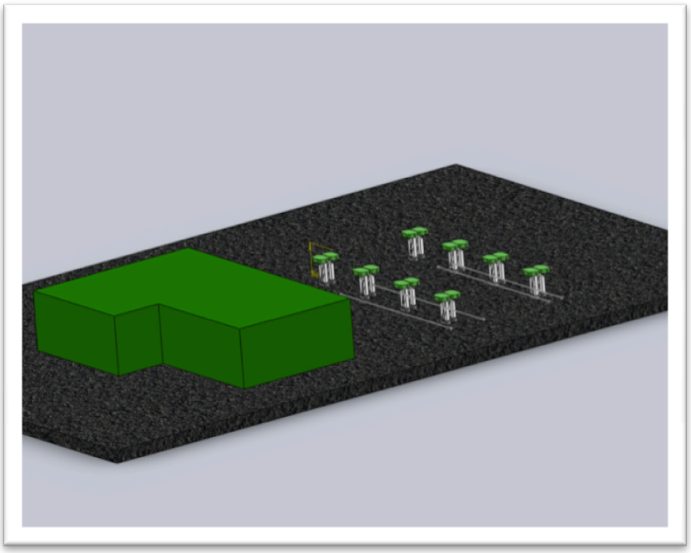
Team 1
EDSGN100.019
Submitted to Prof. Liz Kisenwether 4/25/11

H_2 Fueling City Project

Sponsored By Air Products



Above is a CAD model of our H_2 Station

Left to Right: Tyler Caruso (CAD Design), Jill Morris (Report), Chelsea Buxton (Costing), and Andrew Wilson (Presentation)

Using wind and agricultural waste, Air Products can produce a H_2 City in Pittsburgh, Pennsylvania. H_2 fuel can be produced at a low cost of $5.00 per gram of H_2 for a car station and $5.50 per gram of H_2 for a bus station. This H_2 fuel will have a reduced CO_2 footprint compared to fossil fuels. It is the fuel of the future and the future is near. Using Electrolysis to produce H_2 and renewable energy sources, a gas station can be operated without CO_2 production. Pittsburgh was once popular for their famous steel industry, but now they can be known for being the first H_2 city.

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Project Description:

This proposal contains a design and city plan on building H_2 fueling stations in Pittsburgh, Pennsylvania. These stations will be designed for functionality, sustainability, and efficiency. H_2 fueling stations can lower the city's CO_2 footprint. With the world becoming more environmentally aware, new fuels are needed for sustainability.

Four Key Factors:

Geographic Location:

Pittsburgh shows the most potential for a H_2 city. Once known for being a steel city, Pittsburgh needs a new symbol and source for jobs. H_2 fueling stations can provide that source. In addition, Pittsburgh has a large bus line that could convert into H_2 buses. Pittsburgh can become the first H_2 City.

Safety:

Safety is the number one issue. There have been many cases where tanks have exploded because they were not pressurized at the right level. By manufacturing the H_2 at each individual station we can eliminate the dangers of transporting H_2. In addition, we will require all personal working at the station to undergo safety training.

Environmental Impact:

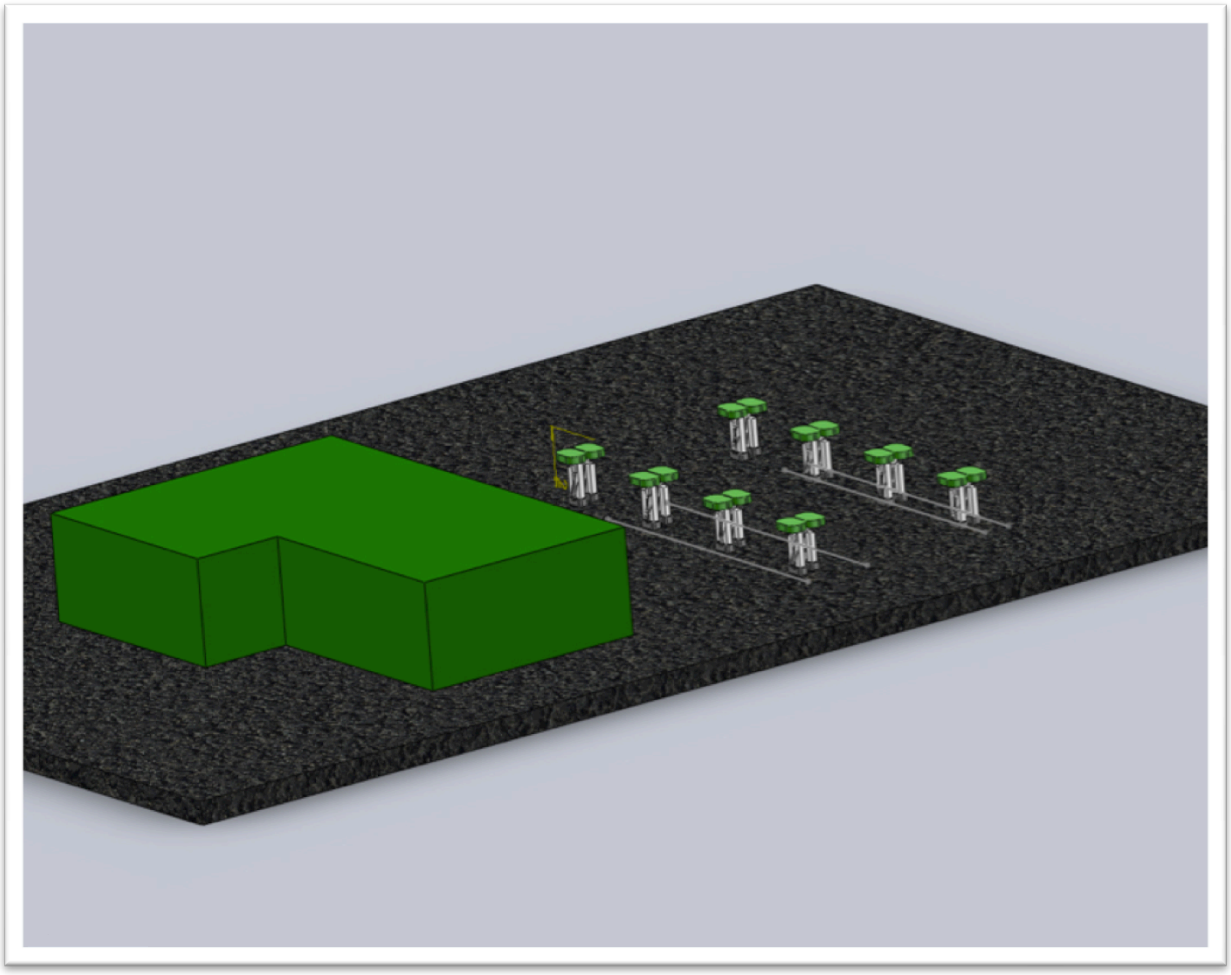
H_2 fuel creates a better environment. This fuel has a zero carbon footprint. It is a healthy and cheap alternative to natural gas. By creating a fuel alternative such as H_2, cars will use less natural gas that creates pollutants. In other words, H_2 fuel creates cleaner air.

Economic:

The cost of a station will be costly in the long run, but over the years as cars convert to H_2 fuel tank, there be more demand for H_2 fuel. It provides a cheap alternative that is produced at home. The

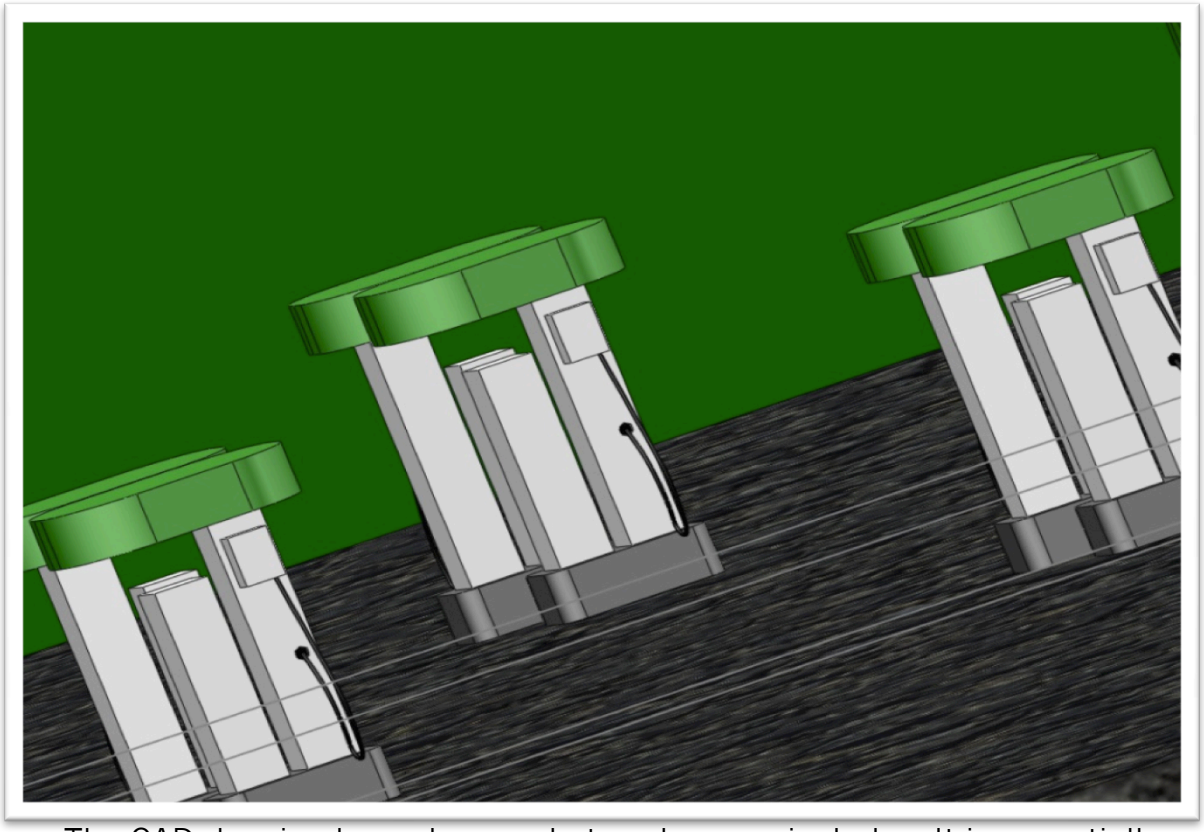
price of fuel will not be determined by the supply of fuel one week to the next, but instead by the cost of production.

Station Layout Diagram:



This station has sixteen pumps, a store, and on-site production facilities.

CAD Views of Fueling Station:



The CAD drawing here show s what each pump includes. It is essentially a lot simpler than the ordinary gas station. In addition, the green has been incorporated to give the station that environmental feel, that when a driver pulls up to the station they know that they are contributing to cleaning the air.

Station Components:

- Separate car and bus fueling stations
- Buses fuel at bus center
- This is logical because bus fueling pumps may need to be larger than car stations
- Stations will produce 100% of the H_2 at the site
- Car stations will accommodate similar amounts of cars to current gas stations

Station Capacity and City Plan

There are 21 gas stations in the city of Pittsburgh. Our plan is to convert 10 of these stations into hydrogen fueling stations immediately, and slowly add more stations as hydrogen become more popular. The bus fueling station will add a hydrogen station. Then new buses added to the fleet will be hydrogen buses and over the span of ten years natural gas buses will be phased out. When planning which stations to change we will convert the medium size stations and we will attempt to spread them out as much as possible. In addition, each car station will have 16 pumps. Each bus station will have 2 pumps.

Costing:

Below is a costing spreadsheet for car stations.

	Discount rate		5.00%
	First Cost		$3,436,881
	Annual Cost		$22,192,000
	Number of units sold annu		6,132,000
	Cost per Unit		$5.00
Year	First Cost	Annual Cost	Annual Income per Unit
0	$3,436,881	$22,192,000	$30,660,000
1		$21,135,238	$29,200,000
2		$20,128,798	$27,809,524
3		$19,170,284	$26,485,261
4		$18,257,413	$25,224,058
5		$17,388,013	$24,022,912
6		$16,560,012	$22,878,964
7		$15,771,440	$21,789,490
8		$15,020,419	$20,751,895
9		$14,305,161	$19,763,709
10		$13,623,963	$18,822,580
NPV	$3,436,881	$193,552,742	$267,408,393
Profit %			35.7%

Below is a spreadsheet for the bus station.

Discount rate	5.00%
First Cost	$1,303,276
Annual Cost	$4,116,000
Number of units sold annually	1,051,200
Cost per Unit	$5.50

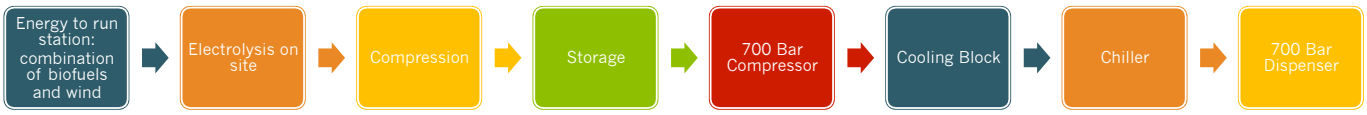
Year	First Cost	Annual Cost	Annual Income per Unit
0	$1,303,276	$4,116,000	$5,781,600
1		$3,920,000	$5,506,286
2		$3,733,333	$5,244,082
3		$3,555,556	$4,994,363
4		$3,386,243	$4,756,537
5		$3,224,994	$4,530,035
6		$3,071,423	$4,314,319
7		$2,925,164	$4,108,875
8		$2,785,871	$3,913,214
9		$2,653,210	$3,726,871
10		$2,526,867	$3,549,401
NPV	$1,303,276	$35,898,661	$50,425,583
Profit %			35.5%

For these profits we had to make some assumptions. We assumed that wind turbines cost $0.10 per kilowatt/hour. In addition, electrolysis machine needs 38 thousand kilowatt/hour per day and we assumed we need three of those.

Process Flow Diagram:

For a car station:

For a bus station:



CO_2 Management:

There will be no use or exhaust of carbon dioxide with the H_2 fueling station. The H_2 fuel will emit clean water vapor. In addition, the process of operating the station will only include renewable energy: agricultural waste and wind energy.

Lessons Learned:

Team 1 has learned that the future is out there. There are so many possibilities that we, as engineers, can contribute to society. With the H_2 City Project, our team learned that being able to work as a group is the most important thing as engineers.