Fuel Cells

- Similar to PV: direct conversion process
  
  chemical potential $\rightarrow$ electrical potential

- First demonstrated in $\sim$ 1840: Germany, UK

- Practical designs/prototypes not developed until late 1950’s

- Developmental push from US space program: power and water on spacecraft
Key distinction with all other technologies examined so far: FC is not a technology for exploiting/utilizing a specific energy resource.

- Rivers: hydropower
- Wind: wind turbines
- Hydrocarbon fuels: heat engines (gas turbines, Stirling)
- Solar energy: active, passive solar heating, photovoltaic, Stirling cycle.

Are not FC another way of utilizing HC fuels?
• Direct use of HC fuels in fuel cells has unresolved technological problems, and is not currently practical.

• Indirect use of HC fuels in FC – in which the fuel is first converted to a form (i.e., hydrogen) that is practical for FC – is of questionable merit with regard to broader (energy and environmental) issues.

• Fuel cells use H₂ as a fuel.

• H₂ is not an energy resource. There are no reserves of H₂.

• Currently, most H₂ is produced via the reformation of natural gas (CH₄) and other fossil fuels.
A more sensible model:

- H₂ becomes an energy carrier and/or storage mechanism.
- Produced via electrolysis of water:
  \[ \text{H}_2\text{O} + \text{electricity} \rightarrow \text{H}_2 + \frac{1}{2}\text{O}_2 \]

- Electricity is derived from renewable resources.
- FC then become a method for utilizing the stored energy in H₂.

This is basically a battery paradigm.
The (perhaps utopian) vision (J. Rifkin, *The Hydrogen Economy*)

- Fuel cells + photovoltaics + H\textsubscript{2} storage technology: enables the *individual* to become energy producers as well as consumers.
- Effect on energy infrastructure would be similar to the effect of the internet on the information infrastructure: *decentralization*.

- Early 2000’s: significant push by US government to develop FC vehicle technologies and associated H\textsubscript{2} infrastructure.
- More recently: effort has been scaled back. Governmental and industry focus shifting more towards battery technology.