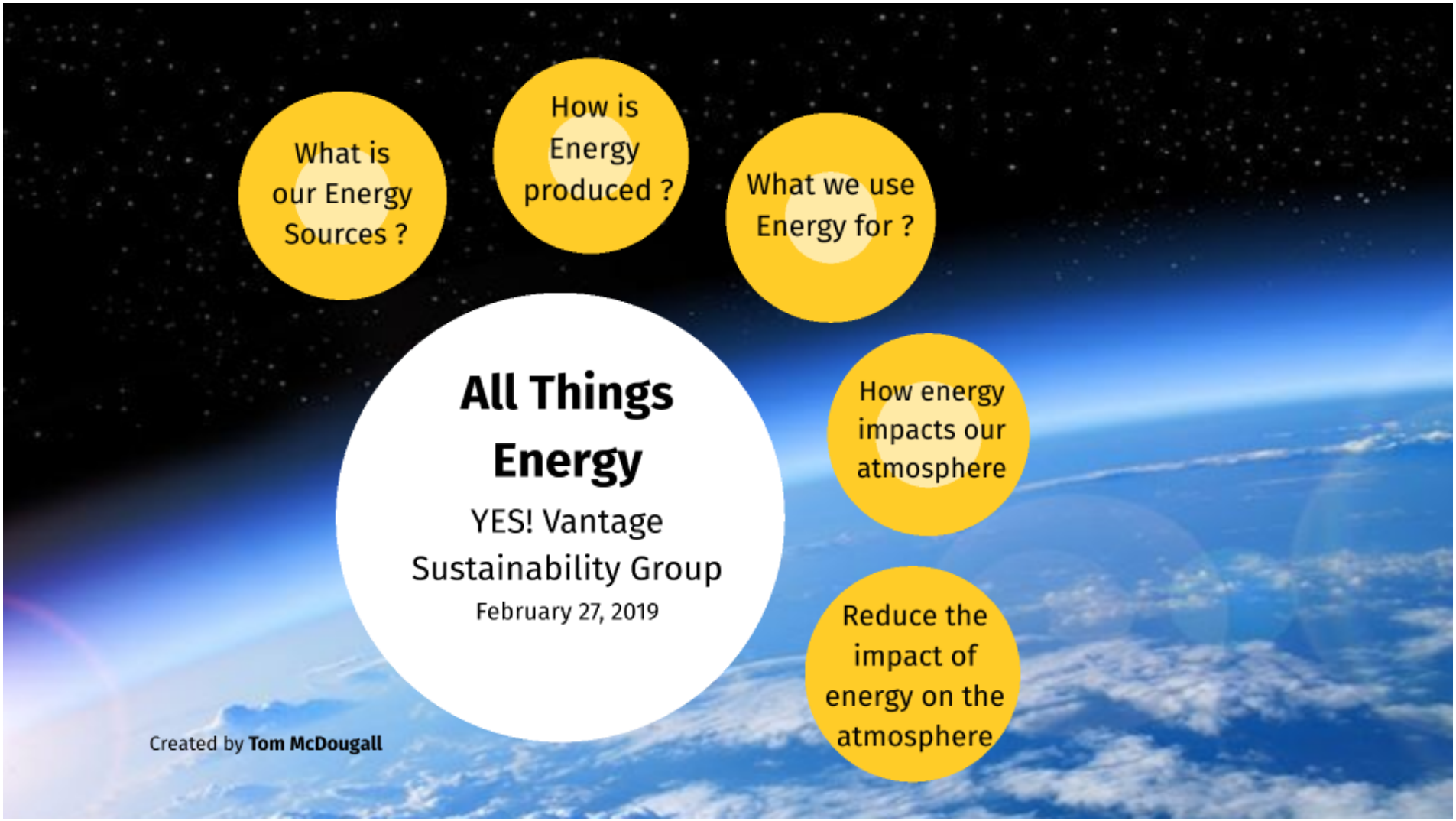
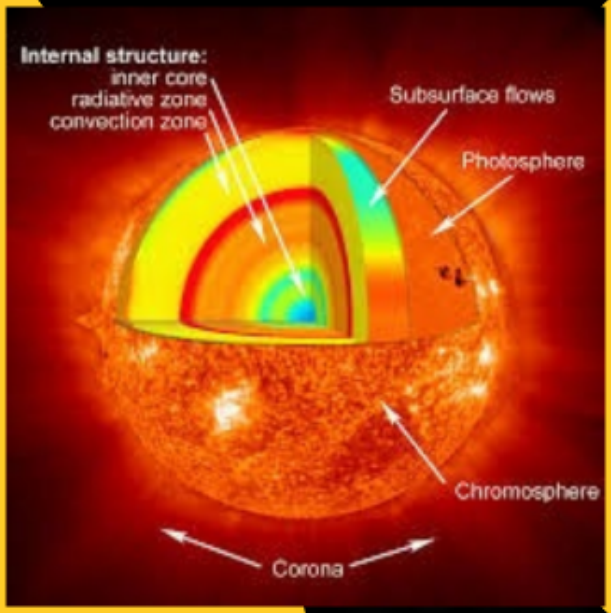

What is our Energy Sources ?
How is Energy produced ?
What we use Energy for ?
All Things Energy
YES! Vantage Sustainability Group
February 27, 2019
How energy impacts our atmosphere
Reduce the impact of energy on the atmosphere
Created by Tom McDougall

The Sun is the source of energy for life on earth
It created all the fossil fuel energy we use today over many years ago
And continues to deliver solar radiation that warms the earth which creates the wind and our climate
How the Sun works
How Fossil Fuels are made



The Sun is a very large star composed primarly of Hydrogen and Helium gasses

Over 1.3 million Earths can fit inside the Sun

The surface temperature of the Sun is about 10,300 degrees Farhenheit

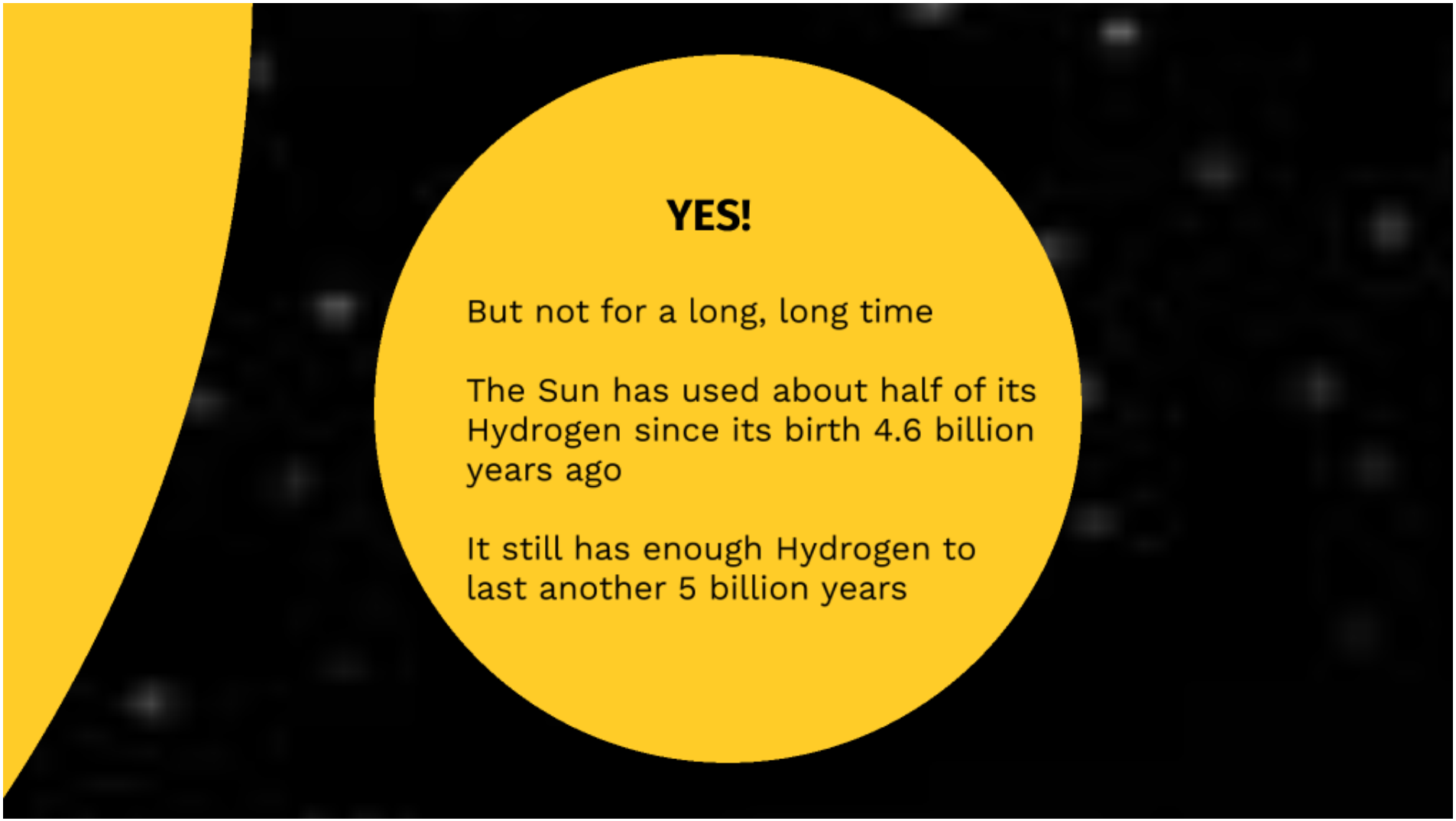
At the core of the Sun, gravitational attraction produces immense pressure and temperature, which can reach more than 27 million degrees Farhenheit. Hydorgen atoms get compressed and fused togther, creating Helium

This process is called nuclear fussion

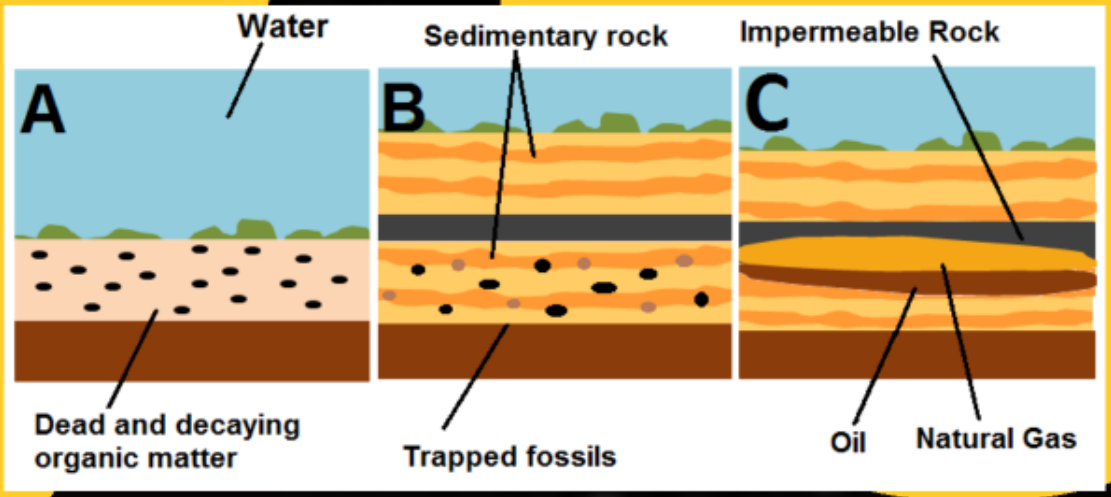
How much energy does the Sun produce?

Will The Sun Burn Out?

In **one hour** the Earth receives from the Sun **all the energy people on Earth use in one year**
About 140,000 Terra Watt Hours of energy

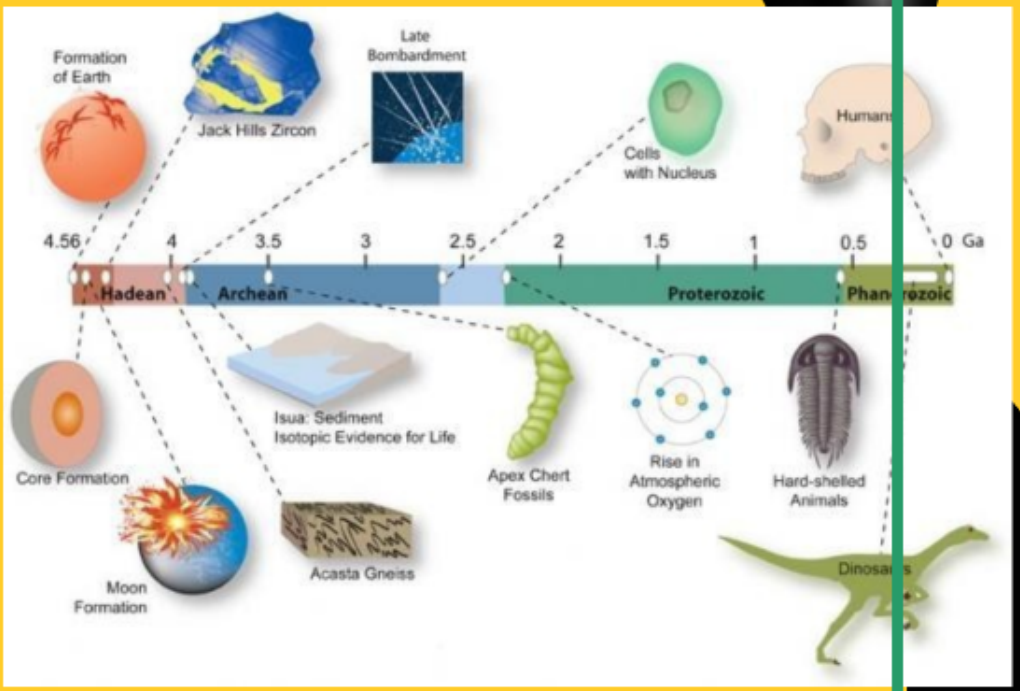

YES!
But not for a long, long time
The Sun has used about half of its Hydrogen since its birth 4.6 billion years ago
It still has enough Hydrogen to last another 5 billion years

Fossil fuels are created from plant and biological life decaying over millions of years, and undergoing temprature and pressure to turn into coal, oil, and natural gas



Time Line

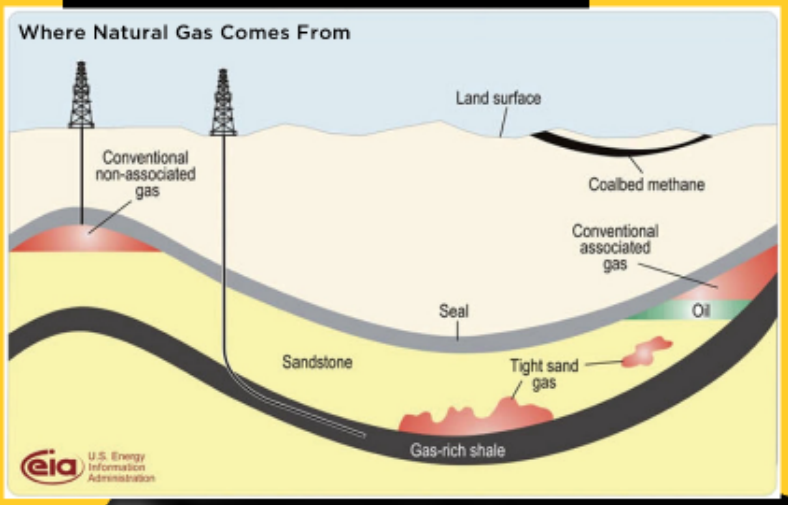
Delivery

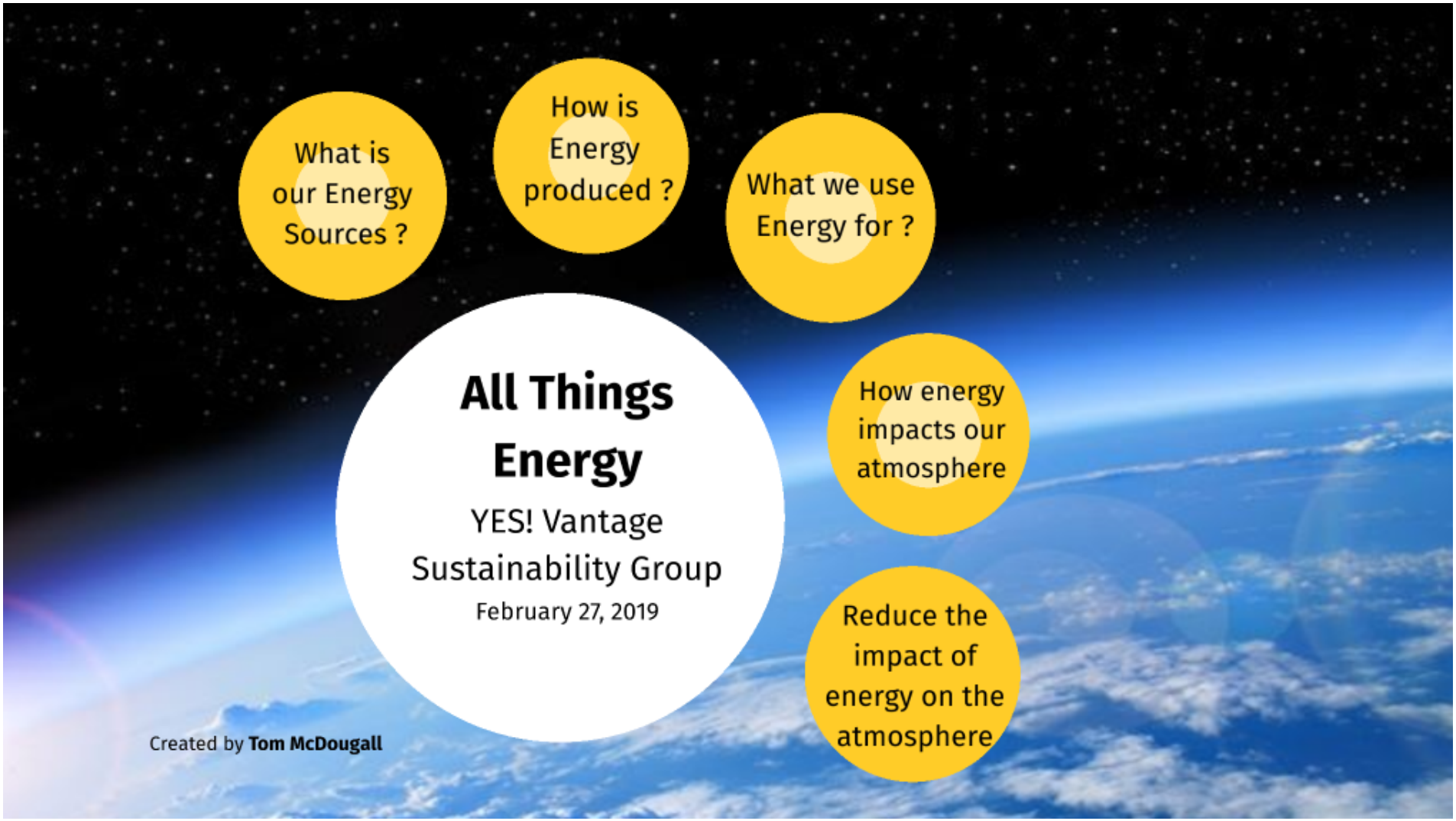


Fossil Fuel Desposits

Started being created around 300 to 400 million years ago

Fossil Fuels are obtained by exploring then mining and drilling




What is our Energy Sources ?
How is Energy produced ?
What we use Energy for ?
All Things Energy
YES! Vantage Sustainability Group
February 27, 2019
How energy impacts our atmosphere
Reduce the impact of energy on the atmosphere
Created by Tom McDougall

Useful Energy to power our civilization is developed using many different types of sources and technologies
Electricity
Fossil Fuels
Bio Fuels

Electricity has become the dominate form of useful energy and uses many sources to produce it

All use the same technological method except for one ...

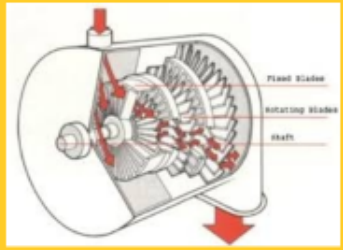
- Fossil Fuels
- Nuclear Fusion
- Hydro Power
- Wind Power
- Solar

Electricity produced from fossil fuels, nuclear fussion, hydro power, and wind, all work pretty much the same way

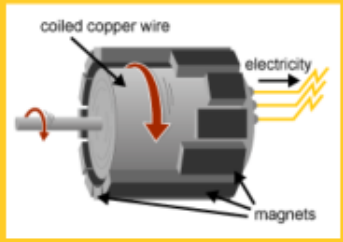
A turbine converts the kinetic energy of a moving liquid or gas to mechanical energy

In a steam turbine, steam is forced against a series of blades mounted on a shaft.

The steam rotates the shaft connected to a generator

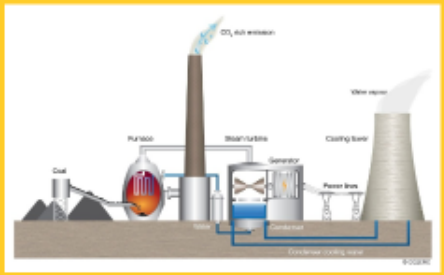


The generator, in turn, converts its mechanical energy to electrical energy based on the relationship of magnetism and a spining coil of copper wire



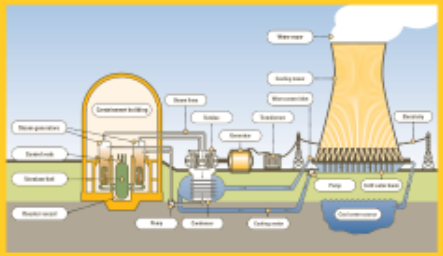
Electric power plants that use Coal, Natural Gas, and Nuclear Fussion heat water into steam to drive the turbine that turns the generator to make electricity

Coal or Natural Gas fired plant



The burning of coal or natural gas **creates green house gases**, primarly carbon dioxide that goes into our atmosphere

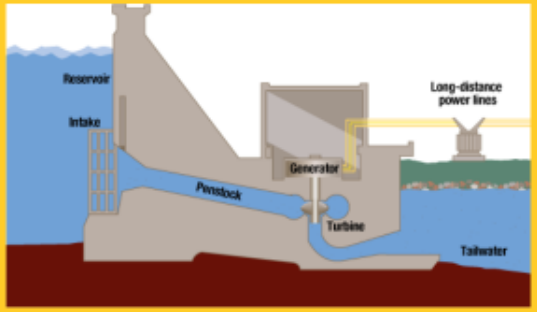
Nucler Fusion plant



The nuclear fusion process **does not create green house gases**, however, it creates radioactive waste that is toxic and harmful and will remain harmful for a very long time. Soutions for minimizing this impact is still on-going

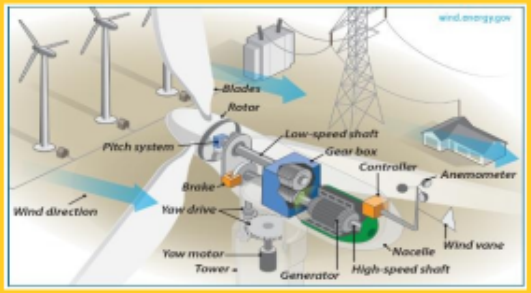
Hydro Power plants and Wind Turbines use water and wind to drive the turbine that turns the generator to make electricity

Hydro Plant



Since no fuel is burned a **Hydro plant does not create green house gases**, however, dam and resevoirs can create environmental consequences for the local ecology

Wind Turbine

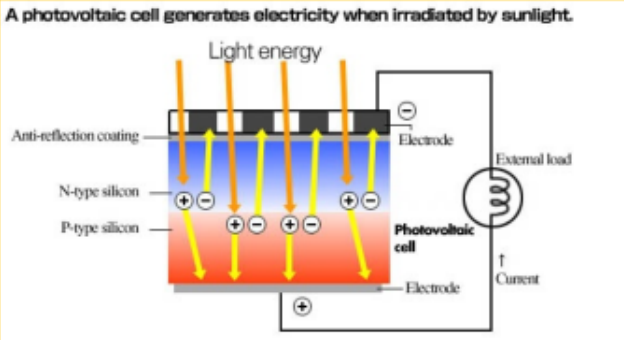


Like wise with **Wind Turbines no green house gases are created.** But they only produce power when the wind is blowing

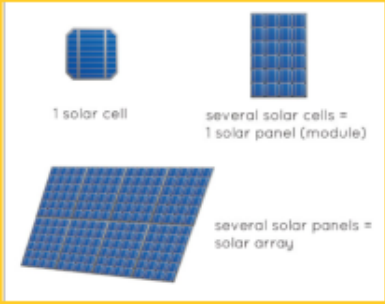
Solar Energy Photo Voltaic panels generate electricity in a completley different way
They do not use a turbine or a generator to produce an electric current
Solar Photo Voltaic Cells (Pv) produce electrical energy by light photo...

Solar Photo Voltaic Cells (PV) produce electrical energy by light photons striking 2 different silcone substates to create an electrical current

How it works

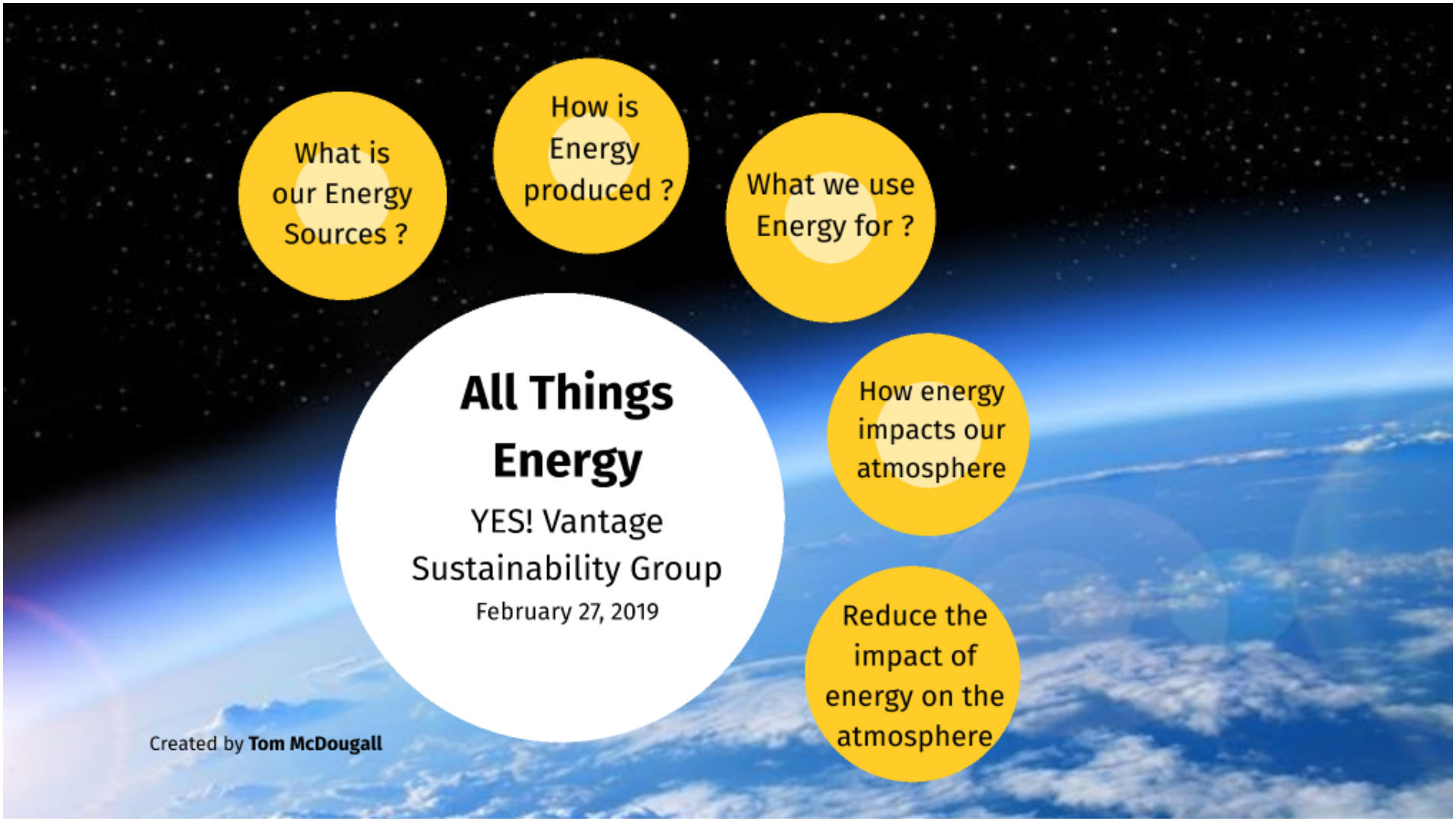


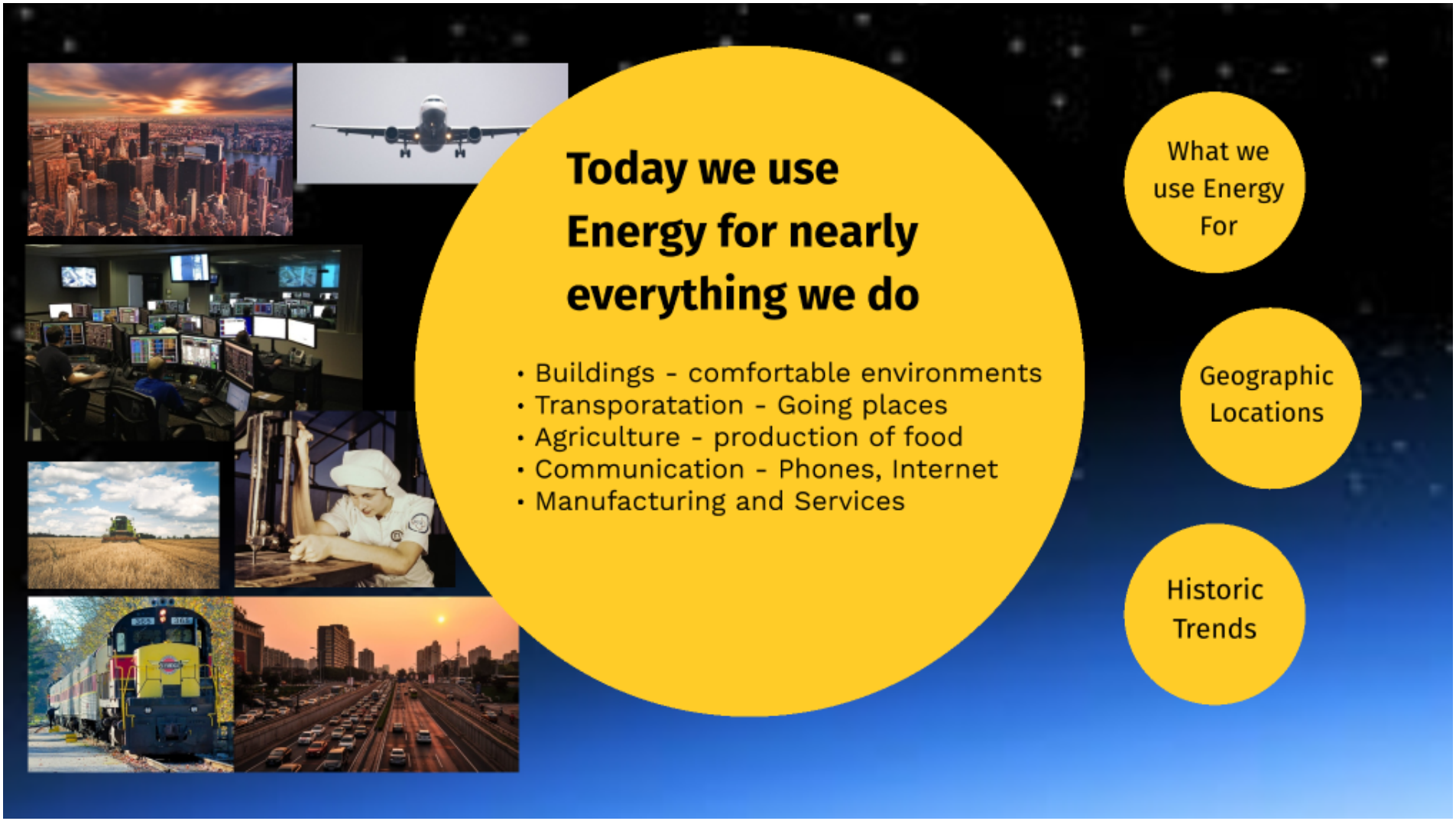
A solar cell is made up of two different types of silcone layers - a P layer and a N layer. Each layer has a different charge. When light photons strike each layer **positve electrons collect on the P layer conducter** and **negative electrons collect on the N layer conducter** and start the flow of electric current

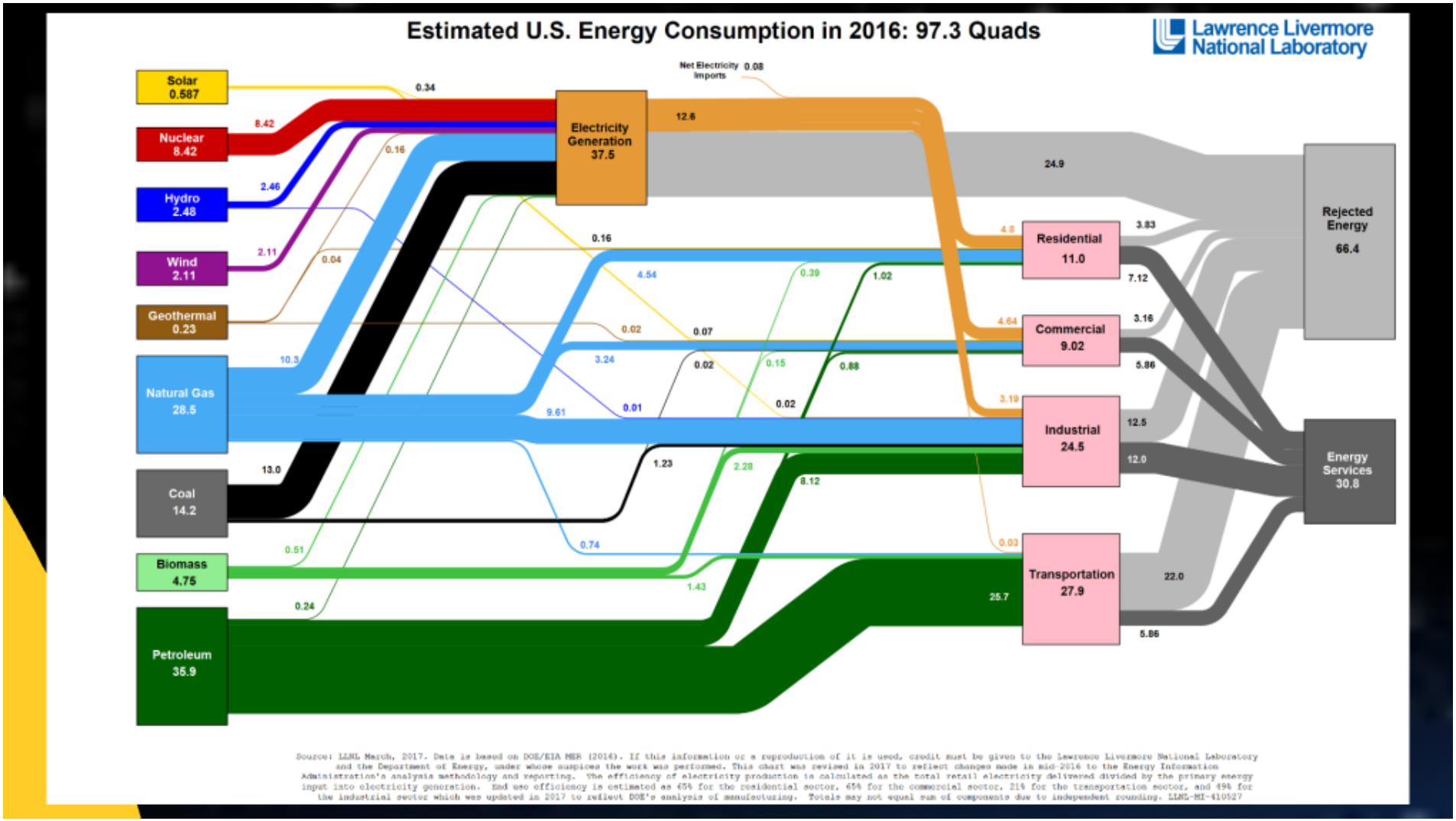


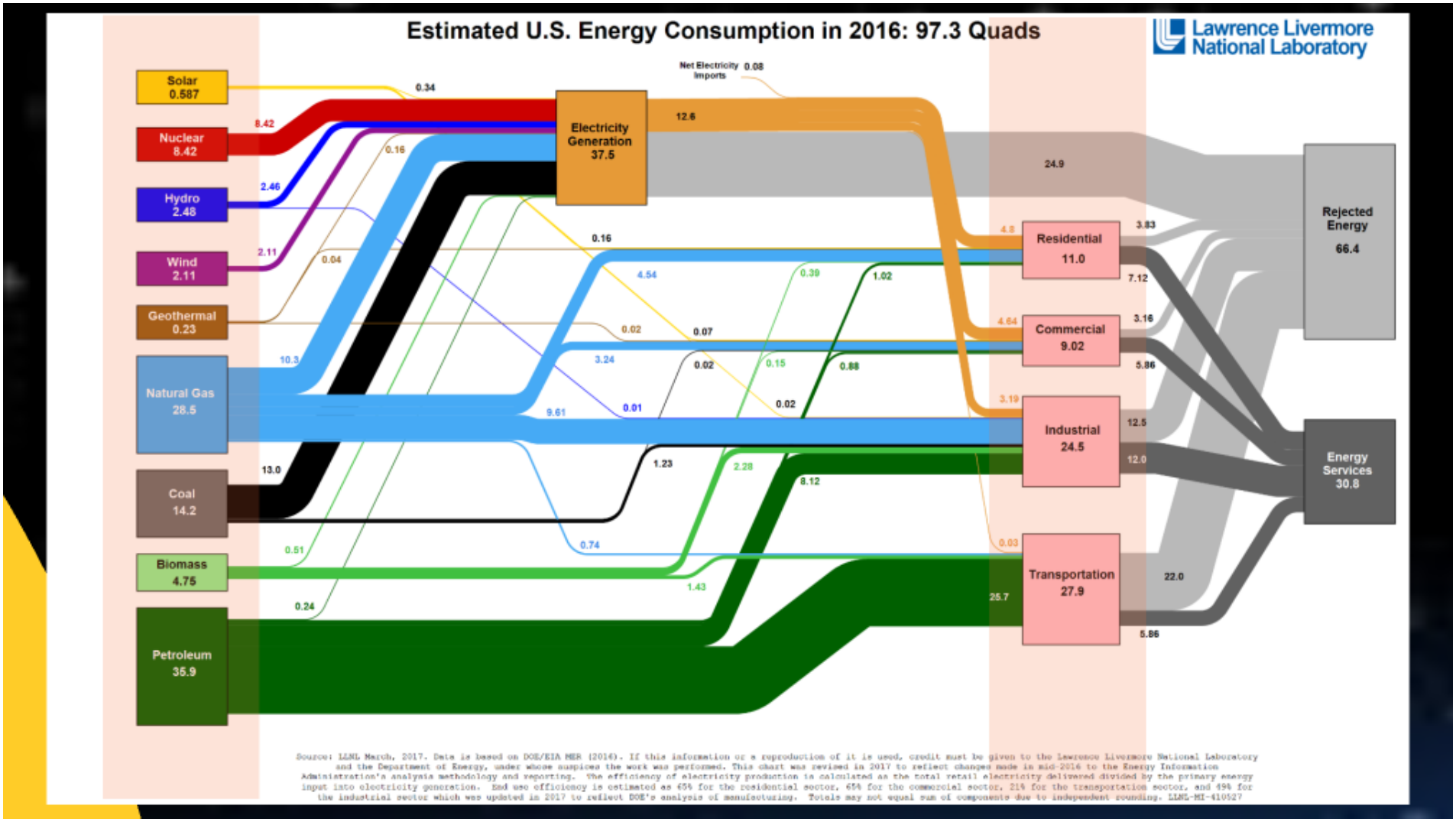
Each solar cell is about 6 inches by 6 inches and manufatured into panels about 3 feet by 5 feet

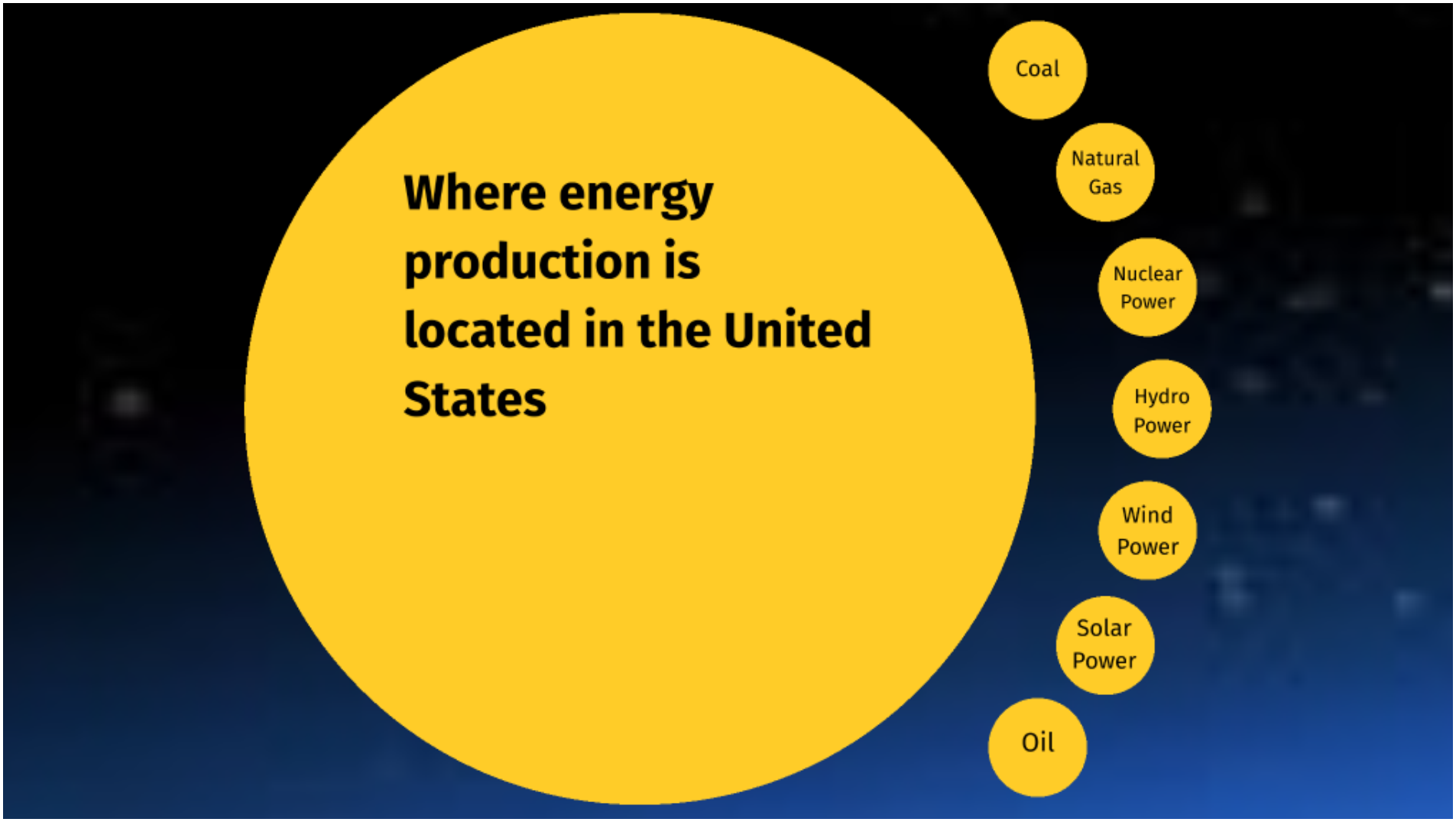
Like Hydro and Wind Power, Solar energy **does not emit any green house gases,** however it only produces electrical energy when the sun is shining


What is our Energy Sources ?
How is Energy produced ?
What we use Energy for ?
All Things Energy
YES! Vantage Sustainability Group
February 27, 2019
How energy impacts our atmosphere
Reduce the impact of energy on the atmosphere
Created by Tom McDougall

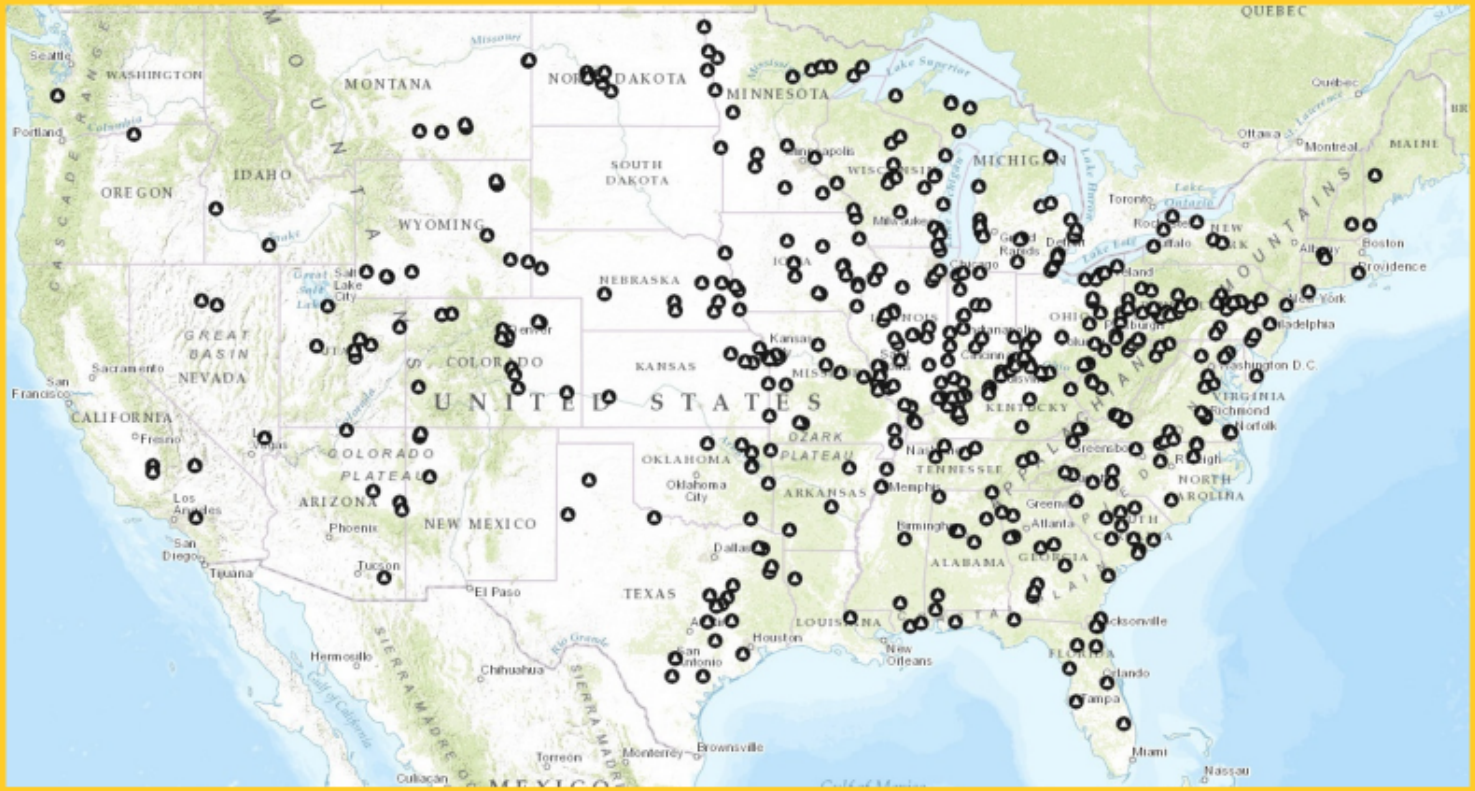

Today we use Energy for nearly everything we do
• Buildings - comfortable environments
• Transporatation - Going places
• Agriculture - production of food
• Communication - Phones, Internet
• Manufacturing and Services
What we use Energy For
Geographic Locations
Historic Trends


Estimated U.S. Energy Consumption in 2016: 97.3 Quads
Lawrence Livermore National Laboratory
Solar 0.587
Nuclear 8.42
Hydro 2.48
Wind 2.11
Geothermal 0.23
Natural Gas 28.5
Coal 14.2
Biomass 4.75
Petroleum 35.9
Net Electricity Imports 0.08
Electricity Generation 37.5
Residential 11.0
Commercial 9.02
Industrial 24.5
Transportation 27.9
Rejected Energy 66.4
Energy Services 30.8
0.34
8.42
2.46
2.11
0.04
0.16
10.3
13.0
0.51
0.24
12.6
24.9
0.16
4.54
0.02
3.24
9.61
0.01
0.07
0.02
1.23
0.74
0.39
0.15
2.28
1.43
1.02
0.88
8.12
25.7
4.3
4.64
3.19
0.03
3.83
7.12
3.16
5.86
12.5
12.0
22.0
5.86
Source: LLNL March, 2017. Data is based on DOE/EIA MER (2016). 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. This chart was revised in 2017 to reflect changes made in mid-2016 to the Energy Information Administration's analysis methodology and reporting. 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

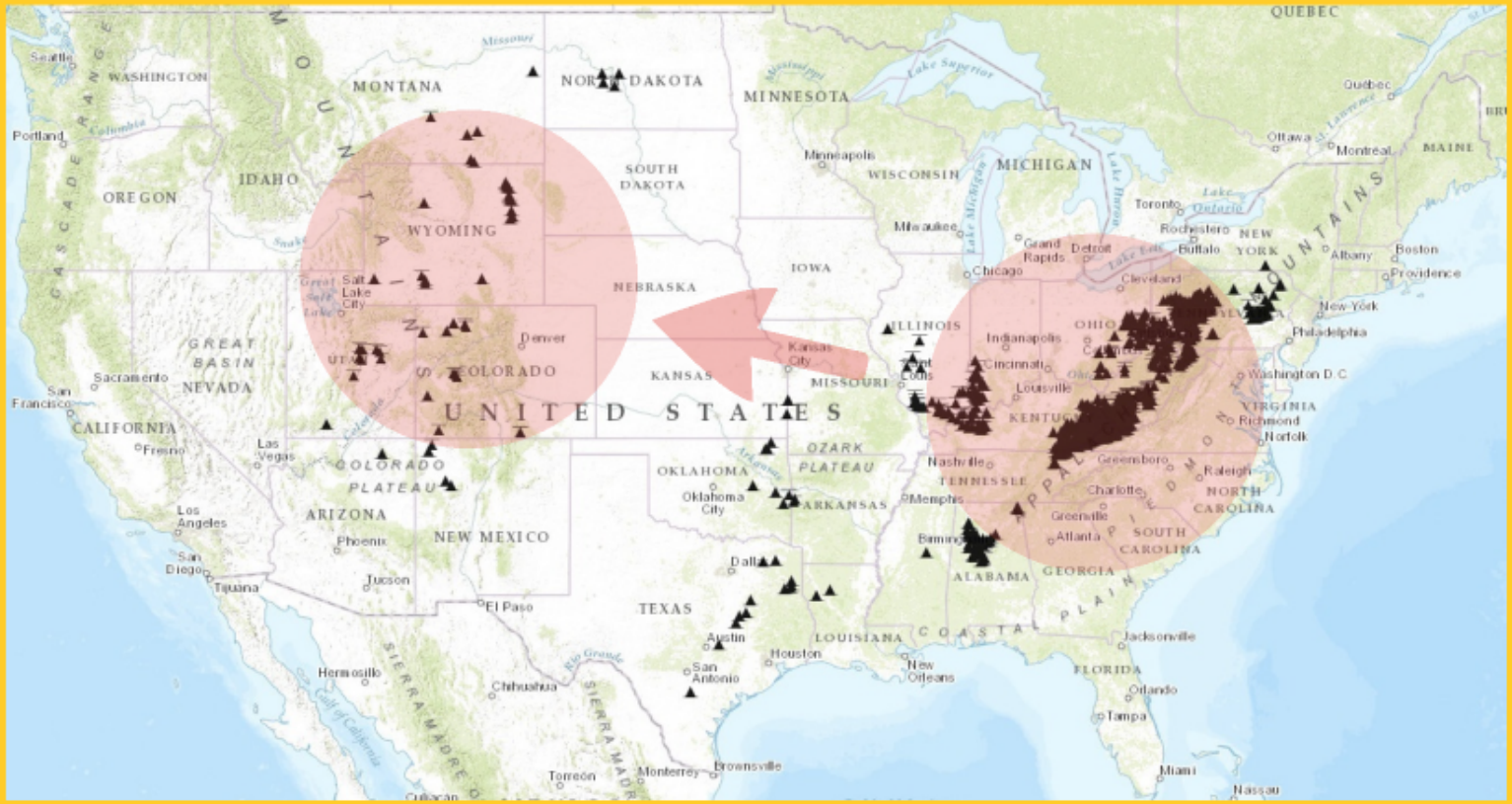

Estimated U.S. Energy Consumption in 2016: 97.3 Quads
Lawrence Livermore National Laboratory
Solar 0.587
Nuclear 8.42
Hydro 2.48
Wind 2.11
Geothermal 0.23
Natural Gas 28.5
Coal 14.2
Biomass 4.75
Petroleum 35.9
Net Electricity Imports 0.08
Electricity Generation 37.5
Residential 11.0
Commercial 9.02
Industrial 24.5
Transportation 27.9
Rejected Energy 66.4
Energy Services 30.8
0.34
8.42
2.46
2.11
0.16
0.04
10.3
13.0
0.51
0.24
12.6
24.9
0.16
4.54
0.02
3.24
9.61
0.07
0.02
0.01
1.23
0.74
0.39
0.15
2.28
1.43
1.02
0.88
0.02
8.12
4.8
4.64
3.19
0.03
25.7
3.83
7.12
3.16
5.86
12.5
12.0
22.0
5.86
Source: LLNL March, 2017. Data is based on DOE/EIA MER (2016). 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. This chart was revised in 2017 to reflect changes made in mid-2016 to the Energy Information Administration's analysis methodology and reporting. 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


Where energy production is located in the United States
Coal
Natural Gas
Nuclear Power
Hydro Power
Wind Power
Solar Power
Oil

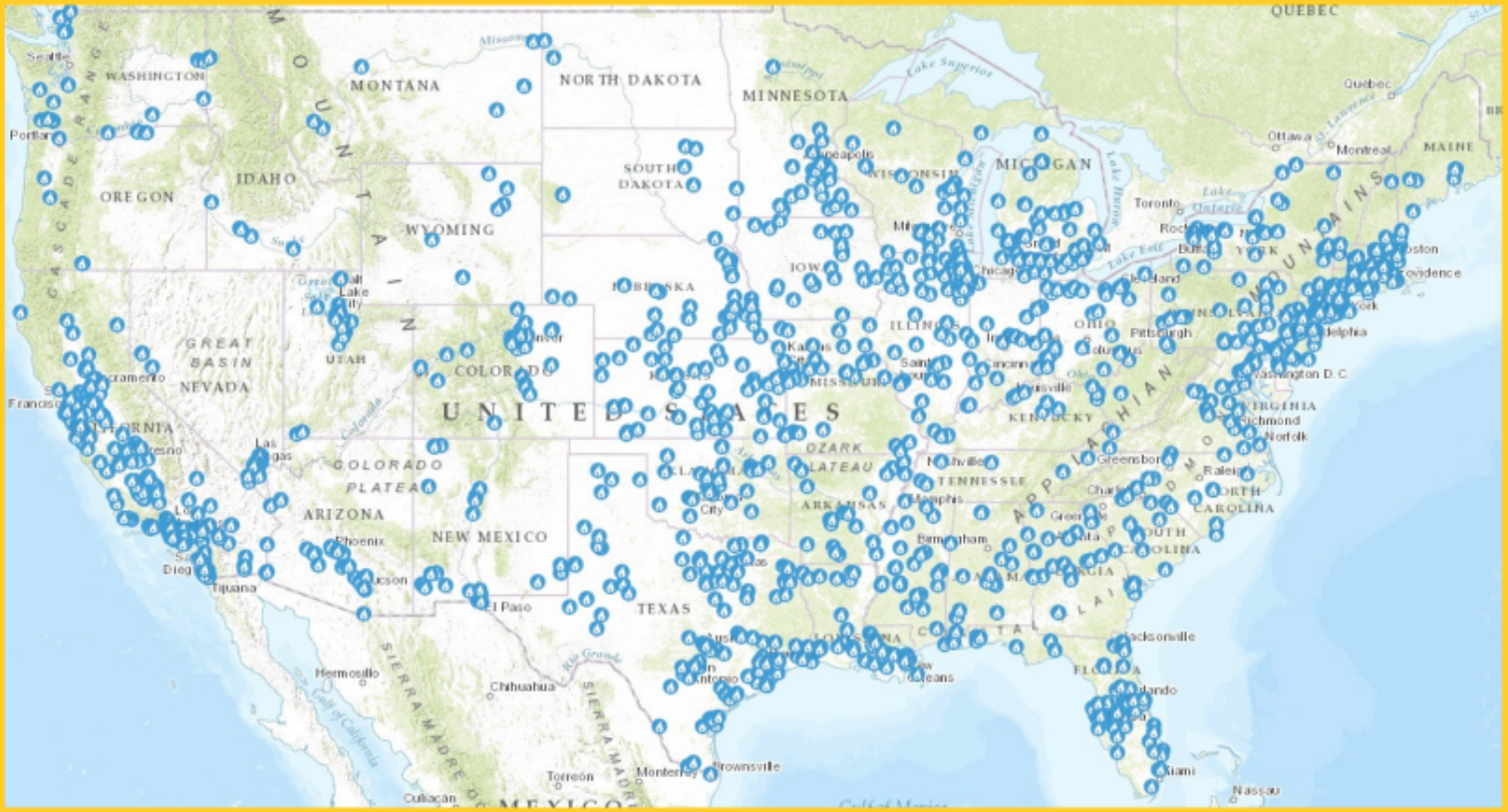
Coal power plants once producing over 50% of the electricity now only produce 37%

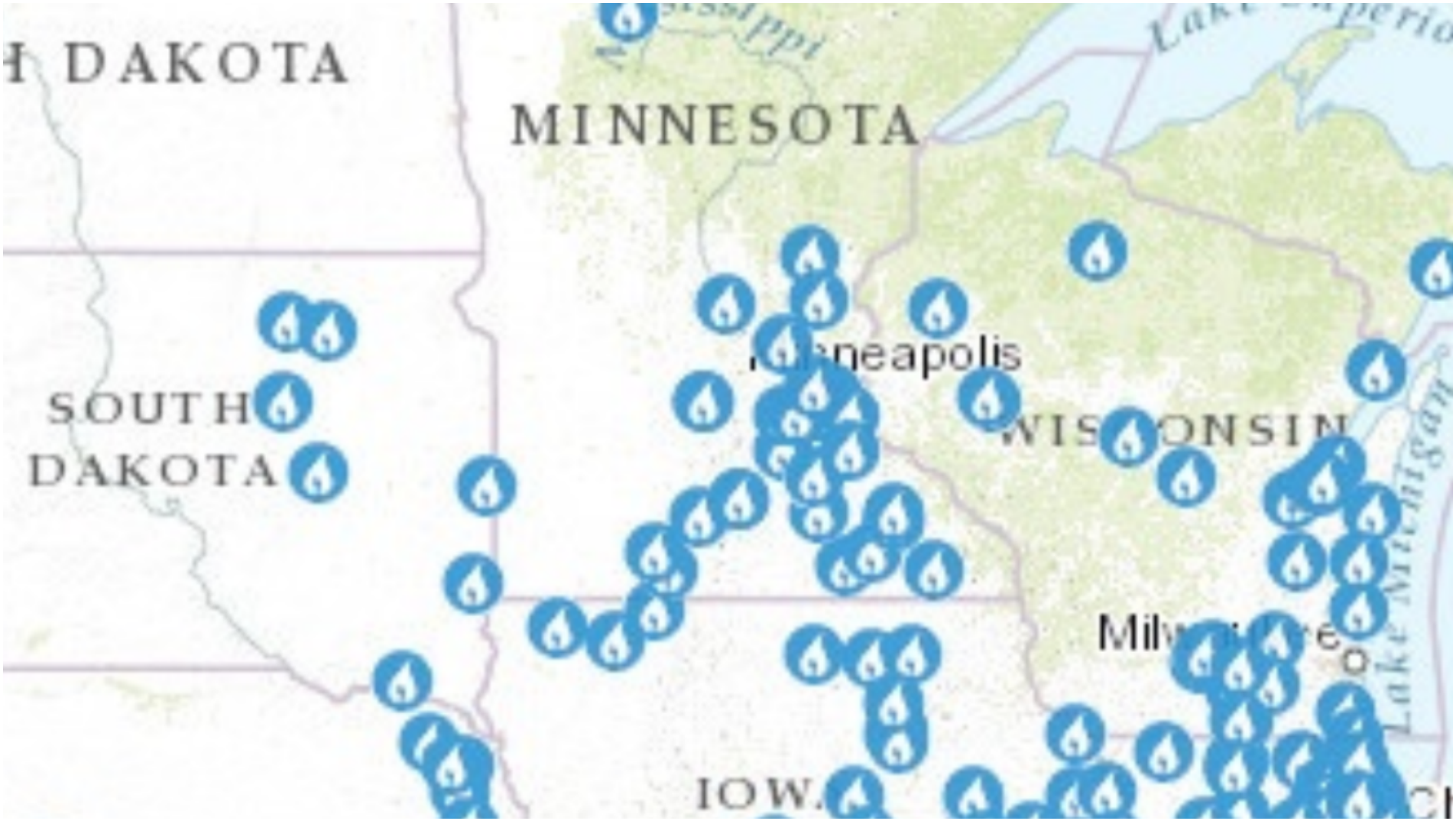


Coal mining has shifted from Appalachia to out West, due to a lower sulpher content in the coal and easier mining operations



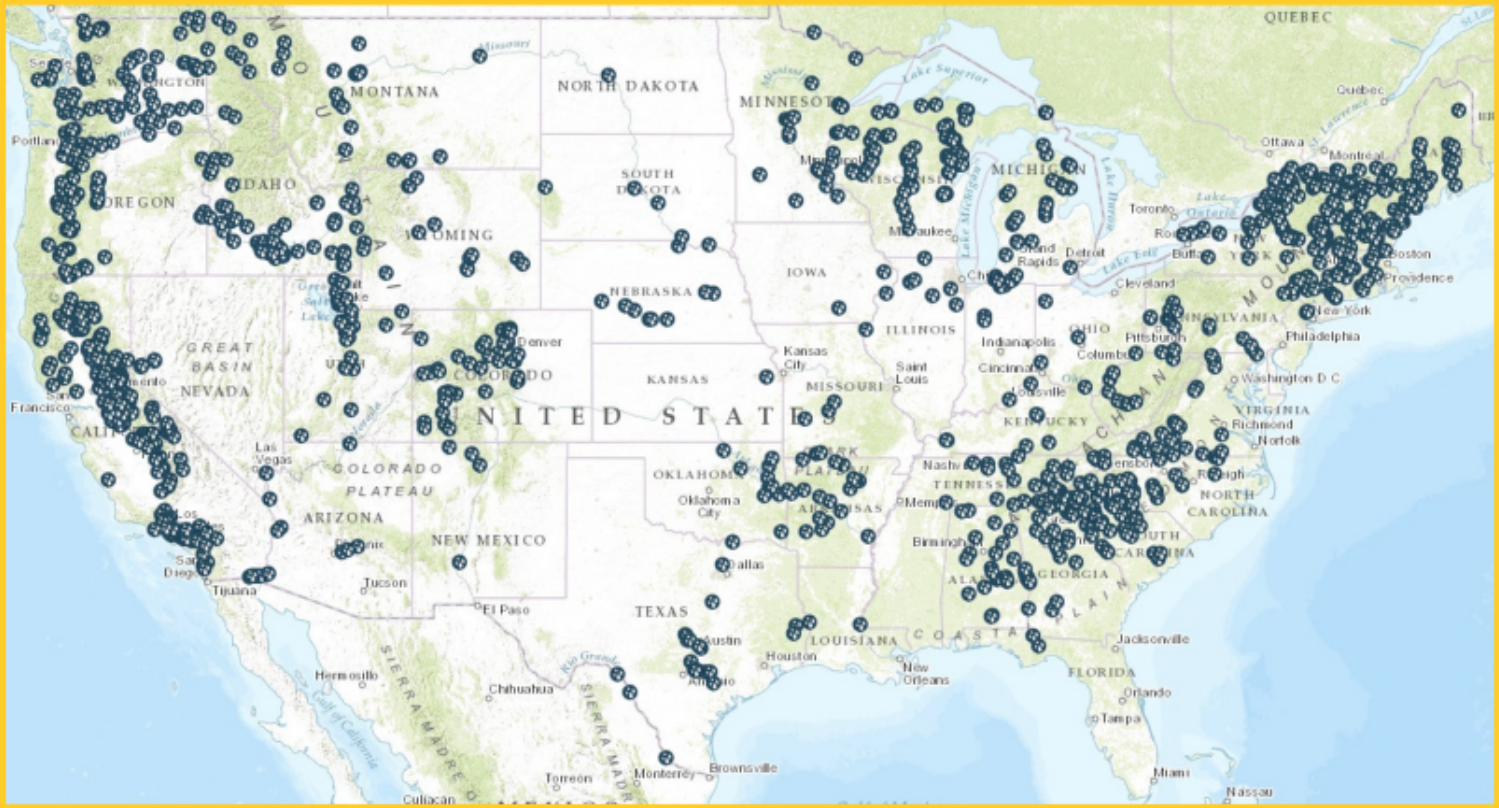
Natural Gas power plants now provide over 30% of the electricity produced, and is increasing



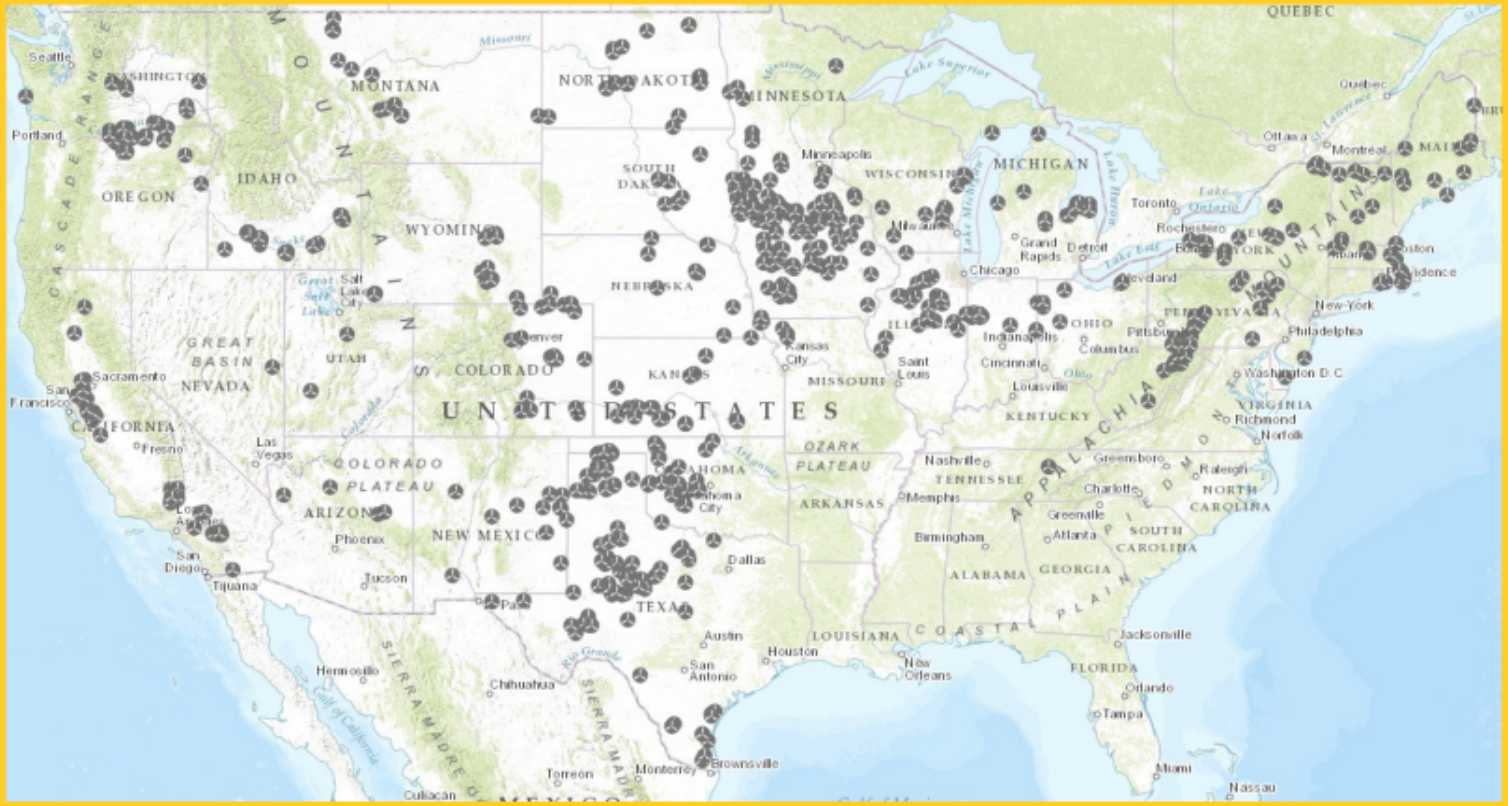

DAKOTA
MINNESOTA
SOUTH
DAKOTA
WISCONSIN
IOWA

Nuclear power has remained stagnate at 20% of electricity production for many years, they are now expensive to build to maintain saftey

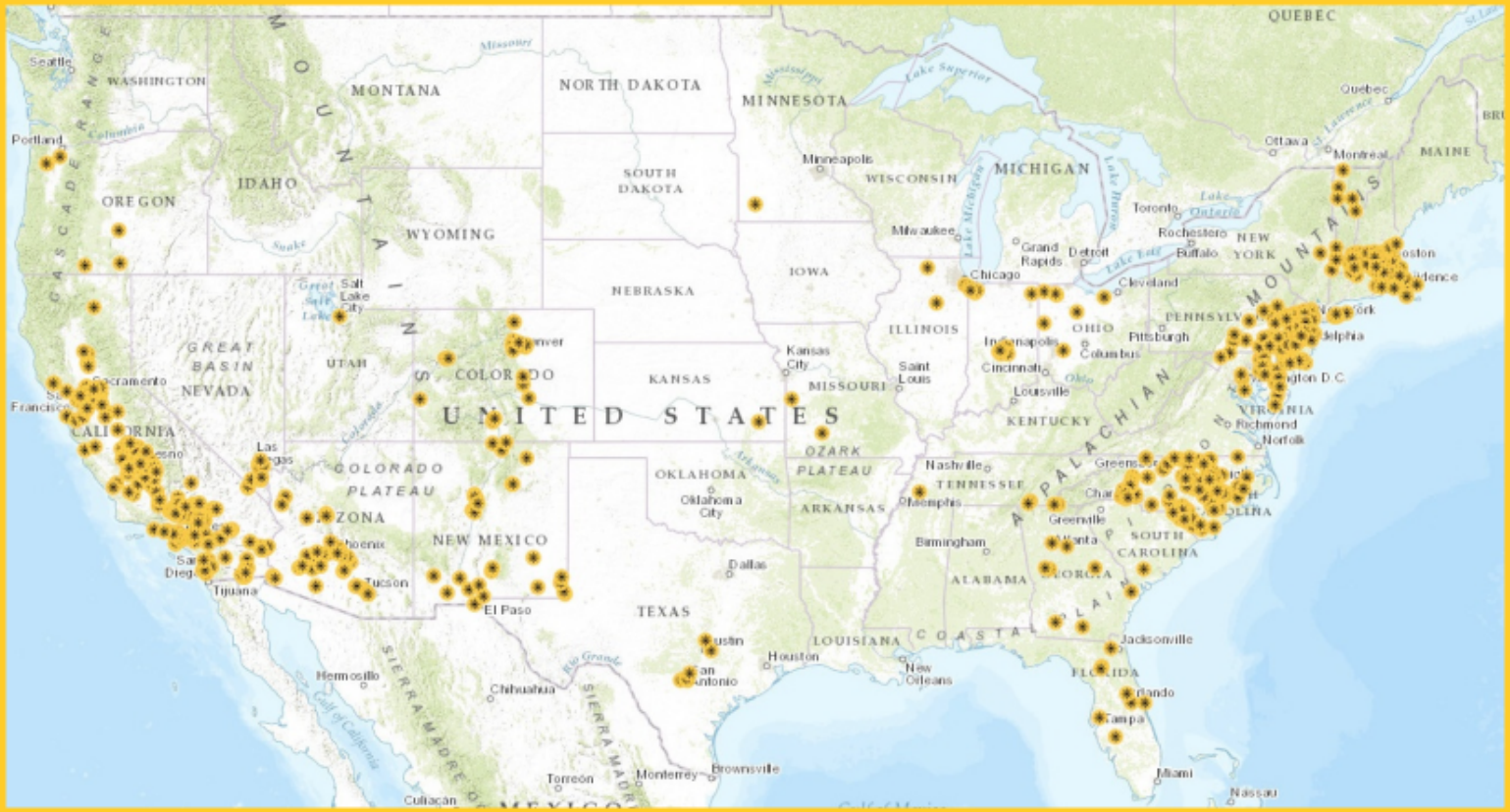
Hydro power is the biggest renewable source, at 7 percent of electricity



Wind power is surging in the Midwest, and the US has more wind energy than any other country in the world



Solar energy is growing fast, but represents less than 1% of electric power

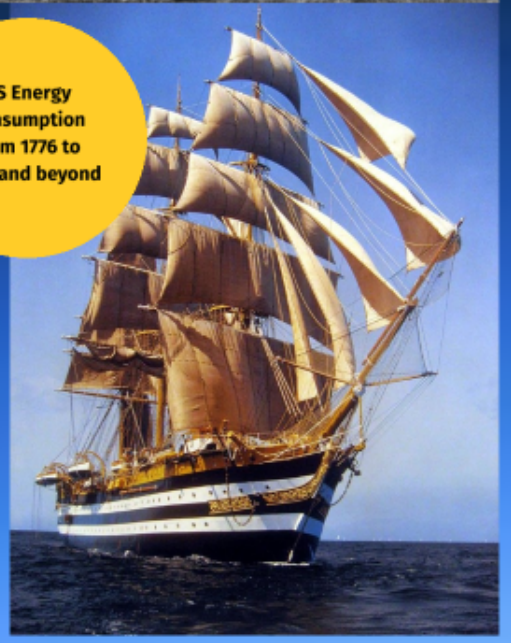


The United States uses 19 million barrels of oil a day and produces about 62% within its borders, the rest is imported

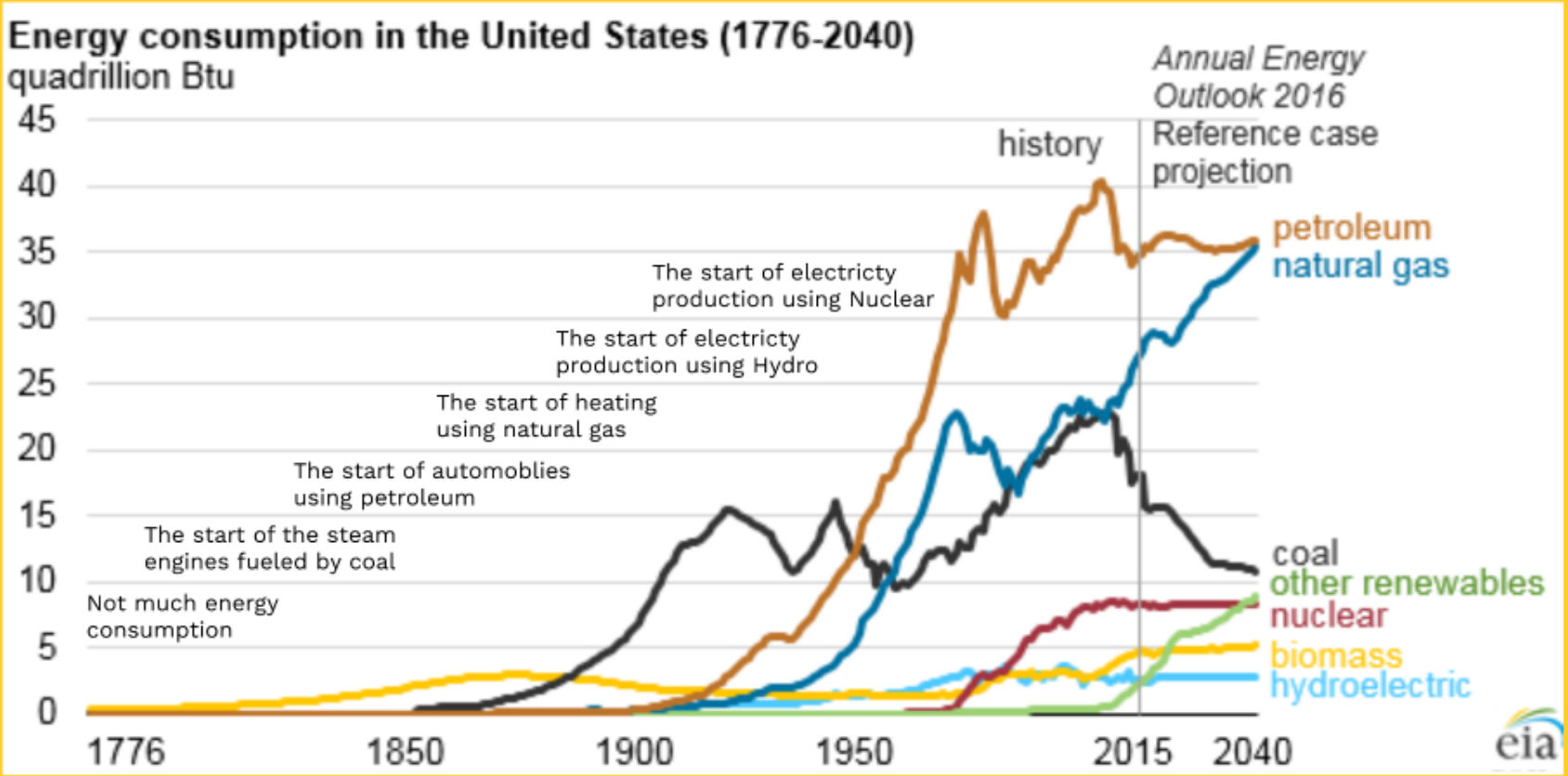
United States and World Energy consumption has increased dramatically in the last 150 years, in part due to increases in:

- Human comfort levels
- Human convenience levels
- Human population

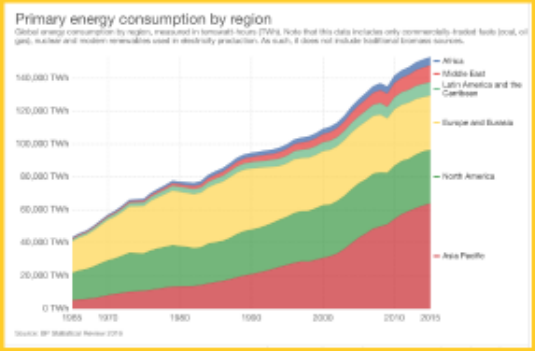
US Energy Consumption from 1776 to 2015 and beyond



US Energy Consumption from 1776 to 2015 and beyond



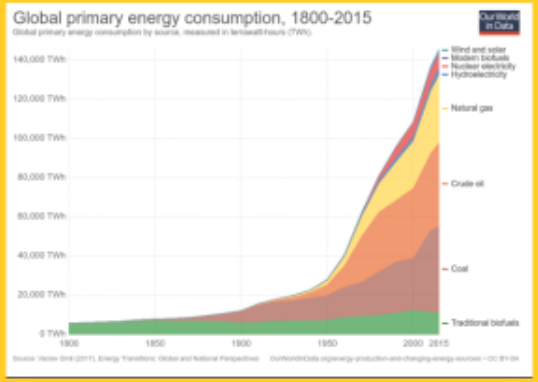
Global Energy Consumption by Region



Since 1965 all global regions have increased energy consumption. The fastest growing regions are in underdeveloped countries where human convenience and comfort will be demanded as their economies grow

Global Energy Consumption

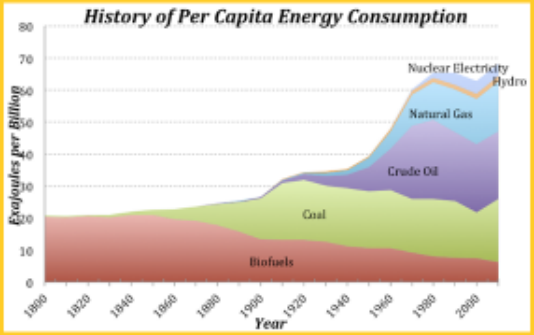
By Primary Type Total



Global Energy consumption has **increased 7 times** since the 1940's due to increased desire for comfort, convenience and population growth

World population growth over the same time frame has **only increased 3 times** from 2.5 Billion to 7.5 Billion today

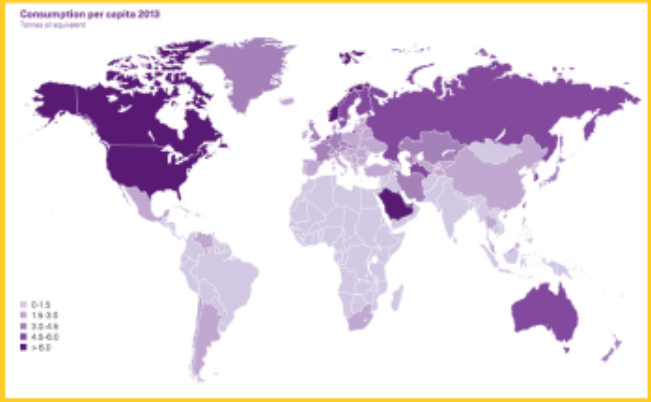
By Primary Type per Capita



The per capita graph clearly illustrates the impact of increased energy consumption due to the humand desire for Comfort and Convenience

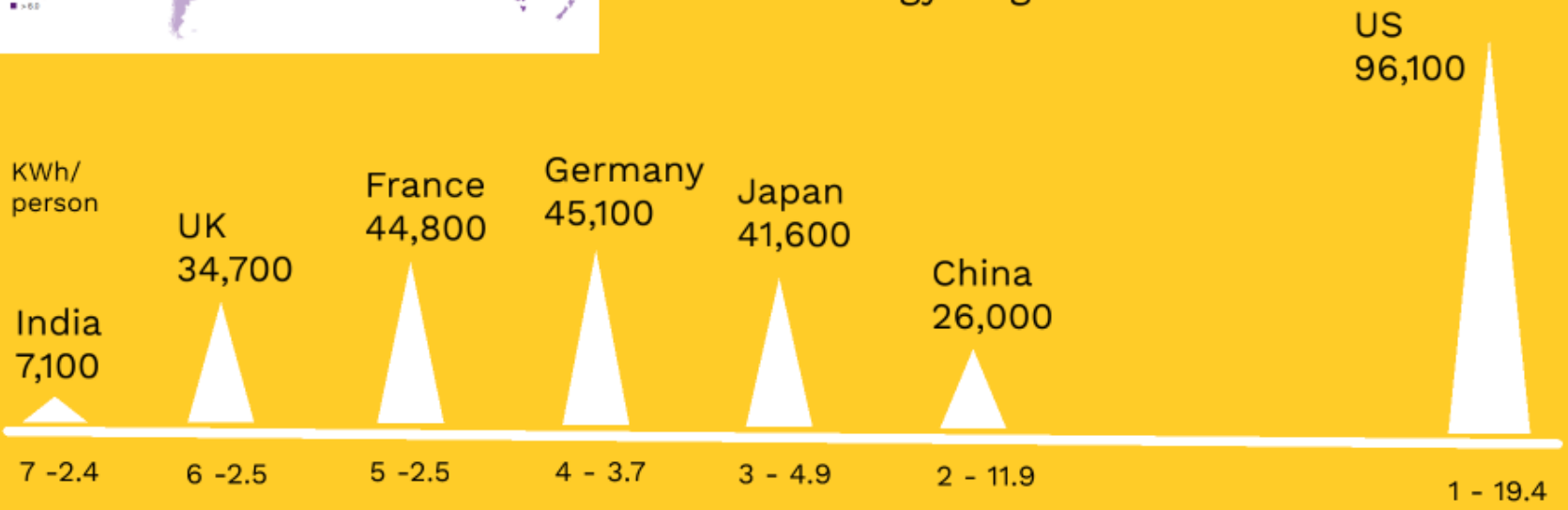
Just in the last 75 years the **energy consumption per person around the globe has almost doubled**

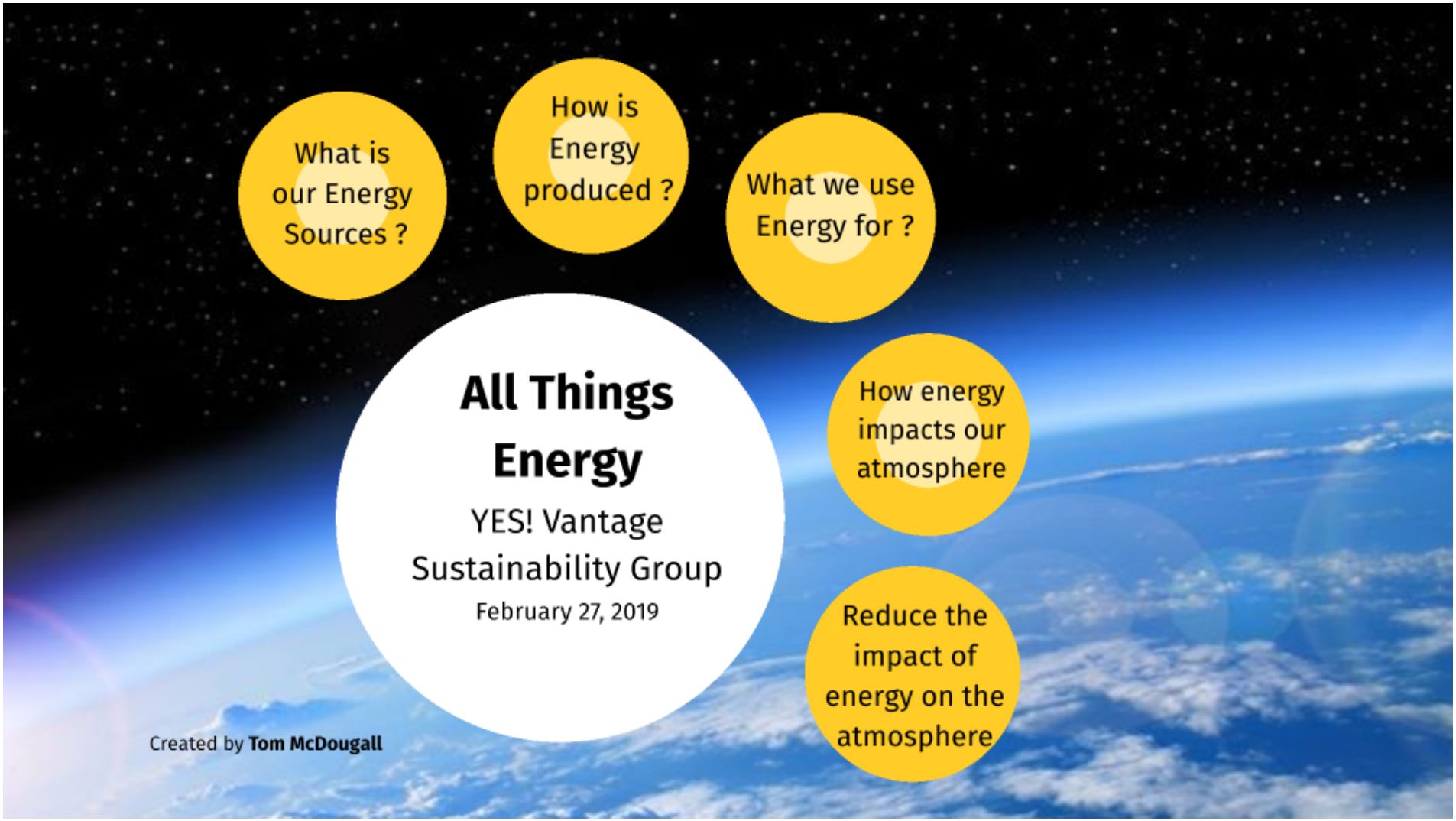
Global Energy Consumption per Person

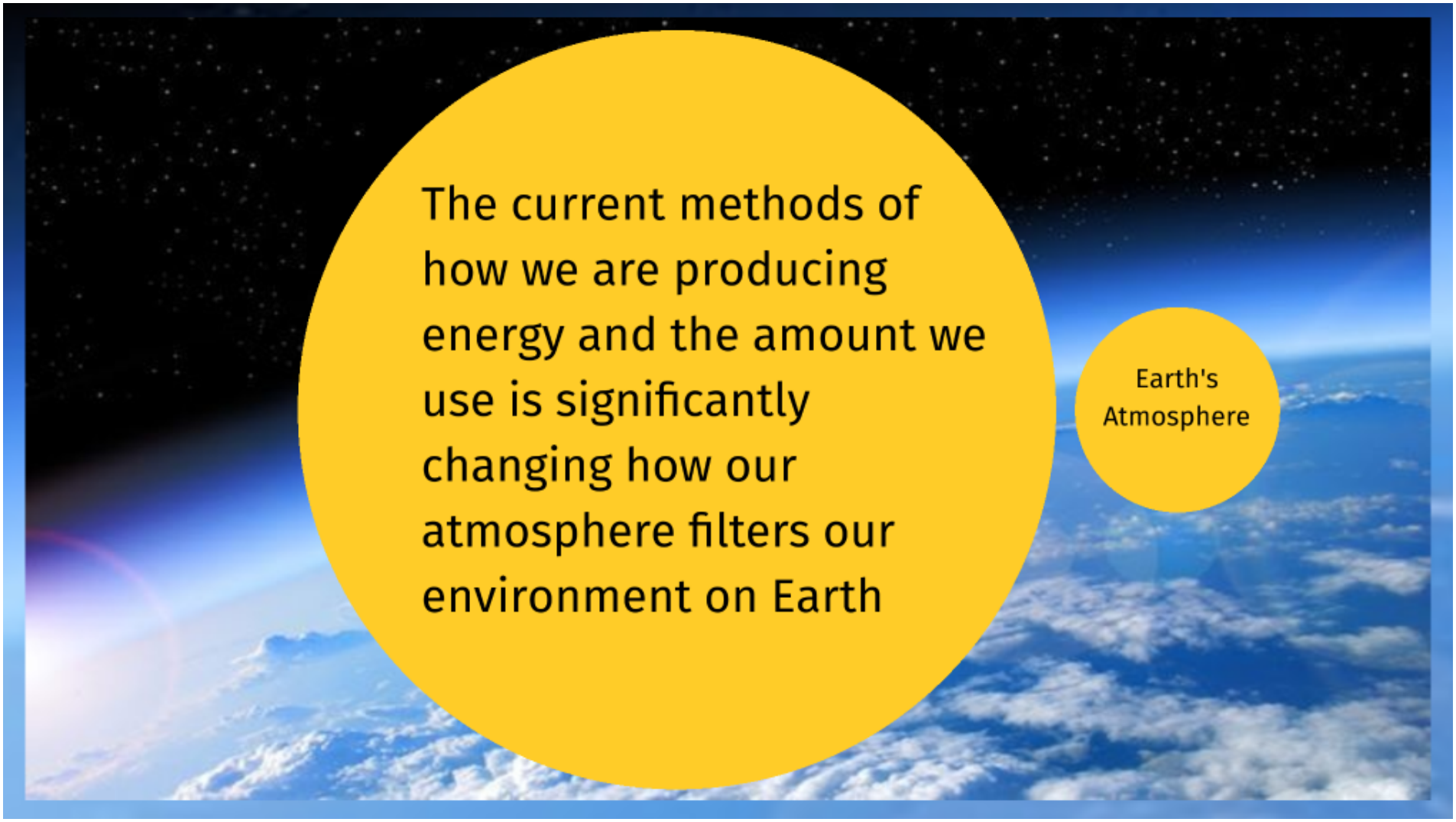


The United States and Canada consumes more energy per person than most any other country in the world!

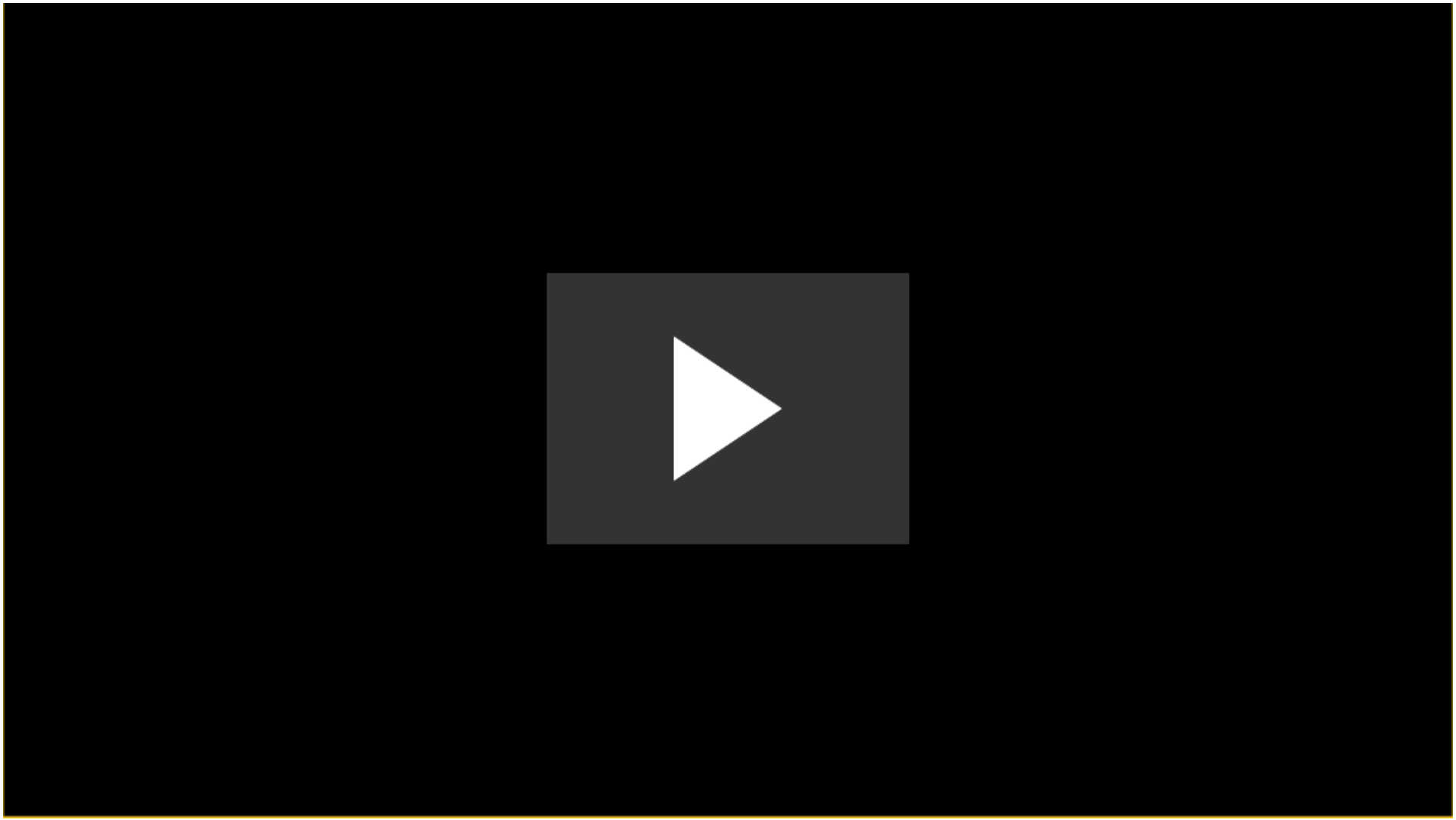
If all countries used as much energy as the US, we simply would not have enough useable energy to go around



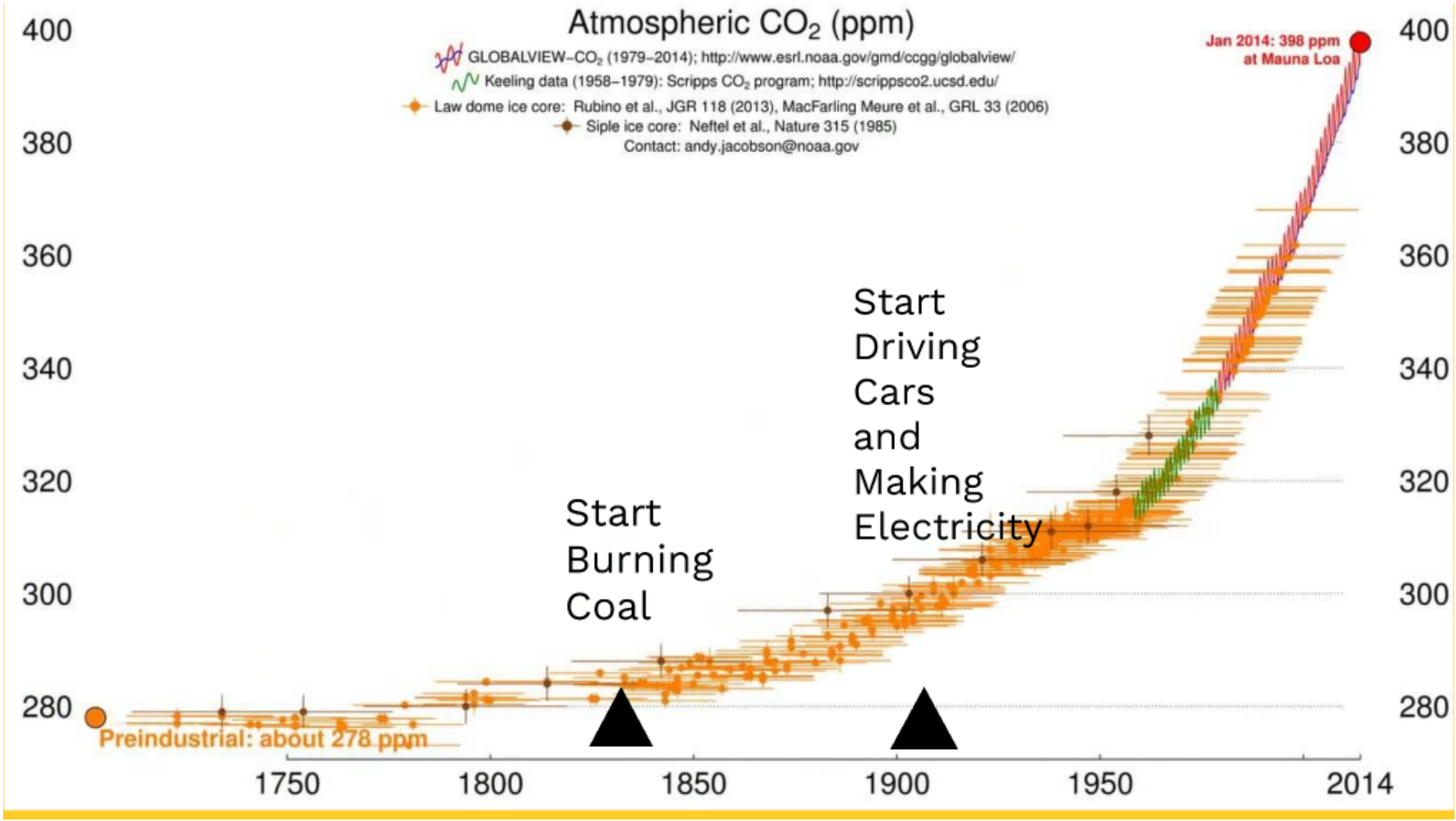

What is our Energy Sources ?
How is Energy produced ?
What we use Energy for ?
All Things Energy
YES! Vantage Sustainability Group
February 27, 2019
How energy impacts our atmosphere
Reduce the impact of energy on the atmosphere
Created by Tom McDougall


The current methods of how we are producing energy and the amount we use is significantly changing how our atmosphere filters our environment on Earth
Earth's Atmosphere

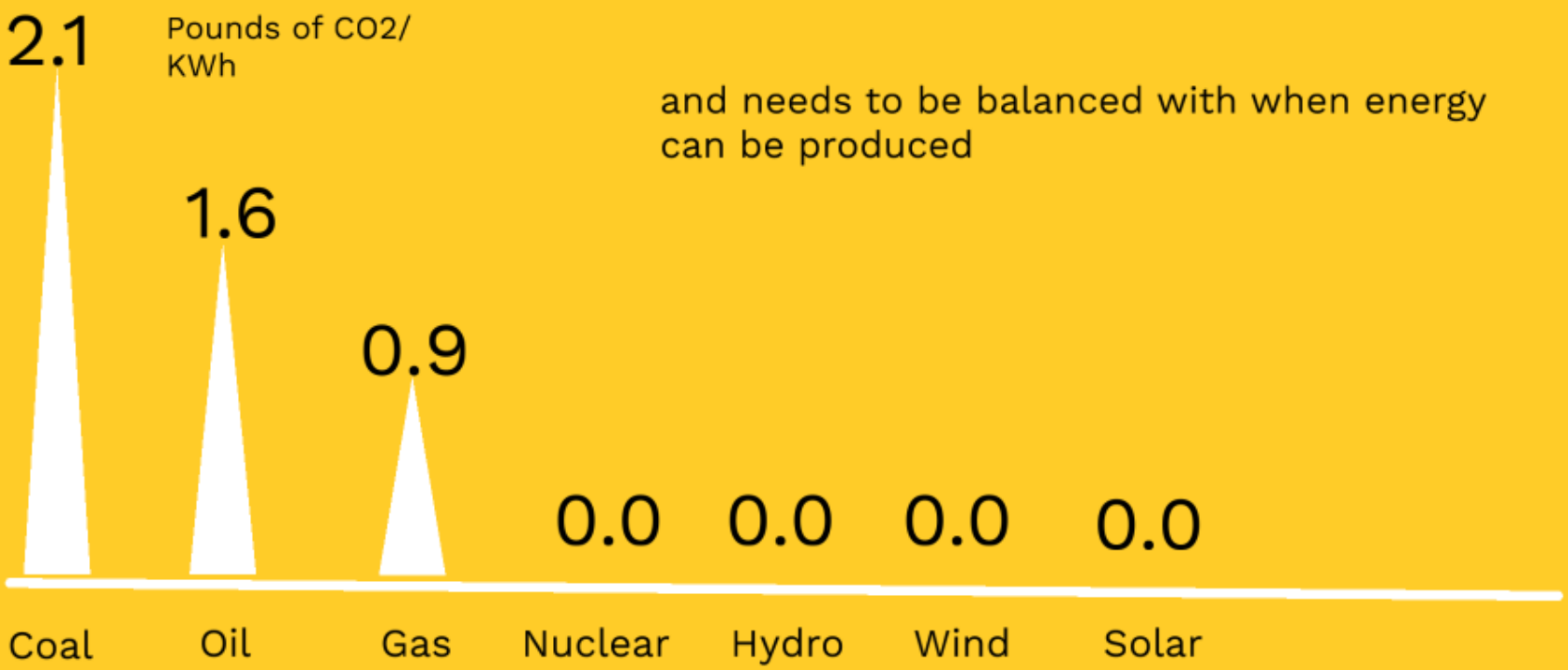
How are atmosphere works



We are Dumping 110 Million Tons of Manmade Global Warming Pollution into the Atmosphere every 24 Hours
With no ecomomic consequence except for natures reaction
Photo © Peter Weber/Shutterstock


Atmospheric CO_2 (ppm)
GLOBALVIEW–CO_2 (1979–2014); http://www.esrl.noaa.gov/gmd/ccgg/globalview/
Keeling data (1958–1979): Scripps CO_2 program; http://scrippsco2.ucsd.edu/
Law dome ice core: Rubino et al., JGR 118 (2013), MacFarling Meure et al., GRL 33 (2006)
Siple ice core: Neftel et al., Nature 315 (1985)
Contact: andy.jacobson@noaa.gov
Jan 2014: 398 ppm at Mauna Loa
Start Burning Coal
Start Driving Cars and Making Electricity
Preindustrial: about 278 ppm
400
380
360
340
320
300
280
1750
1800
1850
1900
1950
2014

Electric power CO2 Emissions by fuel type and generation efficiency varies significantly

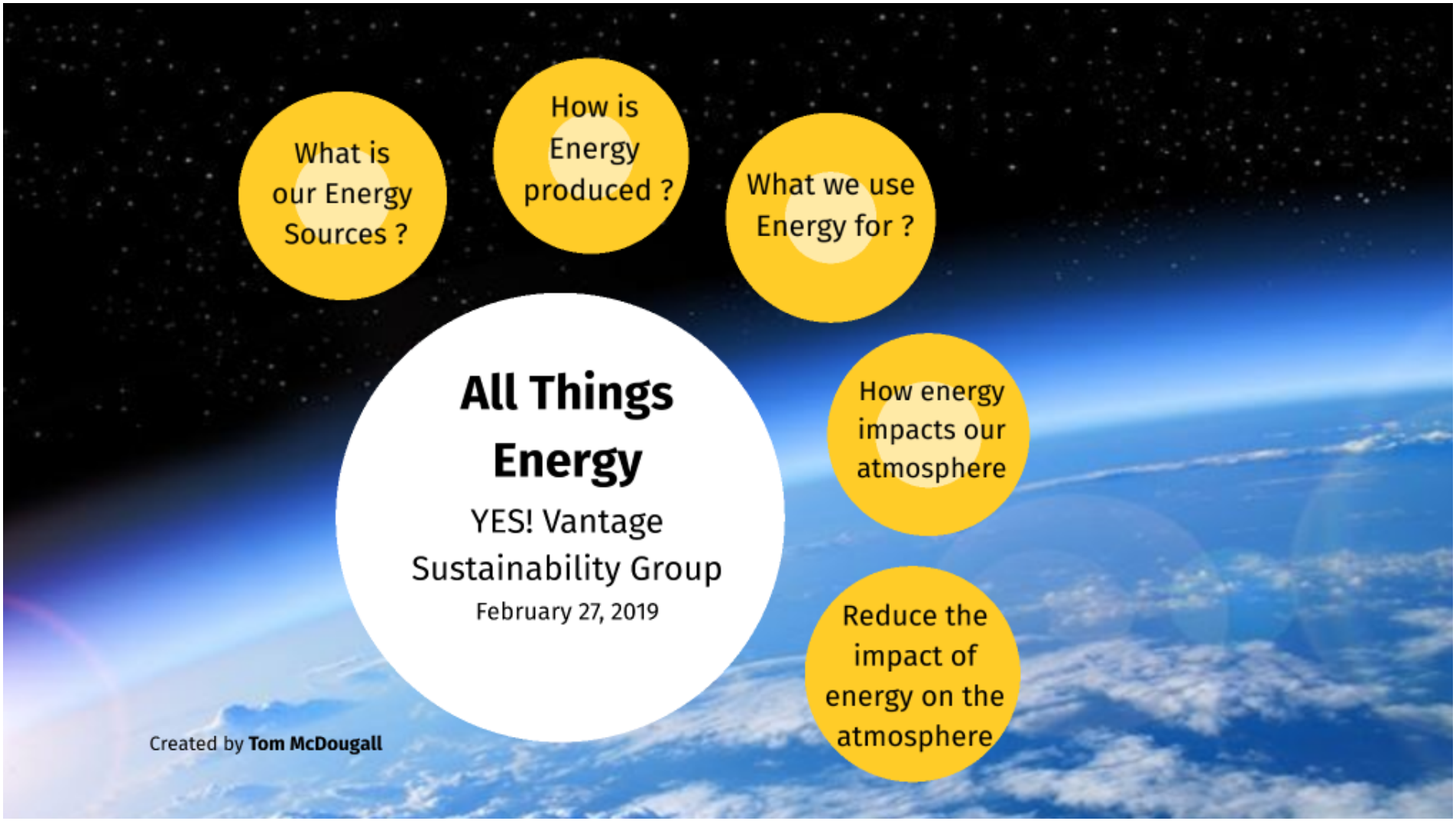


Automobile CO2 Emissions by fuel type and generation efficiency also varies significantly

Pounds of CO2/ mile

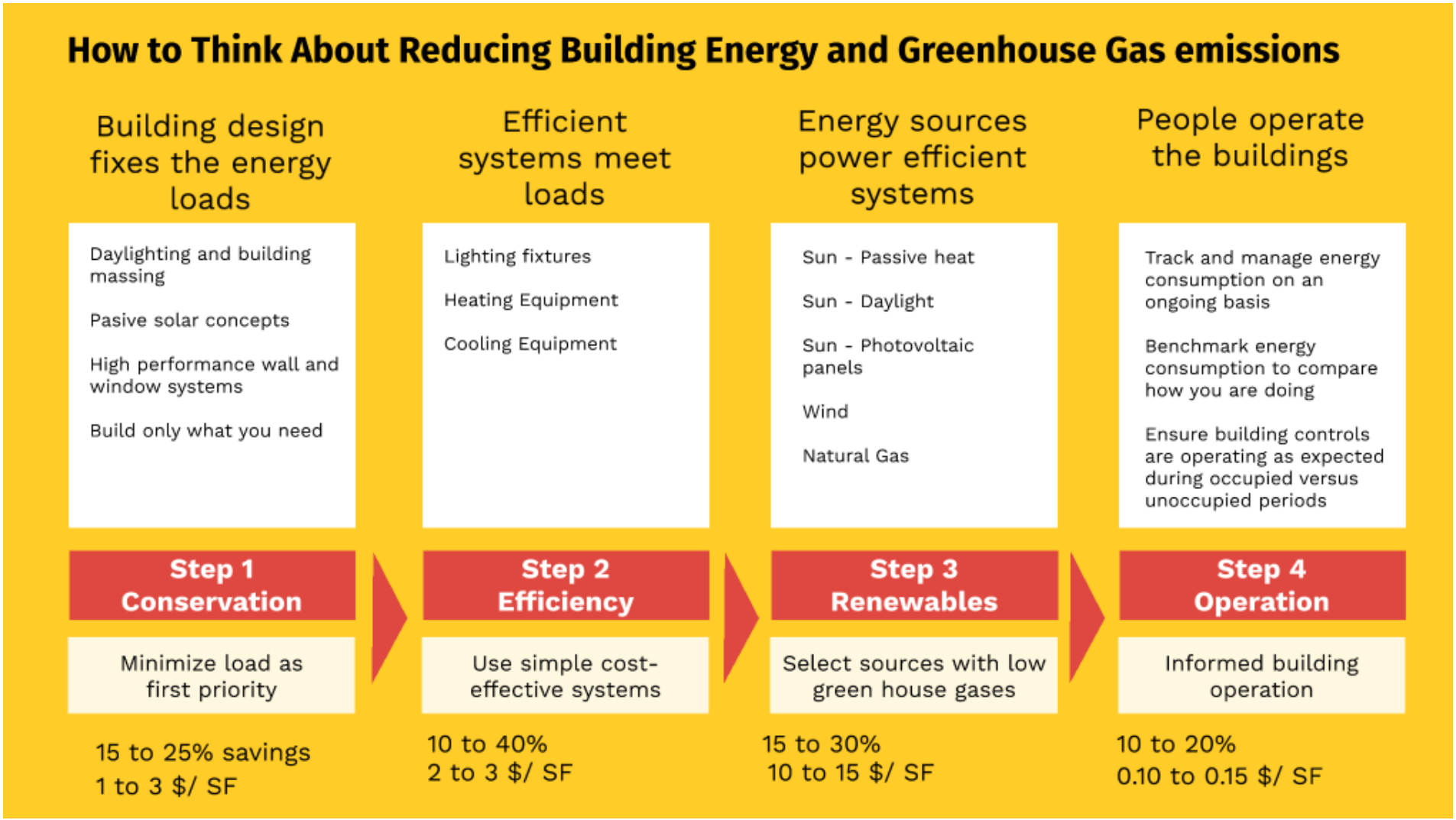
Gasoline combustion engines are much less effcient than electric motors

Hummer	Typical SUV	Typical Car	Hybrid Car	All Electric Car
1.7	1.0	0.7	0.3	0.3
12 mpg	20 mpg	30 mpg	55 mpg	3 kWh/ mile


What is our Energy Sources ?
How is Energy produced ?
What we use Energy for ?
All Things Energy
YES! Vantage Sustainability Group
February 27, 2019
How energy impacts our atmosphere
Reduce the impact of energy on the atmosphere
Created by Tom McDougall

The opportunities to reduce energy consumption and greenhouse gases have never been better !
Just say YES! and Take Action
Design Process
Conservation
Efficiency
Energy Sources
Informed Operation

How to Think About Reducing Building Energy and Greenhouse Gas emissions

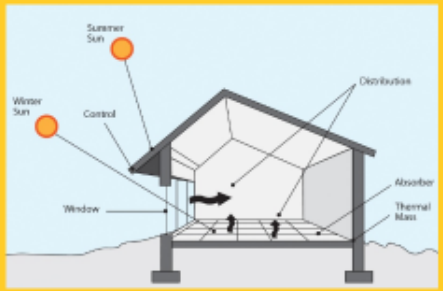


Conservation = Building design to reduce building loads

Pasive Solar

Passive solar gain - increase window area on south, minimize on north, east, and west

Shade summer sun angles to reduce cooling loads, while letting sun in during winter months

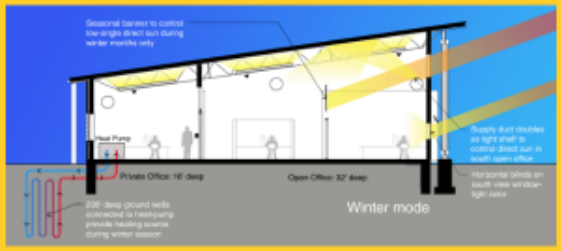


Daylighting

Use daylight through windows to keep lights turned off during the day time

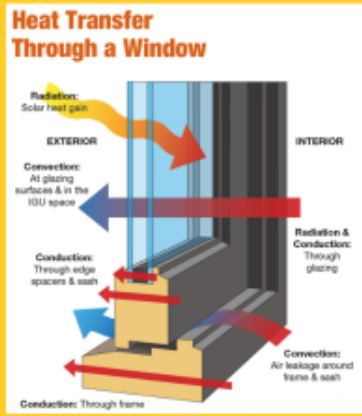
Shape building so daylight can illuminate most spaces

Room depths no greater than 2 times the window head height



Effective Insulation

Increase thermal resistance of wall and roofs - higher R values

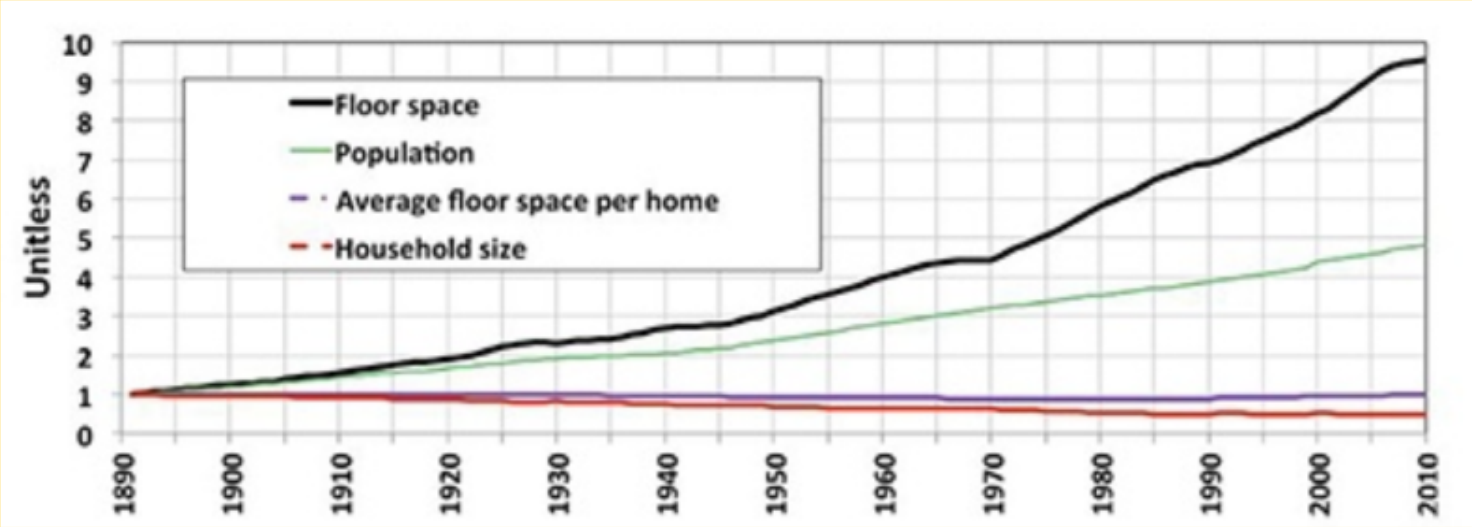


Build only what you need

Since 1890, housing floor space has increased 10 times, while the population has increased only 5 times

This corresponds to a doubling of floor space per capita from 400 square feet in 1890 to 800 square feet

U.S change in residential floor space and poulation from 1890 to 2010 (Pacific Northwest Labs study 2015)



Efficiency = Energy input / Energy output

Lighting efficiency has increased dramatically over the last 100 years

Cost to purchase and operate for 3 hours a day for an entire year:

Incandescent $ 8.60
LED $ 1.20

Efficiency = Energy input / Energy output

Heating efficiency with furnaces or boilers have a made significant effciency improvments as compared to coal and oil fueled systems 100 years ago

Old coal / oil / wood boilers are have effciency ratings from 55% to 65%

Average boilers and furnances have an efficiency rating 80% to 85%

High Efficiency condensing boilers have efficiency ratings of 92% to 96%. They can be combined with heating domestic hot water to improve overall effieciency

Cost increase can be 25 to 30% more

Efficiency = Energy output / Energy input

Air Conditioning invented in the 1930's has also seen increases in efficiency

Average air conditioners have an energy effeciency rating (EER) of 8 to 12 Btu output per watt of energy input

Some new ductless split air conditioning systems now approach over 25 EER

The Renewable Energy Revolution is NOW - continuing to use old energy sources are no longer sustainable - it is time to start the transition

Wind energy was predicted to provide 30 gigawatts of electricity worldwide by 2010

As of 2016 we had exceeded that prediction by 16 times over

Solar energy is an even more dramatic story. 15 years ago the best projection was that we would install 1 gigawatt of solar energy capacity per year by 2010

By 2010, we exceeded that goal by 17 times In 2016 we exceeded the goal by 75 times.

Support Community Solar projects - like the one in Granite Falls

Step 1 Reduce
Practice conservation
and efficiency first

Support Community Solar projects - like the one in Granite Falls

Step 1 Reduce
Practice conservation and efficiency first

Typical home uses 6,000 kWh per year

Support Community Solar projects - like the one in Granite Falls

Step 1 Reduce
Practice conservation and efficiency first

Typical home uses 6,000 kWh per year

Convert all lights to LED's - around 30 to 35

Save 2,000 kWh per year

at a cost of $200

Support Community Solar projects - like the one in Granite Falls

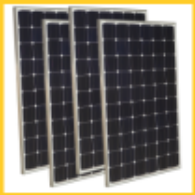
Step 1 Reduce
Practice conservation and efficiency first

Typical home uses 6,000 kWh per year

Convert all lights to LED's - around 30 to 35

Save 2,000 kWh per year

at a cost of $200



This is equivalent to installing 4 Solar PV panels to

generate 2,000 kWh per year

at a cost of $3,200

Support Community Solar projects - like the one in Granite Falls

Step 1 Reduce
Practice conservation and efficiency first

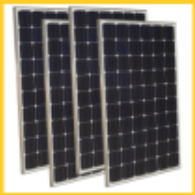
Typical home uses 6,000 kWh per year

After efficiency upgrade you only use 4,000 kWh per year

Convert all lights to LED's - around 30 to 35

Save 2,000 kWh per year

at a cost of $200



This is equivalent to installing 4 Solar PV panels to

generate 2,000 kWh per year

at a cost of $3,200

Support Community Solar projects - like the one in Granite Falls

Step 1 Reduce
Practice conservation and efficiency first

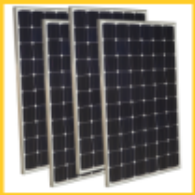
Typical home uses 6,000 kWh per year

After efficiency upgrade you only use 4,000 kWh per year

Convert all lights to LED's - around 30 to 35

Save 2,000 kWh per year

at a cost of $200



This is equivalent to installing 4 Solar PV panels to

generate 2,000 kWh per year

at a cost of $3,200

Step 2 Select
Determine the amount of panels you want to subscibe to

Support Community Solar projects - like the one in Granite Falls

Step 1 Reduce
Practice conservation and efficiency first

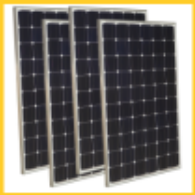
Typical home uses 6,000 kWh per year

After efficiency upgrade you only use 4,000 kWh per year

Convert all lights to LED's - around 30 to 35

Save 2,000 kWh per year

at a cost of $200



This is equivalent to installing 4 Solar PV panels to

generate 2,000 kWh per year

at a cost of $3,200

Step 2 Select
Determine the amount of panels you want to subscibe to

To generate 4,000 kWh, you will need 10 Solar PV panels

Support Community Solar projects - like the one in Granite Falls

Step 1 Reduce
Practice conservation and efficiency first

Typical home uses 6,000 kWh per year

After efficiency upgrade you only use 4,000 kWh per year

Convert all lights to LED's - around 30 to 35

Save 2,000 kWh per year

at a cost of $200

This is equivalent to installing 4 Solar PV panels to

generate 2,000 kWh per year

at a cost of $3,200

Step 2 Select
Determine the amount of panels you want to subscibe to

To generate 4,000 kWh, you will need 10 Solar PV panels

If you buy and intsall them they will cost $7,800 and your electricty will be free

Support Community Solar projects - like the one in Granite Falls

Step 1 Reduce
Practice conservation and efficiency first

Typical home uses 6,000 kWh per year

After efficiency upgrade you only use 4,000 kWh per year

Convert all lights to LED's - around 30 to 35

Save 2,000 kWh per year

at a cost of $200

This is equivalent to installing 4 Solar PV panels to

generate 2,000 kWh per year

at a cost of $3,200

Step 2 Select
Determine the amount of panels you want to subscibe to

To generate 4,000 kWh, you will need 10 Solar PV panels

If you buy and intsall them they will cost $7,800 and your electricty will be free

If you subscribe to the community solar program the net cost will be around $150 per year and your electricity will be free

Informed Operation - Energy use is invisble - you need a dashboard !

And **you can build one** using the free Minnesota B3 Energy Benchmarking program to enter meter energy consumption data for your school building to see:

Potential energy savings

If your school is using more or less energy than before

How your school ranks with different benchmarks

How your school ranks to other schools

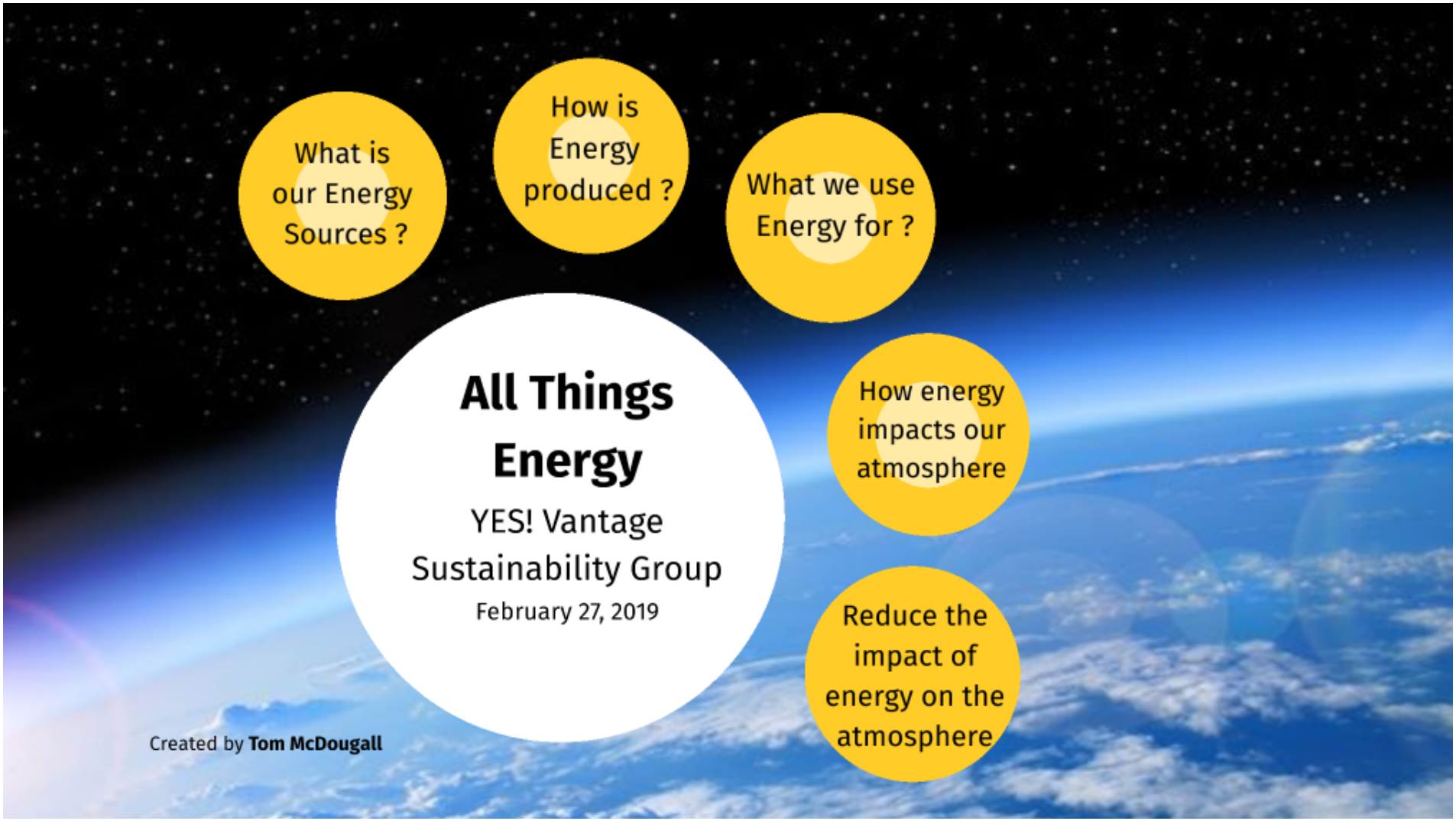
What schools in your district have the highest savings potential

Monitoring Real Time Energy Use

There are now simple systems to measure your home or school energy consumption

In Closing - What you can do ?

- **Support legislation** to account for the cost of carbon in the atmosphere
- **Be Vigilant - Don't waste Energy** - turn off lights, TV's and computers, when not being used
- **Install LED lamps** in all fixtures in your house, and upgrade to efficient heating/ cooling systems
- **Drive hybrid or all electric cars** and carpool
- **Invest in renewable energy sources for your home**


What is our Energy Sources ?
How is Energy produced ?
What we use Energy for ?
All Things Energy
YES! Vantage Sustainability Group
February 27, 2019
How energy impacts our atmosphere
Reduce the impact of energy on the atmosphere
Created by Tom McDougall