314: FUELS

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AIA Continuing Education Provider

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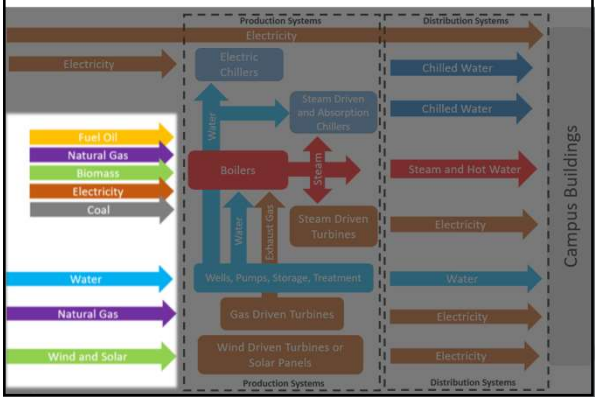
FUELS



COURSE OVERVIEW

- Fuel terms and concepts
- Primary fuels
  - Natural Gas
  - Coal
  - Oil
  - Carbon Free (sun, wind, & nuclear)

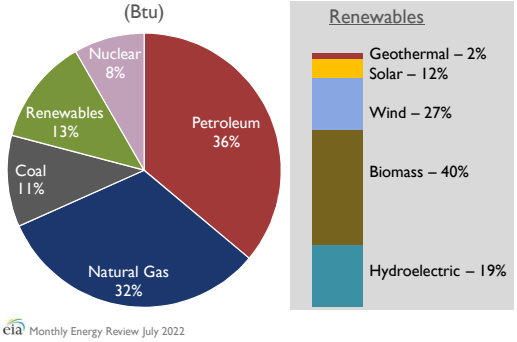
COURSE OVERVIEW

Common issues for each fuel type:

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

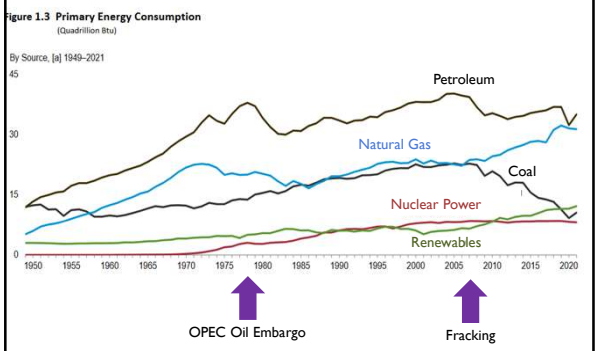
U.S. ENERGY CONSUMPTION

97.3 quadrillion British thermal units (Btu)



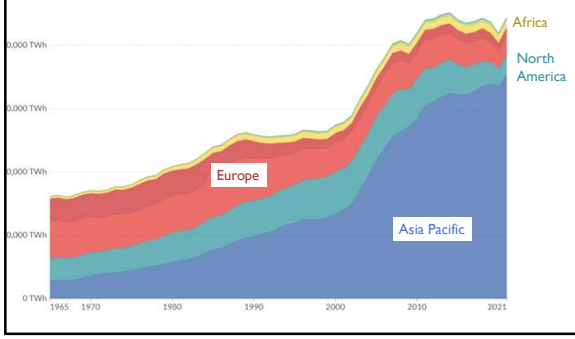
eia Monthly Energy Review July 2022

U.S. ENERGY CONSUMPTION



GLOBAL COAL CONSUMPTION

Coal Consumption by Region



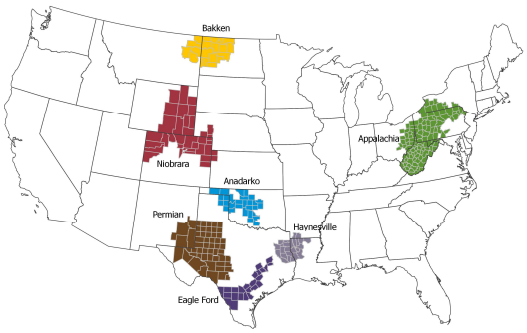
Colorless and odorless gas

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

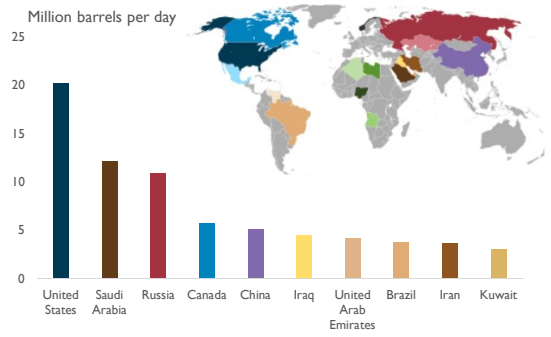
FUEL OIL

Distilled from Crude Oil

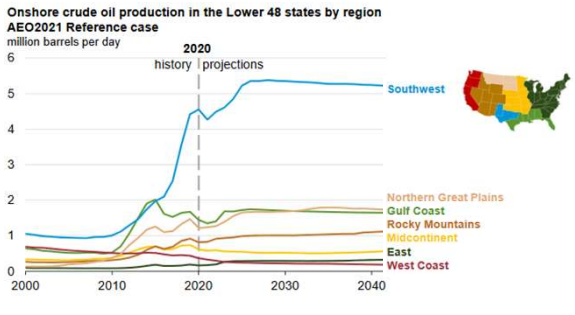
- 86% - carbon
- 12% - hydrogen
- 1% - sulfur
- 0.5% - nitrogen
- 0.5% - oxygen

Transported via rail, pipeline, or truck

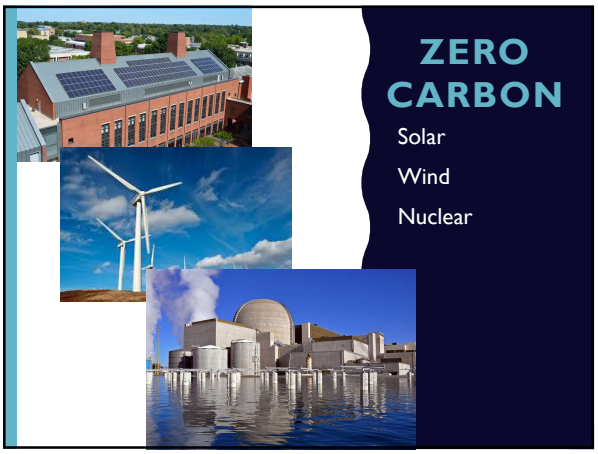
WHERE IS THE OIL?



US TOTAL CRUDE OIL PRODUCTION



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

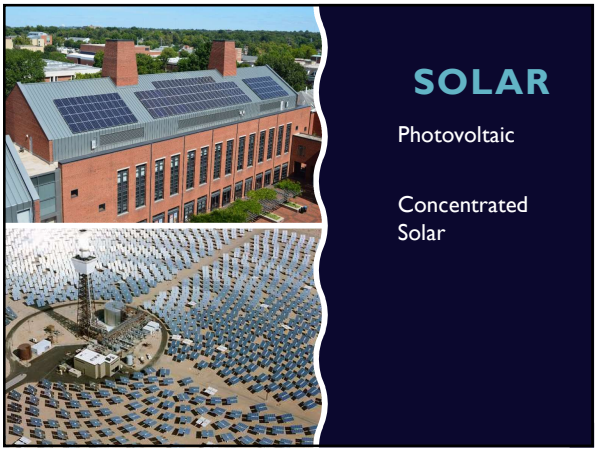


ZERO CARBON

Solar

Wind

Nuclear

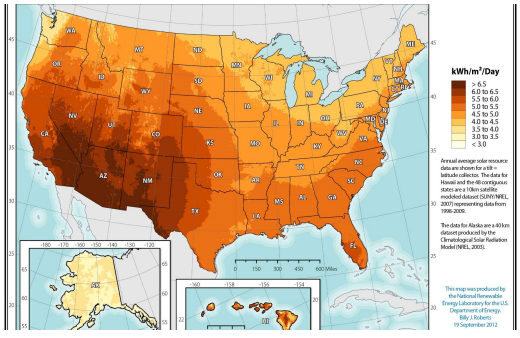


SOLAR

Photovoltaic

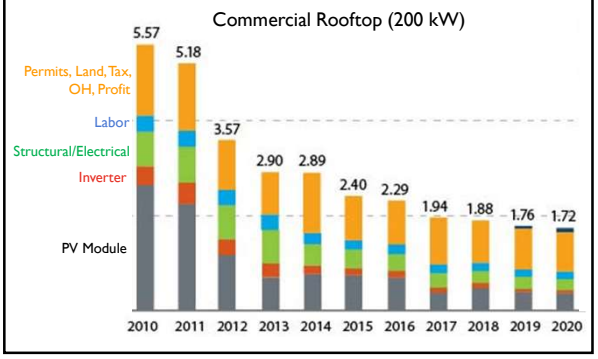
Concentrated Solar

POTENTIAL SOLAR ENERGY

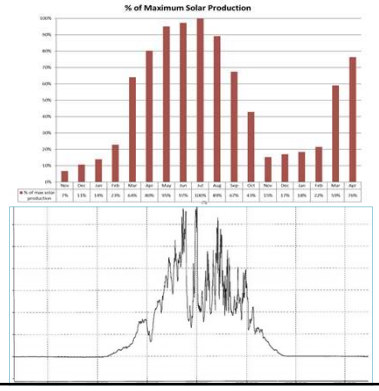


TOP 10

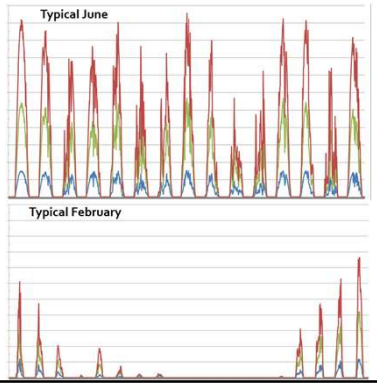
SOLAR PV COST



MICHIGAN CARPORT PV



MICHIGAN CARPORT PV



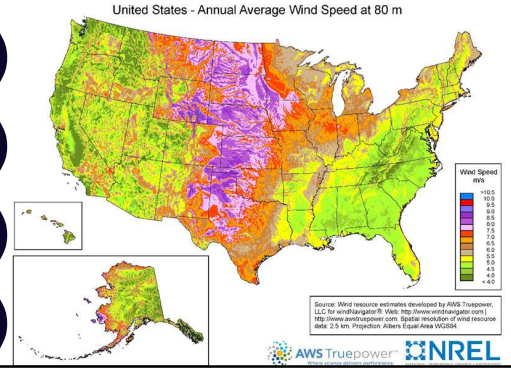
"DUCK CURVE"

WIND

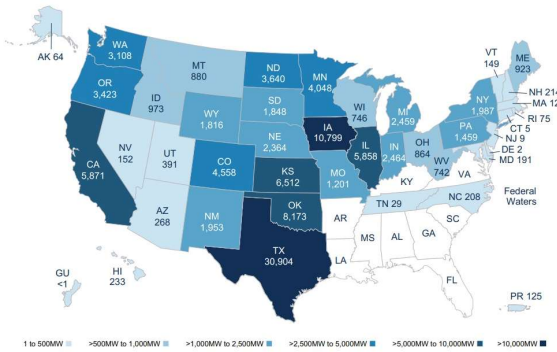
Wind Farm - PPA

On Campus

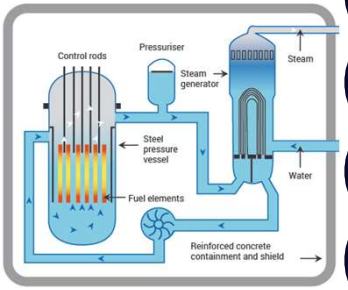
POTENTIAL WIND ENERGY



INSTALLED WIND ENERGY



NUCLEAR



Photovoltaic

Uranium

Plutonium

ed

96% of spent fuel can be recycled

Nuclear Design History

GEN IV ~2020+

GEN I & II 1950 ~ 1965 1965~ 1995	GEN III / III+ 1995 ~ 2010 2010 ~ 2020	ADV REACTORS	SMALL AND MICRO MODULAR REACTORS
• Limited standardization • Evolving regulations	• Some passive safety features • Standardization • Emergence of SMRs	• Beyond LWR's • Simpler designs • More passive fail-safe features • Increased efficiency • Evolving regulatory framework • Owner-operator requirements established	• 30 MW - 320 MW • Containerized reactors • Factory fabricated & tested • Plug-and-play • Fail-safe and self-adjusting designs • Simple design with fewer components

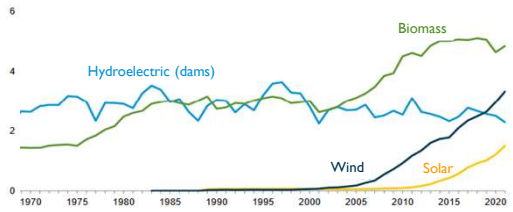
Three Mile Island
Fukushima
Chernobyl

Nuclear design history information from the Electric Power Research Institute, Inc. and US DOE Office of Nuclear Energy.

Nuclear Plans – Higher Education

- **Purdue University** – SMR feasibility study with Duke Energy
- **Penn State** - MOU with Westinghouse to design and install eVinci MMR
- **University of Illinois** - submitted plans to construct and operate a 5 MW MMR demonstration project by Ultra Safe Nuclear Corporation (operational by 2027)

RENEWABLE ENERGY USE



COMPARE

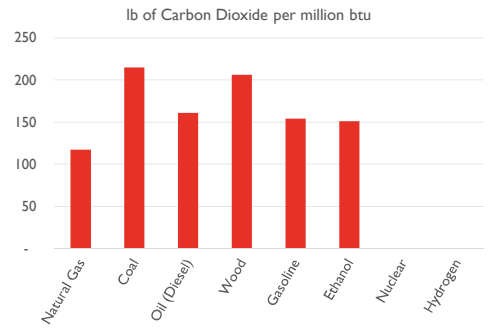
Greenhouse Gases

Pollutants

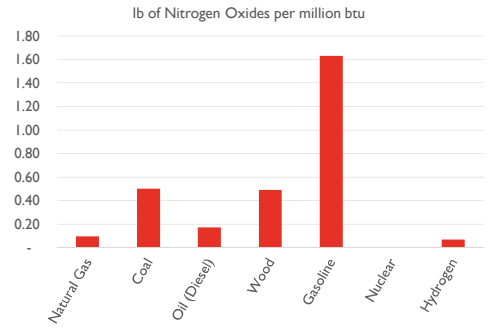
Energy Density

Price Factors

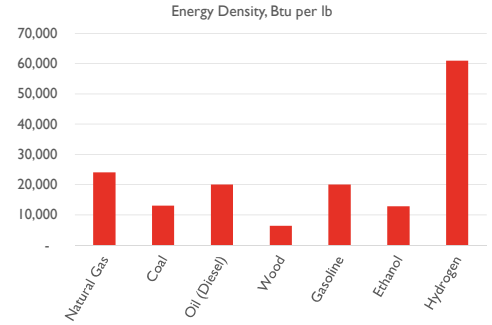
EMISSIONS – CARBON



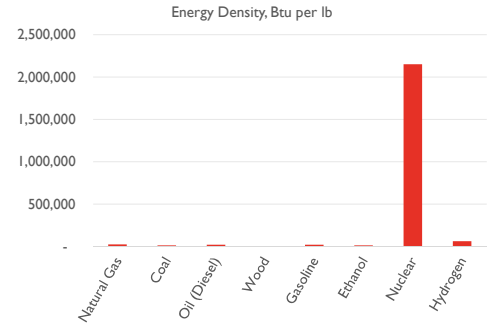
EMISSIONS – NO_X



ENERGY DENSITY



ENERGY DENSITY - NUCLEAR



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
  - Politics
  - Weather
  - Production Limits
- 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 cost of electricity
- Availability varies based on local laws/regulations
- Requires connection to local utility

NUCLEAR PRICE FACTORS

- Construction
- Permitting

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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