Production of Hydrogen Using Nuclear Energy

Dr. Charles Forsberg

Oak Ridge National Laboratory
P.O. Box 2008; Oak Ridge, TN 37831-6179
Tel: (865) 574-6783; E-mail: forsbergcw@ornl.gov

Safety and Economy of Hydrogen Transport: Second International Symposium
Town of Sarov, Nizhniy Novgorod Region, Russia.
18-21 August, 2003

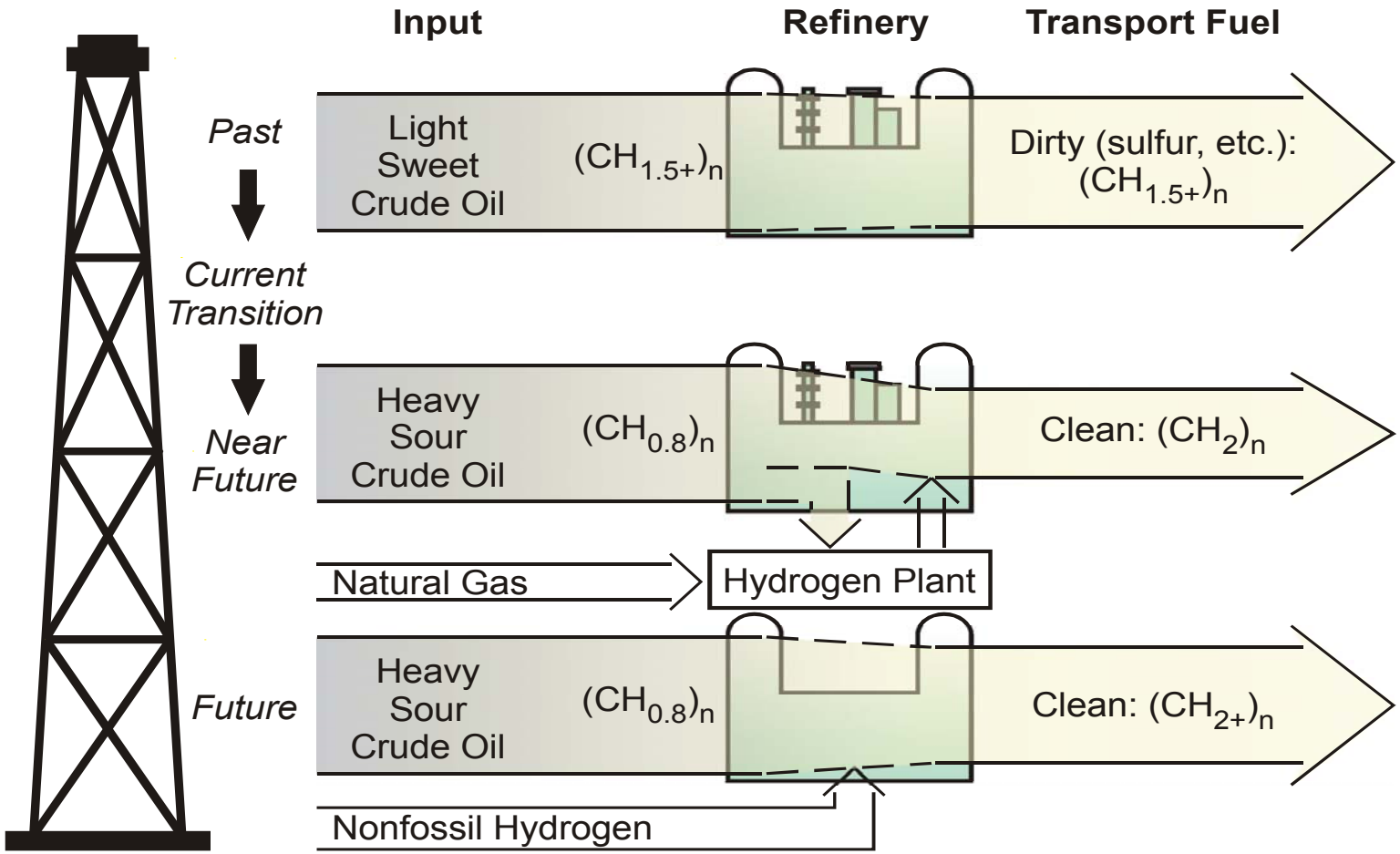
The submitted manuscript has been authored by a contractor of the U.S. Government under contract DE-AC05-00OR22725. Accordingly, the U.S. Government retains a nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or allow others to do so, for U.S. Government purposes. File name: Hydrogen_Viewgraphs:Russia.ORNL.AUG2003.Futures

Production of Hydrogen (H_2) Using Nuclear Energy Depends Upon the Answers to Three Questions

- Is nuclear energy compatible with H_2 production?
- Do methods exist for H_2 production?
- Is H_2 production the future of nuclear energy?

Is Nuclear Energy Compatible With Hydrogen Production?

The World H_2 Market Is 50 Million Tons/Year and Growing



Nuclear Reactor Sizes Match H_2 Production

Hydrogen Plant Size

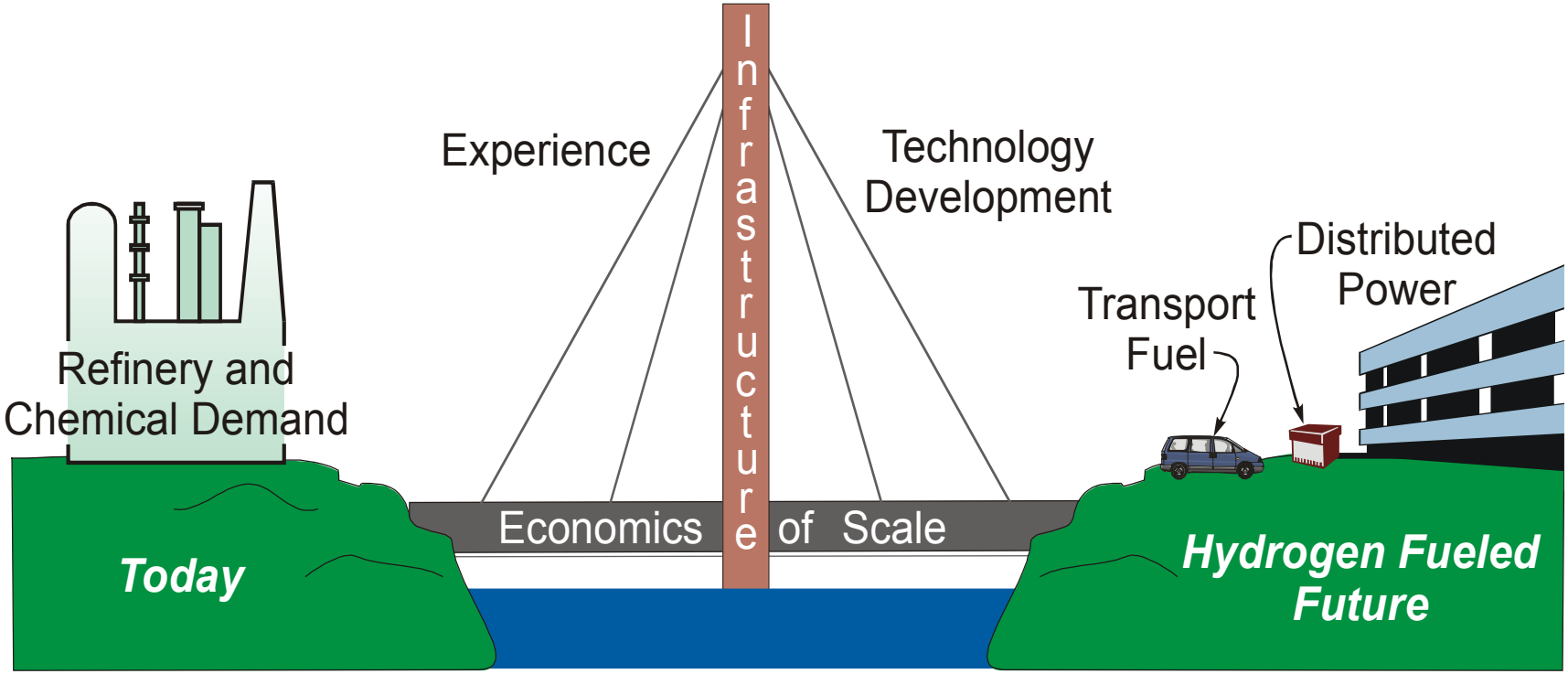
H_2 Plants	Energy to Produce H_2 (50% Efficient)
5.7×10^6 m^3/d (Existing)	1600 MW(t)
8.0×10^6 m^3/d (Future)	2400 MW(t)

Time

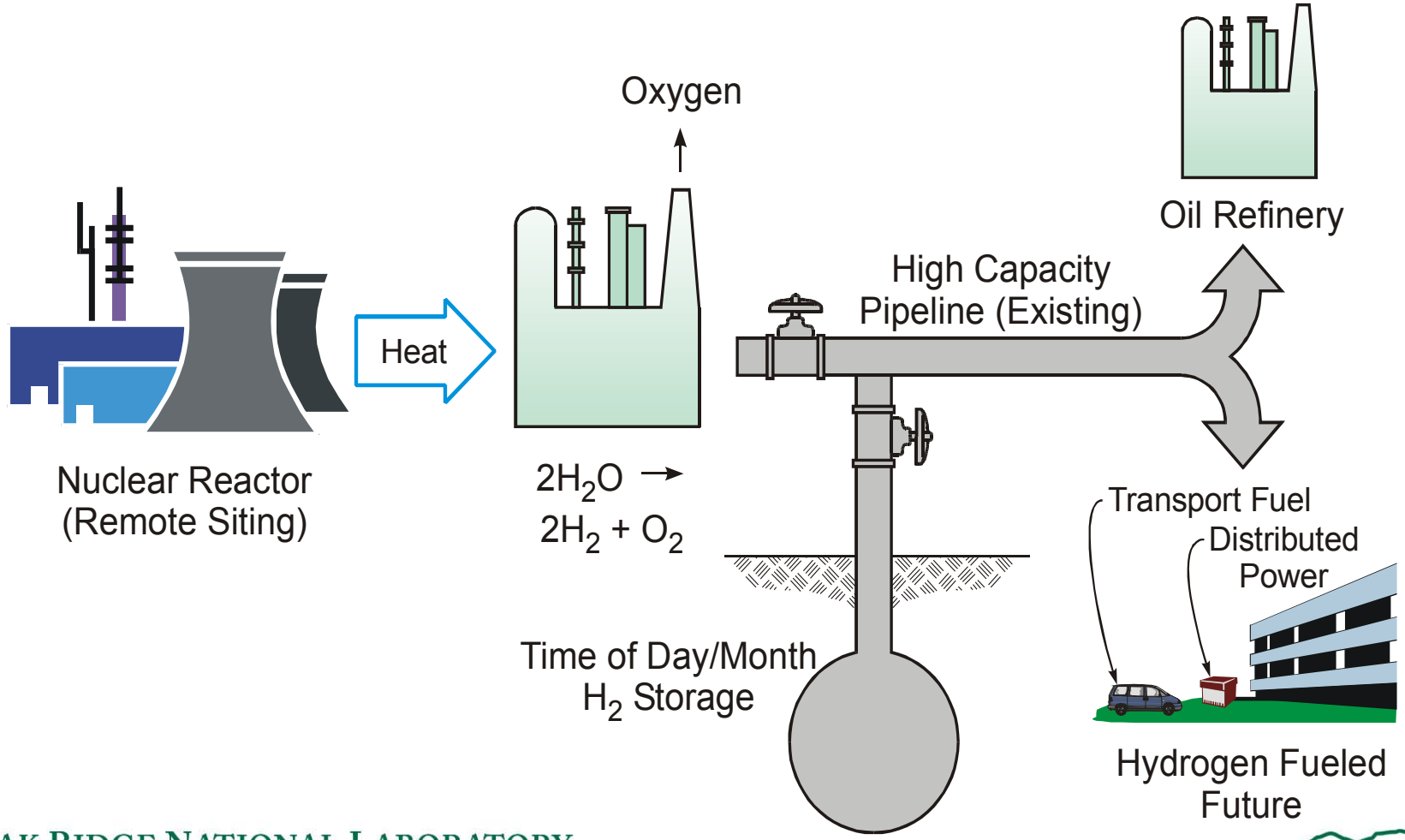
Nuclear Reactor

2000–4000 MW(t)

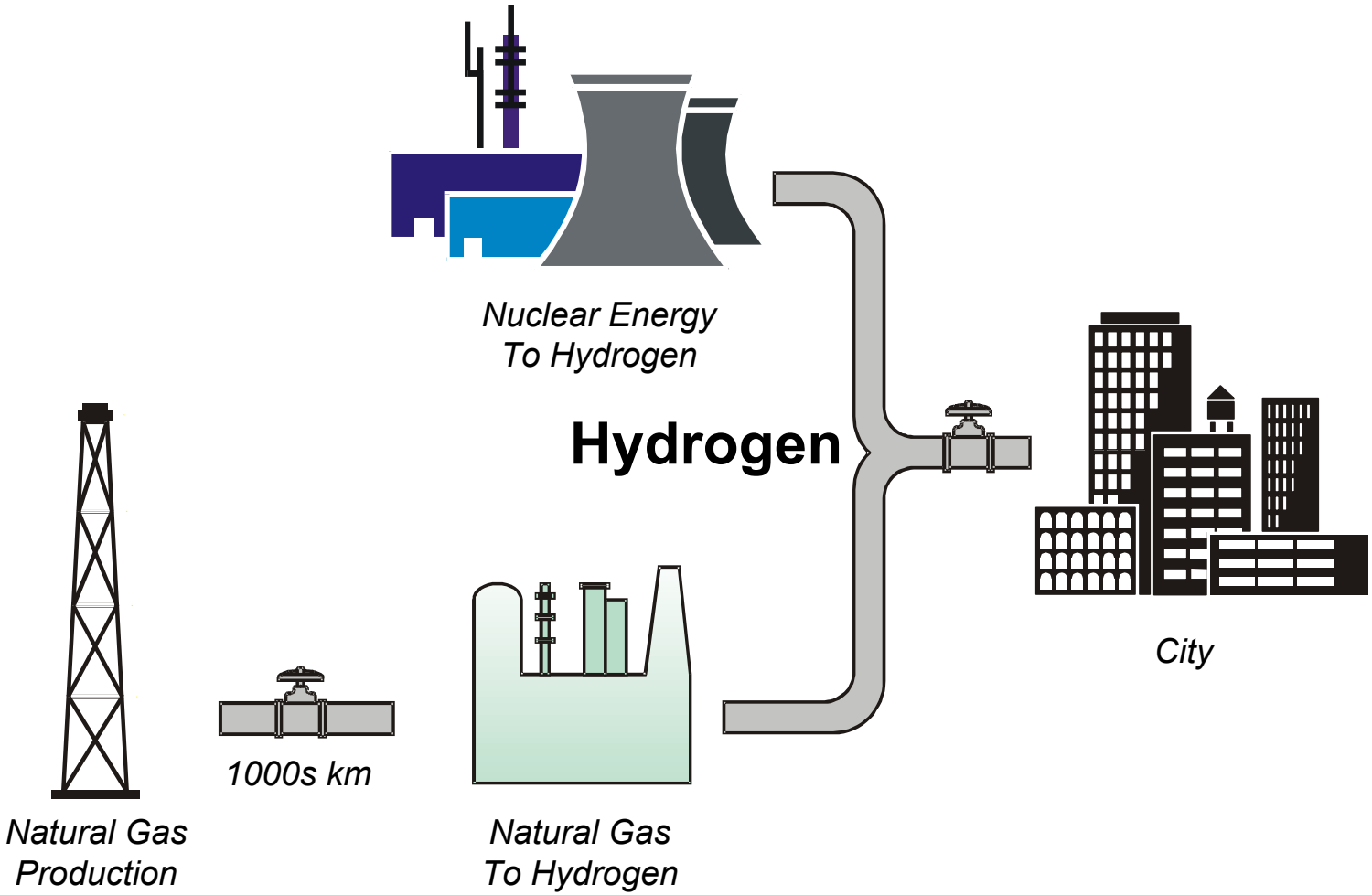
The Growing H_2 Demand Creates a Bridge to the H_2 Economy



Nuclear Energy Is Compatible with H_2 Production



Shorter Transport Distances Favor Nuclear Energy



Nuclear / Hydrogen Compatibility

Similar Size Facilities

Full Utilization of Nuclear Reactor Output

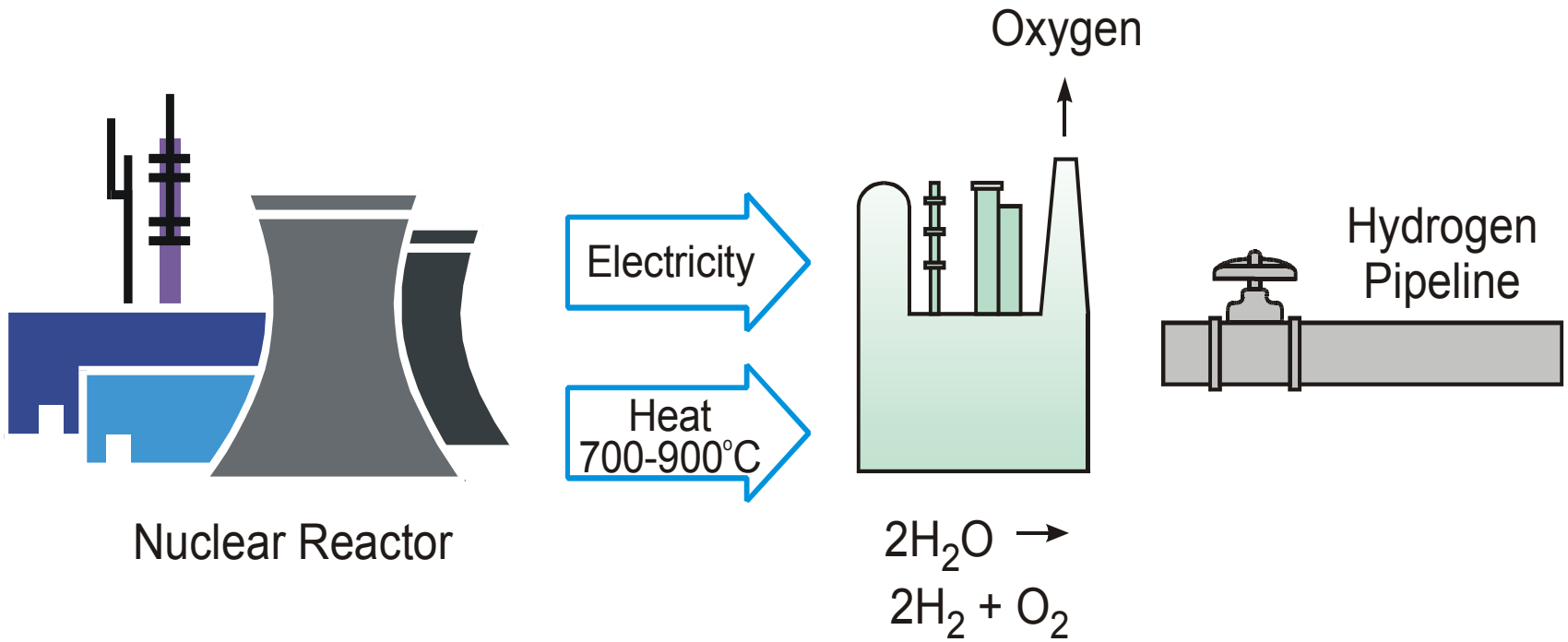
Pipelines Are Smaller than Electric Lines

Do Methods Exist For H_2 Production?

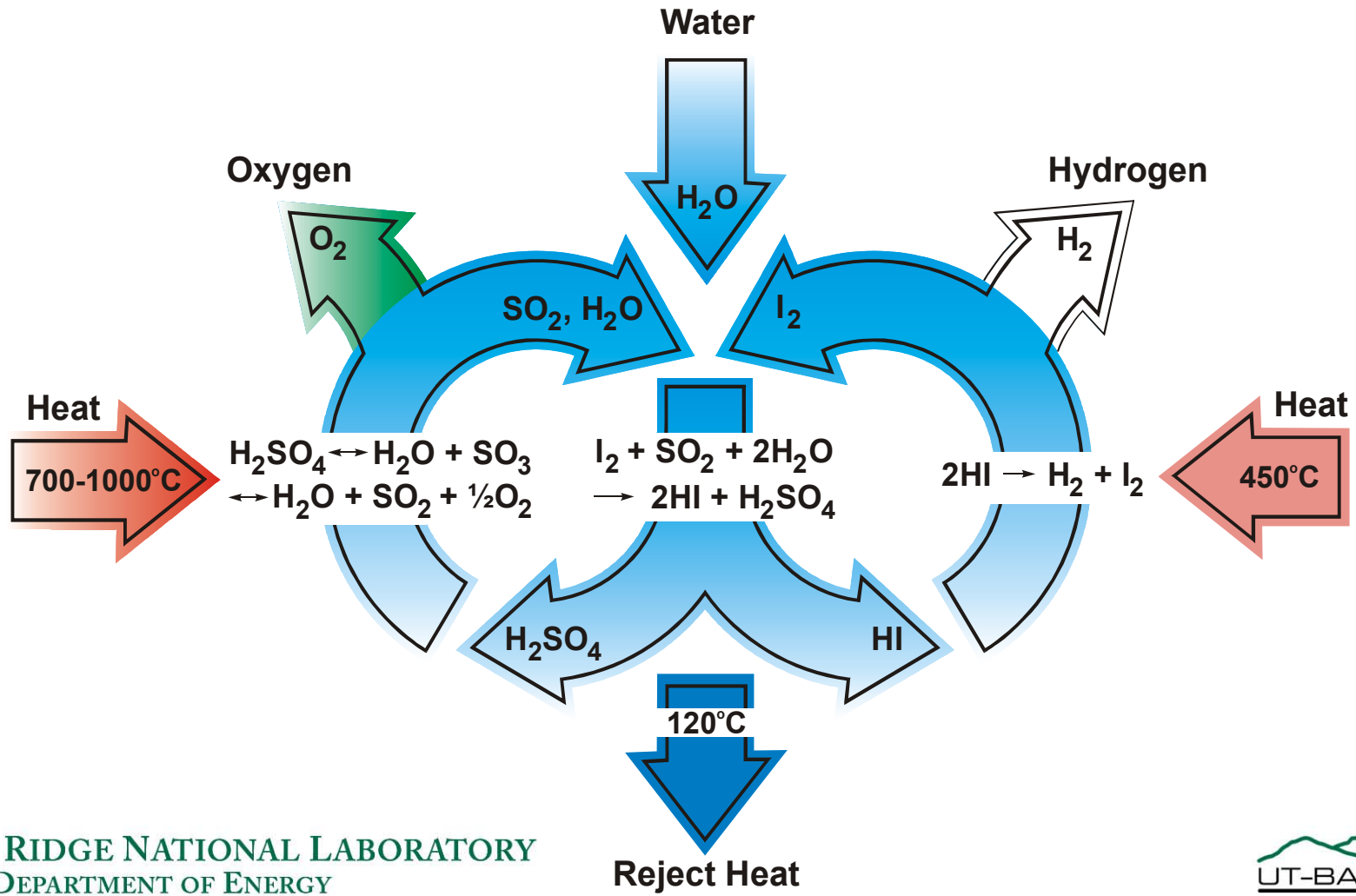
Hot electrolysis

Thermochemical cycles

Hot Electrolysis Uses Electricity and Nuclear High-Temperature Heat (700-900°C) to Produce Hydrogen



Thermochemical Processes Use Nuclear High-Temperature Heat and Water to Produce H_2



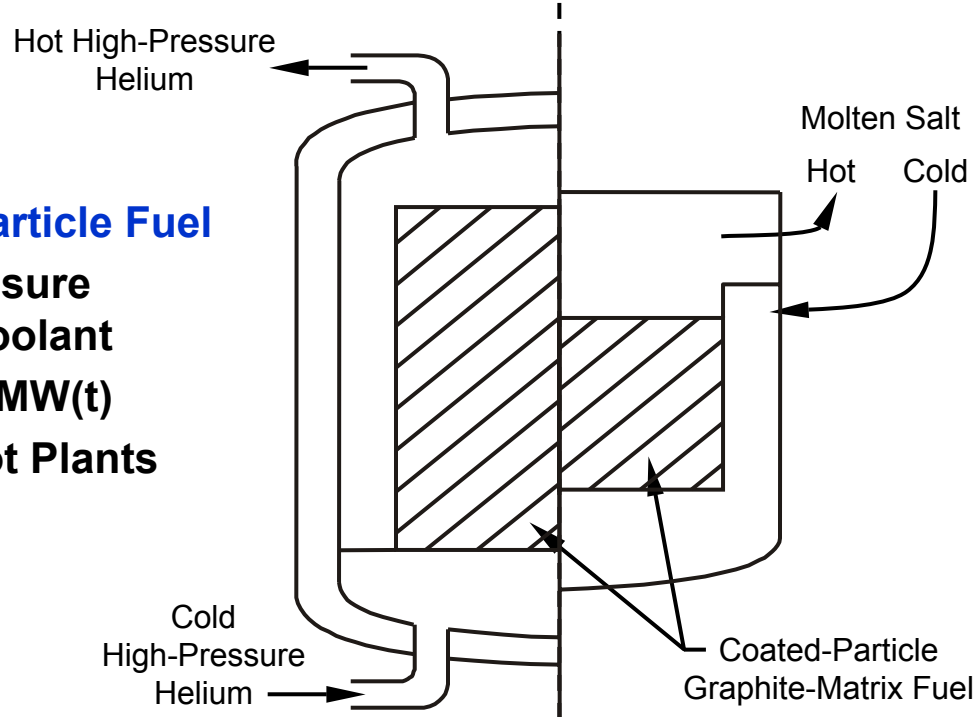
Two Nuclear Reactor Options Can Produce the Required High-Temperature Heat

Very-High-Temperature Reactor

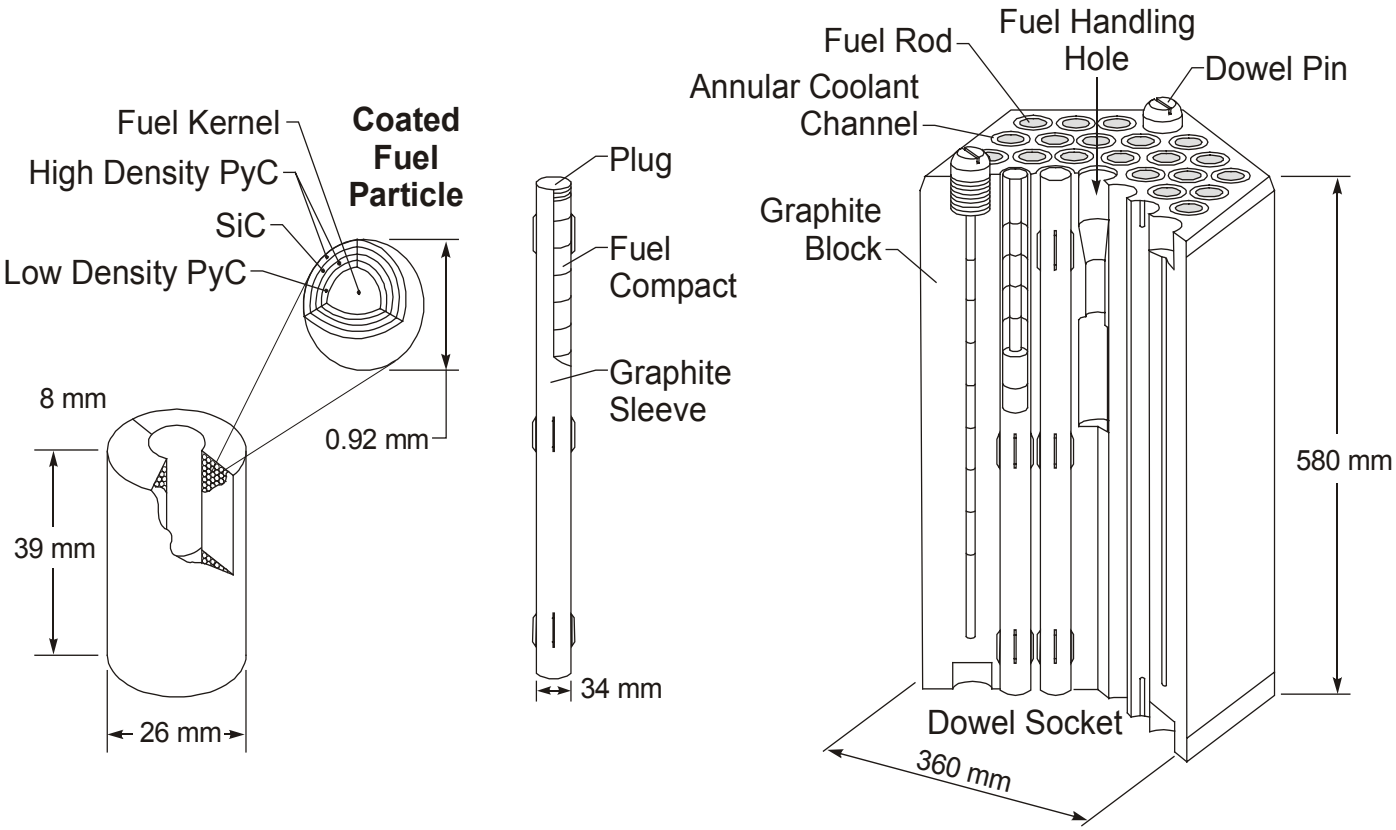
- **Coated-Particle Fuel**
- **High-Pressure Helium Coolant**
- **Size: 600 MW(t)**
- **Small Pilot Plants**

Advanced High-Temperature Reactor

- **Coated-Particle Fuel**
- **Atmospheric-Pressure Molten Salt Coolant**
- **Size: To 2400 MW(t)**
- **New Concept**



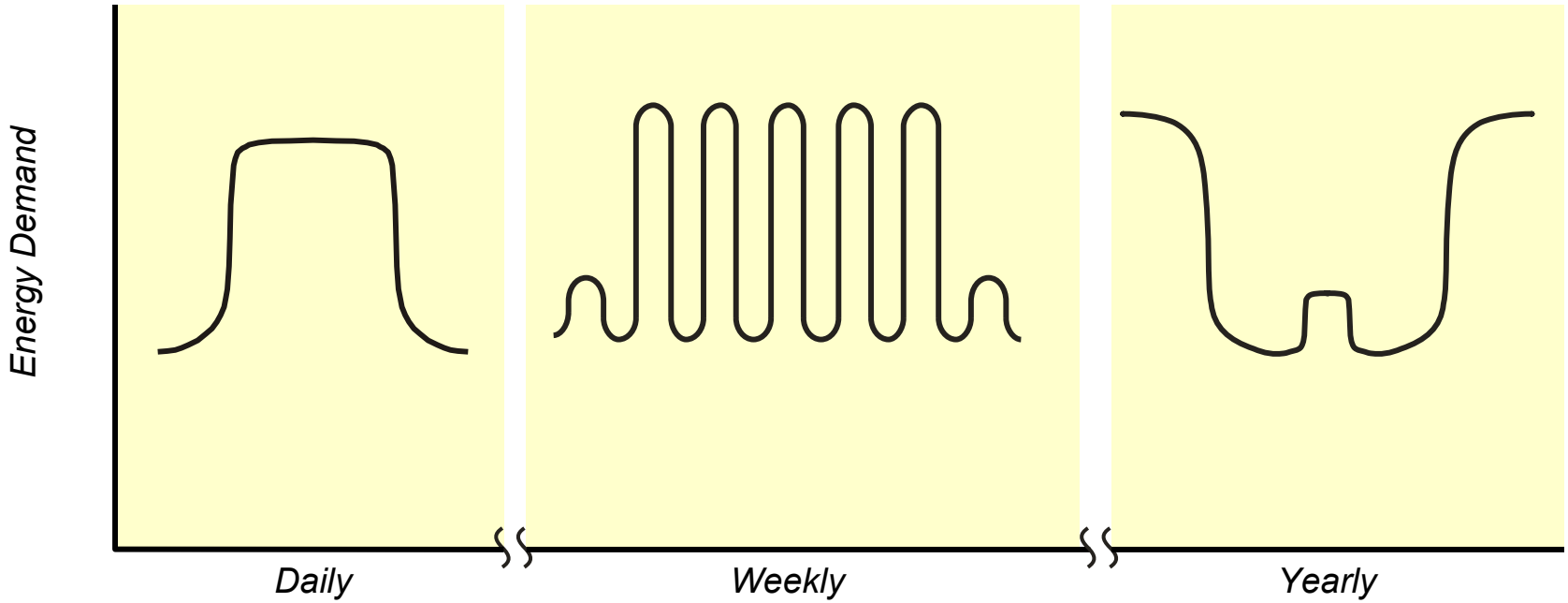
Reactor Options Limited by Fuel: Only One Type of Demonstrated High-Temperature Fuel



Fuel Compact **Fuel Rod** **Fuel Block**

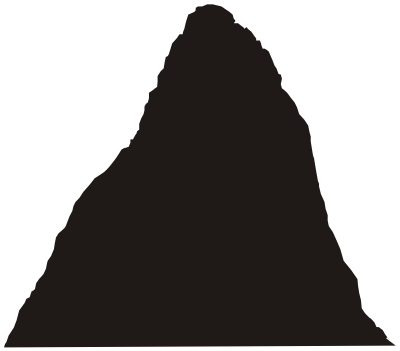
Is Hydrogen Production the Future of Nuclear Energy?

The Great Energy Mismatch: Energy Generation vs. Energy Demand

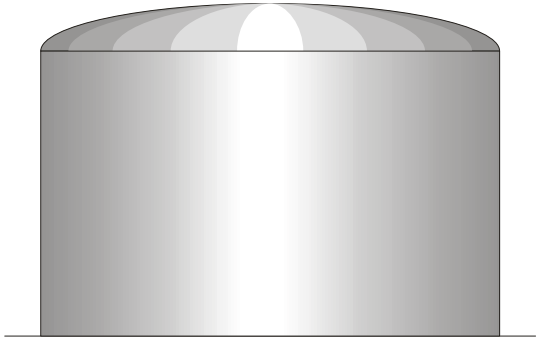


Today Stored Fossil Fuels Meet Variable Energy Demands

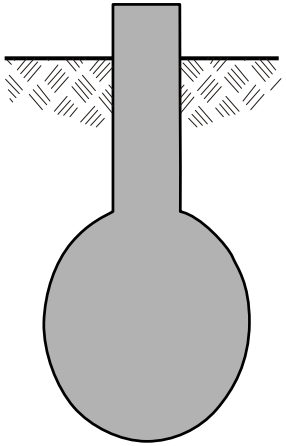
Coal Piles



Oil Storage

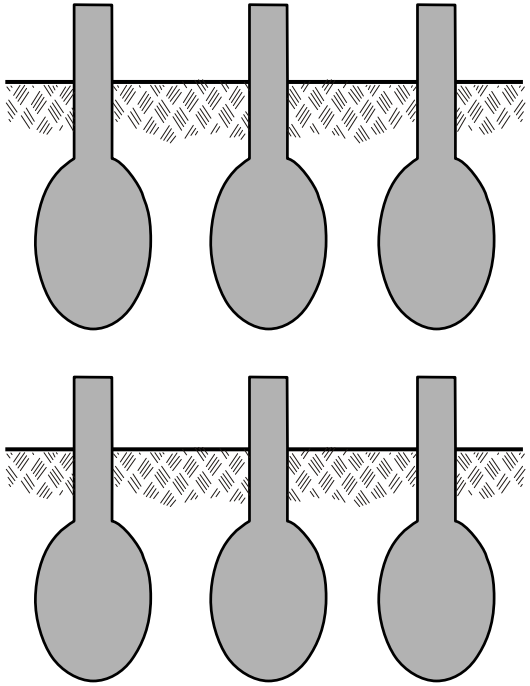


Underground Natural Gas Storage

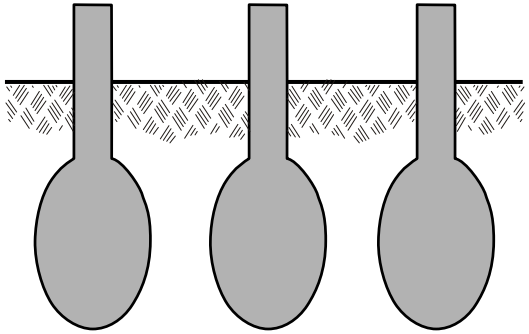


In a H_2 Economy, H_2 Storage Is a Major Cost; The Source of H_2 Determines Storage Costs

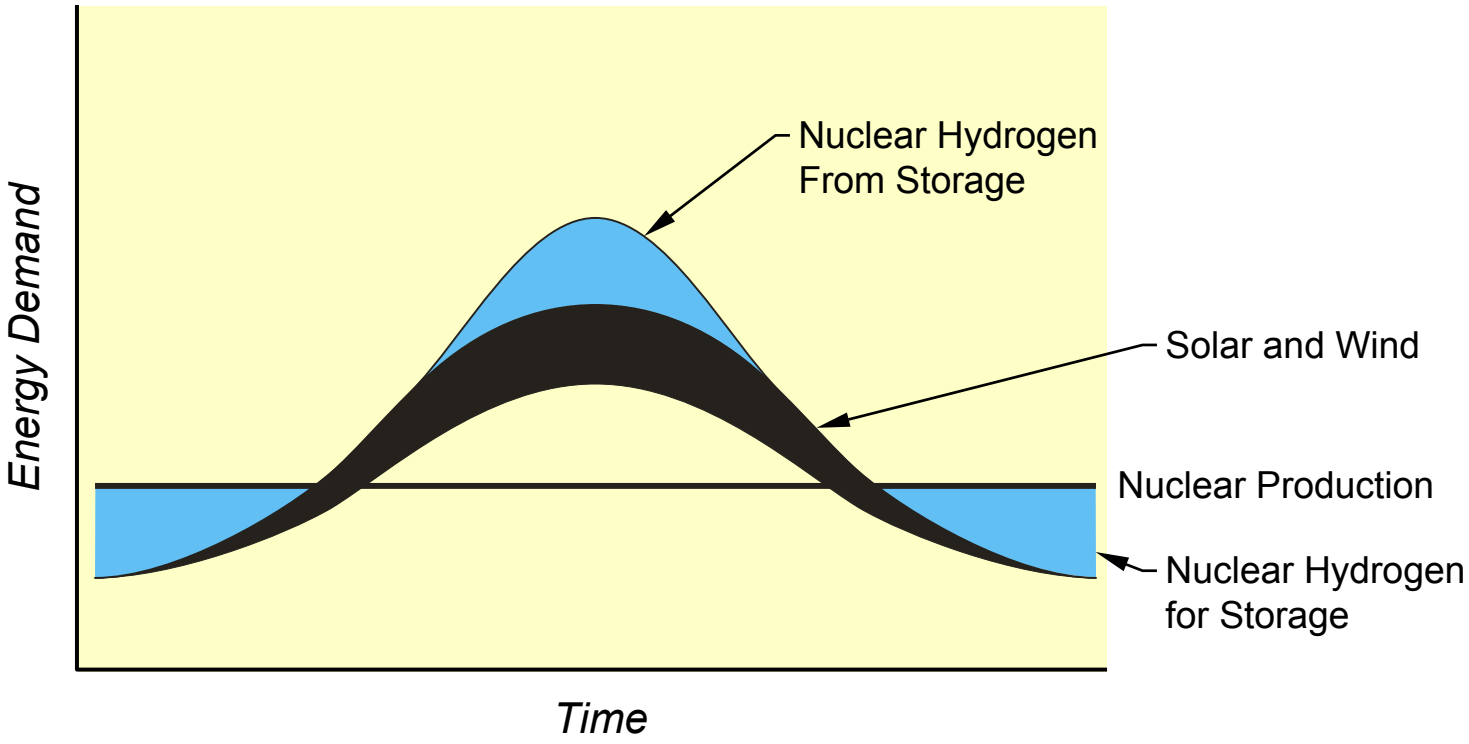
Hydrogen Storage and
Solar Seasonal H_2 Production



Hydrogen Storage and
Nuclear H_2 Production



Lower H_2 Storage Volume Requirements Favor H_2 Production From Nuclear Energy



Hydrogen Production May Be The Future Of Nuclear Energy

Hydrogen Production Using Nuclear Energy Minimizes the Large H_2 Storage and Transport Costs

The Characteristics of a Hydrogen Economy Favor H_2 Production Using Nuclear Energy

Hydrogen Production Is the Great Technical Challenge for Nuclear Energy