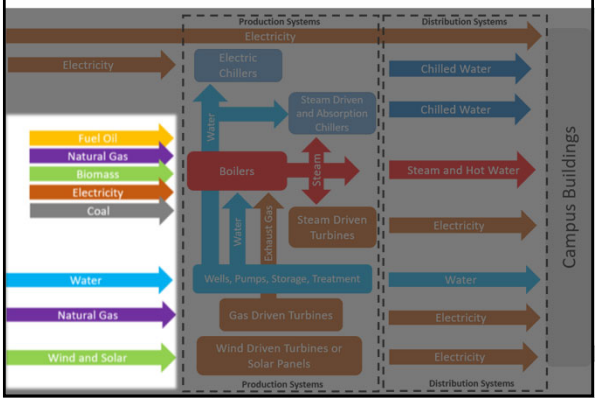
314: FUELS

SEPTEMBER 2019

JEFF ZUMWALT

FUELS



COURSE OVERVIEW

- Fuel terms and concepts
- Primary fuels
  - Natural Gas
  - Coal
  - Oil
  - Renewables (sun, wind, & biofuels)

COURSE OVERVIEW

Common issues for each fuel type:

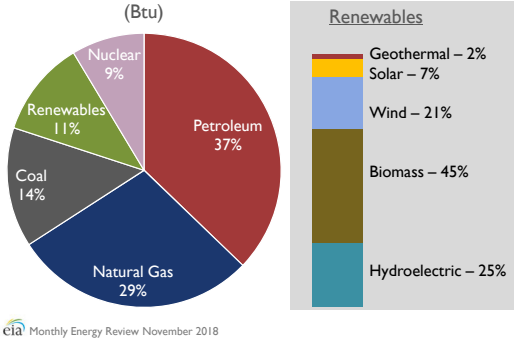
- Emissions
- Reliability
- Flexibility
- Costs – capital and O&M
  - Volatility/risk
  - Purchasing Strategies

CAMPUS FUEL USE

- Space heating
- Autoclaves, sterilization
- Domestic hot water
- Cooking
- Other processes
- Generate electricity (Cogeneration)
- Absorption Chillers

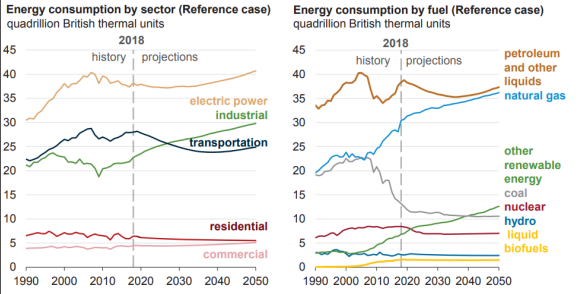
U.S. ENERGY CONSUMPTION

97.9 quadrillion British thermal units (Btu)



eia Monthly Energy Review November 2018

U.S. ENERGY CONSUMPTION



U.S. Energy Information Administration #AEO2019 | www.eia.gov/aeo

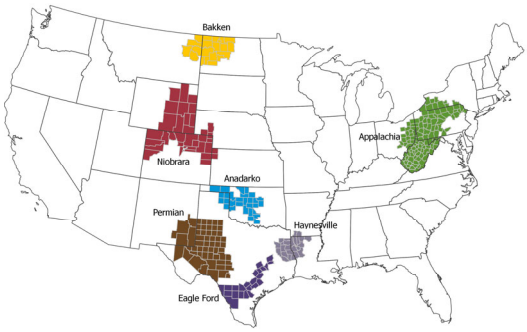
Colorless and odorless gas

NATURAL GAS

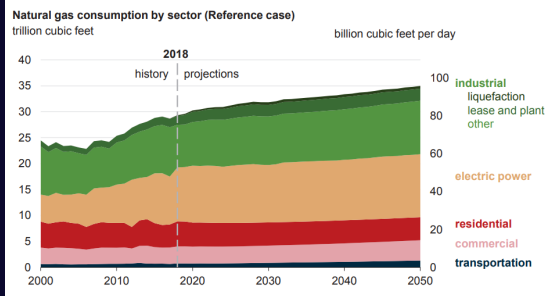
94% - Methane (CH_4)
4% Ethane (C_2H_6)
1% - Propane (C_3H_8)
1% - Nitrogen

Transported via pipeline and ship

WHERE IS THE NATURAL GAS?



U.S. NATURAL GAS USAGE

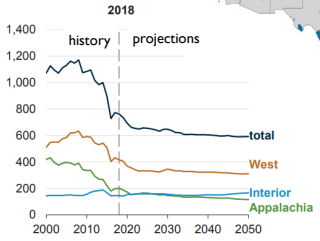


COAL

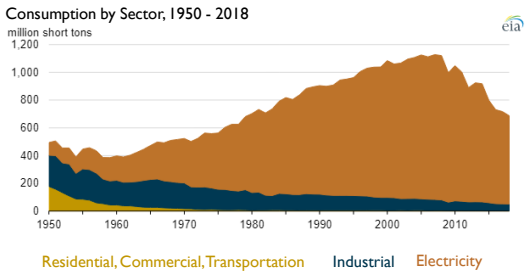
Solid – fossilized plant matter

- Carbon
  - sulfur
  - hydrogen
  - nitrogen
  - oxygen
- Transported via rail or truck

COAL BASINS



U.S. COAL USAGE



Liquid – fossilized plants and animals

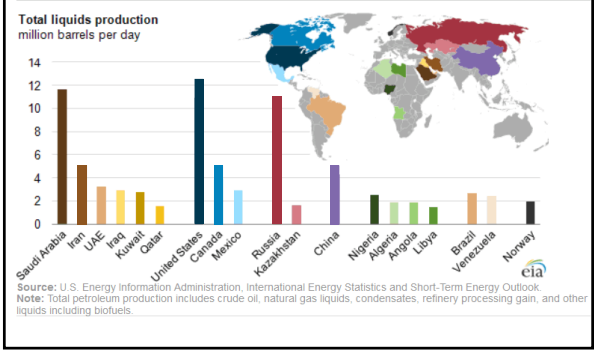
FUEL OIL

Distilled from Crude Oil

- 86% - carbon
- 12% - hydrogen
- 1% - sulfur
- 0.5% - nitrogen
- 0.5% - oxygen

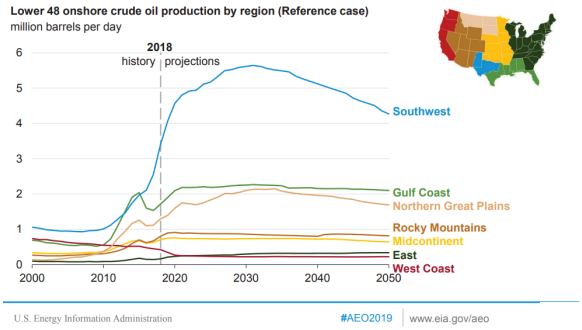
Transported via rail, pipeline, or truck

WHERE IS THE OIL?

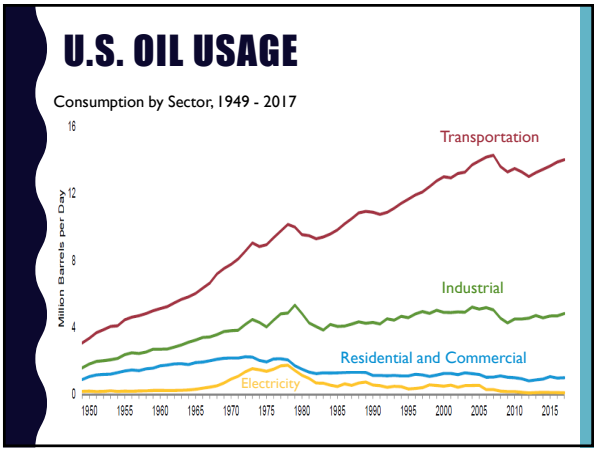


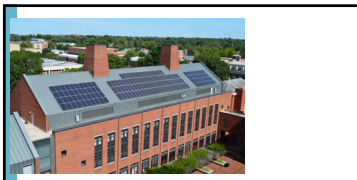
Source: U.S. Energy Information Administration, International Energy Statistics and Short-Term Energy Outlook.
Note: Total petroleum production includes crude oil, natural gas liquids, condensates, refinery processing gain, and other liquids including biofuels.

US TOTAL CRUDE OIL PRODUCTION



U.S. OIL USAGE





RENEWABLES

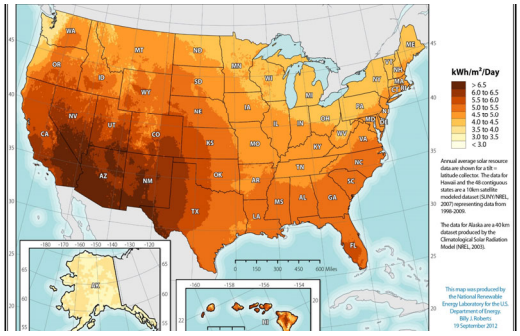
- Solar
- Wind
- Biofuels/Biomass

SOLAR

Photovoltaic

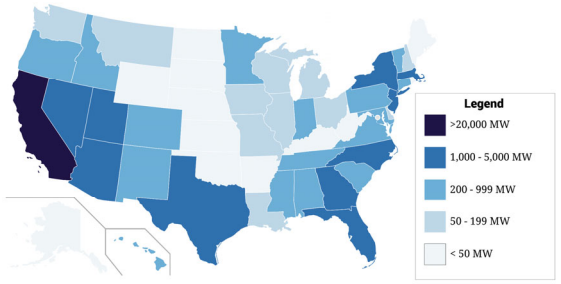
Concentrated Solar

POTENTIAL SOLAR ENERGY



INSTALLED SOLAR ENERGY

Cumulative Solar Capacity by State through 2017



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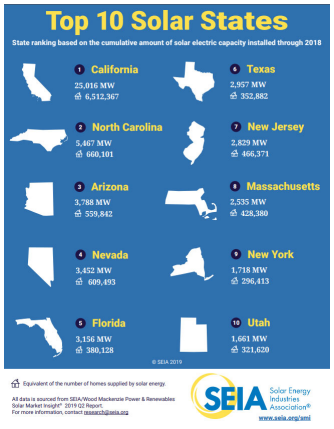
INSTALLED SOLAR ENERGY



SOLAR PV COST

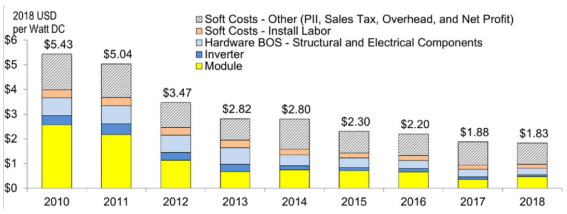


Figure 22. NREL commercial PV system cost benchmark summary (inflation adjusted), 2010–2018

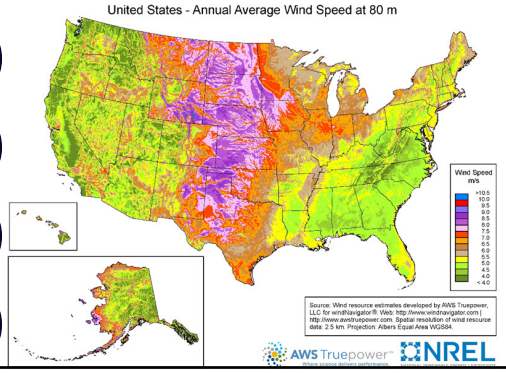
WIND

Wind Farm - PPA

On Campus

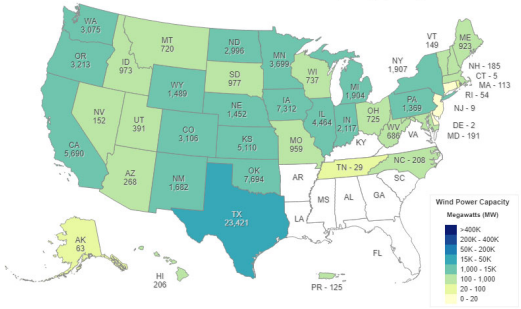
POTENTIAL WIND ENERGY

United States - Annual Average Wind Speed at 80 m



INSTALLED WIND ENERGY

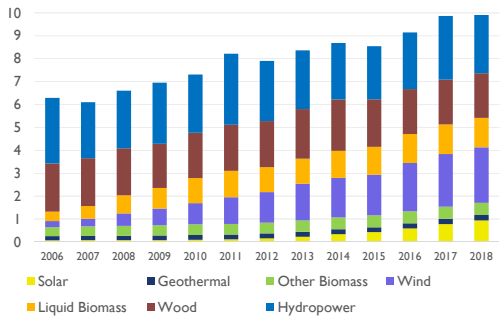
Q3 2018 Installed Wind Power Capacity (MW)



Total Installed Wind Capacity: 90,550 MW

Source: American Wind Energy Association Market Report

RENEWABLE ENERGY USE



All Economic Sectors (quadrillion Btu)

COMPARE

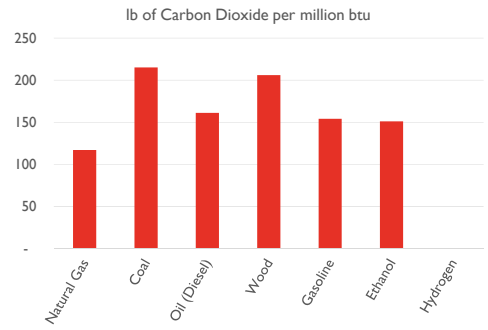
Greenhouse Gases

Pollutants

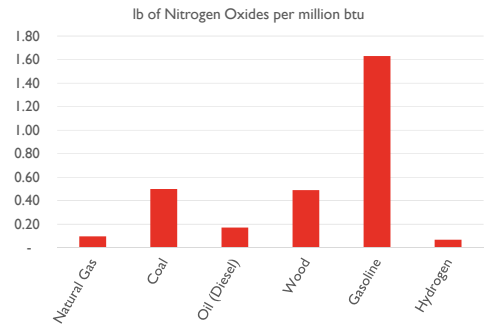
Energy Density

Price Factors

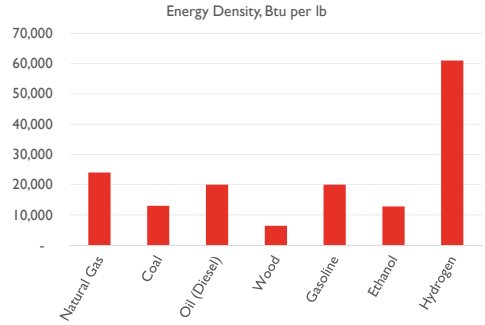
EMISSIONS – CARBON



EMISSIONS – NO_X



ENERGY DENSITY



NATURAL GAS PRICE FACTORS

- Distance from wells
- Pipeline proximity and capacity
- Load profile
- Local costs - distribution, taxes, other
- State regulations
- Competing suppliers

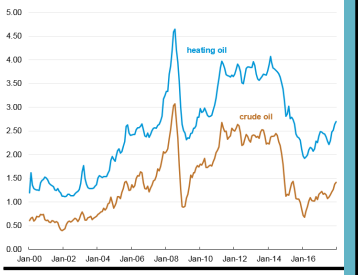
COAL PRICE FACTORS

- Transportation - train, barge, truck
- Sulfur content
  - Sulfur dioxide causes "acid rain"
- Surface coal is cheaper than underground coal
- Government regulations

FUEL OIL PRICE FACTORS

- Crude oil price
- Storage space
- Delivery costs
- Demand

U.S. average monthly heating oil and crude oil prices, 2000 – 2017
Dollars per gallon



Note: Heating oil price is the retail price including taxes. Crude oil price is the composite refiner acquisition cost of crude oil.
Source: U.S. Energy Information Administration, *Short Term Energy Outlook* and *Petroleum Marketing Monthly*, March 2018

SOLAR/WIND VALUE FACTORS

- "Transportation" – geographical
- Linked to local rates
- Availability varies based on local laws/regulations
- Requires connection to local utility

VOLATILITY AND RISK

- Commodity Markets
  - Natural Gas
  - Coal
  - Crude Oil
- Transportation and Storage
  - Increases volatility and risk
- Procurement/Contracting Process
  - Take or pay requirements
  - Balancing issues

COST/RISK MANAGEMENT STRATEGIES

- Hedging or Futures Options
- Ability to Switch Fuels
- Demand Management/Peak Shaving
- Thermal Energy Storage
- Combined Heat & Power
- Customer Incentives
- Renewables

MORE INFORMATION

- U.S. Energy Information Administration
  www.eia.gov
- National Renewable Energy Laboratory
  www.nrel.gov