Chapter 9
Hydrogen, the Homeopathic Energy Crisis Remedy

Homeopathy involves diluting substances so much that there's virtually nothing left of it. Hydrogen is also an empty remedy, so absurd that I wasn't going to waste words and energy on it. But hydrogen is so often mentioned as a solution for the energy crisis that I'm going to attempt to thrust a stake into its heart.

Since water is one of the few substances besides air and dirt abundant enough to scale up as a fuel, hydrogen does seem to be a logical candidate.

But hydrogen gas (H_2) isn't an energy source—it is an energy carrier, like a battery. You have to put energy in to get energy out, and producing H_2 puts you in negative energy territory immediately. To put hydrogen in your tank first requires repeated infusions of energy:

1. To split hydrogen out of water takes a tremendous amount of energy. That is why 96 % of H_2 is made from natural gas, the other 4 % from water that needs to be extremely pure.
2. Once you have hydrogen gas, it must be compressed, or purified for fuel cells, or liquefied and chilled to −423 °F using energy-demanding cryogenic support systems.
3. Storage tanks and pipelines are heavy and energy-intensive because hydrogen is the Houdini of elements, the smallest one, enabling it to escape through the tiniest imperfections. Consequently, fuel cell engines and storage tanks have many seals, gaskets, and valves. Hydrogen requires expensive, heavy, large tanks, and pipelines made of special steel that won't become brittle and crack or fissure.
4. Hydrogen gas is very flammable and explosive. Remember the Hindenburg?
5. Absent hydrogen pipelines, delivery requires a $250,000 canister truck weighing 40,000 kg delivering a paltry 400 kg of fuel, enough for 60 cars. The same truck can carry 10,000 gallons of gas, enough to fill 800 cars. The hydrogen delivery truck will eat a lot of energy itself: over a distance of 150 miles, it will burn the equivalent of 20 % of the usable energy in the hydrogen it is delivering.
6. Turning that hydrogen back into electricity with a fuel cell will only be 24.7 % efficient. There are multiple stages where energy is lost due to inefficiencies at

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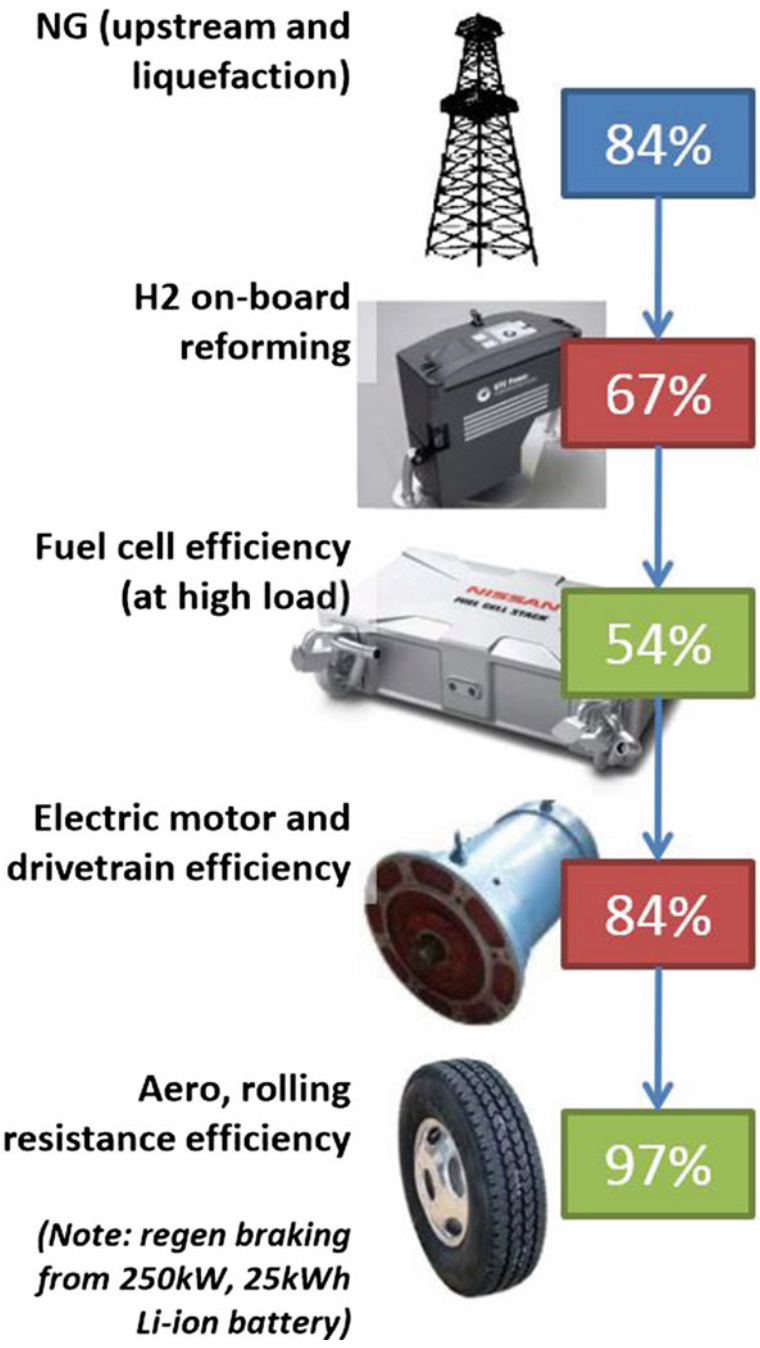

Fig. 9.1 Heavy truck: PEM hydrogen fuel cell on-board reforming. U.S. Department of Energy Vehicle Technologies Program, Estimated for 2020. *Source* (DOE 2011)

each step: Natural gas upstream and liquefaction, hydrogen on-board reforming, fuel cell efficiency, electric motor and drivetrain losses, and aerodynamic/rolling resistance (Fig. 9.1).

7. References and additional information can be found at The Hydrogen Economy. Savior of Humanity or an Economic Black Hole? http://energyskeptic.com/2011/hydrogen/.

Without unlimited energy from fusion, hydrogen is impossible because it requires enormous amounts of energy to make hydrogen gas.

Even if Thomas Edison was resurrected and (in a second miracle) invented a black box that could turn water into hydrogen, it wouldn't be easy to sell cheap hydrogen to a trucker. Trucks don't use hydrogen tanks because they take up 10 % of payload weight (DOE 2011), or fuel cells, because the best only last 2500 h but need to keep on going at least 14,560 h in long-haul trucks and 10,400 in distribution trucks (den Boer 2013).

There is plenty more to be said that would burst the bubble of the hydrogen economy, but this is enough wasted ink.

References

den Boer, E. et al. 2013. *Zero emissions trucks*. Delft.

DOE. 2011. Advanced technologies for high efficiency clean vehicles. Vehicle Technologies Program. Washington DC: United States Department of Energy.