Today’s Question

How can rates encourage hydrogen production and distribution that benefits the grid and lower price at the pump?

Analysis of electric utility rates (7,182 utility rates)

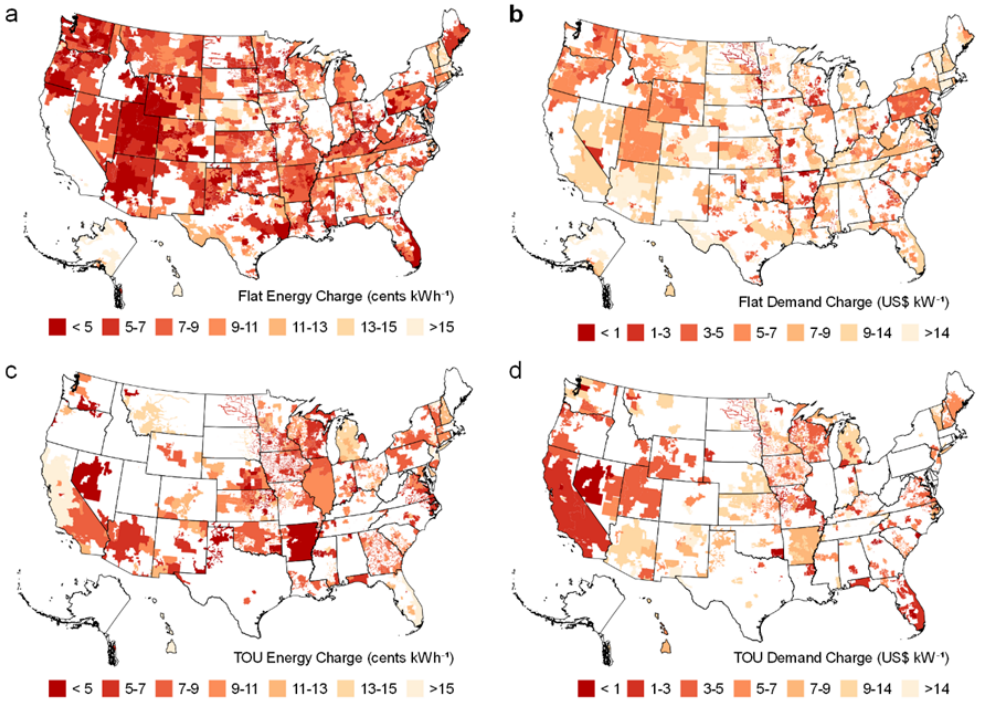
Electricity cost = energy charge + demand charge

Based on quantity of energy consumed during a single interval, i.e., kWh	Based on the maximum demand that occurs during a billing period

Three basic structures for energy and demand tariffs: NO, Flat, and TOU.

- NO: no charge for either energy or demand.
- Flat: single constant charge for electricity during each billing period
- TOU: any form of dynamic pricing for energy or demand (time-of-use).

Example: Flat_TOU = Flat charge for energy & TOU charge for demand.



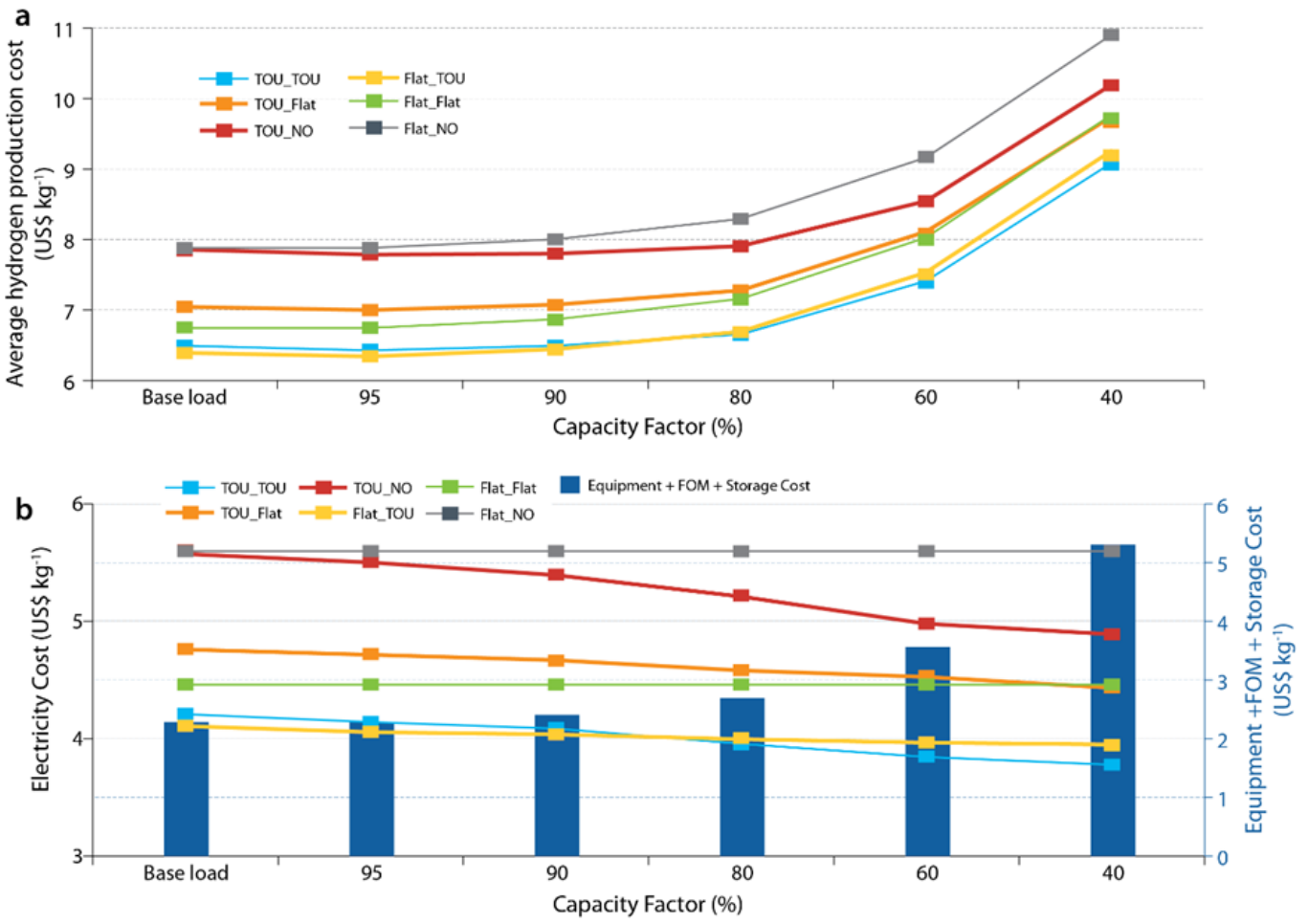
Geographic distribution of industrial and commercial utility rates across the United States

Ranking of energy and demand charges for California						
	Flat_NO	Flat_Flat	Flat_TOU	TOU_NO	TOU_Flat	TOU_TOU
Energy charge	13th	47th	41th	41th	28th	42th
Demand charge	-	14th	8th	-	24th	17th

H2 production cost: Effects of capacity factor

Technology assumptions (1 MW electrolyzer). Ref: Eichman et al. 2016.

- Capital cost: $1,691/ kW
- Replacement cost: $18.64/kW-year
- H2 storage capital cost: $1000 /kg
- Fixed O&M cost: $75.2/kW-year
- Lifetime: 20 yrs
- Efficiency: 54.3kWh/kg
- Capacity factor (CF): 40%, 60%, 80%, 90%, and 95%
- Storage duration: 8 h

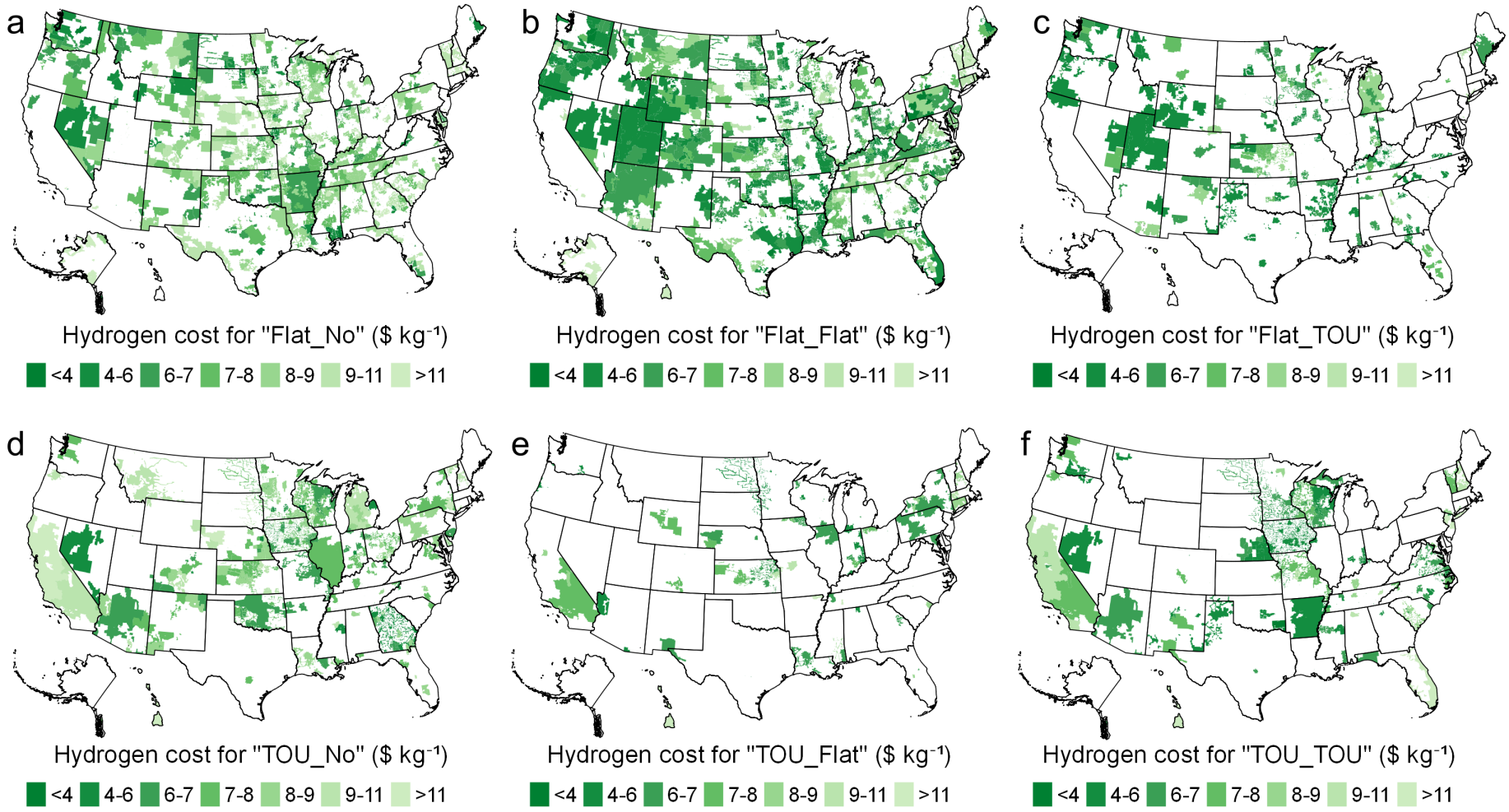


Tariffs with dynamic pricing: There is a trade-off between electricity cost and equipment, FOM, and storage costs, with an optimal capacity factor of ~95%, for all rate structures.

i. Stations → no demand charge for low utilization

ii. Production facilities → more aggressive rates

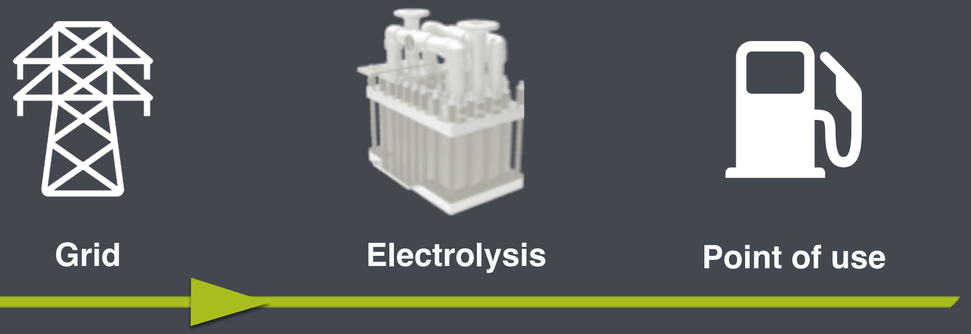
H2 production cost: Geographic distribution



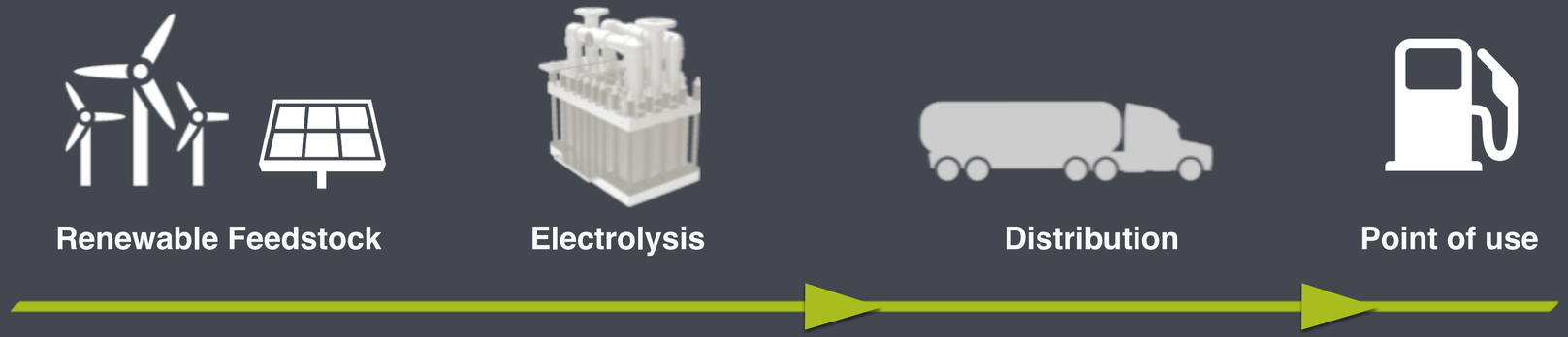
Renewable Hydrogen Production: Electrolysis

Multiple methods to yield renewable hydrogen through electrolysis.

Onsite Production:

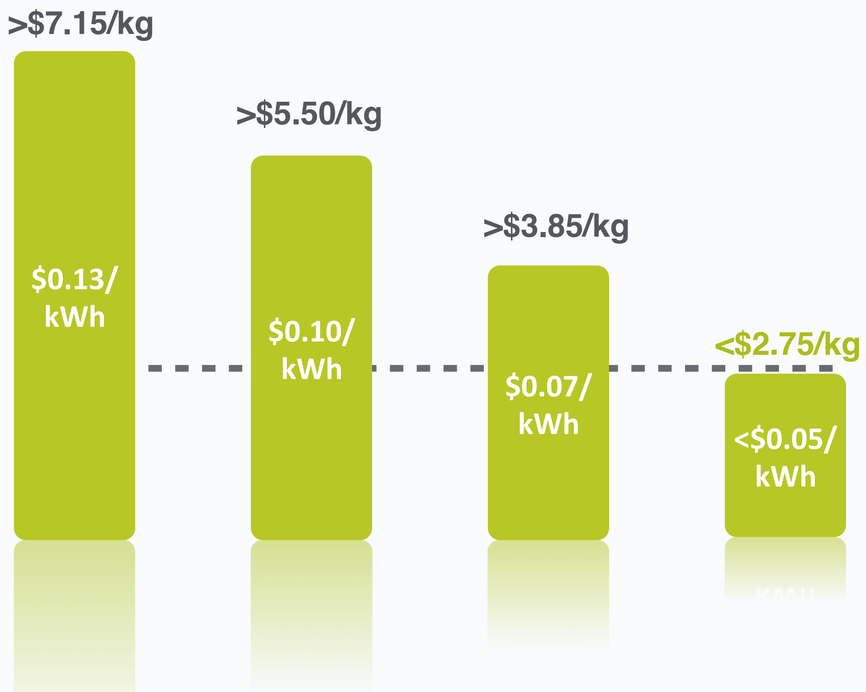


Centralized Production:



Centralized & Onsite Production Cost

Cost competitive renewable hydrogen via electrolysis is strongly determined by renewable electricity.



Electrolysis Generation model by $/kWh:

- Onsite generation typically requires REC's, which add between $0.02-$0,04/kWh.
- Compression, chilling, dispensing, and logistics are not accounted for in model.

<$0.05/kWh

Renewable Power

<$2.75/kg

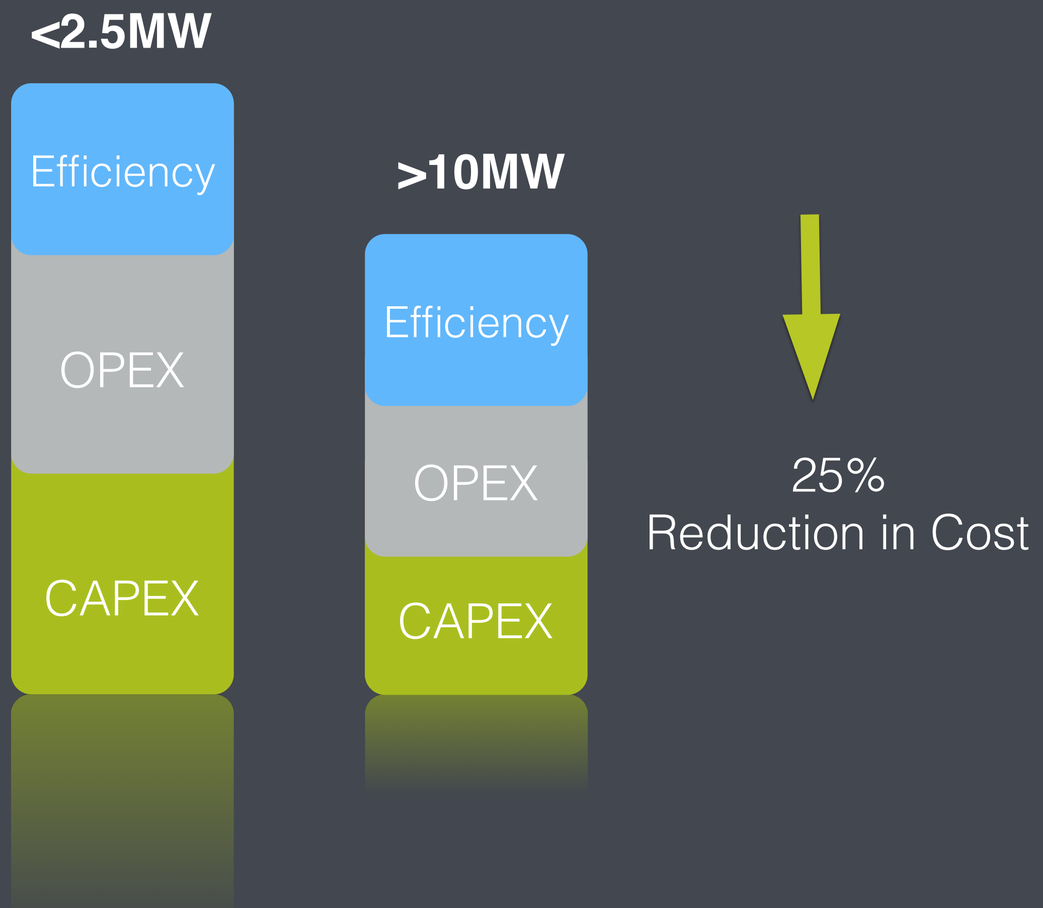
Production Cost

LCFS

Comparable to non-renewable H2

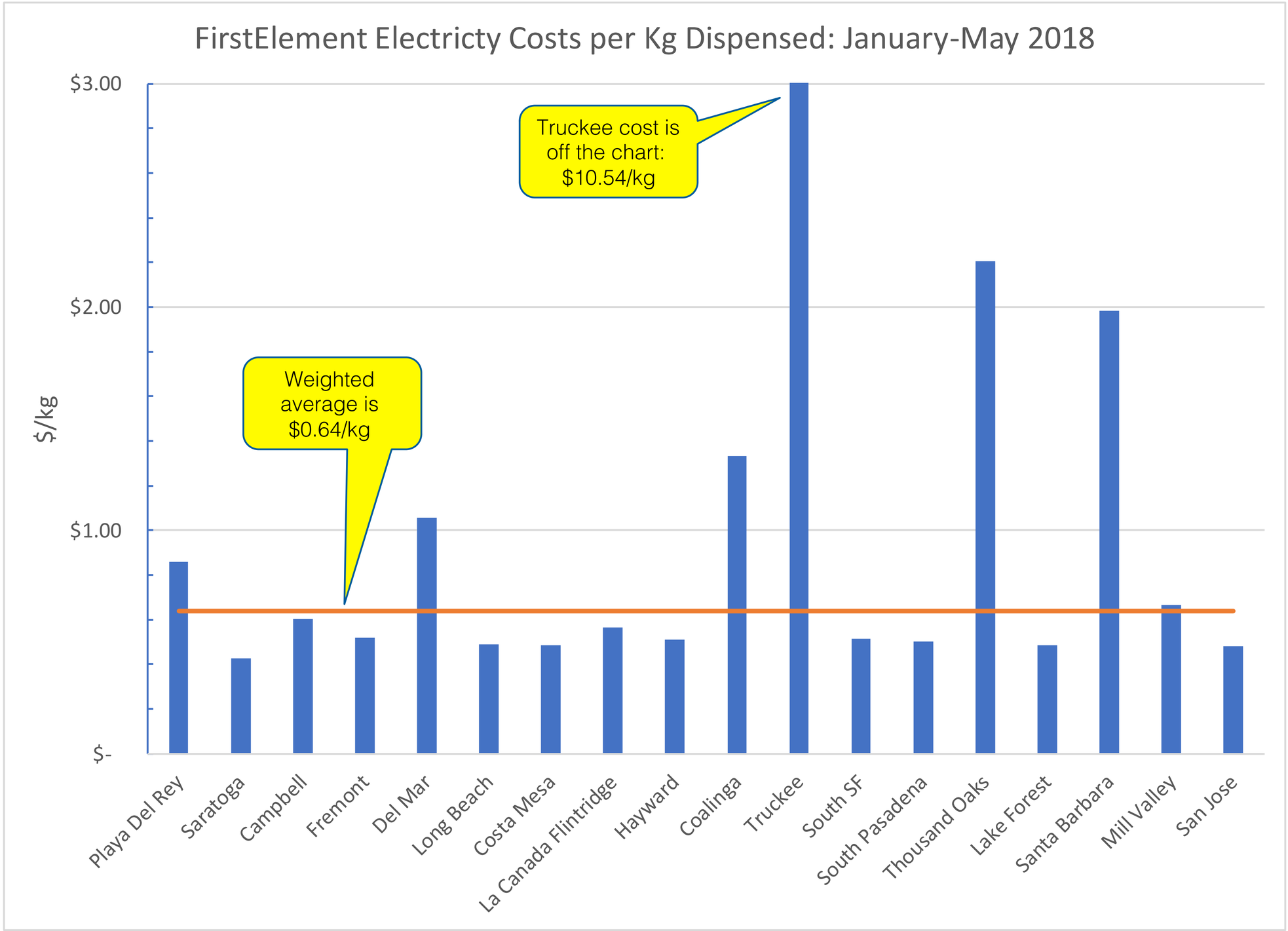
Reaching Economy of Scale Through Centralized Production

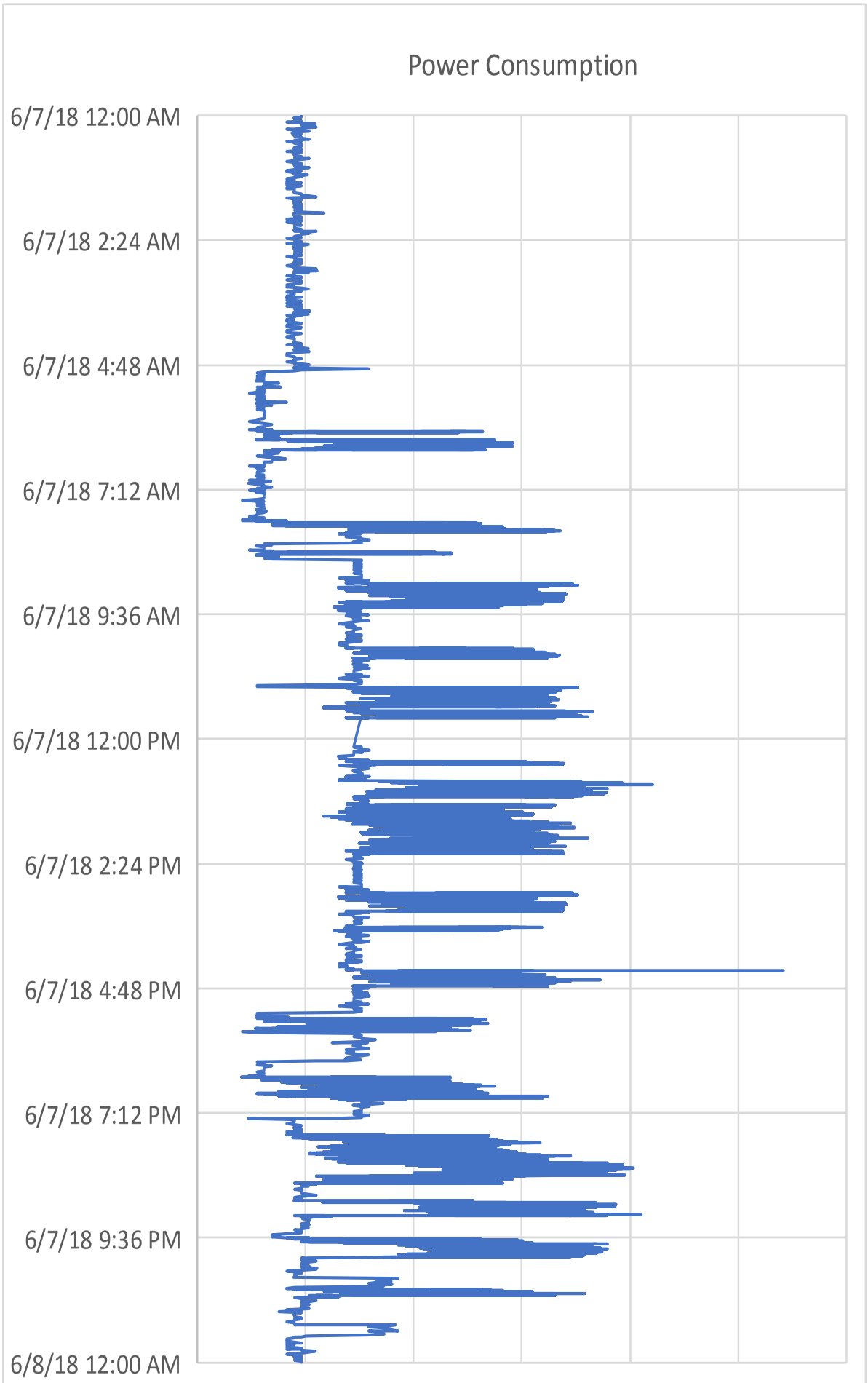
As production capacity surpass >10MW, economy of scale begins to make renewable hydrogen cost competitive with non-renewable hydrogen and gasoline.



25%
Reduction in Cost

- Electricity costs include both demand and energy charges
- Major uses of electricity are compressing and chilling of hydrogen




Power Consumption
6/7/18 12:00 AM
6/7/18 2:24 AM
6/7/18 4:48 AM
6/7/18 7:12 AM
6/7/18 9:36 AM
6/7/18 12:00 PM
6/7/18 2:24 PM
6/7/18 4:48 PM
6/7/18 7:12 PM
6/7/18 9:36 PM
6/8/18 12:00 AM