Hydrogen Fueling Station Final Report

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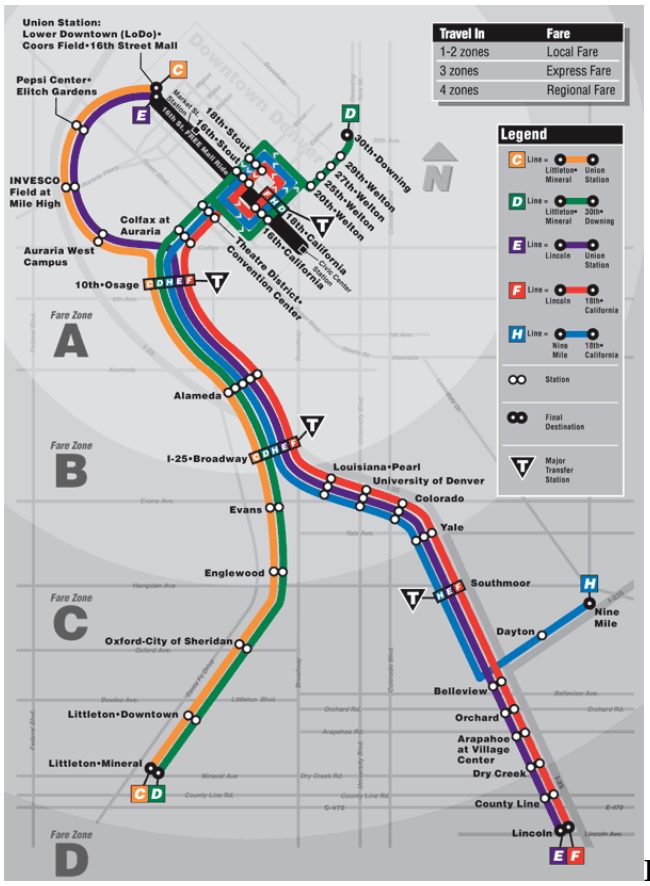
The goal of this project is to create the best fueling system that is safe for the environment. We planned on doing this by utilizing different types of renewable energy to lower the dependence of environmentally harmful substances throughout an entire city, making it more sustainable.

The city we chose to change the fueling system for is Denver Colorado. Denver has a population of about 600 thousand people. We chose Denver because of the different energy sources around the city. Denver most prominent energy sources are wind and solar energy. Another reason we chose Denver is because Denver has a public transportation system. This system has an existing light rail system and also has HCNG buses that carry passengers around the city. In the city of Denver, we discovered that about 450 thousand people own a car and on average each person will drive about 12 thousand miles each year. For these personal cars, the hydrogen gas can have a car travel at 60 miles/kg of hydrogen gas. Also in Denver, about 120 thousand people use public transportation which means that the entire fleet of transportation travels about 3 million miles per year. The hydrogen gas for the public transportation travels at 30 miles/kg of hydrogen gas.

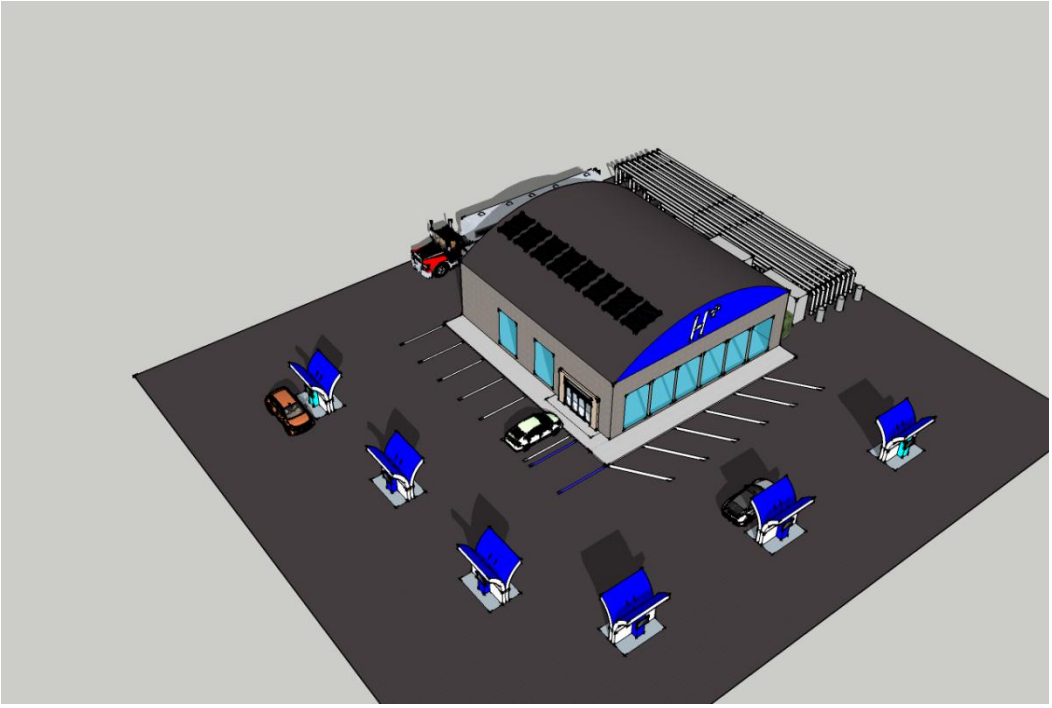
In our analysis of the transportation needs of Denver, we discovered that although the city has a lot of public transportation opportunities the residents don't utilize the system as much as they should. They have a light rail system that comes in from the suburbs of Denver and goes around the city as well as buses that run on HCNG. In order to reduce the need for large amounts of hydrogen fuel for personal vehicles, we want to encourage people to use the bus system and the light rail system as much as possible because the amount of HCNG per person when many people use public transportation is very small compared to the amount of hydrogen gas per person in a personal vehicle.



Light Rail Map as of 2011

The most important part of this project was determining how the hydrogen gas will be produced. Our team decided as the system is being introduced electrolysis will be used to get hydrogen with energy coming from solar panels to power the process. As technology advances we want to continue to develop a new process of getting hydrogen from urine. It is incredibly similar to electrolysis in the fact that it is using electricity to separate the parts of a cell to obtain hydrogen. In a urea cell, the components are not as tightly bonded than the water cells that are used in electrolysis. In fact, only .37 volts are needed to split a urea cell where 1.23 volts are needed for electrolysis. Hydrogen Production is 332% more energy efficient using urine than water.

Our design for the fueling station itself is very simple but very effective. 6 individual stations (with a pump on each side) are placed around the convenience store so that it is easy for vehicles to get in and out. There is a place where trucks come to drop off the hydrogen gas in liquid form in the back of the plot where the storage tanks are. It was made using Google Sketch-Up.

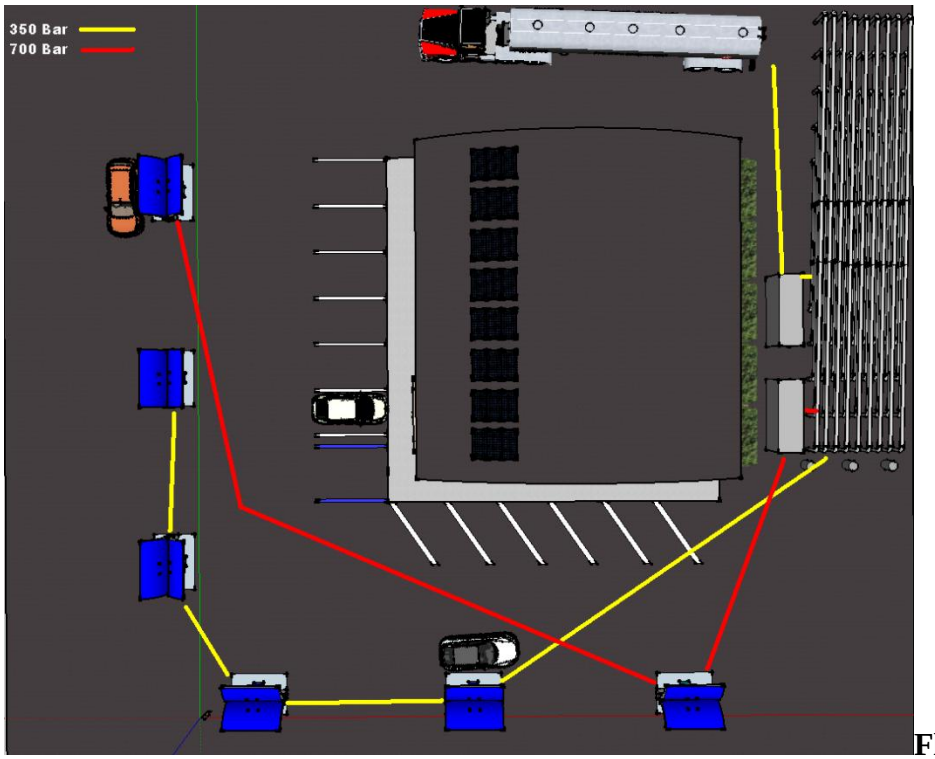


Sketch-Up Model of Fueling Station

Physical Model

The picture shown is a physical model of our pump design. The pump is very simple, yet appealing to the eye. The curved roof gives the pump a futuristic feel, while providing customers with adequate shelter from the elements. The individual roof also cuts down on costs, and reduces the risk of injury from collapsing roofs. The pump interface is a touch screen monitor, allowing the customer to choose what product they want, as well as pay at the pump.

The safety concerns of this project were a top priority while designing the station. In order to keep the public safe, we put the hydrogen storage in the back of the facility away from anyone entering the parking lot. Along with this we added barriers in front of the pipes in order to stop anyone from hitting them. The pumps themselves were also designed with safety in mind. Instead of creating one large roof covering all of the pumps, we gave each pump its own separate arched roof. We did this, because the harsh winters of Denver lead to buildups of snow, which can severely weaken the integrity of roofs, and endanger the customers.



Flow Diagram

By using sustainable resources to provide the energy to create the H2, there will be minimal negative effects on the environment. Since we plan to install solar panels on the roofs of homes, we will not have to destroy any land in order to utilize solar energy.

The use of H2 also means that there will be no toxins released into the air from car exhausts. H2 only emits water vapor into the air which will have no negative effect on the environment.

We also plan to have two HCNG stations located in the city. This is for the use of public transportation vehicles. Most of these vehicles currently run on diesel fuel. By switching over to HCNG the exhaust emitted from busses will be more than 5% cleaner than they currently are.

Safety was another concern that needed to be addressed. We plan to have to H2 produced off site and trucked in to the stations in the form of a liquid. By transferring it as a liquid there will be almost no concern for explosions in the case of an accident because the trucks will not have to be pressurized. If H2 is able to gather at a station it could be a fire hazard. To address this problem we created pumps with curved roofs. This way the driver will still be shielded from the elements while filling their car and not have to worry about a spark igniting the H2.

Using the Excel Cost Estimation tool provided to us, we were able to calculate the start-up cost per station. Although the city of Denver only requires 20 or so pumps to provide enough H2 for drivers, we chose to install 50 stations with 12 pumps at each instead. Not only will this reduce the waiting time to fill up at each station, it will also help to lower the cost per station. We concluded that each Hydrogen station will cost approximately $12.3 million with a total cost of about $615 million. The cost for a HCNG (hydrogen compressed natural gas) will be slightly more at $13.8 million with a total cost of $27.6 million. This difference in price is primarily due to the fact that we will only have two HCNG stations.

The cost of installing solar panels on the homes of car owners is another issue that we had to address. Each home would have to install about 15 sq. meters on top of their homes. Solar panels can be quite expensive initially to install. Over time however, they will pay for themselves because of tax breaks and various government refunds.
We were able to come up with a fairly simple design that was very effective in using renewable resources to power a hydrogen city. One of the best features of our plan was the utilization of roofs to install solar panels rather than destroying a large amount of land. We learned about all the different things that go into the creation of a hydrogen city, such as the creation process, transportation, and storage of the H2. We also learned that it is very difficult and potentially expensive to produce all of the energy needed to create the H2 needed to run a city. Despite this, it is possible to create a more sustainable world in which we live.