Convergence of Transportation and Energy in the Future

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ABSTRACT

Energy and transportation are major world industries joined inextricably together. Each available energy source – fossil, nuclear, renewable - has used as used as a transportation fuel. The future of fuel availability is the future of transportation. The existing dominance of fossil fuels can only persist through a transition period. In the future hydrogen, solar, natural gas and other renewable will dominate the transportation. Solar cars, battery vehicles, PHEV, hydrogen fuel cell vehicles, and natural gas vehicles, represent tomorrow's propulsion future.

1. Introduction

Efficient and environmentally sound energy conversion depends on new and improved transportation technology. Reducing energy use, reducing the negative human impact on the environment in a constrained, highly populated state with frequent interactions of unknown consequences is critical to doing as little damage as possible and to intruding as little as possible, in an attempt to extend the transition period so we have time to make right decisions for the future.

2. Oil

The world is rapidly consuming the finite amounts of stored energy, especially petroleum. By way of example, US consumes 20 million BBL/day (7 billion BBL/year) petroleum products. Canada (2-3 million BBL/day - half from tar sands) and Middle East (1.5 million BBL/day) help supply USA petroleum. Canada tar sands contain 300 BBL, one of the world's largest resources ever known, would supply US for only 40 years

3. Natural Gas

We benefit from the chemical energy extracted from sunlight on this planet. As long as there is life and sunlight, we will always have renewable natural gas on this planet in the future. Methane from human (ADG) and plant and animal and plant residues and wastes captured from sunlight are available. Currently, the only natural gas light-duty vehicle manufactured in the U.S. is the Honda Civic GX ($26,000 list price; 24 city/36 hwy/28 combined gasoline equivalent mpg). Only roughly 110,000 of the 12 million CNG vehicles worldwide are in the U.S., including aftermarket conversions. There are roughly 250 million registered passenger vehicles in the US (EIA). The cost to convert vehicles to NG is estimated $12,500 to $22,500 depending on the vehicle, engine, size of CNG tanks needed, and who does the converting (Green Car Journal, 2011**).** Without the development of significant infrastructure, natural gas vehicles cannot be a reality.

4. Hydrogen

Natural gas is currently the principle method to generate hydrogen. Production from renewable energy – wind, solar, geothermal and biomass is possible. Hydrogen fuel cell vehicles will require a hydrogen infrastructure. Fuel cells technology transforms electricity production in stationary and transportation applications because it is the most efficient way to convert chemical energy to electricity. According to some fuel cell cars are decades away from commercialization. While major development has centered on polymer electrolyte fuel cells, solid oxide fuel cells operating on natural gas are a definite possibility.

5. Solar

All the energy stored on the earth comes from the supernova of suns or the Sun itself. With the SEV solar system, the Toyota Prius can operate up to 30 miles per day in electric mode thus improving fuel economy by up to 34-60%. Power from a solar array is limited by the size of the vehicle and area that can be exposed to sunlight. While energy can be accumulated in batteries to lower peak demand on the array and provide operation in sunless conditions, the battery adds weight and cost to the vehicle. The power limit can be mitigated by use of conventional electric cars supplied by solar (or other) power, recharging from the electrical grid. triple hybrid vehicle—the PHEV that has solar panels as well to assist. While sunlight is free, the creation of PV cells to capture that sunlight is expensive. Costs for solar panels are declining.

6. Stationary Power from Coal, Nuclear, Natural Gas, Renewables for Transportation

These fuels will continue to be used until extinct.
While direct propulsion in transportation is limited, the use of this energy for transportation and especially plug-in hybrids is increasing. However, the efficiency of stationary power generation is problematic (Figure 2). Greater use by hybrids will only shorten the life of those fuels. In the nuclear industry, the fuel rods will spend about 3 operational cycles (typically 6 years total now) inside the reactor. Generally until about 3% of their uranium has been fissioned, then they will be moved to a spent fuel pool where the short lived isotopes generated by fission can decay away. After about 5 years in a spent fuel pool the spent fuel is radioactively and thermally cool enough to handle, and it can be moved to dry storage casks or reprocessed. There is no storage facility for nuclear waste in USA. All nuclear waste belongs to the American people. Of course, complete electrification of the transportation through stationary power will eliminate the need to depend on petroleum.

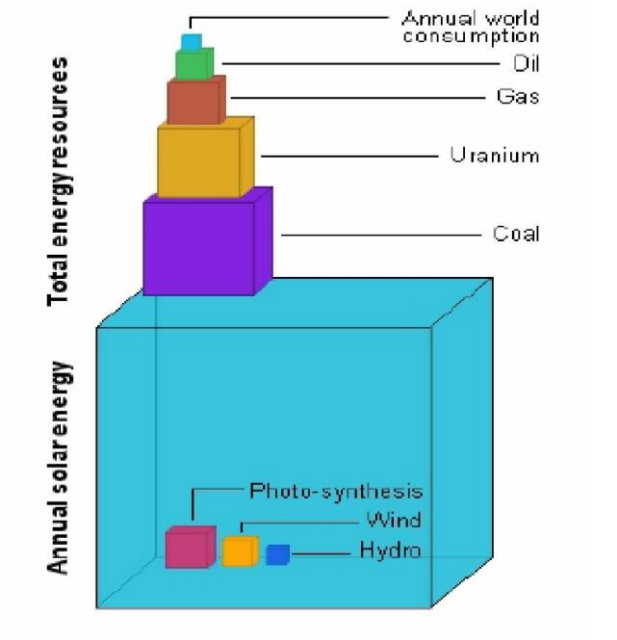

Fig. 1 Energy Consumption, storage energy, and incident energy

7. Battery

The energy for charging batteries must come from some available energy source – fossil, nuclear, renewable. Energy storage costs are falling but batteries remain expensive. The electric car is making great progress (Figure 3).

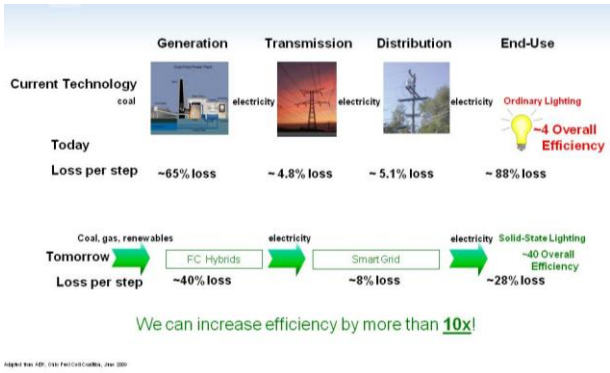

Fig. 2 Energy Efficiency in Stationary Power

8. Concluding remarks

Energy and transportation are major world industries joined inextricably together. The available energy in the future will determine the fuel to be used in transportation. Efficiency of energy conversion will determine when and to what fuel the industry will vector. Technology innovation will help shape this future. Ultimately, solar and renewable natural gas will dominate in the fture.

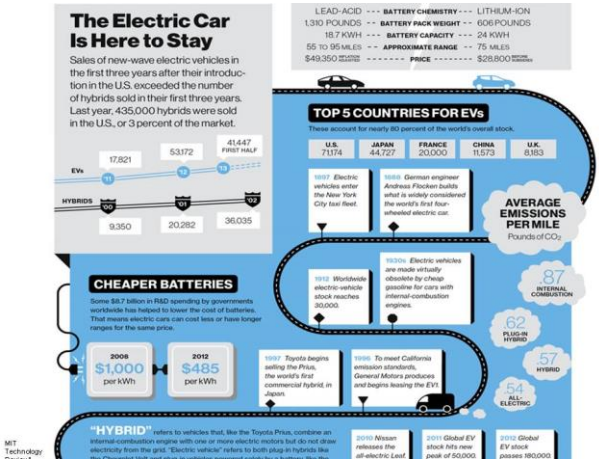

Fig. 3 Status of Battery Cars

References

[1] EIA, 2013.
[2] Green Car Journal, 2011.
[3] Adapted from AEP, Ohio Fuel Cell Coalition, June 2009.
[4] MIT, newsletters@technologyreview.com, August 2, 2013.