WAKE TECH

APPLIED TECHNOLOGY

College for the Real World

Fuel Cell Workshop

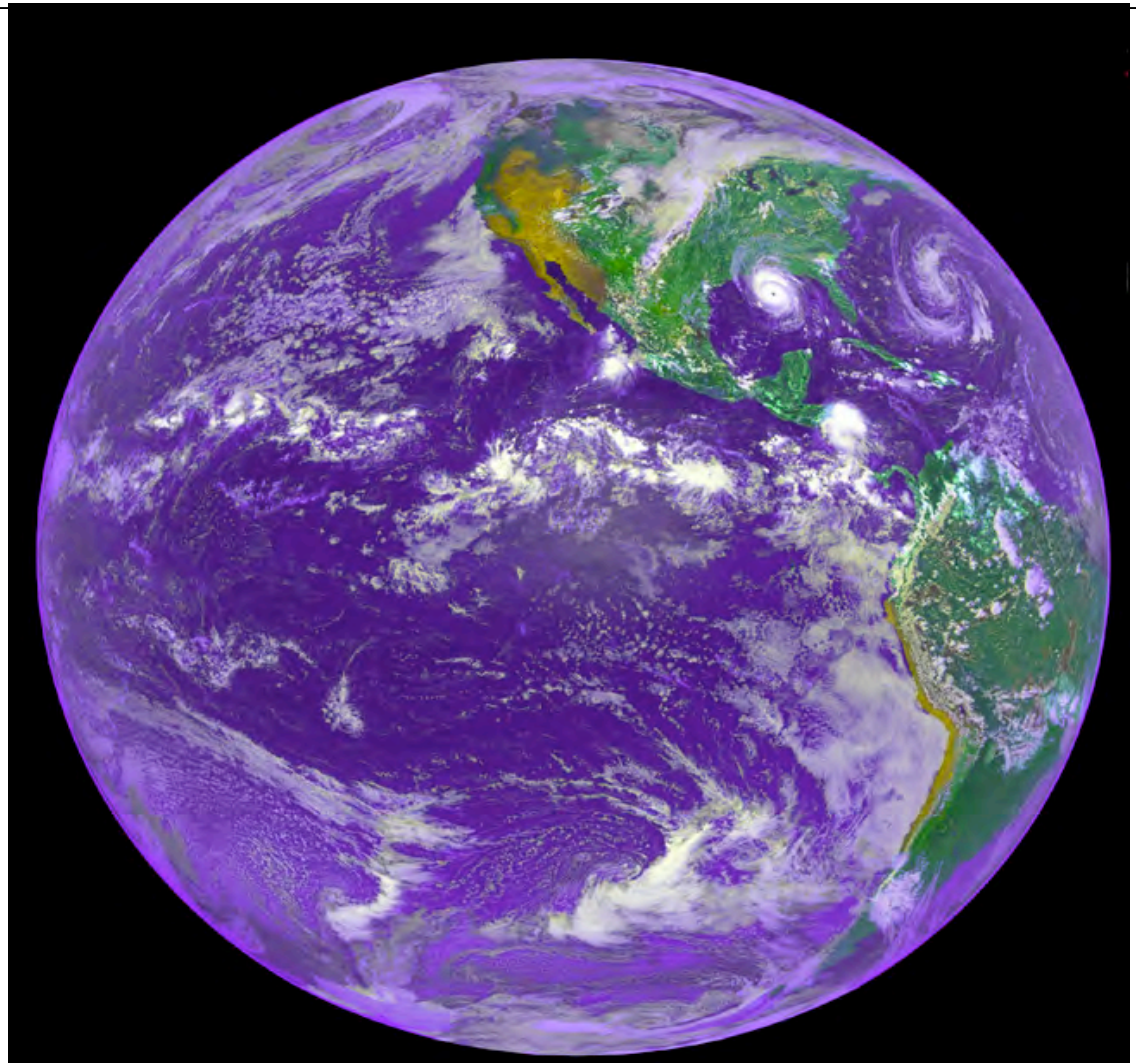
Rich Cregar, Instructor
Wake Technical College

WAKE TECH
APPLIED TECHNOLOGIES

Objectives

- Discuss Electric Drive Technologies Including Battery-Electric Hybrids
- Discuss the Theory and Operation of a PEM Fuel Cell
- Conduct a Hands-On Demonstration of PEM Fuel Cell Technology
- Discuss the Future of Hydrogen Based Transportation

Where Do We Go From Here?



Alternative Fuels

- EPAct Alternative Fuels can be classified as Fossil based, renewable Bio mass, electricity (Which can be either one) and Hydrogen

- Fossil based alternative fuels:
- Methane (Either as CNG or LNG)
- Propane (LPG)
- GTL fuels (Fischer-Tropsch & P type)

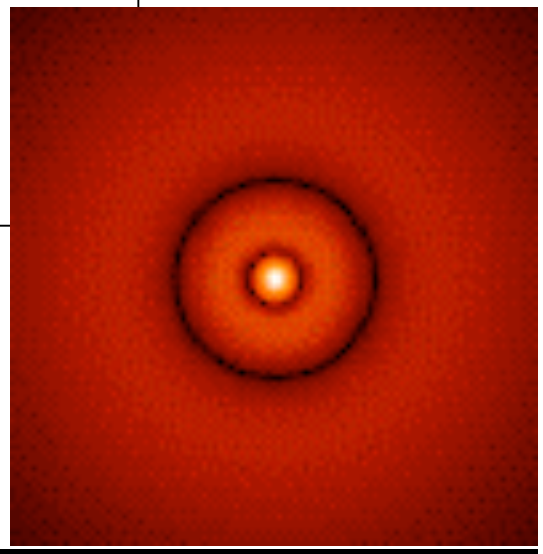
Alternative Fuels

- Renewable Bio mass fuels:
- Bio-Diesel
- Ethanol
- Methanol
- E-85 & M-85

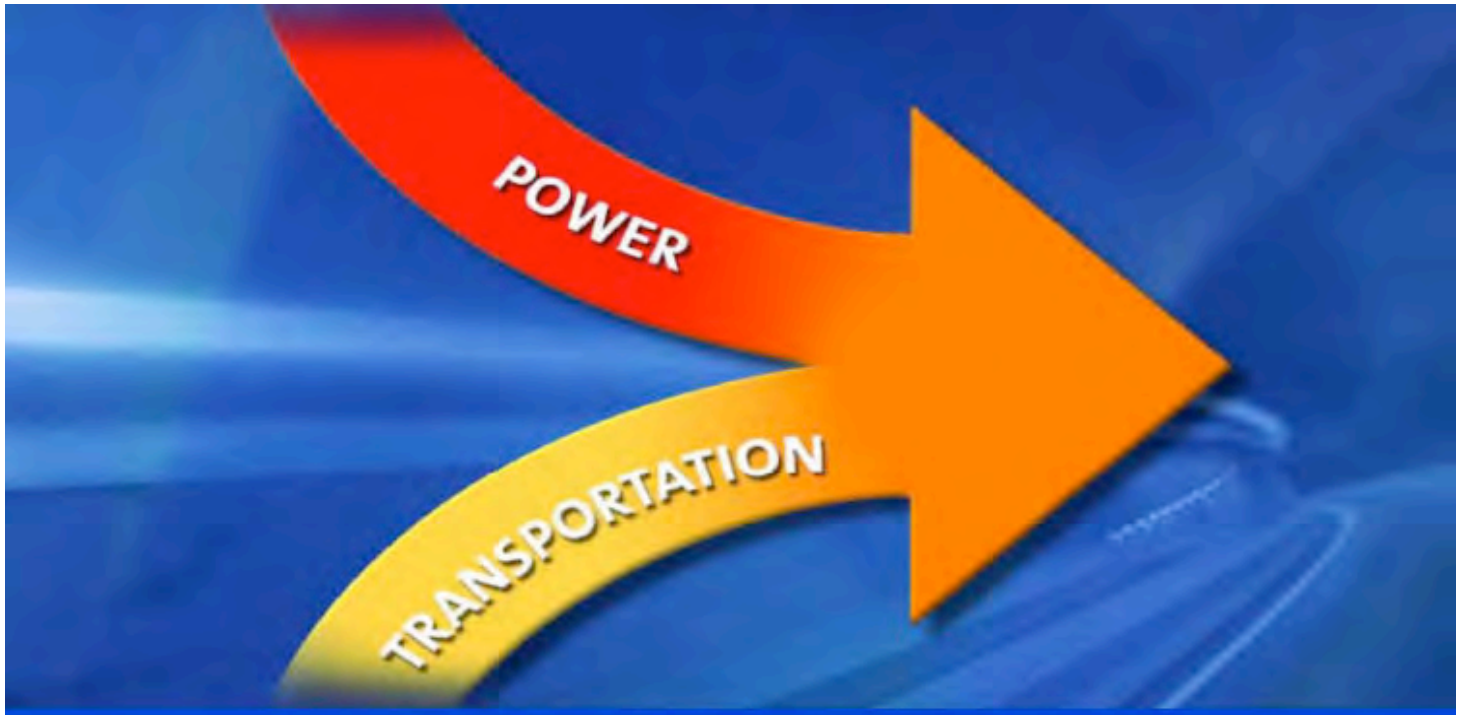
- Electricity can be generated by a number of sources, in the U.S. most comes from coal fired plants, but is considered to be an alternative vehicle fuel.

Alternative Fuels

- **Hydrogen:**
- **The most abundant element in the universe. On Earth it is locked up in various molecular configurations, such as water, carbo-hydrates and hydro-carbons. It must be liberated as free hydrogen to be usable. Presently this requires a great expenditure of energy.**



The Future of Transportation



More and More, Transportation will be "Electron" Based

Advanced Vehicles

- EPAct AFV's:
- Any dedicated, flex fuel or dual fuel vehicle which can run on an alternative fuel. Does this include EV's?

Photo: Rich Cregar

Advanced Vehicles

- Advanced technology vehicles:
- NEV's
- Hybrids

- Note-these are NOT AFV's!

Photo: Miles EV

Advanced Vehicles

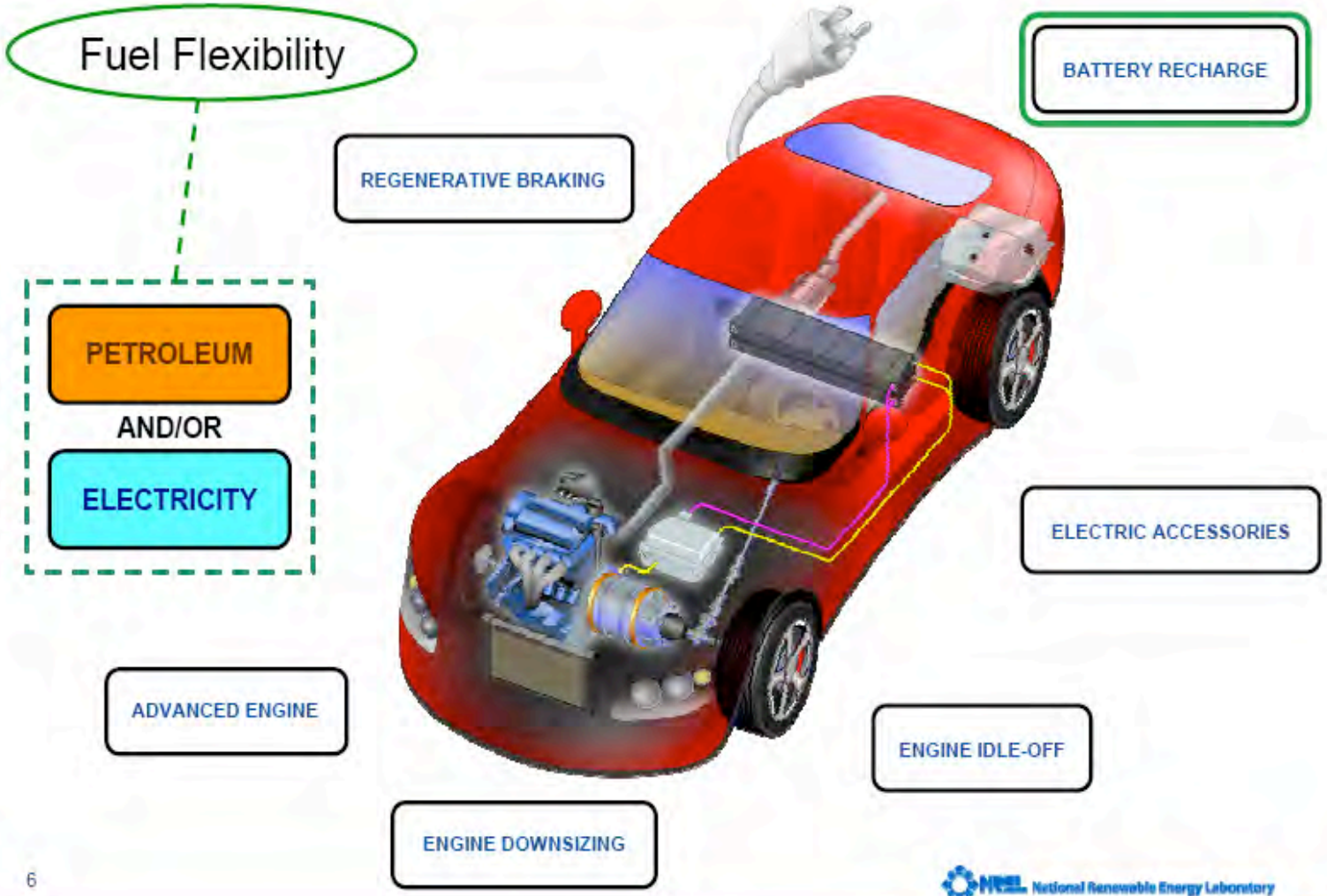
- Hyundai's Fuel Cell powered Hybrid

Photo: Rich Cregar

Plug In Hybrid Electric Vehicles

- 2005 energy bill provides funding for plug-in hybrid electric vehicles PHEV
  - The goal is to produce a vehicle capable of 250 MPG
- Plug-in hybrids use the electric motors more and the I.C.E. less
  - A Prius modified with plug-in capability can easily achieve 100+ MPG
  - Chrysler is already producing PHEV Sprinter vans for fleet customers

A Plug-In Hybrid-Electric Vehicle (PHEV)



Some PHEV Definitions

Charge-Depleting (CD) Mode: Vehicle operation on the electric drive, engine subsystem or both with a net decrease in battery state-of-charge

Charge-Sustaining (CS) Mode: Vehicle operation on the electric drive, engine subsystem or both with a 'constant' battery state-of-charge (i.e., within a narrow range)

All-Electric Range (AER): After a full recharge, the total miles driven electrically (engine-off) before the engine turns on for the first time.

Charge-Depleting Range (CDR): After a full recharge, the total miles driven before the vehicle reaches charge-sustaining mode.

PHEV20: A PHEV with useable energy storage equivalent to 20 miles of driving energy on a reference driving cycle. A PHEV20 can displace petroleum energy equivalent to 20 miles of driving on the reference cycle with off-board electricity.

NOTE: PHEV20 does not imply that the vehicle will achieve 20 miles of AER or CDR on the reference cycle nor any other driving cycle. Operating characteristics also depend on the power ratings of components, the powertrain control strategy and the nature of the driving cycle

Hydrogen

- **Hydrogen**

- **By weight has the greatest energy density of any fuel: 283%of diesel**
- **Problem: It is extremely light!**
- **Smallest atom in the universe, hard to contain**
- **It is a cryogenic fuel.**
- **Transition from liquid to gas requires expansion to 800 times the liquid volume**
- **Can be used as a fuel in internal combustion engines**
- **Must be extremely pure (99.9%) to be used as fuel in fuel cells.**
- **Current technology requires approx 4000kw of energy (usually electricity) to produce 1000kw of useable hydrogen**
- **Many other infrastructure issues to be solved!**

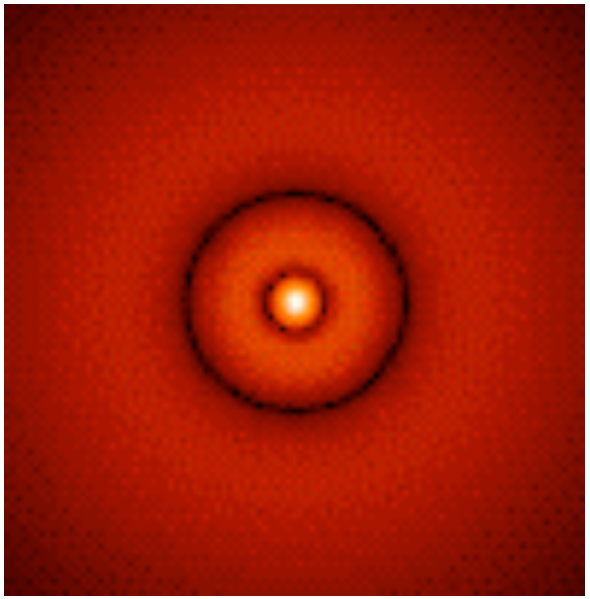
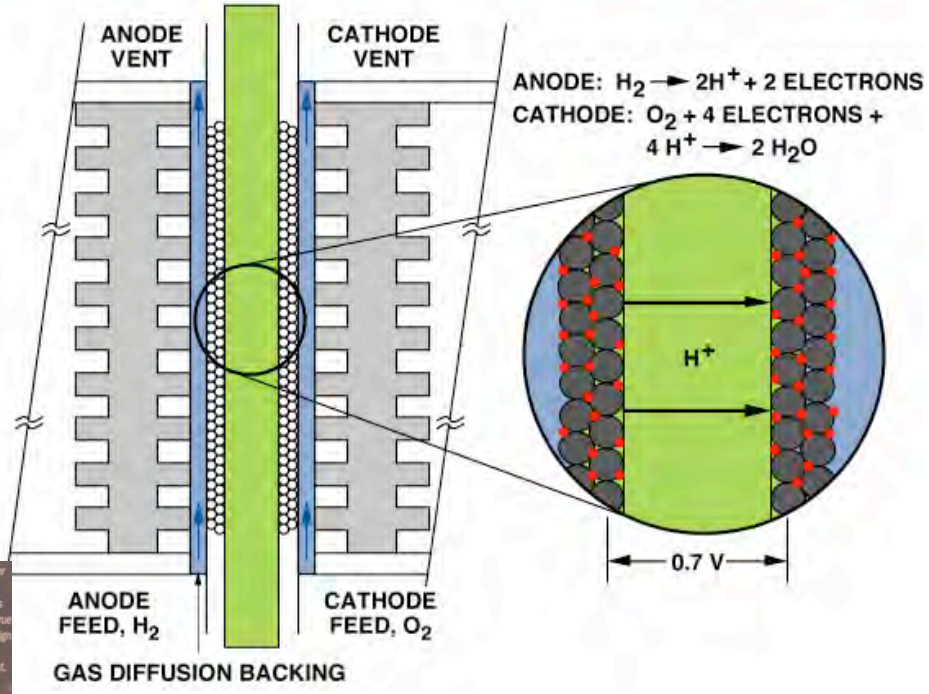


Photo credit: US. D.O.E.

Fuel Cells

Fuel Cells require pure Hydrogen as fuel and Platinum as a catalytic agent. Platinum today costs around $900/oz.

CROSS SECTION OF POLYMER ELECTROLYTE FUEL CELL



The Future of Transportation

WAKE TECH

APPLIED TECHNOLOGIES

Looking Ahead: GM VOLT

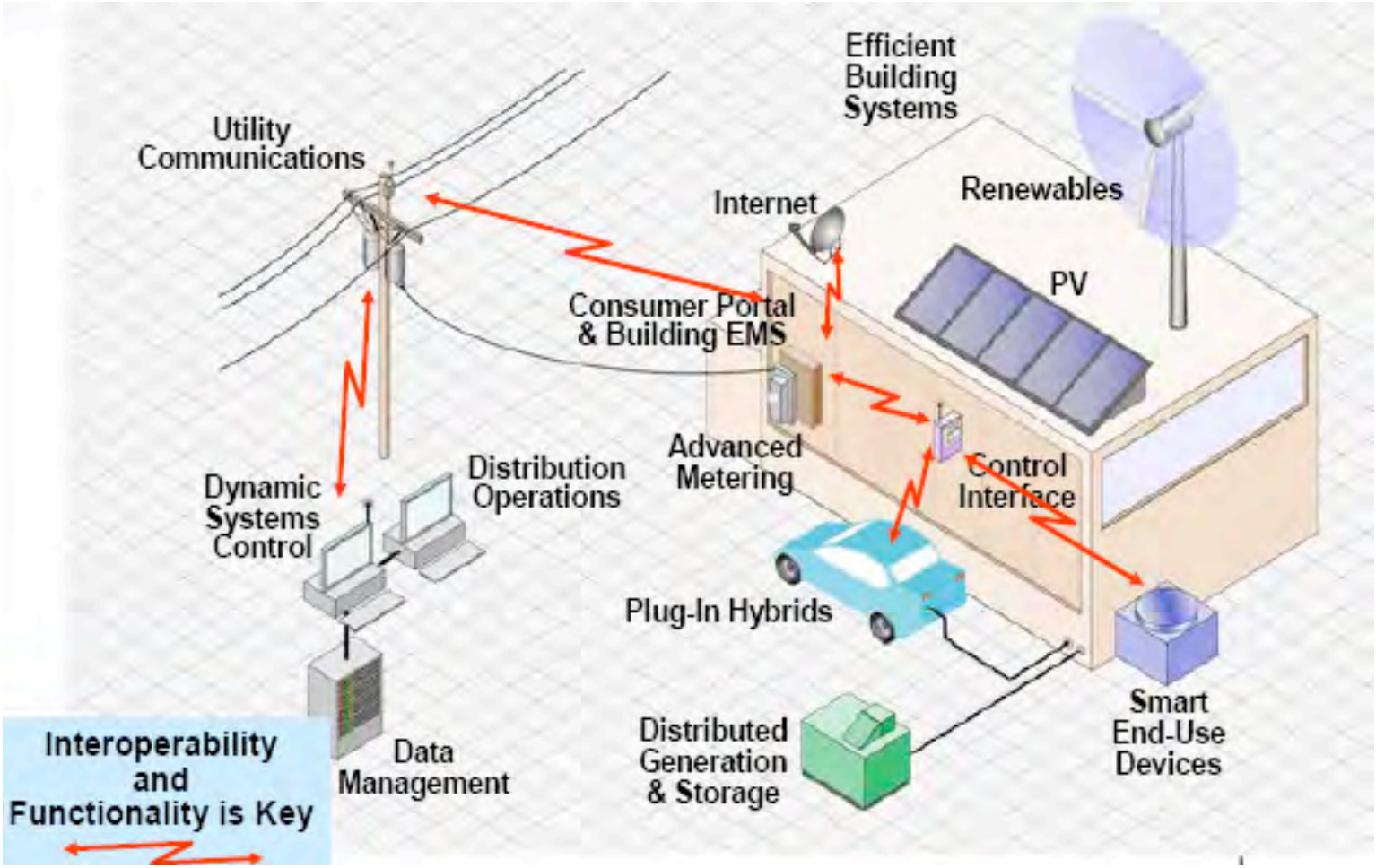
PHEV-40
Range extender: 53 kW direct engine-mounted generator and 3-cylinder 1.0L Turbocharged, intercooled internal combustion engine
Dual (left- and right-side) charge ports
Onboard Li Ion battery pack
12-gallon fuel tank (gasoline)
Uses Charge Depletion & Charge Sustaining Technology

120-kW electric motor is equivalent to a 160-hp engine
Instantaneous torque in electric mode means acceleration faster than traditional torque
0–60 in 8 to 8.5 seconds
Estimated Battery life is about 10 years


Photo Credit: Automotive News

Problem: Lithium-Ion Batteries

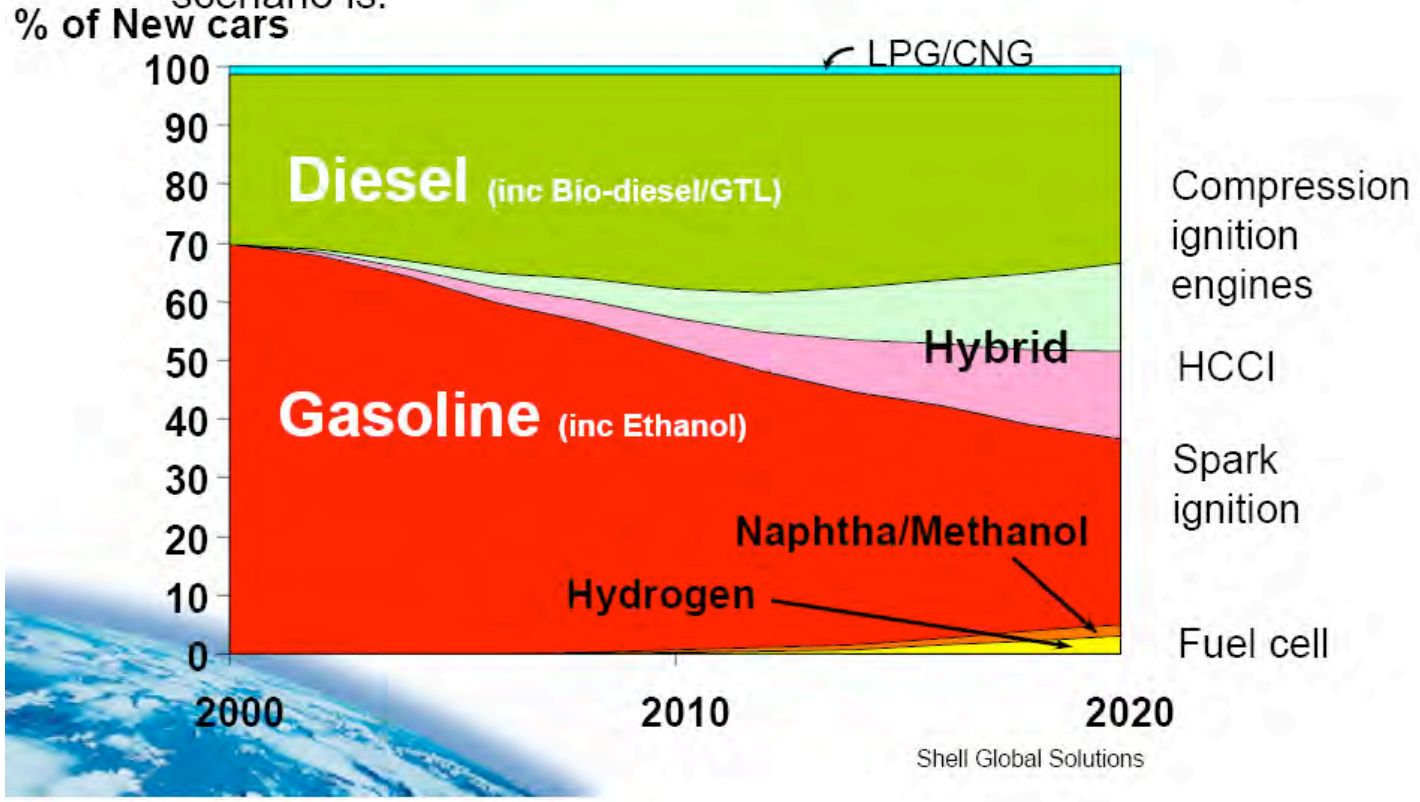
Future Technologies



The Future

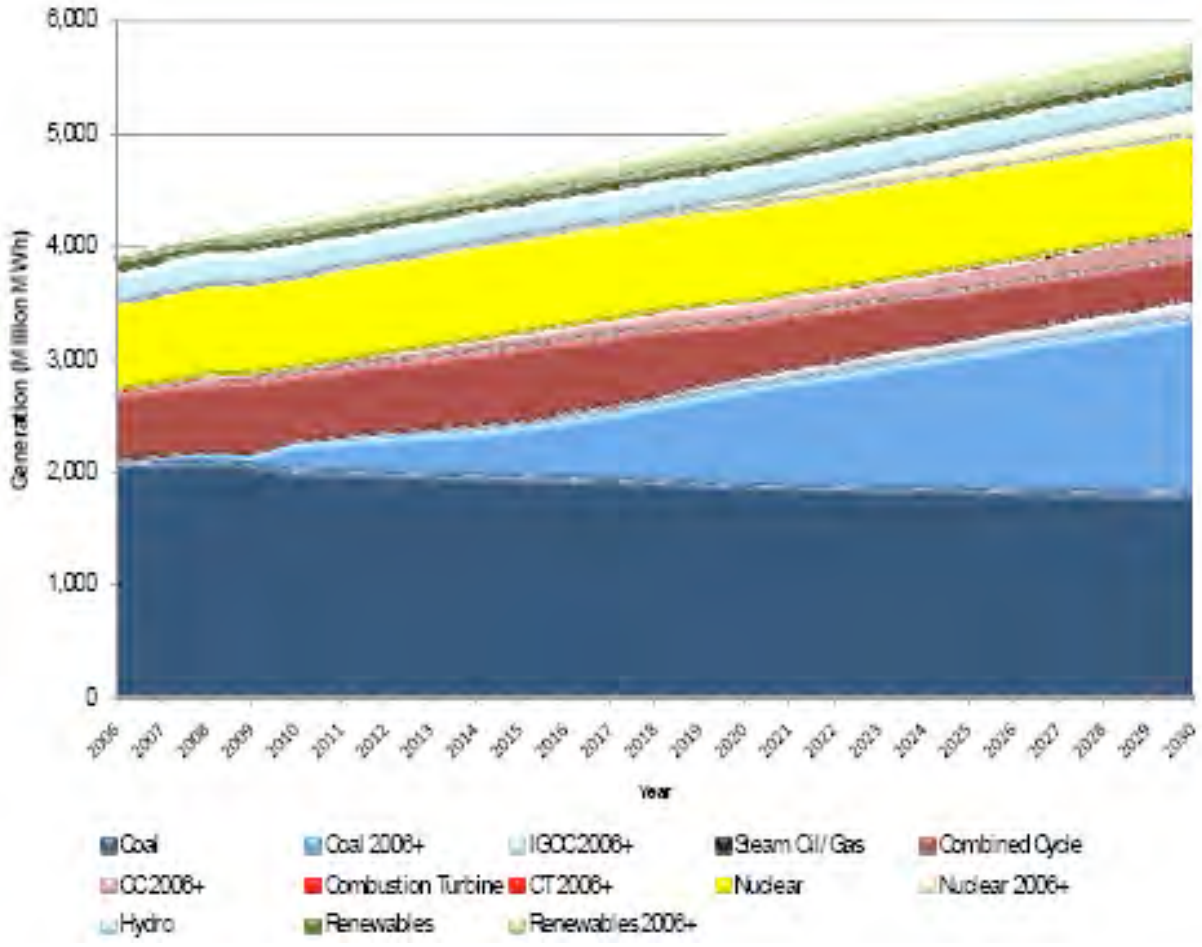
One view of the Future

- The next 20 years will see a wider range of technologies and fuel types, especially in the developed world……one possible scenario is:



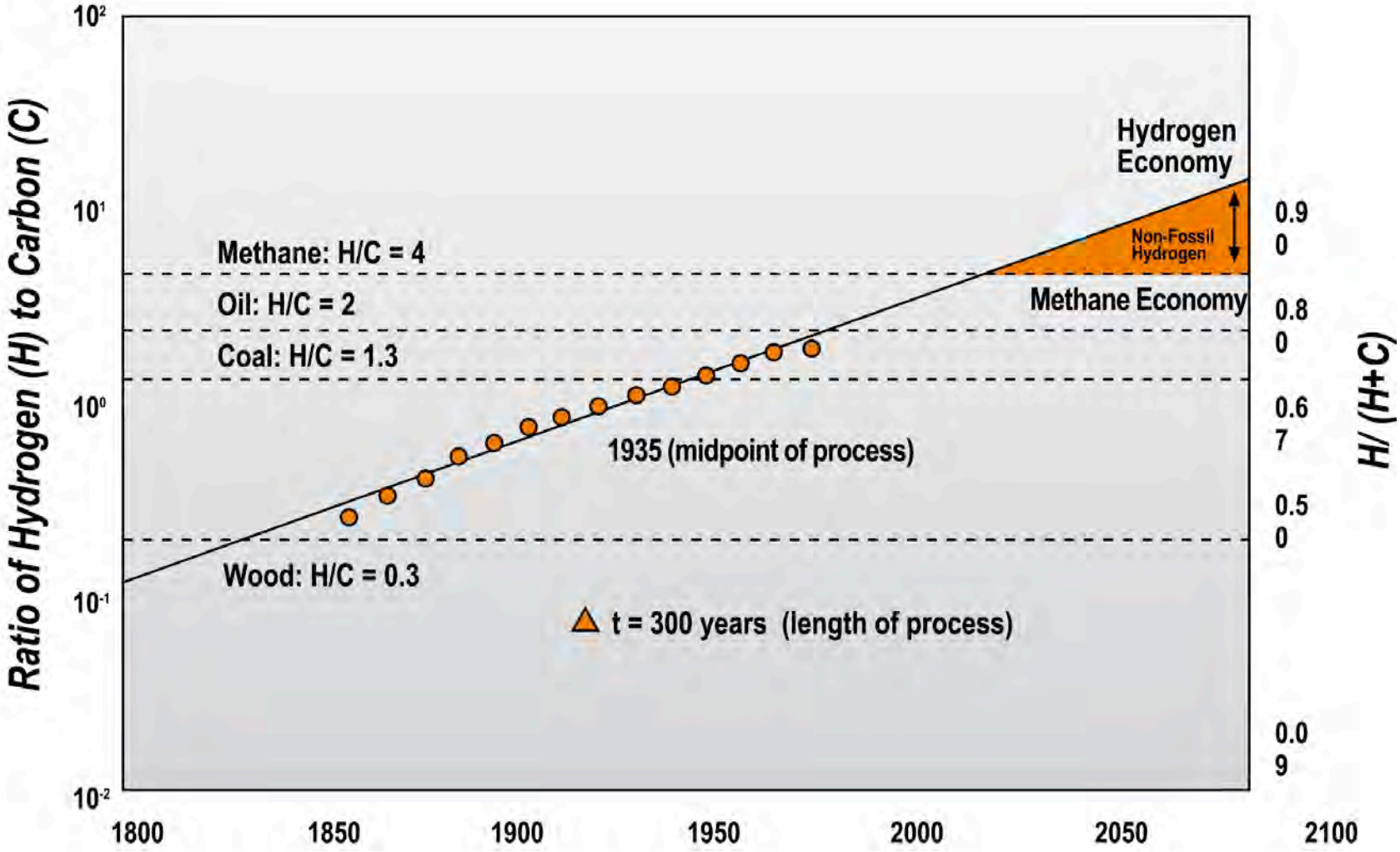
Advanced Technologies

- Electricity



EPRI ELECTRIC POWER RESEARCH INSTITUTE

Mankind's Carbon Pathway



Thanks!!

- Questions??