Fuel Cell Case Study

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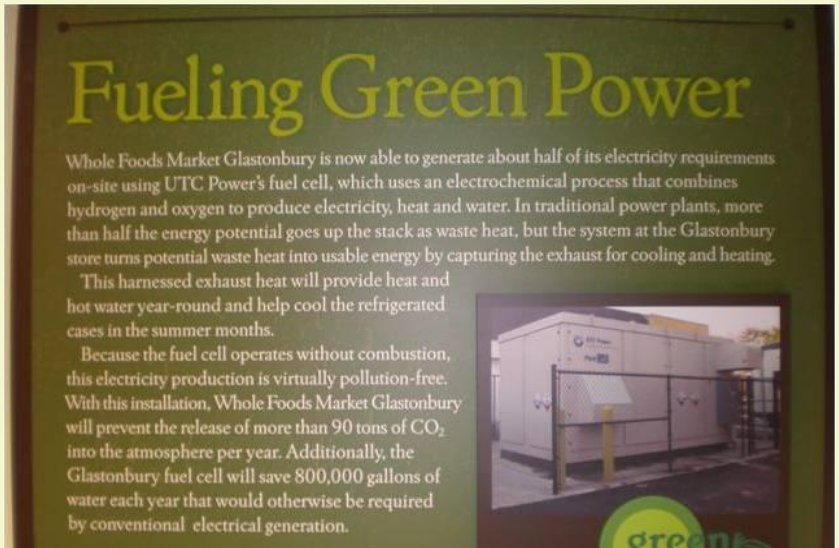


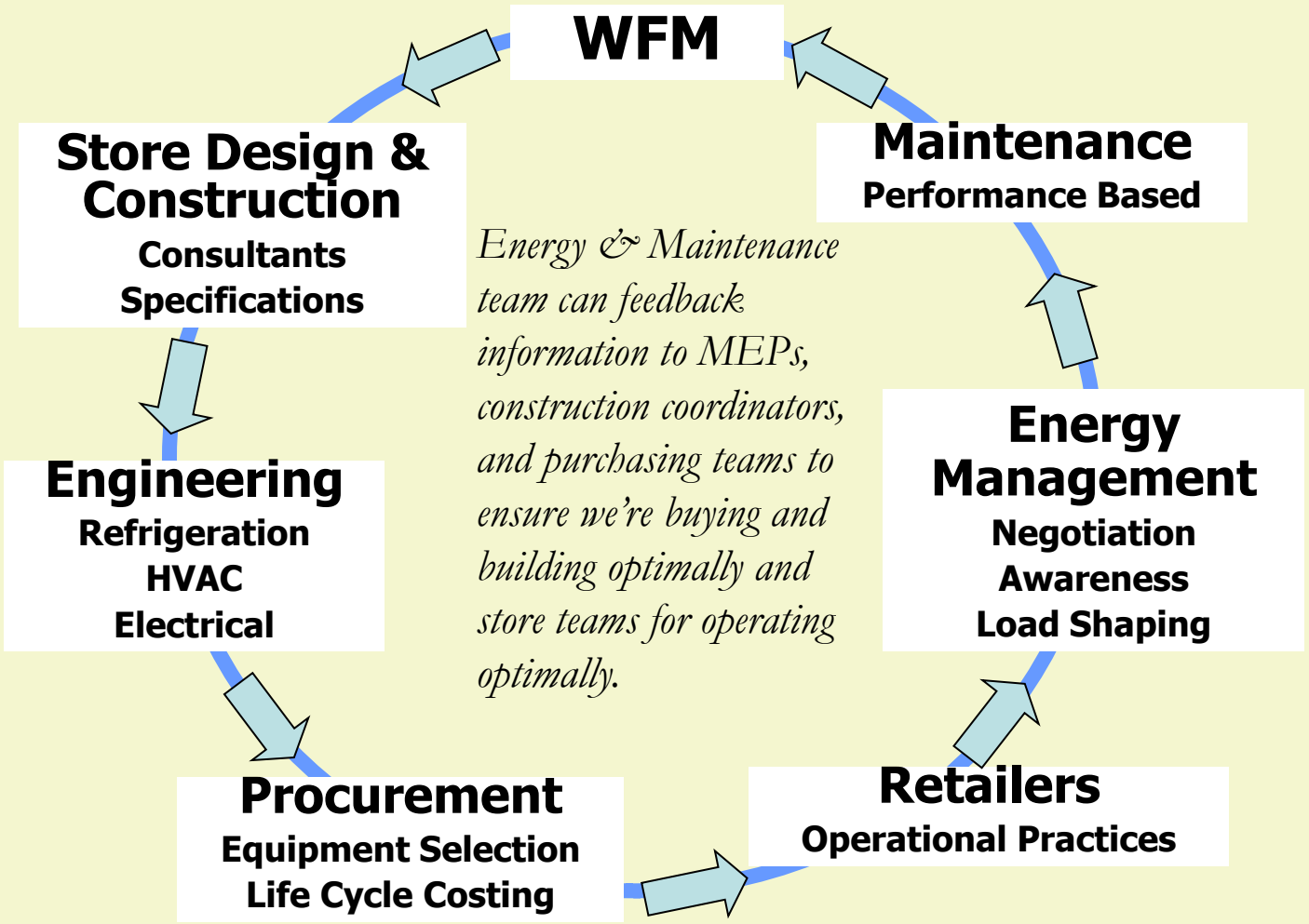
Fueling Green Power

Whole Foods Market Glastonbury is now able to generate about half of its electricity requirements on-site using UTC Power's fuel cell, which uses an electrochemical process that combines hydrogen and oxygen to produce electricity, heat and water. In traditional power plants, more than half the energy potential goes up the stack as waste heat, but the system at the Glastonbury store turns potential waste heat into usable energy by capturing the exhaust for cooling and heating.

This harnessed exhaust heat will provide heat and hot water year-round and help cool the refrigerated cases in the summer months.

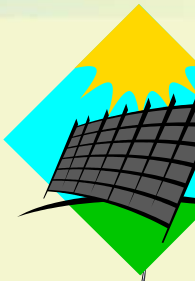
Because the fuel cell operates without combustion, this electricity production is virtually pollution-free. With this installation, Whole Foods Market Glastonbury will prevent the release of more than 90 tons of CO_2 into the atmosphere per year. Additionally, the Glastonbury fuel cell will save 800,000 gallons of water each year that would otherwise be required by conventional electrical generation.

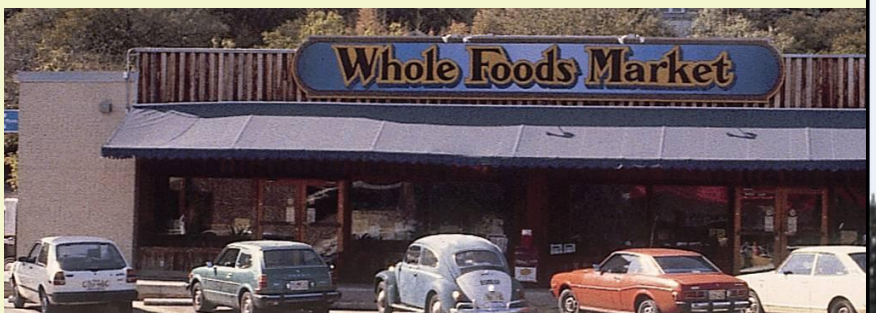
Holistic Approach from Development to Operation



Building & Energy Initiatives

- Solar 20 new; 30 total, eventually ¼ of our roofs
- Wind-contracted for 100% offsets again 09
- Alternative Energy-Fuel Cells, waste to electricity, on-site wind
- Energy Conservation-15 million kWh saved; more to come; GHG tracking approved
- DOE, EPA, LEED, & GreenGlobes partnerships





History of Fuel Cell Contemplation

- Back in 2006, UTC Power approached us for California locations
- Economics were close, but not there
- Considerations: recent hurricanes Katrina, Rita and others forecasted larger back up power requirements; incentive programs increasing in several states; tax credits, etc.

Why a Fuel Cell for Glastonbury, CT?

- In 2007, UTC Power approached us again, but this time for CT, where the CCEF offered some lucrative incentives
- Glastonbury close to UTC Power's HQ
- We were already heavily into design…could we pull this off?!

Immediate Considerations

- Need to ensure the A/E team can understand, move quickly and integrate
- Helps to have a third party independent engineer with heavy refrigeration, HVAC, and plumbing knowledge-both design and field, as well as who is practically minded!
- Best to have plenty of design and engineering time, but we didn’t have much!
- Need serious coordination with mfr, engineers and owner
- Location, location, location (parking or other impacts could be a large factor)…roof not really an option

Lessons Learned

- Due to late start and on-going time constraints with Glastonbury, the system was design-built; the fuel cell manufacturer actually performed in a design/build capacity. This can lead to many coordination issues during construction…
- Since we had time with the recently opened Dedham, MA store, the entire fuel cell system was designed into the building documents. MEP fully designed up to all points of equipment connection allowing construction to be a far smoother process.
- We were able to centralize the heat use in Dedham to 4 main, nearby loads: 1M BTU hydronic coil in a central Seasons-4 unit, domestic hot water pre-heating, receiving area hot water fan coil, and driving an absorption powered chiller for liquid refrigerant sub-cooling.
- From GLA to Dedham we increased the fuel cell energy output from 200kW and 850,000BTU, to 400kW and 1.7M BTU. Fully engineering the application and simplifying the thermal integration allowed us to maintain level installation costs.
- We structured all construction across the traditional job trades under the General Contractor in Dedham to maintain complete, streamlined control.
- First doesn't always mean best though; new 400 kW system had major issues

Our strategy…

- For both Glastonbury and Dedham applications, we utilize the fuel cell's waste heat to provide space heating, dehumidification reheat, domestic water pre-heating, and chilling of liquid refrigerant. Dedham's entire MEP design and service locations allow for a much greater streamlined build.
- We approached the grid independent loading of the Dedham store much more aggressively – using real world data. We have also engineered in a few manual transfer switches to dial in the full load on the fuel cell, preparing it for maximum utilization for store operations during a grid outage. The loads are prioritized for business function and loading will be established on a near design, hot summer day. The goal is to operate all refrigeration, IT/POS equipment, 50% sales area lighting, and all backroom lighting to continue to operate the store.
- In both locations the fuel cell is electrically isolated from the main service with a transfer switch. Should anything ever happen to the fuel cell, the store operations will not be affected, even momentarily.
- We provided simple time delay relays on the strategic grid independent loads to "hard wire" stage up all building equipment in a fixed sequence, feeding a smooth ramp up of demand to the fuel cell during grid independent operation.
- San Jose operational for a few months; Fairfield, CT soon to be.

Glastonbury's Economic Benefits & Reliability

- Glastonbury's total energy costs are 30% lower than W. Hartford's; same utility providers, normalized for size
- 2008 Availability was 98.945% with planned maintenance (over 99.5% without)
- Jan 1, 2009 to July 31, 2009 Availability was 98.25%, again with planned maintenance

Fuel Cell Process Overview

Process Overview

1 Fuel Processor

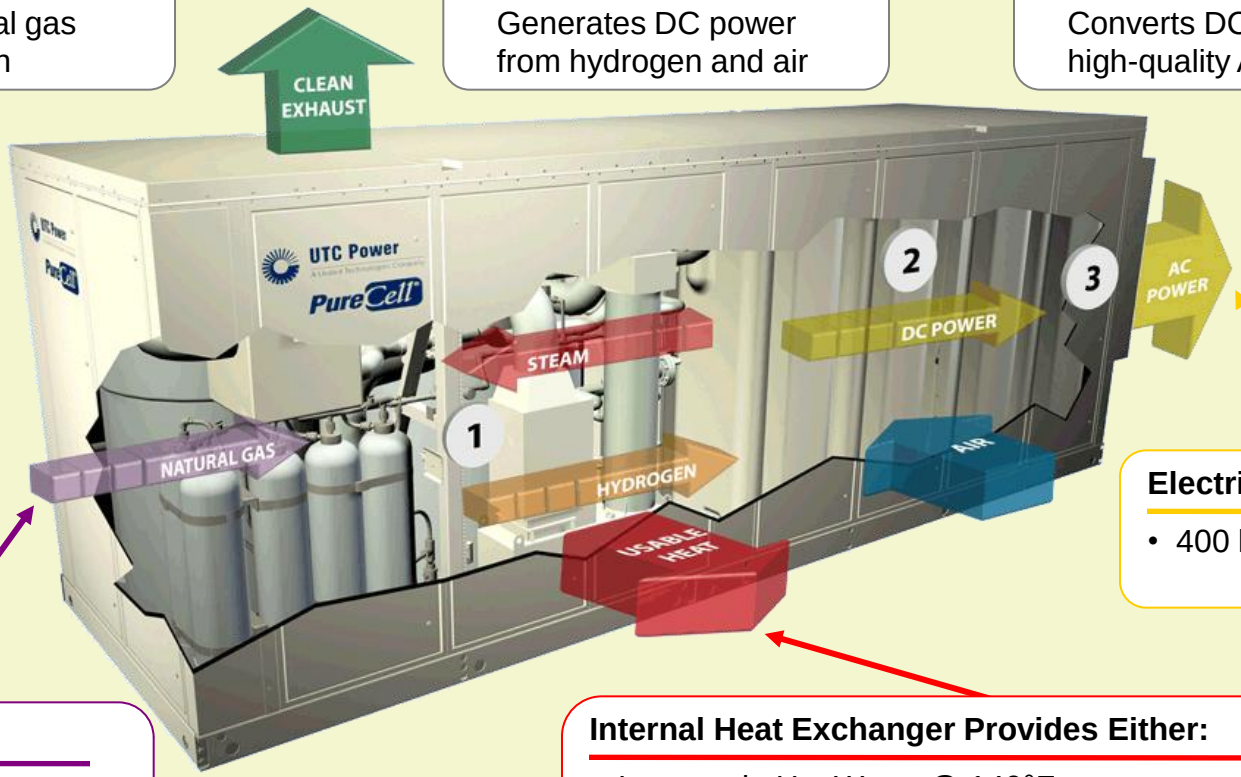
Converts natural gas fuel to hydrogen

2 Fuel Cell Stack

Generates DC power from hydrogen and air

3 Power Conditioner

Converts DC power to high-quality AC power



Fuel Input:

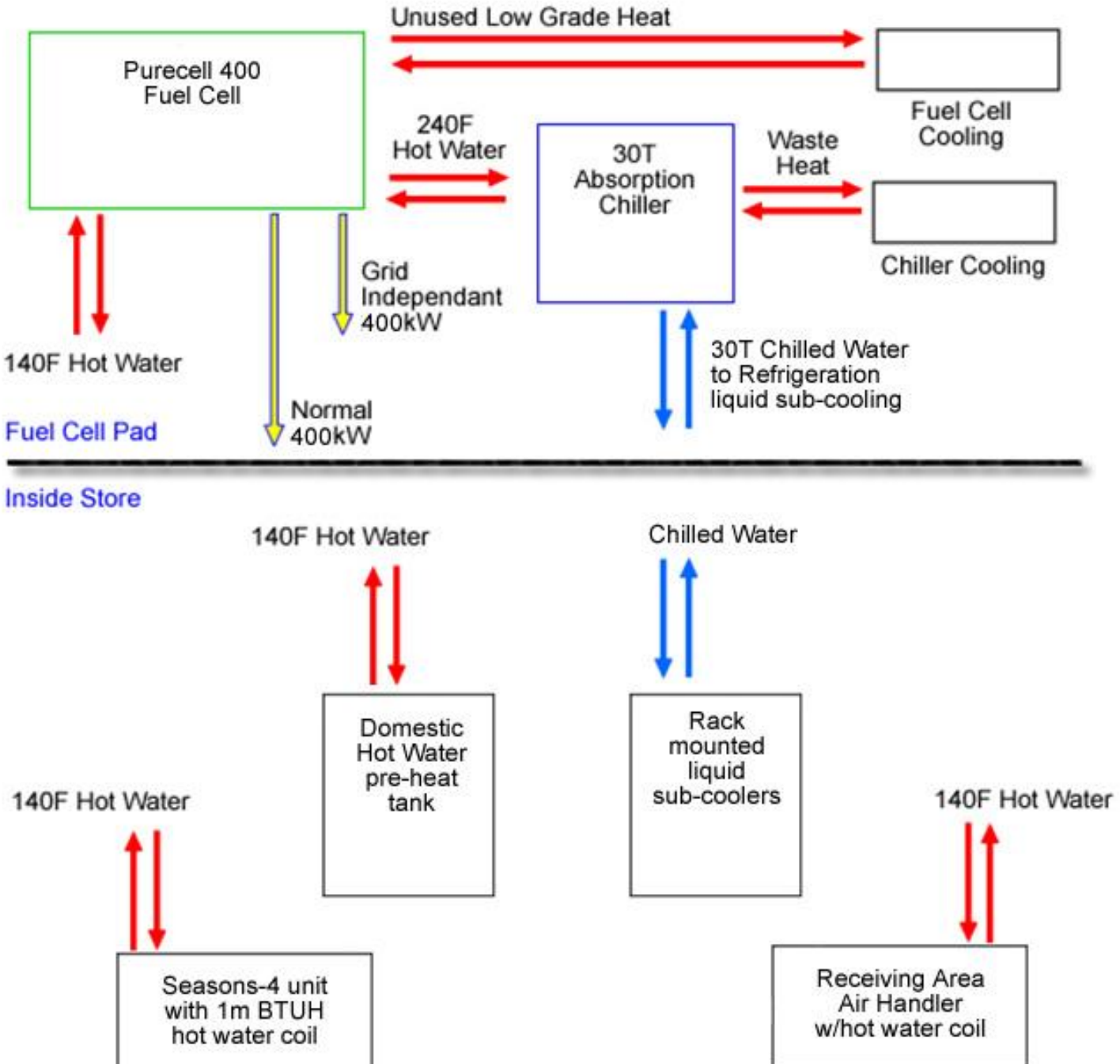
Natural gas
3.6 million Btu/hr

Electric Output:

- 400 kW, 480V, 60 Hz

Internal Heat Exchanger Provides Either:

- Low grade Hot Water @ 140°F
  Or a mix
- High & Low Grade Hot Water @ 240°F & 140°F
- 1.7 million Btu/hr available


Unused Low Grade Heat
Purecell 400
Fuel Cell
Fuel Cell
Cooling
240F
Hot Water
30T
Absorption
Chiller
Waste
Heat
Chiller Cooling
Grid
Independant
400kW
140F Hot Water
30T Chilled Water
to Refrigeration
liquid sub-cooling
Fuel Cell Pad
Normal
400kW
Inside Store
140F Hot Water
Chilled Water
Domestic
Hot Water
pre-heat
tank
Rack
mounted
liquid
sub-coolers
140F Hot Water
140F Hot Water
Seasons-4 unit
with 1m BTUH
hot water coil
Receiving Area
Air Handler
w/hot water coil

Green Building Programs

- Glastonbury—went for LEED after the store opened! Have LEED certification; point tally initially added to gold, but due to the timing and requirements for documenting certain areas, expense wasn't worth the rating.
- Dedham—Wanted to try Green Globes, as it's marketed as an easier, less expensive green building certification process. Achieved 3 Green Globes for Dedham.

Business Considerations

- Northeast and California have highest incentive levels
- Maximizing use of the heat or “Thermal Integration” is critical to overall financials
- Fuel Cell can act as a massive store generator
  - MEP considerations during layout design
  - Life safety may require its own system
- Integrate simple backup systems for heat use
- All added costs to WFM structured as a lease
  - All equipment, installation, & maintenance inclusive
- Marketing and Managing Expectations are key
- Ensure demand charges are considered for cost effectiveness