POPULATION 7 BILLION
How your world will change
Let’s get our units right

Basic unit of power is the W

This is actually the rate of energy consumption (Joules/sec)

One Joule is enough energy to launch one apple 1 meter in the air

Something putting out 1 Watt then would generate enough energy to put one apple one meter in the air every second

Average coal power plant is 667,000,000 Watts

That is enough energy to send two apples to the moon EVERY SECOND
How energy is reported

Kilowatt*hour or British Thermal Units
BTU is the amount of energy it takes to raise 1 lb. of water 1 degree F

A 50” Plasma screen TV draws ~ 700 Watts

Just watch TV every night from 5 PM to 10 PM EST

\[
700 \frac{\text{Joules}}{\text{sec}} \times \frac{3600 \text{ sec}}{\text{hour}} \times \frac{5 \text{ hours}}{1 \text{ day}} \times \frac{365 \text{ days}}{1 \text{ year}} = 4.6 \times 10^9 \text{ Joules}
\]

\[
700 \text{ Watts} \times 5 \text{ hours} \times 365 = 1.28 \times 10^6 \text{ Whours or 1.28 MWhours/year}
\]

\[
4.4 \times 10^6 \text{ BTU}
\]

This would send our apple to 1/10 of the way to Mars in a year
Energy Measures and Units

1 log = 24,500 BTU

BTU is the amount of energy it takes to raise 1 lb. of water 1 degree F

1 gallon gasoline = 5 logs

1 gallon gasoline = 36 kWh
13,000 AA batteries
4,000 smart phone batteries
2010 U.S. Daily Per Capita Energy Demand

Household Use: 7

Personal Transportation: 6

Commercial Buildings: 6

Commercial Transportation: 4

Industrial: 11

Total: 34
2010 World Daily Energy Demand

U.S. Per Capita
34
7

World Per Capita
9
1.7

7 billion people =
~12 billion gallons per day

Or

~50 billion gallons US...
Total Energy "consumption"
NOT just Electricity

US Energy By Source - 2013

- Total U.S. = 97.5 quadrillion Btu
- Natural gas 26.6 (27%)
- Petroleum 35.1 (36%)
- Coal 18.1 (19%)
- Renewable energy 9.3 (10%)
- Nuclear electric power 8.3 (8%)
Energy Needs - Growth

Primary Energy Demand by Sector
Quadrillion BTUs

- Electricity Generation
- Industrial
- Transportation
- Res/Comm

- Non OECD
- OECD

ExxonMobil 2015 Outlook for Energy
3000 calories for one marathon

250 kWh/day

Every day, each one of us uses the electricity of 25,000 marathons.
### US Electricity Generation Report (November 2015)

"Rooftop Solar PV" is estimated by the US EIA.

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>YTD 2015</th>
<th>YTD 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>1,266,336</td>
<td>1,223,218</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>1,223,218</td>
<td></td>
</tr>
<tr>
<td>Nuclear</td>
<td>727,544</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>227,819</td>
<td></td>
</tr>
<tr>
<td>Wind</td>
<td>170,602</td>
<td></td>
</tr>
<tr>
<td>Wood and Wood-Derived Fuels</td>
<td>38,769</td>
<td></td>
</tr>
<tr>
<td>Solar PV (utility-scale)</td>
<td>21,685</td>
<td></td>
</tr>
<tr>
<td>Petroleum Liquids</td>
<td>16,470</td>
<td></td>
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<tr>
<td>Geothermal</td>
<td>15,404</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>12,102</td>
<td></td>
</tr>
<tr>
<td>Other Gas</td>
<td>11,800</td>
<td></td>
</tr>
<tr>
<td>Rooftop Solar PV (est.)</td>
<td>11,369</td>
<td></td>
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<tr>
<td>Pet Coke</td>
<td>10,227</td>
<td></td>
</tr>
<tr>
<td>Landfill Gas</td>
<td>10,213</td>
<td></td>
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<tr>
<td>Biogenic Municipal Solid Waste</td>
<td>6,750</td>
<td></td>
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<tr>
<td>Solar Thermal</td>
<td>3,117</td>
<td></td>
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<tr>
<td>Other Waste Biomass</td>
<td>2,888</td>
<td></td>
</tr>
</tbody>
</table>

Latest CO₂ reading
May 30, 2016
407.46 ppm

Carbon dioxide concentration at Mauna Loa Observatory

Month ending June 5, 2016

Hourly average
Daily average
Weekly average

CO₂ Concentration (ppm)

6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1 2 3 4 5
May Jun

400
405
410

SCRIPPS INSTITUTION OF OCEANOGRAPHY
Guess who said all this?

• “I believe in clean air. Immaculate air, but I don’t believe in climate change. “

• “This very expensive GLOBAL WARMING bullshit has got to stop. Our planet is freezing, record low temps, and our GW scientists are stuck in ice.”

• “The concept of global warming was created by and for the Chinese in order to make U.S. manufacturing non-competitive.”
• I think the environment should be put in the category of our national security. Defense of our resources is just as important as defense abroad. Otherwise what is there to defend?
  - Robert Redford

• Global warming is not only the number one environmental challenge we face today, but one of the most important issues facing all of humanity...
  - Leonardo DiCaprio
Germany is showing that it is leading the world in renewable energy use with news that renewable energy sources were responsible for 74% of the country’s ENTIRE ELECTRICITY DEMAND"
Electricity Production in Germany: Calendar Week 21

Actual production

<table>
<thead>
<tr>
<th>Date</th>
<th>Conventional &gt; 100 MW</th>
<th>Wind</th>
<th>Solar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mo 21.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tu 22.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>We 23.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Th 24.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fr 25.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sa 26.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Su 27.05</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Solar: max. 22.4 GW; 1.1 TWh (Fr 25 May, 12:45)
- Wind: max. 9.1 GW; 0.65 TWh
- Conventional: max. 47.0 GW; 6.0 TWh

• **Misconception #2: You need storage for solar power**

• The prevailing misconception is that one must consume the energy as it’s generated or lose it if it is not stored. In this scenario, without storage batteries, there would be no available power at night.

• The net metering system allows the utility companies to “absorb” the energy your system would generate then credit you for the energy supplied. Consumption of energy is supplied from the power grid at any time during the day or night. First the credits are used up, and you pay only for the excess usage.

Solarenergy.net
Myth 3: Renewable energy can’t supply electricity 24/7

“The key to getting a constant supply of electricity from renewable energy is to have a mix of sources: solar and wind power, natural gas, and anaerobic digestion plants. By having a mix of renewable sources which are spread over a wide area, we ensure there will always be a supply of energy.”
Net power generation for the public grid
Year 2015

Electricity production in 2015

The graph shows net power generation from power plants for the public power supply. Electricity from power plants in the processing sector, mining, quarries, and excavation is not included.

Fraunhofer Institut Freiburg
Installierte Netto-Nennleistungen

Jahr 2014

GW

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>GW</th>
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</thead>
<tbody>
<tr>
<td>Uranium</td>
<td>12,068 GW</td>
</tr>
<tr>
<td>Brown Coal</td>
<td>21,206 GW</td>
</tr>
<tr>
<td>Hard Coal</td>
<td>27,853 GW</td>
</tr>
<tr>
<td>Gas</td>
<td>28,439 GW</td>
</tr>
<tr>
<td>Wind</td>
<td>35,678 GW</td>
</tr>
<tr>
<td>Solar</td>
<td>38,124 GW</td>
</tr>
<tr>
<td>Biomass</td>
<td>8,153 GW</td>
</tr>
<tr>
<td>Hydro power</td>
<td>5,619 GW</td>
</tr>
</tbody>
</table>

Netzstromerzeugung 2014

Jahr 2014

TWh

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>TWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uranium</td>
<td>91,8 TWh</td>
</tr>
<tr>
<td>Brown Coal</td>
<td>140,9 TWh</td>
</tr>
<tr>
<td>Hard Coal</td>
<td>99,0 TWh</td>
</tr>
<tr>
<td>Gas</td>
<td>33,2 TWh</td>
</tr>
<tr>
<td>Wind</td>
<td>51,4 TWh</td>
</tr>
<tr>
<td>Solar</td>
<td>32,8 TWh</td>
</tr>
<tr>
<td>Biomass</td>
<td>53,9 TWh</td>
</tr>
<tr>
<td>Hydro power</td>
<td>18,5 TWh</td>
</tr>
</tbody>
</table>
What Are Our Renewable Options?
Guess which one produces more noise...
Wind

• ~0.5% of solar energy ends up in wind.
• Wind power plants use spinning blades to capture the kinetic energy in wind to produce electricity.
• Regions where average wind speeds exceed ~12 mph are good wind power plant sites.
• Wind power is the lowest-cost renewable energy technology available on the market today.
World’s Largest Wind Turbine

• The world’s largest wind turbine is now the Enercon E-126.
• This turbine has a rotor diameter of 413 feet.
• Rated at 6 megawatts.
• That’s enough to power about 1700 American homes on one wind turbine.
• The turbine being installed in Emden, Germany.
• Enercon E101
• 3 MW per turbine
• Generator height: 149m
• Diameter: 101m
• Up to 8,000 homes
Tägliche Produktion Wind

Jahr 2014

TWh


0,1  |  0,2  |  0,3  |  0,4  |  0,5  |
There must be a source of energy down there.
Rückblick auf das Energieprojekt der Sparkasse

Was bedeutet Energie?
Wo kommt sie eigentlich her?
Welche erneuerbaren Energien gibt es?


Vielen Dank sagen die Schülerinnen und Schüler der GS Herzog Höhe!
Photovoltaic Solar Resource: United States - Spain - Germany

Annual average solar resource data are for a solar collector oriented toward the south at a tilt = local latitude. The data for Hawaii and the 48 contiguous states are derived from a model developed at SUNY/Albany using geostationary weather satellite data for the period 1998-2005. The data for Alaska are derived from a 40-km satellite and surface cloud cover database for the period 1986-1991 (NREL, 2003). The data for Germany and Spain were acquired from the Joint Research Centre of the European Commission and is the yearly sum of global irradiation on an optimally-inclined surface for the period 1981-1996.

States and countries are shown to scale, except for Alaska.

[Map of the United States, Spain, and Germany showing solar resource data with a color gradient indicating kWh/m²/Year.]