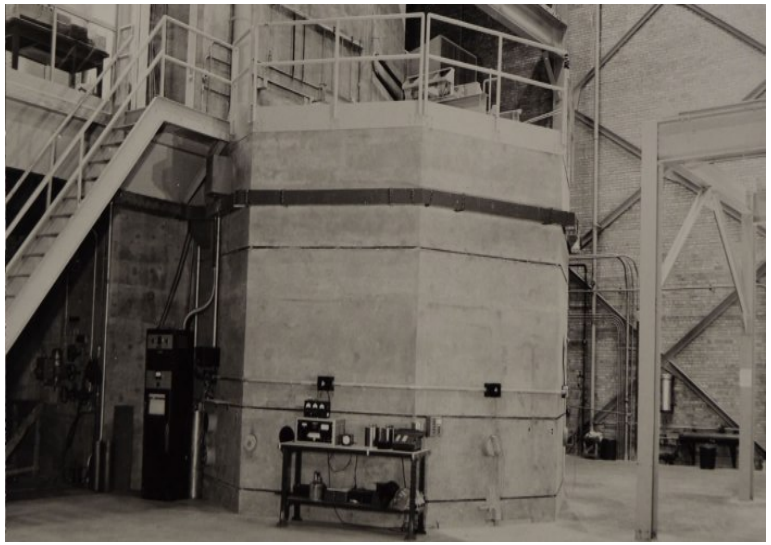


Source: NuScale Corp

A Lecture Presented at
ARCH 289i:
Sustainability at the University of Maryland

Safe and Clean Nuclear Power: A path to No Carbon Future

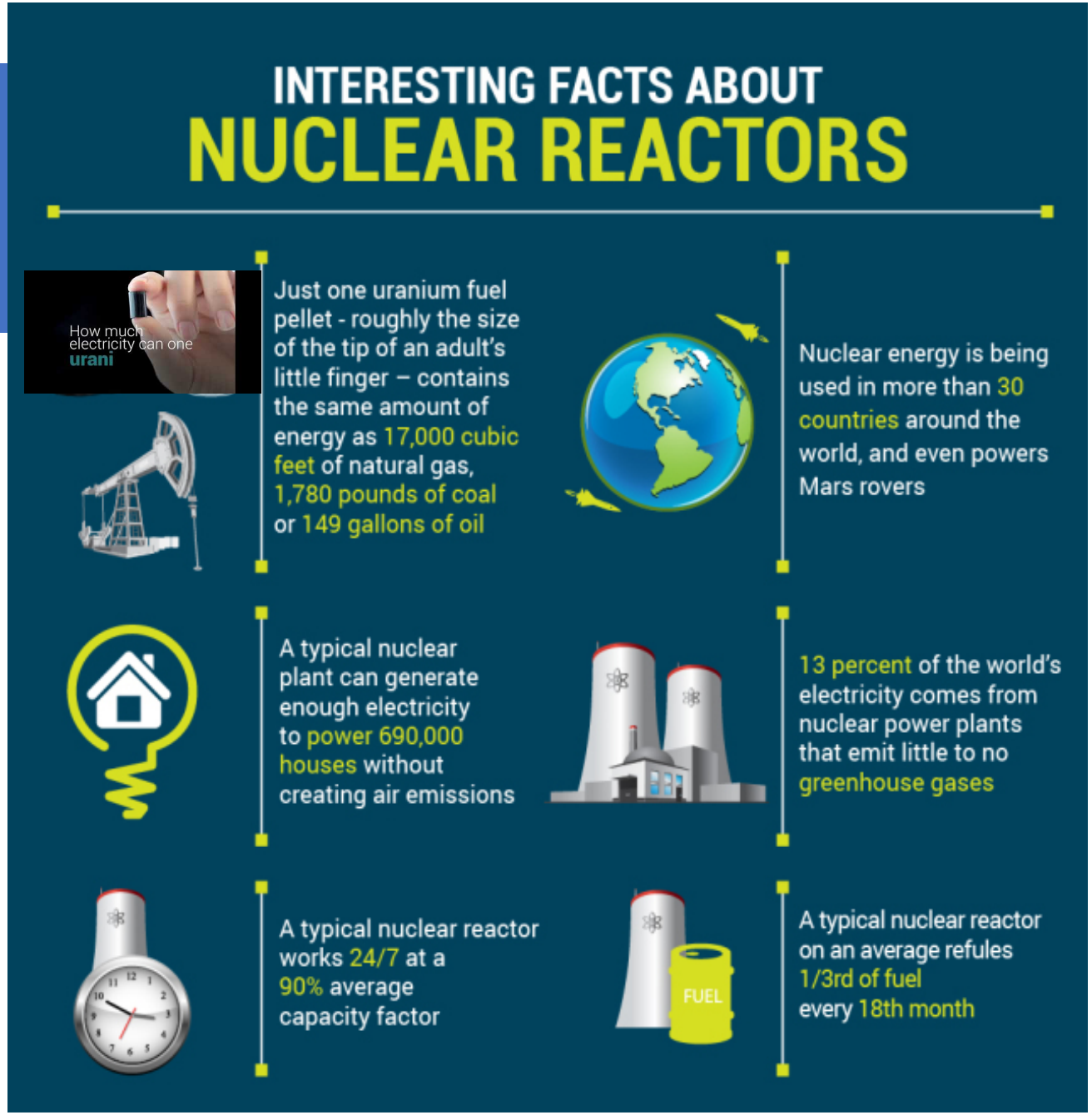
Mohammad Modarres
University of Maryland
Department of Mechanical Engineering
20 April 2021

Facts

- U.S. ranks highest in production of nuclear energy.
- Nuclear power plants don't emit greenhouse gases.
- They generate many jobs and have low operating costs.
- Electricity from nuclear is a nonintermittent base-load.

2019 Capacity Factors of Sources of Electrical Energy

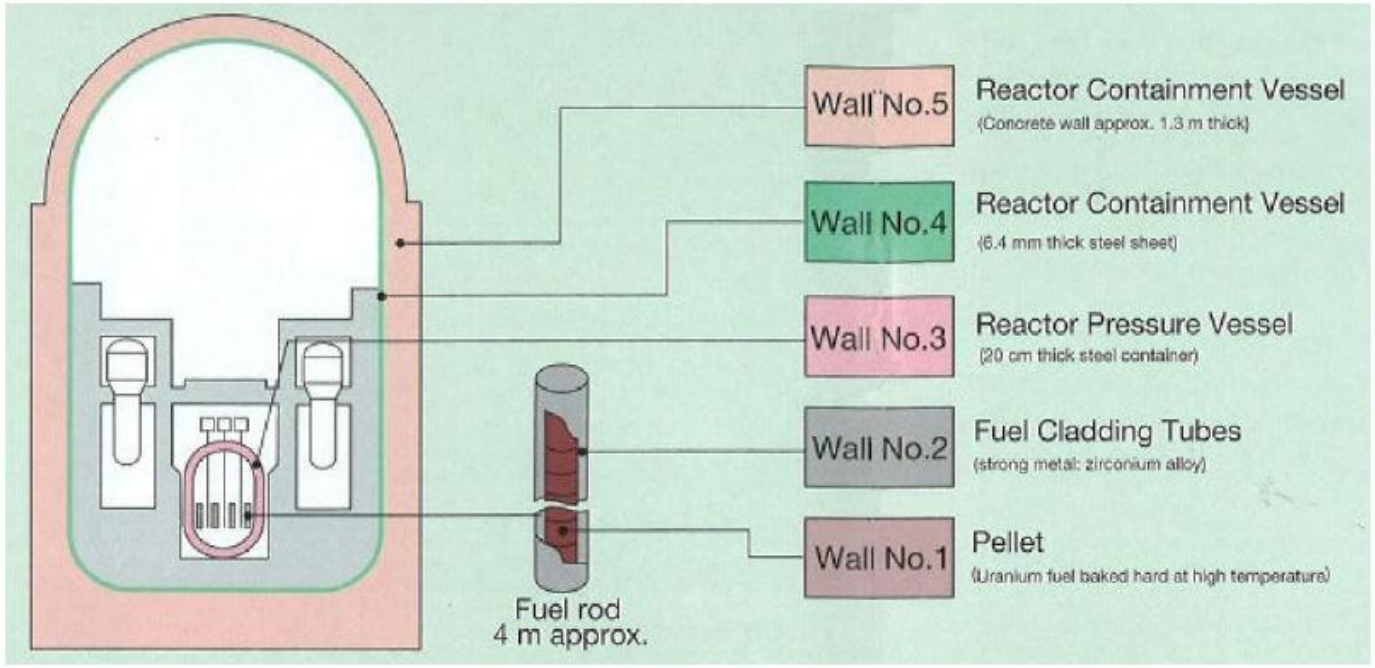
- Solar 25%
- Wind 35%
- Hydro 39%
- Coal 47%
- Nat. Gas 57%
- Nuclear 94%



Source: NEI

Design for Safety

- Defense in Depth
- Active and passive systems
- Strict regulation and inspection
- Excellent safety record
- Over 70 years of experience



Source: Energy Central

Five Walls of Protection

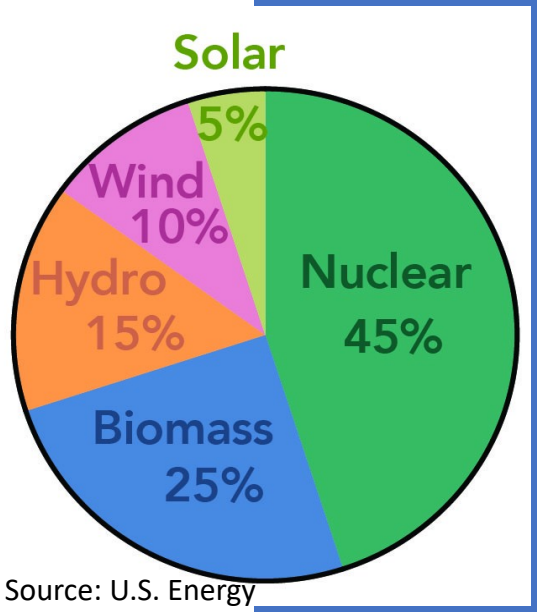
Economy

- Nuclear electricity generation is cost competitive
- Fuel costs are a minor part of total generating costs
- Capital costs are much greater
- Decommissioning and waste disposal costs considered
- Average generating costs for nuclear was about 3 cents / KW-h in 2020

Source: NuScale

Clean and Climate Friendly

- Need to decarbonize the grid
- Fast growing needs for electricity in remote areas
- Electricity needed to remove excess carbon
- Wind and solar
  - Becoming cheaper
  - Not available 24/7
  - Batteries that could power mega cities not yet available
- Hydro limited (Norway, New Zealand) best places already dammed
- Proven rapid decarbonization: France and Sweden



Source: U.S. Energy Information Administration

Unfounded Dread

Unfortunate Origin

- Manhattan Project
- Hiroshima and Nagasaki

Nuclear accidents

- Small risks
- Environmental damage and human risks of fossil fuel
- Human toll of coal
- Human loss in 70 years of nuclear is less than one-month of coal operation

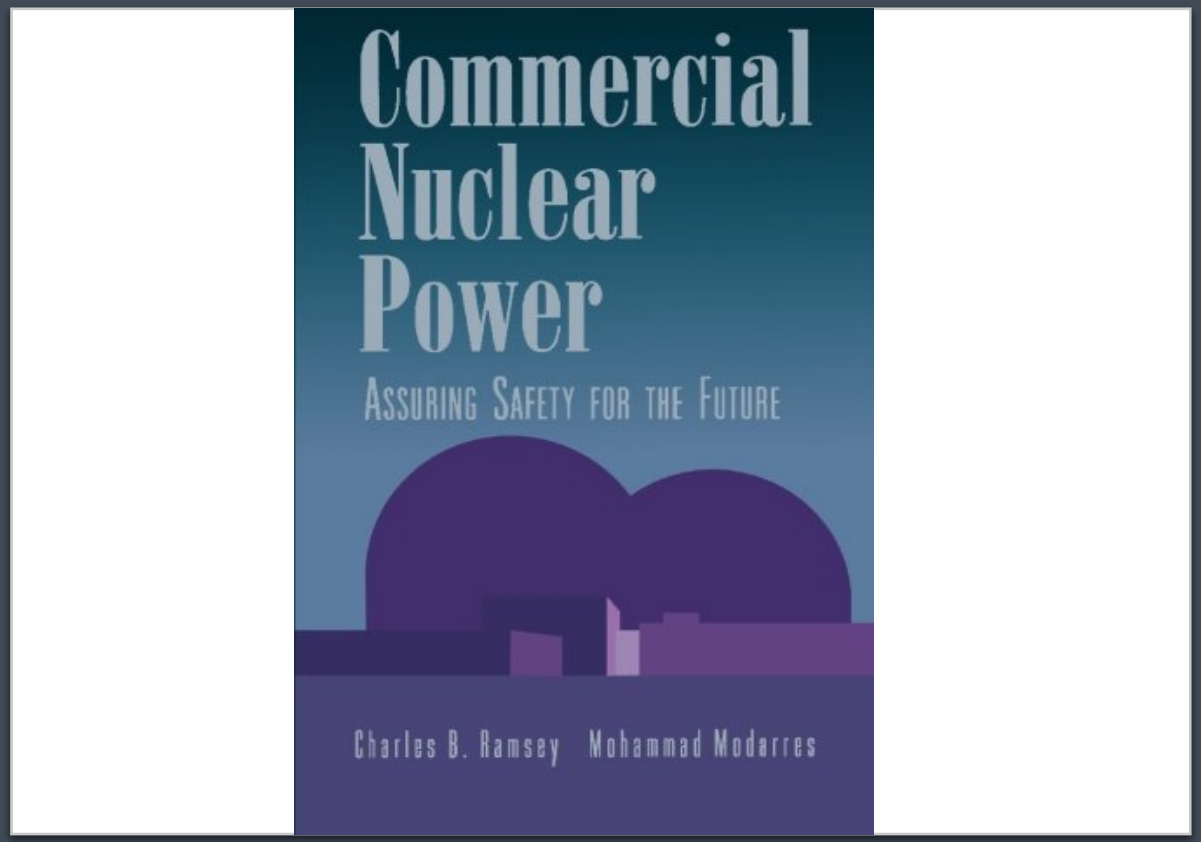
Proliferation concerns

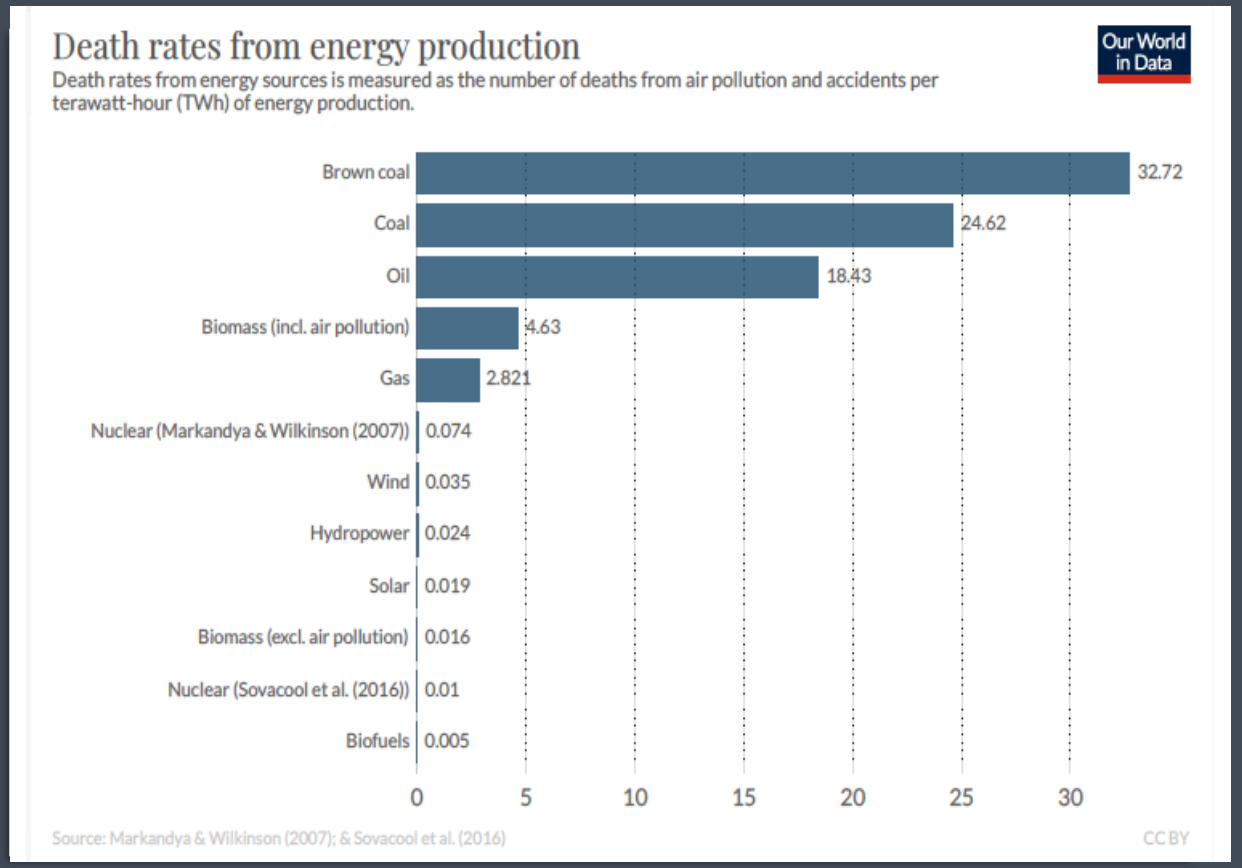
- Most countries with nuclear power have no nuclear weapons

Nuclear waste a political matter

- New designs that burn spent fuel
- Reprocessing
- Yucca Mountain

Safety: Nuclear vs. other Sources





Source: What are the safest sources of energy? by Hannah Ritchie, Feb. 2020, https://ourworldindata.org/safest-sources-of-energy

Renewable Nuclear Power

- Nuclear Power is sustainable
- Yes, nuclear is also renewable!
- Other renewable energies: solar, wind, hydro, and geothermal
- Geothermal is renewable but not sustainable! (can't be regenerated fast enough)
- Using uranium from seawater makes nuclear renewable
- 3.3 micrograms/liter of uranium in seawater (or 4.4 billion tons!)
- But U extracted from seawater is replenished continuously from balanced chemical reaction between sea water and the bed rocks
- Seawater extraction should be economical for this paradigm to work.

Conclusion

Nuclear power a powerful solution to the climate crisis—possibly the most challenging problem facing humanity and its survival

Coordinated governmental, industrial and policy change needed to overcome fear

Nuclear power is a proven, safe, sustainable, proliferation proof and reliable source of energy

We need to overcome high cost of construction. Encouraging new designs can supply energy economically

Technologies for permanent and safe disposal of the nuclear waste exist. Political ramifications are more complex

Nuclear power from seawater is renewable with a lower lifecycle carbon footprint than solar and wind

“It was the best of times, it was the worst of times, it was the age of wisdom, it was the age of foolishness, it was the epoch of belief, it was the epoch of incredulity, it was the season of light, it was the season of darkness, it was the spring of hope, it was the winter of despair.”

— Charles Dickens, A Tale of Two Cities