People Say About Electric Cars





**Questions?**  
**ken at [EnergyShouldBe.org](https://EnergyShouldBe.org)**

**Sankey - Google LLNL flowcharts**  
<https://flowcharts.llnl.gov>

**Very Detailed Energy Sankey**  
[EnergyLiteracy.com](https://www.energyliteracy.com)

**NREL charts - Google NREL 70485**  
<https://www.nrel.gov/docs/fy18osti/70485.pdf>  
page 18

**UC Berkeley Reports. 90% Renewables  
& Saving Trillions on Transport**  
[2035Report.com](https://2035Report.com)

Image: [EnergyShouldBe.org](https://EnergyShouldBe.org)