



# Alternatives uses for natural gas and the impacts it will have on the Israeli chemical industry

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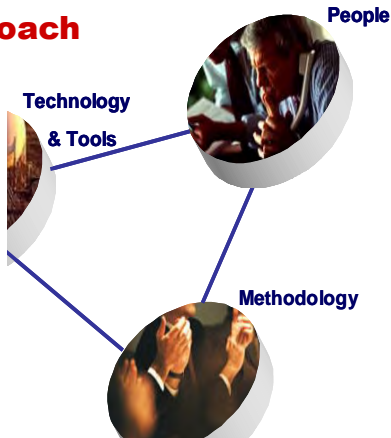
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## KBC Office Locations



- Net Revenues: £53 million in 2010.
- Provide Independent, Objective Advice
- About 300 employees worldwide. KBC has established global non-exclusive collaboration agreements with leading engineering contractors
- Enhance Capital & Asset Effectiveness
- KBC is continuously expanding its competencies through targeted acquisitions and alliances
- Improve Operational Performance and increase Competitive Advantage
- Clients include worldwide leading companies in the oil & gas, refining, petrochemical, and other process industries as well as governments.
- Meet Individual Client Needs with Consulting, Implementation & Technology

## KBC Approach



- A reversal of fortune for the international gas industry in terms of demand recovery for 2010. Demand drop in 2009 will prove an aberration.
- Increase in World LNG demand in 2010 by 12%
- Shale gas remains a game changer in the US and possibly in other parts of the world.
  - e.g. China, Argentina and Poland
- Seems clear that coming years will continue to see ample US supply pressing on US Henry Hub prices in a fully competitive market.
- In Europe, 2010 saw potentially defining moves to shift pricing from oil linkages to hub based indexation.
- But gas pricing will remain regionally based for sometime.

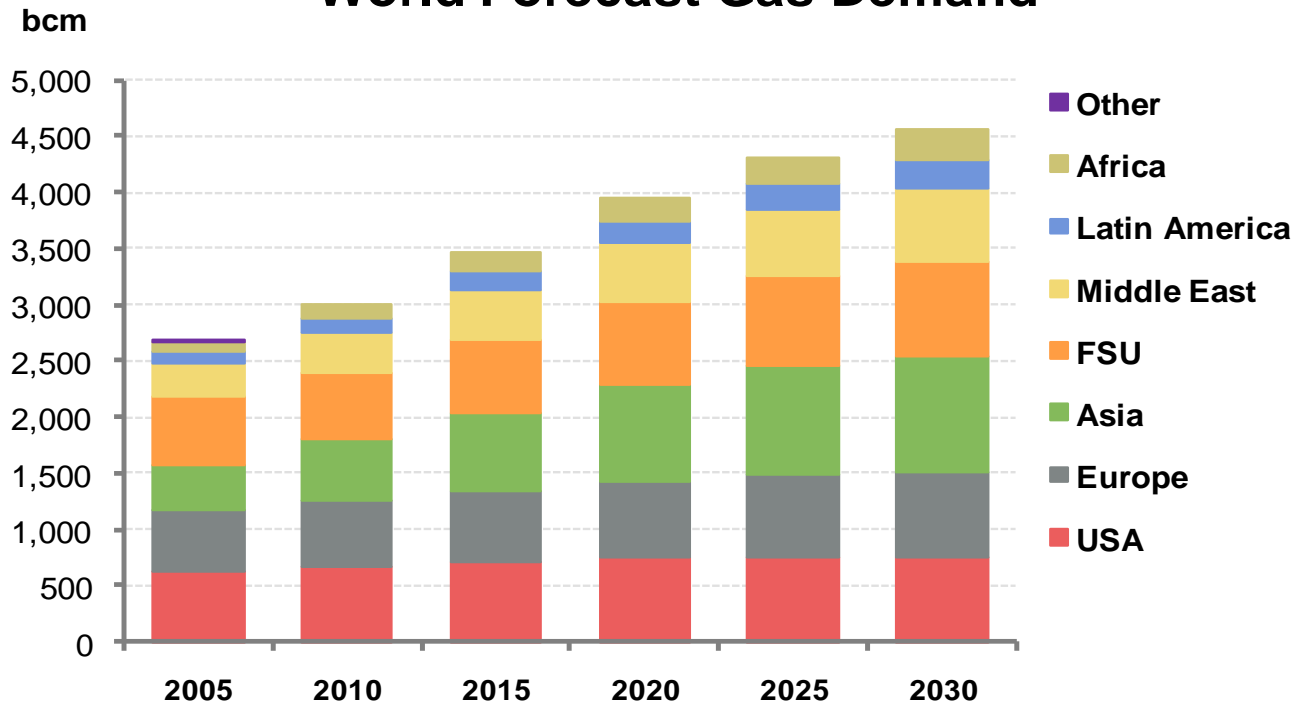
## World - Annual Changes in Natural Gas Demand

%	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
<b>USA</b>	-4.6	-0.2	-3.1	0.6	-1.2	-0.7	5.8	0.4	-1.6	5.5
<b>Europe</b>	2.6	0.4	4.4	2.6	2.2	0.3	0.5	2.5	-6.2	6.8
<b>FSU</b>	1.7	0.3	5.0	1.2	1.8	3.8	1.2	0.6	-11.7	5.0
<b>Latin America</b>	0.4	1.8	3.2	6.9	4.6	4.0	2.5	2.3	-4.3	6.0
<b>Africa</b>	7.5	6.4	7.7	6.5	3.2	9.0	6.6	16.7	3.3	5.0
<b>Middle East</b>	3.1	9.3	11.2	10.3	7.9	3.7	3.5	5.6	4.2	4.1
<b>Asia</b>	4.9	6.1	2.6	5.6	6.5	5.7	6.7	5.5	1.5	12.2
<b>Other</b>	-4.3	4.5	4.2	-2.1	-1.3	7.8	2.5	0.3	-9.3	1.6
<b>WORLD</b>	<b>0.4</b>	<b>2.1</b>	<b>3.0</b>	<b>3.0</b>	<b>2.4</b>	<b>2.8</b>	<b>3.4</b>	<b>2.8</b>	<b>-3.8</b>	<b>6.4</b>

- Growth was apparent in all major markets but notably the USA, Asia and Europe.
- World demand in 2010, 3160 billion cu meters – around 53 million b/d o.e.
- Basis of growth remains essentially for power generation in CCGT's competing in developed markets with coal and in developing markets with oil and coal.

# Outlook for Gas Demand Remains Bullish

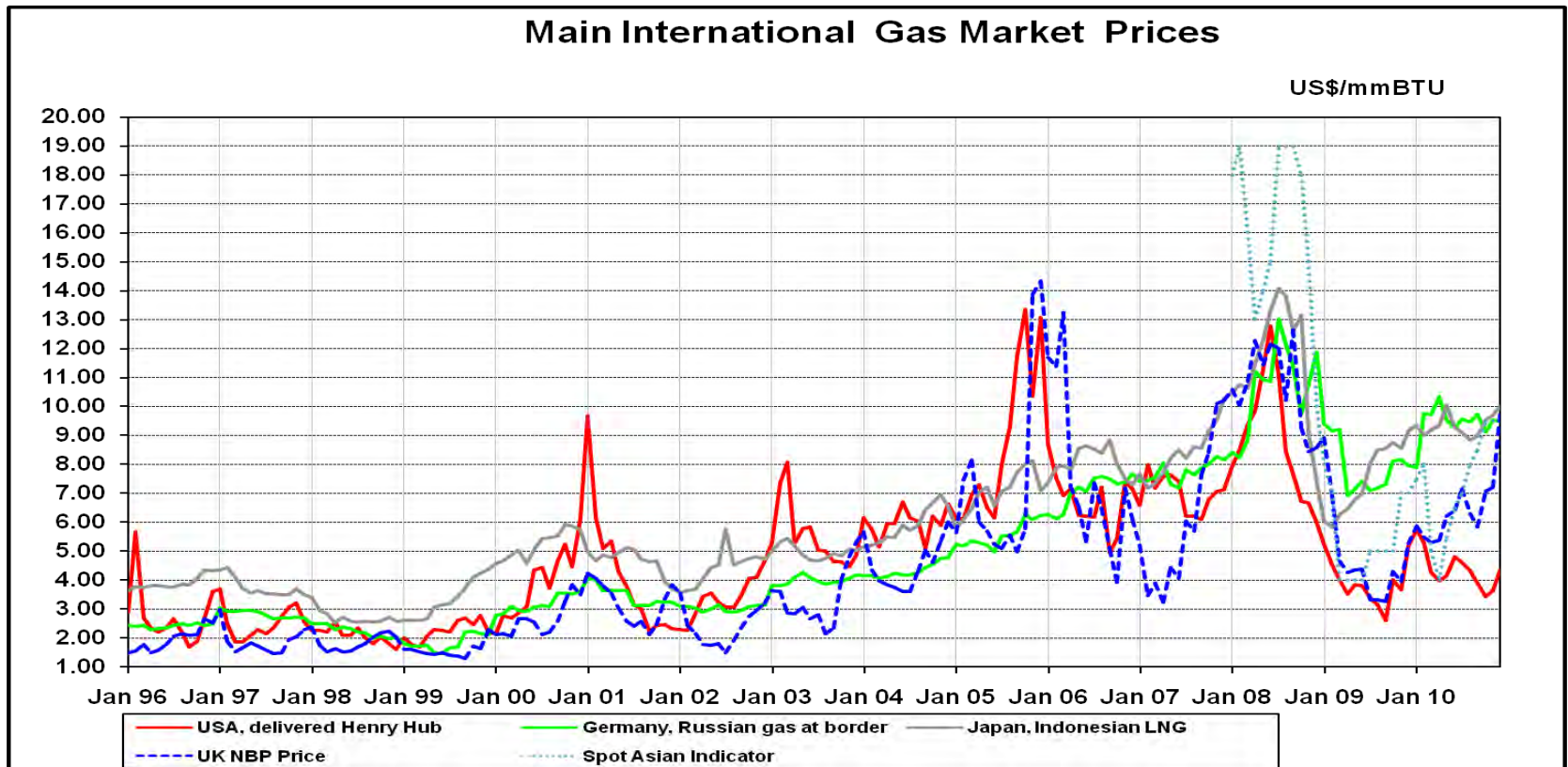
## World Forecast Gas Demand



- Gas is not the fuel of the future – it is the fuel of today. Demand growth will be buoyant and sustained; renewables can only have a limited global role given the scale of rising energy demand; gas often needed as back-up to renewables.
- The volumetric growth is massive – 1,500 billion cu metres by 2030.

- LNG supply overhang characterised 2010 and weaker spot prices apparent.  
....even before events in Japan, market was set to re-balance mid decade; this may come sooner.
- Liquefaction Capacity looks likely to attain some 475 bcm by 2015, from around 350 bcm currently. But demand will be moving towards this.
- Key to LNG balance and prices late decade will be extent of realisation of a large number of Australian planned projects with FIDs in 2011.
- Regasification plans in many countries.
  - e.g. China, India, Brazil, Canada, Mexico, Albania, Italy, Netherlands, Poland and Spain to name a few.
  - Unlikely for all to be fully utilised but yield a degree of security and negotiating position.

# Little Sign of Gas Price Convergence



- In 2009 the divide was manifest between prices in regions with oil indexation and those with gas-to-gas competition.
- 2010 saw recovery in spot prices (NW Europe and Asia) but US totally de-linked due to shale gas impact.

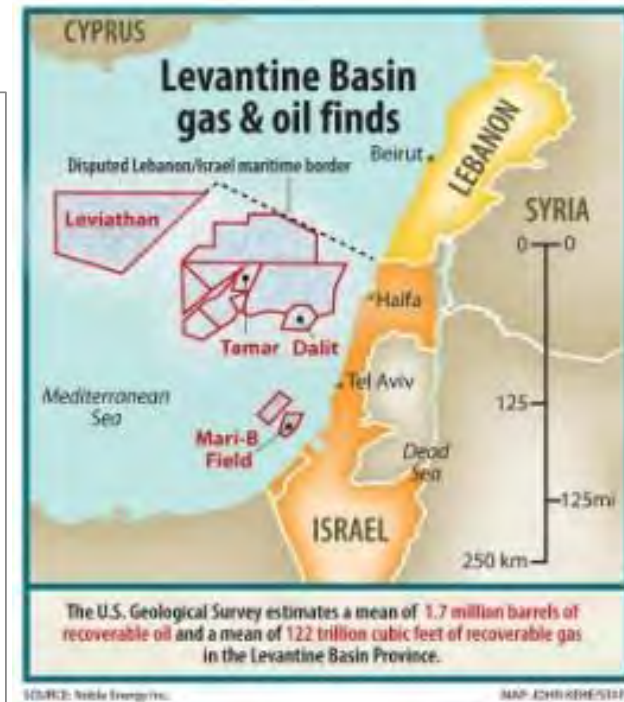
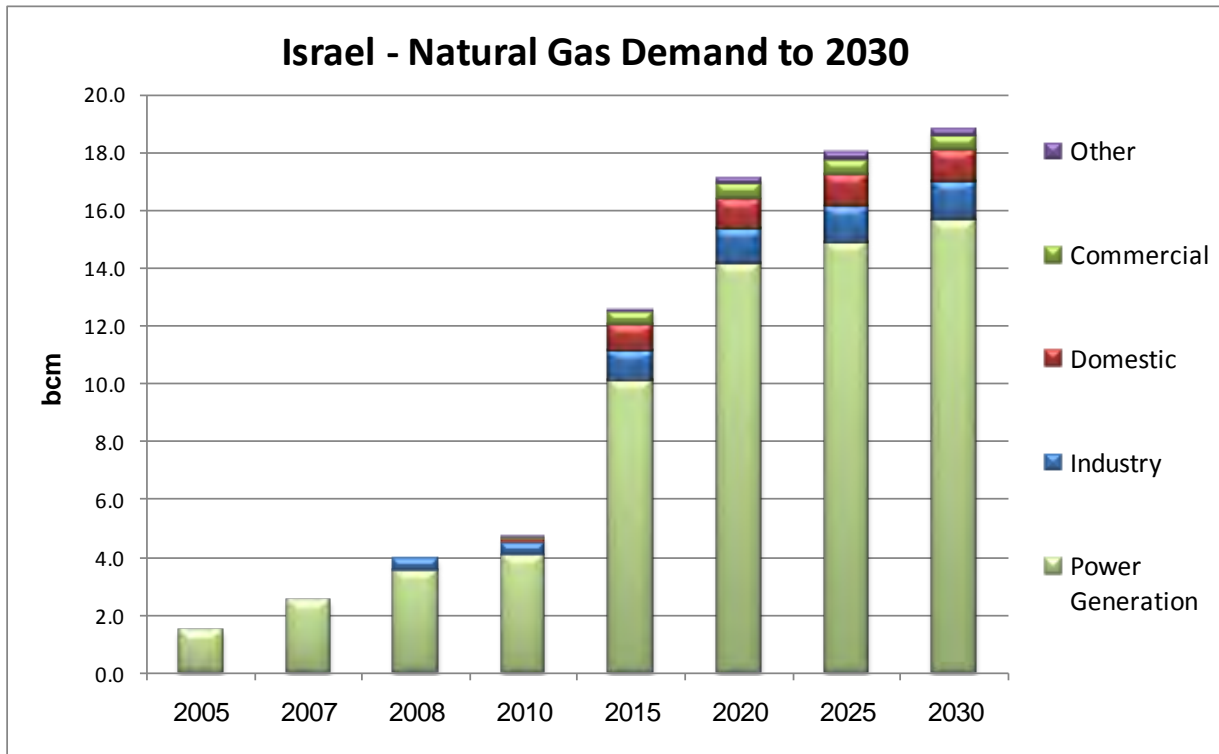
# Pricing Outside Major International Markets



- In other regions around the world gas prices reflect local circumstances; they are generally not competitive markets nor exposed to necessary import parity pricing.
- In the Middle East prices for ample otherwise flared associated gas have been kept very low - \$1-\$1.50 million BTU – but upward price pressures apparent.
- Netback value from LNG exports is pushing prices higher; as is need to cover higher costs of non associated gas or import LNG – Dubai.
- FSU gas prices have traditionally been kept very low emanating in the principles adopted in former Soviet times when gas was notoriously almost given away.
- Recent years have seen moves to lift prices towards international levels – a difficult task from a set of base prices around the turn of this decade somewhere in the \$1-\$1.50/million BTU range, and given the moving target of international prices as they peaked in 2008 at some \$15/million BTU.
- Latin America and Africa have their own ‘local considerations’

- Overhang in the market will dissipate in next year or two; but US import expectations of last decade are in tatters – LNG exports under consideration now.
- US gas prices will remain weak for sometime.
- Jury out on quite how dramatic shale gas revolution may be – huge potential, but environmental issue to overcome.
- In Europe the pressure on gas sellers to relent with oil indexation in long-shift from oil linked contracts will be intense.
- In Asia there is a genuine gas/oil competitive interface which should support oil indexation as long as producers are prudent not to flood the market.
- Fully competitive markets are likely to generate prices broadly around those from oil indexation. Indeed full value of gas could support even higher prices – long term possibilities of gas as a transport fuel.
- Needs to meet massive demand growth mean that supply cost base has to be covered.

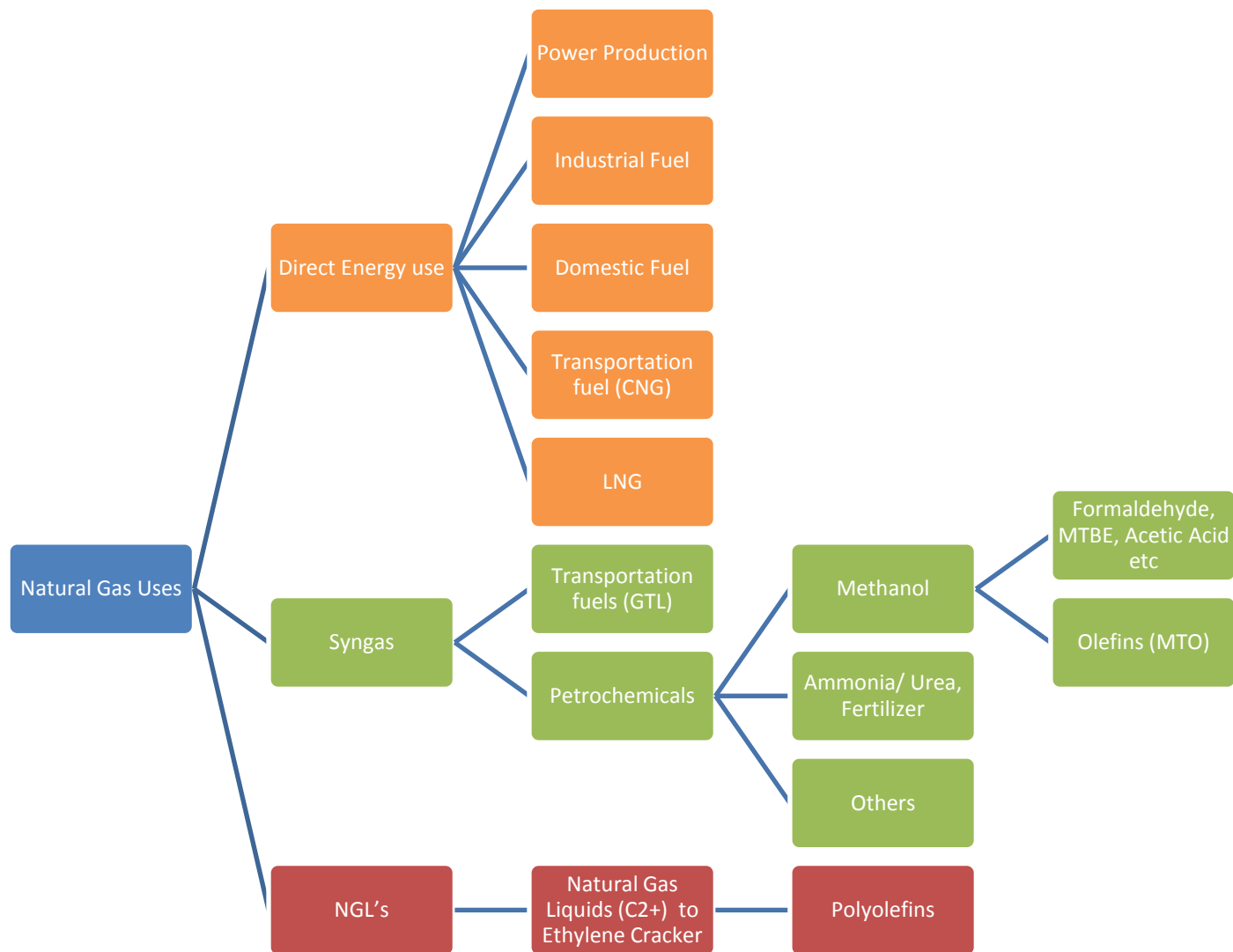
- Israel NG reserves estimated ~ 26 tcf (0.7 tcm)
- 37 years at 2030 forecast demand rate



# Uses of Natural Gas



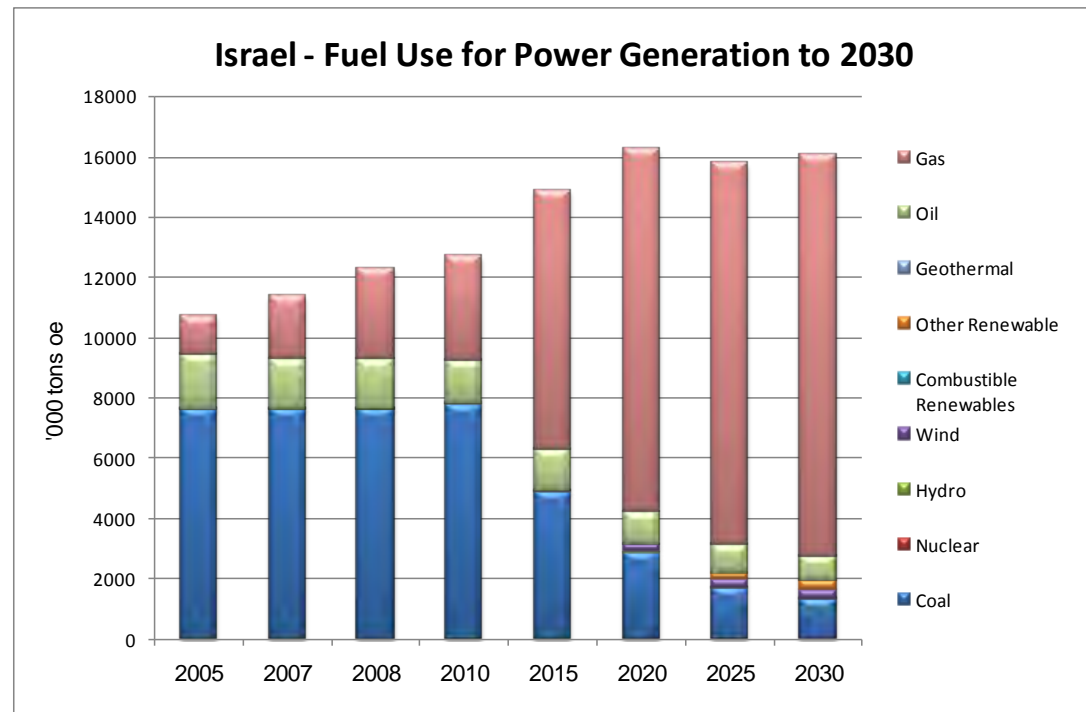
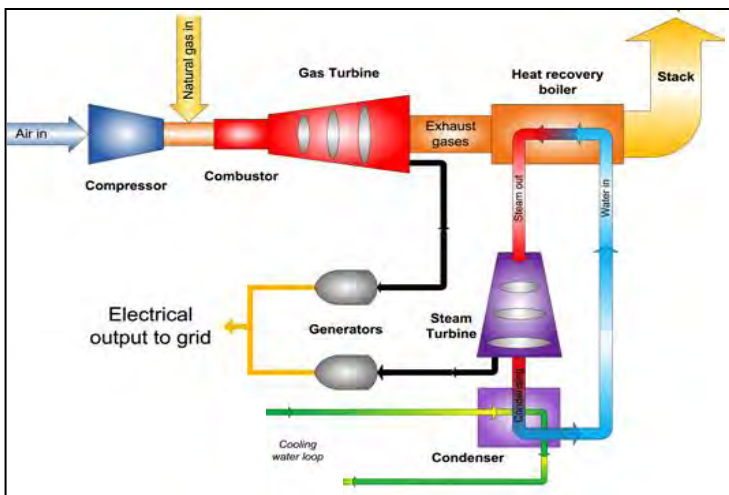
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# NG for Power Generation

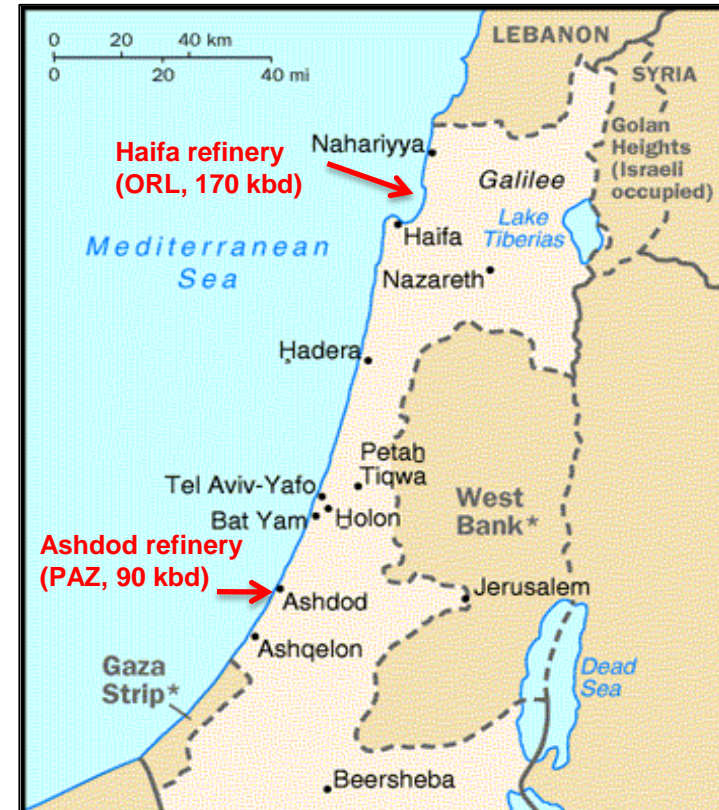
- NG can be burnt in Gas Turbines for power production
  - Combined cycle has relatively high thermal efficiency 50 – 60%
    - Conventional coal fired ~35% efficiency
  - Environmental benefits from low emissions compared to coal and fuel oil (SO<sub>x</sub> and CO<sub>2</sub>)
  - Capex ~ \$ 1200/kW (coal fired plant ~ \$ 2500/kW)
- Some power companies agreed in Dec '10 to 20 y r NG contract with EMG (Egyptian gas)

Price 2010, NWE	
\$/MMBTU	
NG	9.0
Coal	4.5

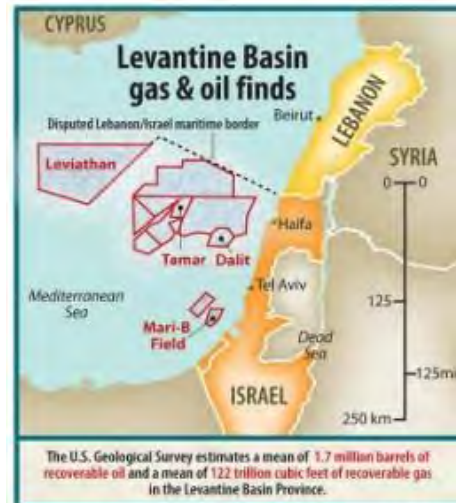


# Use NG in Refineries

- Use as refinery fuel (power, steam, process furnaces)
  - Replaces fuel oil, LPG and distillates which are more valuable sales products
  - Reduced emissions (SOx and CO<sub>2</sub>)
- Hydrogen Plant feed
  - Can replace more valuable naphtha and LPG
    - But Haifa/Ashdod do not have H'Ps yet
- Both refineries now connected to National NG transmission system
- ORL agr eedin Dec ' 10 to 20 yr NG contract with EMG (Egypt) to supply refinery and Petrochemicals



Source: www.geography.about.com



SOURCE: Noble Energy/IN. MAP: JCHR/KEH/SIEFF

	Price 2010, NWE	
	\$/MMBTU	S/bbl
Natural Gas	9.0	
LPG	15.0	55.59
Naphtha	16.7	78.89
Distillate	16.2	89.01
Fuel Oil 1%S	12.1	73.49
Fuel Oil 3.5%S	11.5	71.45

- Benefit 5 – 10 \$/MMBTU

# CNG for Transport Fuel

- Compressed NG can be used as transport fuel
  - Gasoline engines can be converted to run on CNG (bi-fuel cars)
- Environmental advantages compared to liquid fossil fuels
  - Lower emissions (particulates, SOx, CO<sub>2</sub> etc)
- Larger storage volume required
  - CNG has 25% volumetric energy density of diesel so lower journey distance per fill
  - Stored in cylinders (steel or aluminium)
- Example – Delhi Transport Corporation
  - Operates worlds largest fleet of CNG buses ~ 3000
  - Entire Public City bus fleet converted to CNG by end 2002
  - Legislation forced the change
  - Objective was pollution reduction but is cheaper fuel
    - Investment in CNG infrastructure required
  - Many private taxis, autorickshaws and minibuses in Delhi now run on CNG

COUNTRY	NG Vehicle Population, 2010
Pakistan	2,740,000
Iran	1,954,925
Argentina	1,901,116
Brazil	1,664,847
India	1,080,000
Italy	730,000
China	450,000
Colombia	340,000
Thailand	218,459
Ukraine	200,000
Others	1,395,055
<b>Total</b>	<b>12,674,402</b>

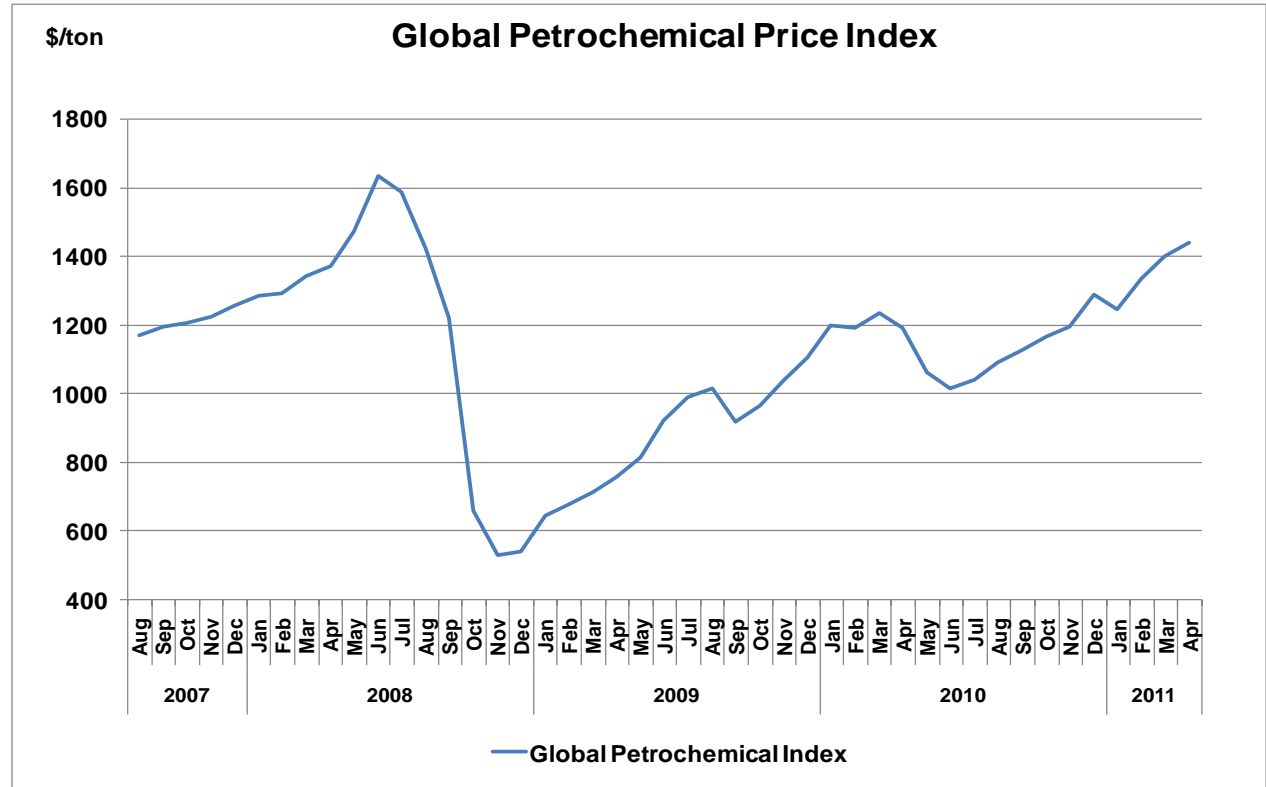
Source: NGV Global

- 11.6% growth compared to 2009

	Price 2010, NWE	
	\$/MMBTU	\$/bbl
Natural Gas	9.0	
LPG	15.0	55.59
Gasoline	17.2	85.99
Diesel	16.2	89.01

# Petrochemical Differentials/prices are Improving

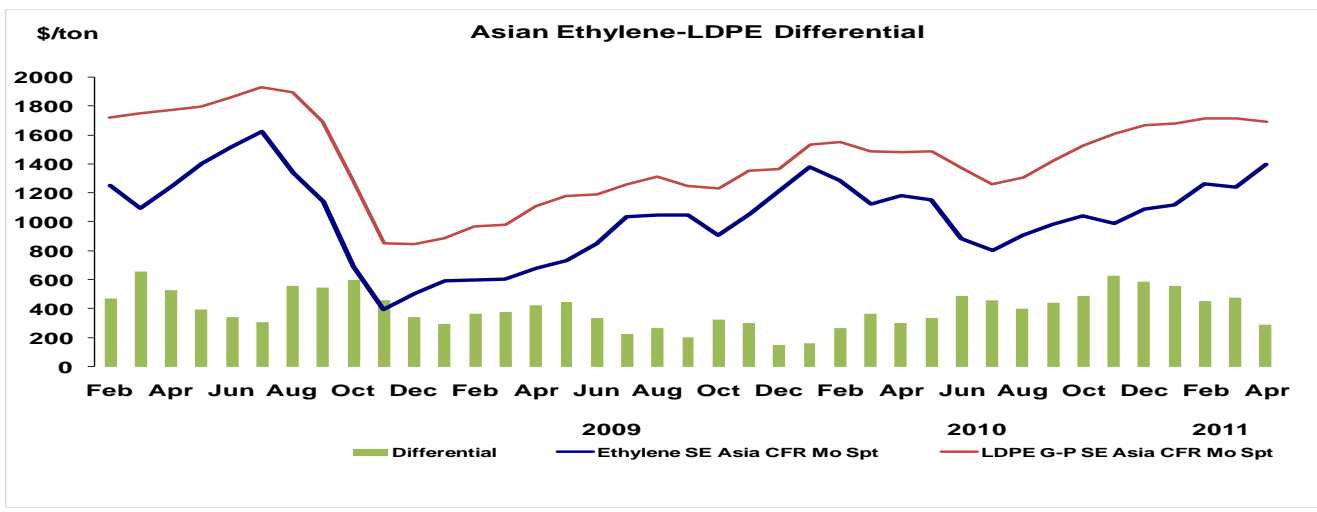
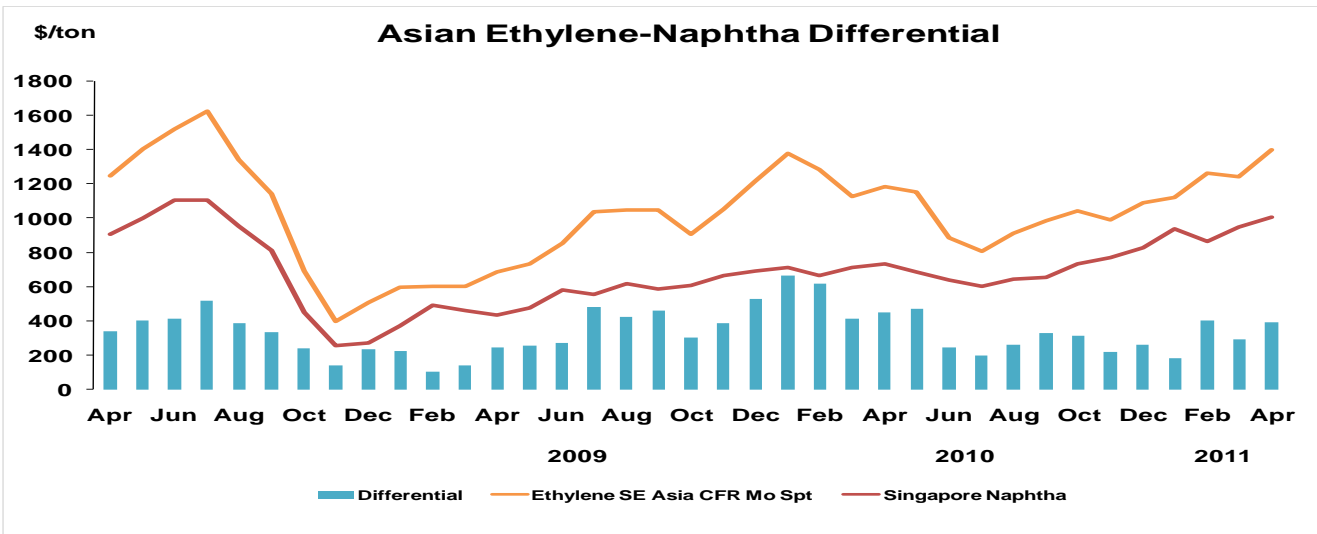
- This year global the petrochemical index continues to improve month on month
- This strength continues to be led by Asia.
- Despite problems in Japan
- Differentials remain in a healthy state.....



# Despite high crude and feedstock prices, differentials further down the chain still healthy



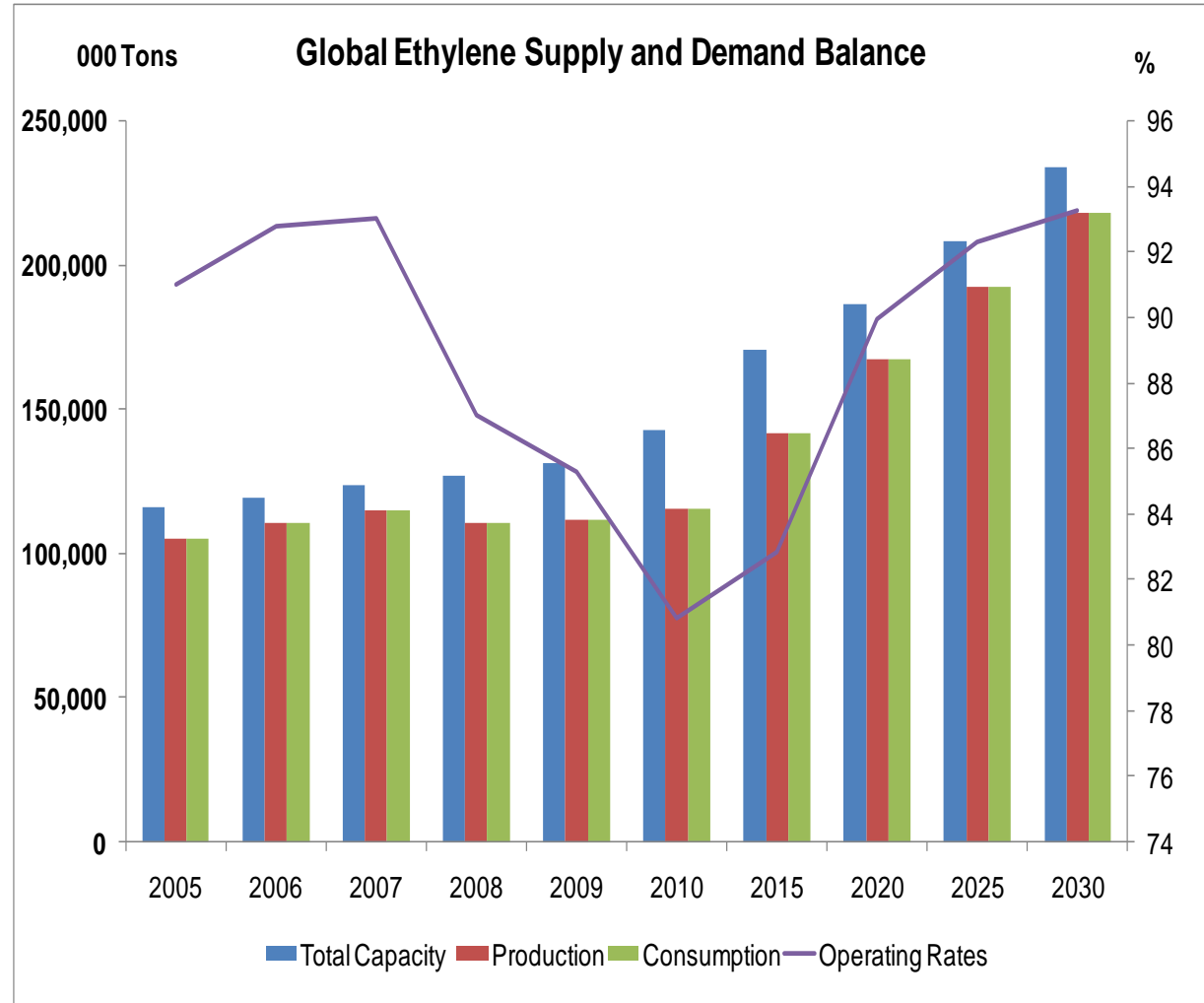
- The first half of 2010 showed strong recovery prices and margins for end 2008/2009.
- Mainly led by rapid recovery and growth in Chinese demand,
- Despite mid-2010 lull due to Chinese demand cooling off, differentials again improved by the end of 2010.
- Upward momentum has carried on into 2011



- The Global Economy is in fragile state
  - Ethylene demand growth correlates well with GDP
  - Supply growth will outpace demand increases
  - Operating rates were in decline
  - Ethylene prices and cracker margins will be in "rough" until 2011
  - Asia outperforming other regions
- Largest volume petrochemical - global consumption ~115 mm tpa
    - Representative of the industry and its main driving force
      - Particularly regarding margins over the "petrochemical cycle"
    - Only ~1% traded between regions due to high costs of cryogenic liquid shipping
    - Most Europe, (regions Asia... (based primarily on naphtha feed, though anything from ethane through heavy gas oil can be used
    - Global average feed getting lighter as many large new ethane crackers are added in the Middle East
    - Worldscale crackers now over 1 mm tpa, requiring over 3.2 mm tpa (~80,000 bpd) naphtha & costing over \$1 billion (
    - Almost 60% used in polyethylene production; also EDC/VCM/PVC, ethylene oxide/glycol, EB/styrene etc
    - Most capacity addition is in Middle East (feedstock advantage) and Asia (mainly China; driven by demand growth)
    - Global surpluses coming as massive additions in Saudi, Iran, China and Asia are completed

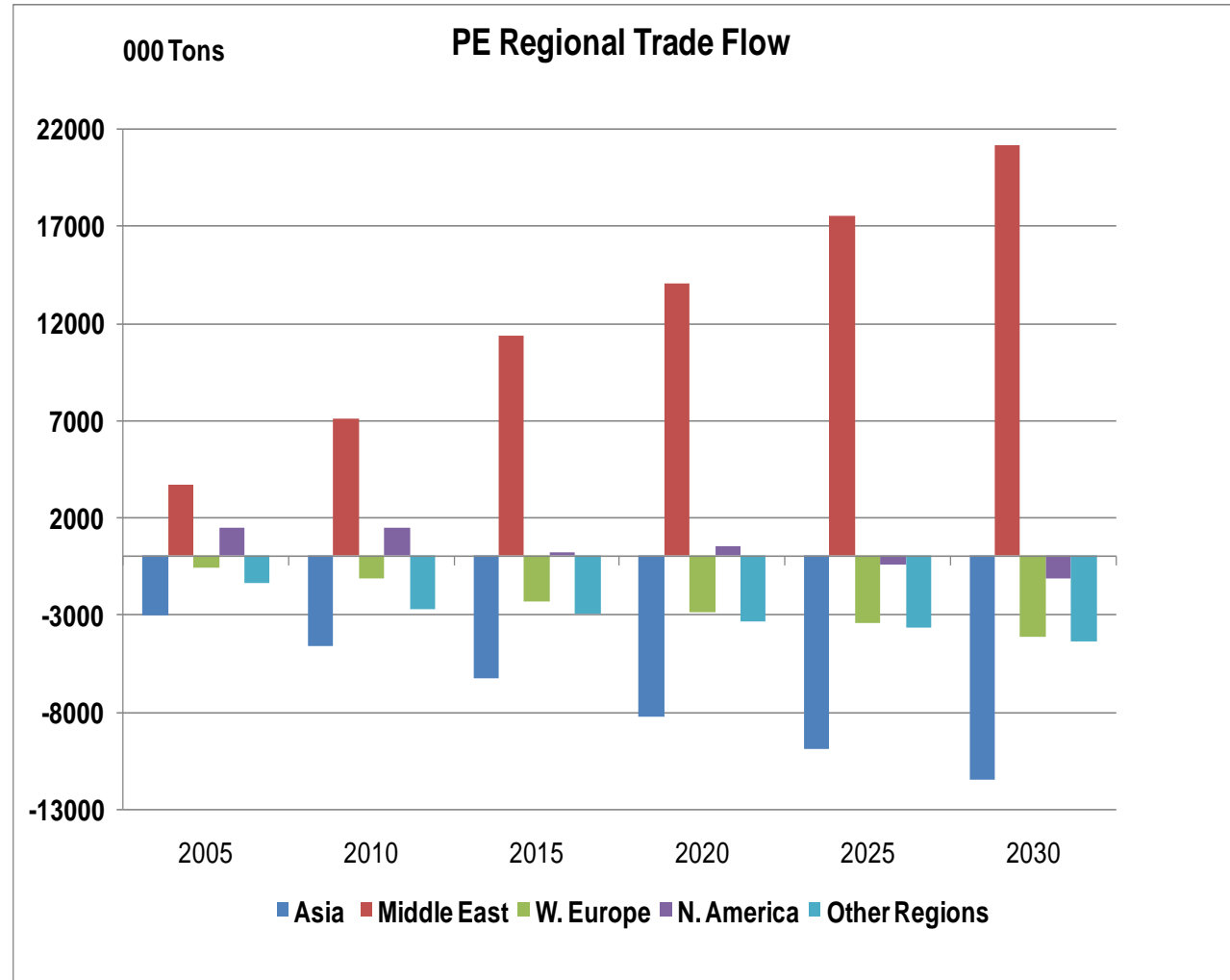
# Ethylene Outlook- Global

- Global Ethylene demand growth to average 4.1% pa in the next 5 years
- Longer term, demand growth to average around 3% pa



# PE Regional Trade Flow

- The Middle East will continue to add Ethylene capacity.
- Much of this ethylene will be shipped in PE form (Main derivative)
- Majority of exports will go to Asia, as region especially China will remain in deficit despite additional capacity



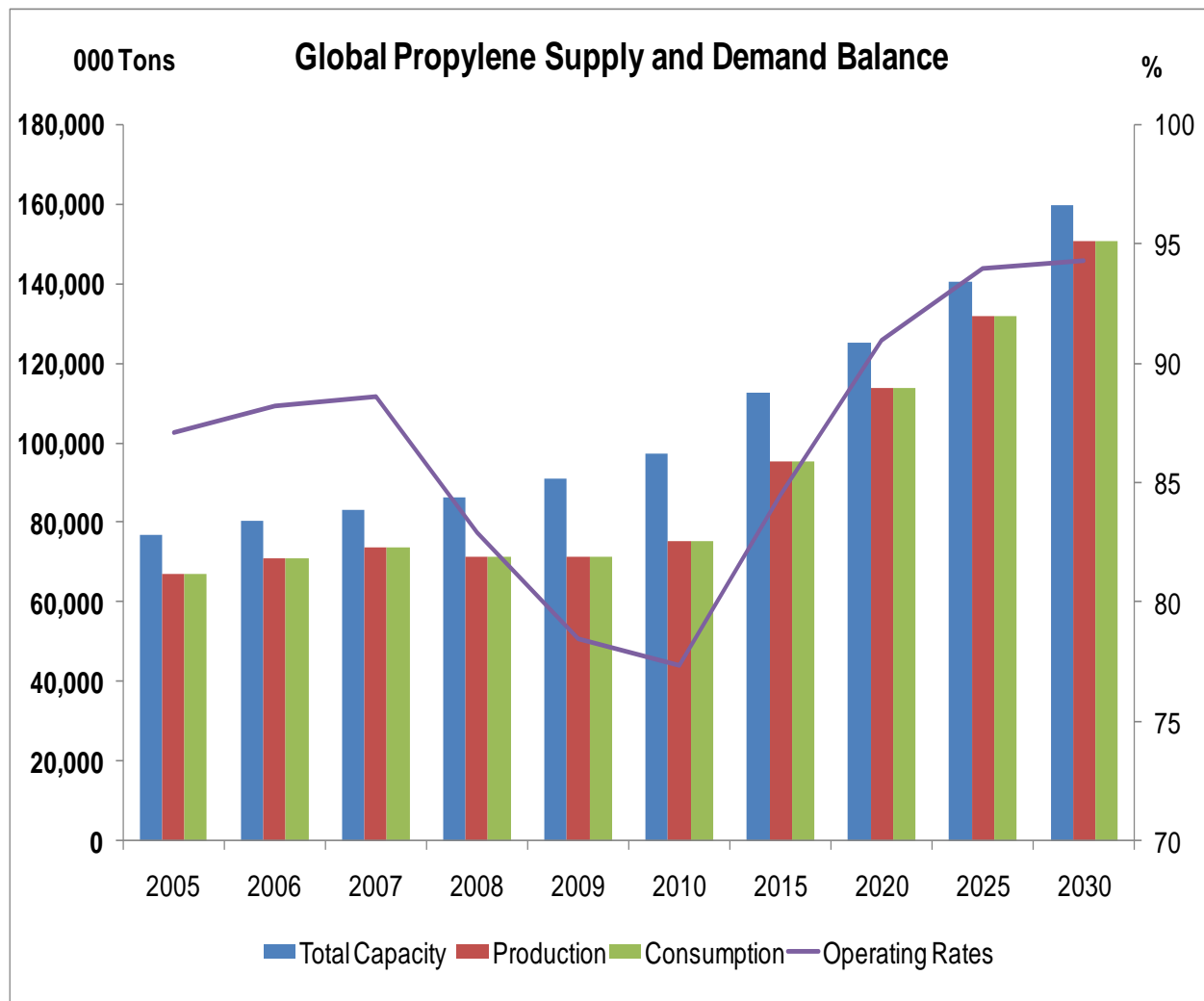
- C<sub>3</sub>- demand growth outpaces C<sub>2</sub>-
- Large capacity additions in Asia and the Middle East
- Especially "on purpose" C<sub>3</sub>- projects
- Second largest petrochemical; global consumption 73 mm tpa
  - Mostly co-product from Ethylene plants and from refineries (FCC units)
  - Refinery (~60 wt %), Chemical (95%) and Polymer (99.5%) grades all traded; polymer grade dominates (two thirds +)
  - Little traded (1-2% net between regions) due to relatively high costs of shipping
  - Over 60% used for polypropylene; also acrylonitrile, propylene oxide, oxo alcohols, cumene/phenol etc
  - Growth above ethylene, and lightening ethylene feed slate means propylene supply is permanently "tight"
    - Increased refinery production/recovery plus on-purpose production (via propane dehydro & metathesis from ethylene + butenes) are all growing fast
    - Price has risen to around parity with ethylene
  - Much new production is in the Arabian Gulf
    - Far smaller production cost advantage than is the case for ethylene due to more limited feedstock advantage

# Propylene Outlook - Global



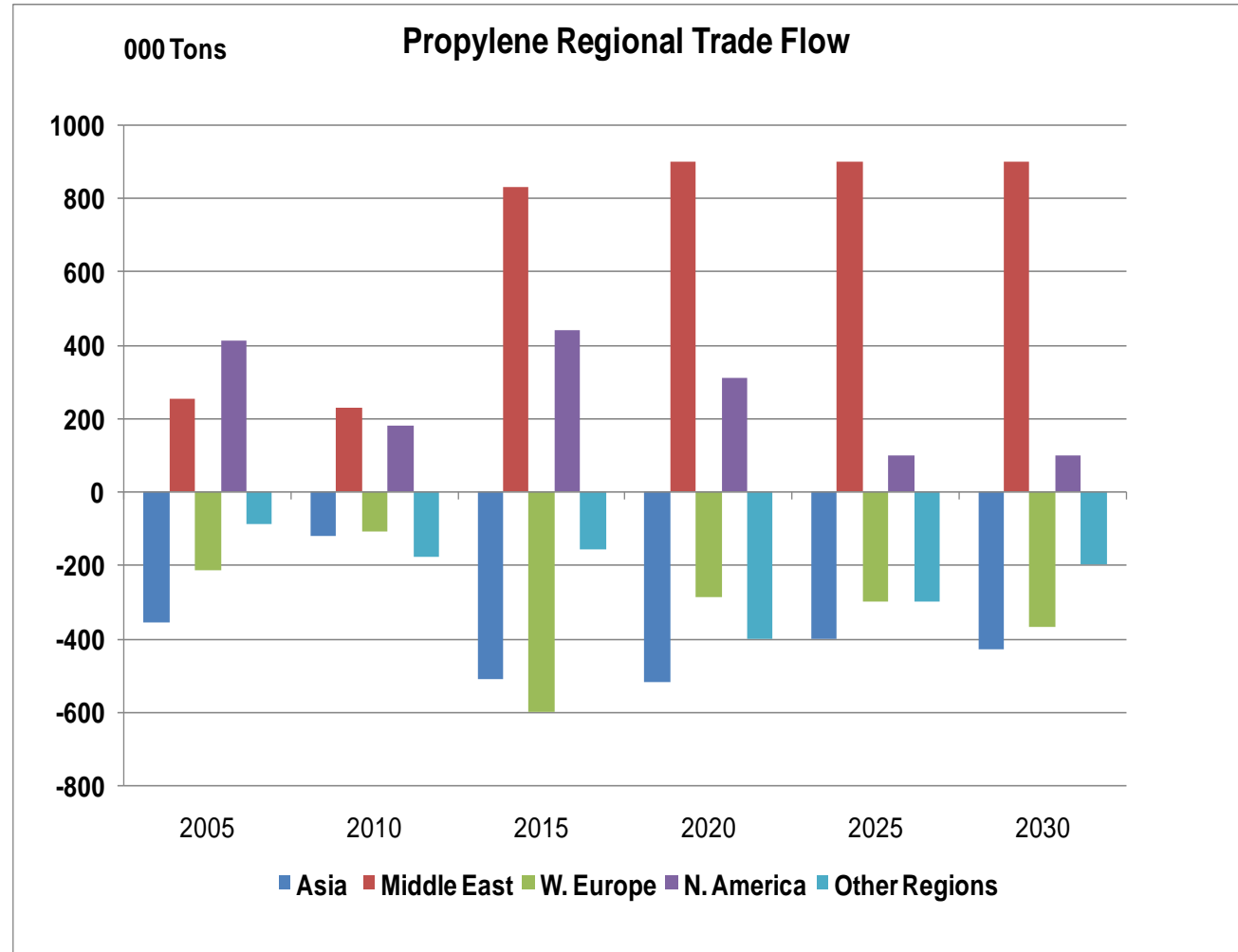
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- Global Propylene demand growth to average 4.8 % pa in the next 5 years
- Longer term, demand growth to average around 3.6% pa



# Propylene Regional Trade Flow

- Middle East will be biggest exporter
- Much of the propylene will be shipped in derivative form
- Asia will have the largest deficit in the longer term



# Use NGL's for Ethylene Cracker Feed



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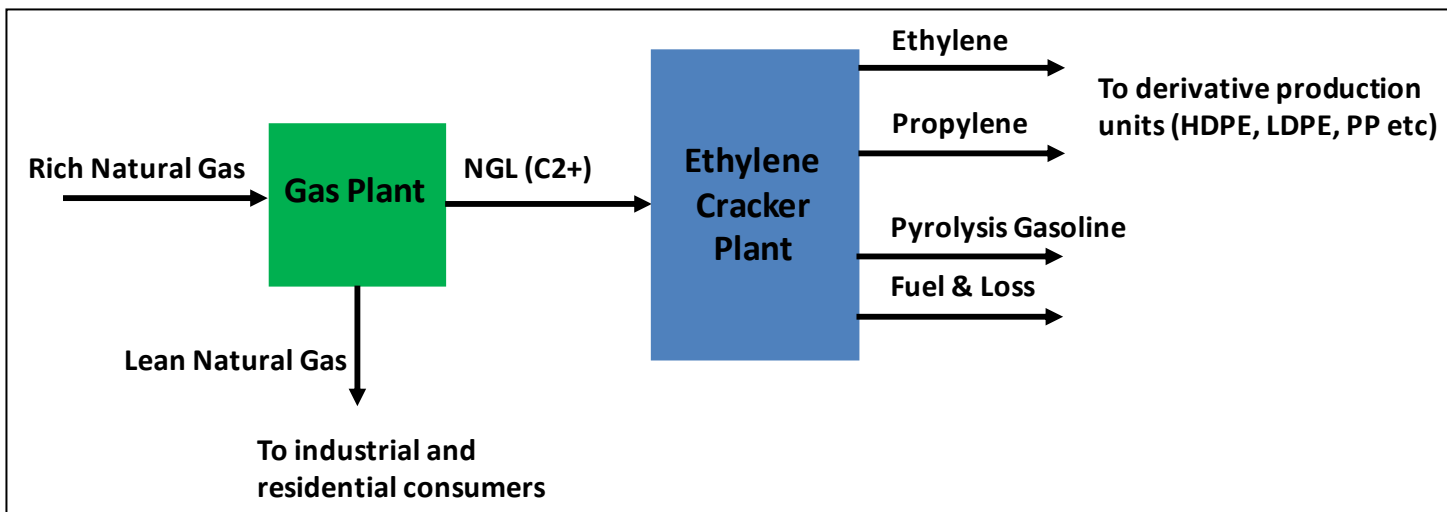
- Ethane and heavier components (Natural Gas Liquids) can be recovered as EC feed
  - NG composition varies widely depending on geology etc
- World scale ECs in range 800– 1200 ktpa ethylene
- 800 ktpa EC requires ~1500 ktpa NGL
  - Requires ~22 MSCMD NG feed of which ~3 MSCMD is fed to EC (90% C2+ recovery from NG)
- Capex for Gas plant + 800 ktpa EC ~\$1.2 billion
  - Does not include derivative plants

Example NG Composition		
	%mol	%wt
Methane	84.5	67.6
Ethane	5.1	7.8
Propane	2.2	4.8
Butane	3.3	9.7
Pentane	0.8	2.9
Hexane+	0.2	1.0
Carbon dioxide	1.0	2.1
Nitrogen	2.9	4.1
total	100.0	100.0

- 6.2%wt inerts
- 26.2%wt NGL

	Price 2010, NWE	
	\$/MMBTU	\$/t
NG	9.0	285
Ethylene		1082
Propylene		1229

- Delta ethylene/NG 797 \$/t

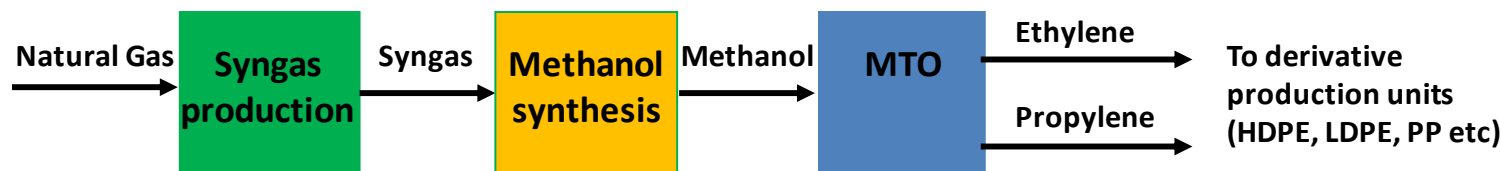


# Natural Gas for MTO

- Natural Gas converted to synthesis gas
  - $\text{CH}_4 + \text{H}_2\text{O} \longrightarrow \text{CO} + 3\text{H}_2$  (nickel catalyst)
  - Common building block for many larger molecules
- MTO (Methanol to Olefins)
  - Synthesis gas converted to methanol
    - $\text{CO} + 2\text{H}_2 \longrightarrow \text{CH}_3\text{OH}$  (copper, zinc oxide, alumina catalyst)
    - Other Methanol derivatives are Formaldehyde, MTBE, Acetic Acid, dimethyl terephthalate, methyl methacrylate etc
  - MTO (silicoalumino phosphate catalyst)
    - $2\text{CH}_3\text{OH} \longrightarrow \text{C}_2\text{H}_4 + 2\text{H}_2\text{O}$  (30% ethylene)
    - $3\text{CH}_3\text{OH} \longrightarrow \text{C}_3\text{H}_6 + 3\text{H}_2\text{O}$  (60% propylene)
    - UOP semi-commercial scale unit – Total Belgium
    - SYN Energy/Lummus commercial scale - China

	Price 2010, NWE	
	\$/MMBTU	\$/t
NG	6.5	285
Methanol		324
Ethylene		1082
Propylene		1229

- Delta ethylene/NG 797 \$/t
- Capex ~ \$1.4 billion for 800ktpa olefins

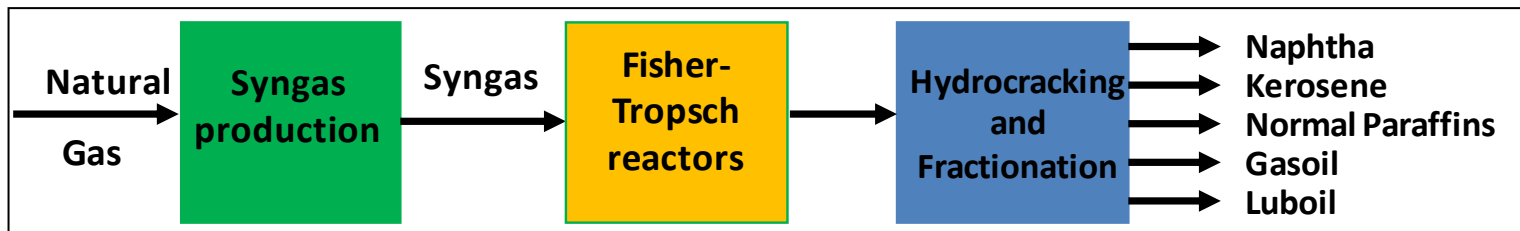


# NG to Liquid Transport Fuels (GTL)

- Natural Gas converted to synthesis gas
  - $\text{CH}_4 + \text{H}_2\text{O} \longrightarrow \text{CO} + 3\text{H}_2$  (nickel catalyst)
- Fischer-Tropsch Reaction
  - Synthesis gas reacted over iron or cobalt catalyst to produce long chain hydrocarbons
- Further Processing
  - Longer chain molecules hydrocracked to desired product
  - Range of products separated by fractionation
- Produces clean, high quality products
- Capex for 140,000 bpd ~ \$18 billion (\$130k/bbl)

	Price 2010, NWE	
	\$/MMBTU	\$/t
Natural Gas	6.5	285
Naphtha	16.7	695
Diesel	16.2	664

• Delta diesel/NG 379 \$/t



**KBC has been monitoring and forecasting developments in natural gas markets around the world, since the mid 1990s. We have undertaken a range of project studies and provided regular reports to our retainer client base on the evolving structure and economics of the business. For those involved in gas project development there are three main consultancy elements we can provide. This can be done as pre commissioned regular reports, review meetings or studies.**

- **FUNDAMENTALS ANALYSIS**
- **LNG PROJECT SUPPORT**
- **GAS INDUSTRY PLANNING**