

314: FUELS

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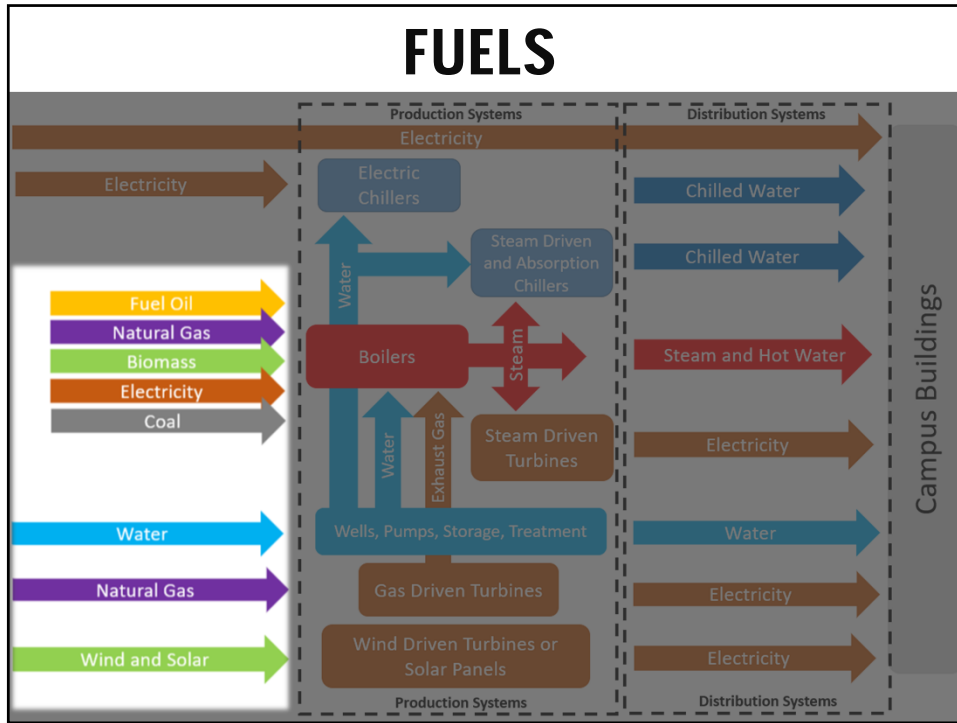
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COURSE OVERVIEW

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

COURSE OVERVIEW

Common issues for each fuel type:

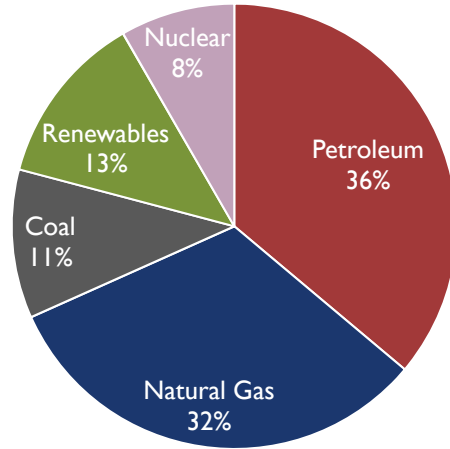
- Emissions
- Reliability
- Flexibility
- Costs – capital and O&M
 - Volatility/risk
 - Purchasing Strategies

CAMPUS FUEL USE

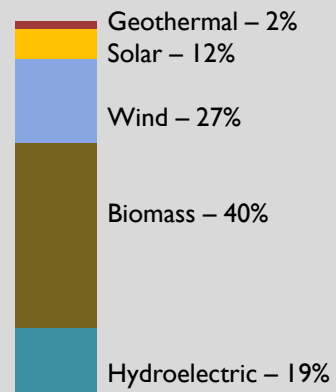
- Space heating
- Autoclaves, sterilization
- Domestic hot water
- Cooking
- Other processes
- Generate electricity (Cogeneration)
- Absorption Chillers

U.S. ENERGY CONSUMPTION

97.3 quadrillion British thermal units (Btu)



Renewables

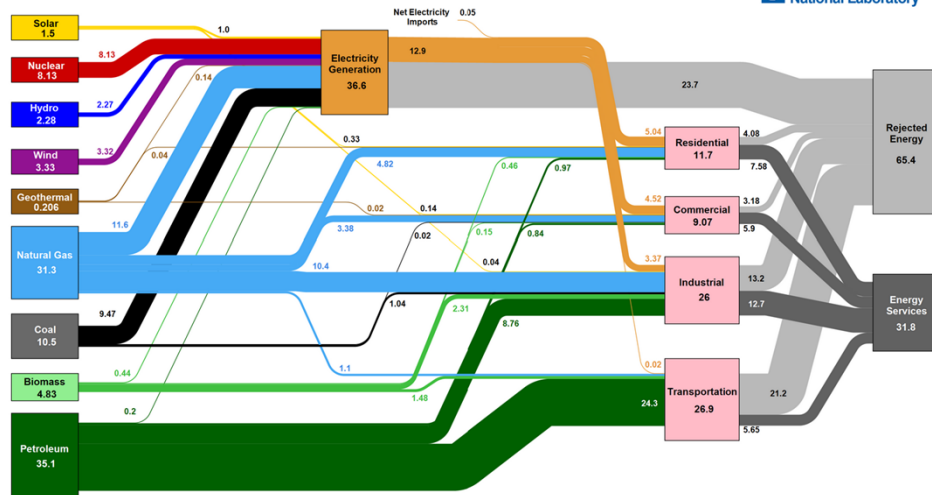


Monthly Energy Review July 2022

U.S. ENERGY CONSUMPTION

Estimated U.S. Energy Consumption in 2021: 97.3 Quads

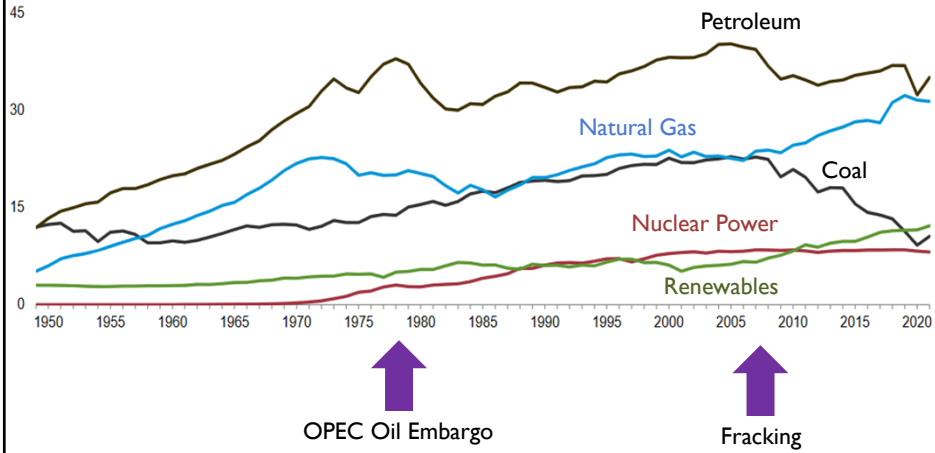
Lawrence Livermore National Laboratory



U.S. ENERGY CONSUMPTION

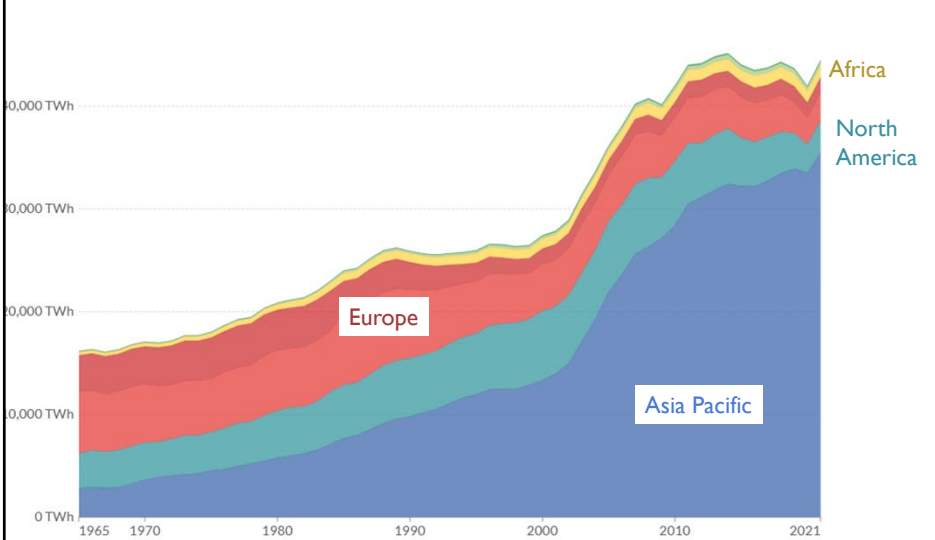
Figure 1.3 Primary Energy Consumption
(Quadrillion Btu)

By Source, [a] 1949–2021



GLOBAL COAL CONSUMPTION

Coal Consumption by Region



Colorless and odorless gas



NATURAL GAS

94% - Methane (CH_4)

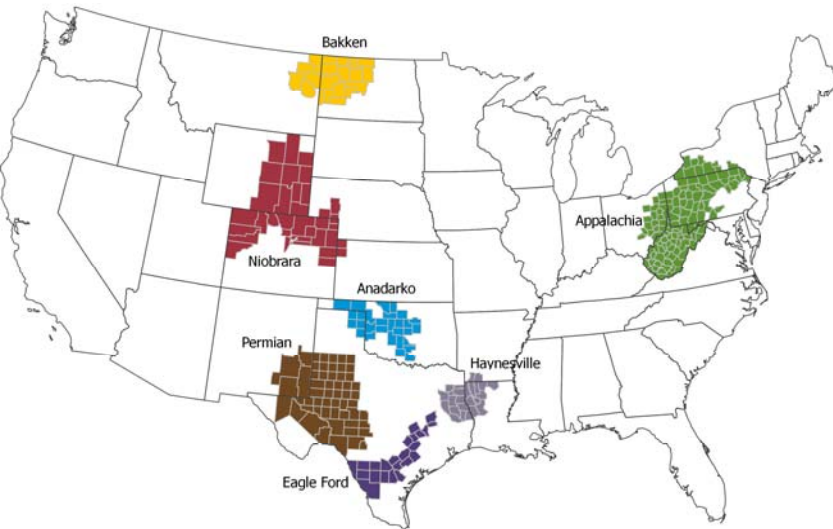
4% Ethane (C_2H_6)

1% - Propane (C_3H_8)

1% - Nitrogen

Transported via pipeline and ship

WHERE IS THE NATURAL GAS?



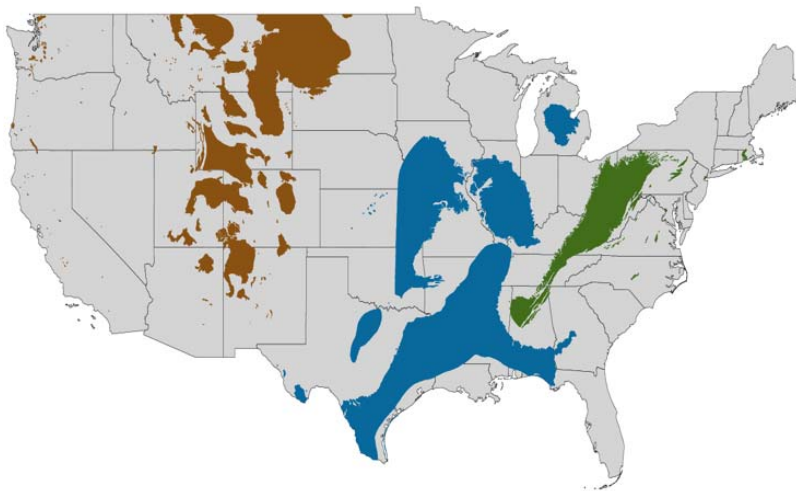
Solid – fossilized plant matter



COAL

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

COAL BASINS



Liquid – fossilized plants and animals



FUEL OIL

Distilled from Crude Oil

86% - carbon

12% - hydrogen

1% - sulfur

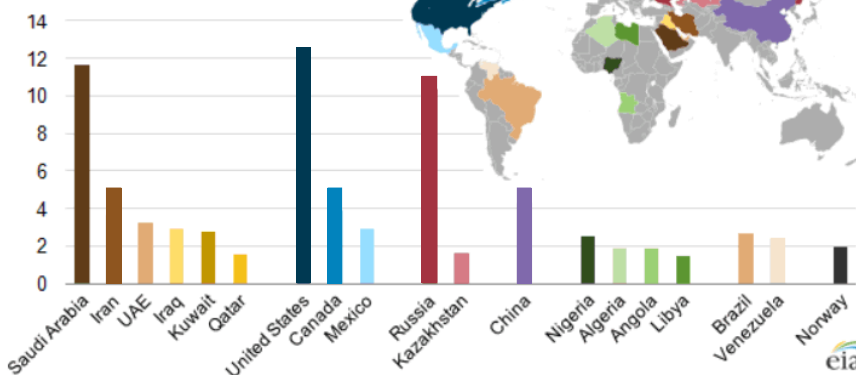
0.5% - nitrogen

0.5% - oxygen

Transported via rail,
pipeline, or truck

WHERE IS THE OIL?

Total liquids production
million barrels per day

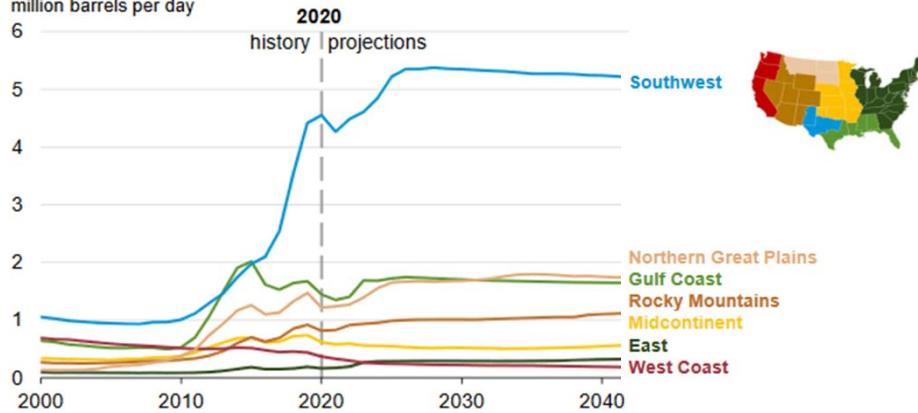


Source: U.S. Energy Information Administration, International Energy Statistics and Short-Term Energy Outlook.
Note: Total petroleum production includes crude oil, natural gas liquids, condensates, refinery processing gain, and other liquids including biofuels.

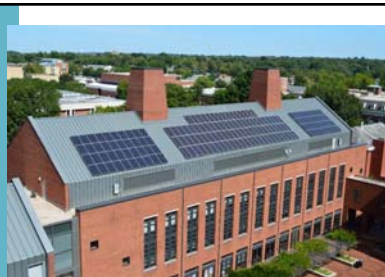
US TOTAL CRUDE OIL PRODUCTION

Onshore crude oil production in the Lower 48 states by region
AEO2021 Reference case

million barrels per day



Source: U.S. Energy Information Administration, *Annual Energy Outlook 2021*



RENEWABLES

Solar

Wind

Biofuels/Biomass

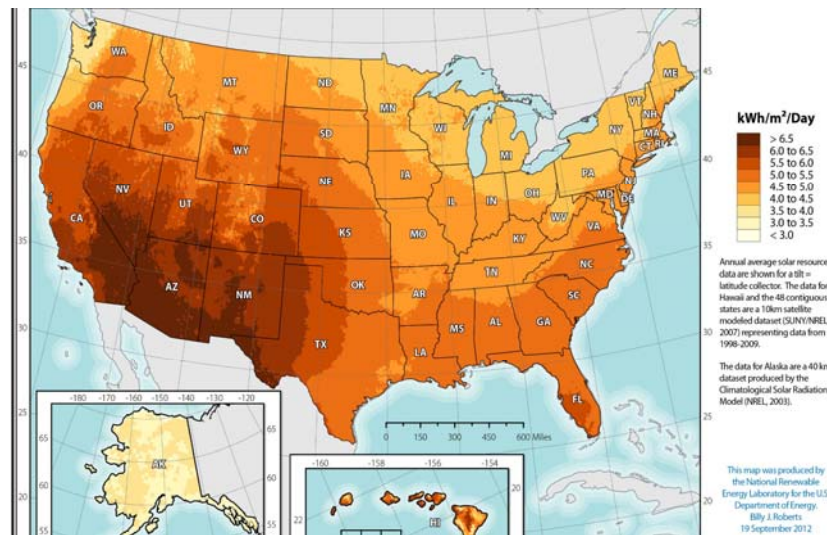


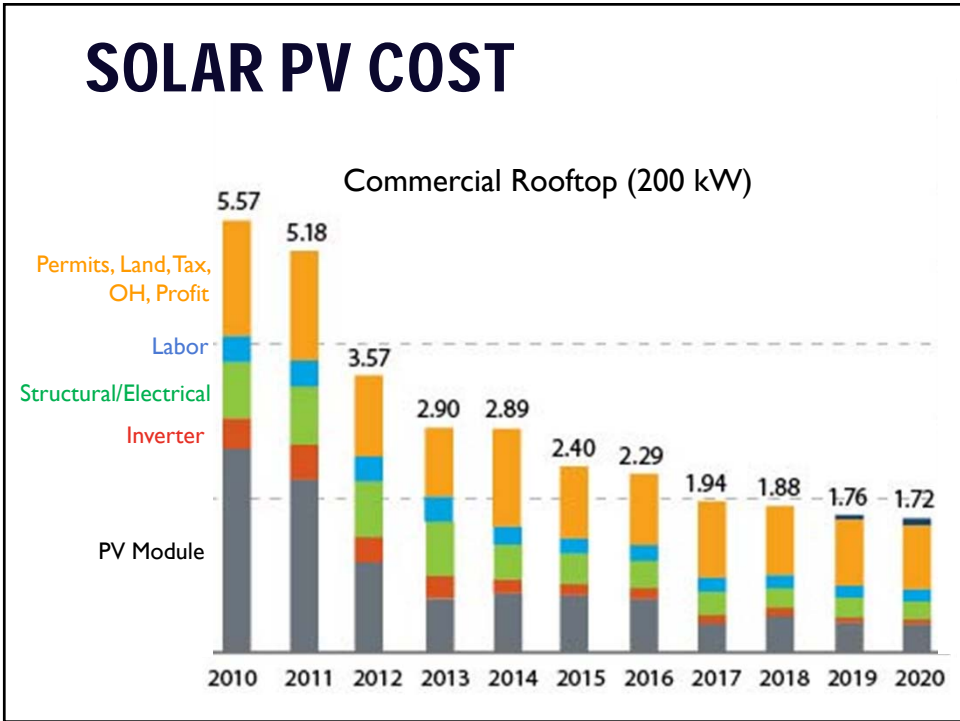
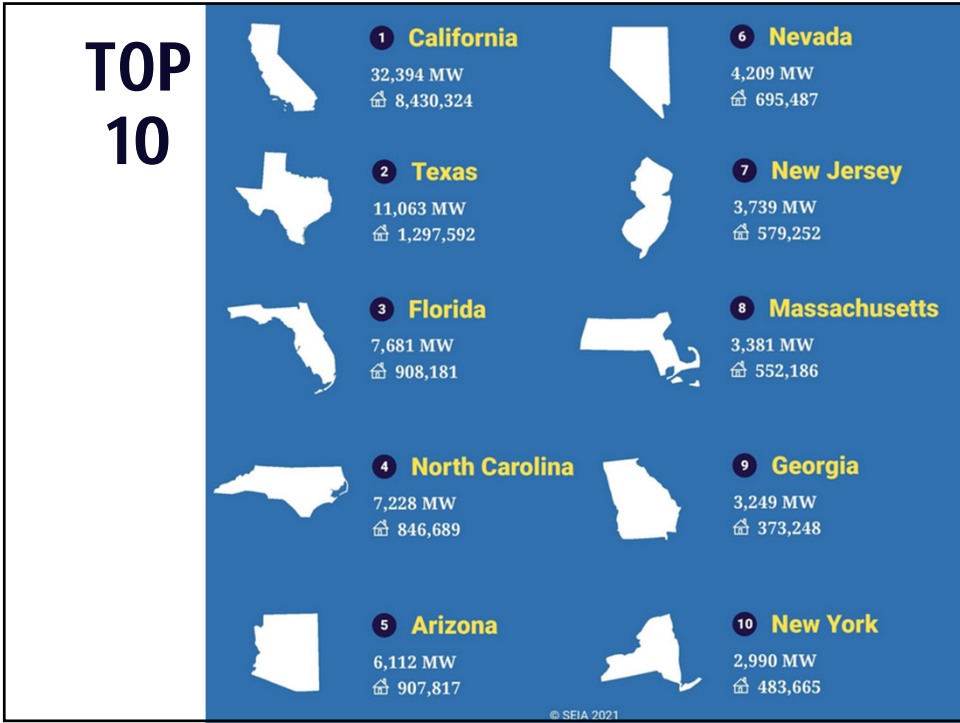
SOLAR

Photovoltaic

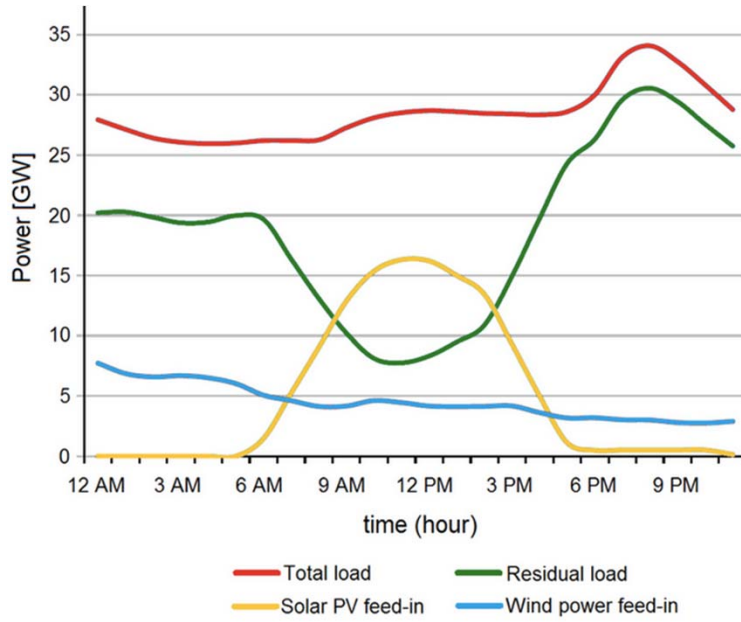
Concentrated
Solar

POTENTIAL SOLAR ENERGY

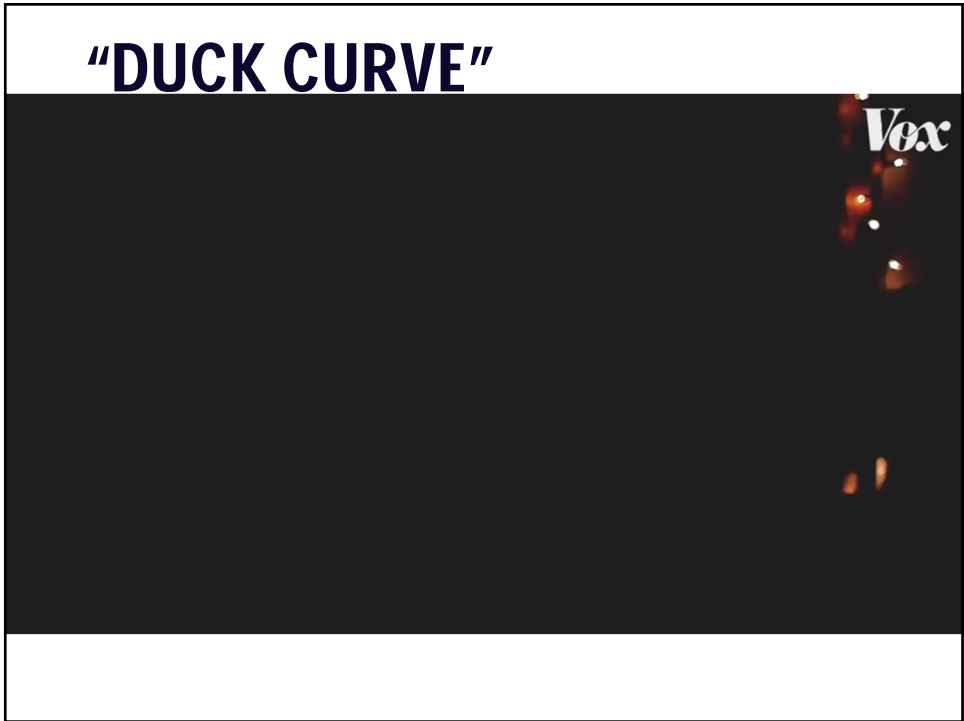




"DUCK CURVE"



"DUCK CURVE"





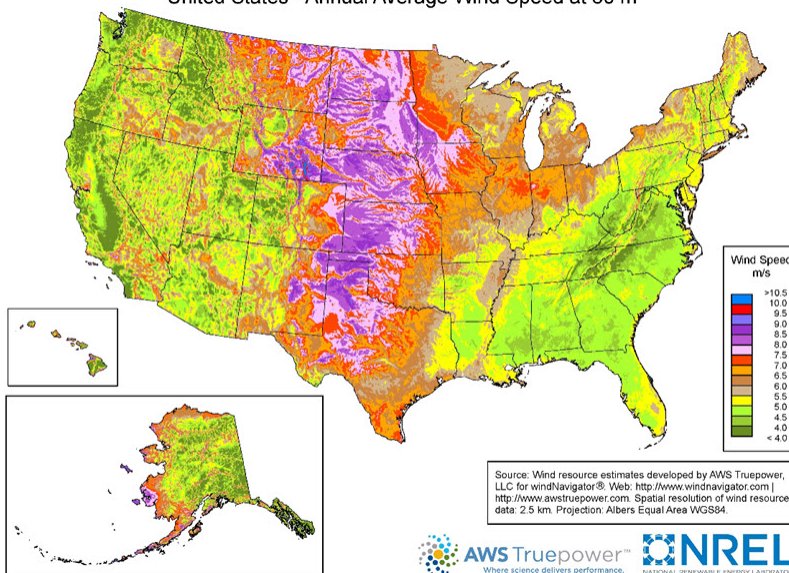
WIND

Wind Farm - PPA

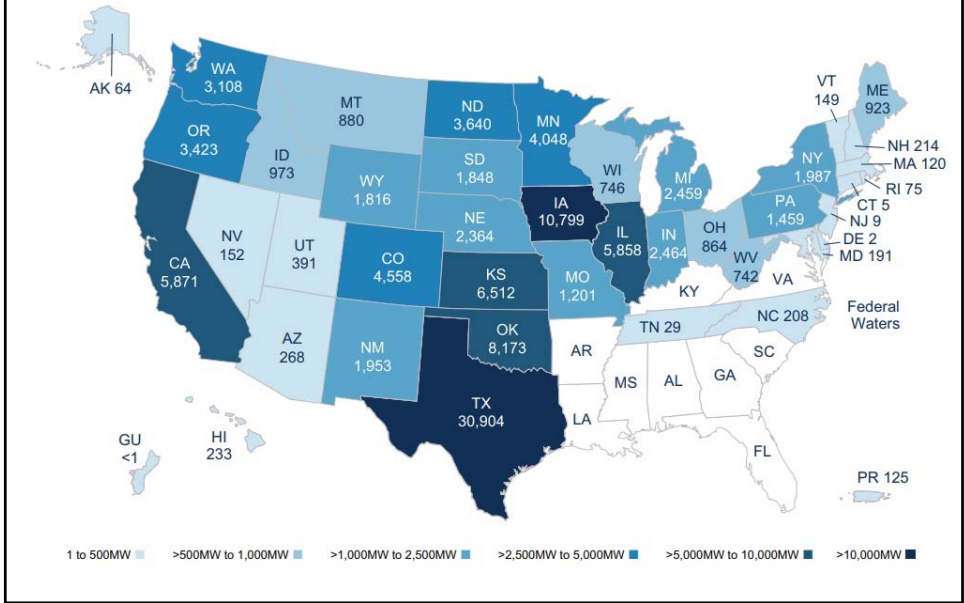
On Campus

POTENTIAL WIND ENERGY

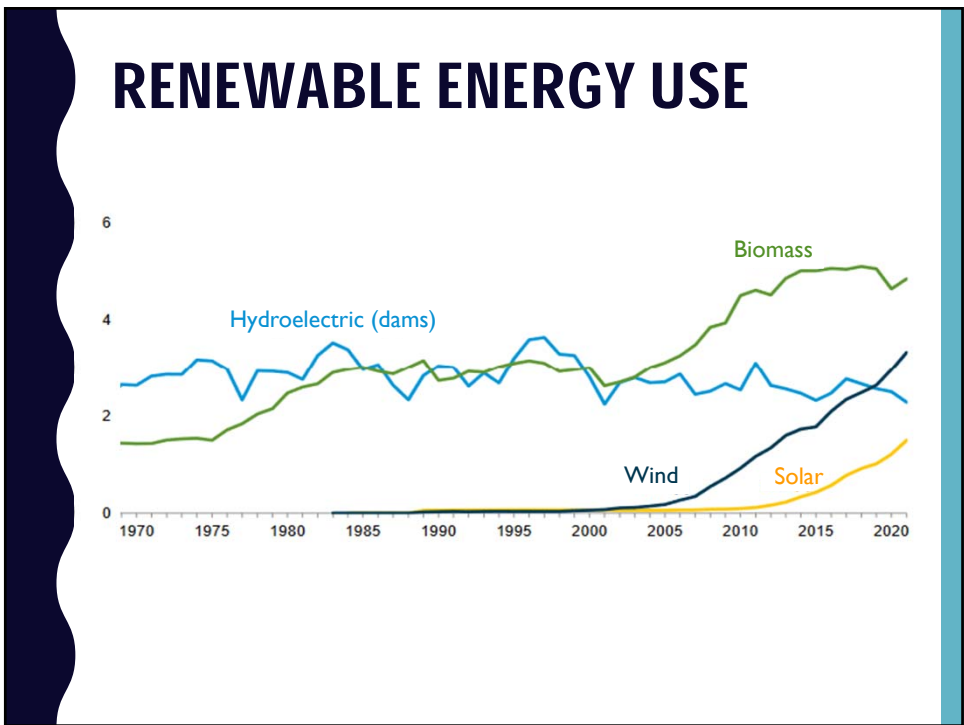
United States - Annual Average Wind Speed at 80 m



INSTALLED WIND ENERGY

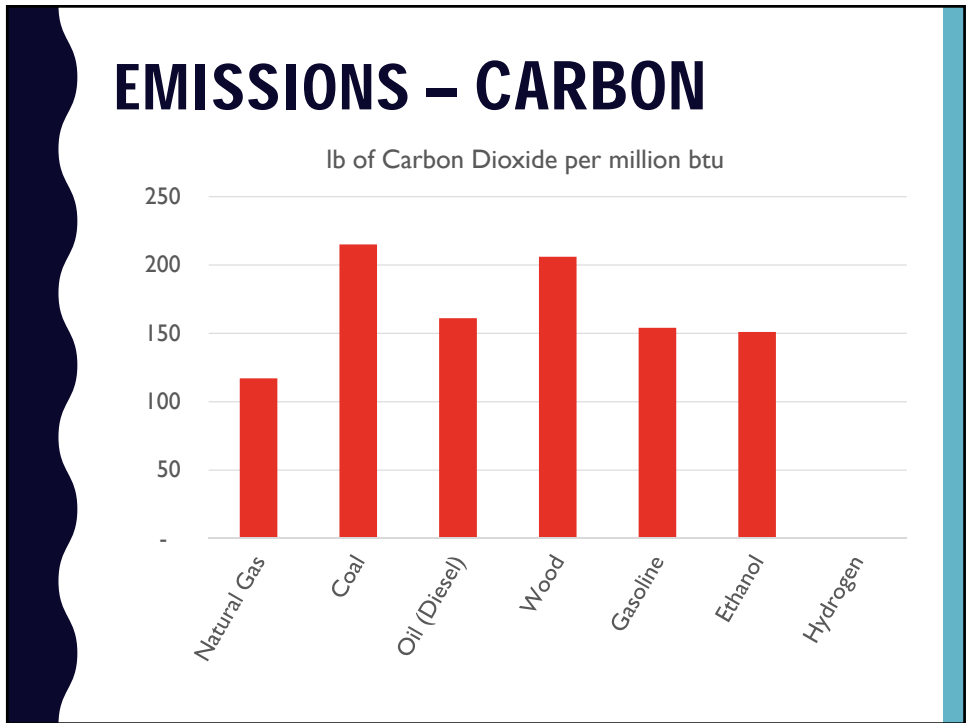


RENEWABLE ENERGY USE



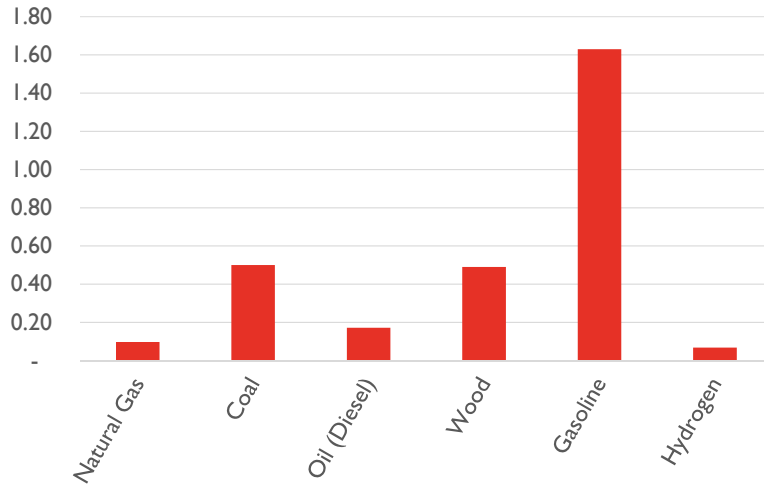
COMPARE

- Greenhouse Gases
- Pollutants
- Energy Density
- Price Factors



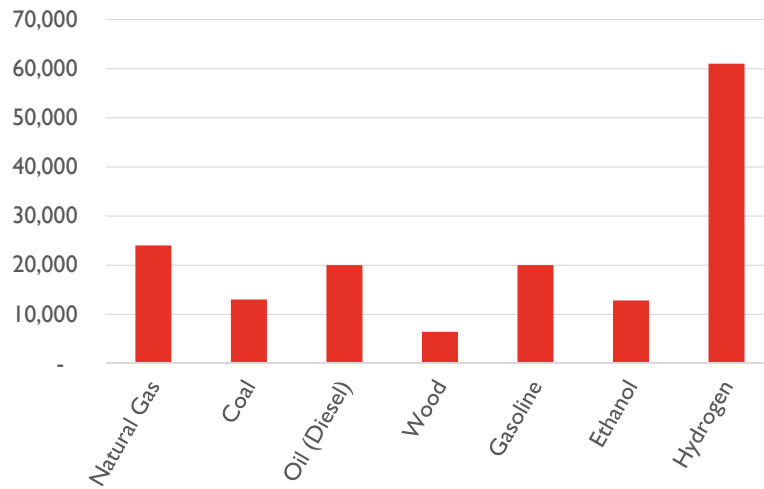
EMISSIONS – NO_x

lb of Nitrogen Oxides per million btu



ENERGY DENSITY

Energy Density, Btu per lb



NATURAL GAS PRICE FACTORS

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

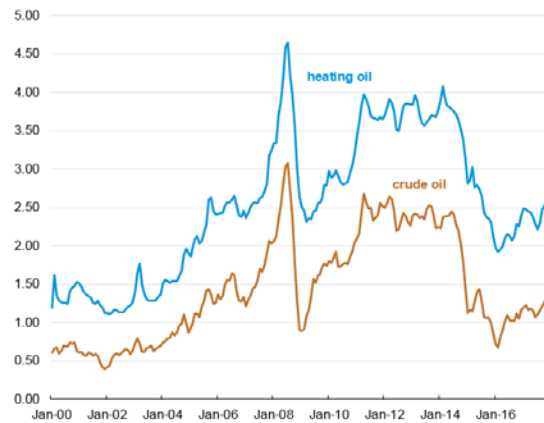
COAL PRICE FACTORS

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

FUEL OIL PRICE FACTORS

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

- Crude oil price
 - Politics
 - Weather
 - Production Limits
- Storage space
- Delivery costs
- Demand



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 cost of electricity
- 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

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