Markets for the Alternative Energy Products

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Key Points

- There are a number of syngas derivatives related to the energy market - *large volume/ low margin - low cost feedstock, economies of scale*
- The time frame for considering the market potential *is necessarily long (20 - 30 years)*
- Energy market historically cyclical thus, there must be *flexibility in VISION and PROCESS*
- The "flexibility" -- *will need to be built into the design and implementation strategy*

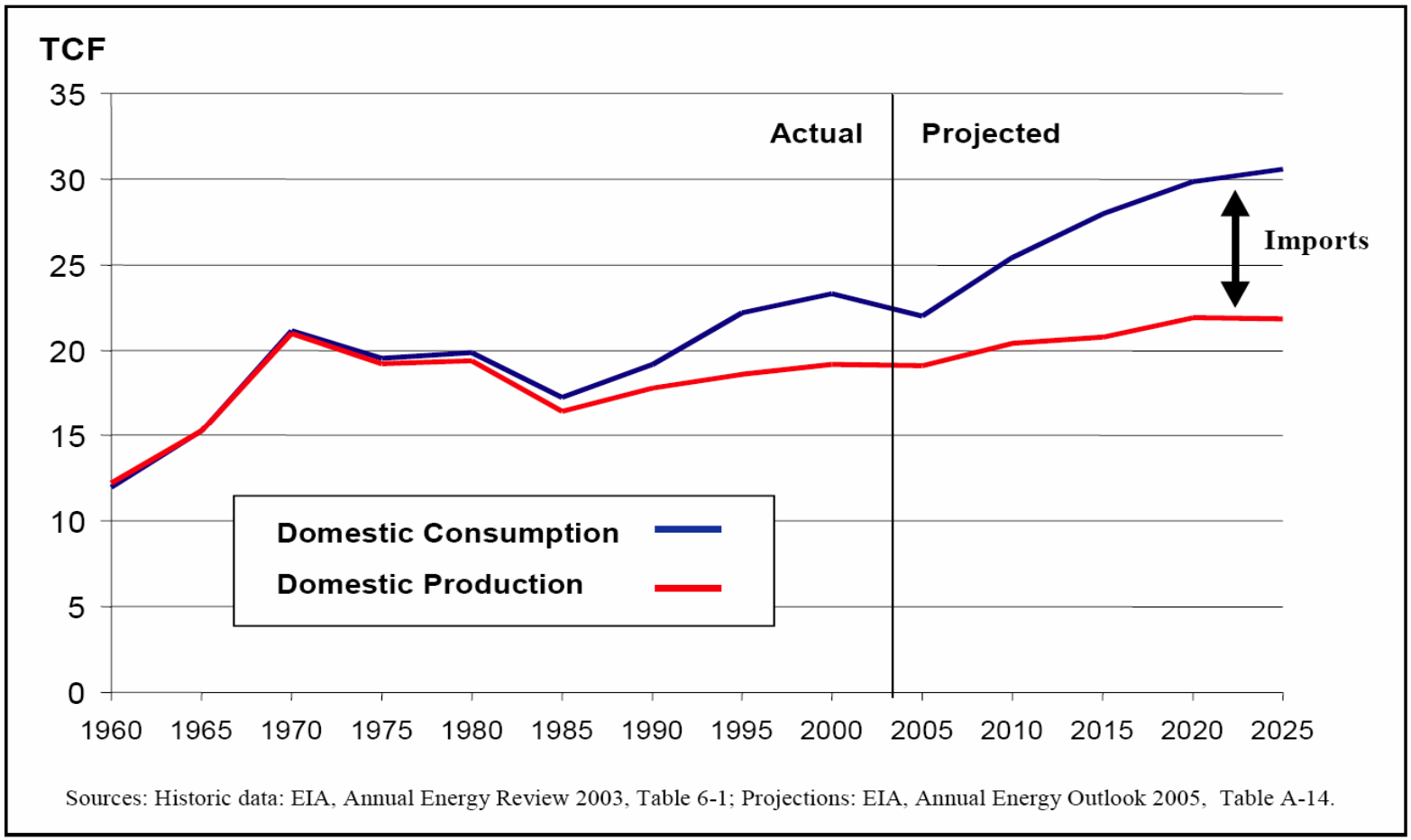
Possible Syngas Products

Direct Synthesis	Indirect Synthesis (via Methanol)
Hydrogen	Formaldehye
Methane	Acetic Acid
Ammonia	Methyl Acetate
Methanol	Vinyl Acetate
Carbon Monoxide	Methyl Formate
Medium BTU gas	Formic Acid
Higher (C_1-C_6) Alcohols	Ethanol
Gasoline	Dimethyl Carbonate
Diesel Fuel	Dimethyl Oxalate
Isobutanol	Ethylene
Isobutane	Propylene
	BTX
	Chloromethane
	Methyl Glycolate
	Ethylene Glycol

Markets

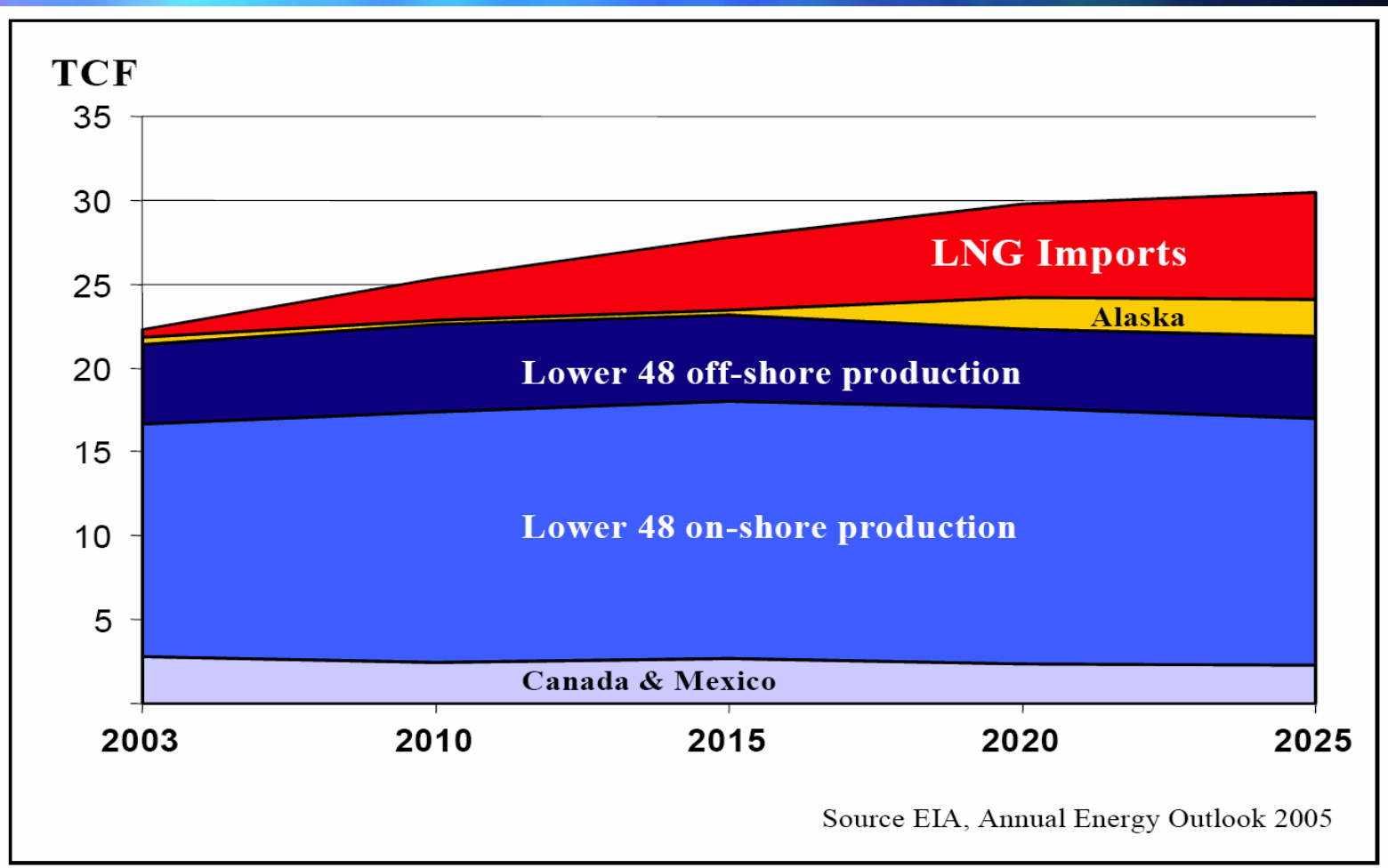
- **Energy Market:**
  - ✓ ***Potential Products:***
    - Methane
    - MEOH (FC, Neat Fuel, Fuel Additive)
    - DME/ CI Engines
    - Ethanol
    - Gasoline/Diesel
    - Hydrogen

Energy Markets -Methane

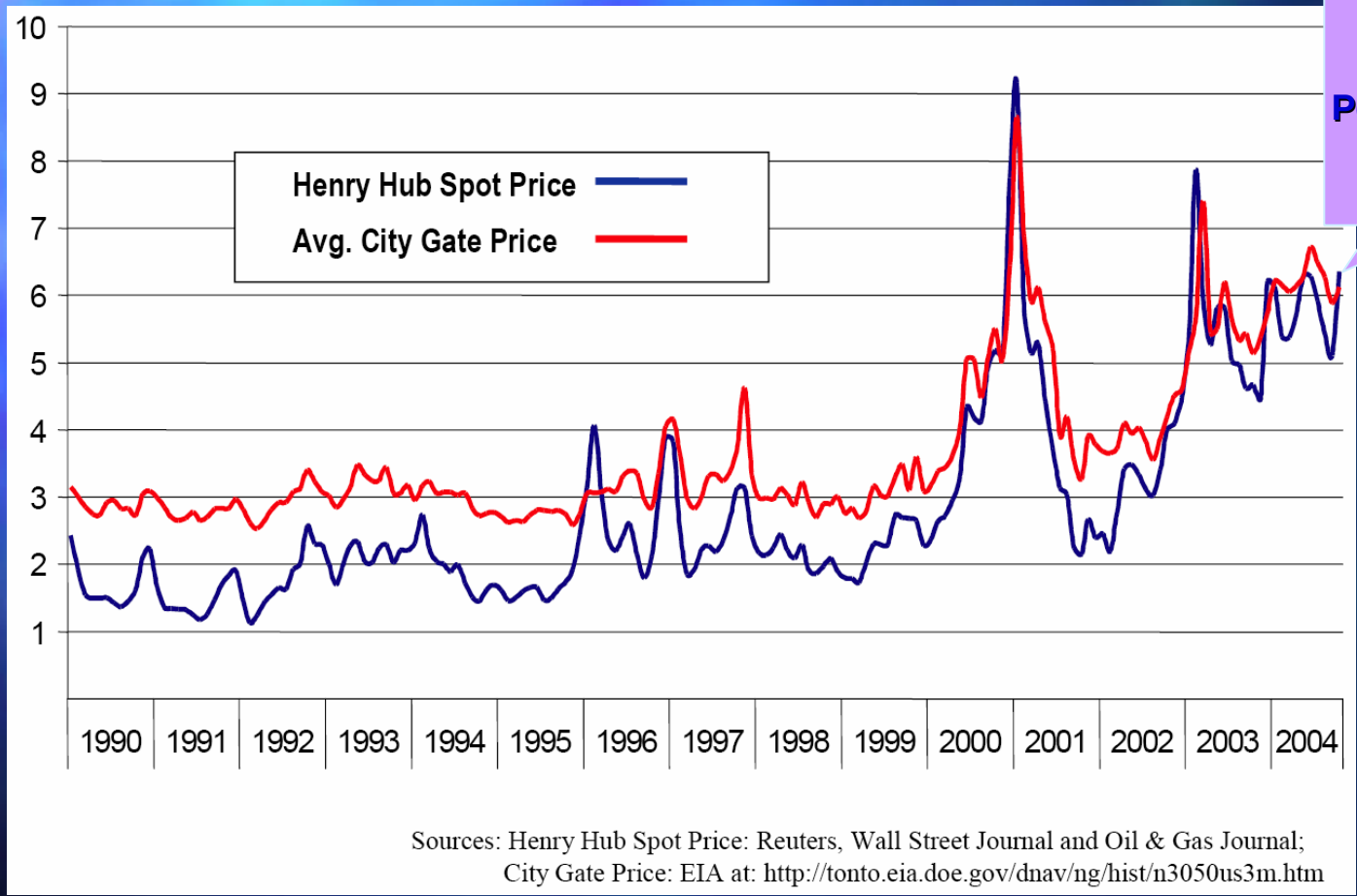


Sources: Historic data: EIA, Annual Energy Review 2003, Table 6-1; Projections: EIA, Annual Energy Outlook 2005, Table A-14.

Energy Markets -Methane



Energy Markets -Methane



Sources: Henry Hub Spot Price: Reuters, Wall Street Journal and Oil & Gas Journal;
City Gate Price: EIA at: http://tonto.eia.doe.gov/dnav/ng/hist/n3050us3m.htm

Bottom Line for Methane

- In the 1990's there was a surge in construction of natural gas fired power plants.
- Most of these plants are now operating at low capacity.
- Natural gas consumption is expected to increase 41% by 2025.
  - ✓ *Demand from electricity generators will grow the fastest (increasing 90% by 2025).*
- LNG imports are expected to grow from less than 3% of demand to 20% by 2025.

Bottom Line for Methane

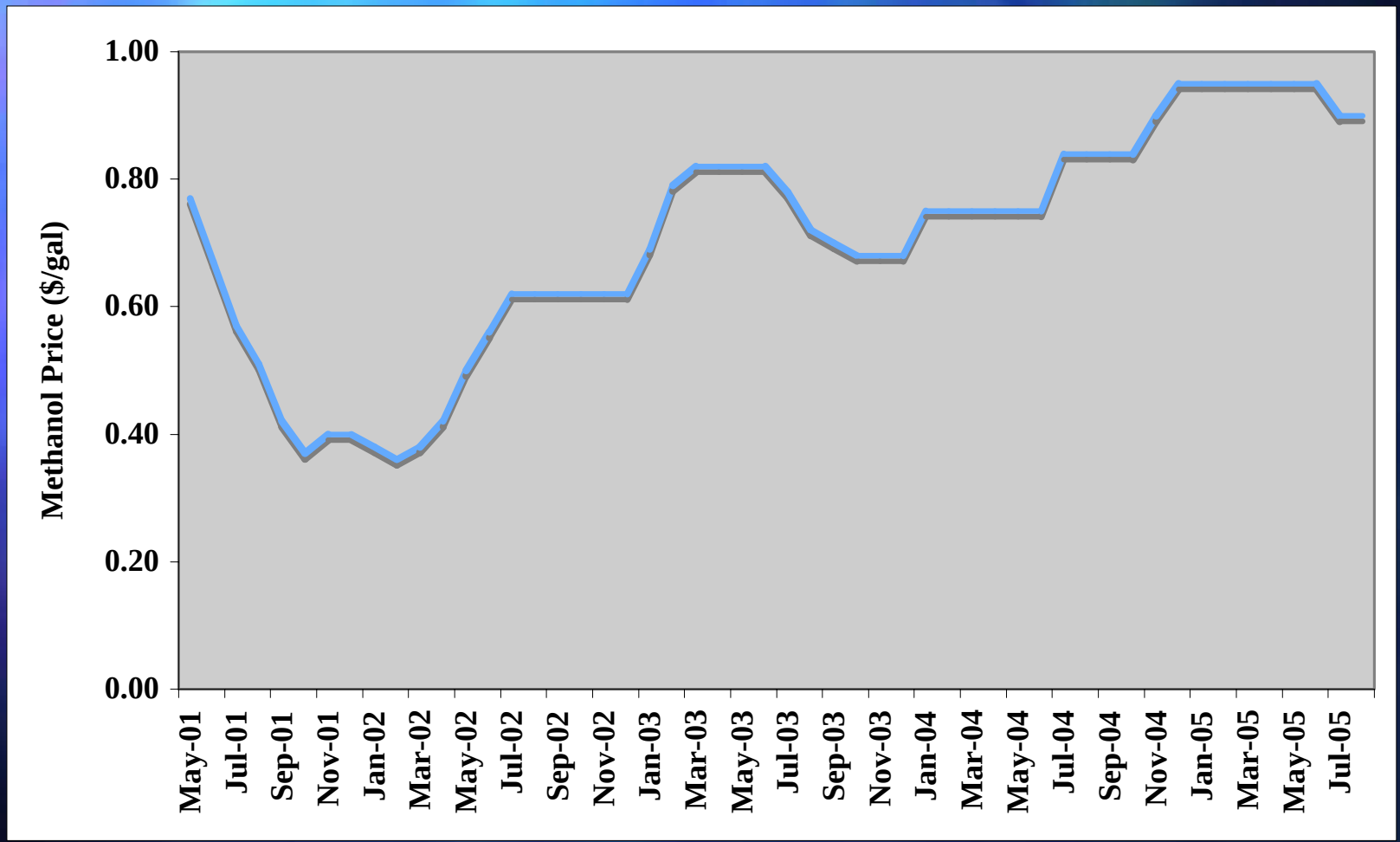
- Potential market for biomass gasification to methane.
- Coal to methane - estimated costs $4 and $5 per Mcf.
- Production of pipeline quality natural gas.
  - ✓ *Issue H_2 in the gas.*

Methanol

- US methanol production - about 2 billion gallons per year - 25% of the world's production.
- 90% via steam reforming of natural gas
- Since 1983 methanol price varied between $0.30 to $0.80 per gallon except for a large price spike in 1994 to $1.60 (MTBE demand).
- Recent rise in price due to natural gas price increases.

Data Sources: Ekbom, 2003; Methanex, 2005; Hamelinck, 2002

Methanol Price



Methanex Monthly Average Regional Posted Contract Price History

Methanol

- Estimated for 420 MW electricity plant and 450-770 tons/day methanol co-producing plant, methanol from coal would cost under ~$0.50/gallon.
- From a dedicated methanol plant - $0.60 to $70/gal
- A low cost feedstock - black liquor?? the cost could be very low.

Data Sources: Hamelinck, 2002, Roan 2004

Big Questions

- Is there a market?
- US market hurt by phase out of MTBE.
- Possible "developing" markets:
  - ✓*Neat fuel or Blends*
  - ✓*Fuel Cell Vehicles (FCV)*

Methanol

- Has a lower energy density than gasoline (49% of gasoline) has reduced range/ tank in an ICE engine.
- Toxicity issue???
- Flame invisible.
- Cold start issue below 45°F - gasoline blends.

Data Sources: Ekbom, 2003; Methanex, 2005; Hamelinck, 2002

Estimates of Alternative Fuel Vehicles in Use, 1995–2004

Fuel type	1995	1998	2000	2001	2002	2003	2004[a]	Average annual percentage change 1995–2004
LPG	172,806	177,183	181,994	185,053	187,680	190,438	194,389	1.3%
CNG	50,218	78,782	100,750	111,851	120,839	132,988	143,742	12.4%
LNG	603	1,172	2,090	2,576	2,708	3,030	3,154	20.1%
M85	18,319	19,648	10,426	7,827	5,873	4,917	4,592	-14.3%
M100	586	200	0	0	0	0	0	-100.0%
E85[b]	1,527	12,788	87,570	100,303	120,951	133,776	146,195	66.0%
E95	136	14	4	0	0	0	0	-100.0%
Electricity	2,860	5,243	11,830	17,847	33,047	45,656	55,852	13.0%
Total	**246,855**	**295,030**	**394,664**	**425,457**	**471,098**	**510,805**	**547,904**	**9.3%**

Source:

U. S. Department of Energy, Energy Information Administration, *Alternatives to Traditional Transportation Fuels, 2003* Washington, DC, 2003, web site www.eia.doe.gov/cneaf/alternate/page/datatables.html. (Additional resources: www.eia.doe.gov)

[a] 2004 data are based on plans or projections.
[b] Does not include flex-fuel vehicles.

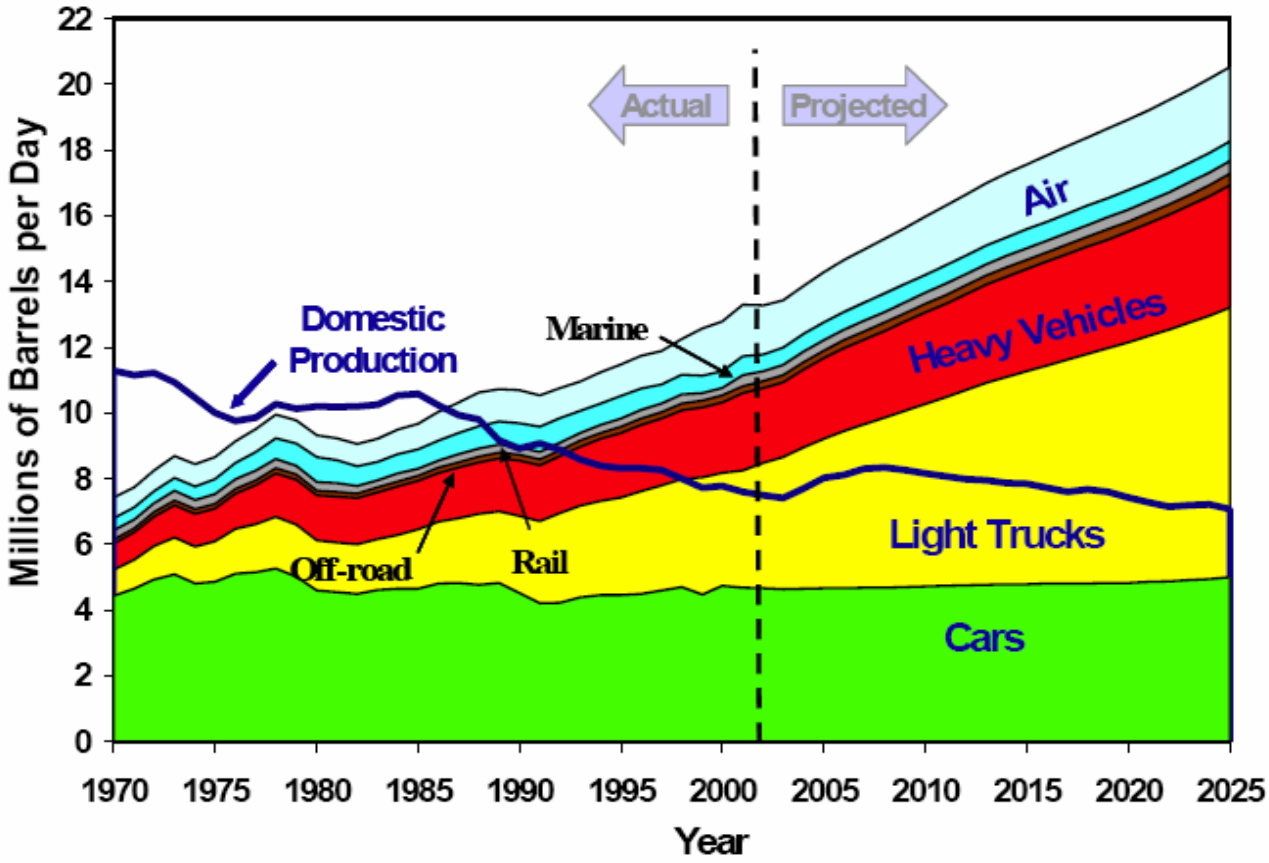
FC Vehicle

- About 800 vehicles currently on the road as test vehicle.
- Costs for FC must be reduced by a factor of 10 before reaching consumer prices.
- Once introduced 15 to 20 years for fleet turnover.
- When????? Some say 5 to 10 years, Others say 20 to 50 years.

FT Diesel

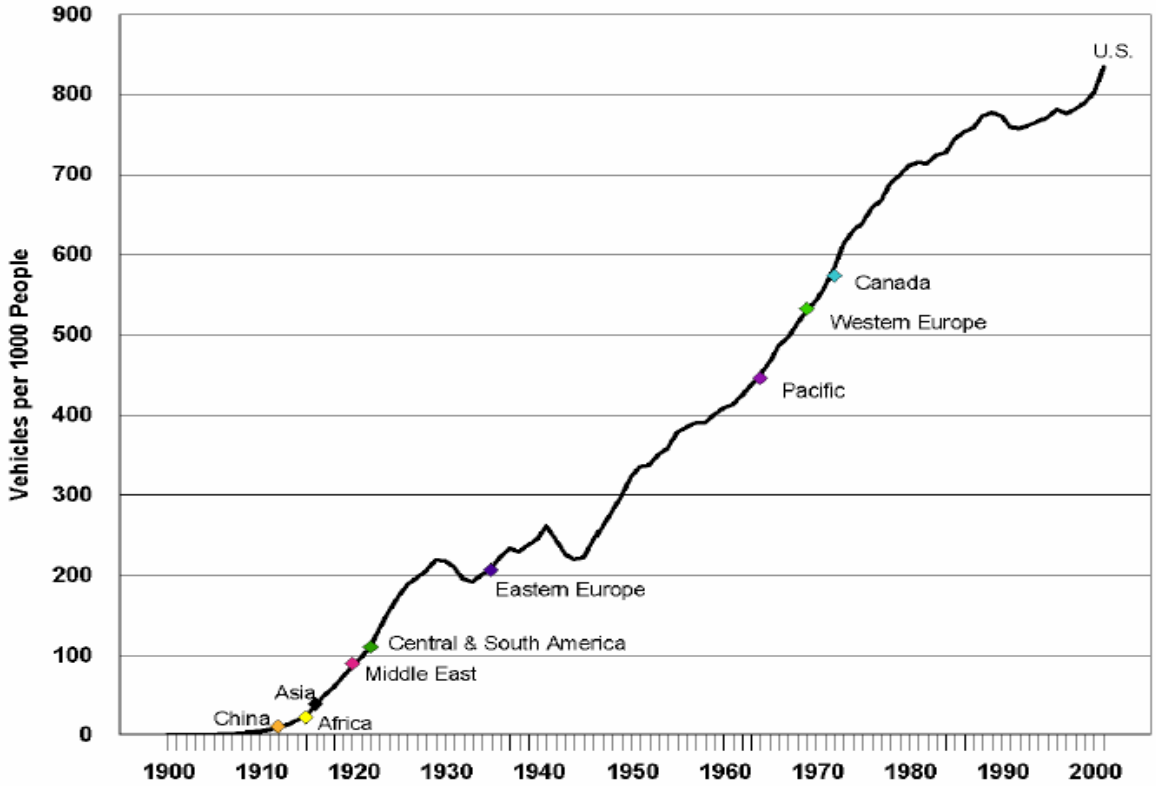
- Methane to syngas to diesel fuel.
- Low sulfur diesel.
- Currently stranded gas considered a feedstock for FT to diesel.
- Shell imports from Malaysia FT diesel to blend with diesel to meet sulfur standards in CA.
- Exxon/Qatar NGL plant development.
- Very large economies of scale - billion dollar investments.

Figure 1.7. United States Petroleum Production and Consumption, 1970–2025



Source:
See Tables 1.12 and 2.5. Projections are from the Energy Information Administration, *Annual Energy Outlook 2004*, January 2004.

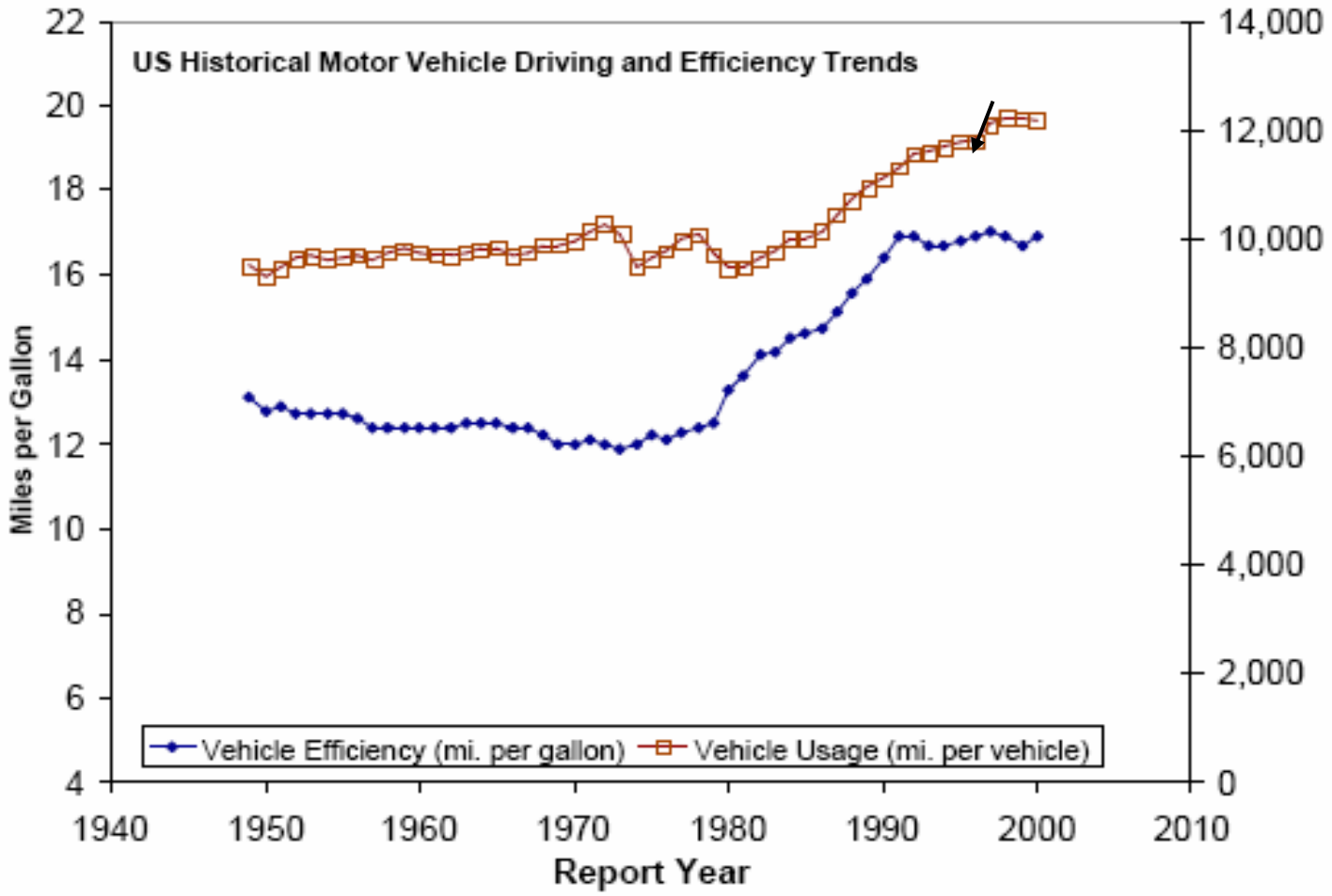
Figure 3.1. Vehicles per Thousand People: U.S. (Over Time) Compared to Other Countries (in 2002)



Sources:

Population – (2003) U.S.: U.S. Bureau of the Census, *Statistical Abstract of the United States: 2003*, Table No. 2. All others: United Nations Secretariat, Population Division, *World Urbanization Prospects, The 2003 Revision*, March 24, 2004. (Additional resources: www.un.org/esa/population/unpop.htm)

Vehicles – (2002) U.S.: U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics 2002*, Washington, DC, 2004. All others: Ward's Communications, *Ward's Motor Vehicle Data 2003*, pp. 231-234. (Additional resources: www.fhwa.dot.gov, www.wardsauto.com)


US Historical Motor Vehicle Driving and Efficiency Trends
Miles per Gallon
22
20
18
16
14
12
10
8
6
4
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
1940
1950
1960
1970
1980
1990
2000
2010
Report Year
Vehicle Efficiency (mi. per gallon)
Vehicle Usage (mi. per vehicle)

FT Diesel Outlook

- FT Diesel is expected to make-up 10% of the world diesel market by 2020.
- 26 million bpd distillate consumption worldwide.
- Scale is a big issue:
  - ✓ *ExxonMobil, 150,000 to 180,000 bpd; $7 billion.*
  - ✓ *Royal Dutch/Shell and Qatar Petroleum, 140,000 bpd; 5 billon.*
  - ✓ *ConocoPhillips, 180,000 bpd, $6 billion.*

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