Energy Storage in Vehicular Applications

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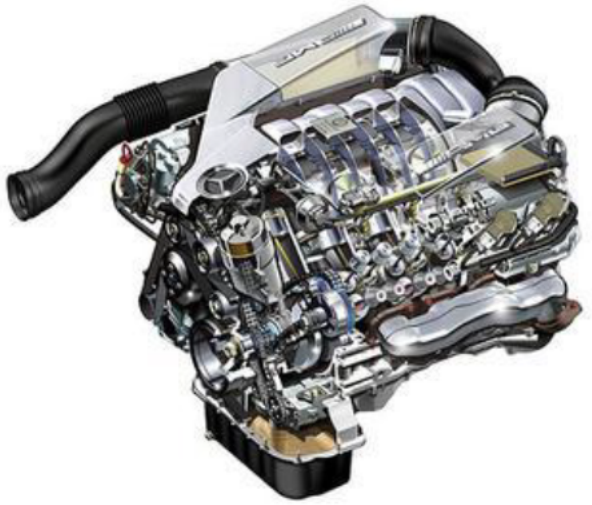
Motivation

- Increasing cost of gasoline and diesel
- Possible future shortage of gasoline and diesel fuel supply
- Carbon dioxide release and global climate change
- Other pollutants that abound in oil
- Heavy dependence in US on imports of foreign oil
- Economic gain to using domestic energy storage options

Energy Storage Options

- Gasoline / Diesel
- Natural Gas
- Batteries
- Hydrogen Fuel Cells
- Kinetic Flywheel
- Photovoltaic Cells

Gasoline / Diesel



- Specific Energy = 46 MJ/kg
- Specific Power = HIGH
- Currently the leader in energy storage in ground vehicles
- Trend is to use other storage options which have lower emissions and are still economical
- Can be hybridized with other storage methods

Natural Gas

- Specific Energy = 46 MJ/kg
- Specific Power = HIGH
- $2-3 per gallon gasoline equivalent
- Can be easily incorporated into current engine designs, even hybrid engines
- Has fewer net emissions than gasoline
- Has huge potential as a bridge to a 100% emission-free economy
- http://www.economist.com/blogs/babbage/2012/05/natural-gas
- http://www.ehow.com/video_6378687_convert-vehicle-natural-gas.html

Batteries

Lead-Acid

- Specific Energy = 100 kJ/kg
- Specific Power = LOW

Nickel-Metal Hydride

- Specific Energy = 288 kJ/kg
- Specific Power = MED

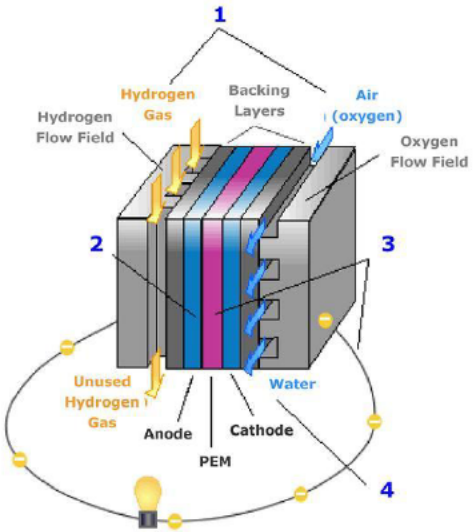
Lithium-Ion

- Specific Energy = 720 kJ/kg
- Specific Power = MED

Batteries – cont.

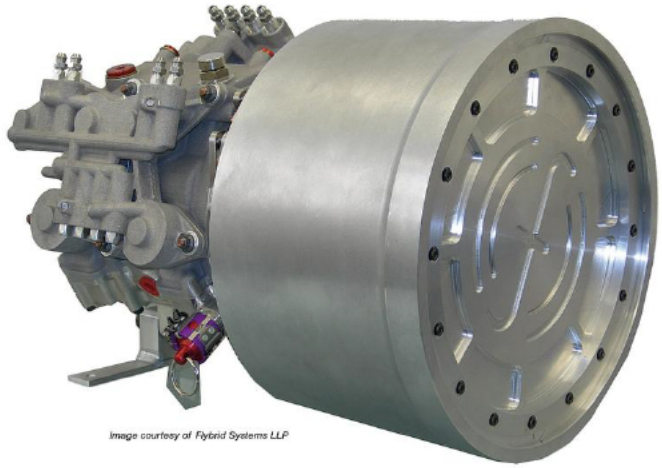
- Lithium-Ion batteries are the most promising
- Relatively low specific energy and power makes them non-ideal for vehicular application
- High refilling time and short range
- Have some potential for either hybrid systems that use other energy storage methods, or in public transportation

Hydrogen Fuel Cells



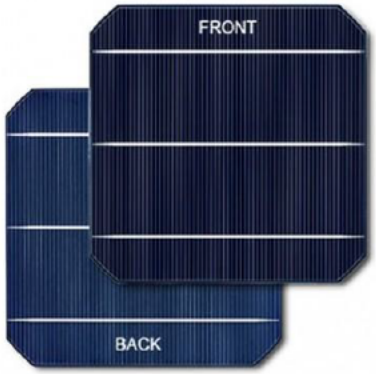
- Specific Energy = 123 MJ/kg
- Specific Power = HIGH
- Has great potential as an emission free energy carrier
- Can be refueled just like natural gas or gasoline
- Currently too expensive to compete
- Possibly the most viable future energy storage system for vehicles
- http://www.youtube.com/watch?v=wS_It55oOFk

Kinetic Flywheel



- Specific Energy = 400 kJ/kg
- Specific Power = MED
- Stores energy as rotational kinetic energy
- Rotational momentum associated with flywheel can be problematic in vehicles, need to counteract gyroscopic effect with a second
- Can recapture most energy from braking
- Best used for larger vehicle applications, such as buses or trains
- http://www.youtube.com/watch?v=-knIZj-Z0Zs

Photovoltaic Cells



- Not storage, but rather an on-board source
- There has already been a significant amount of development in this area, but no vehicle is commercially available for use in the US
- Depends largely on the research into the manufacturing of cheaper, more efficient photovoltaic cells
- Currently unable to sustain large distances, long recharging period, requires batteries
- http://www.youtube.com/watch?v=wESgc-ndYEY

Summary

- Gasoline: hopefully a source we do not depend on, currently has largest use
- Natural Gas: good for public transportation, great bridge toward emission free storages
- Batteries: non-ideal for vehicular applications
- Hydrogen Fuel Cells: probably the best future solution for vehicular energy storage
- Kinetic Flywheels: ideal for public transportation and short-range vehicles
- Photovoltaic Cells: possible option in the extended future for short-range vehicles

References

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