

**Unconventional Hydrocarbons Potential
in Europe [and Greece?]:
Towards a New Energy Map**

Vasili Nicoletopoulos
Natural Resources GP

Athens Energy Forum 2014:
The Road towards a New Energy Map, Mar 13-14, '14

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Introduction...

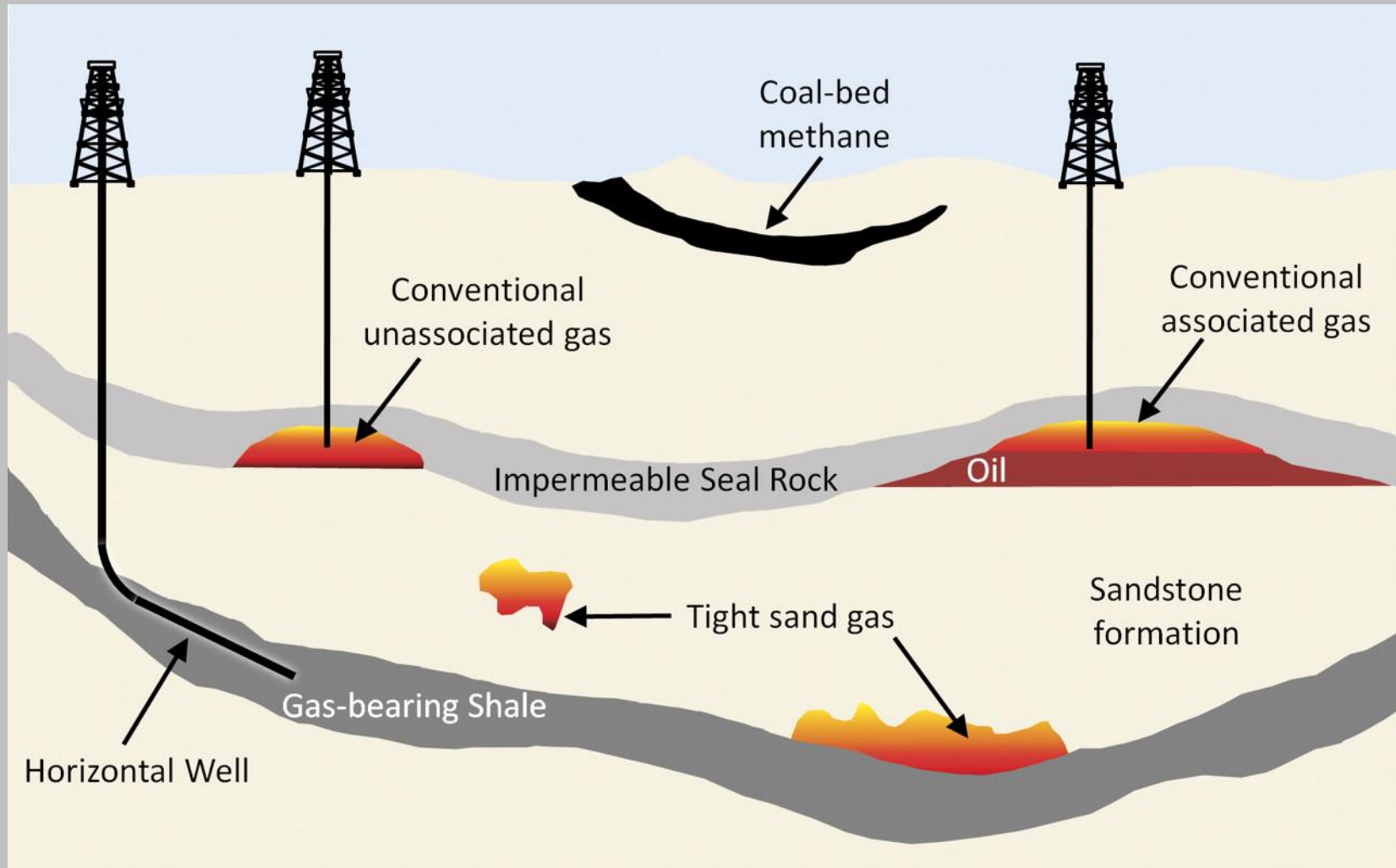
Unconventional Gas

- **Coal--bed methane [CBM]:** Trapped in coal seams, adsorbed in the solid matrix of the coal
- **Tight gas:** Trapped in relatively impermeable hard rock, limestone or sandstone, sometimes w/ quantified permeability limits
- **SG:** Trapped in fine grained sedimentary rock called shale, which has a characteristic 'flaky' quality

Unconventional Oil

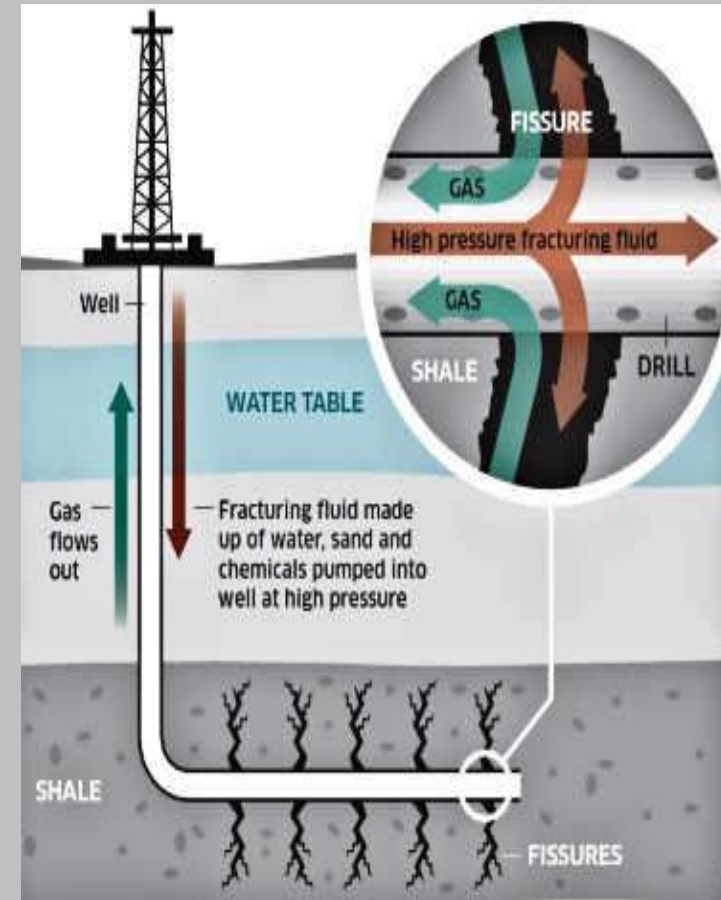
Shale oil: substitute for conventional crude oil from oil shale by pyrolysis, hydrogenation, or thermal dissolution

...Introduction...



...Introduction

- **Fracking:** chemically treated water & sand pumped into the ground @ extremely high pressure -> generate fractures or cracks in rocks -> release trapped oil, NG [conventional or not], geothermal energy, & water
- **Horizontal drilling:** same operators drill & set pipe for ≥ 1 mile horizontally through the same rock formation



Technological Developments

Techniques

- **Ceramic Proppants, Guar gum, frac sands, resin coated sands**
- **Foam fracking:** CO₂ foam, not water
- **LPG:** propane-based

Developments

- **Pad drilling:** drill *several wells from the same pad* to target a shale play more effectively
- **Combination of waste CO₂ with salt + water** -> products incl. baking soda (Na bicarbonate) and HCl -> as a SG fracking fluid
- **Non-Flammable Propane (NFP) Stimulation:** using a fluorinated form of propane (heptafluoropropane) as a stimulation fluid, eliminating use of water and all chemical additives

...Shale resources worldwide

Top 10 countries w/ technically recoverable shale oil resources, EIA, June '13

Rank	Country	Shale oil (billion barrels)	
1	Russia	75	
2	U.S. ¹	58	(48)
3	China	32	
4	Argentina	27	
5	Libya	26	
6	Australia	18	
7	Venezuela	13	
8	Mexico	13	
9	Pakistan	9	
10	Canada	9	
World Total		345	(335)

¹ EIA estimates used for ranking order. ARI estimates in parentheses.

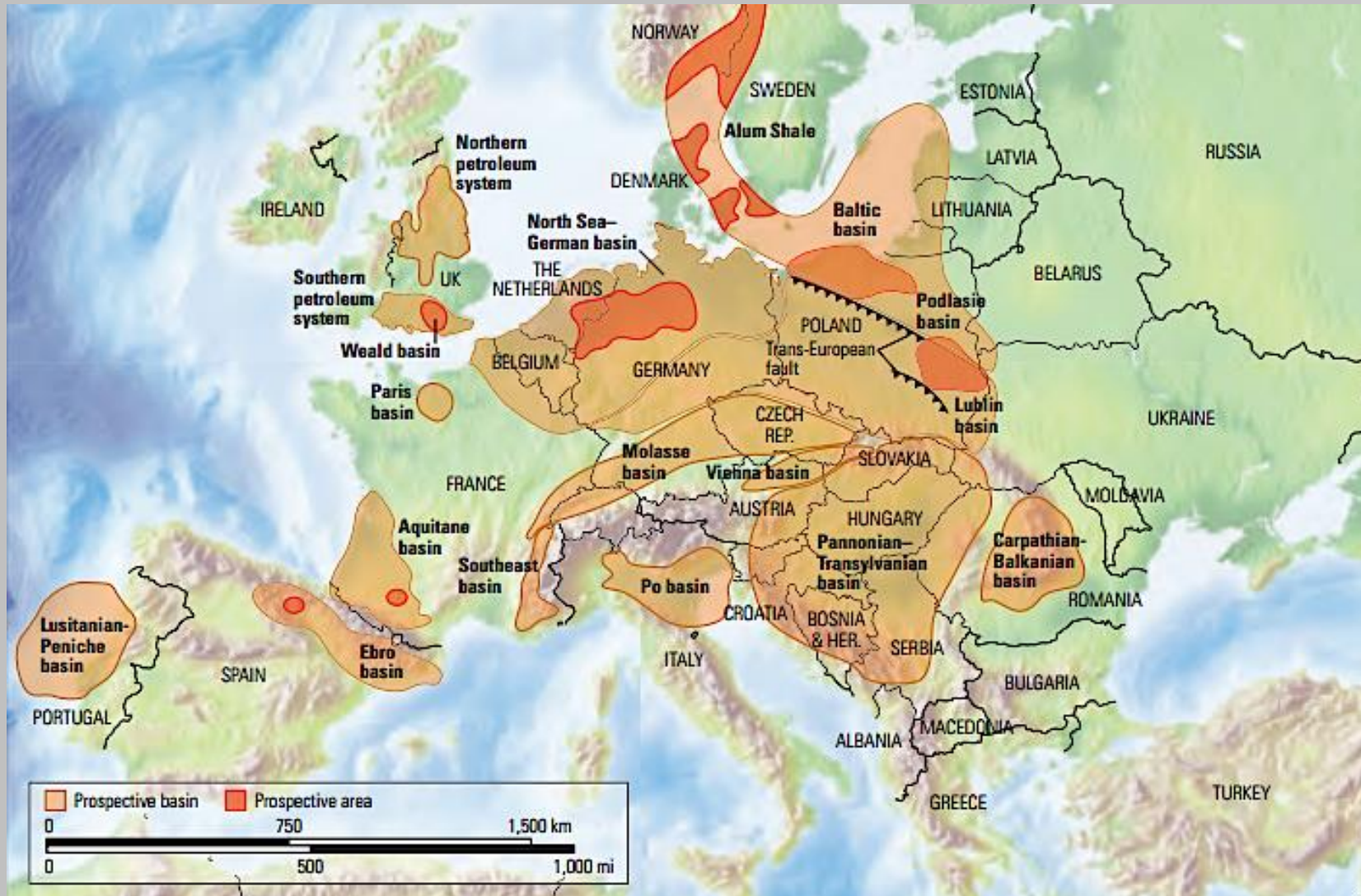
Top 10 countries w/ technically recoverable shale gas resources, EIA, June '13

Rank	Country	SG (trillion cubic feet)	
1	China	1,115	
2	Argentina	802	
3	Algeria	707	
4	U.S. ¹	665	(1,161)
5	Canada	573	
6	Mexico	545	
7	Australia	437	
8	South Africa	390	
9	Russia	285	
10	Brazil	245	
World Total		7,299	(7,795)

¹ EIA estimates used for ranking order. ARI estimates in parentheses.

The European situation...

Institute for Energy Resourcefulness



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...The European situation...

- **Poland[*], Ukraine, UK:** SG development

**Mar 12, '14* SG extraction will be tax-free until 2020, and after that the burden < 40 pct of income

- **Spain:** *Oct '13* govt legalised HF. *Dec 5th, '13* new law speeding up exploration approvals. *Jan 26, '14* Cantrabria's fracking ban challenged fm Madrid

- **Italy:** ENI: 'SG is a solution for the EU', Jan 22, '14

- **Bulgaria, Czech Republic, Netherlands:** moratorium

- **France :** Oct '13 constitutional court upheld HF ban, but: Feb 3, '14 Minister Montebourg 'ready to back proposal to allow local govts to individually decide on fracking using fluoropropane'

- **Denmark:** large reserves by European standards, issued two SG licences to Total of France

...The European situation...

Germany: *June '13* HF not yet approved, although govt commissioned legal framework for strict regulation. *Feb 6, '14:* 'govt will usher in scientific research on fracking effects' Economy Ministry. Berlin could make environmental impact tests, citizens' involvement

UK: *Dec 5, '13* Tax breaks for SG explorers: 24p in tax/ £1 spent developing. *Jan 27, '14* Cameron, Davos: 'SG reduced industrial gas prices in America, set to create a million more manufacturing jobs, firms build new factories', but *Feb 5, '14* 'Large-scale UK fracking unlikely to result in big cuts to household gas bills' George Osborne

Romania: lifted HF moratorium; exploration permits to Chevron in Black Sea region

...The European situation...

European Commission

Work Programme for 2013 includes 'Environmental, Climate and Energy Assessment Framework to Enable Safe and Secure Unconventional Hydrocarbon Extraction'

Sept '13 study on regulatory provisions for unconventional gas in 8 member states: BG, DK, D, LI, PL, RO, ES, UK

Oct '13 public consultation 'Unconventional fossil fuels in Europe' ->

Jan 22, '14 non-binding SG exploration recommendations*, call on MS to prepare 'strategic environmental assessment', keep public informed of fracking activities. **part of wider EC initiative -> integrated climate/energy policy framework for up to 2030*

...The European situation

European Parliament

Apr '12: MEP N.Tzavela report on '**Industrial, energy and other aspects of SG and oil**' for EP's industry committee; adopted 492 in favour, 129 against, 13 abstentions, *Nov '12* adopted 2 non-legislative reports on different aspects of SG: Industry, Energy and Research Committee & Environment and Public Health, *Oct '13* adopted amendments to Environmental Impact Directive 2011/92/EU, incl. automatic requirement for Environmental Impact Assessment for SG exploration/extraction with HF

Mar 12, '14 EP excludes shale gas fm tougher environmental code

Joint Research Centre

Sept '13 JRC's Institute for Health & Consumer Protection commissioned by DG Environment report on use of certain substances in HF of SG reservoirs under REACH

EHS issues

Environmental

- Water contamination/depletion
- Seismic risks
- Impacts on landscape and land use
- Air emissions and soil contamination
- GHG emissions [methane etc]
- Radioactivity?

But...

- IEA recent report: US SG boom decreased CO2 levels over last couple of years
- China increases overseas SG acquisitions under domestic and international pressure to cut CO2 emissions, move to cleaner energy

Economic aspects...

- US' SG and tight oil change global energy markets → lower NG prices → economic activity & enabled a return of energy-intensive industry that originally left due to high domestic energy prices. SG viewed by [some] European politicians & industry representatives as means to spur competitiveness of EU economy
- Development of new sectors: proppants, petrochemicals, chemicals
- Investors starting to ask questions: 'where are the earnings and the free cash flow?'. Shale companies spending a lot more than they are earning
- March 13: Shell abandons fracking

...Economic aspects...

- SG boom not sustainable except at higher gas prices in the US →lots of gas—not that much that is commercial @ current prices
- US NG companies faced w/ collateral damages of lower profits and large write-downs in their reported reserves
- Shale plays expensive, need high oil and gas prices to work. W/ high prices for oil, oil plays are fine; w/o high prices for gas plays, they are not working
- Preliminary negotiations in Washington on Trans-Atlantic Free Trade Agreement [TAFTA]. For Europe, *imports* fm the *US* likely to present faster way of lowering prices than overcoming social/ planning/geological barriers to developing continent's own reserves

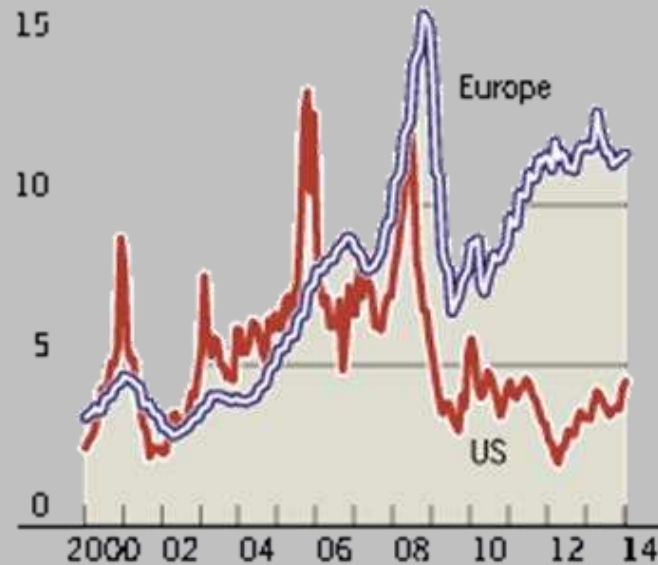
...Economic aspects

EU, US Natural gas Prices

Costly sources

Natural Gas prices

\$/mbtu



Source: World Bank

Geopolitics...

- Energy a big factor: mining/metallurgy, steel, cement, glass, refractories, transport etc all very energy-intensive
- Users of energy as raw material, eg. petrochemicals, could move to the US, eg Sabc
- Reducing import dependency: SG viewed by European govts as a way to lessen their dependence on external suppliers & create greater energy autonomy. Russia's geopolitical influence can only be mitigated w/ cheap, domestic gas & oil in Europe
- Europe now importing US coal!
- Shale plays will eventually spread to Europe but will take longer than in N.America. Biggest reason: lack of private mineral ownership in most of Europe

...Geopolitics...

EU Gas Imports 2010-'13

TABLE: Gas flows to Europe
unit: billion cubic meters

	2010	2011	2012	2013*
Imports from Russia to Europe	144.5	156.6	148.0	167.2
<i>Transit through Ukraine</i>	<i>93.9</i>	<i>99.1</i>	<i>78.9</i>	<i>82.3</i>
Total European imports from sources other than Russia:				
- imports from North Africa	71.6	56.5	60.4	48.5
- imports from Iran, Azerbaijan	12.3	12.0	11.6	13.0
- LNG imports	86.7	86.2	63.7	45.8
OECD Europe				
- demand	560.4	511.1	502.2	503.2
- production	293.6	272.4	274.9	270.3

* All import data refer to OECD Europe and non-OECD Europe together. In contrast, demand and production refers to OECD Europe only, as 2013 estimates for non-OECD Europe are not yet available.

Source: IEA, Mar 4, '14

...Geopolitics...

- Domestic shale production limited in volume but will foster gas-on-gas competition in Europe and help EC's liberalization efforts.
- Europe's national leaders would therefore do well to deal with SG as a European-level policy issue. Needed: clear analysis of what SG might and might not add to their country's energy security; SG governance framework @ EU and national levels; public debate surrounding it.
- Tight oil, produced w/ same technology as SG, boosting US oil production too, output up 56 pct since 2008 - an increase larger than the total output of each of eight of the 12 OPEC members

...Geopolitics

- Much of new global LNG capacity developed w/ US market in mind. Now, w/ US market cordoned off by cheap domestic gas, some of that LNG is going to Europe-> unexpected competition for Russia/Norway
- American SG changes balance of competitiveness in world economy, gives US an unanticipated advantage
- Throughout Europe, industrial leaders increasingly alarmed by loss of competitiveness to factories using low-cost NG -> shift of manufacturing fm Europe to US
- Iran now in serious nuclear negotiations, might not have happened w/o tight oil; the increase in US oil production over the last two years has more than made up for the missing Iranian output, enabling the sanctions

Shale prospects in and around Greece?...

Ukraine: very large potential incl. off-shore Crimea; moving; recent events ???

Turkey: exploration in SE Turkey and E.Thrace

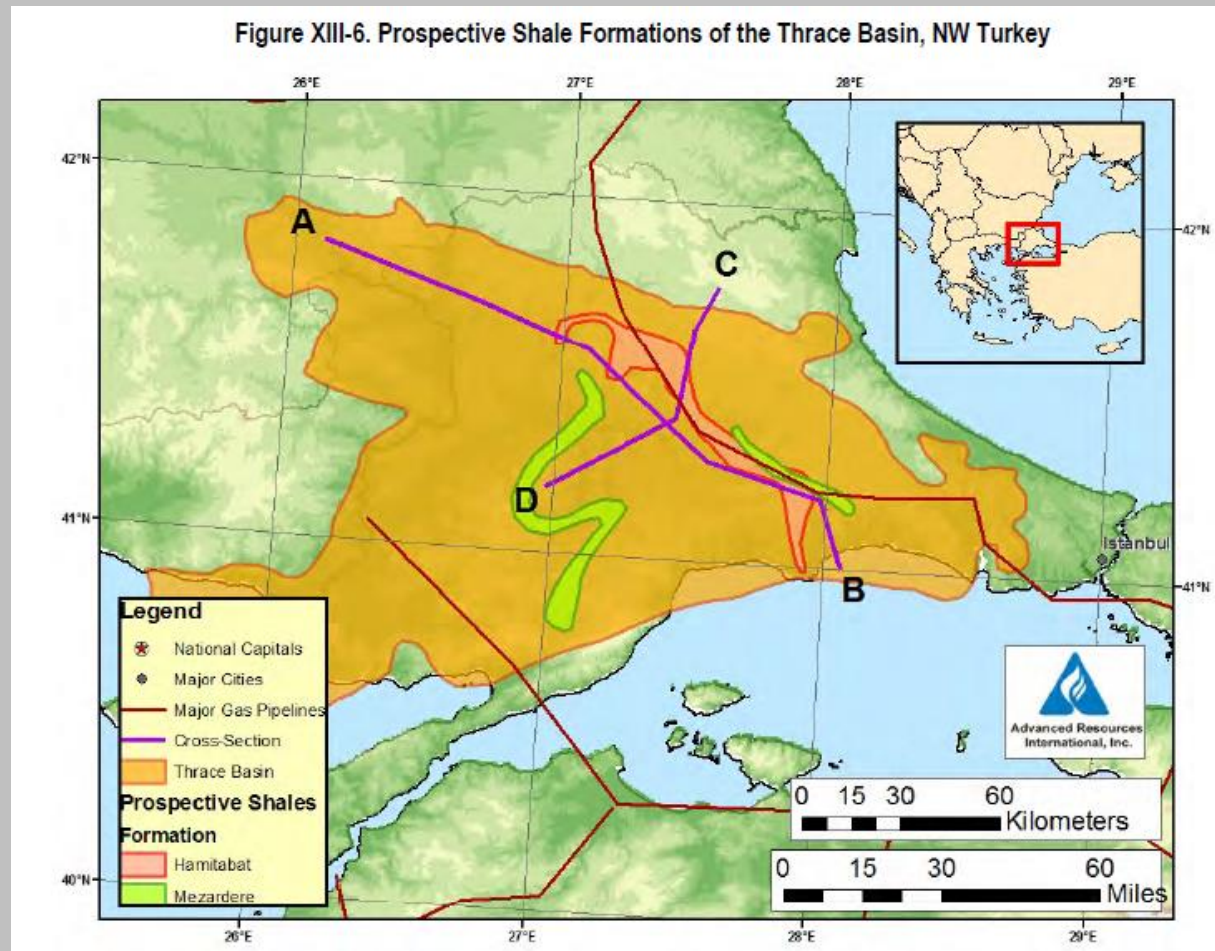
Bulgaria: potential in N.Thrace but moratorium

Greece:

April '13: 'Encouraging preliminary findings of SG existence, esp. in N. Greece': Vice-Minister Mr M.Papageorgiou at Informal Council of EU Ministers for Energy, Dublin

- *Thrace [Alexandroupolis – Orestiada] and Lemnos*
- *Kavala - Prinos*
- *Axios Basin - Thermaikos*
- *Western Greece: Epirus, Katakolo, Akarnania*
- *Grevena*

...Shale prospects in Greece?



Conclusions

- **Fracking is a real revolution**
- **Already a huge advantage for the US**
- **But fracking is also a victim of its own success, especially SG**
- **Negatively affected conventional producers: Russia, Qatar, Norway for gas, S.Arabia etc for oil**
- **Export license control in the US**
- **Europe years behind, might never catch up**
- **East Europe sees HF as a tool for independence**
- **China and Russia getting in the act as producers**
- **Turkey and, sooner or later, Bulgaria to find recoverable reserves**
- **Greece: a ‘?’ as is often the case**

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Main source

**'Hydraulic Fracturing and the Growth of Shale Gas and
Shale Oil Internationally'**

A New Study by Natural Resources GP

Thank you very much!
Vasili Nicoletopoulos

www.naturalresources.gr