

On the Road: How Quality Will Shape Future Transport Fuels



By

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Some Definitions

- **Western Data Sources:** International Energy Agency (IEA), US Department of Energy's Energy Information Agency (EIA), BP Statistical Yearbook
- **Mideast Gulf and Asia-Pacific Data:** Asia Pacific Energy Consulting (APEC)
- **Diesel – Road/Land Diesel or Automotive Diesel Oil (ADO):** Better-quality gas oil with minimal sulfur, aromatics/polyaromatics (PAH) content, and higher cetane value. Used solely in land transport.
- **General Gas Oil:** Gas oil containing higher sulfur and polyaromatics/PAH, lower cetane value. Used mainly in power generation, industry, and marine bunker fuel.
- **North America:** United States, Canada and Mexico
- **Europe:** European Union (EU) members that are also members of the Organization for Economic Cooperation and Development (OECD). We have excluded current EU members Estonia, Latvia, Lithuania, Slovenia, Cyprus, Malta, Bulgaria, and Romania.
- **Mideast Gulf:** Bahrain, Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia, the United Arab Emirates (UAE), and Yemen.
- **Asia Pacific:** Pakistan to Japan to New Zealand

Land Transport Fuels: Points of Focus/1

- Four Regions: North America, Europe (OECD/EU), Mideast Gulf, and Asia Pacific
- Comparing transport fuels
- Shifting product balances, within and between regions
- Competition between gasoline and road diesel (AKA Automotive Diesel Oil/ADO)
- Product imbalances, by region, as price driver

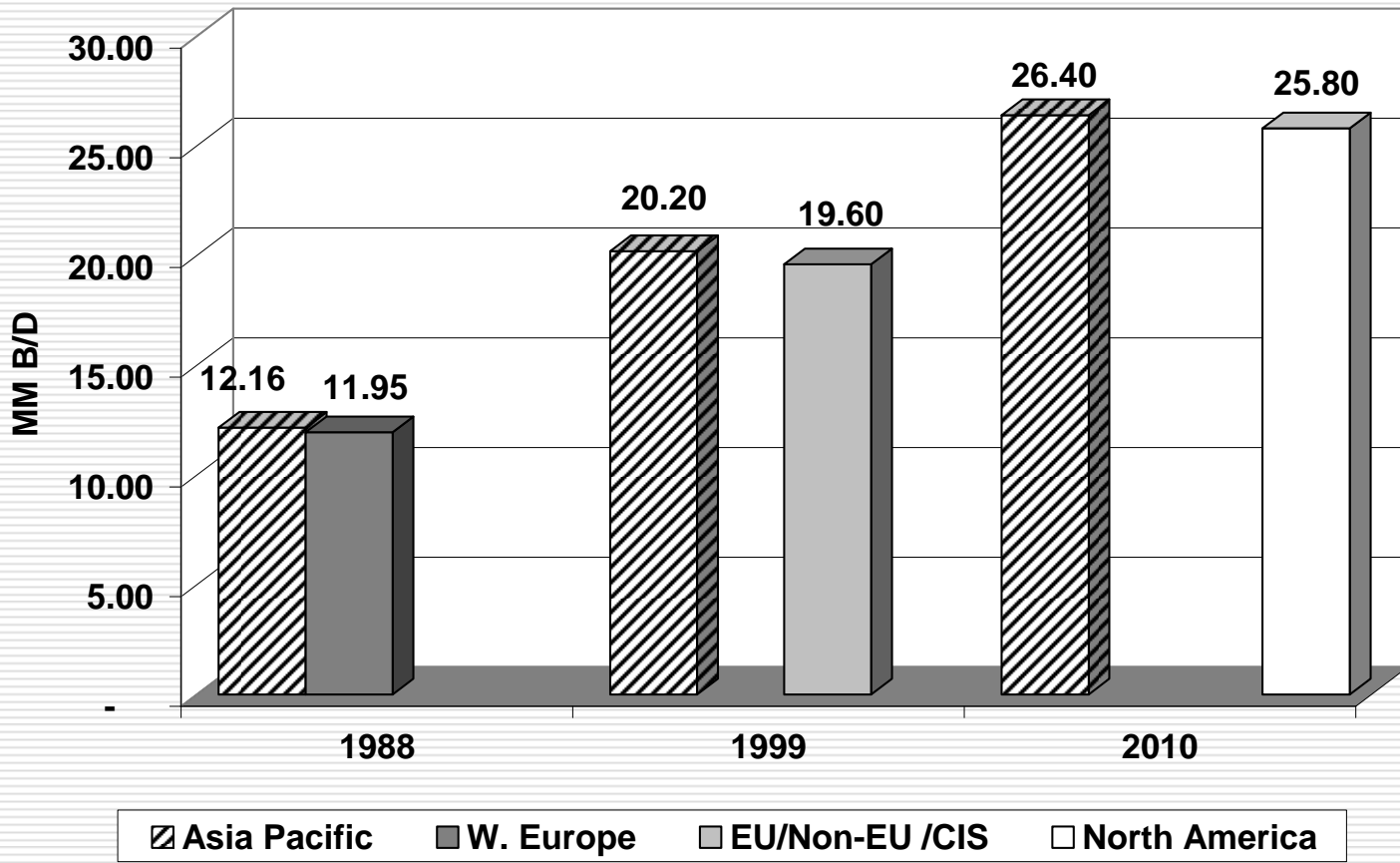
Land Transport Fuels: Points of Focus/2

- Product quality as a driver
- Tax/tariff impact
- Impact biofuels and condensate
- A view of transport fuel surplus/deficit

Total Oil Use Pecking Order

- Despite the Asian Contagion of 1997-1998, Asia Pacific...
 - Overtook Western Europe by 1988 (European Union 15 countries): 12.16 MM B/D vs. 11.95 MM B/D.
 - Overtook all Europe and Ex-Soviet Union by 1999: 20.2 MM B/D vs. 19.6 MN B/D.
 - Will overtake US/All North America by no later than 2010 (forecast 26.4 MM B/D vs. 25.8 MM B/D; maximum growth North America).

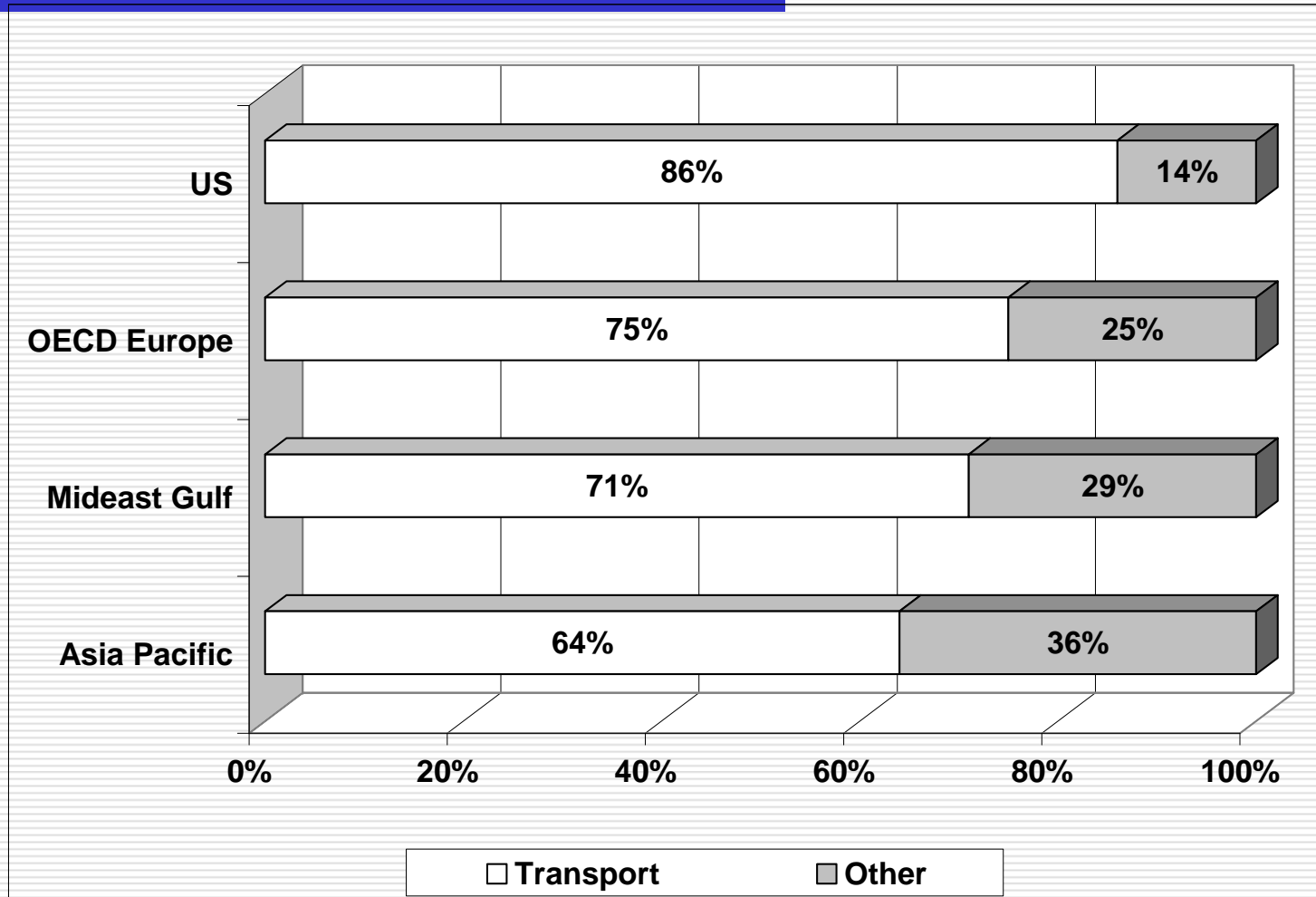
Total Oil Use Pecking Order



While Transportation Index Higher in Western Markets

- Diesel and gas oil are not synonymous
- Much of Asia-Pacific road fuel hidden in gas oil
- Despite *dieselization* of Europe, Asia Pacific will overtake no later than by 2012.
- There remains substantial room for expansion of Asia-Pacific ADO use, particularly China.

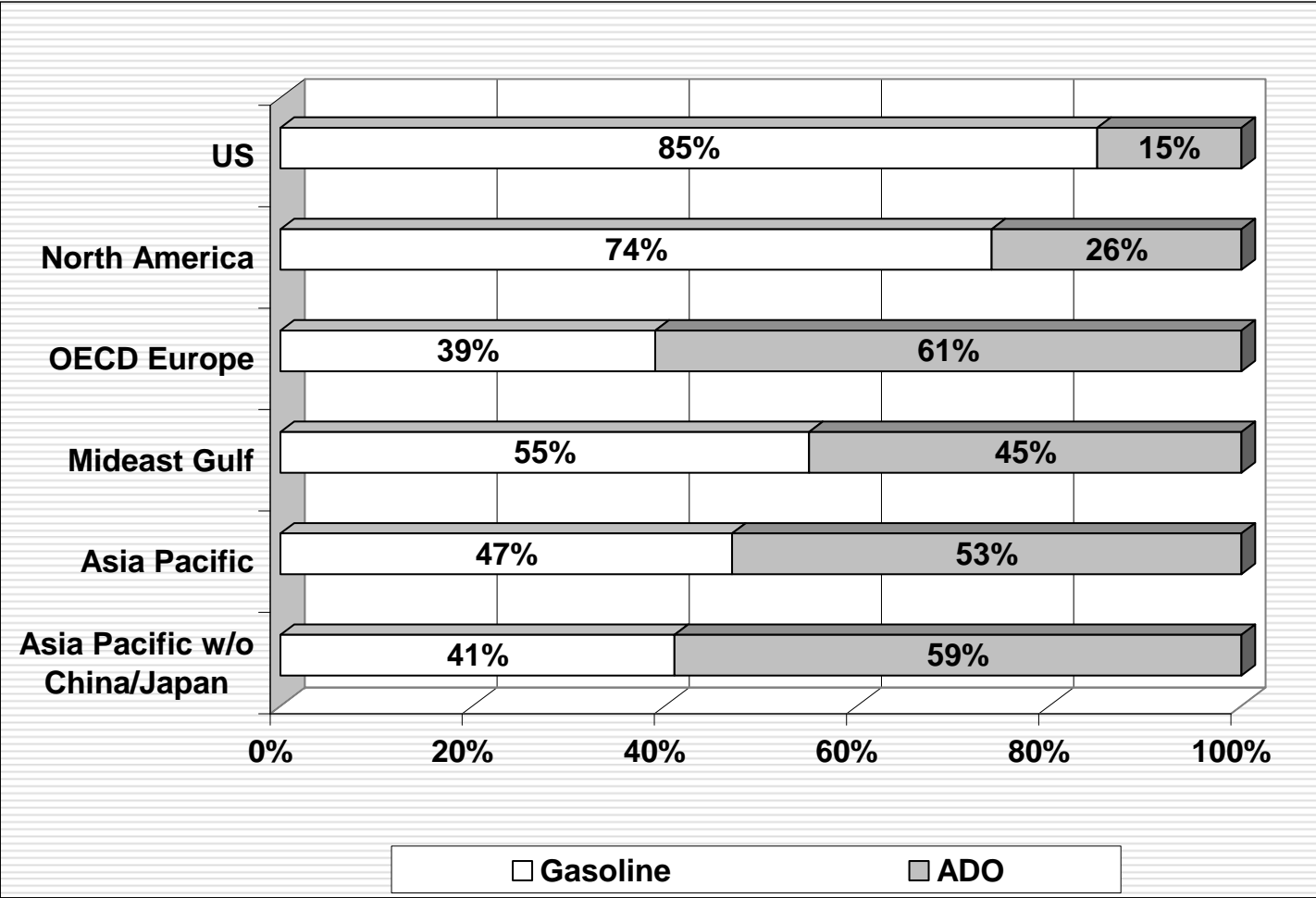
Transport Use of Gas Oil – Asia Pacific Largest User of Non-Transport Gas Oil



Yet Very Different Focus on Land Transport Fuels

- **North America:** Gasoline dominant; In US, nearly half of total oil use, more than two-thirds of road fuel.
- **OECD/EU:** A Mirror-Inverse Image - Diesel dominant
- **Northern vs. Southern Europe Divide:** Germany vs. Italy
- **Mideast Gulf:** Gasoline dominant and growing proportion
- **Asia Pacific:** Road Diesel dominates; China/Japan traditional exceptions

Gasoline Vs. ADO Use



Land Transport Fuel Balances – 2006/1

	Demand	Net-Export (Net-Import)
NORTH AMERICA		
Gasoline	10,929	(1,135)
ADO	3,674	190
<i>Of which: US</i>		
Gasoline	9,492	(922)
ADO	3,210	150
EUROPE		
Gasoline	2,546	902
ADO	4,680	(600)

Note: Finished gasoline only; ADO includes finished product, even if blended. Net-Import/Net-Export excludes intra-regional trade.

Land Transport Fuel Balances – 2006/2

	Demand	Net-Export (Net-Import)
MIDEAST GULF		
Gasoline	1,193	(250)
ADO	906	350
ASIA PACIFIC		
Gasoline	3,966	150
ADO	4,297	100

Trade Patterns/US

- US a large finished gasoline net importer (nearly 1 MM B/D); imports still rising.
- USWC (PADD-5) remains semi-isolated, from Asia Pacific and rest of US.
- Imports favor components over finished gasoline.
- MTBE phase-out further fragmented gasoline spec; *boutique* quality standards.
- Europe and Venezuela main gasoline supply sources; India emerging
- Exports in two directions – higher-quality ADO to Europe; general gas oil to Latin America, Africa.
- While overall gas oil exports strong, net importer low-sulfur gas oil; exporter of high-sulfur gas oil.

Trade Patterns/Europe

- Steady decline of gasoline demand since 2002
- Excess gasoline mainly to the US
- Nearly half of US gasoline and component imports
- Tightening specs make finished ADO difficult to import
- General gas oil imported as blendstock; desulfurized
- Mideast Gulf ADO/gasoline minimal (< 10 MBD)
- Russian supply rises; Problems meeting 0.1%S heating gas oil (1/2008)

Trade Patterns/Mideast Gulf

- Net regional importer of gasoline (nearly 200 MBD)
- Export avails depend on Iran; India main supplier
- Condensate splitters plug gap before new refineries
- Gas oil exports over 500 MBD; ADO overhang much less
- Asia Pacific takes most gasoline, gas oil and ADO; Singapore blending
- Quality constraints beginning to handicap even Asia-Pacific sales (ADO- S%; gasoline – aromatics/benzene)
- Demand growth prompted by price controls (gasoline up 24%; ADO Up 19% for 2003-2006).

Trade Patterns/Asia Pacific

- Steady overall demand growth (>1.9 MM B/D for 2003-2006)
- China increasingly leads, half or more, of Asia-Pacific demand growth.
- Traditional buyer Mideast Gulf product; Asia-Pacific quality concerns growing
- Despite attention on gasoline, China shifting to ADO; half of gas oil use in 2006
- Huge range of product quality; focus on improving ADO
- Will compete with EU on bidding for top-quality ADO
- India emerging as major gasoline, ADO exporter
- USWC trade minimal (> total 350 MBD); Expect upsurge USWC/USGC

Diesel Vs. Gasoline in Land Transport/1

- Gasoline and diesel/ADO make up the overwhelming majority of road fuels used worldwide.
- Diesel is manufactured; gasoline is assembled (i.e. blended).
- Product quality will continue to improve; Spec-tightening pressures on both.
- Blending will increase for both fuels.
- Bio-diesel will have more impact than ethanol; Volumetric replacement vs. multiplier impact.
- Diverging specs making it harder to meet demand through finished product imports (US/MTBE; Europe/PAH caps in diesel).

Diesel Vs. Gasoline in Land Transport Use/2

- Price controls/retail subsidies encourage breakneck demand growth (Mideast Gulf; parts of Asia Pacific)
- Government tax/tariff policy can promote one fuel over another
- *Green concerns* create further supply obstacles (EU directive on *sustainable* biofuels).
- Renewable fuels will have impact by 2010; Alternative transport fuels further out.
- Ultimately refiners can produce greater volumes of high-quality ADO than gasoline.
- Transportation is the sector hardest to substitute for oil products.

The Coming of *Dieselization*? A Look at High-Price Era, 2003-2006

- **OECD Europe *Dieselizing*** : Gained 431 MBD ADO; Lost 262 MBD gasoline demand
- **US**: Gasoline's share of land transport fuel fell marginally from 76.1% in 2003 to 74.3% in 2006.
- **Mideast Gulf**: Gasoline demand growth averages above 7%, compared to 5.5% for ADO.
- **Asia-Pacific**: Incremental gasoline demand average 2.4%; ADO 3.9%.
- **Asia Pacific**: Lowest proportion of gas oil use in transport – vast scope for expansion

The China Card

- China traditionally attempted to suppress gas oil, in particular ADO, demand.
- Stupendous Chinese gasoline demand growth; Nearly 200 MBD for 2003-2006.
- China overtook Japan as top gasoline consumer in 2004.
- Yet little-noticed diesel demand grew faster – more than 300 MBD from 2003-2006.
- Chinese rail system overwhelmed; Shift of coal transport to road diesel
- In 2007, ADO likely to overtake gasoline; ADO half of all gas oil use.
- By 2008, ADO demand almost equal to France/Germany; Gasoline demand greater than France/Germany/UK.

China *Real* Demand

Product	2003	2006	Incremental Volume	PA Growth
Gasoline	989	1,178	189	19.1%
ADO	865	1,181	316	36.5%
General Gas Oil	1,134	1,224	90	7.9%

Tax/Tariff Scenarios “What if ...”

- US not only funded biofuels, but evened tax/tariff between gasoline/ADO?
- What if EU restricts biodiesel imports on *sustainability*?
- What if China lifted restrictions on ADO use?
- What if transport fuel prices in Mideast Gulf and most of Asia Pacific rose to world levels?

Selected Mideast Gulf Countries' Retail Gasoline Price – Regular Grade (Lowest Octane Sold as of mid-2006)

Country	\$/Liter	\$/Gal	Comments
Iran	0.12	0.47	As of mid-2007
Iraq	0.10	0.38	
Kuwait	0.09	0.34	
Oman	0.31	1.17	
Qatar	0.22	0.83	
Saudi Arabia	0.16	0.83	Prices reduced 5/2006 by a third; less costly 91 RON launched 1/2007.
UAE	0.45	1.70	Price rise of 31% in 9/2005; less costly 91 RON grade launched 10/2006.
Yemen	0.26	0.98	Price rise 85% in early 2005, then reduction of 20% after civil unrest.

Quality Issues - Gasoline

- **Primary Specs:** Octane, sulfur, aromatics/benzene and olefins
- US, EU have regional standards; Mideast Gulf/Asia Pacific none
- Yet increased fragmentation of gasoline specs (California)
- OECD Asia Pacific catching up with Atlantic Basin specs
- First MTBE phase-out; More with biofuels?
- Aromatics/benzene drawdown; Olefins caps limit refiner options.
- Leaded gasoline still used in Mideast Gulf and Asia Pacific.
- High-quality gasoline (octane) can still be low-quality (aromatics/benzene) in the Mideast Gulf.
- Rise in components trade in the Atlantic Basin; Export blending in Mideast Gulf/Asia Pacific.

Basic Gasoline Specs - 2007

Region	Unleaded				
	Octane RON	Sulfur Max %Wt.	RVP Max kPa @ 37.8C		Benzene Max % Vol.
			Summer	Winter	
US	87/92/95	0.003	7 PSI	7 PSI	0.97
EU	95	0.005	60	70	1
Abu Dhabi	91/95/96/98	0.035/0.035/0.001/0.035	60/60/30/60	70/70/50/70	1.0/3.0/1.0/3.5
Japan	89/96	0.005	65	93	1
Region	Aromatics	Olefins	MTBE	Ethanol	Oxygenates
	Max % Vol.				
US	25	8.5	banned	10	2
EU	35	18	allowed	5	2.7
Abu Dhabi	40/50/70/55	10/10/2/10	0/15/none/15	N/A	none
Japan	20-25	no limit		N/A	1.3

Quality Issues - Diesel

- Primary Specs: Sulfur, aromatics/PAH, cetane value
- Eurospec generally leads
- Japan ADO specs exceed US; In some ways better than Eurospecs.
- Triple witching hour for Eurospec (S%, PAH cap, cetane increase); Asia Pacific following.
- Substantial volumes of lower-quality general gas oil needed still in Asia Pacific.
- Sulfur and aromatics/PAH removal mechanical; Cetane depends on feedstock.
- EU already is short high-quality blendstock.

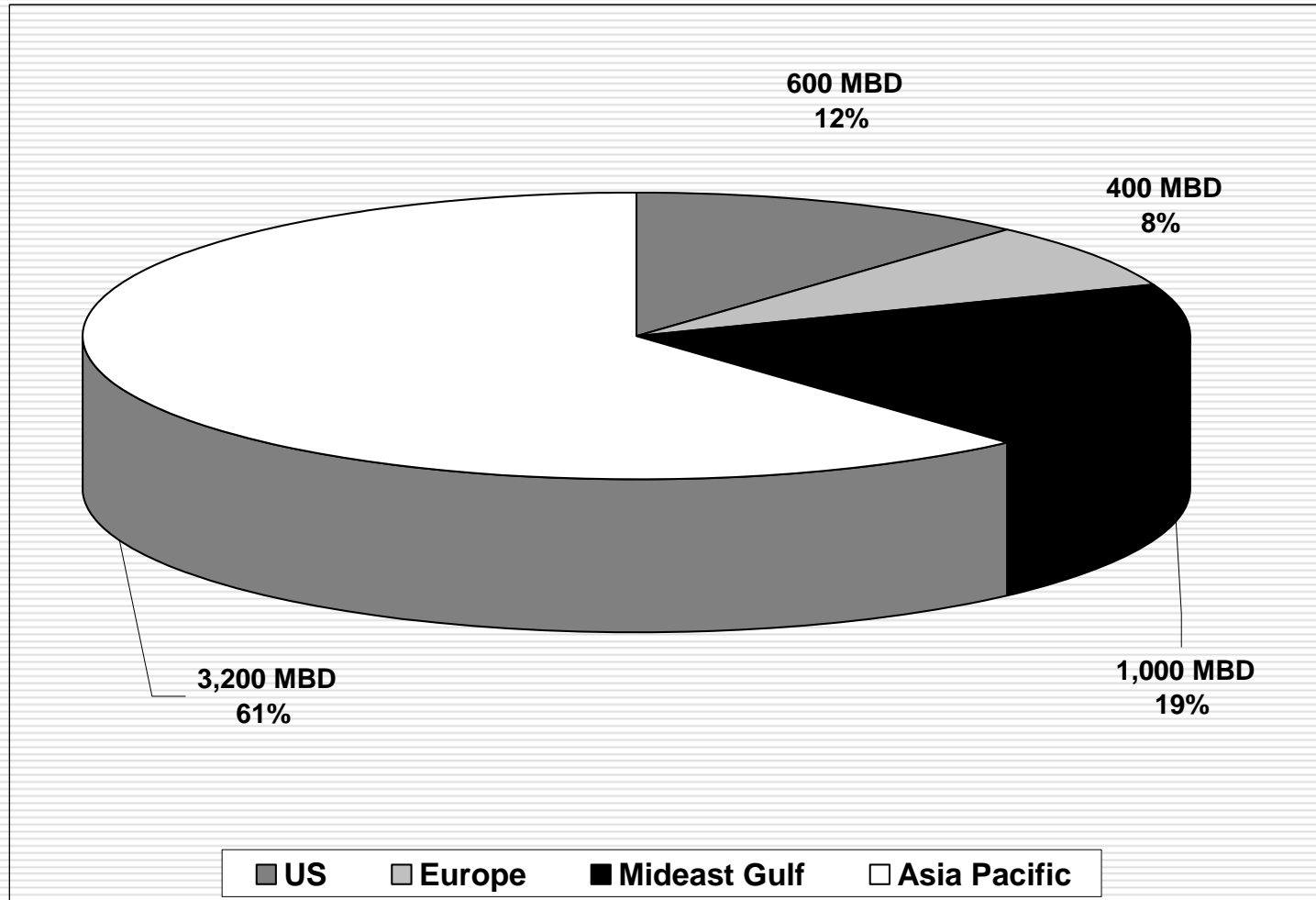
Basic ADO Specs - 2007

	Automotive Diesel (ADO)					Poly Aromatics
	Sulfur	Min. Cetane	Density			
	Max. % Wt.	Index	KG/LTR @ 15C	T90 (Deg C)	T95 (Deg C)	PAH% _m
US	0.0015	40	N/A	N/A	N/A	AH: 35
EU	0.005	51	0.845		360	11
Qatar	0.05	50	0.820-0.850	338		2
Japan	0.001	52	max 0.8757	< 360		11

A Summary of Incremental Refining Capacity by 2010

- **US:** Moderate volume additions; Focus base capacity, gasoline
- **Europe:** Minimal volume base capacity; Focus gas oil/ADO desulfurization.
- **Mideast Gulf:** Expansion existing plant; New grassroots capacity generally post-2012.
- **Asia Pacific:** Adding the most base capacity; Considerable intermediate/severe secondary capacity.
- **China/India:** Will make up more than three-quarters of Asia-Pacific incremental base capacity.

Incremental Base Refining Capacity from mid-2007 through 1/2010



Focus: Mideast Gulf Export Avails/1

- Delays in building grassroots refining capacity as well as units focused on improving gasoline quality will keep exports of finished gasoline to Europe and the US to a minimum (30 MBD or less) through 2010. Most gasoline will move to Asia Pacific.
- Yet Kuwait, Qatar, Oman and the UAE will increase their sales of reformat and other gasoline components, possibly to as much as 80 MBD by 2010, supported by increased reforming capacity and the startup of added condensate splitting capacity.
- While there are a number of high-octane gasoline grades in the Mideast Gulf, aromatics, particularly benzene, and sulfur, exceed Atlantic Basin ceilings. Singapore upgrades Mideast Gulf gasoline imports. The startup of grassroots plants will improve gasoline quality post-2010.

Focus: Mideast Gulf Export Avails/2

- Iran remains the key to Mideast gasoline exports. If Tehran's resolve to rein in runaway demand weakens, as it appears to have by early 2008, then Iran will continue to absorb most export avails.
- Gas oil exports will rise steadily through 2010; ADO exports will outpace general gas oil. Asia Pacific remains the main export market for both.
- A growing number of exporters regularly could produce 0.05 S% ADO (500 PPM) by 2007, including Bahrain, Kuwait, Qatar, Oman and the UAE. Yet 100 PPM and 50 PPM sulfur ADO will only be exported in a regular way by 2010-2011, from Kuwait and Qatar in volume.
- We see the Eurospec region only increasing imports of ADO from the Mideast Gulf in a limited fashion.

Mideast Gulf Transport Fuels Export Avails

Product	2007	2008	2009	2010
Gasoline	(105)	98	163	240
Gas Oil	593	662	674	700
<i>Of which:</i> <i>ADO</i>	350	395	410	440

Biofuels and Their Impact on Transport Fuels

- **Biofuels Green?** EU ponders the point – *Sustainable ADO?* 10% transport by 2020; Cellulosic biodiesel>
- **Ethanol:** A volumetric replacement; Doesn't expand gasoline pool, doesn't improve quality.
- **Biodiesel:** A supply multiplier, by rescuing general gas oil barrels; Cetane boost key to ADO.
- **Waiting:** Cellulosic gasoline/ADO at least three years away.
- **Grandiose:** US target of 379 MBD of ethanol by 2022; Ethanol impact only modest. Little attention to biodiesel.
- **Rest of World:** Ethanol will have minimal impact (Europe less than 15 MBD Brazilian ethanol imports 2007), but biodiesel could change gas oil blending.

Demand Assumptions/Short-Term

- **Overall Demand:** IEA 1.7 MM B/D gain in 2008; EIA/DOE estimate of 1.4 MM B/D; APEC 1.2-1.4 MM/BD
- **US:** Marginal gasoline demand growth; Static to declining ADO
- **Europe:** Accelerating decline in gasoline demand; Modest decline in ADO.
- **Mideast Gulf:** Continued strong growth for both gasoline and ADO.
- **Asia Pacific:** Slowing gasoline growth, depending on China; slower but more substantial ADO growth.

World Finished Products Demand Forecast – 2010/1

	2006	2008	2010
NORTH AMERICA			
Gasoline Demand	10,929	11,120	11,340
Gasoline Surplus (Deficit)	(1,135)	(1,100)	(870)
ADO Demand	3,674	4,200	4,300
ADO Surplus (Deficit)	190	120	180
EUROPE			
Gasoline Demand	2,546	2,430	2,334
Gasoline Surplus (Deficit)	902	1,000	1,200
ADO Demand	4,680	4,821	4,937
ADO Surplus (Deficit)	(600)	(710)	(750)

World Finished Products Demand Forecast – 2010/2

	2006	2008	2010
MIDEAST GULF			
Gasoline Demand	1,193	1,368	1,545
Gasoline Surplus (Deficit)	(250)	(120)	(200)
ADO Demand	906	1,003	1,101
ADO Surplus (Deficit)	350	380	500
ASIA PACIFIC			
Gasoline Demand	3,966	4,210	4,505
Gasoline Surplus (Deficit)	150	250	300
ADO Demand	4,297	4,780	5,190
ADO Surplus (Deficit)	100	150	250

Conclusions/Direct Impacts on US

- US structurally dependent on gasoline imports
- US dependence even greater on gasoline imports – and will grow
- Traditional gasoline sources not enough; Turning to India?
- Greater US dependence on gasoline imports has national security dimension.
- Added refining capacity planned by 2010 will not eliminate the need for imports.
- The US is partially isolated in transport fuels by dependence on gasoline, lagging quality standards.

Conclusions/Longer-Term Implications for US Transport Fuels Policy

- Jumble of *boutique product specifications* must be standardized.
- California's right to mandate fuel quality continues PADD V isolation.
- Coordinate OECD product quality changes through IEA to spur products arbitrage.
- Reduce tariff walls to encourage biofuel imports.
- Accelerate research cellulosic biofuels
- Even out tax/tariff between gasoline and diesel to ease gasoline short.

Conclusions/The Future of Global Transport Fuels

- Near-term demand growth in Atlantic Basin will slow.
- The Mideast Gulf and Asia Pacific will continue steady expansion, though Asia will slow its rate of increase.
- The key product that will move between Europe, the Mideast Gulf and Asia Pacific will be gas oil/ADO.
- Europe will be structurally short of high-quality ADO; refinery investment is too limited and the Mideast Gulf will not make a difference through 2010-2011.
- The EU is painting itself further into a corner by mandating 10% biofuels and then dictating *sustainable* biofuels.
- Quality will increasingly dictate price differentials between ADO and general gas oil as well as various grades of ADO.
- Europe will likely outbid Asia Pacific for limited high-quality ADO through 2010; Asia's continued economic growth will draw an ever larger proportion of high-quality product east.