

Nuclear-Renewable Hybrid Energy System Market Analysis Plans



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Nuclear and Renewable Energy Synergies Workshop**

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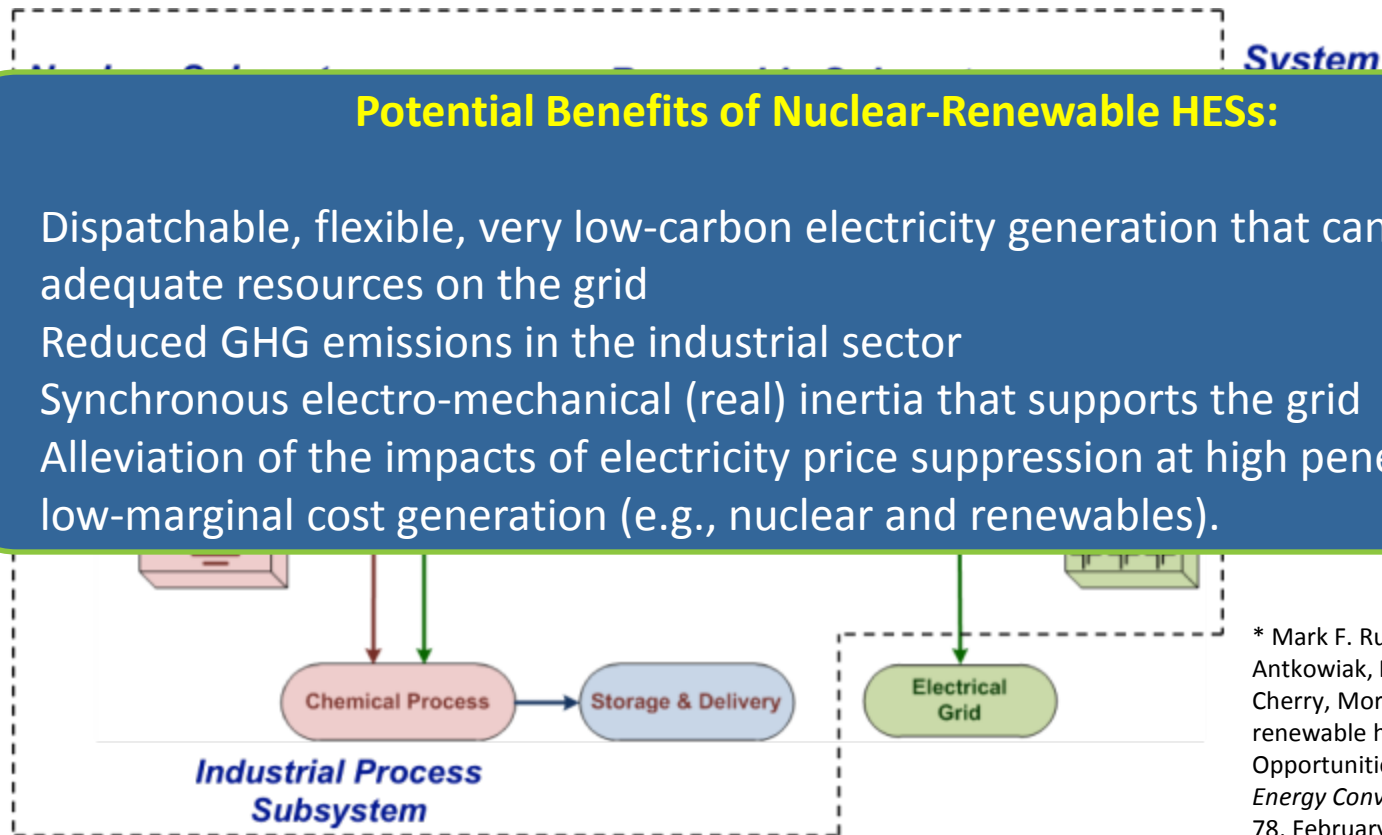
Nuclear-Renewable Hybrid Energy Systems

Nuclear-Renewable Hybrid Energy System (N-R HES) Definition:

Single, physically-coupled facility that takes two or more energy resources as inputs and produces two or more products, with at least one being an energy commodity such as electricity or transportation fuel. Energy and materials flows among energy production and delivery systems are dynamically integrated.*

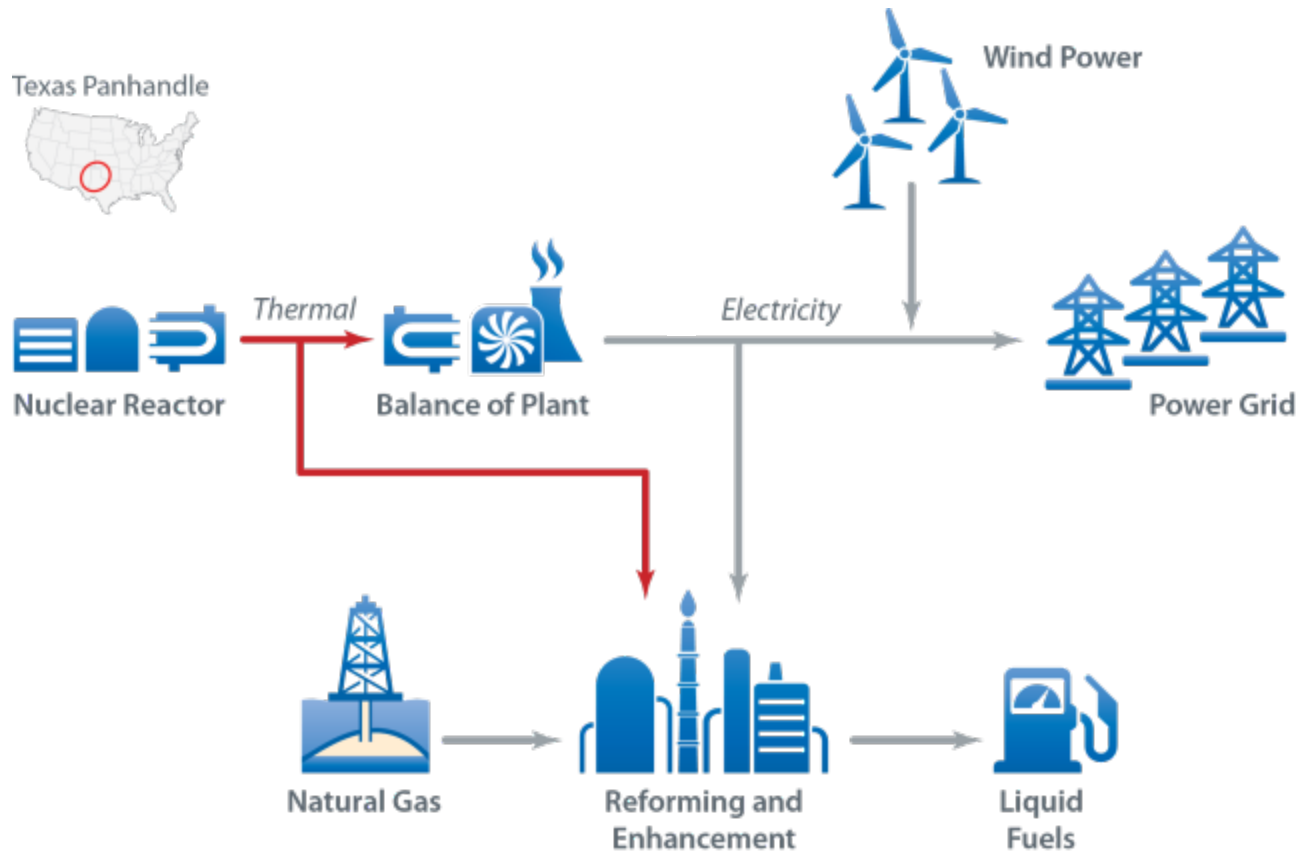
Potential Benefits of Nuclear-Renewable HESs:

- Dispatchable, flexible, very low-carbon electricity generation that can support adequate resources on the grid
- Reduced GHG emissions in the industrial sector
- Synchronous electro-mechanical (real) inertia that supports the grid
- Alleviation of the impacts of electricity price suppression at high penetration of low-marginal cost generation (e.g., nuclear and renewables).



* Mark F. Ruth, Owen R. Zinaman, Mark Antkowiak, Richard D. Boardman, Robert S. Cherry, Morgan D. Bazilian, "Nuclear-renewable hybrid energy systems: Opportunities, interconnections, and needs," *Energy Conversion and Management*, Volume 78, February 2014, Pages 684-694.

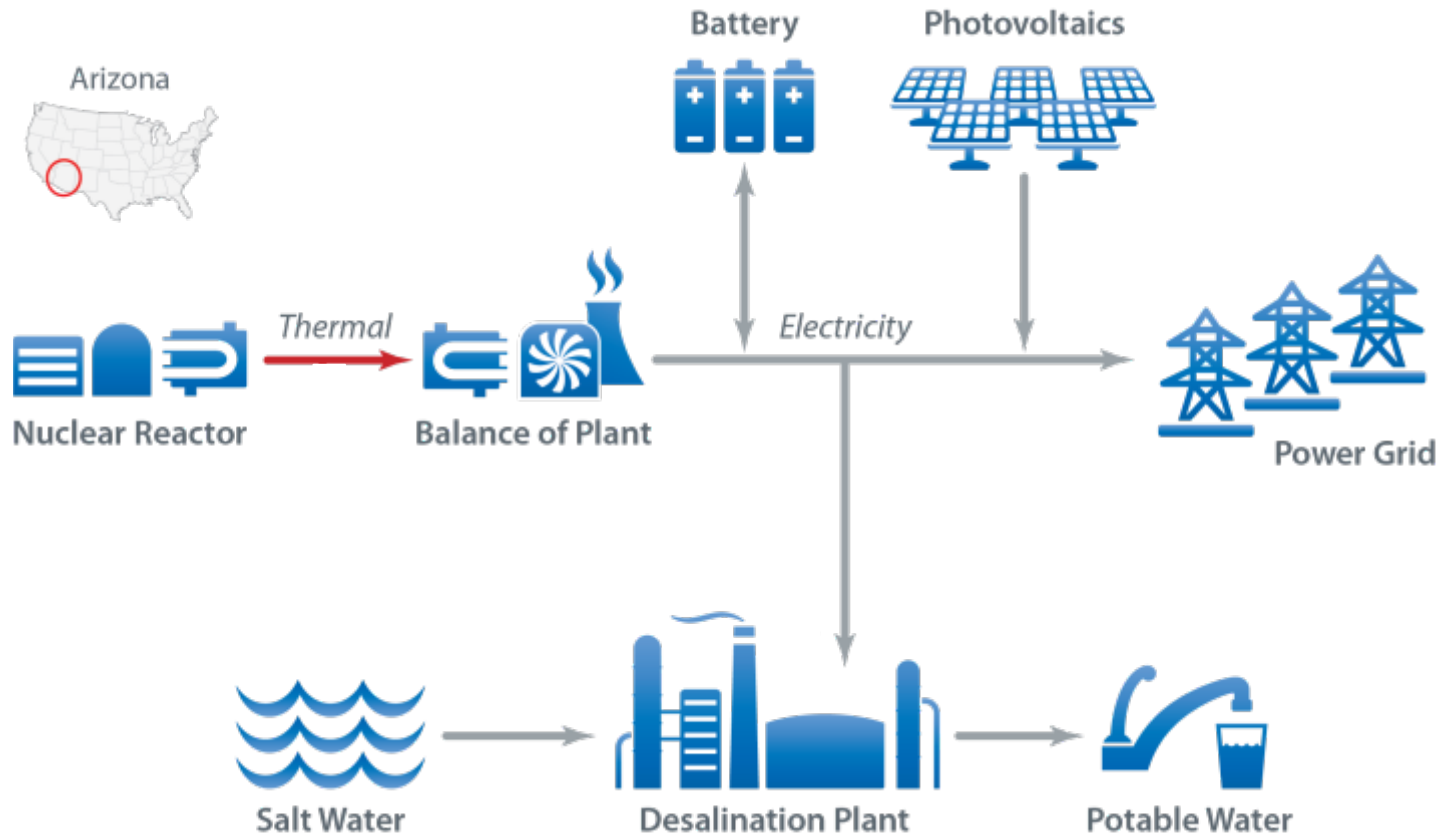
N-R HES #1: Synthetic Gasoline



Possible Variations

- Thermal storage
- Battery storage
- NG Boiler to maintain steady state
- Renewable thermal energy production
- CO₂ to liquid fuel
- Coal-to-synfuels

N-R HES #2: Desalination



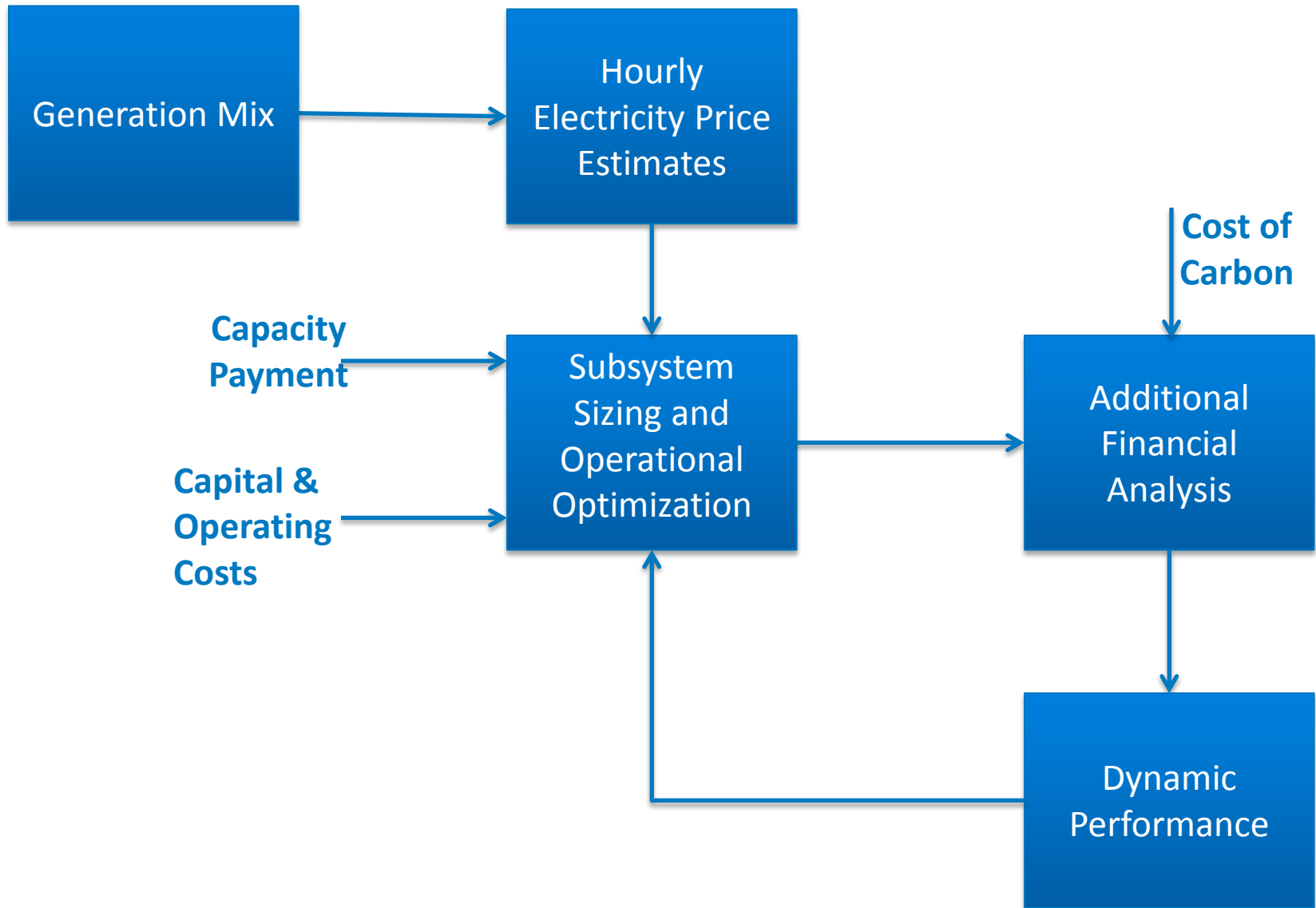
Possible Variations

- Thermal desalination
- Concentrated solar power
- Battery storage
- Water preheating

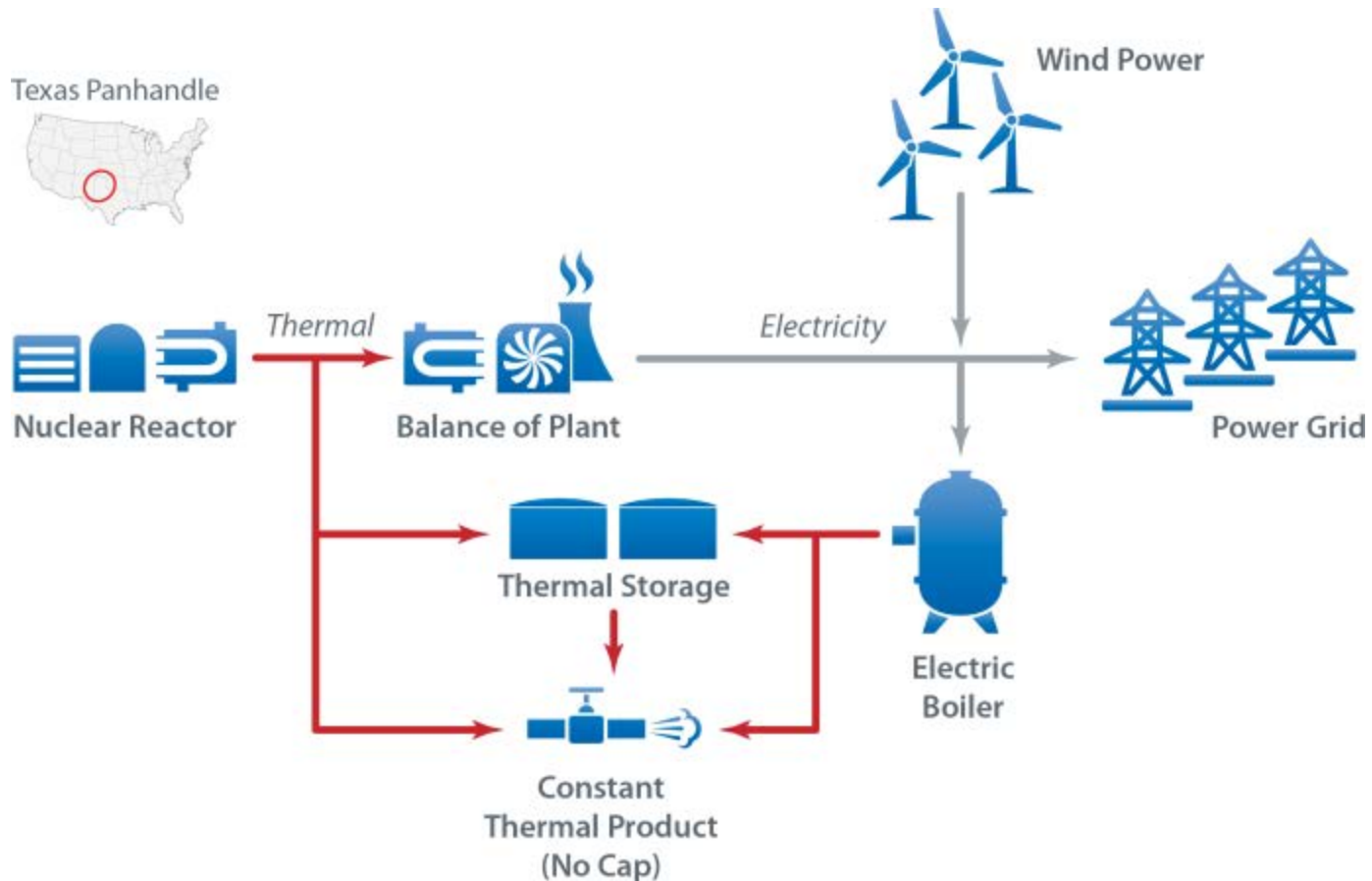
Key Hypotheses in the Analysis

- 1. Profitability**
- 2. Reduced greenhouse emissions from industrial subsystems**
- 3. Provision of on-demand capacity to grid**
- 4. Flexibility increases profitability**
- 5. Flexibility provides hedging against future prices**

Analysis Methodology



N-R HES #3: Thermal Energy Product



Possible Variations

- Variable thermal product flow
- Electricity-thermal conversion using resistance heating of ceramics
- Use of ceramics for thermal storage

N-R HES #4: Hydrogen Production

