Comparing Business Case Descriptions of Near-Term Hydrogen Stations

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Station Business Cases for Focus Group

- Focus Group goal was to understand retailers' potential motivations to install hydrogen stations
- Relatively simple apples-to-apples comparisons
- Wanted to identify variations in preferences associated with not only costs, but also technology types, station operations, configurations, and "green" PR value
- Used "near-term" costs from a recent UC Davis report* with 2X capital costs and high installation and site prep costs

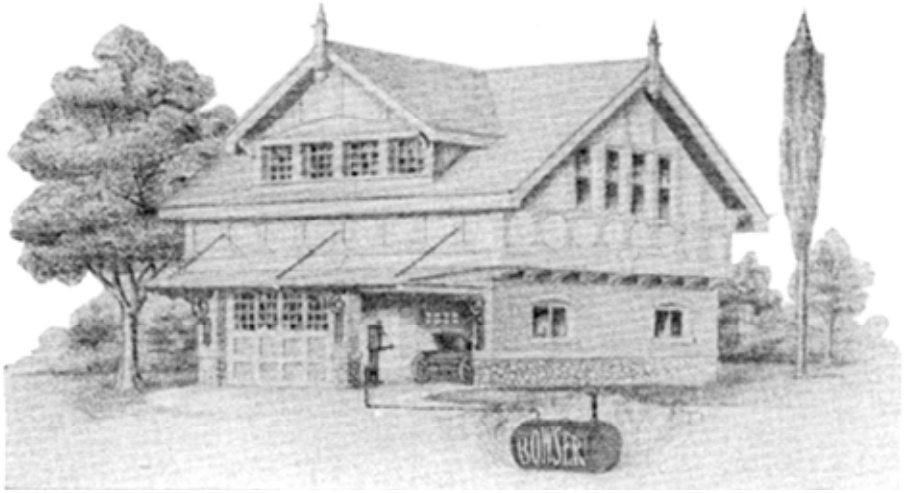
* "Roadmap for Hydrogen and Fuel Cell Vehicles in California: A Transition Strategy through 2017", 12/21/09, Institute of Transportation Studies, University of California, Davis, A Collaborative Effort by Public and Private Stakeholders

Early H2 Stations may be highly innovative

- Innovative early gasoline delivery methods preceded what is thought of today as a “filling station”

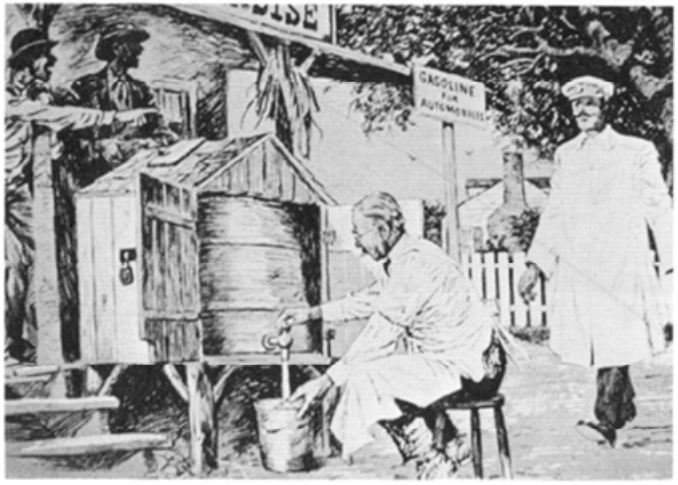
Williamson et al. 1963, 220

Mobile hand carts



Bowser 1905

Home filling pumps



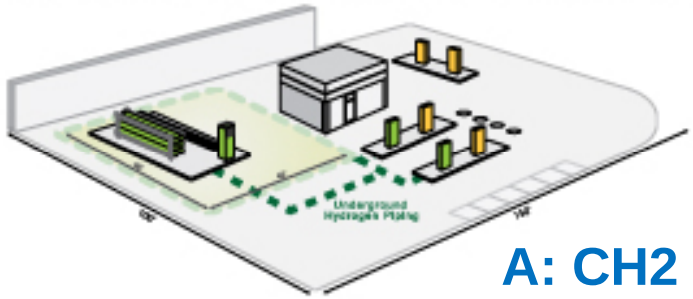
Vieyra 1979, 4

Barrels at Grocery Stores

(from Melaina 2007)

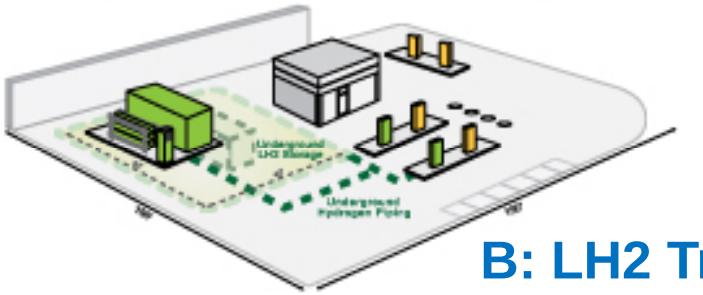
Five “Standard” Station Business Cases

Station A: Hydrogen is delivered as a compressed gas



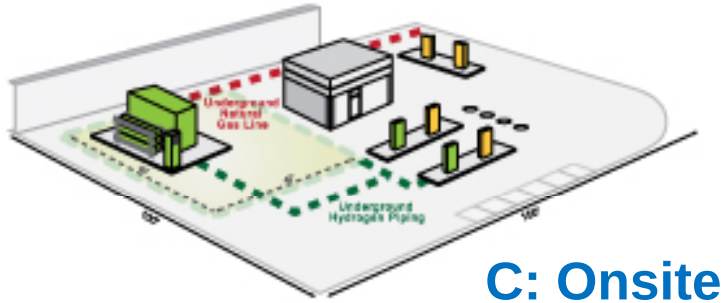
A: CH2 Truck

Station B: Hydrogen is delivered and stored as a liquid



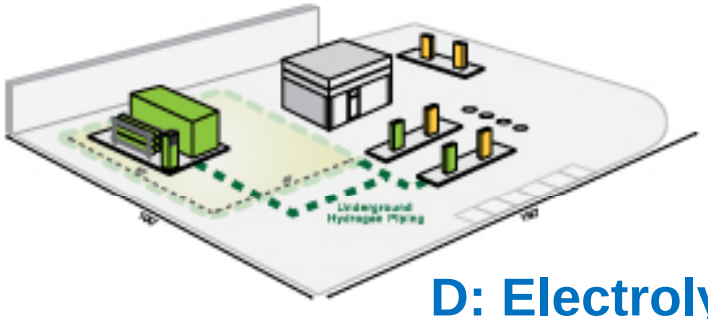
B: LH2 Truck

Station C: Hydrogen is produced onsite from natural gas



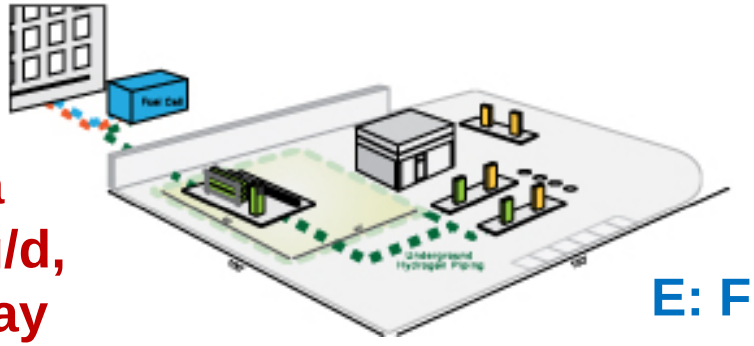
C: Onsite SMR

Station D: Hydrogen is produced by electrolysis



D: Electrolysis

Station E: An offsite fuel cell uses natural gas to produce electricity, heat and hydrogen



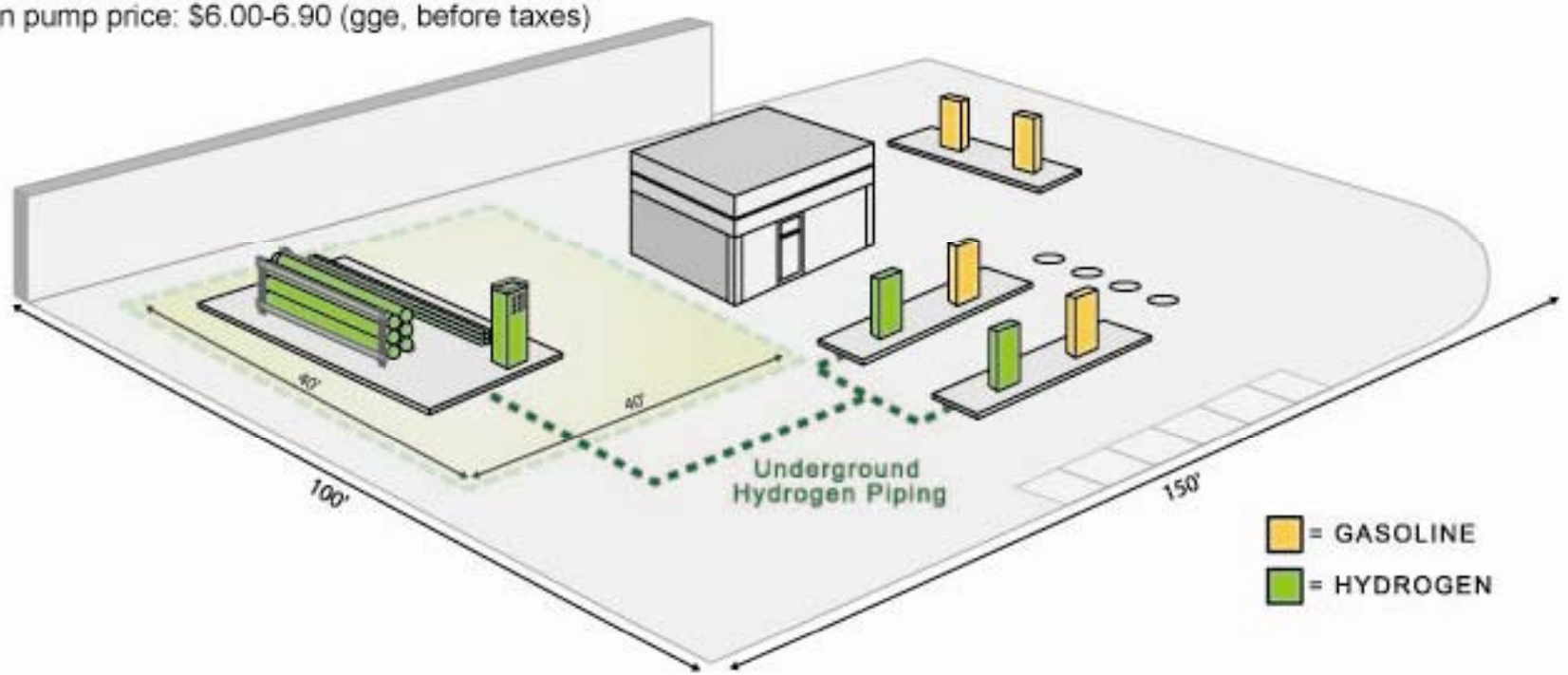
E: Fuel Cell CHHP

Each station has a Capacity of 700 kg/d, or 200 FCVs per day

Station A – CH2 Truck

Station A: Hydrogen is delivered in tubes as a compressed gas

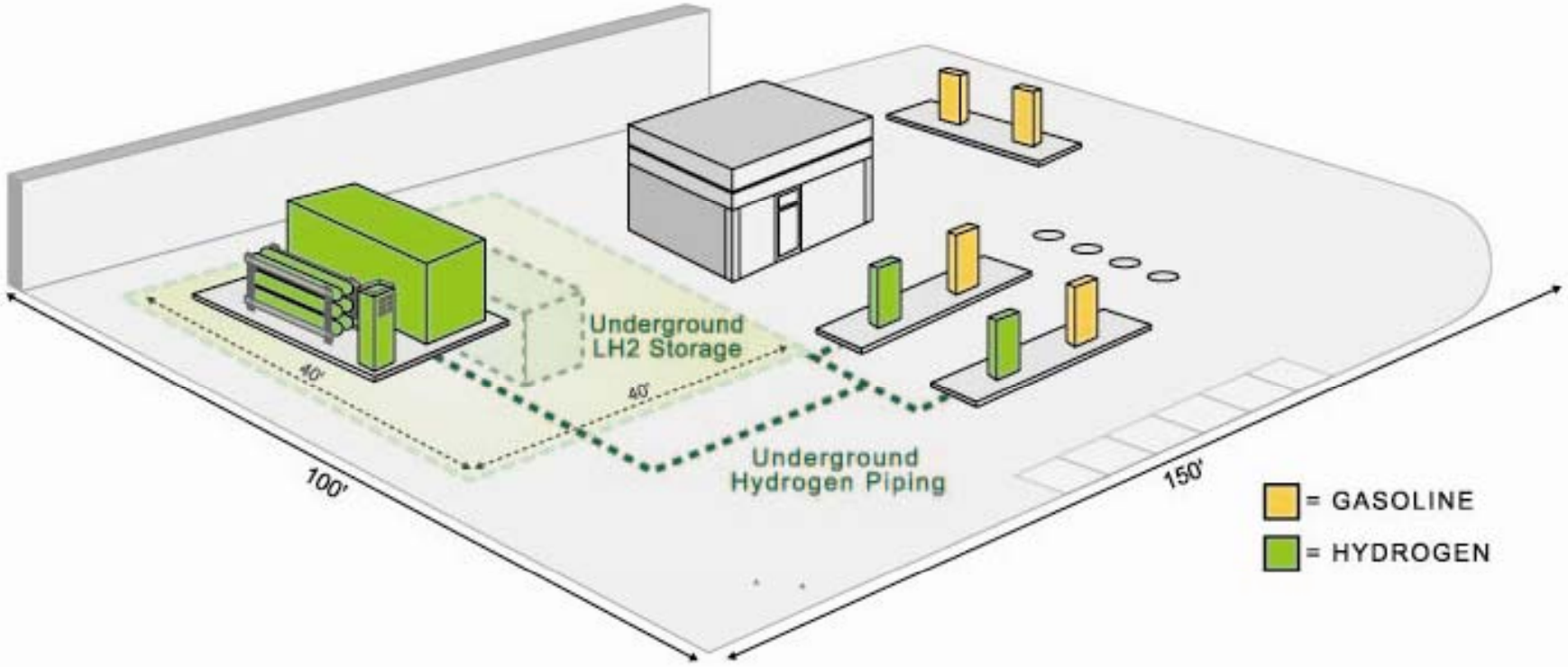
700 kg/day station serving 200 vehicles a day (85% equipment utilization)
Filled tubes are delivered twice a day
Capital cost: $3.7 million (equipment, site prep, installation)
Annual feedstock and O&M: $940k
Annual anticipated revenue: $1.45m
Hydrogen pump price: $6.00-6.90 (gge, before taxes)



Station B – LH2 Truck

Station B: Hydrogen is delivered and stored as a liquid, and dispensed as a gas

700 kg/day station serving 200 vehicles a day (85% equipment utilization)
Hydrogen delivered once a week by tanker truck
Capital cost: $2.0 million (equipment, site prep, installation)
Annual feedstock and O&M: $1.0m
Annual anticipated revenue: $1.1m
Hydrogen pump price: $5.00-5.40 (gge, before taxes)



Station C – Onsite SMR

Station C: Hydrogen is produced onsite from natural gas or biogas

700 kg/day station serving 200 vehicles a day (85% equipment utilization)

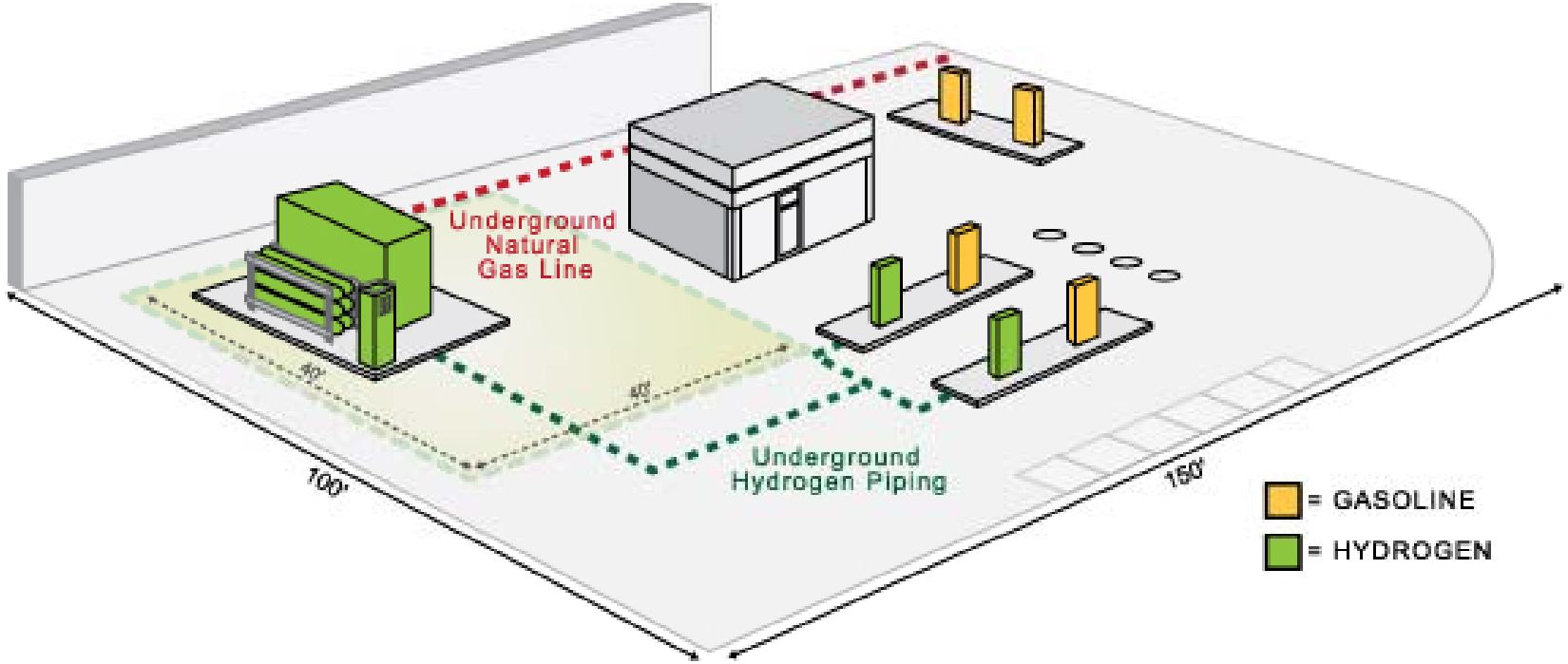
Capital cost: $7.2 million (equipment, site prep, installation)

Annual feedstock and O&M: $585k

Annual anticipated revenue: $1.6m

Hydrogen price at pump: $5.90-7.50 (gge, before taxes)

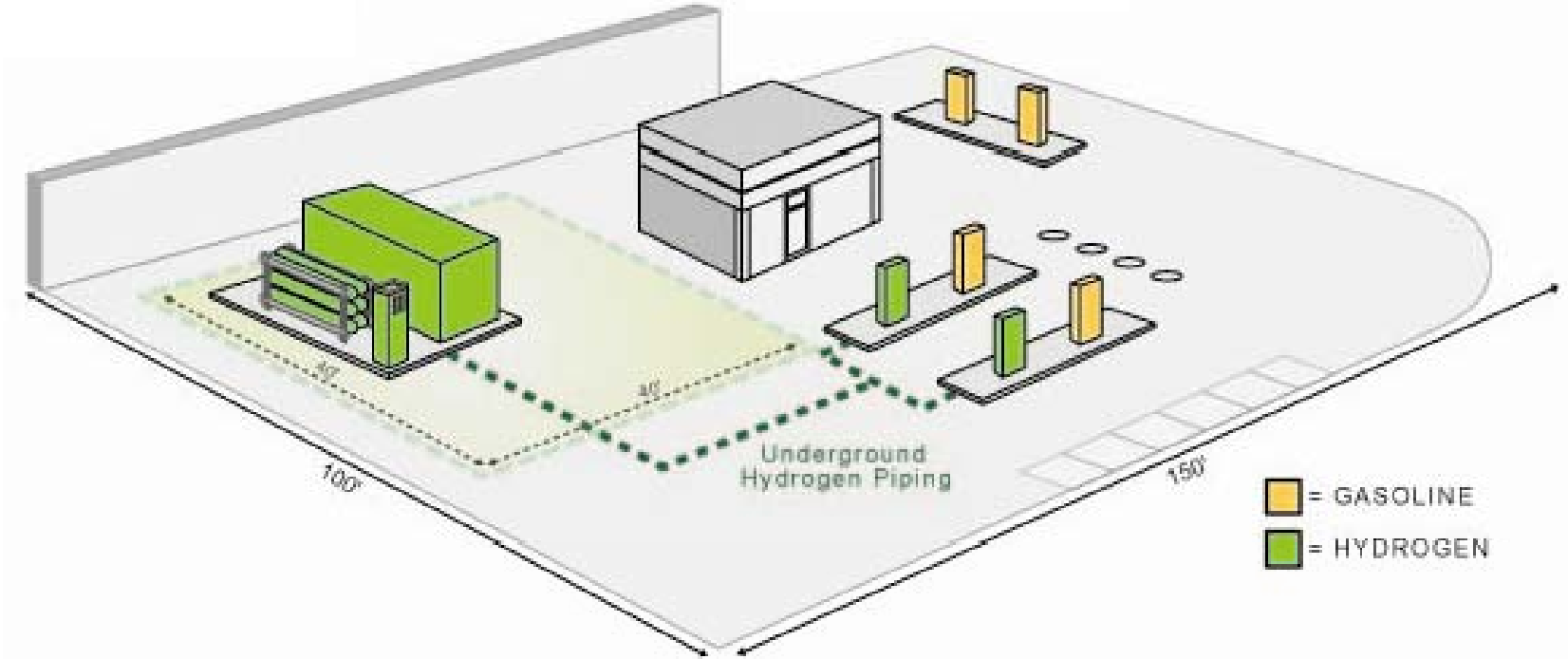
LCFS carbon credit: $50/metric ton



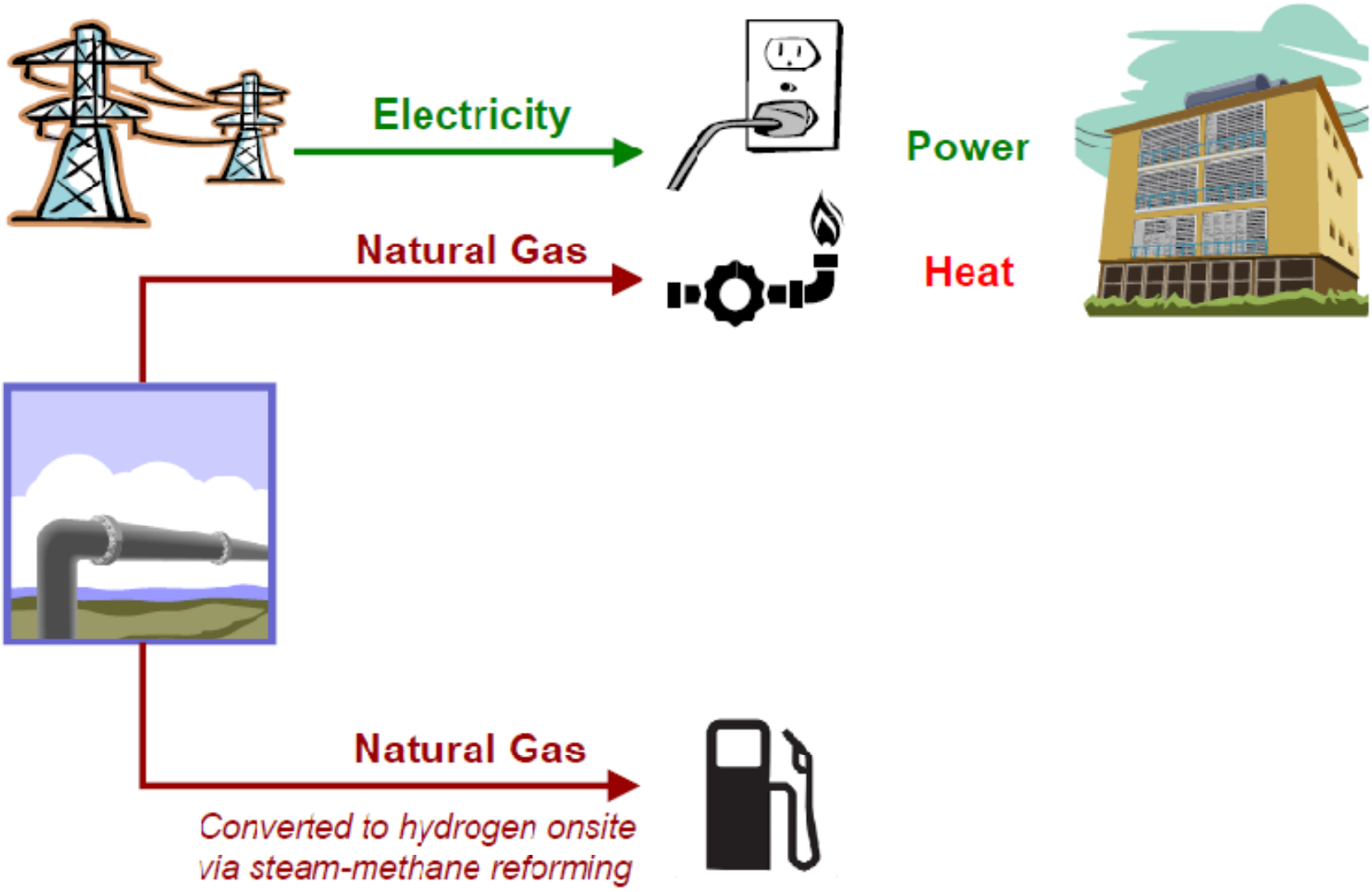
Station D - Electrolysis

Station D: Hydrogen is produced onsite using electricity and water

700 kg/day station serving 200 vehicles a day (85% equipment utilization)
Capital cost: $8.5 million (equipment, site prep, installation)
Annual feedstock and O&M: $1.8m
Annual anticipated revenue: $2.2m
Hydrogen pump price: $8.50-10.40 (gge, before taxes)
LCFS carbon (cost) credit: $50/metric ton



Combined Heat, Hydrogen and Power (CHHP) Stationary Fuel Cell Application



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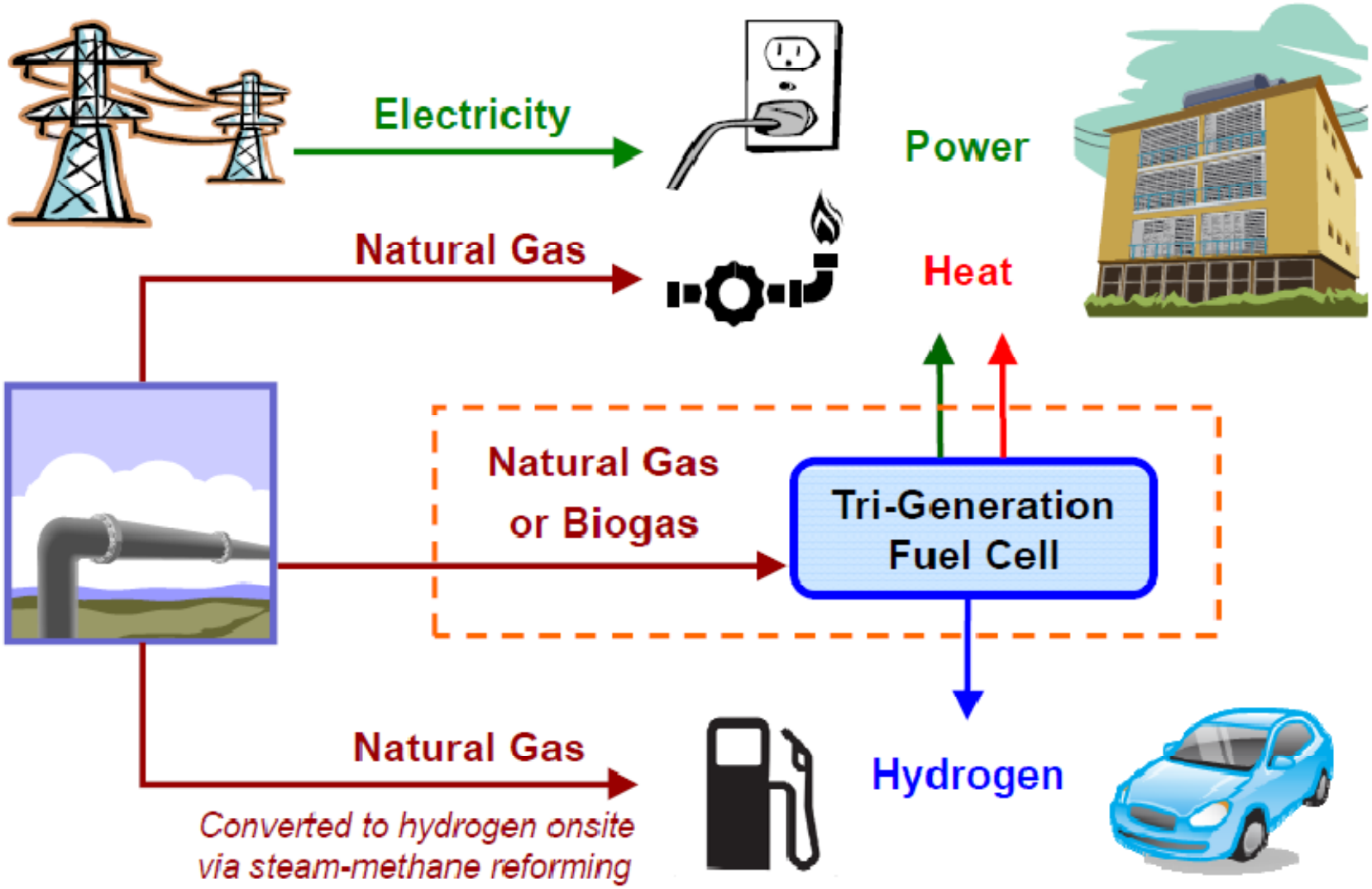
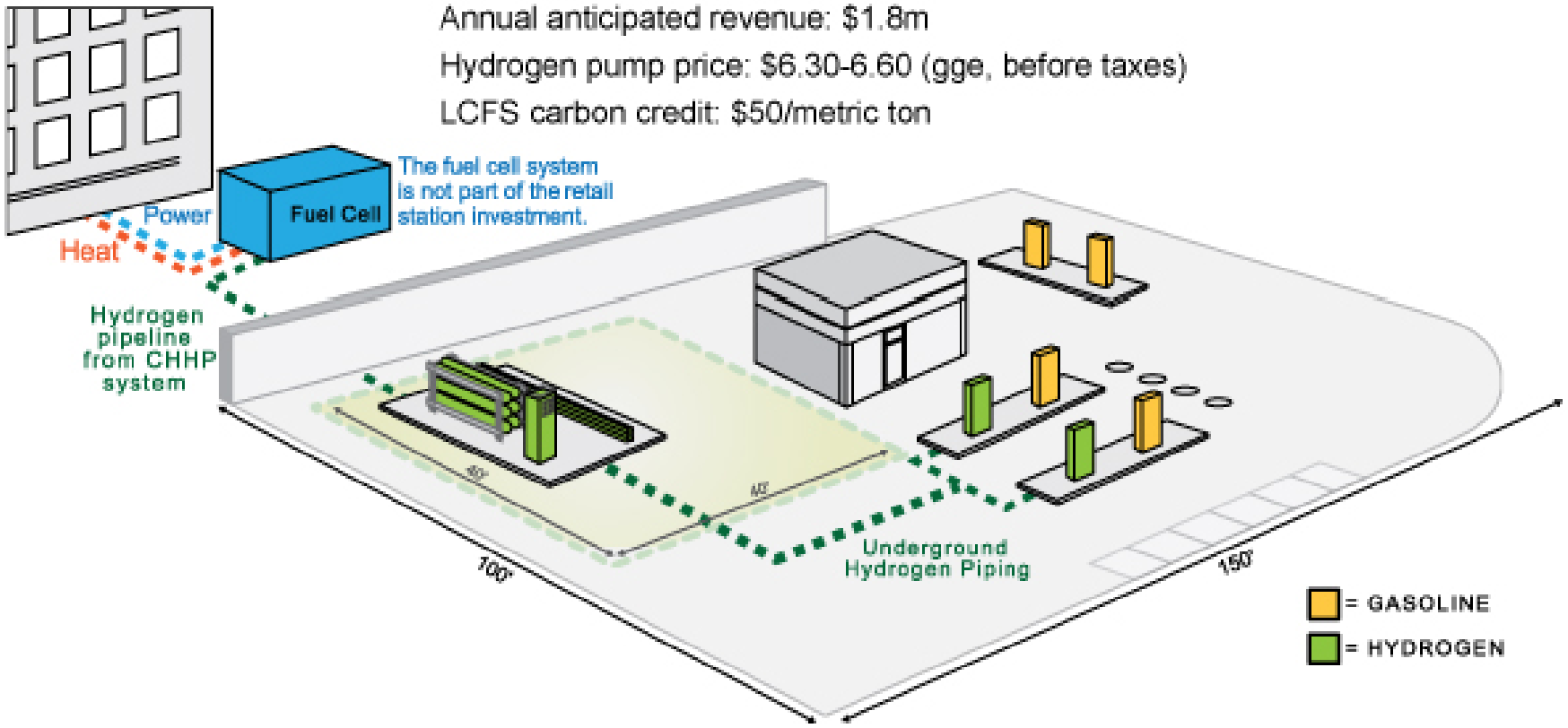


Station E – Fuel Cell with CHHP

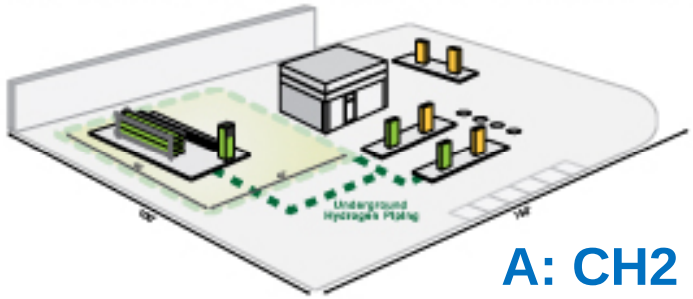
Station E: An offsite fuel cell uses natural gas to produce electricity, heat and hydrogen

700 kg/day station serving 200 vehicles a day (85% equipment utilization)
Capital cost: $4.5 million (equipment, site prep, installation)
Annual O&M: $220k (excludes cost of purchased hydrogen)
Annual anticipated revenue: $1.8m
Hydrogen pump price: $6.30-6.60 (gge, before taxes)
LCFS carbon credit: $50/metric ton



The Five Station Business Cases (recap)

Station A: Hydrogen is delivered as a compressed gas



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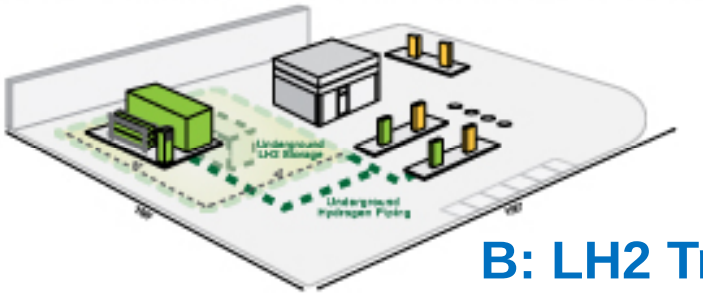

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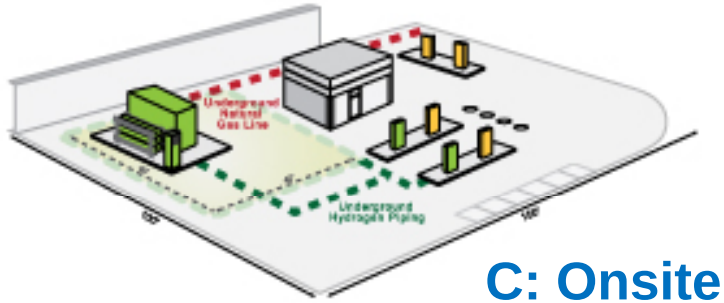

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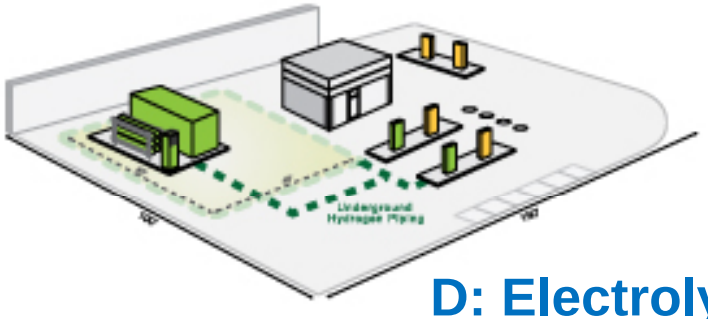

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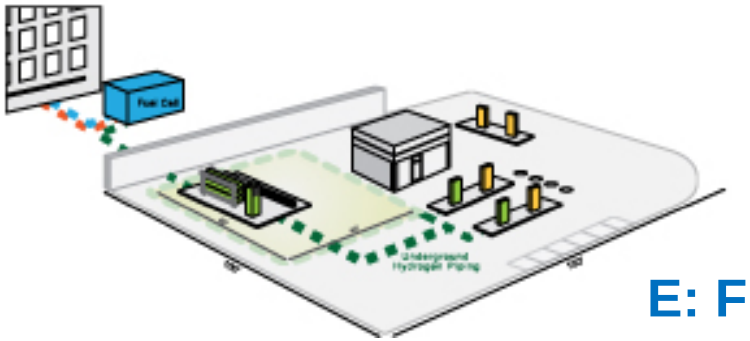
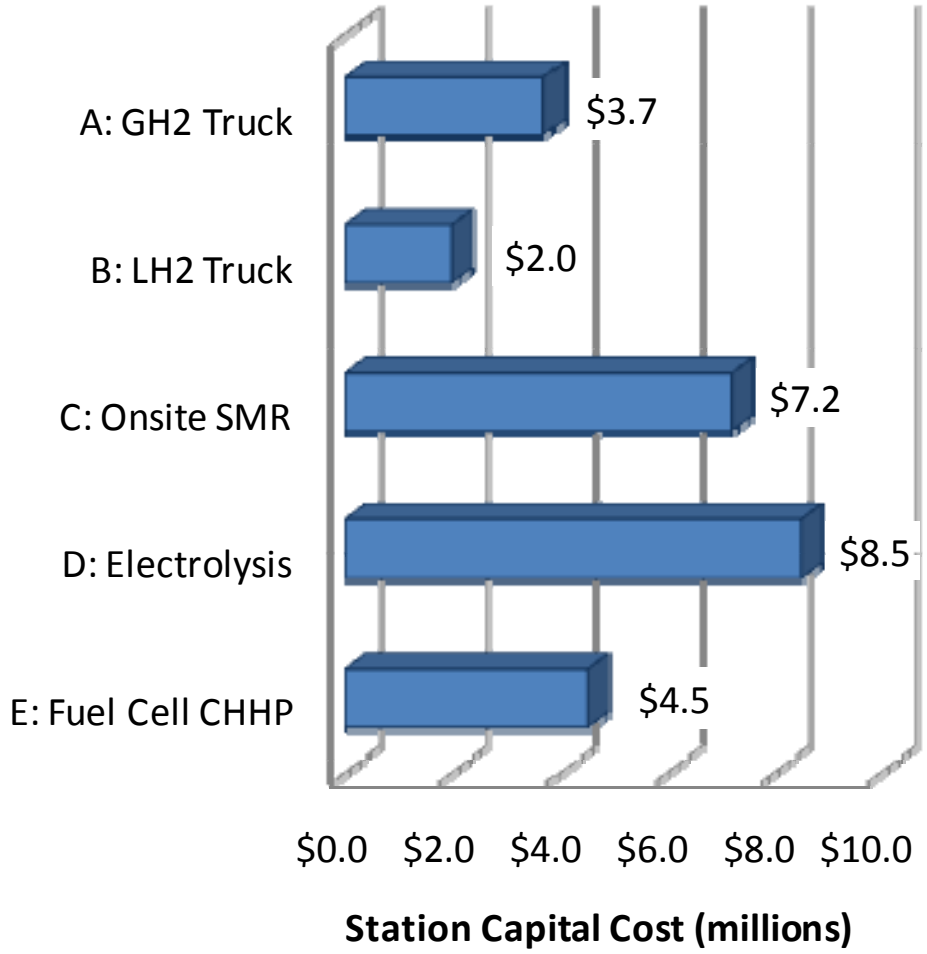
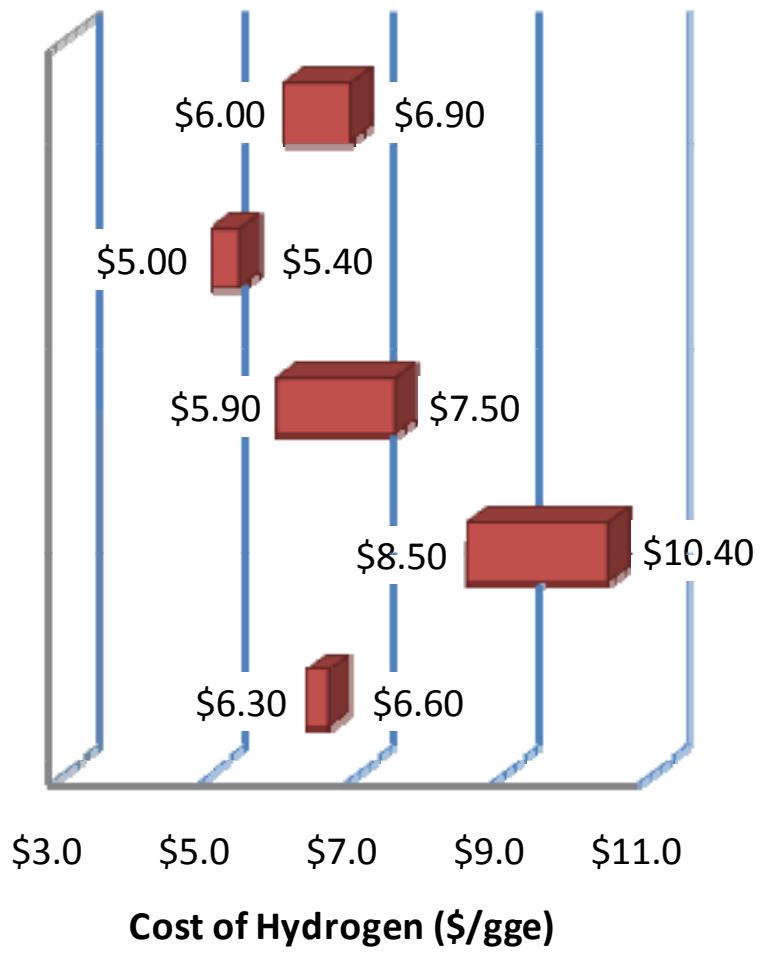


E: Fuel Cell CHHP

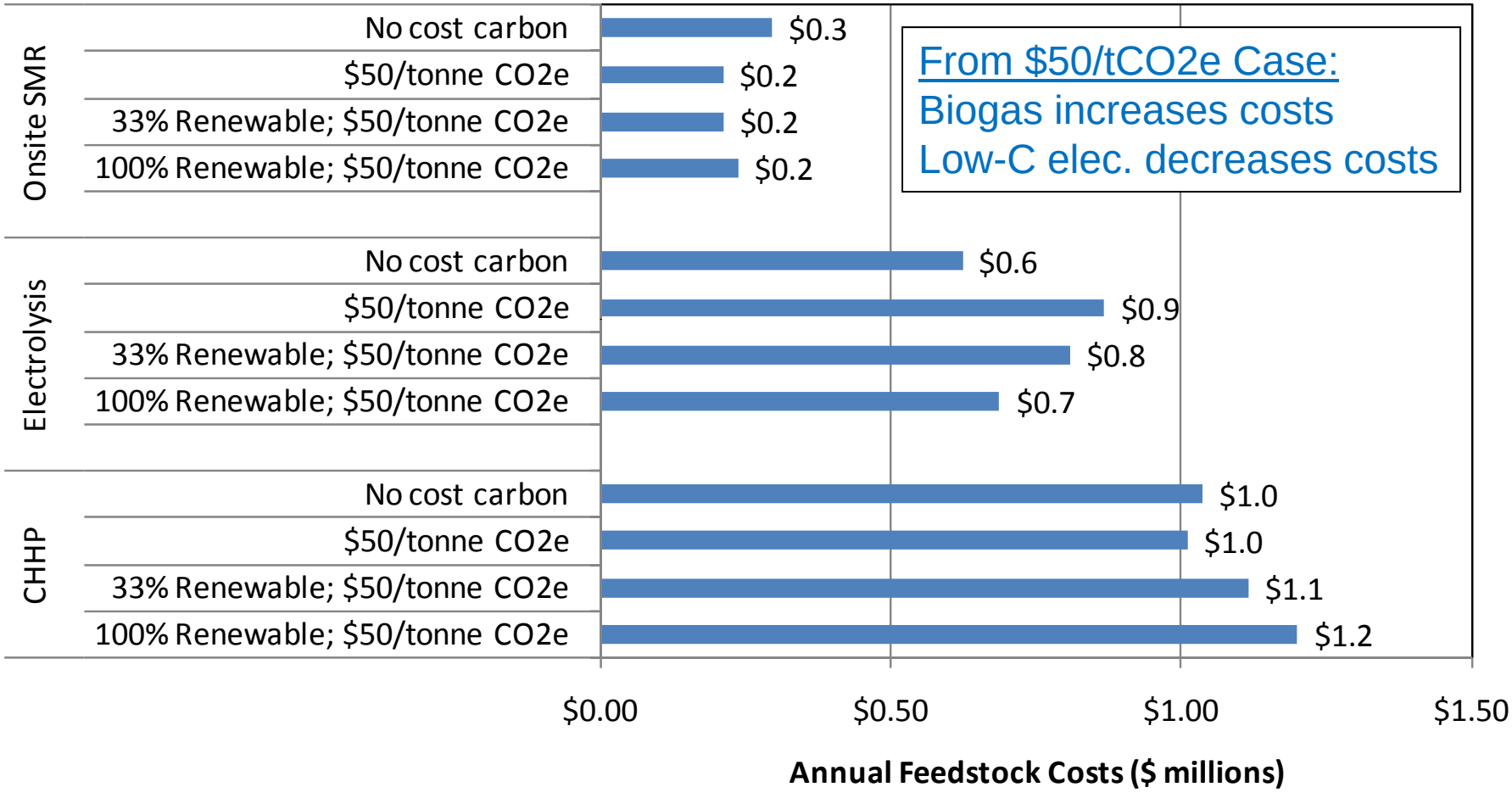
Capital and Cost of Hydrogen Comparisons





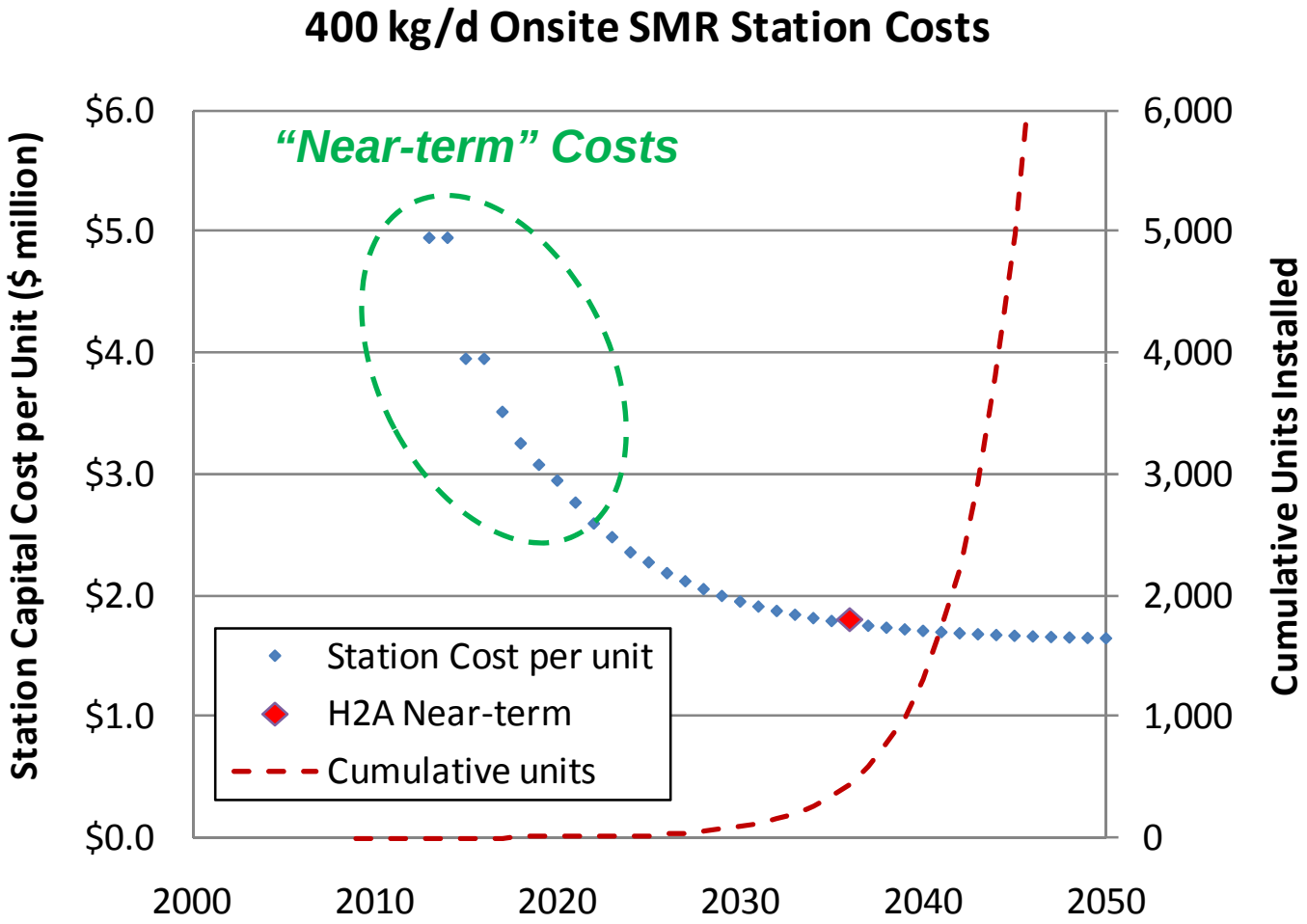
- These comparison graphs were not included in focus group materials

Annual Feedstock Costs when Assuming $50/tCO2e Carbon Tax and Green Energy Premiums



- Assumed premiums of $0.02/kWh for renewable energy and $4/MMBTU for biogas
- Comparison graph not included in focus group materials

Early Mover Risks, Costs, and Benefits



- Experience curve examples not included in focus group materials

Questions?

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Key Assumptions

Cost Details

Feedstock Prices (for station and/or fuel cell owner):

Natural Gas ($/mmBtu)	$7.00
Premium for renewable biogas ($/mmBtu)	$4.00
Grid Electricity ($/kWh)	$0.082
Premium for renewable electricity ($/kWh)	$0.02

- Dairy digester gas emissions values based on California Air Resources Board Detailed California-Modified GREET Pathway for Liquefied Natural Gas (LNG) from Dairy Digester BioGas, version 2.0, Release Date September 23, 2009.
- Set-back distances were determined using NFPA 55