# Hydrogen Fueled Home Generators

Asma Shubair (CHE) Abdul Majid Hussan (MCE) Karim Afifi (MCE) Meera Al Shamali (ELE) Abdul Rahman Barakat (CVE)

## SITUATION

Burning fossil fuel, such as coal, oil and natural gases contribute to pollution and global warming due to the emission of carbon dioxide. 33% of green house emissions are due to electricity generation, which is the highest percentage amongst other factors [1]. Also, fossil fuels are finite resources that will eventually deplete. The suggested hydrogen fuel cell does not burn oxygen rather it simply combines itself with oxygen from air to form water [2]. Hydrogen fuel was already integrated to cars such as the BMW 740i Sedan but this concept has not yet been integrated to home generators [3].

## PROBLEMS

What is Hydrogen fuel?

Hydrogen fuel is a substitute fuel to gasoline. It is much cleaner and has water as the main emission rather than CO2.

Limitations:

- Hydrogen in its pure gaseous form is expensive to obtain. [4]
- Hydrogen fueled machines tend to have a high fuel consumption . [5]
- Large scale hydrogen generators do not exist currently. [5]
- Hydrogen in its gaseous form is hard to store as it has a low volumetric energy density. [4]

## SOLUTION

- Solar power is integrated in our design to create a self-filling cycle to eliminate the need of constantly refilling the motor
- The solar power system diffuses water into its basic component and that way hydrogen is created.
- The system is a perfect replacement to the traditional gasoline cycle as it has double the efficiency.
- Hydrogen fuel cells are used to convert the chemical energy into electric energy.
- One fuel cell generates 236.17 kJ/mol, which is not sufficient energy to power a home, therefore a stacking fuel cells is the solution. [6]
- The amount of electricity generated by the fuel stack is proportional to the number of cells [1].

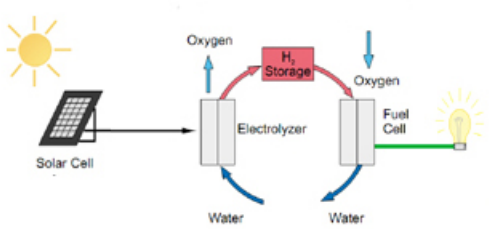


Figure 1: Modeled cost of an 80-kWnet PEM fuel cell system based on projection

## EVALUATION

Cost:

- "Comparing the delivered cost of hydrogen transportation fuel on an energy cost basis (dollars per gigajoule), we find that hydrogen is 50%–100% more costly than gasoline." [7]

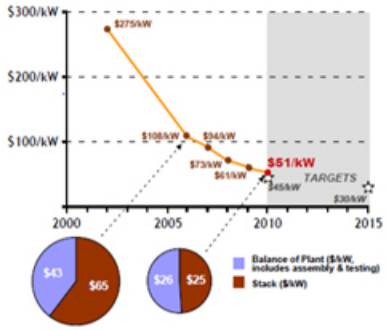


Figure 2: Modeled cost of an 80-kWnet PEM fuel cell system based on projection [8]

Although the initial costs are high, in the long run the costs decrease. (see figure 2)

Efficiency:

The efficiency of these motors reaches 60-70 percent which is better than the efficiency of motors that work with gasoline which have 30% efficiency. [7]

Major Benefits:

| | Hyundai Tucson (gasoline) | Hyundai Tucson FCEV (hydrogen from natural gas) | Hyundai Tucson FCEV (33% renewable California hydrogen)** | Hyundai Tucson FCEV (46% renewable California hydrogen)*** |
|---|---|---|---|---|
| Gasoline vehicle emissions equivalent ($MPG_{GGE}$) | 25 | 38* | 54 | 63 |
| Global warming emissions per mile (g $CO_2$eq/mile) | 436 | 286 | 202 | 173 |
| Emissions reduction relative to gasoline | | 34% | 54% | 60% |

*The EPA rating for the Hyundai Tucson FCEV is 49 miles/kilogram hydrogen.

**California law (California State Senate 2006) requires a minimum of 33 percent renewable hydrogen content.

***The Air Resources Board projects renewable hydrogen content in California for 2015 will be 46% (CARB 2014).

Figure 3: reduction of emissions [9]

Emissions are decreased by %60 (see figure 3)

## REFERENCES

1. C. Woodford, "How do fuel cells work in hydrogen cars?," Explain thatStuff,2016.[Online].Available: http://www.explainthatstuff.com/fuelcells.html. [Accessed:27-Sep-2016].
2. S. Connor. H(2) plus O(2) equals a better future. New Statesman pp. 2. 2003.Available:http://ezproxy.aus.edu/login?url=http://search.proquest.com/docview/224376249?accountid=16946.x
3. ContributionsoftheU.S.to GlobalTransport Emissions," Welcome! [Online]. Available:https://www.e-education.psu.edu/geog438w/node/392. [Accessed: 11-Oct-2016].
4. J. Spendelow and J. Marcinkoski, "DOE Hydrogen Program Record", 2016. [Online]. Available: https://www.hydrogen.energy.gov/pdfs/10004_fuel_cell_cost.pdf. [Accessed: 15- Nov- 2016].
5. "How Clean Are Hydrogen Fuel Cell Electric Vehicles?", Union of ConcernedScientists,2016.[Online].Available: http://www.ucsusa.org/sites/default/files/attach/2014/10/How-Clean-Are-Hydrogen-Fuel-Cells-Fact-Sheet.pdf. [Accessed: 15- Nov- 2016].
6. "H2O, the Mystery, Art, and Science of Water" , WitcomBe, 2016 [Online].Availabe:http://witcombe.sbc.edu/water/chemistryelectrolysis.html
7. S. G. C. and J. F. Miller, "3. The US Hydrogen Fuel Initiative," 2008. *Online+.Available:http://web.idrc.ca/en/ev-132140-201-1DO_TOPIC.html. [Accessed: 06-Jan-2012].
8. M. Joan, "Prospects for building a hydrogen energy infrastructure", EBSCO host,2016.[Online].Available:http://web.b.ebscohost.com.ezproxy.aus.edu/ehost/detail/detail?vid=0&sid=686e7c0b-f5d7-42c3-a104-7a27ca6be20a%40sessionmgr2&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d#db=a9h&AN=5366262. [Accessed: 21- Oct- 2016].
9. C. Grimes et al, Light, Water, Hydrogen: The solar generation of hydrogen by water photoelectrolysis. New ork ;;*London+: Springer, 2008.