

Station Performance & Technical Requirements

Presentation to the California Energy Commission

Linde North America



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Fueling

The Linde Group worldwide

Linde Gas

The Linde logo, featuring the word "Linde" in a white, stylized script font, set against a dark blue background with a wavy, light blue line above it.

- Linde operates in over 100 countries generating over \$17 billion in revenues
- Supplier of compressed and cryogenic gases and technology
 - Hydrogen, oxygen, nitrogen, argon, helium, LNG, LPG, rare gases
- Designed and built over 75 hydrogen fueling stations with over 300,000 safe fuelings
 - Auto, material handling, bus and ship fueling systems
 - Expertise spans entire value chain – hydrogen production & distribution, fueling station & gases supply
 - Member of Fuel Cell and Hydrogen Energy Association, California Fuel Cell Partnership, California Hydrogen Business Council
- Linde designed, built and operates the worlds largest landfill gas to renewable LNG plant in Livermore CA with our partners Waste Management

Cluster station technical performance

Considering station performance in addition to coverage

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- **Linde input on minimal requirements is**
 - Meet fuel cell vehicle driver needs
 - *Customers will want their fueling experience as close to conventional as possible.*
 - *Long fueling times or lines of cars will only serve to diminish the value of these cars*
 - SAE J2601 A70 and B35 with -40 C for A70 and -20C for B35 for ALL car fuelings
 - Daily capacity selected should be based on 12 consecutive hours of fueling
- **Linde recommends incentives be provided to station developers who build stations that exceed minimum performance requirements:**
 - Daily (12 consecutive hours) dispensing throughput of 300 kg or more per day
 - *Enables a station to fuel 4-5 cars or more per hour for multiple hours*
 - If not a minimum specification:
 - *SAE J2601 A70 and B35 with -40 C for A70 and -20C for B35 for ALL car fuelings*
 - Dispensers that can fuel two cars at the same time

Why are 300 kg per day or larger stations needed?

Bay Area example

End 2015: 10,000 FCV's → 10,000 kg/day capacity

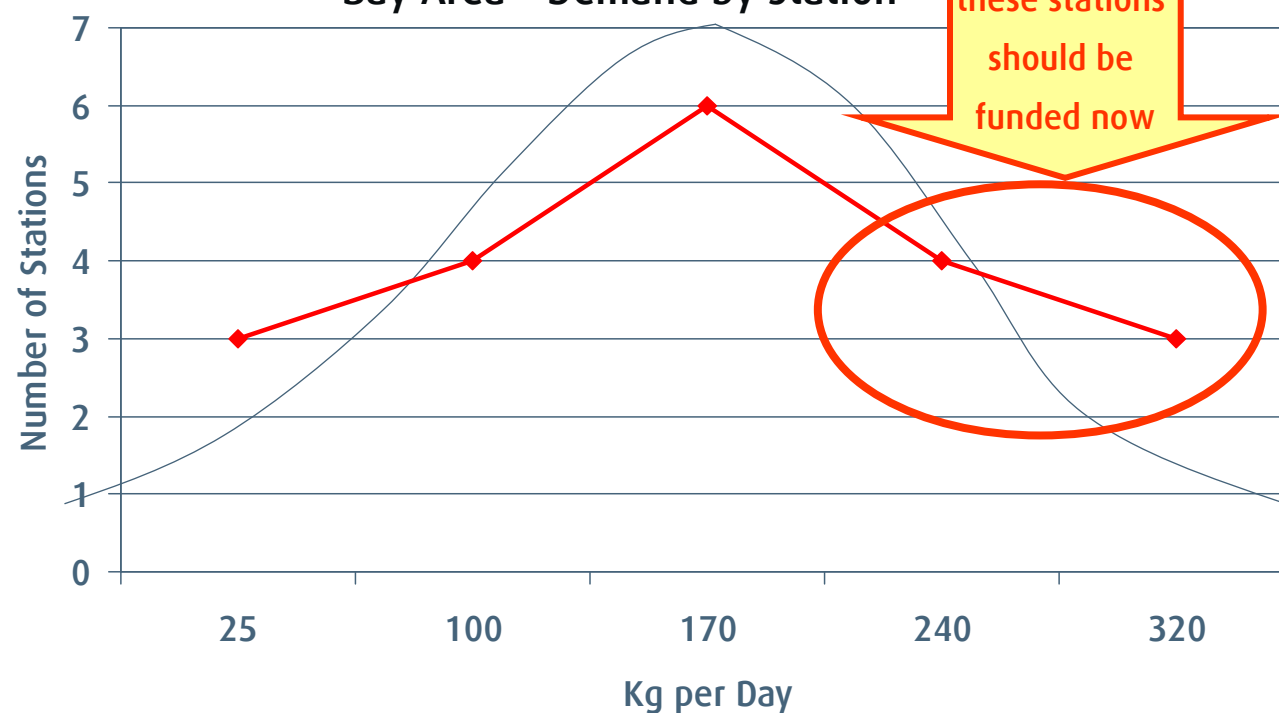
	LA Area	Bay Area	Connector/ Destination	TOTAL
Stations	38	20	10	68
Per Station Daily Capacity	170	170	25	147
Total Daily Capacity	6350	3400	250	10,000

- Better locations
- Better known to customers
- Longer time to drive demand in neighborhood
- The need to prove these stations can perform

Proving the stations:

- Practicality
- Economics
- Technology

Bay Area – Demand by Station



Why 12 consecutive fueling hours to define daily capacity?

Based on real world retail gasoline station demand patterns

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- Based on data from Chevron in a DOE funded study written by Nexant in 2008
 - DOE Award Number: DE-FG36-05G015032. Report June 2008
- Data for all days of week show about 12 consecutive hours with the maximum demand
 - There is no drop off in demand during this period
 - About 75% of daily demand in these hours

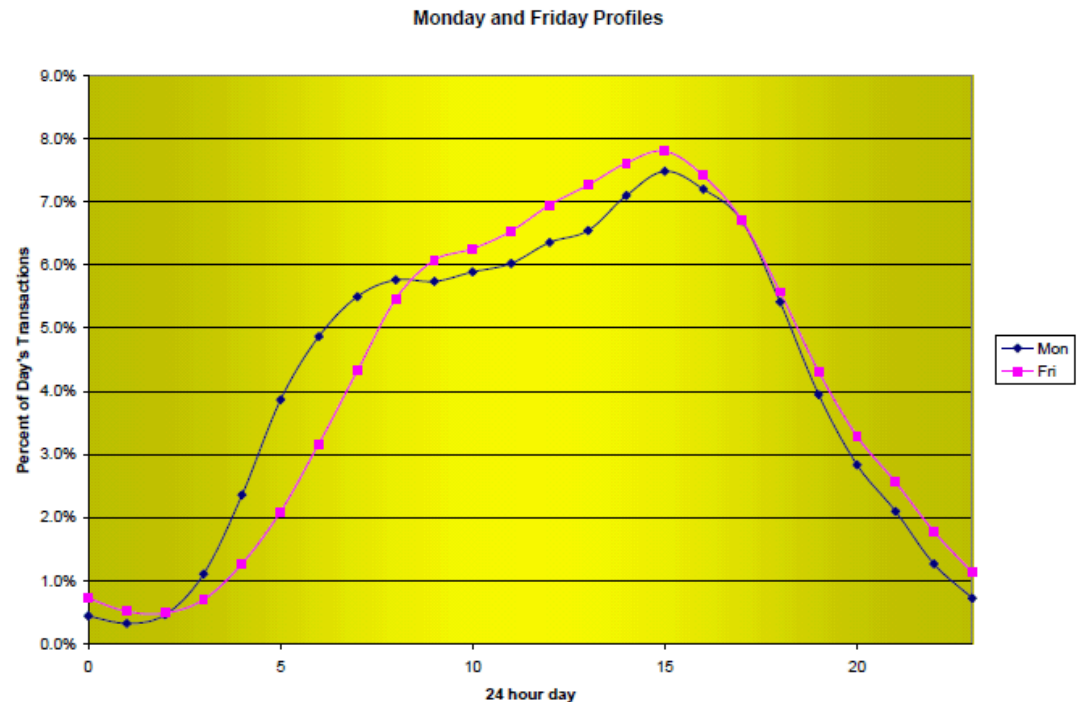
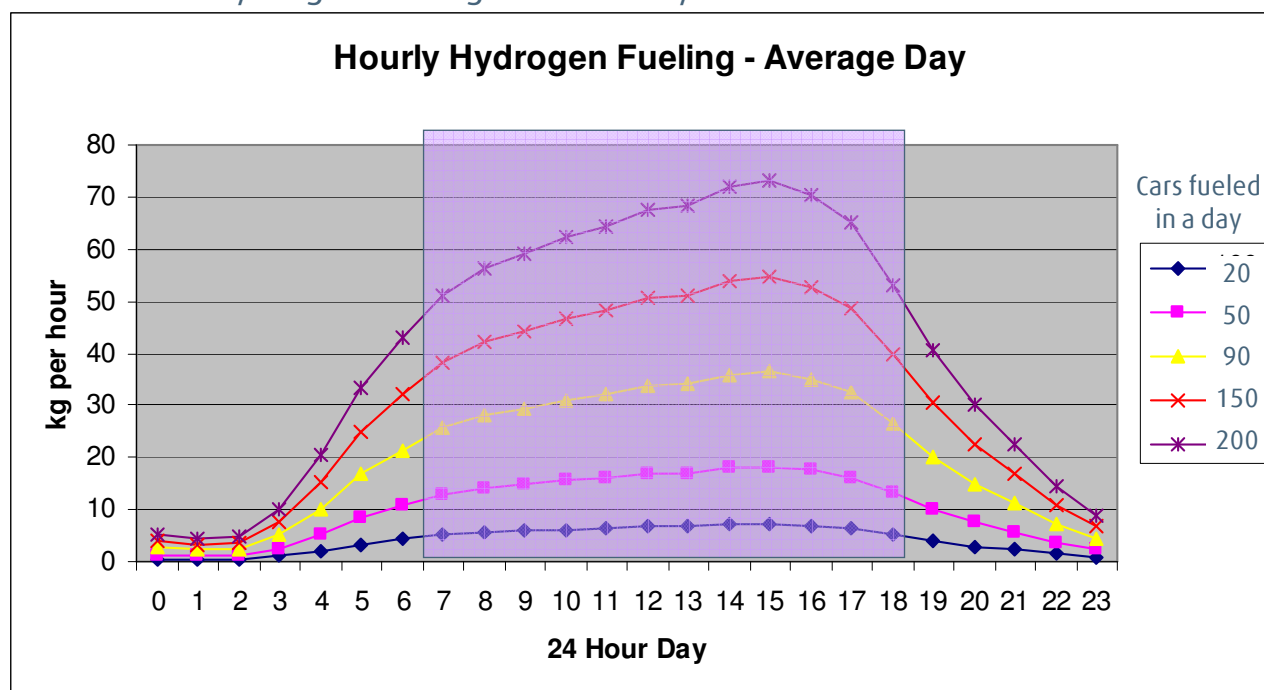


Figure 1-25 Domestic Gasoline Stations
Chart 2 – Monday/Friday within day fueling profile

Measuring station performance and throughput

- Below graph shows various sizes of hydrogen fueling stations
 - Based on retail gasoline fueling patterns from DOE funded 2008 study by Nexant
 - Provides guide on what hydrogen fueling stations may face



Conclusions

- Important to gauge capacity of a station over 12 consecutive hours
 - Most people don't fuel in middle of the night – 24 hour capacity overstates real capacity
- Stations should be able to fuel 4-5 cars per hour over 12 consecutive hours
 - To meet the above consumer fueling patterns

Thank-you

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