# Hydrogen Fuel-Cells and Renewable Energy Integration

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## Abstract


- We analyzed how much hydrogen fuel-cells can offset peak hour energy production in power plants.
- Using Princeton Municipal Lighting Department's (PMLD) wind farm as a case-study, we determined that hydrogen fuel-cells are economically viable if the energy is sold at peak rates.
- Greenhouse Gas emissions would be reduced, but not cost-effectively.


## Background

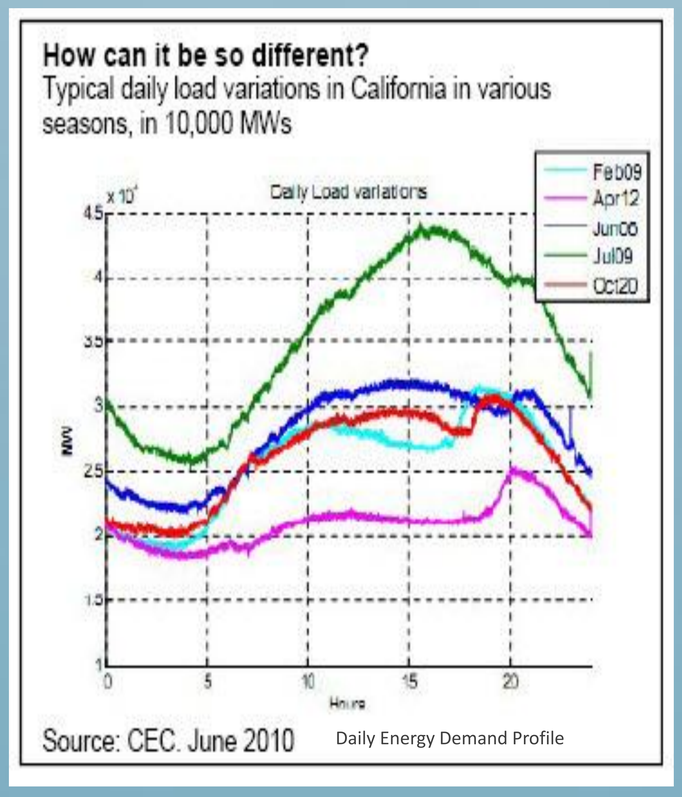
- The energy grid consists of periods of high and low demand. When energy demands exceed the capacity of the local power plant, coal power plants are usually turned on to provide extra energy.
- Many states have implemented government incentives to invest in fuel-cell technologies.
- Fuel-cells are still at most 25% efficient, not including the electrolysis to get the hydrogen, which is about 80% efficient.

## Project Goals

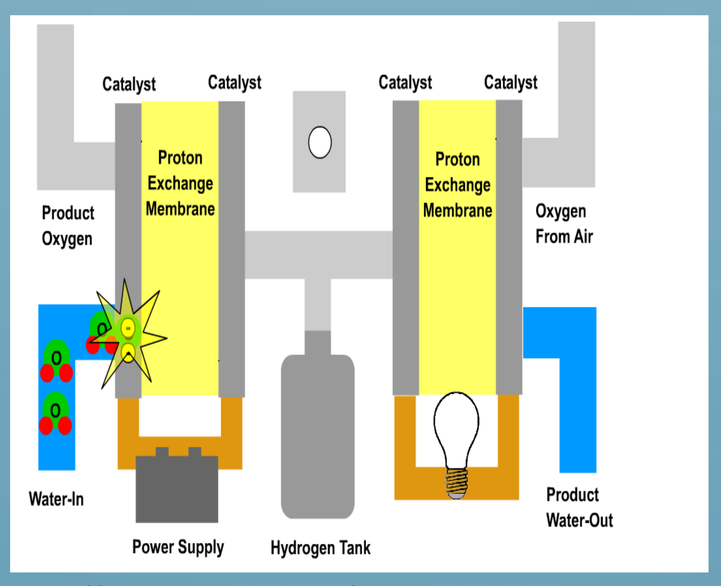
- Determine feasibility of integrating a hydrogen fuel cell system with different energy sources to off-set peak demand and reduce $CO_2$ emissions.
- Find a timeline of when a hydrogen fuel-cell system investment will become profitable.

## Methods/Process

- Obtain a cost estimate of using a stationary fuel cell using empirical evidence and scholarly sources.
- Using local companies data to find the anticipated profit-margin for companies.
  - Princeton Winds
- Compare hydrogen as a storage medium to that of batteries and other storage mediums .



Daily Energy Demand Profile



http://www.infinityfuel.com/regenfuelcells.htm

## Results/Outcomes

- From January to October 2010, PMLD would have saved 615 tons of $CO_2$ using fuel-cells.
- Lifespan of average fuel cell is 10 years when run at half time.
- Three Scenarios
  - Sell excess energy at same rate
    - 18 years payback time
  - Sell excess energy at peak rate
    - 4 years payback time
  - Sell all energy (not only excess) at peak rate
    - 5 years payback time

## Conclusions

- It is economically viable to invest in hydrogen fuel-cells as long as the new energy stored is sold as peak energy.
- If the extra energy is sold at the same rate, there will be $55,000 in additional revenue per year.
- If this energy is sold at peak rates ($0.20 per kWh), then profits will increase by $275,000.
  - Investment in fuel-cells become economically viable.
- If all energy produced was stored in fuel-cells, PMLD would make an additional $440,000 per year.

## Recommendations

- Find someone who knows the fuel-cell field of research and is up-to-date in that area.
- It is critical to make sure sources are current, considering the rapid technological growth of the fuel -cell industry
- Establishing a baseline price that is required to make fuel-cells profitable is necessary.
- Look into the variables affecting the efficiency of the fuel cell and look into where improvements can be made(temperature is a large factor).