



*Hydrogen Delivery Analysis Meeting
May 8-9, 2007
Columbia, Maryland*

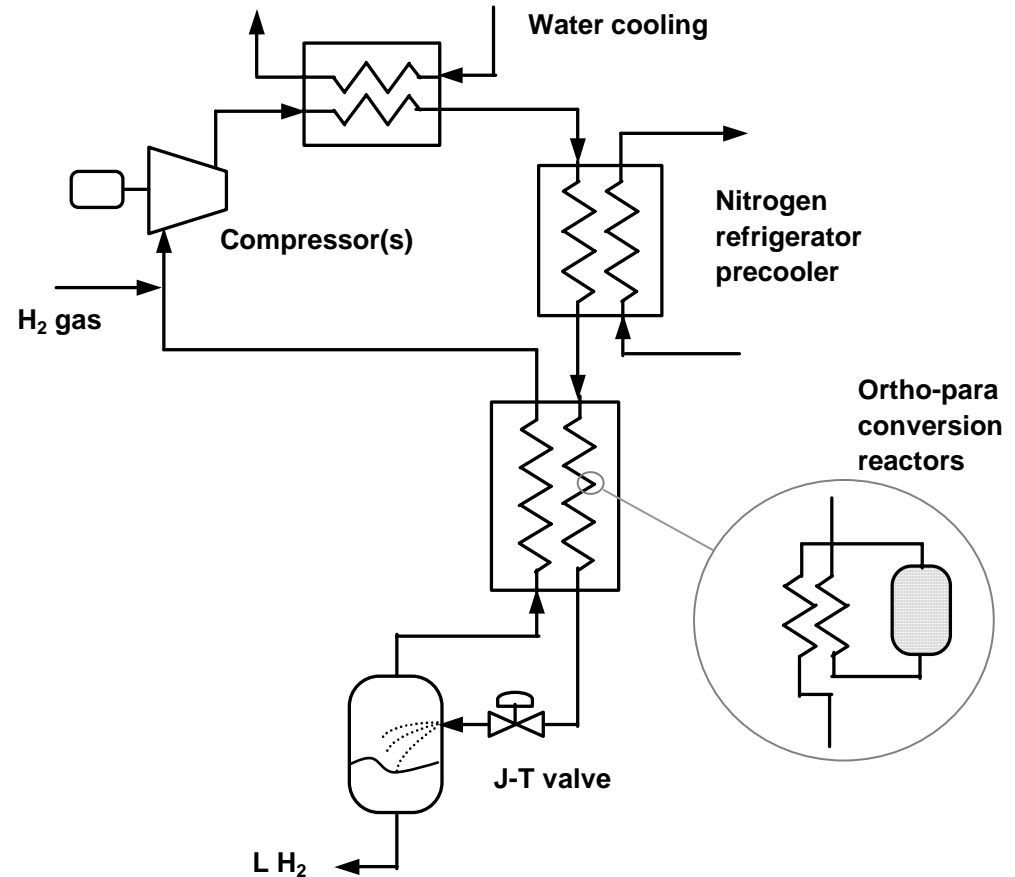
Liquefaction and Pipeline Costs

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Hydrogen Liquefaction

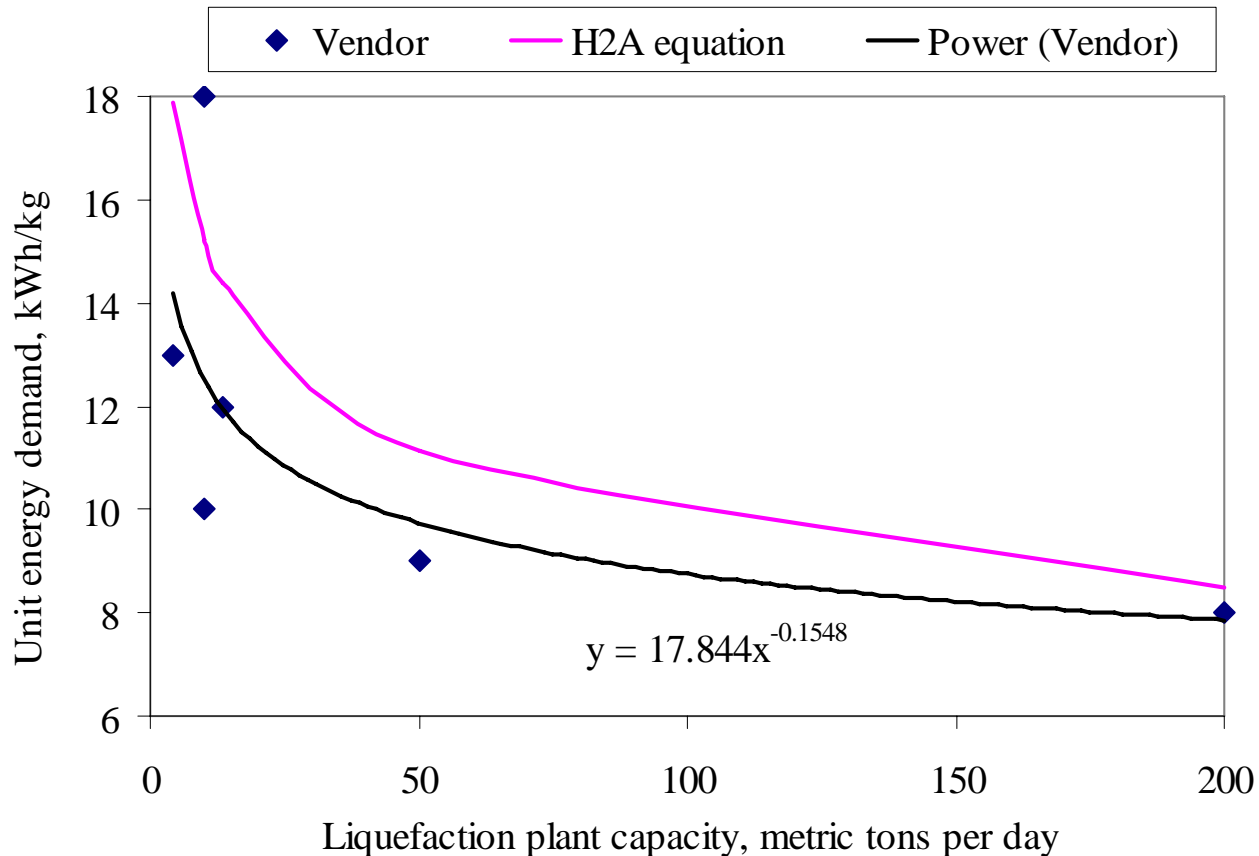
Basic process

- Compress
- Cool to temperature with positive Joule-Thompson coefficient
- Throttle to form liquid



Hydrogen Liquefaction - Continued

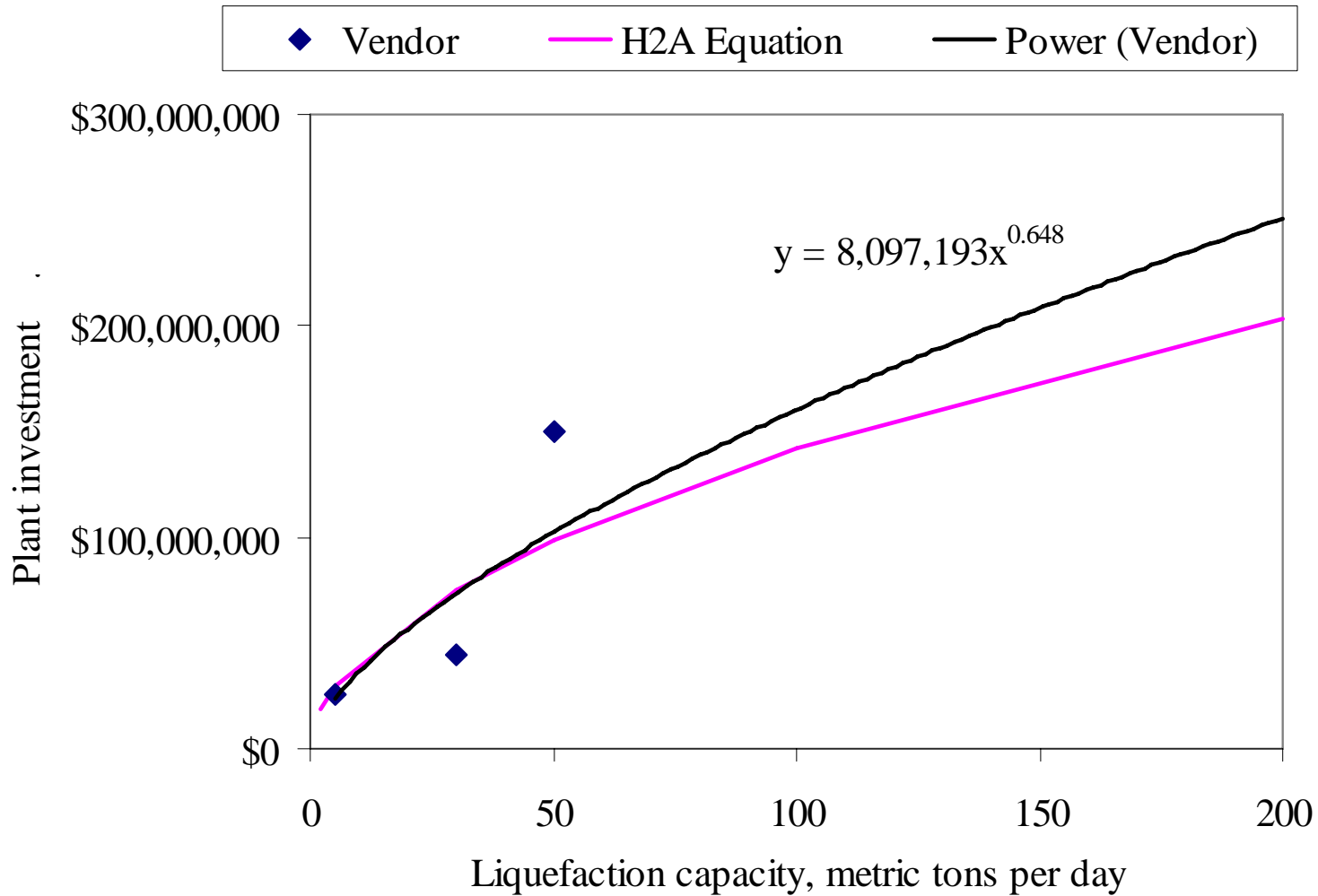
Electric energy requirements



Isentropic demand is 3.9 kWh/kg

Hydrogen Liquefaction - Continued

Total investment cost



Hydrogen Liquefaction - Continued

Recommended inputs to H2A model

- 0 to 200 metric tons per day
- 8 kWh/kg minimum energy consumption
- 98.5 percent annual plant availability
- Indirect cost factors add 20 percent to liquefaction plant total installed cost

Distribution Pipeline Costs

- Collected historical Oil & Gas Journal data, and surveyed for current urban and downtown data
- Verified that historical natural gas pipeline cost data are representative of hydrogen pipeline costs; 10 percent added to unit hydrogen costs as a contingency
- Better defined regulatory issues and other potential concerns in urban areas and their impact:
 - Potential need for odorants or other leak detection technology
 - Allowable operating pressures
 - Right-of-Way availability

Distribution Pipeline Costs - Continued

