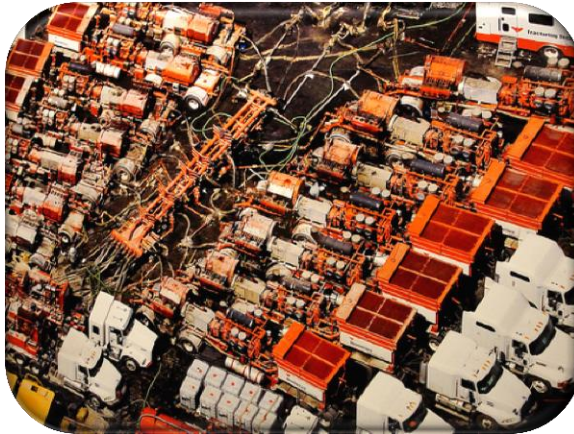


Middle East Shale: Potential and Implications



EAGE Workshop
Jordan, September 2013

Middle East shale – overlooked, but important



“Middle East [was] not addressed by the current study. This was primarily because there [are] significant quantities of conventional natural gas reserves” (EIA 2011)

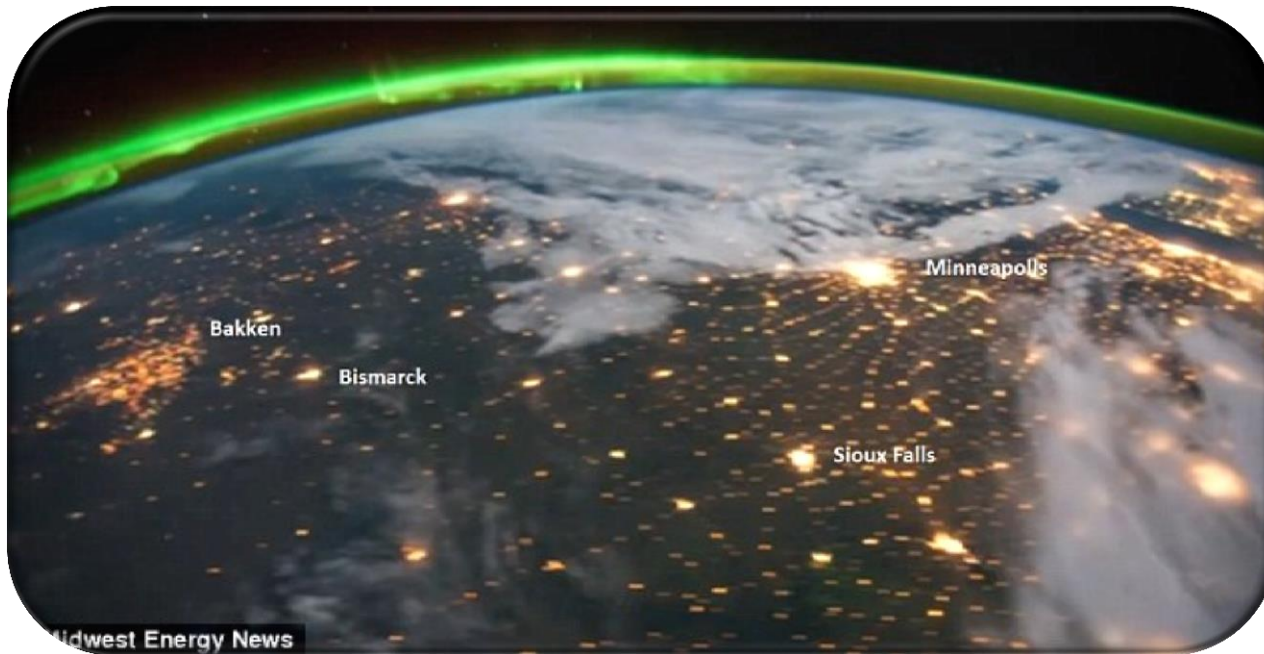
“Shale gas is neither plentiful nor cheap” – Qatar Petroleum (2010)

Middle East Shale: Key points

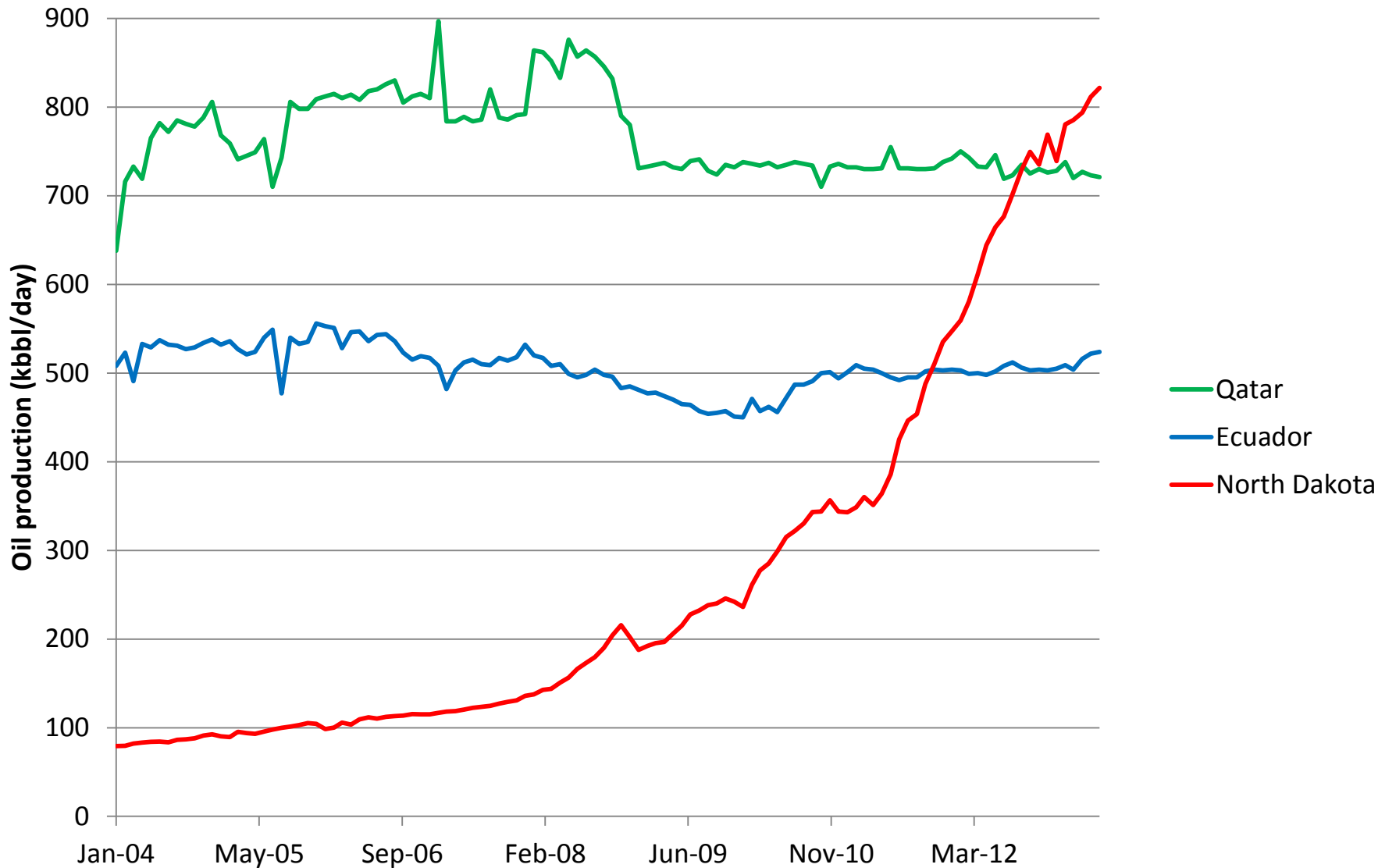
- Most attention to date has focussed on impact of North American shale gas/oil on the Middle East
- But MENA shale raises important questions:
 - Does MENA have shale oil/gas resources? Where and how much?
 - Does the region need to develop its shale oil and gas?
 - Can the region develop shale resources technically & economically?
 - What are the challenges to be overcome?



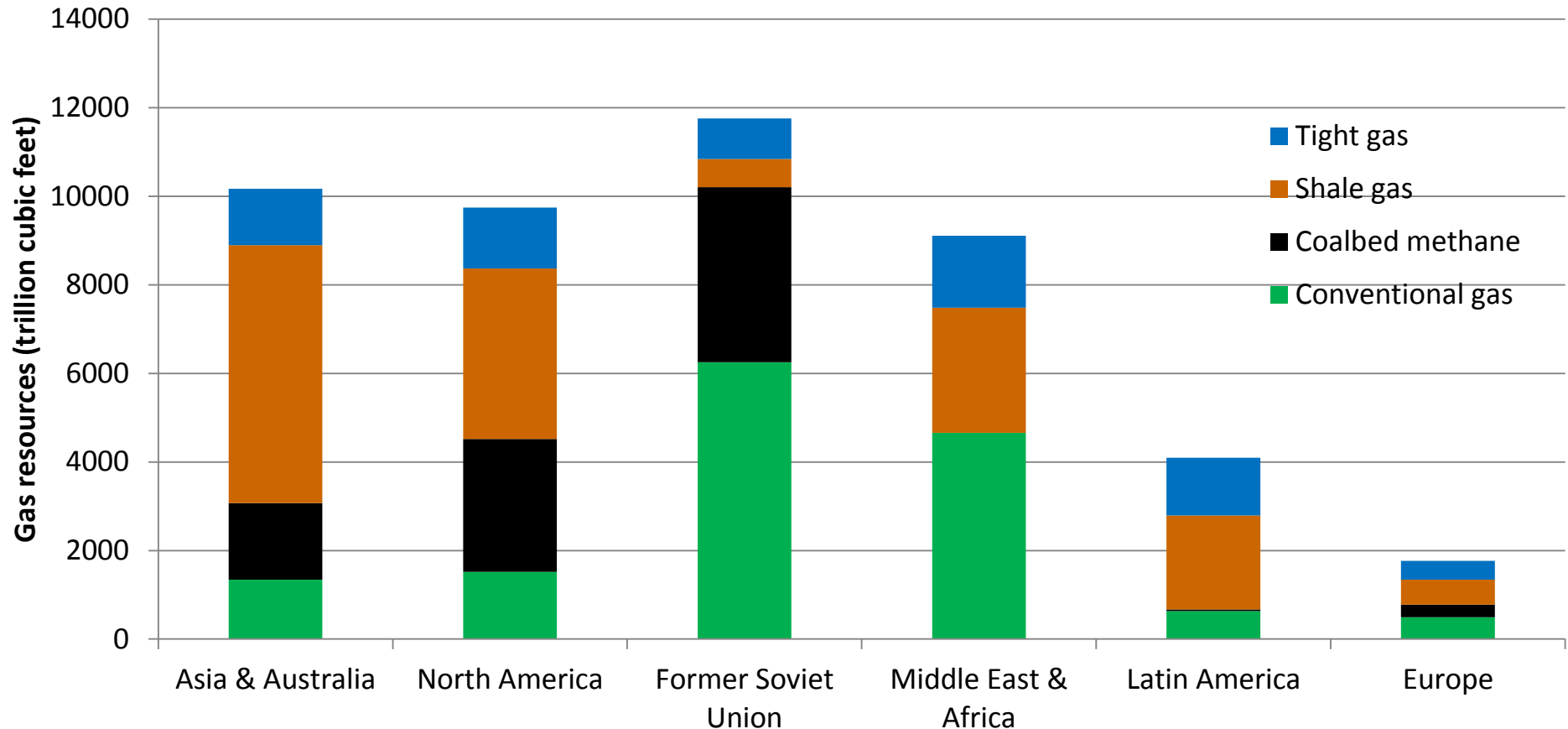
Global Shale Impact



US shale boom – North Dakota (Bakken) overtakes smallest 2 OPEC members

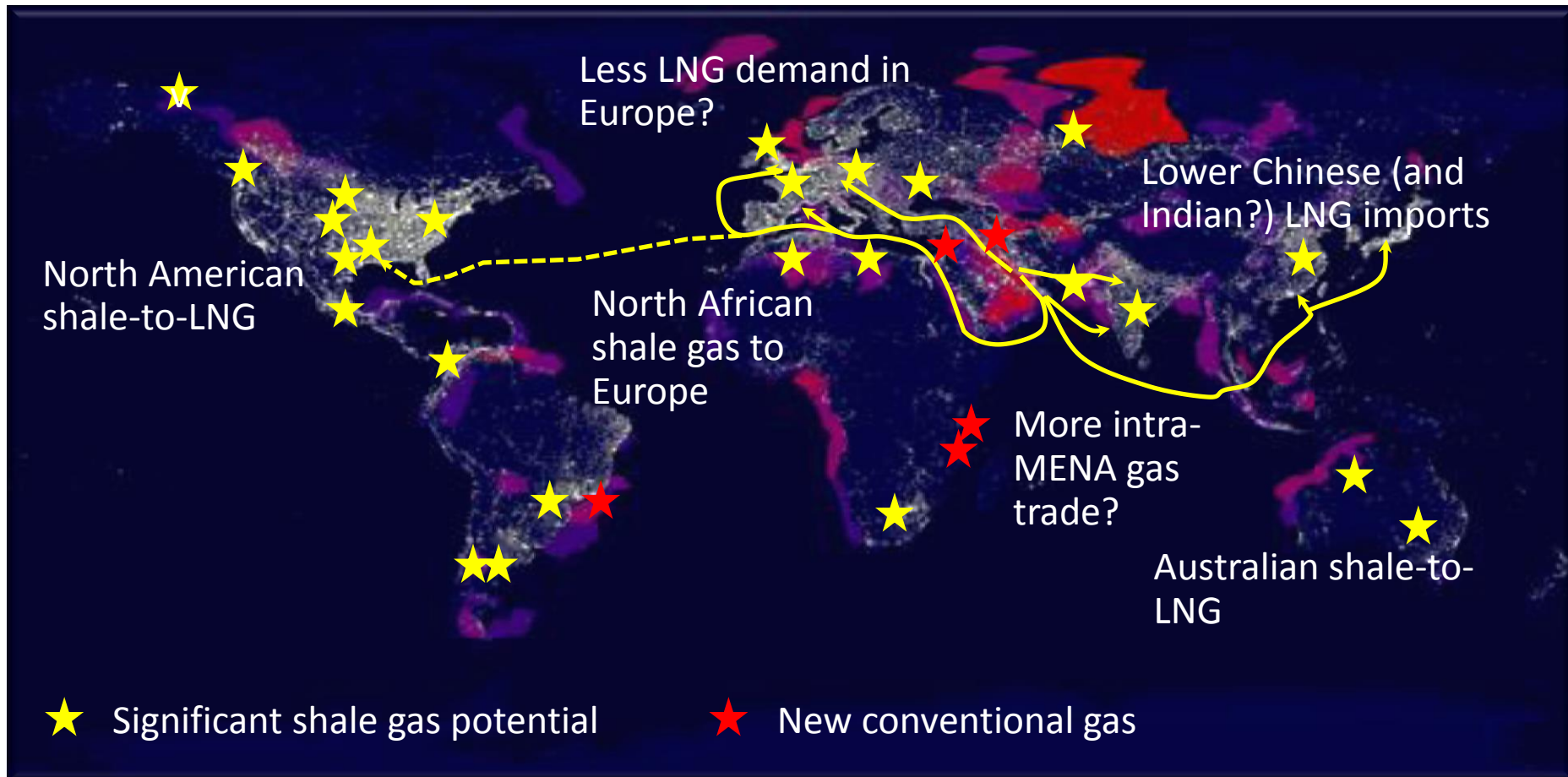


Global gas resources



- Shale means a huge jump in global resources
- Detailed assessment of Middle East unconventional gas not publicly available
- MENA's dominance in conventional gas challenged by unconventional gas

Shale gas can reshape gas trade flows

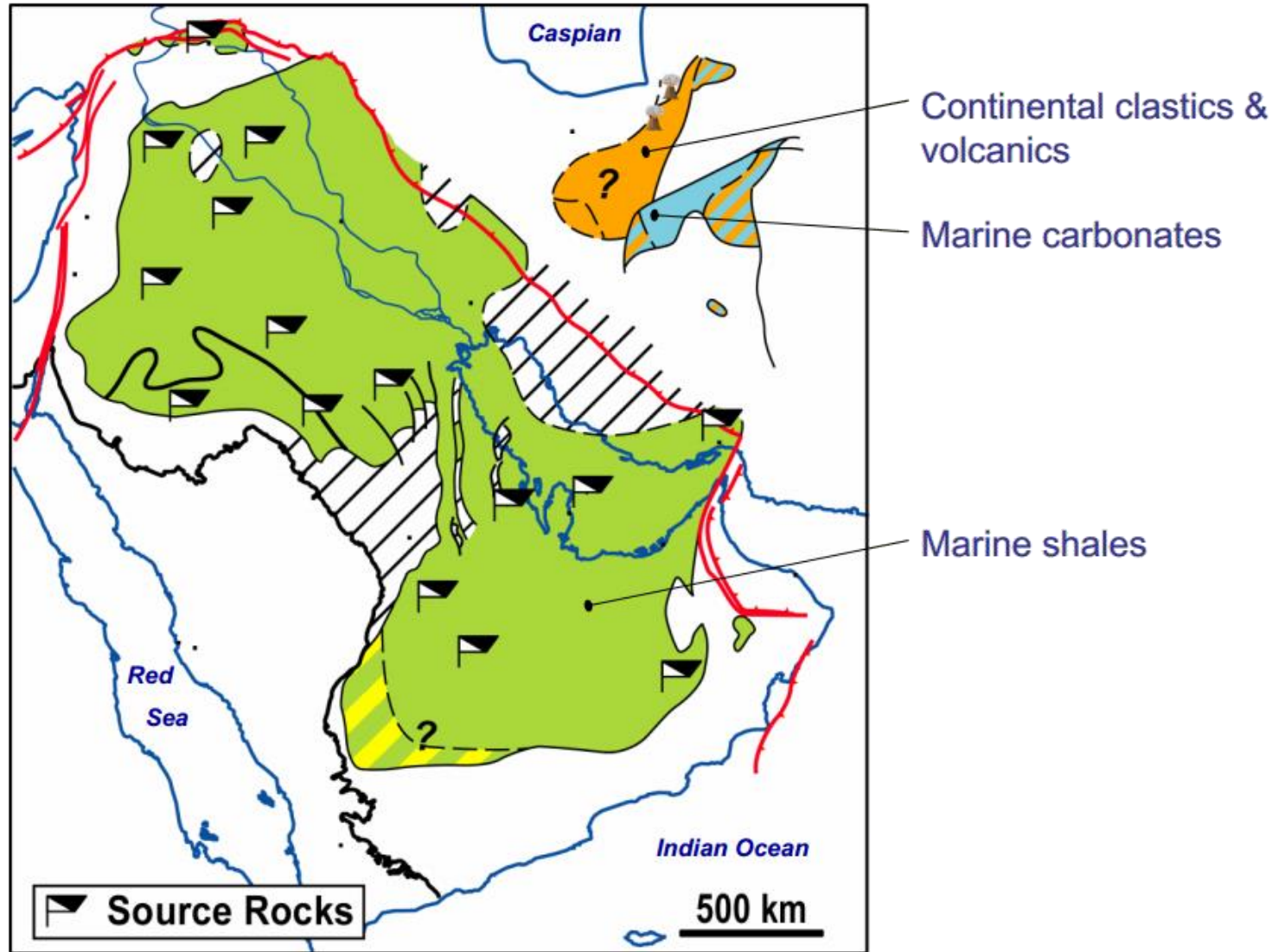


- White: satellite imagery of lights = energy demand
- Purple → Red: global gas basins, in increasing size of resources (USGS)
- Yellow: main current and future export routes for Middle East gas

MENA shale resources

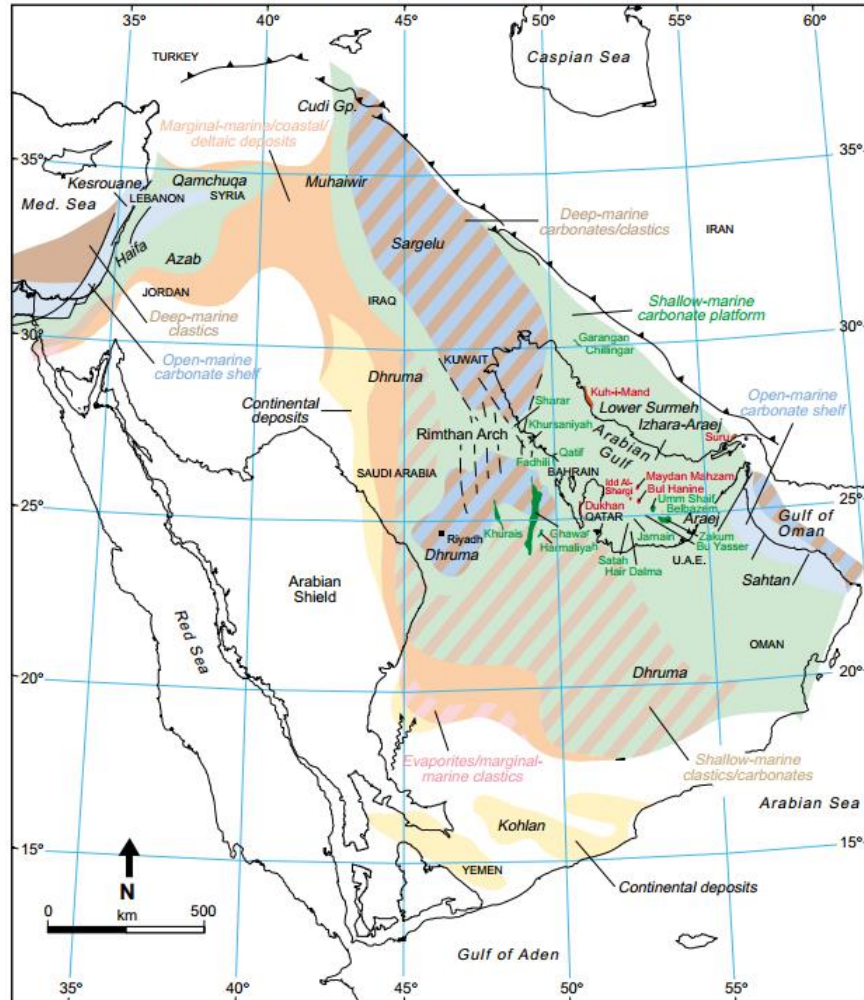


Early Silurian: Qusaiba, Mudawarra

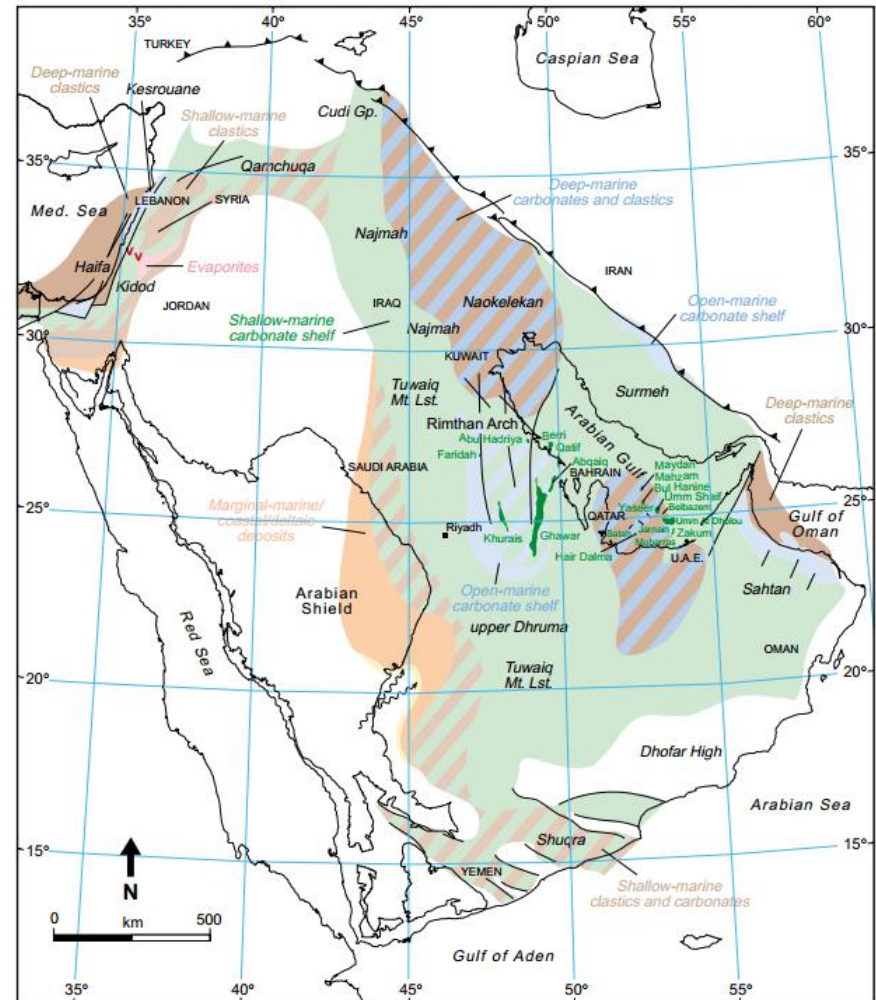


Middle Jurassic: Sargelu, Naokelekan

Middle Jurassic: Bajocian to Bathonian (176.5–164.4 Ma)

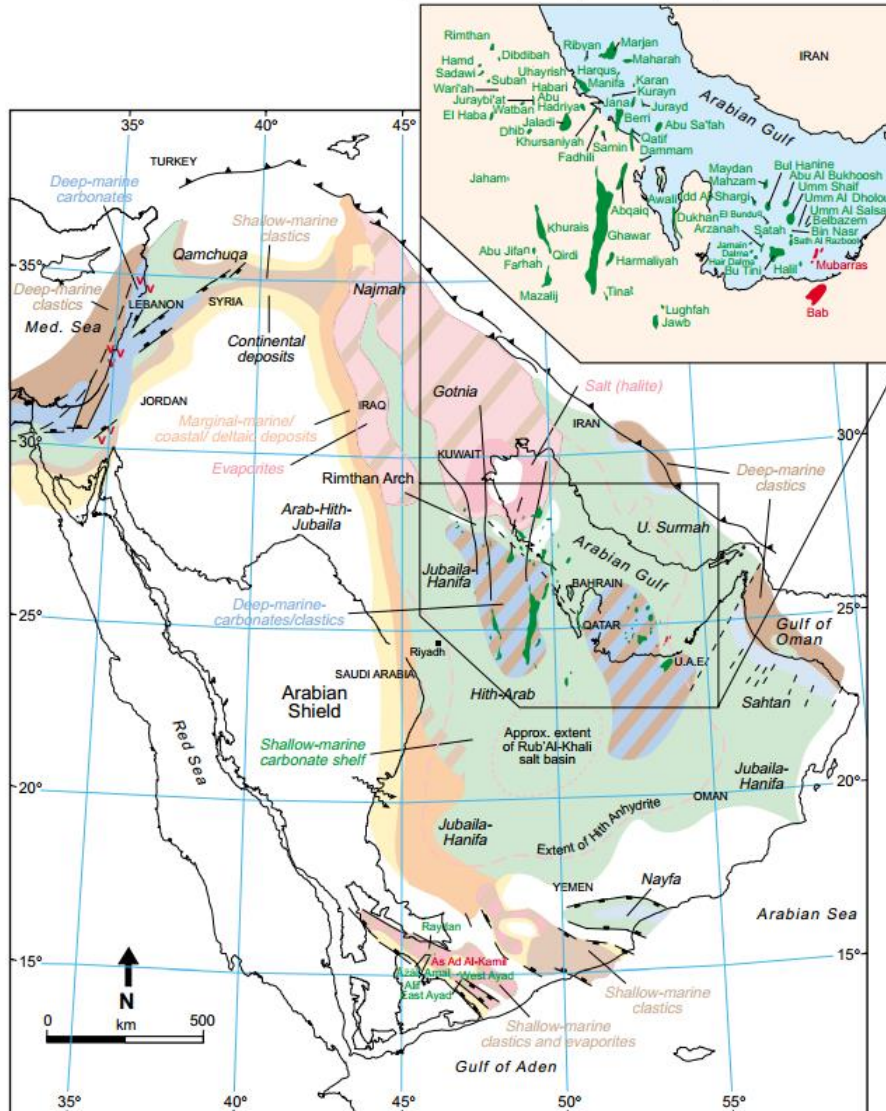


Late Middle Jurassic: Callovian to Oxfordian (164.9–154.1 Ma)

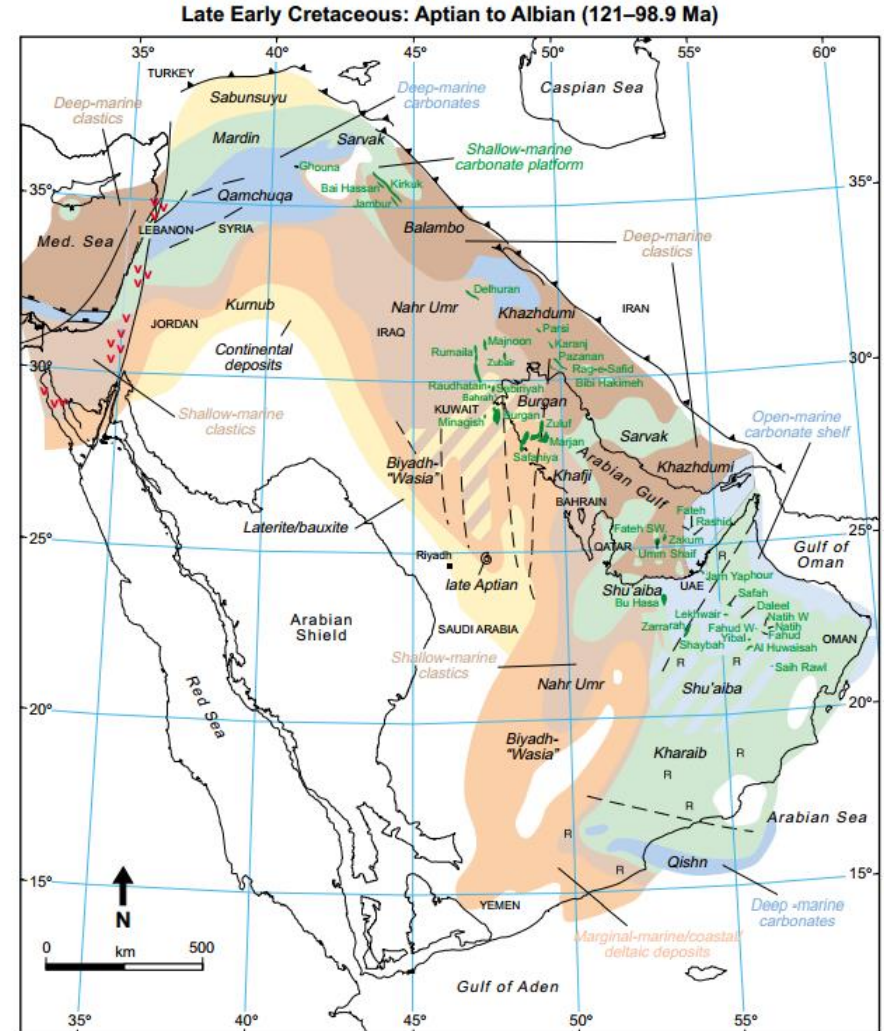
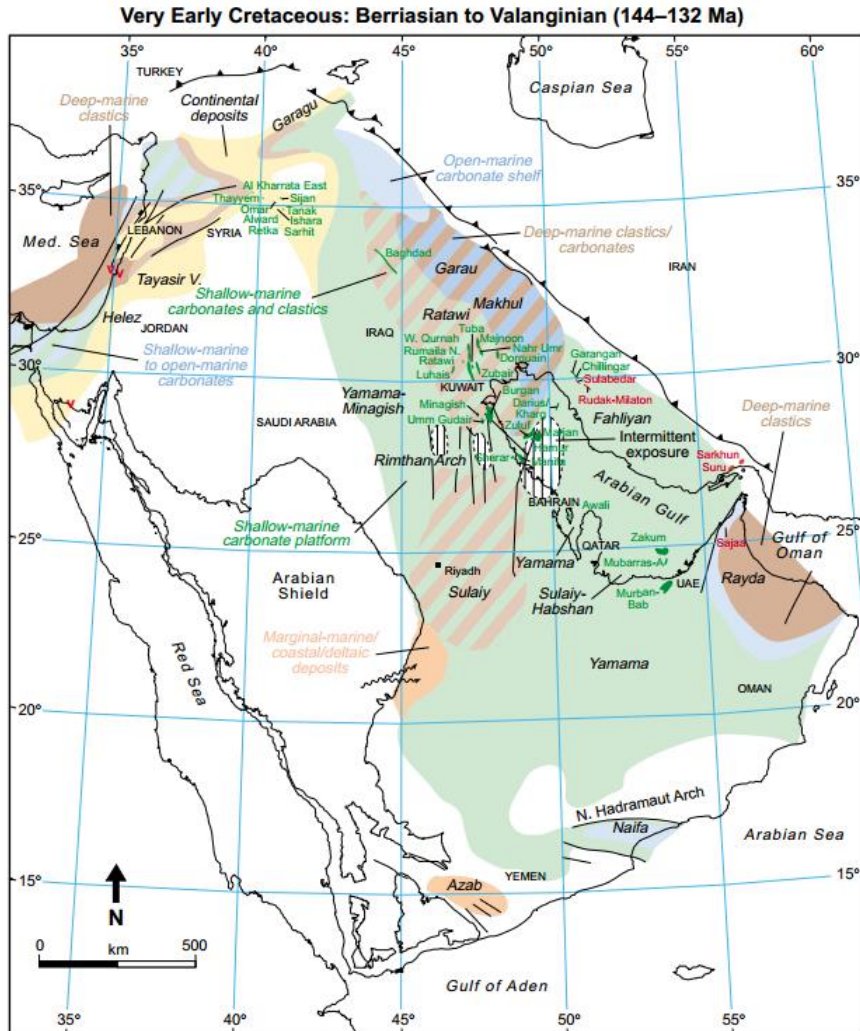


Late Jurassic: Jubaila-Hanifa

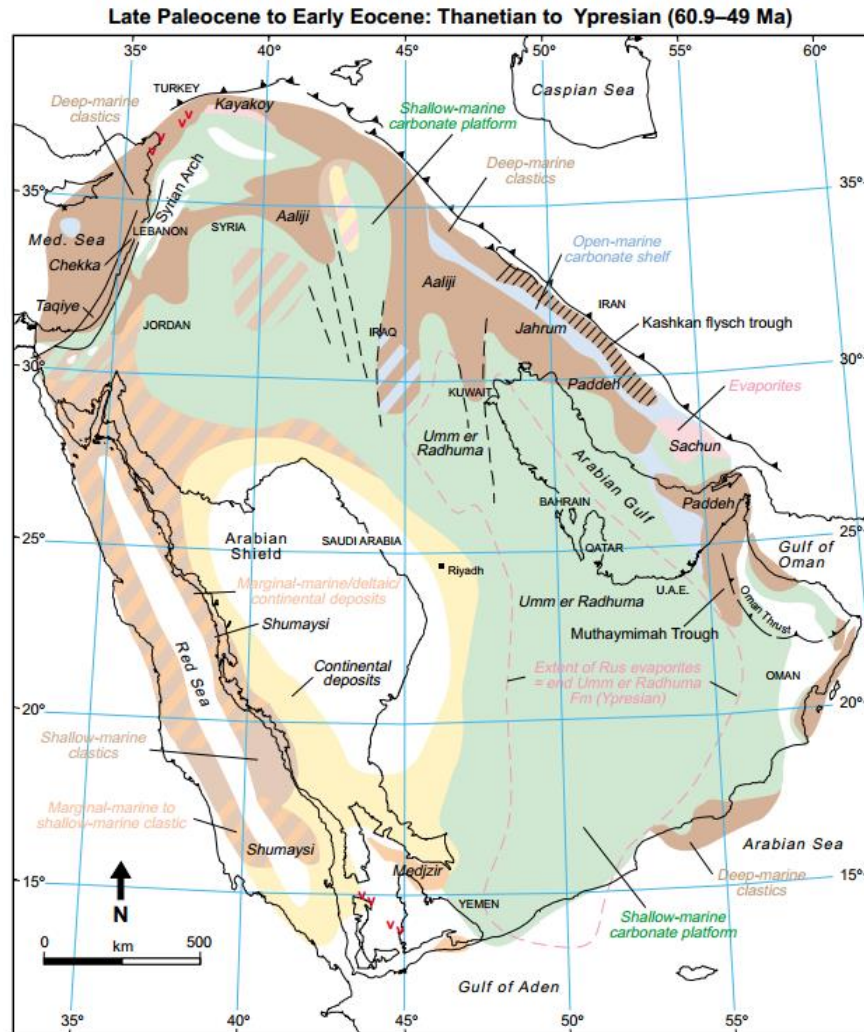
Late Jurassic: Kimmeridgian to Tithonian (154.1–144 Ma)



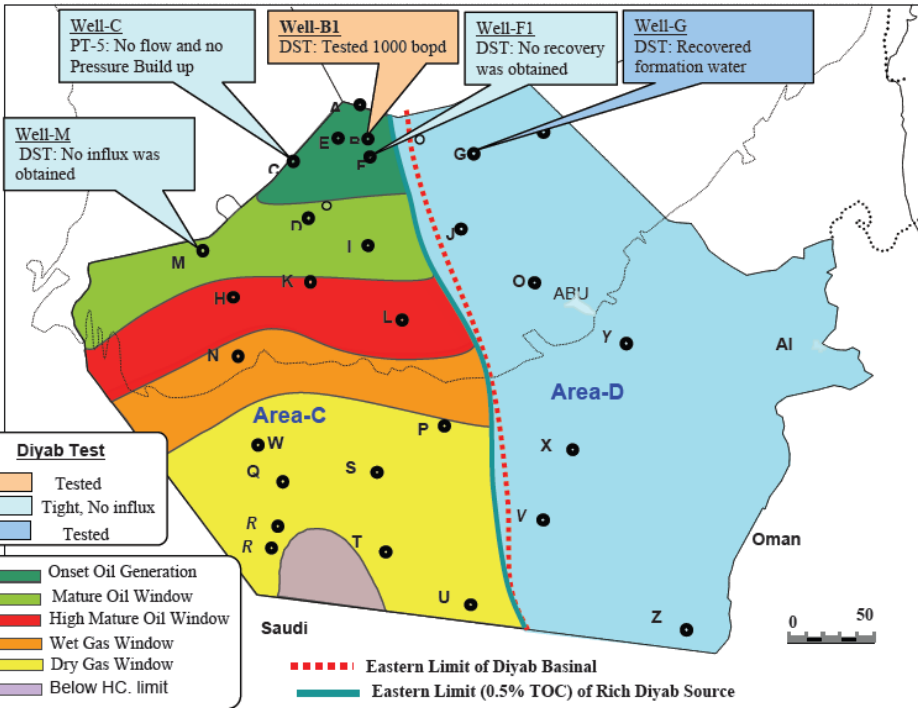
Early-Middle Cretaceous: Garau/Sulaiy; Kazhdumi



Palaeogene: Pabdeh, Aaliji

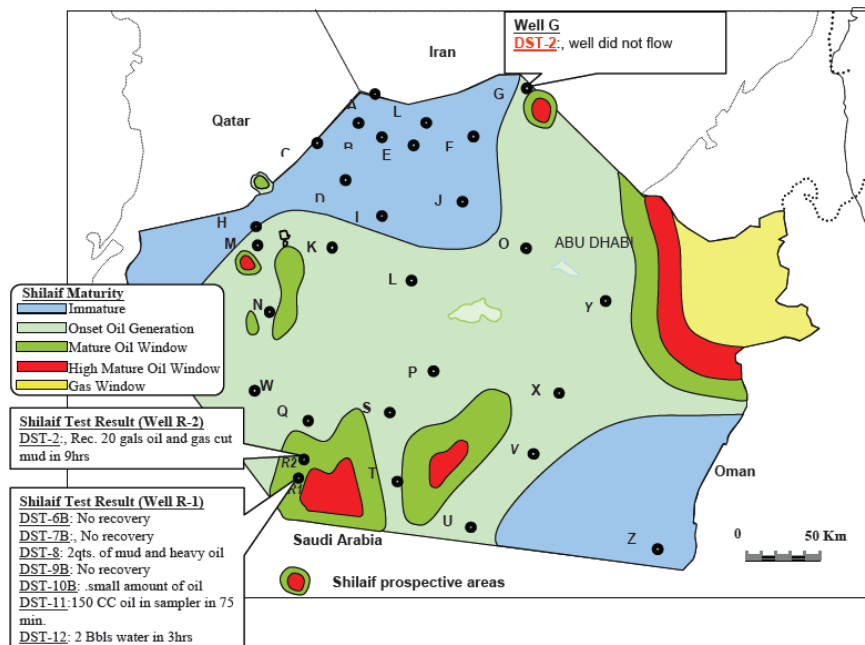


Abu Dhabi examples: Diyyab, Shilaif



- Diyyab (Late Jurassic)
- Well B1 tested 1000 bpd from natural fractures

- Shilaif (Mid-Cretaceous)
- 31 billion bbl generated, most not migrated out of source rock

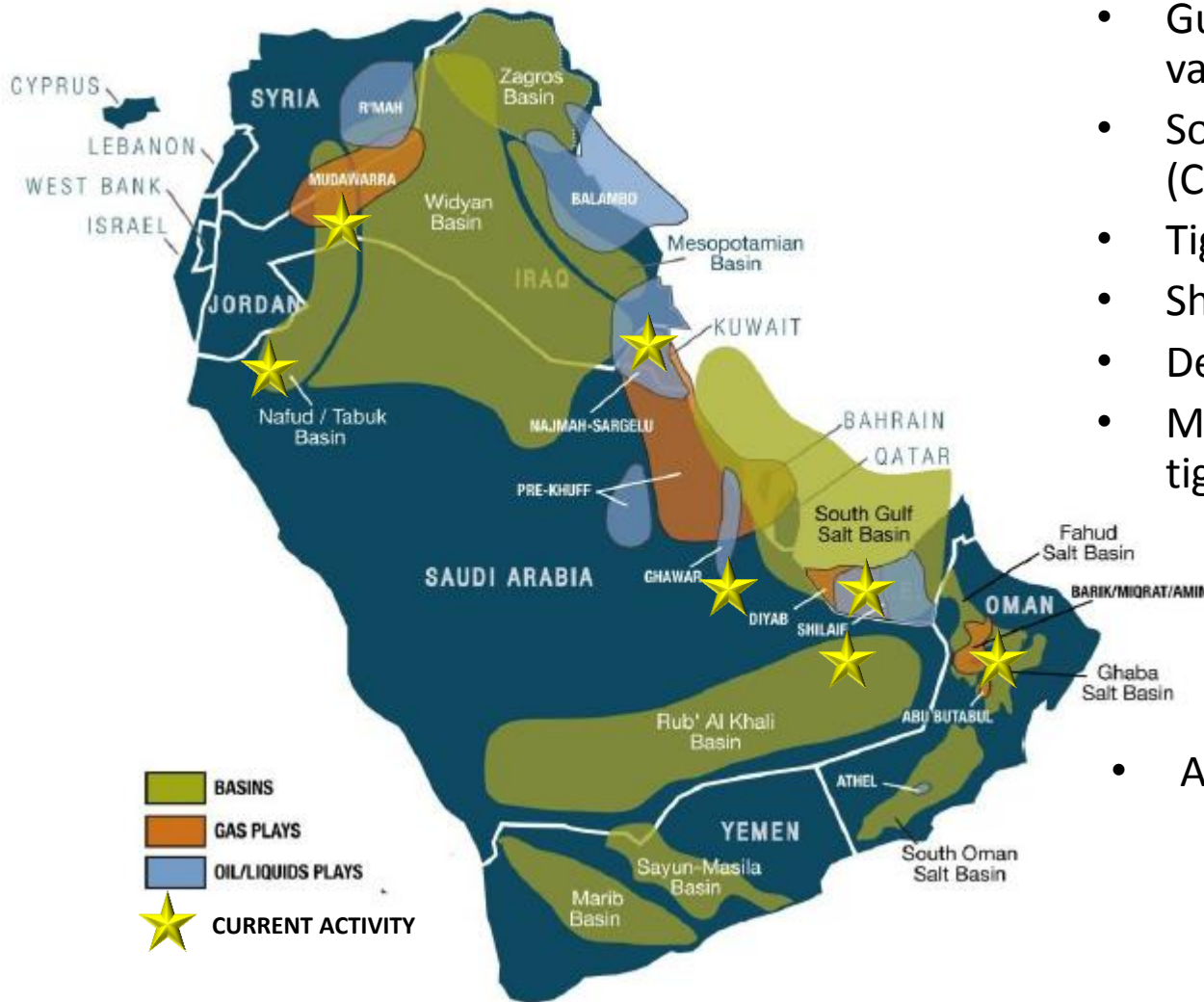


Middle East shales compare favourably with USA

Country	Shale	Age	TOC %	Thickness (m)
Oman	Athel Silicilyte	Infracambrian-Cambrian	4-7	50-1500
Regional	Qusaiba	Silurian	4-12	20-70
Jordan, Iraq	Mudawwara	Silurian	4-7	50-1500
Turkey	Dadas	Silurian	2-8	30-61
Iraq	Chia Gara	Jurassic	2.5-7.5	30-300
Iraq, Iraq, Kuwait	Nahr Umr	Cretaceous	0.4-14	150-220
Iran, Iraq	Pabdeh	Palaeocene	3-7.5	150-220
USA	Barnett	Carboniferous	4.5	90
USA/Canada	Bakken	Devonian-Carboniferous	10-20	46

- Middle Eastern shales often deep (4000+ m) – but comparable to Haynesville
- Likely many are high liquids; carbonate rich (easier to fracture)

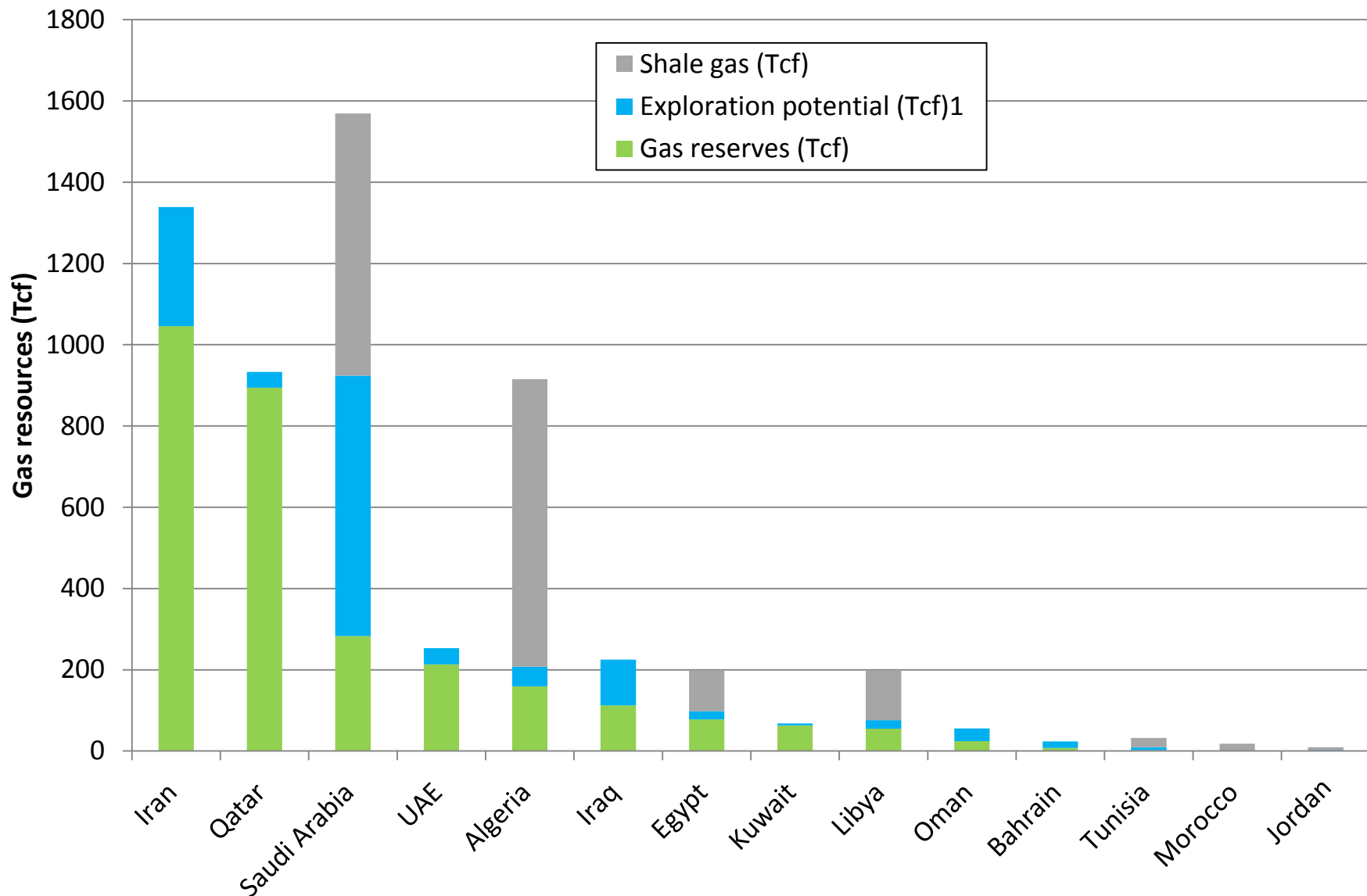
Numerous different Gulf unconventional gas plays



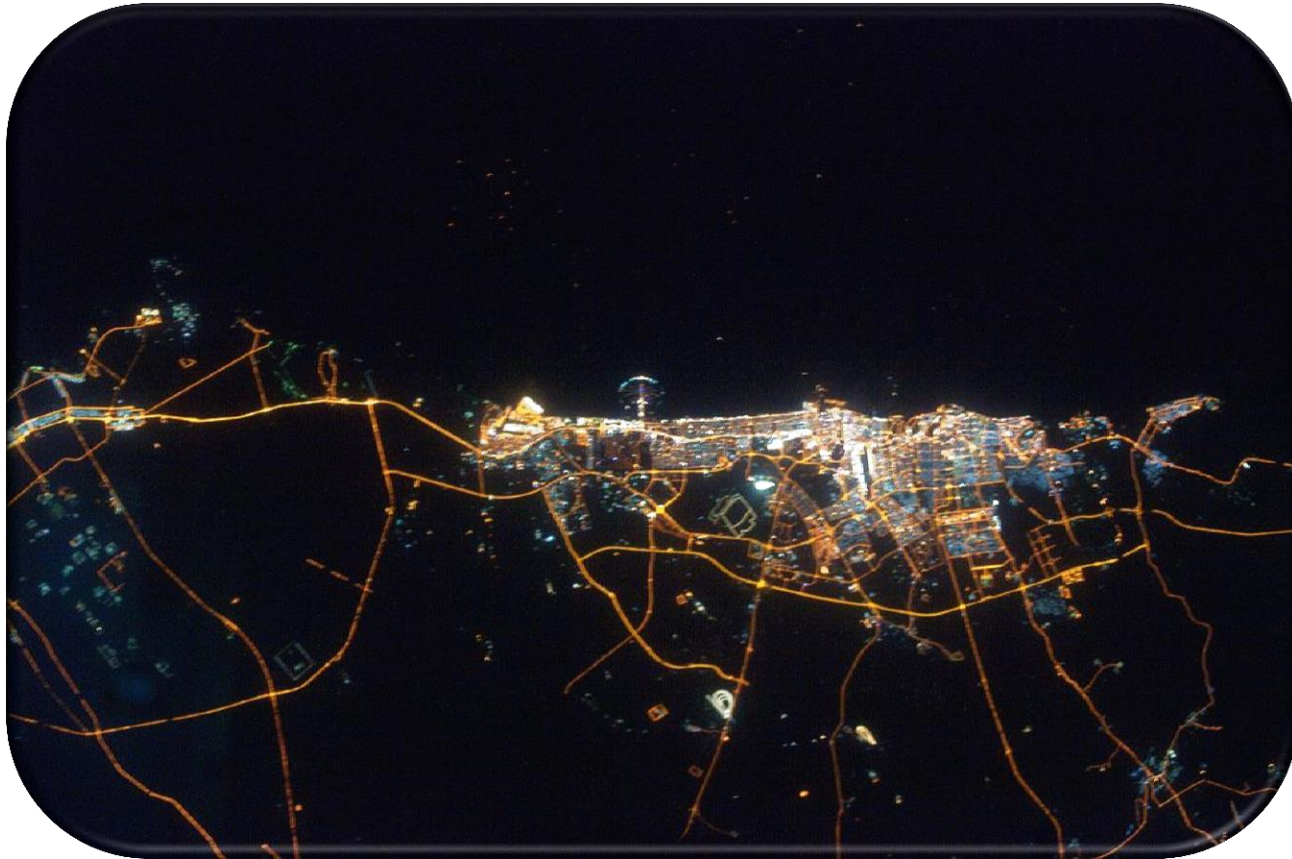
- Gulf unconventional plays varied, potentially large
- Sour and contaminated gas (CO₂, H₂S, nitrogen)
- Tight gas (sands & carbonates)
- Shale gas, condensate and oil
- Deep and ultra-deep
- Mixed resources (e.g. deep, tight and sour)

- Also: Egypt, Tunisia, Algeria ★

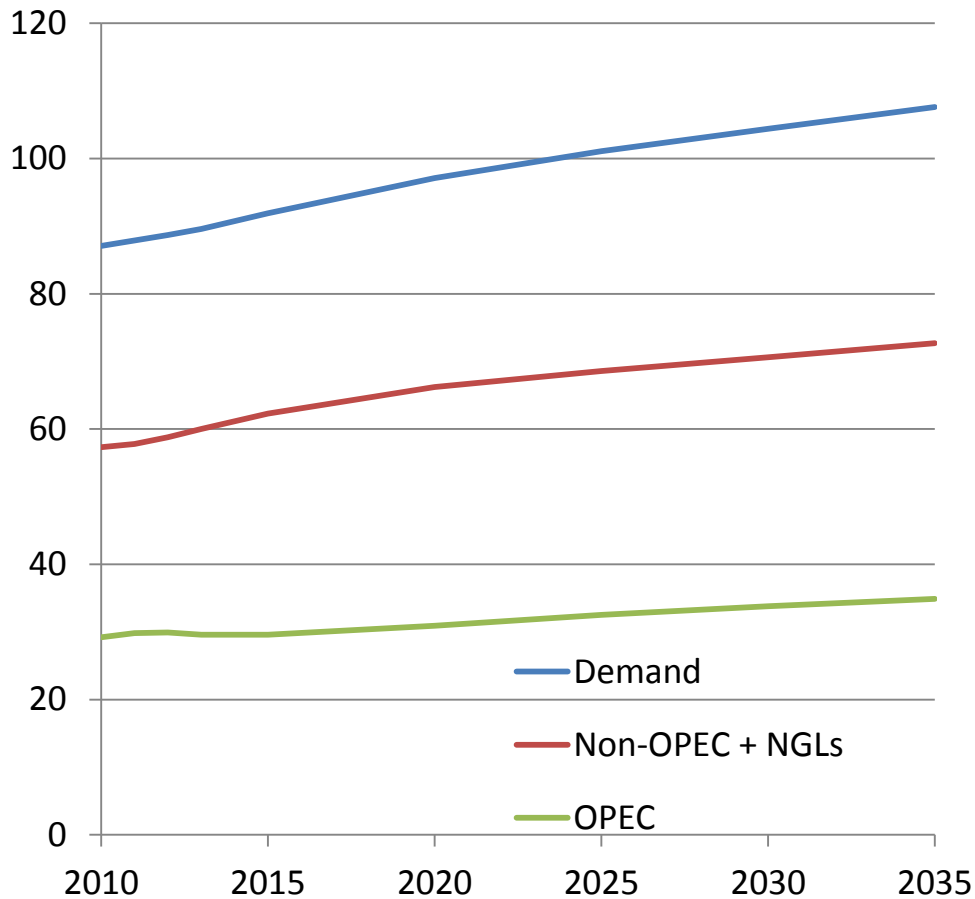
MENA gas: Shale resources significant locally and globally



Middle East need for shale

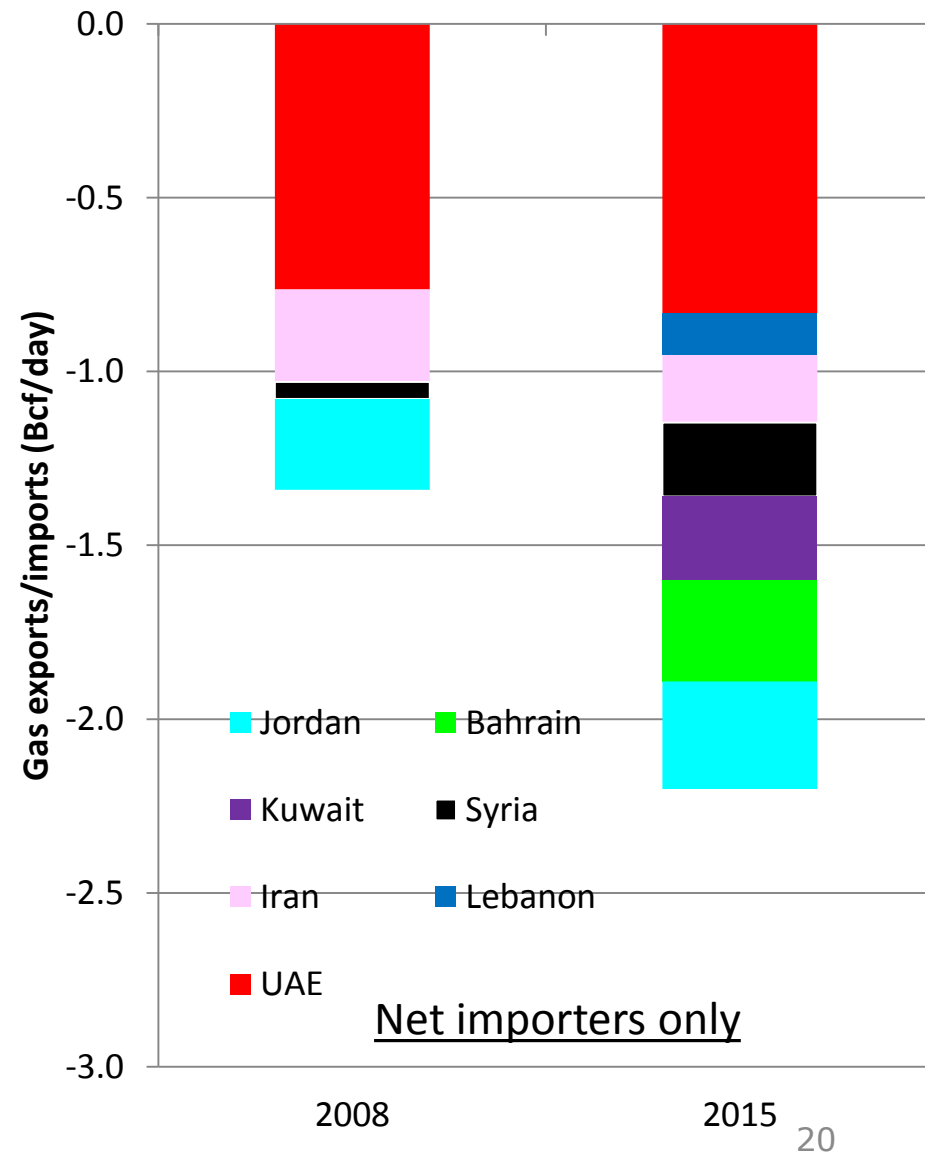
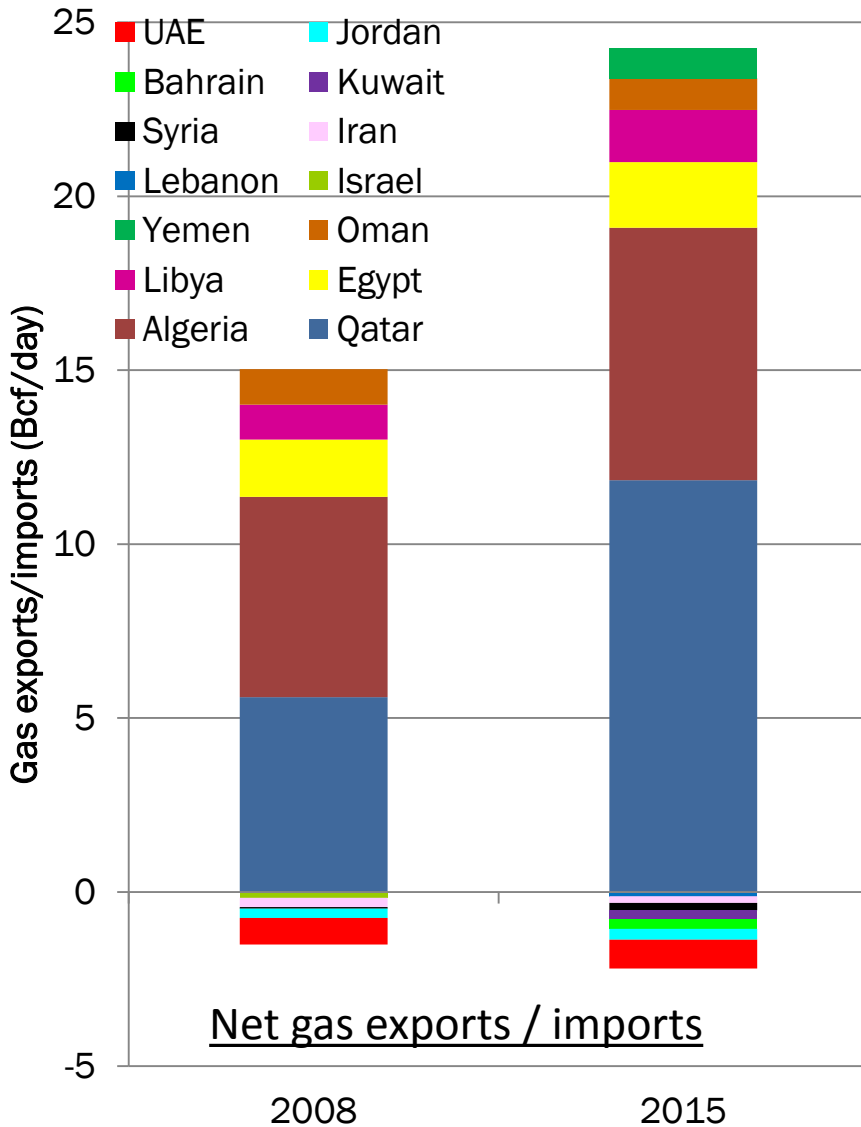


Does Middle East need to produce shale oil?

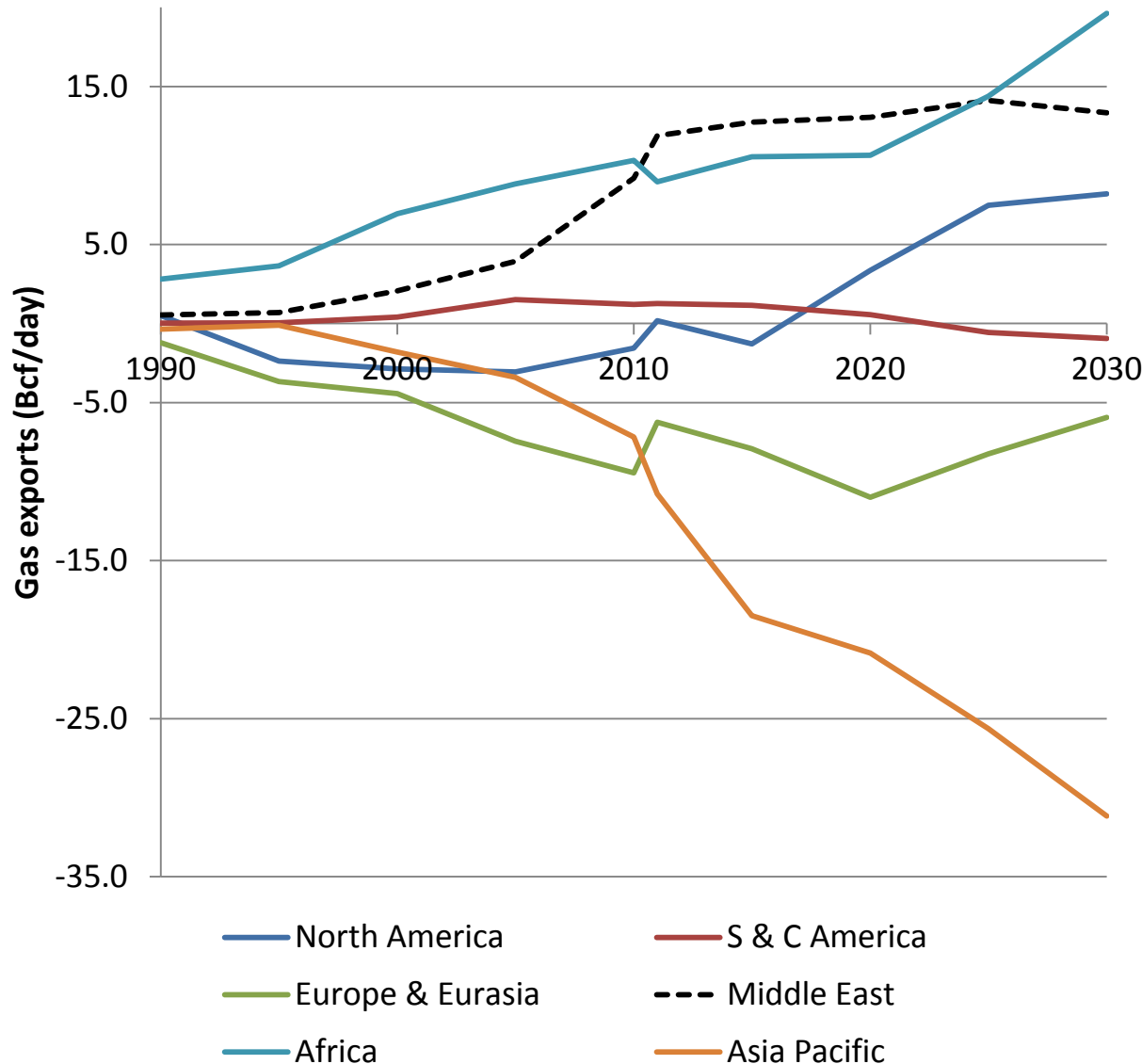


- OPEC itself sees only slow growth in call for its crude
- Forecasts a slowly-falling market share from 34% today to 32% by 2015-35
- Competition for new supplies from Iraq, Iran, Libya, etc
- However shale oil can be important for non-OPEC producers
 - Oman, Egypt, Tunisia, etc
 - Algeria?
 - Associated liquids - Kuwait

Does Middle East need to produce shale gas?

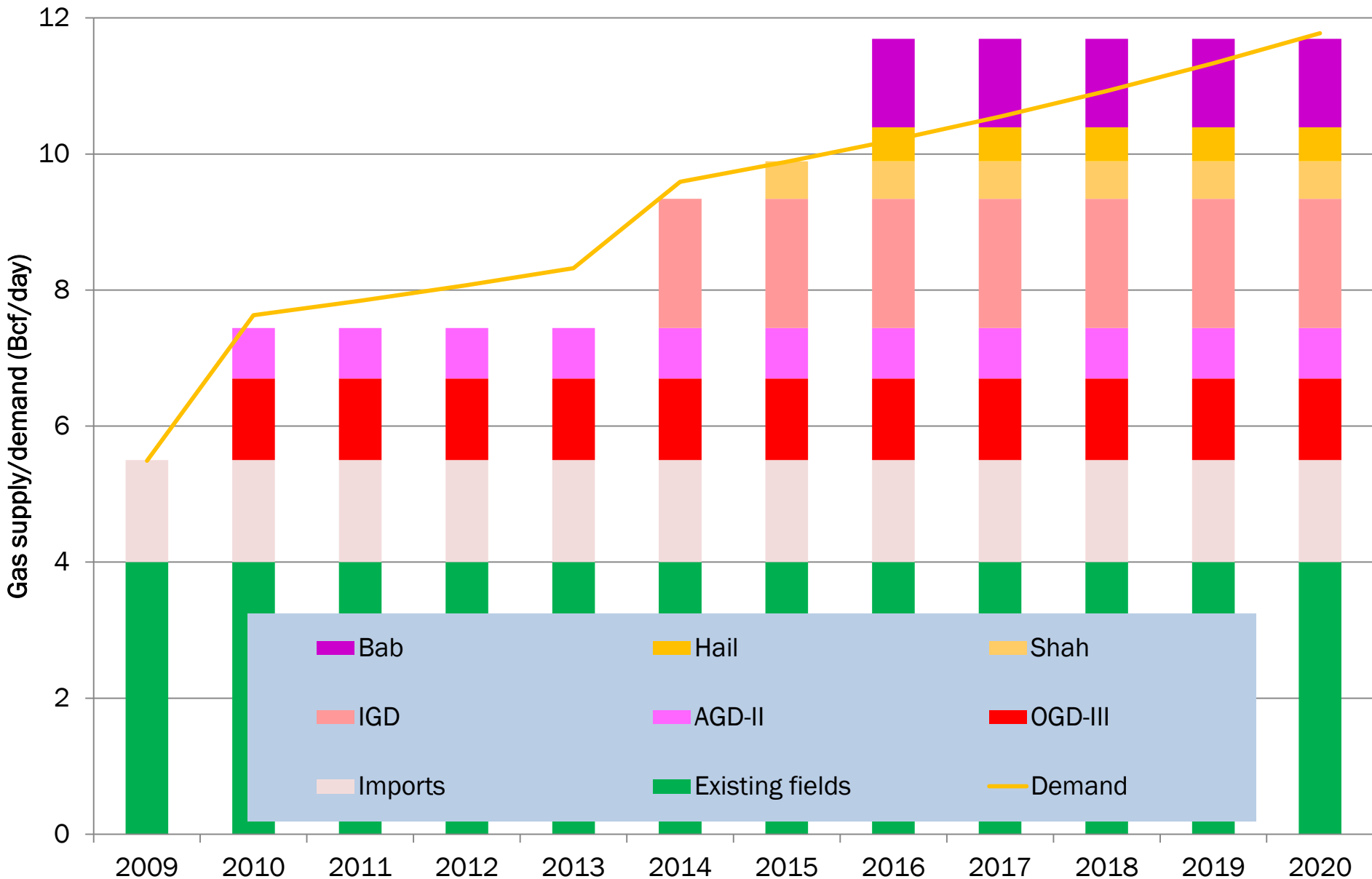


Long-term global gas export balance

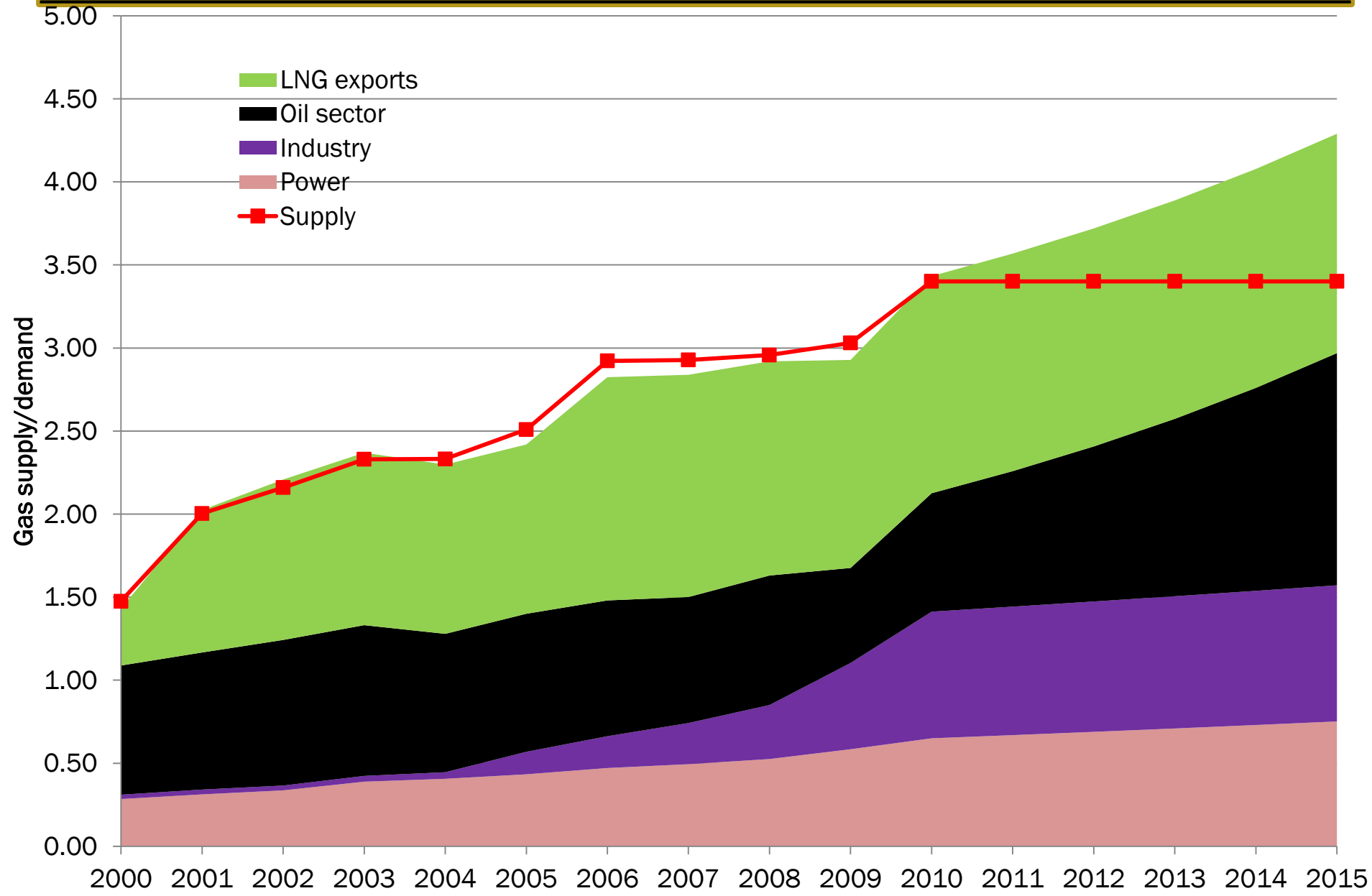


- Middle East and Africa are the two major exporting regions
- Asia is the major importing region
- Russia supplies Europe
- Big change is the emergence of North American gas exports after 2015
- However, total Middle East gas exports do not grow much and it falls behind Africa

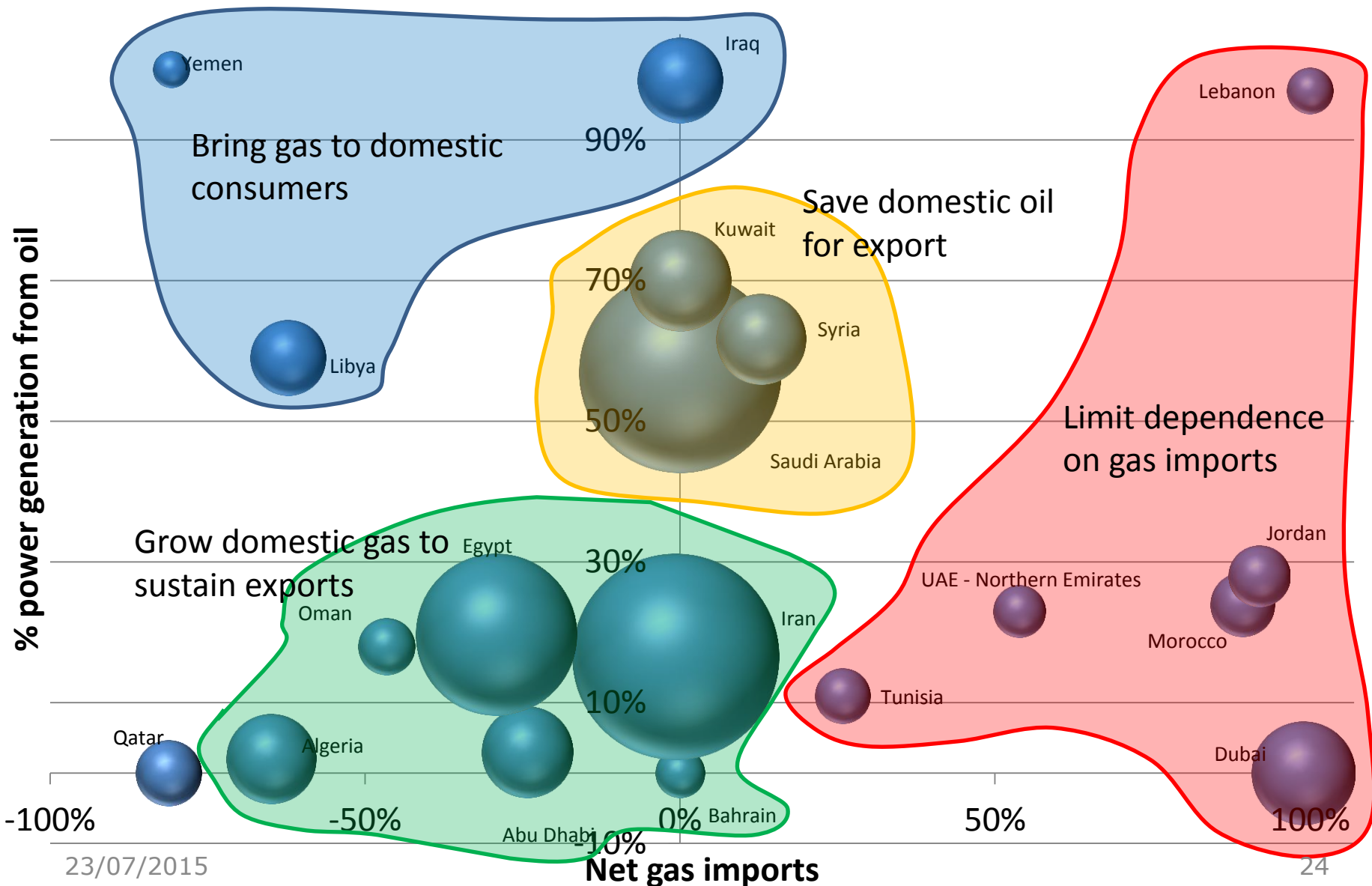
Abu Dhabi: gas supply squeezed to 2016



Oman: needs unconventional gas to maintain LNG exports



Gas policy motivations vary by country



23/07/2015

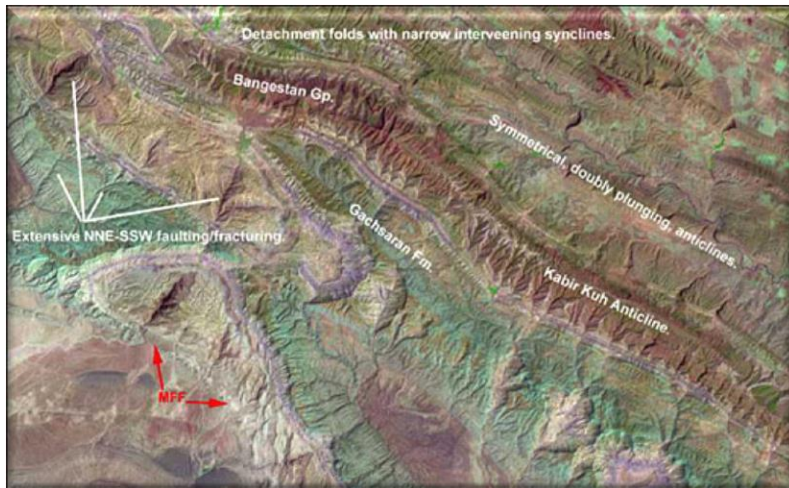
Implications of soaring MENA gas demand



- Need for improved efficiency and end to gas flaring



- Challenges to gas-based industrialisation & job creation



- Need for new gas exploration & development



- Power cuts and unrest

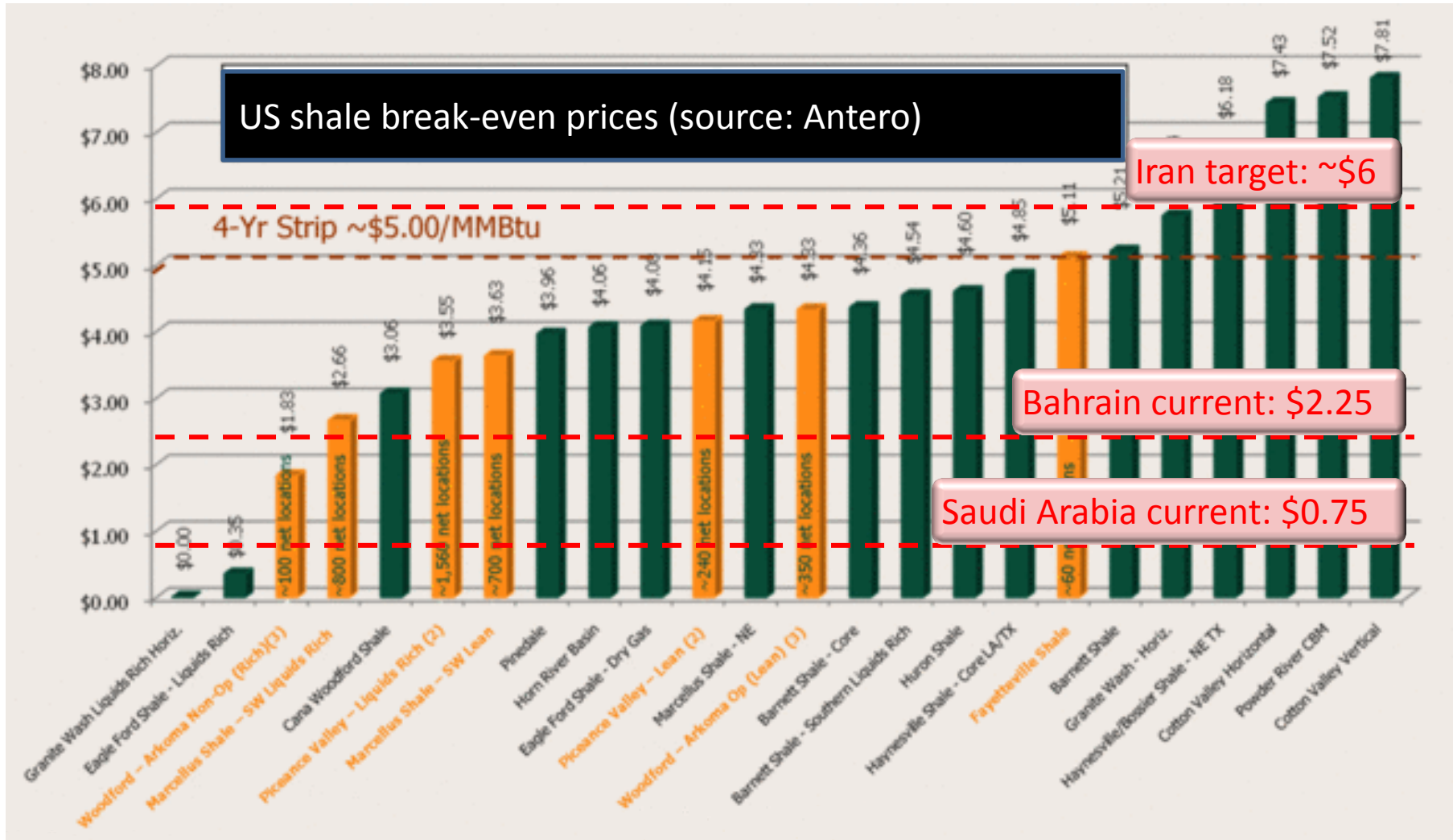
Challenges to overcome



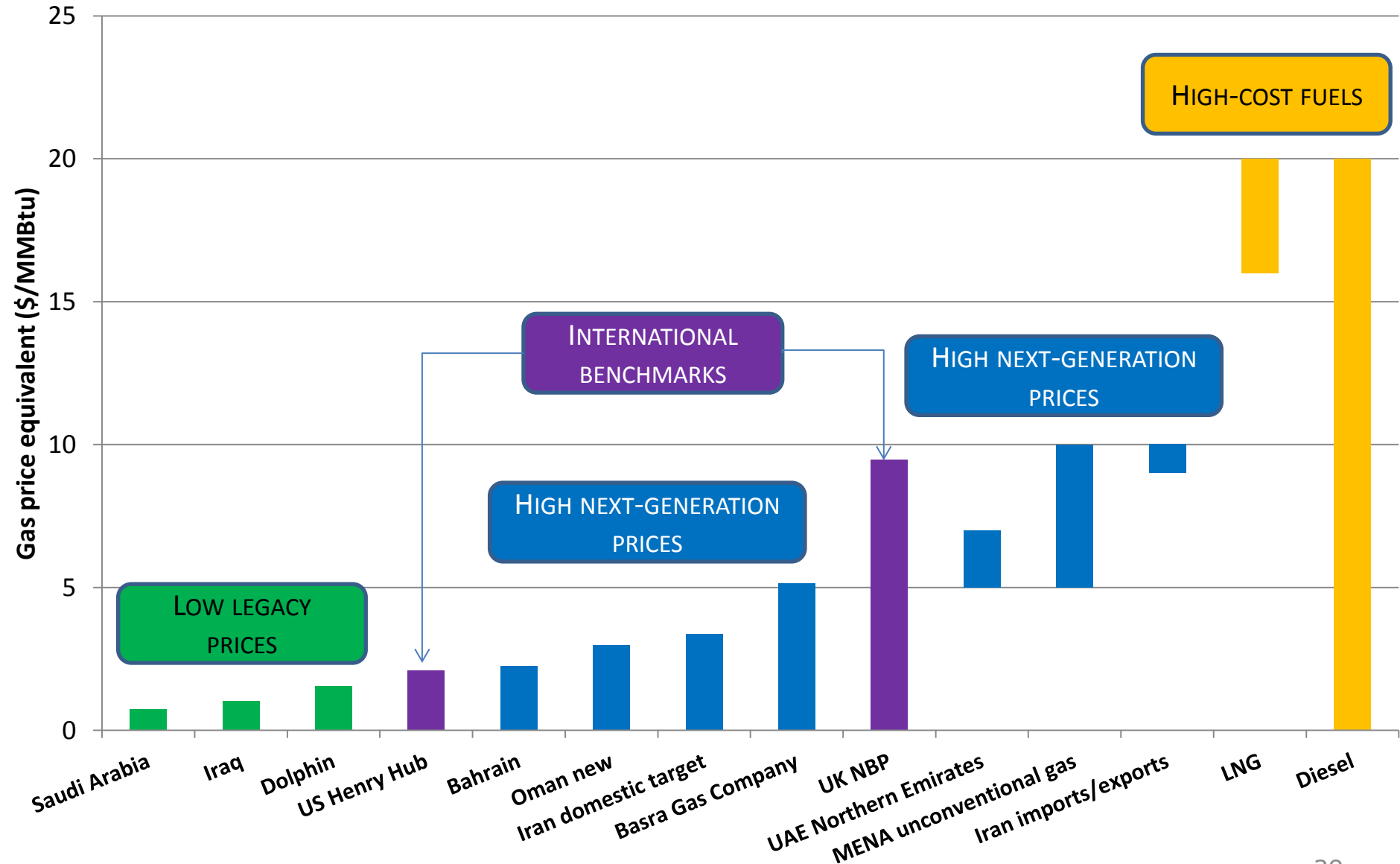
MENA unconventional gas SWOT analysis

Strengths	Weaknesses
<ul style="list-style-type: none"> • Strong existing transportation networks and infrastructure • Numerous organic-rich shale/carbonate horizons • Carbonate-rich shales (easy to fracture) • Preferential pricing for shale gas (Oman) • Incentives for exploration and development (Algeria new Petroleum Laws) • Fast-growing, gas-short domestic markets 	<ul style="list-style-type: none"> • More expensive to produce than conventional gas • Gas prices not high enough to support high costs • Water scarcity • Lack of drilling and exploration resources in North Africa at present as well as skilled labour • Only 3 dominant pumpers in the MENA: Schlumberger, Baker Hughes and Halliburton • Deep reservoirs • Uneven distribution of gas reserves between countries • Traditional mindset of NOCs
Opportunities	Threats
<ul style="list-style-type: none"> • Adequate resources of shale gas and tight gas • Gain to export in thriving gas industry • Local market conditions - gas shortage countries have potential for long term gas supply contracts • Many unexplored reserves in North Africa and Iraq • Saline-water & non-water fracs such as CO₂ and LPG to alleviate water shortages 	<ul style="list-style-type: none"> • Insufficient increases in gas prices • Lack of adaptation of fiscal regimes • Environmental opposition in Egypt and Tunisia • Political instability, particularly in North Africa • Competition from exports from US, East Africa, East Mediterranean

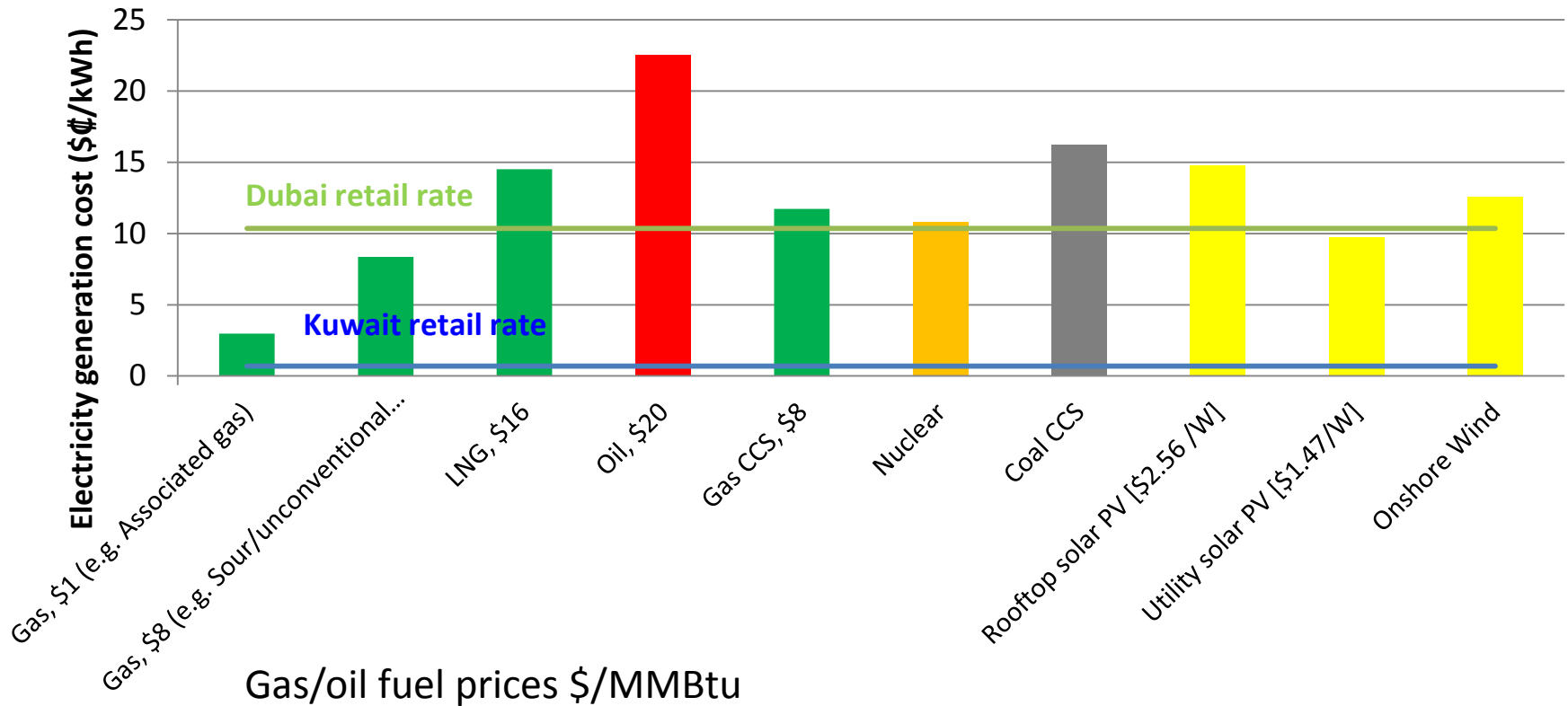
Gas prices have to rise to support shale gas development



Gas pricing reform slowly materialising

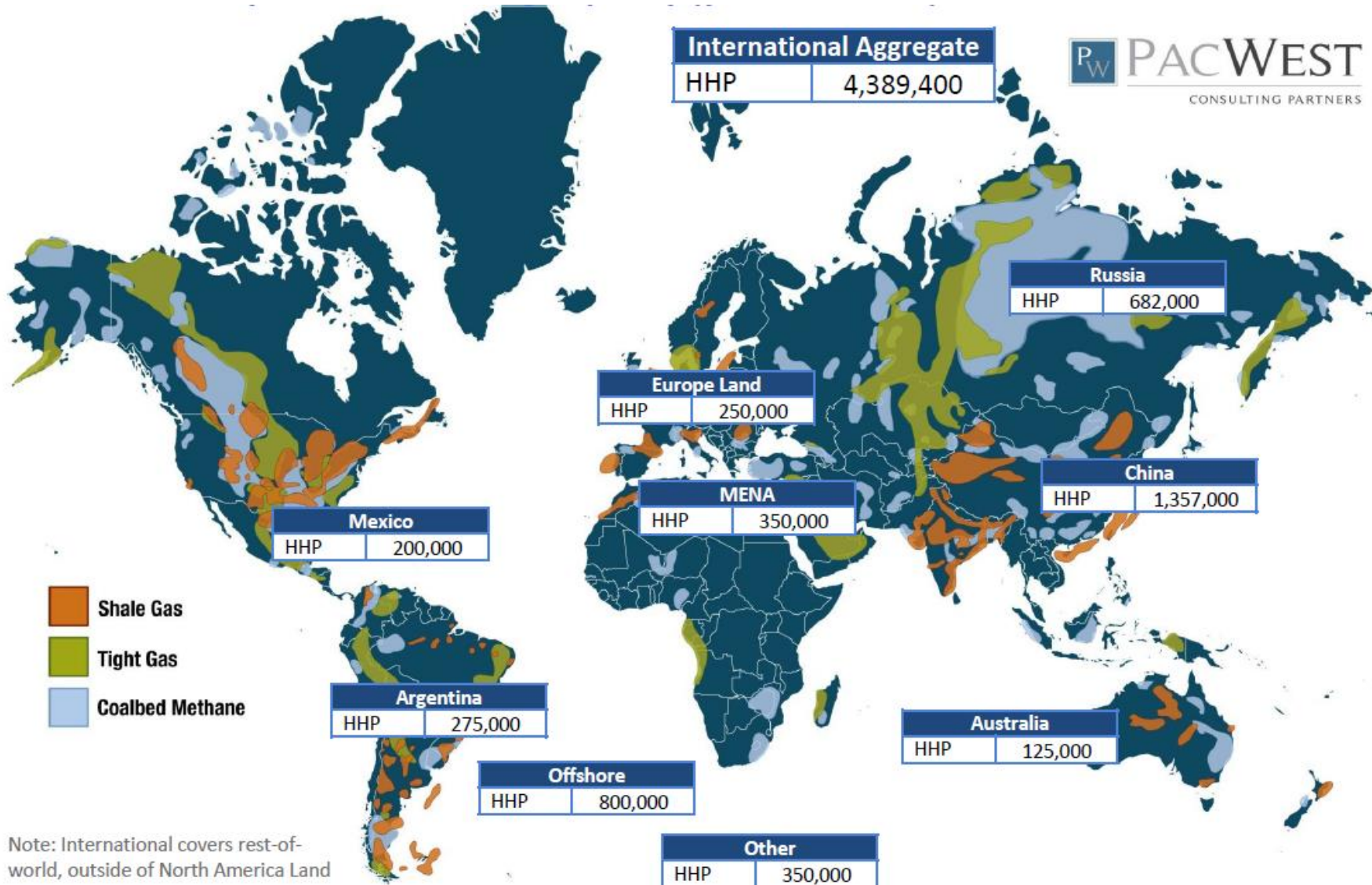


Unconventional gas still competitive



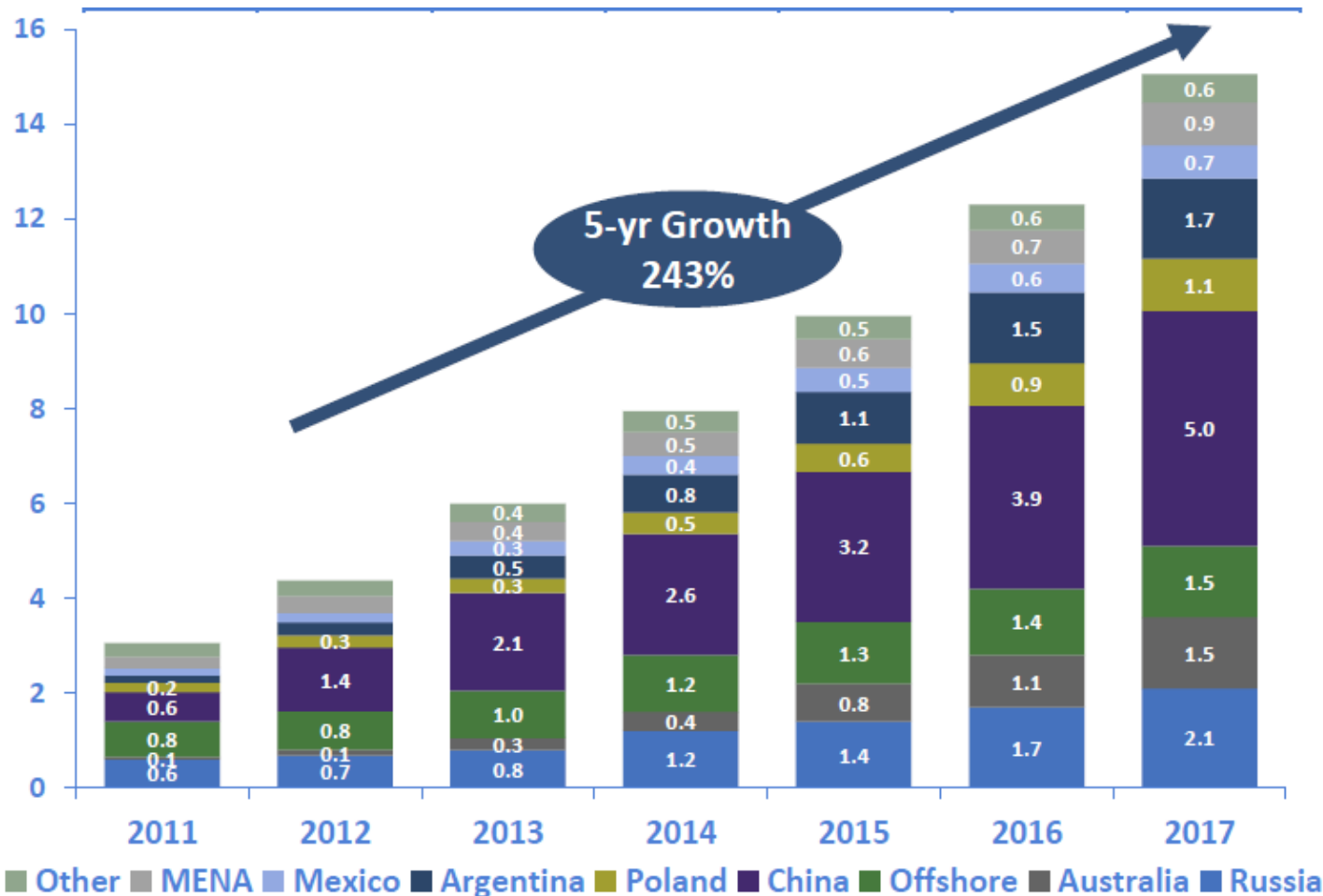
- Alternative generation (solar, nuclear, coal CCS) is cheaper than LNG or oil
- However, high-cost domestic gas (e.g. unconventional) at ~\$8/MMBtu is still competitive against alternatives

MENA frac capacity not insignificant today, but well behind China, Russia



MENA to see fast growth in frac capacity, but still small in global terms

International Frac Capacity (MM HHP)						
2011	2012	2013	2014	2015	2016	2017
3.1	4.4	6.0	8.0	10.0	12.3	15.1



Conclusions

- Shale oil and gas present both challenge and opportunity to MENA
- MENA likely to have large shale oil & gas resources, spread across many countries
- Less immediate need for shale oil given market constraints
 - But could be important in non-OPEC, second-tier producers
- Shale gas potentially important in meeting regional gas demand
 - Relevant to almost every country
- Barriers to development
 - Mainly: commercial terms, low gas prices
 - Also: water, service companies, deep reservoirs
- Region gearing up to activity: Jordan, Saudi Arabia, Oman, Algeria, Abu Dhabi, etc

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