ConocoPhillips

(Hydrogen) Service Stations 101

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DISCLAIMER

Opinions expressed within are strictly those of the presenter and do not necessarily represent ConocoPhillips Company.

Presentation Outline

- ***Introduction to ConocoPhillips***
- Introduction to Service Stations
- Comparison of Conventional with Hydrogen Fueling Stations
- Hydrogen Fueling Life Cycle
- Practical Design Example
- Concluding Observations

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ConocoPhillips

- 7th on Fortune's list of largest companies (2003 revenues)
- 3rd largest integrated petroleum company in U.S.
- 1st (largest) petroleum refiner in U.S.
- 14,000 retail outlets (350 company-owned) in 44 states
  - Brands: Conoco, Phillips 66, 76
- 32,800 miles pipeline, owned or interest in
- 64 terminals: crude, LPG, refined products
- Power generation
  - Own interest in several plants, U.K. and U.S. (about 1500 MW net)
  - Focused on integrated solutions with Upstream and Downstream
- Involvement with DOE hydrogen program
  - Energy partner in FreedomCAR and Fuel Partnership
  - Member of California Hydrogen Infrastructure Project Team that includes Air Products, Toyota, Honda, Nissan, BMW and others

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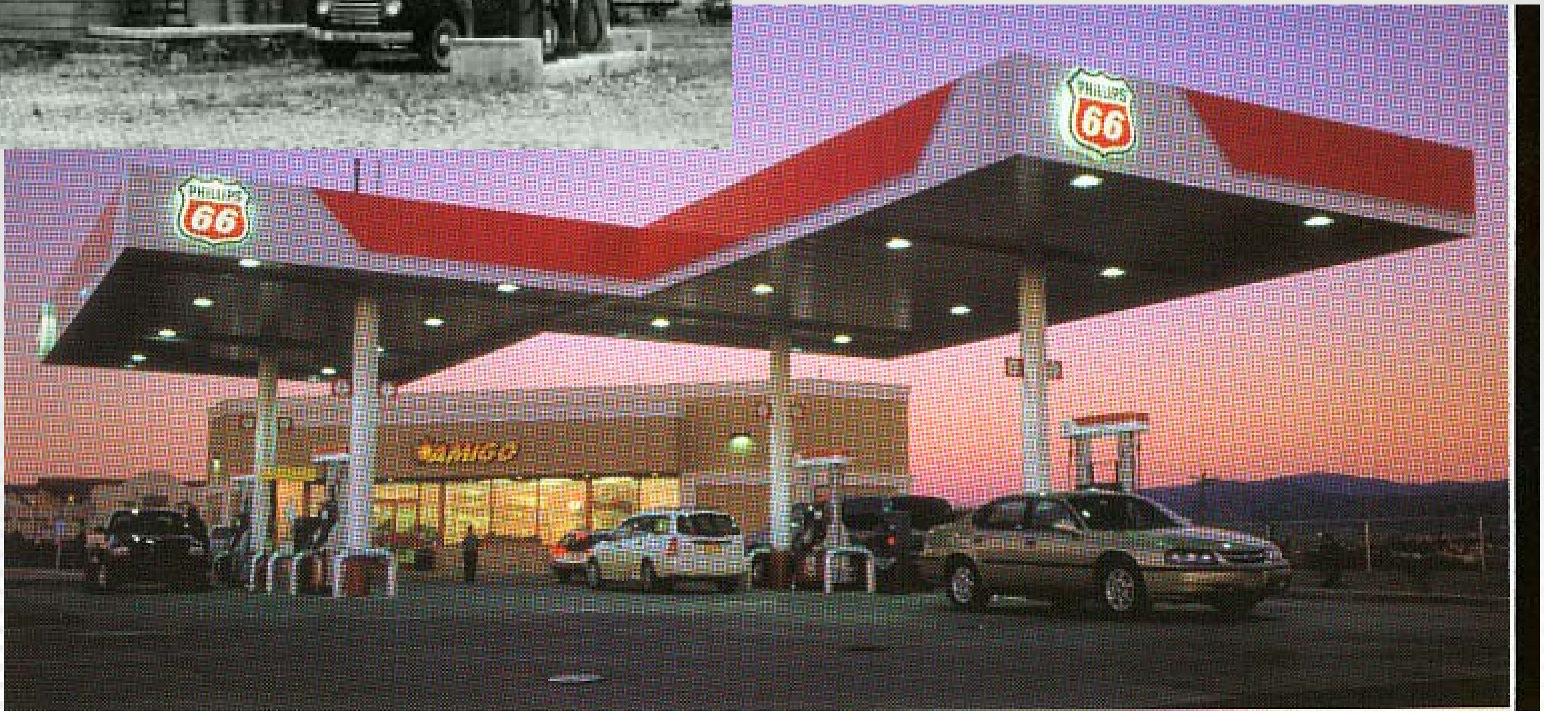
Service station evolution from selling gasoline to marketing a variety of products



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Service Station Product-Mix Timeline

Gasoline →

Lube. Oil →

Crude Oil Products

Vehicle Maintenance & Repair

Convenience Stores →

Hyper-
markets

1920 1930 1940 1950 1960 1970 1980 1990 2000

Today's service stations are more about soda than service.

Station Characteristics -- Customer

- Product quality *
- Product availability *
- Competitively priced *
- Simple to dispense *
- Reliable dispensing *
- Fast dispensing *
- Convenient location
- Easy access to / from
  - Property
  - Pumps
  - C-store
- Quick turnaround
- Desirable C-store product line
- Aesthetically pleasing
- Clean facilities
- Safe

* Referring to motor fuel

Station Characteristics -- Owner

- Safe
- Compliant with codes and regulations
- Reliable and timely delivery of product to the station
- Competitive price from supplier
- Loyalty program
- Minimal labor
  - Attention
  - Expertise
- Minimal downtime
- Minimal maintenance
- Fast customer turnaround
  - Fast dispensing
  - Easy access
- Good (high traffic) location
- Minimal investment
  - Small capital costs
  - Small footprint
- Good access for supply / maintenance vehicles
  - Away from customer traffic
  - Fast stocking
  - Easy supply and maintenance access
- Strong ancillary business (to supplement skinny fuel margins)

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Station Characteristics -- Community

- Safe
- Compliant with codes and regulations
- Quiet
- Acceptable emissions
- Clean and neat
- Aesthetically pleasing
- Small footprint

Innocuous and inconspicuous

Absent any profound motivation to adopt hydrogen (such as a serious disruption of petroleum distribution), anticipate that

– customers, owners and communities will be critical, even skeptical, of hydrogen fueling stations

– they will expect hydrogen fueling stations to provide at least the same degree of safety and quality of product, performance and experience that conventional service stations provide

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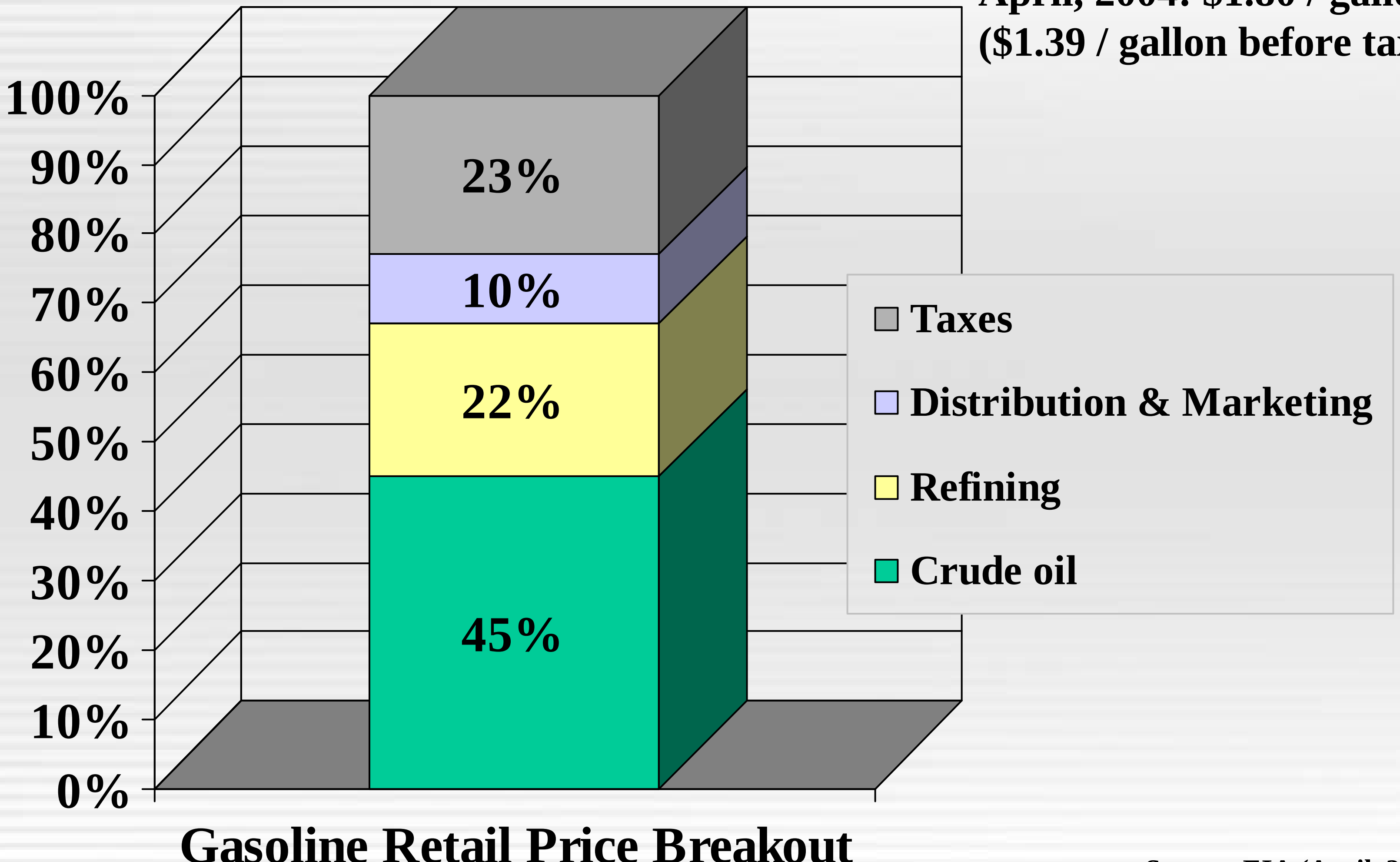
GASOLINE PRODUCT COST

April, 2004: $1.80 / gallon
($1.39 / gallon before taxes)



Source: EIA (April, 2004)

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Distribution & Marketing Cost Component – U.S. Gulf Coast

Transport Segment	Cost ($ / Gallon)
Refinery to pipeline	0.002 - 0.006
Pipeline tariff	0.007 (80 mi) - 0.032 (1610mi)
Terminal service	0.004 - 0.006
Truck loading	0.006 – 0.008
Trucking	0.015 – 0.020
Retail margin *	0.05 – 0.20
Total	0.084 – 0.272

*Includes operations, maintenance, insurance, profit, etc.

SOURCE: DOE FreedomCAR and Fuels Initiative Delivery Tech Team

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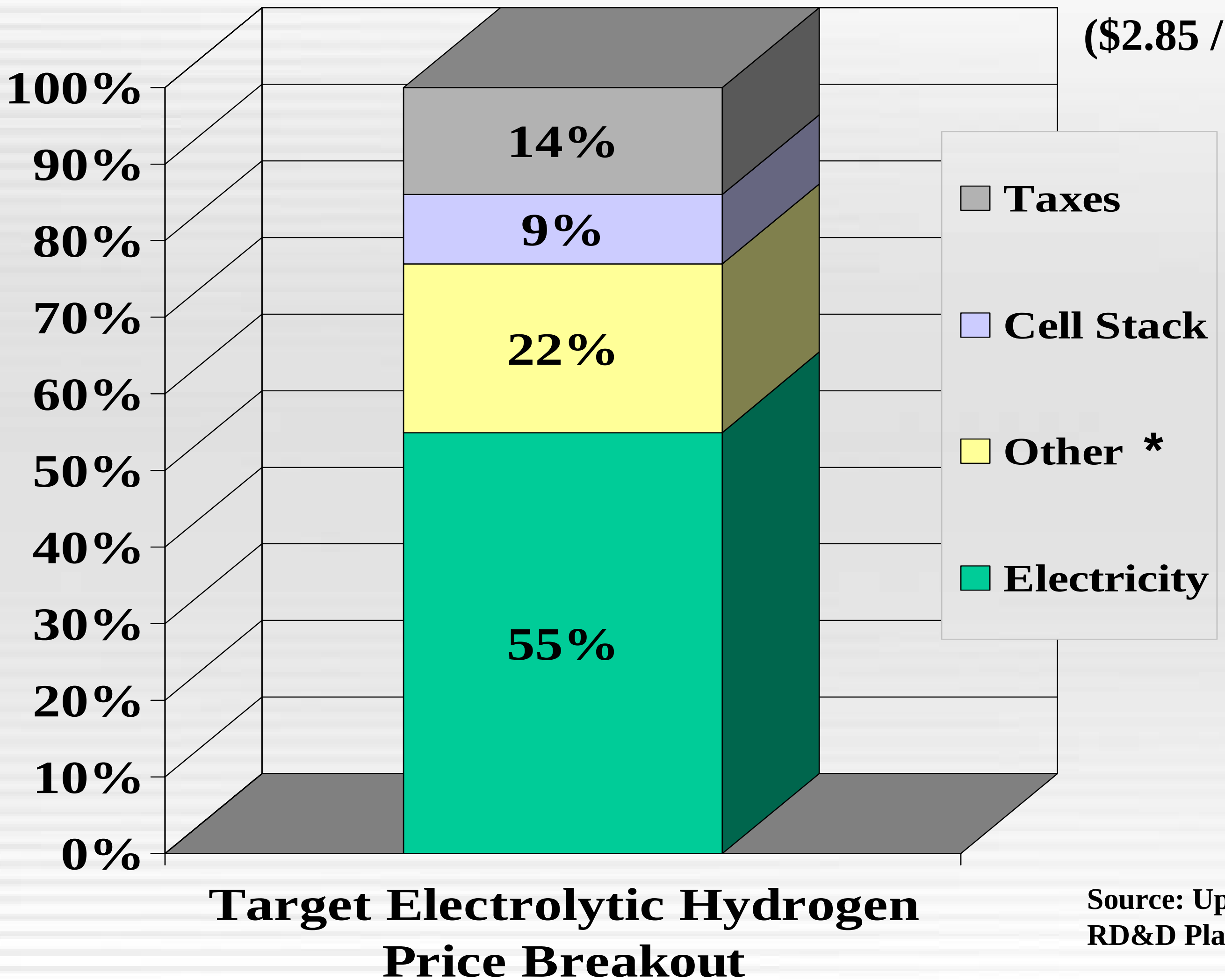
ON-SITE, ELECTROLYTIC HYDROGEN COST

2010 Target: $3.31 / kg
($2.85 / kg before taxes)



Source: Up-dated DOE MultiYear RD&D Plan

* "Other" includes power conversion, compression, storage and dispensing, balance of plant, O&M, labor, profit, etc.

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Components of “Other” Cost

Cost Component	Cost ($/kg)
Power conversion	0.09
Balance of plant (H2 purification, water removal)	0.08
Compression	0.18
Storage and dispensing	0.06
Other (O&M, labor, plant construction, profit, etc.)	0.32
Total	0.73

Source: Up-dated DOE MultiYear RD&D Plan

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Equipment Comparison

Conventional
- Product storage tanks
  - Inexpensive, “low tech”
  - 8/10/12/15/20,000 gallon
  - Diesel, premium, regular
- Pumps, leak detection
- Mixers (octane)
- Vapor collection

- Dispensers
- Pad, guards, canopy
- C-Store (3,000 sq.ft.)
- Car wash

Hydrogen
- Product storage tanks
  - Expensive, “high tech”
  - Single product
- Feed preparation
- Electrolyzer
- Compressor
- Product treatment
- Tube trailer drop
- Dispensers
- Pad, guards, canopy
- C-Store
- Car wash

Service Station Differences

Conventional

- "Distribution" problem
- Retailer purchases finished product priced competitively in free-market
- National codes
- Product differentiation
  - Multiple grades
  - Additives
- Economic justification
- Many customers / competitors

Hydrogen

- "Production" problem
- Retailer purchases electricity or natural gas in regulated system
- Local codes
- Limited opportunity for product differentiation
  - Renewable, non-renewable
- Non-economic basis (security, environment)
- Few customers / competitors

Service Station Differences (cont)

Conventional

- Standard risk
  - Marketing
  - Competition
- Modest investment
- Insurability
  - History
- Nature of fuel
  - Liquid hydrocarbon
- Liability
  - Bad fuel – shared

Hydrogen

- Added risk
  - Production activity *
  - Station technology *
  - Vehicle technology
- Larger investment
- Insurability
  - Lack of history
- Nature of fuel
  - Hydrogen
- Liability
  - Bad fuel – sole

* On-site production represents a significant redistribution of production risk from central plants to stations involving new technologies

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NRC Projected Hydrogen Fueling Life Cycle

- Initial period
  - Demonstration stations
  - Central production, trucked to stations
- Transition period
  - Distributed on-site production
  - Primarily natural gas reforming and grid-based electrolysis
    - Small (5%) load increase on infrastructure
  - Some renewable production (wind, solar)
- Long term
  - Unknown

Initial and Early Transition Periods "Hydrogen Highways"

- California
  - 150 – 200 stations, $75 – 200 million
  - Every 20 miles along major highways
  - Higher concentrations in larger towns
  - Operational in 2010
- British Columbia
  - Between Vancouver and Whistler (about 80 miles)
  - Operational by 2010 Olympics in Whistler
- Illinois
  - I-90 from Indiana to Wisconsin
- New York State Thruway

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Early Life Cycle Issues with Hydrogen Refueling Stations

- How to price product (especially at remote stations)?
  - How to ensure adequate returns to induce investment?
  - Will Public Utilities Commission regulate?
- How to ensure (esp. remote) stations have adequate fuel?
- How will system evolve?
  - Will neighborhood stations share production?
- How to address hydrogen codes that tend to be local?
- How to acquire benefits of high volume manufacture?
  - How to limit the number of standard sizes?
  - Will the number of stations support high manufacturing volumes?
  - Will the number of stations be adequate to support competition among multiple manufacturers?
- How to educate populace?

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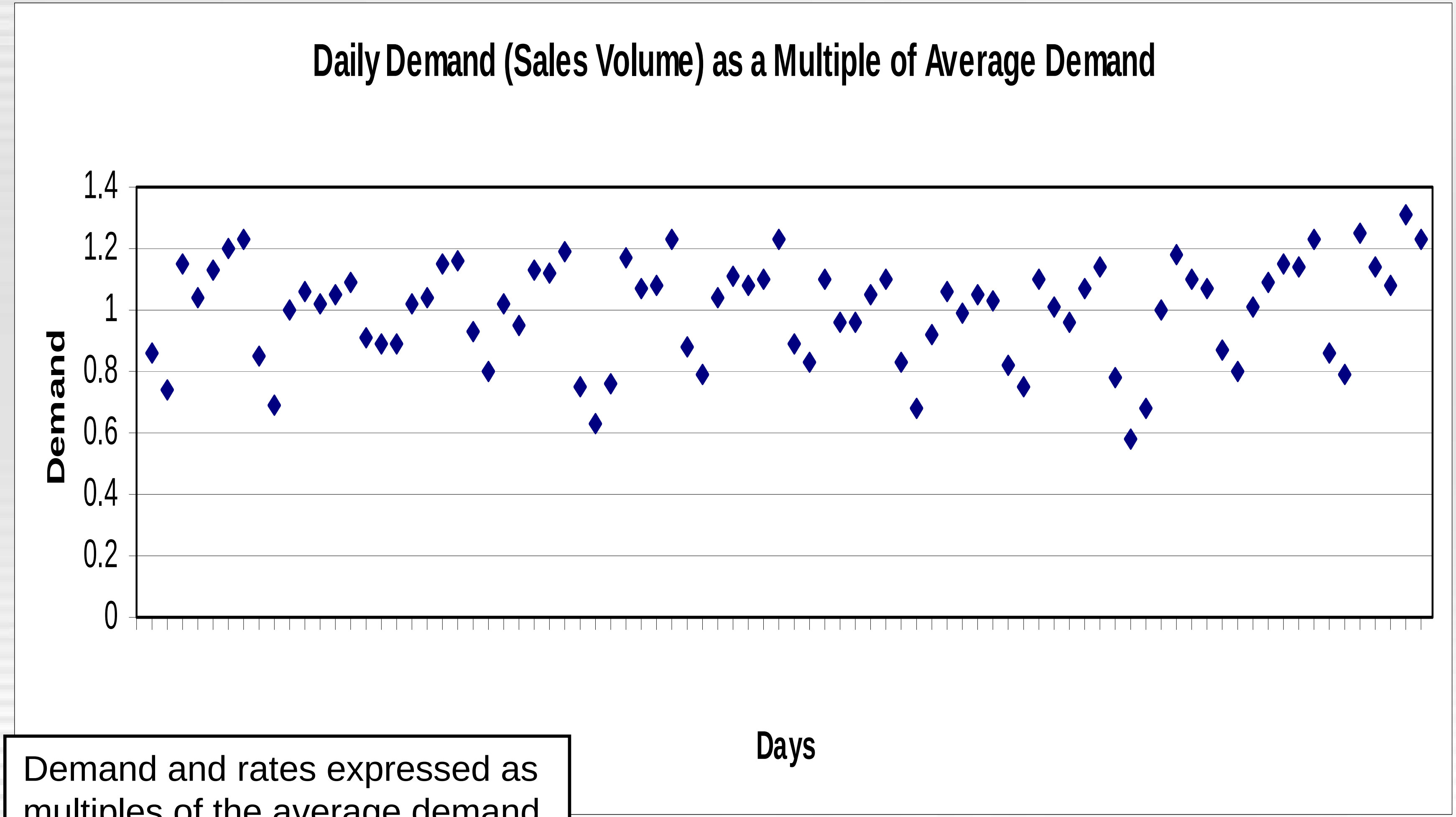
Hydrogen Station Design Considerations

- Avoid running out of product
    - Design
    - Truck delivery
    - Price
    - Rationing
- Optimize cost across capital and operations
    - Capital equipment
        - Production equipment
        - Product storage
    - Individual equipment design
        - Turndown
        - Efficient cycling
        - Durability to cycling
    - Variable utility or feed availability and cost
        - Continuous (grid)
        - Intermittent (wind, solar)
        - Peak / off-peak electric rates
    - Site
        - Location
        - Layout
        - Footprint

May – July Daily Demand (Sales Volume) Data for a Neighborhood Service Station



Demand and rates expressed as multiples of the average demand and rate over the time period

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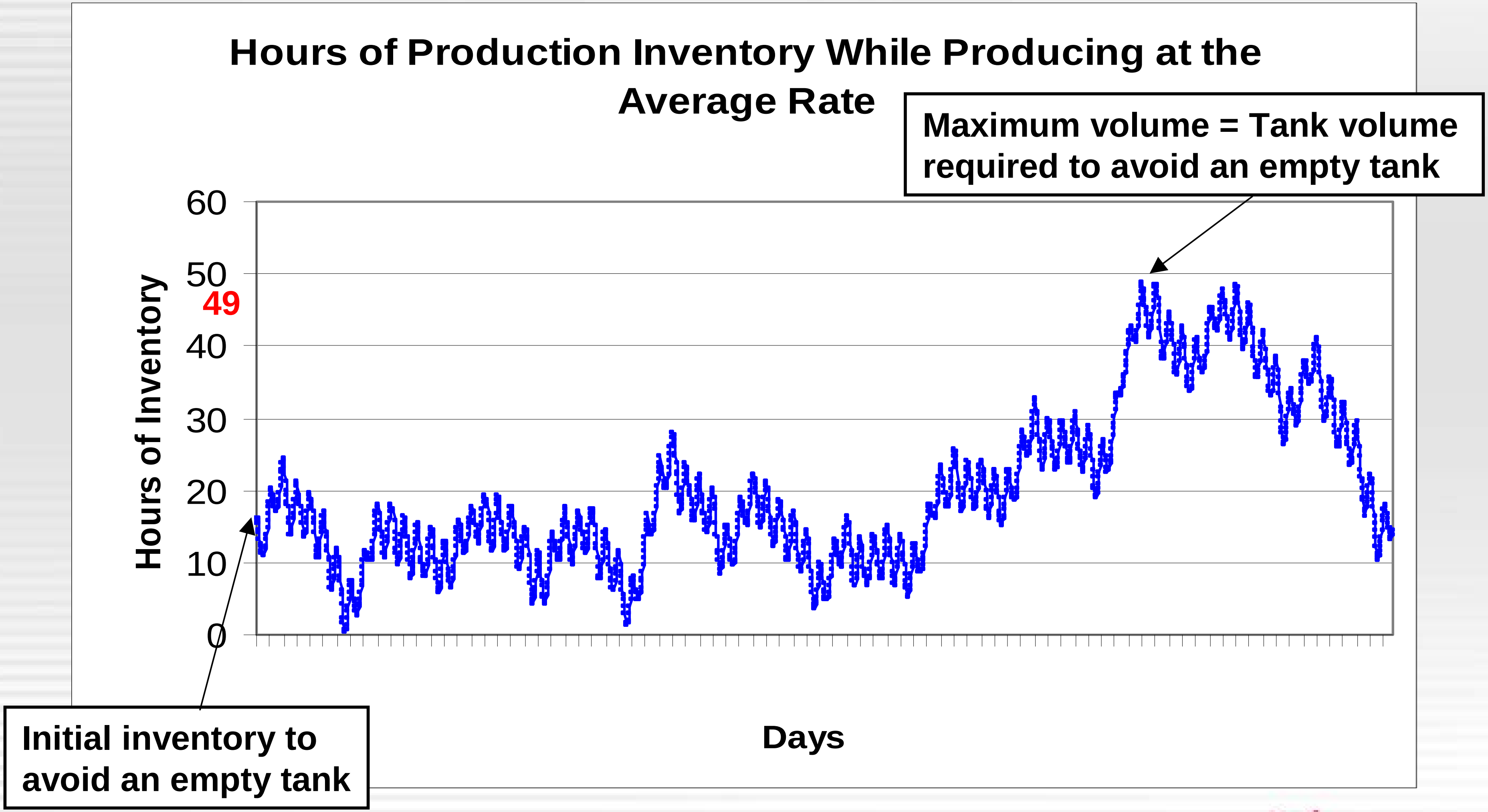
Tank Capacity Required to Keep Tank from Emptying – Constant Production Rate



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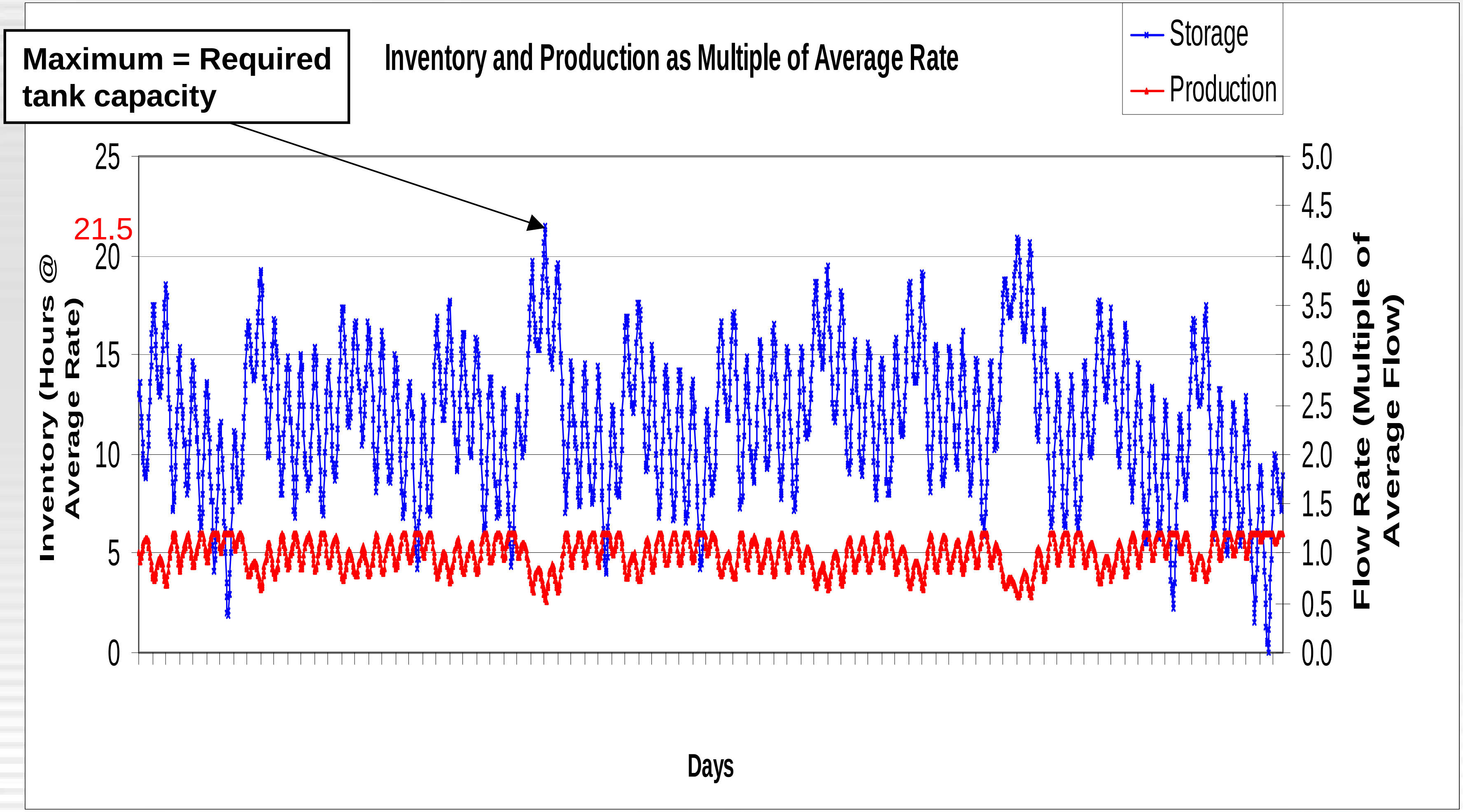
Production Equipment Sizing to Reduce Tank Requirement – 20% Production Overcapacity



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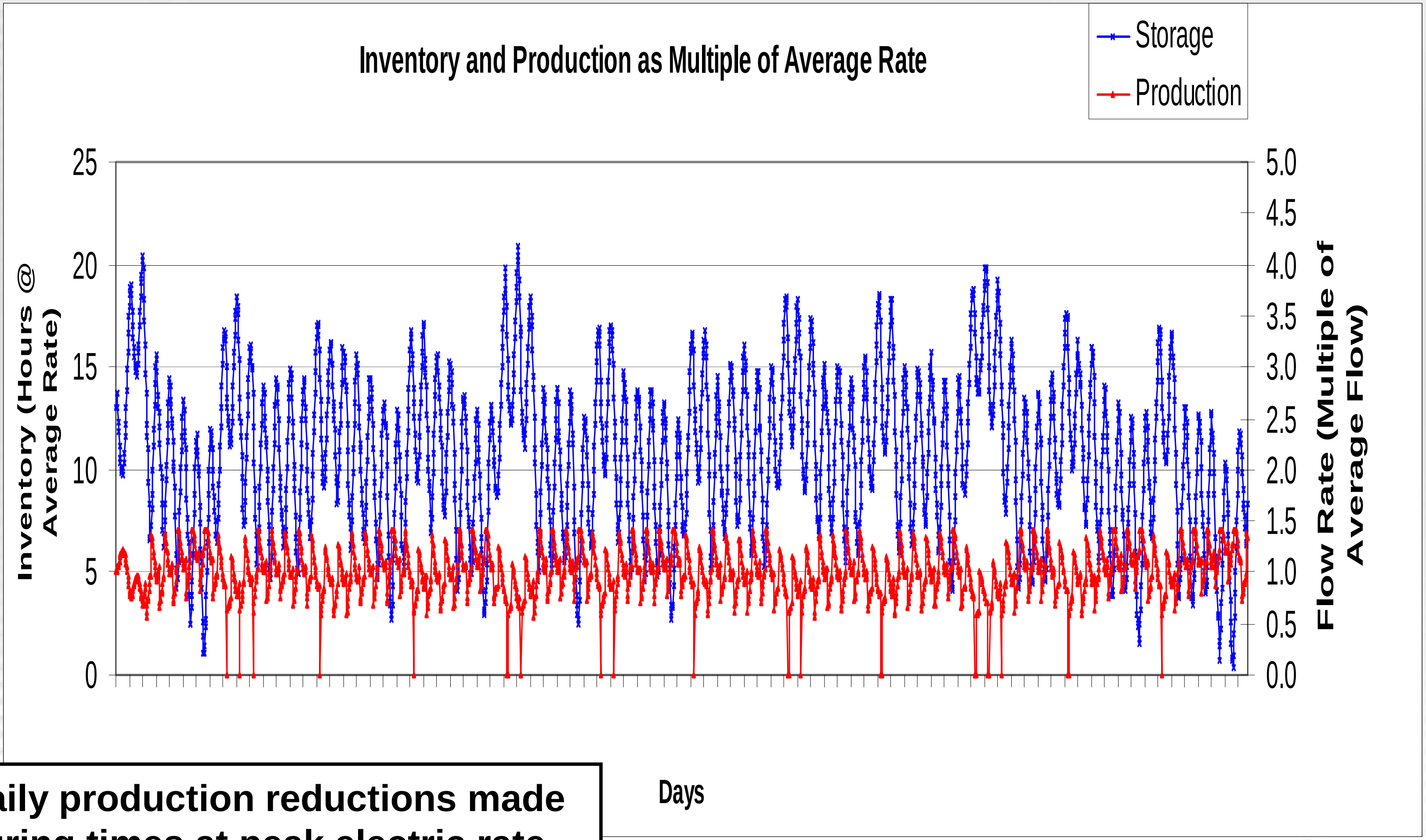
Equipment Sizing – 40% Overcapacity With Small Off-Peak Incentive



Daily production reductions made during times at peak electric rate

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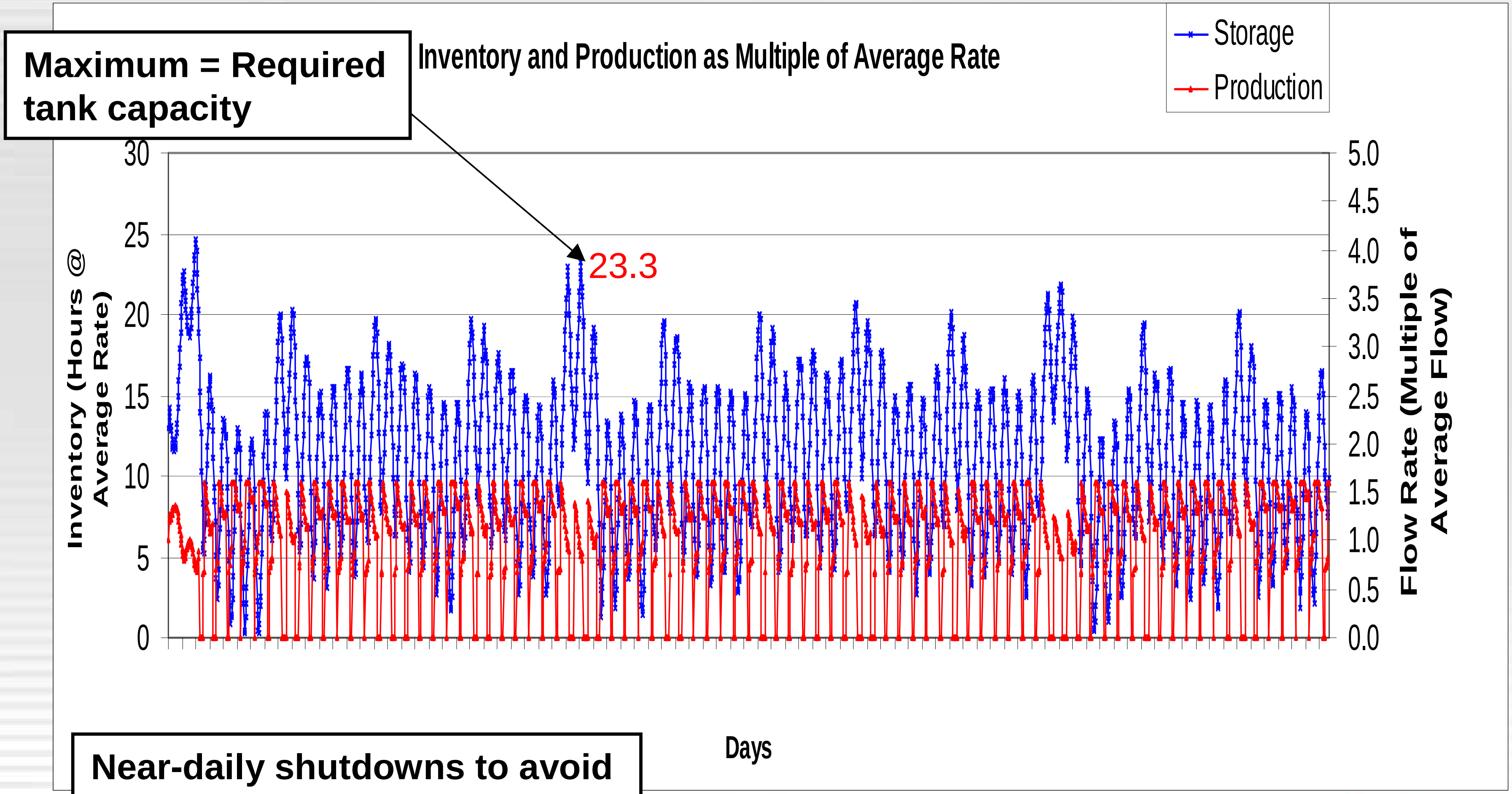
Equipment Sizing – 60% Overcapacity With Larger Off-Peak Incentive



Near-daily shutdowns to avoid peak electric rate periods

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Design Trade-offs

- Storage capacity *
  - storage technology currently under debate
  - 5,000 psi • 10,000 psi • liquid • packed
- Hydrogen production capacity *
  - immediate needs • future demand
- Peak / off-peak operation ***
- Desired hydrogen inventory level **

* Fixed capital ** Working capital *** Operating cost

Effect of Production Equipment Overdesign on Target Hydrogen Cost, Ignoring Tank Savings

Reformer

Capacity	1.0	1.6
Scaling Factor	0.7	0.7
Fixed Cost	0.5	0.582
Non-FC	0.5	0.418
H2 Cost *	$1.500	$1.256

Electrolyzer

Capacity	1.0	1.6
Scaling Factor	0.7	0.7
Fixed Cost	0.3	0.373
Non-FC	0.7	0.627
H2 Cost *	$2.850	$2.552

***Steady state production cost**

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Concluding Observations

- Current U.S. motor fuel production, marketing & distribution
  - Optimized -- evolved over decades and is continuing to evolve
  - Despite stability, system subject to disruptions
- Distributed (on-site) motor fuel production is a new paradigm
  - How much of old paradigm is applicable**?**
  - What will we fail to anticipate?
- Hydrogen production cost expected to exceed that of conventional motor fuels for extended period of time
- Reallocation of production risk premium to fueling stations
  - Production shifts to stations
  - New (riskier) production technologies are employed
- Success of the “hydrogen economy” depends upon reliable availability of fuel, especially in remote areas, which will create a requirement for dependable backup of hydrogen stations that use renewable power sources

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Concluding Observations (cont.)

- Development continues on other vehicular technologies
  - hybrid autos
  - battery-powered autos
  - advanced gasoline or diesel engines
- Effects of exogenous factors
  - Middle East oil disruption
  - many oil producers have the ability to substantially cut oil price
- Public and consumer response

Take Away

- Hydrogen must integrate into a system where fuel currently is important, but not preeminent
- On-site production entails a significant redistribution of risk
- Design of on-site production facilities will be complex and significantly impact station profitability
- Barring exceptional circumstances, petroleum-based fuels will have a cost advantage for an extended period of time

Thank you

Questions ?

BACKUP SLIDES

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Expectations

Codes

Access

Competition

Service Station Siting and Design

Product

Place

Promotion

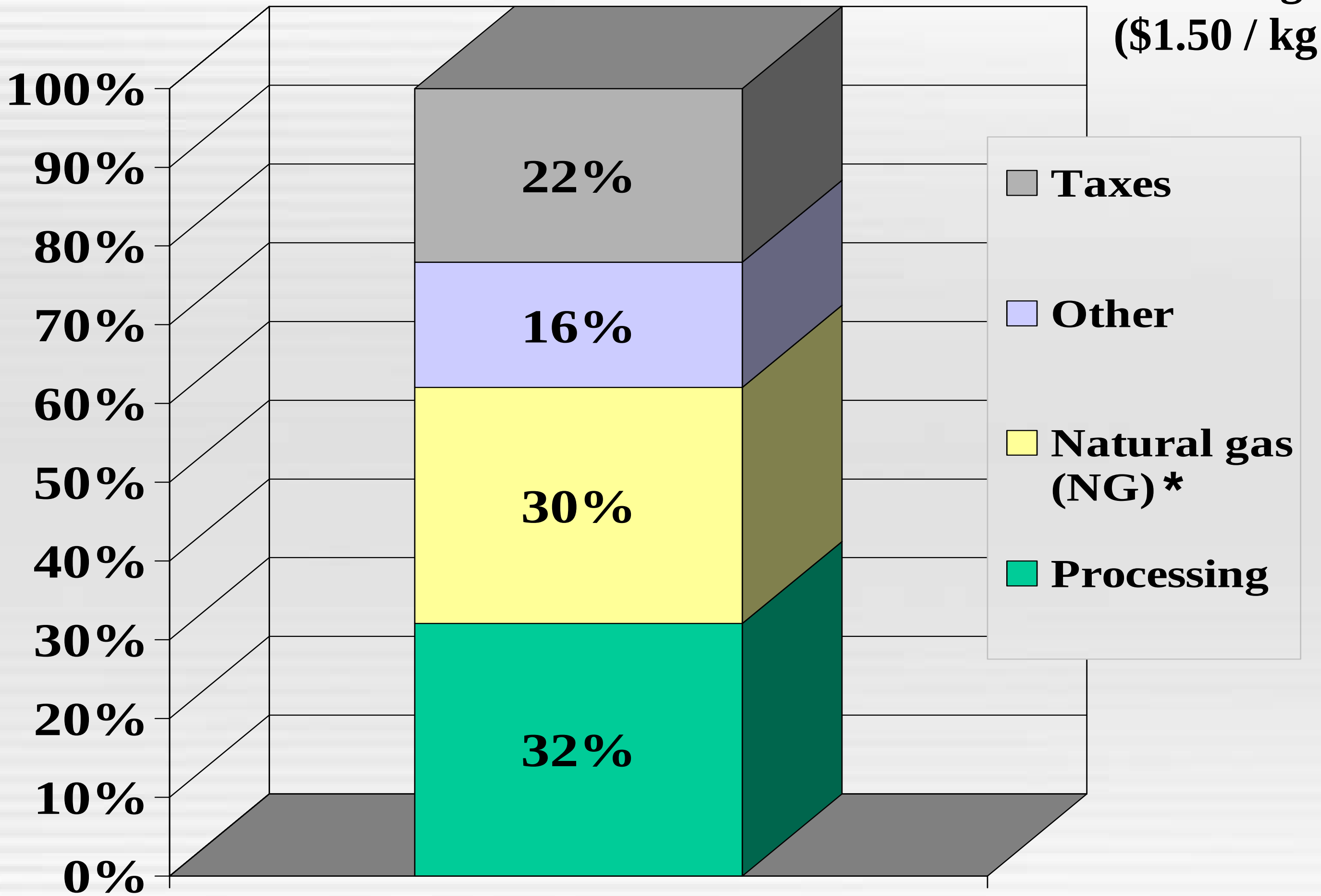
Price

Demand

Regulations

ON-SITE, NG REFORMER HYDROGEN COST

2010 Target: $1.91 / kg
($1.50 / kg before taxes)



Target NG Reformer Hydrogen Price Breakout

Source: DOE MultiYear RD&D Plan

* **"Other"** ($0.30/kg) includes O&M, rent, utilities, site preparation, etc. – **excludes operator profit**

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Components of “Processing” Cost

Cost Component	Cost ($/kg)
Reforming (excluding natural gas)	0.24
Purification	0.03
Compression	0.24
Storage and dispensing	0.11
Total	0.62

Source: DOE MultiYear RD&D Plan

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