The future of energy in Europe and the climate-security nexus: insights from the SECURE scenarios

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Energy and climate: two « bathtub problems »

- **Between now and 2050, humanity have to face a double problem:**
  - The growing scarcity of oil (… and gas, but not of coal !)
  - The accumulation of GHGs in the atmosphere
- **These « bathtub problems » cannot be considered independently as:**
  - Hydrocarbon scarcity paves the way to coal
  - Conversely, climate policies open the path to low carbon societies
- **« Smart » energy policies and associated international relations should combine the security and sustainability dimensions**

Scenarios and their policy settings

Main results of the SECURE scenarios

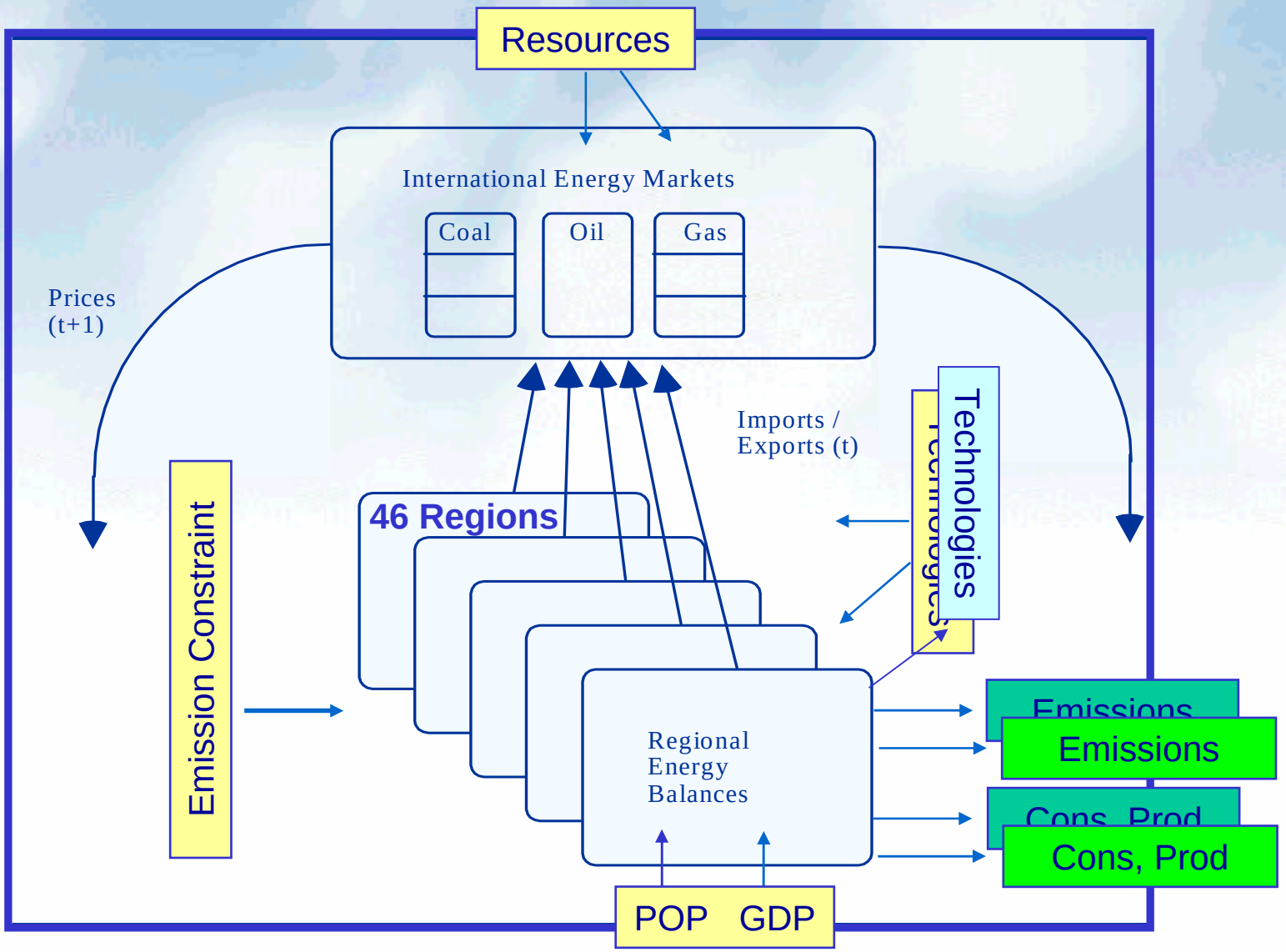
Impacts of scenarios on Russian exports

Impacts of scenarios on European energy vulnerability

SECURE: purpose of the study

- The SECURE project – in FP7 – aims at analysing future energy Security of Supply for Europe
- Research also needs to take into account potential impacts of climate policies on the world energy system
- The POLES long-term world energy model is used to produce a number of framing scenarios, in order to explore the « climate change and energy security nexus »

The POLES model year-by-year recursive simulation process



5 scenarios + 3 sensitivity studies with the POLES model

Scenarios

1. The ***BaseLine*** case is a counter-factual, no climate policy scenario, used mostly for benchmarking
2. The ***Muddling Through*** scenario describes the consequences of non-coordinated, low profile climate policies
3. The ***Muddling Through & Europe Plus*** case represents the same settings but with a stronger effort in Europe
4. The ***Europe Alone*** case represents the outcome of a scenario in which only the European Union commits to strong targets (-80%)
5. The ***Global Regime*** explores a new world energy system, under strong emission constraint, consistent with the 2℃ target

Sensitivity studies and shocks

1. Oil and gas shocks
2. Nuclear accident + phase out
3. Problems in the diffusion of the CCS

The carbon constraint as identified in IPPC AR4

Table SPM.5: *Characteristics of post-TAR stabilization scenarios [Table TS 2, 3.10][a)]*

Category	Radiative forcing (W/m^2)	CO_2 concentration[c)] (ppm)	CO_2-eq concentration[c)] (ppm)	Global mean temperature increase above pre-industrial at equilibrium, using "best estimate" climate sensitivity[b), c)] (°C)	Peaking year for CO_2 emissions[d)]	Change in global CO_2 emissions in 2050 (% of 2000 emissions)[d)]	No. of assessed scenarios
I	2.5-3.0	350-400	445-490	2.0-2.4	2000-2015	-85 to -50	6
II	3.0-3.5	400-440	490-535	2.4-2.8	2000-2020	-60 to -30	18
III	3.5-4.0	440-485	535-590	2.8-3.2	2010-2030	-30 to +5	21
IV	4.0-5.0	485-570	590-710	3.2-4.0	2020-2060	+10 to +60	118
V	5.0-6.0	570-660	710-855	4.0-4.9	2050-2080	+25 to +85	9
VI	6.0-7.5	660-790	855-1130	4.9-6.1	2060-2090	+90 to +140	5
						Total	177

SECURE scenarios, hypotheses and outcomes

	Carbon Price 2050 (€/tCO2)	Emissions 2050 / 1990	AR4 categories
Baseline	0	134%	Type VI (5-6℃) 700 CO2
Muddling Through	40 in Eur 32 in RoW	72% (EU: -21%)	Type IV (3-4℃) 500 CO2
MT E+	89 in Eur 32 in RoW	67% (EU: -40%)	Type IV (3-4℃) 500^{-} CO2
Europe Alone	185 in Eur 32 in RoW	59% (EU: -60%)	Type IV (3-4℃) 500^{-} CO2
Global Regime	392 in A1 257 in NA1	(2050/2000) -50% (Annex 1: -80%)	Type II (2-3℃) 400 CO2

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Main results of the SECURE scenarios

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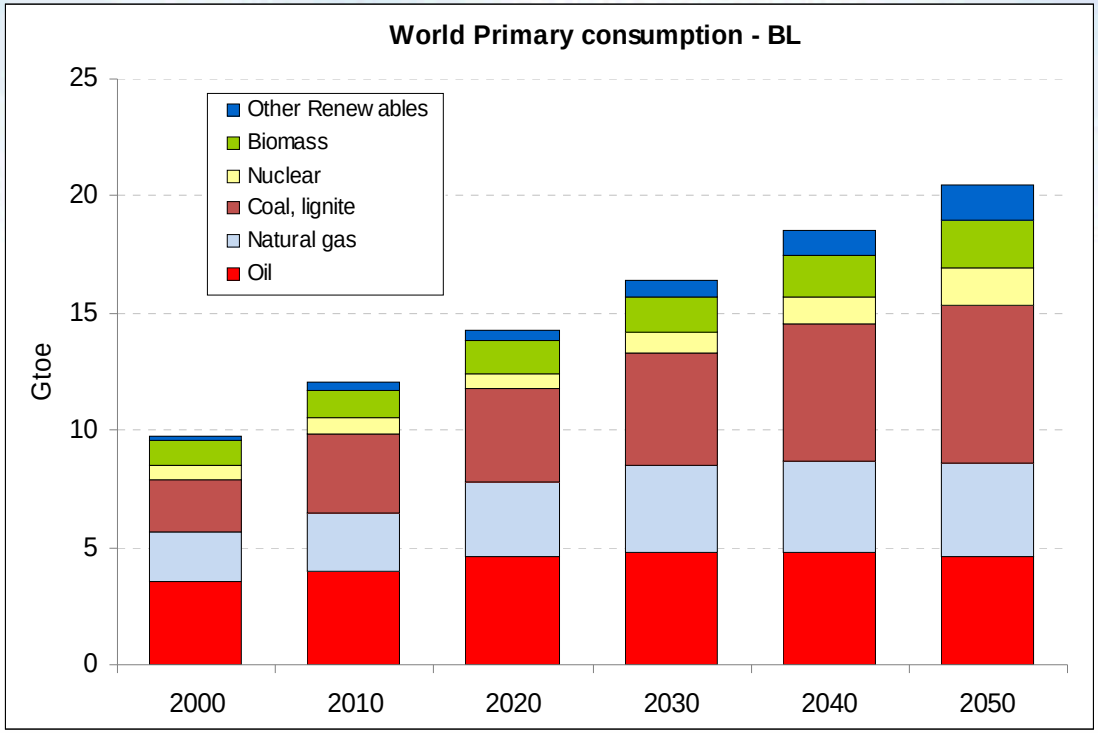
Unsustainability of the Baseline

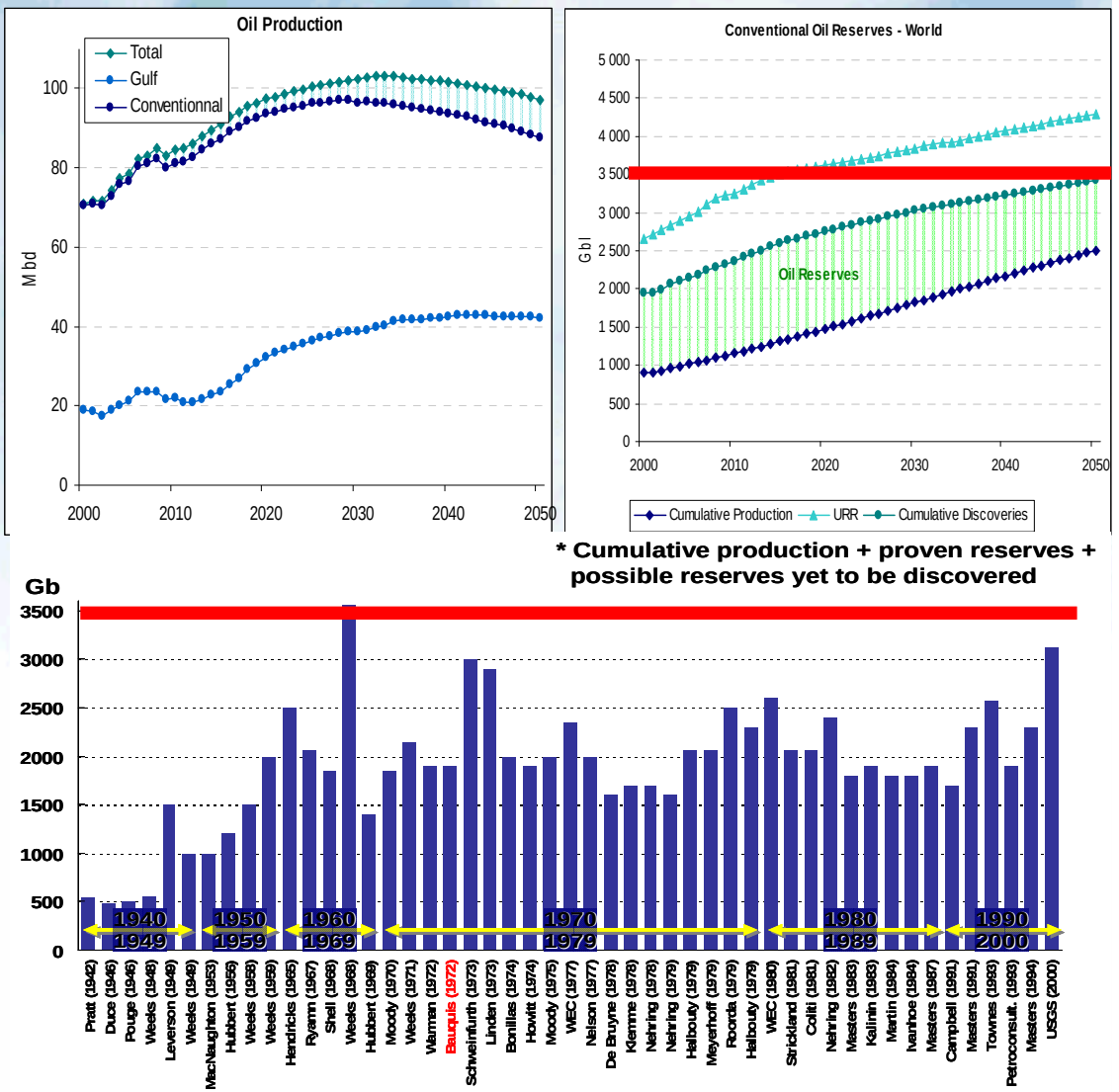
- In the Baseline case, Oil and Gas first increase but then peak in 2030 and 2040 and thus Coal more than doubles, to 6.5 Gtoe in 2050
- World energy consumption and CO2 emissions double in 2050: this is not sustainable from the climate perspective



Sustainability problem N°2

- Oil production profiles and URRs are in the upper range of the available resource estimates

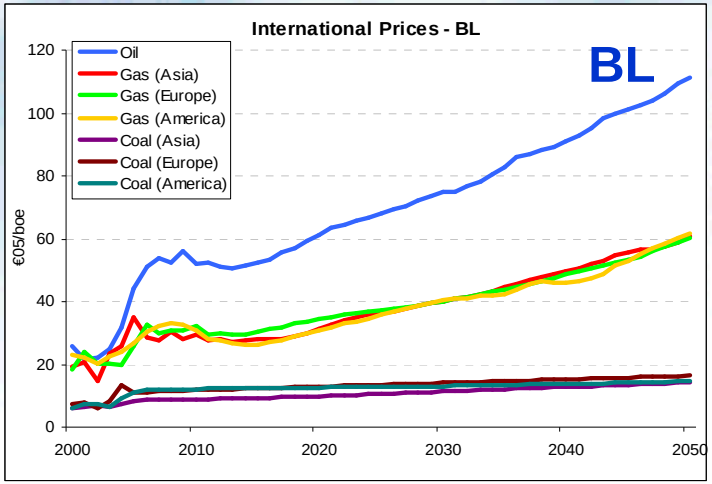
(P.R. Bauquis, ASPO)

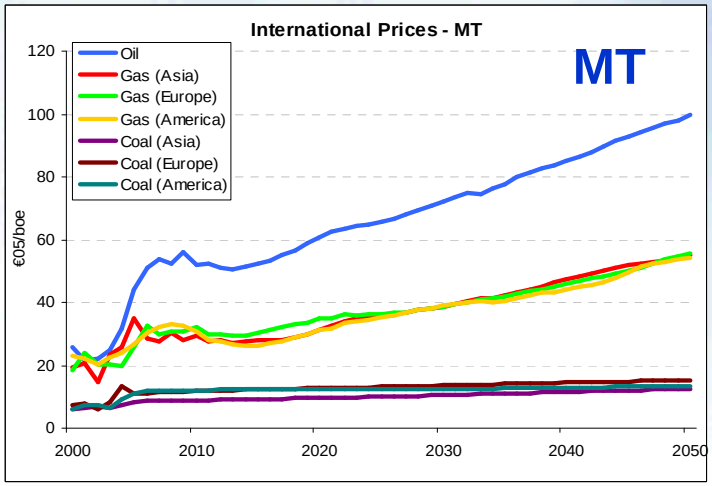


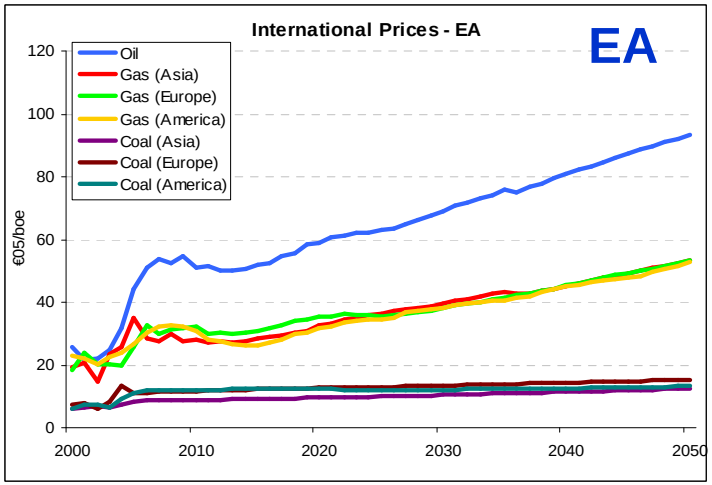
Source: IFP/DSEP adapted from Martin (1985) and Campbell (1992) - Updated 2000

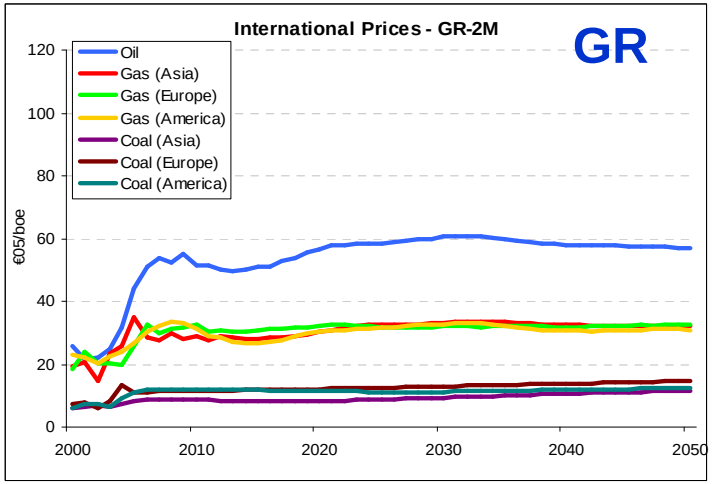
International energy prices

- In 2050, international oil and gas prices are about twice lower in the Global Regime than in the Baseline
- Of course, the risks of price shocks are much higher in the Baseline



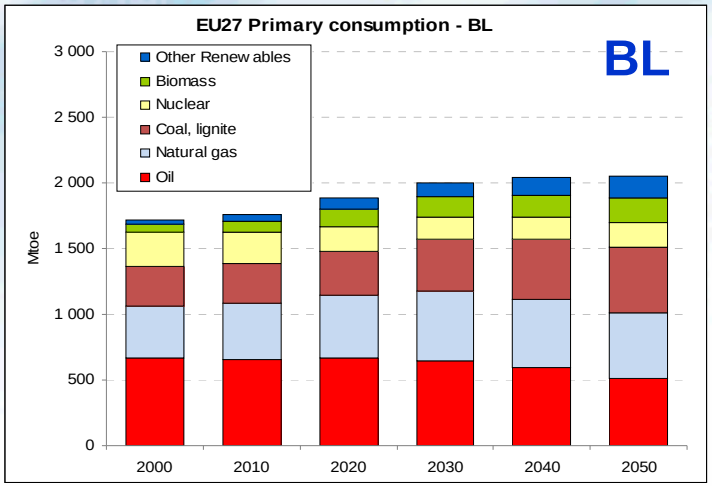


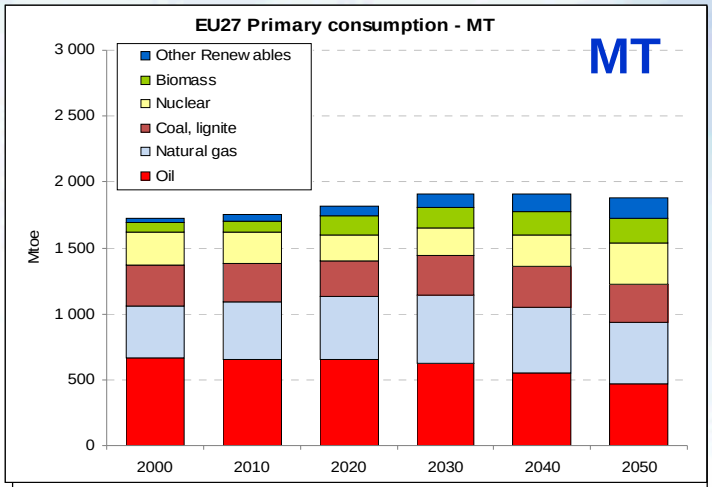


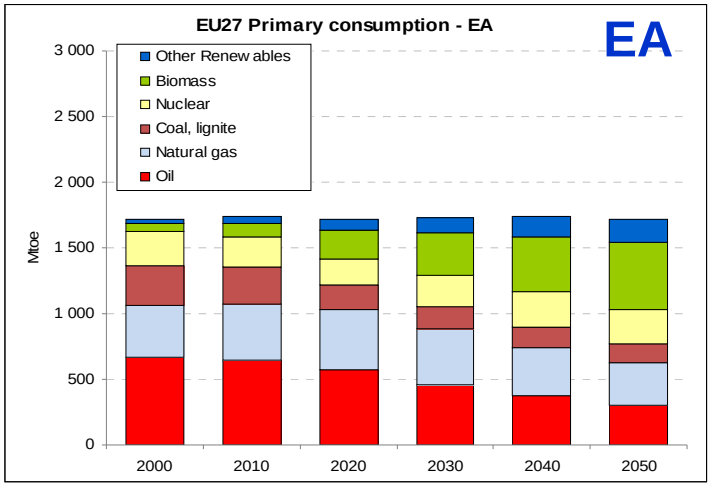


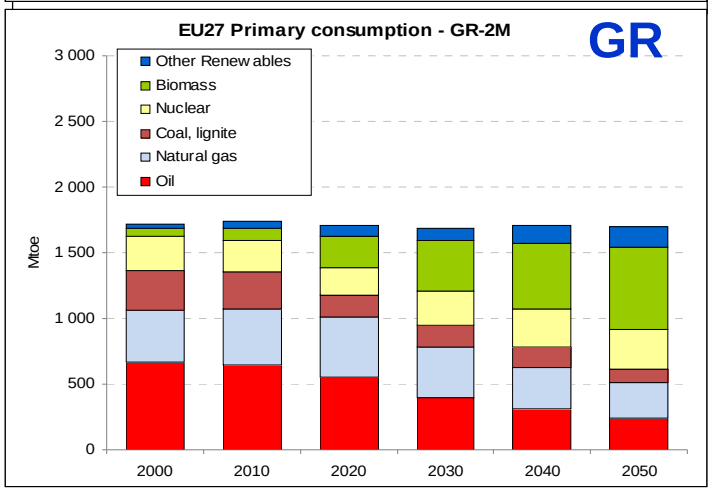
European primary mix by scenario

- In the Global Regime total demand is 20% lower in 2050 than in the Baseline
- And non fossil sources represent almost two thirds of supply, compared to only one fourth in the baseline



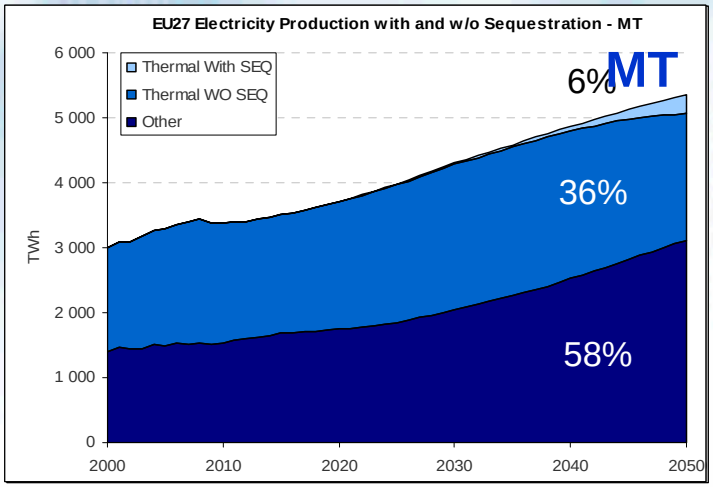


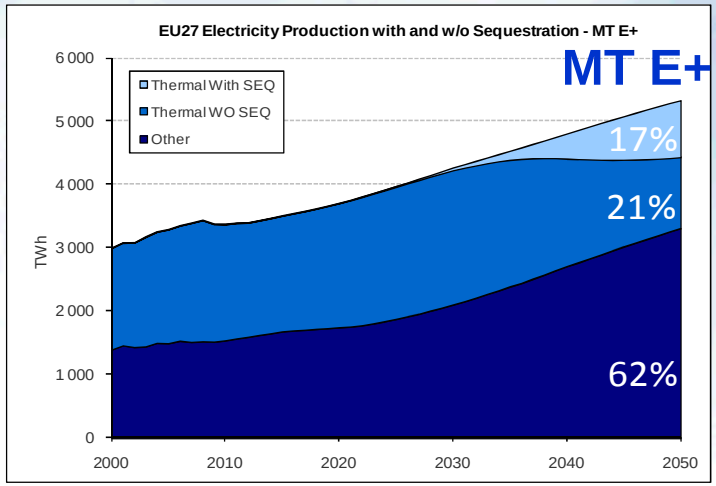


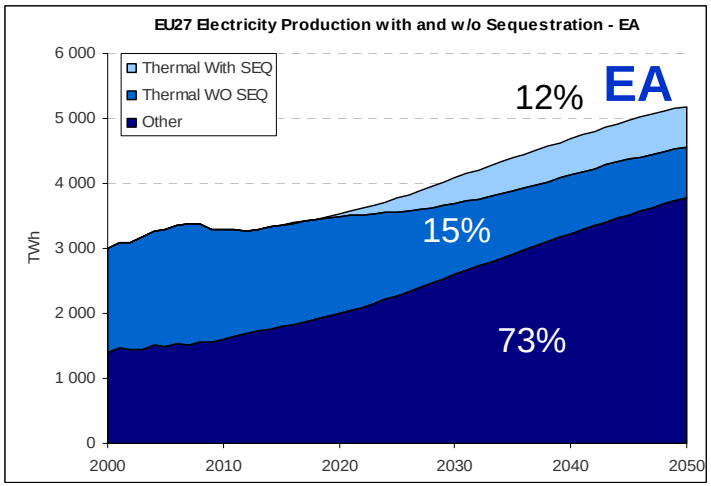


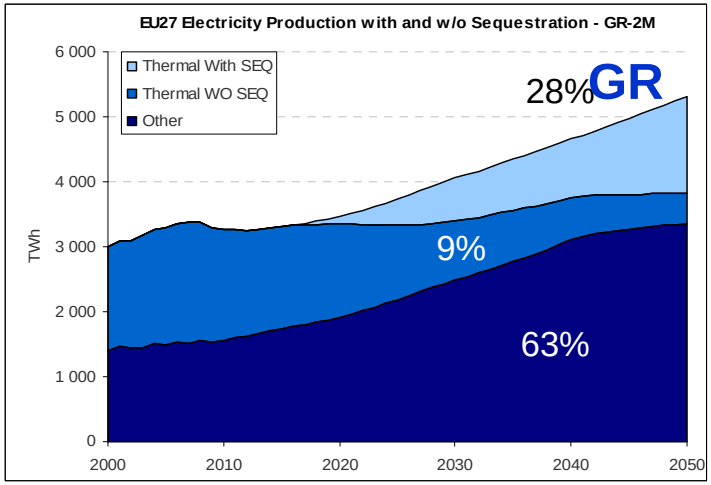
European electricity production

- Total electricity is not impacted as it is a major carrier of decarbonisation
- However the share of thermal production without CCS decreases dramatically when the emission constraint is reinforced



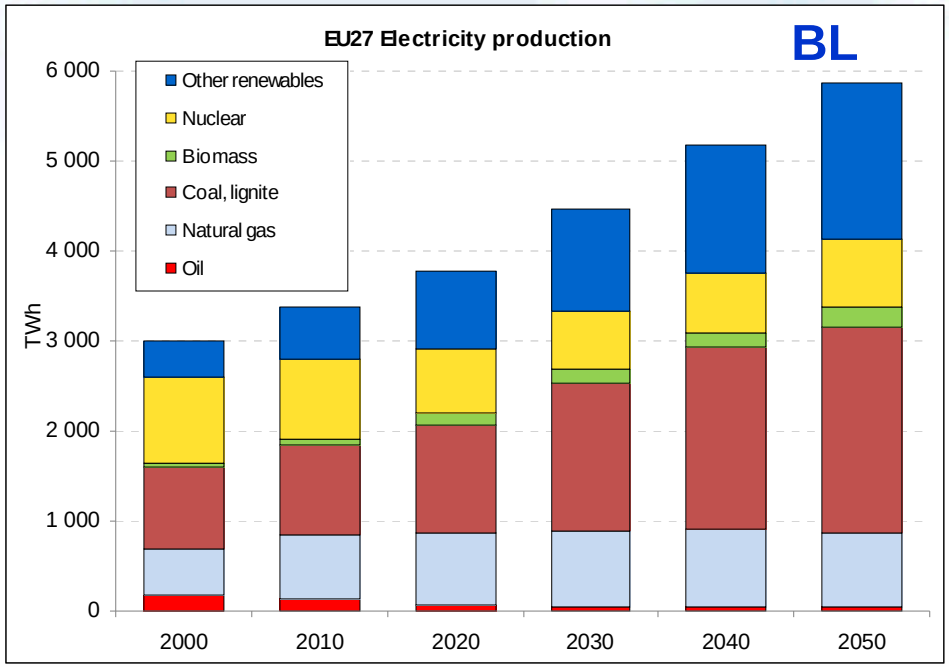


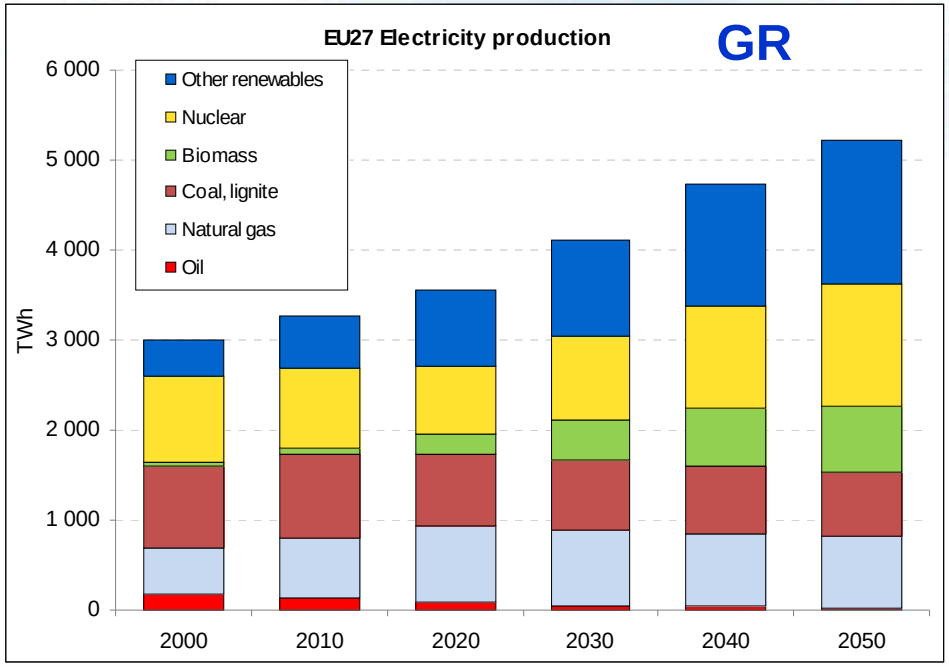




European electricity production by source

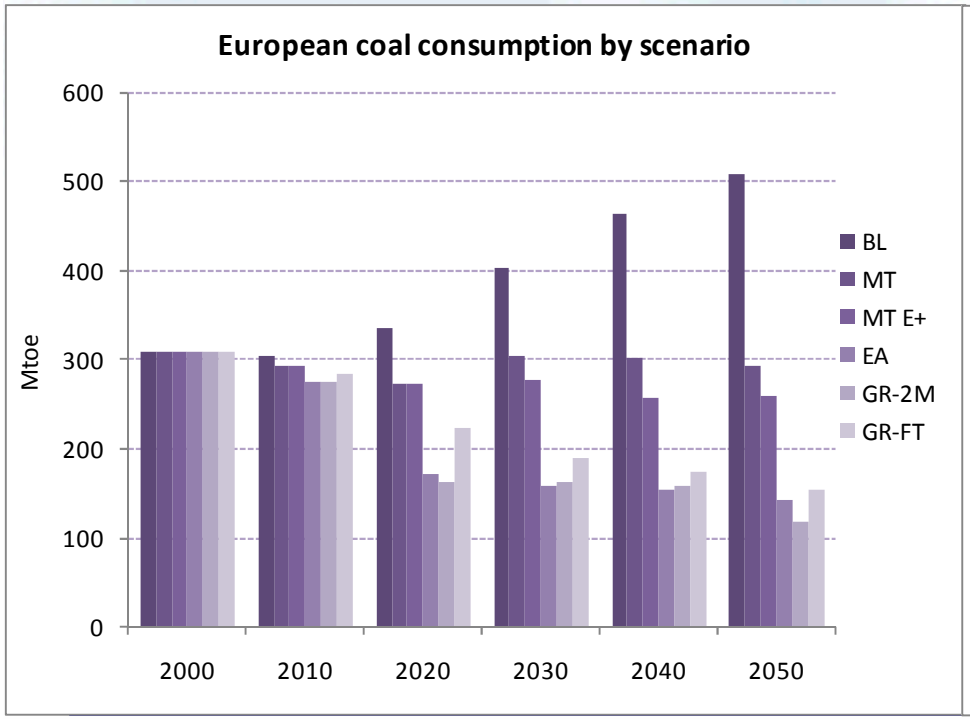
- A strong carbon constraint induces more nuclear and renewables and triggers a substitution of coal-based by biomass-based generation while CCS develops
- Natural gas power generation is hardly impacted

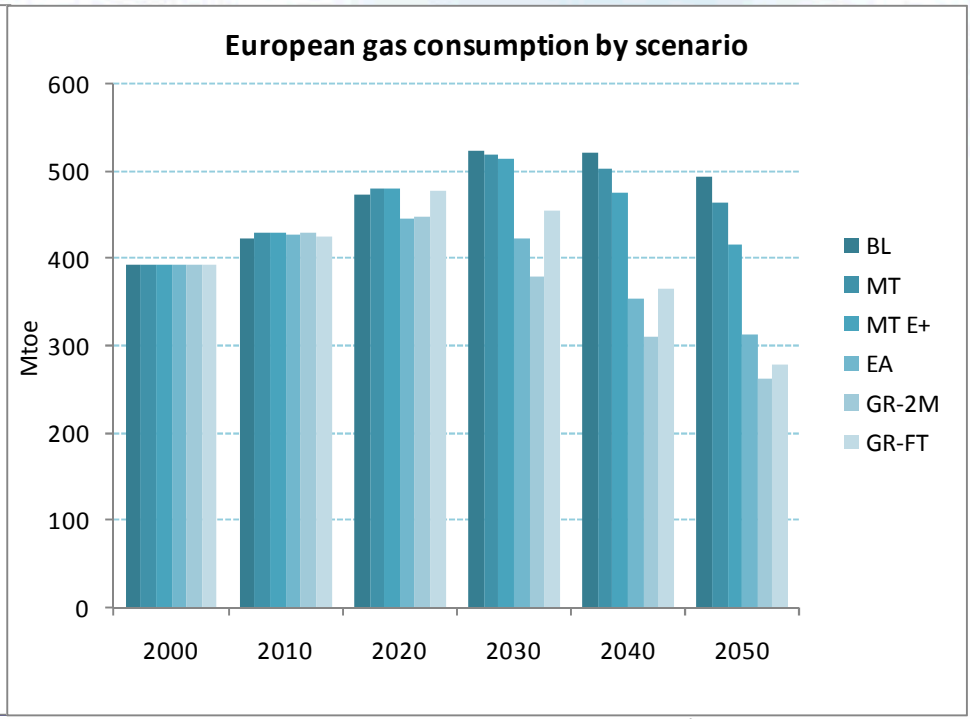




Europe's coal and natural gas consumption

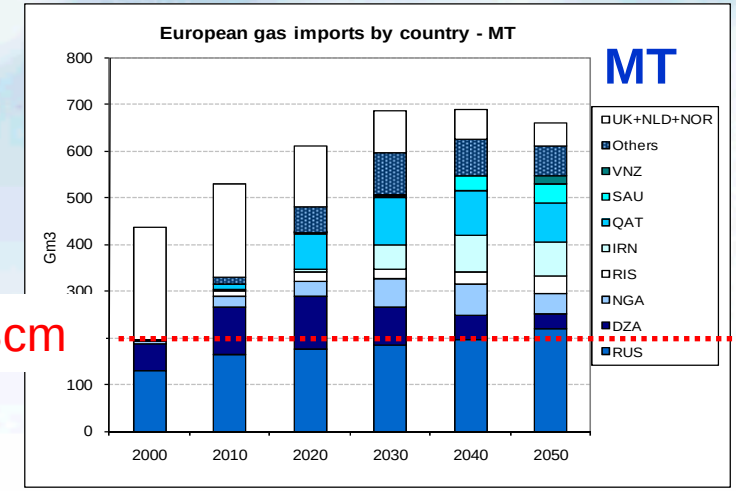
- Natural gas, as a non CO2 intensive fossil is much less impacted by climate policies than coal
- Total 2020 gas supply decreases only from 480 to 450 Bcm between the two extreme cases, however in 2050 it decreases from 500 to 265 Bcm



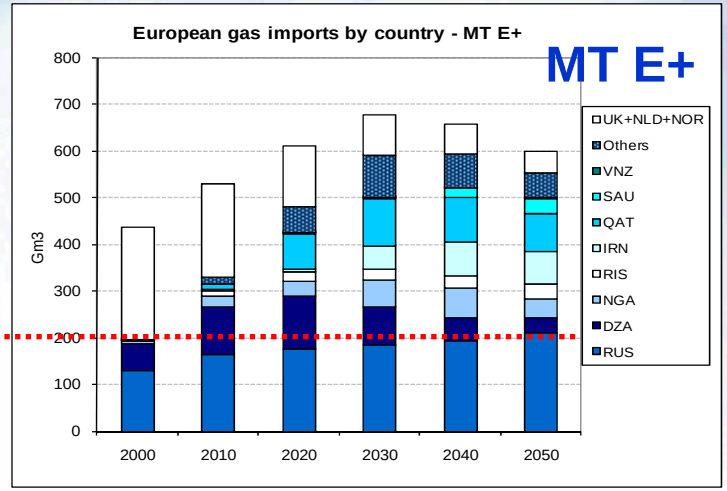


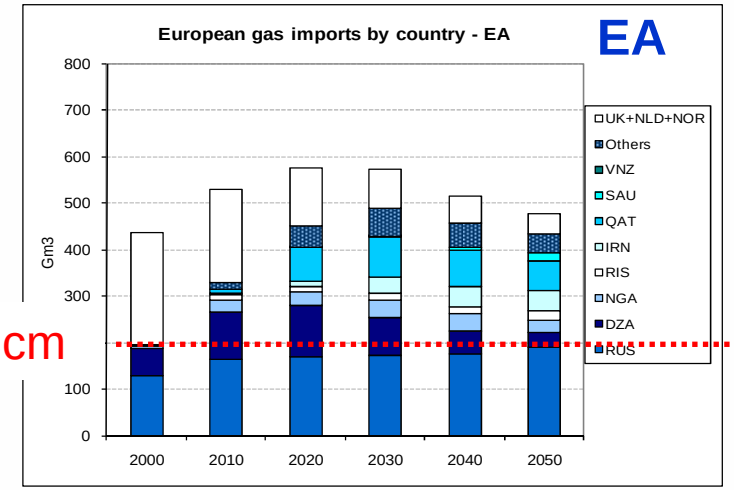
European Gas supply

- Domestic production drops over time and as imports stabilize after 2040 at a level triple of today in BL and MT
- They peak in 2020 and then decrease in the EA and GR cases



200 Bcm





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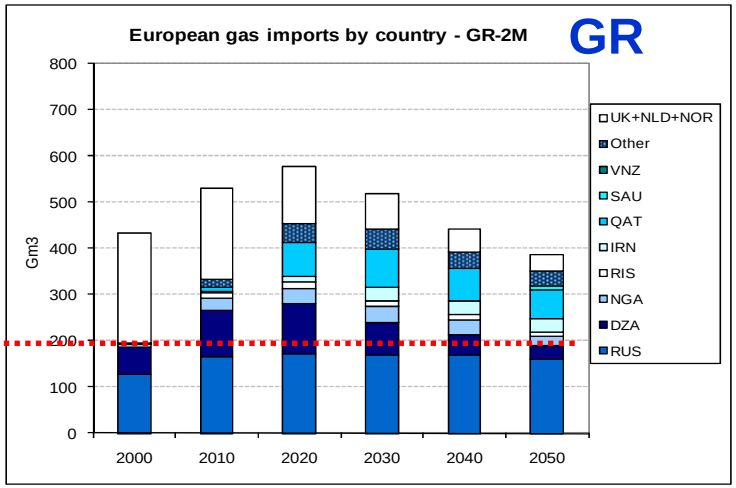

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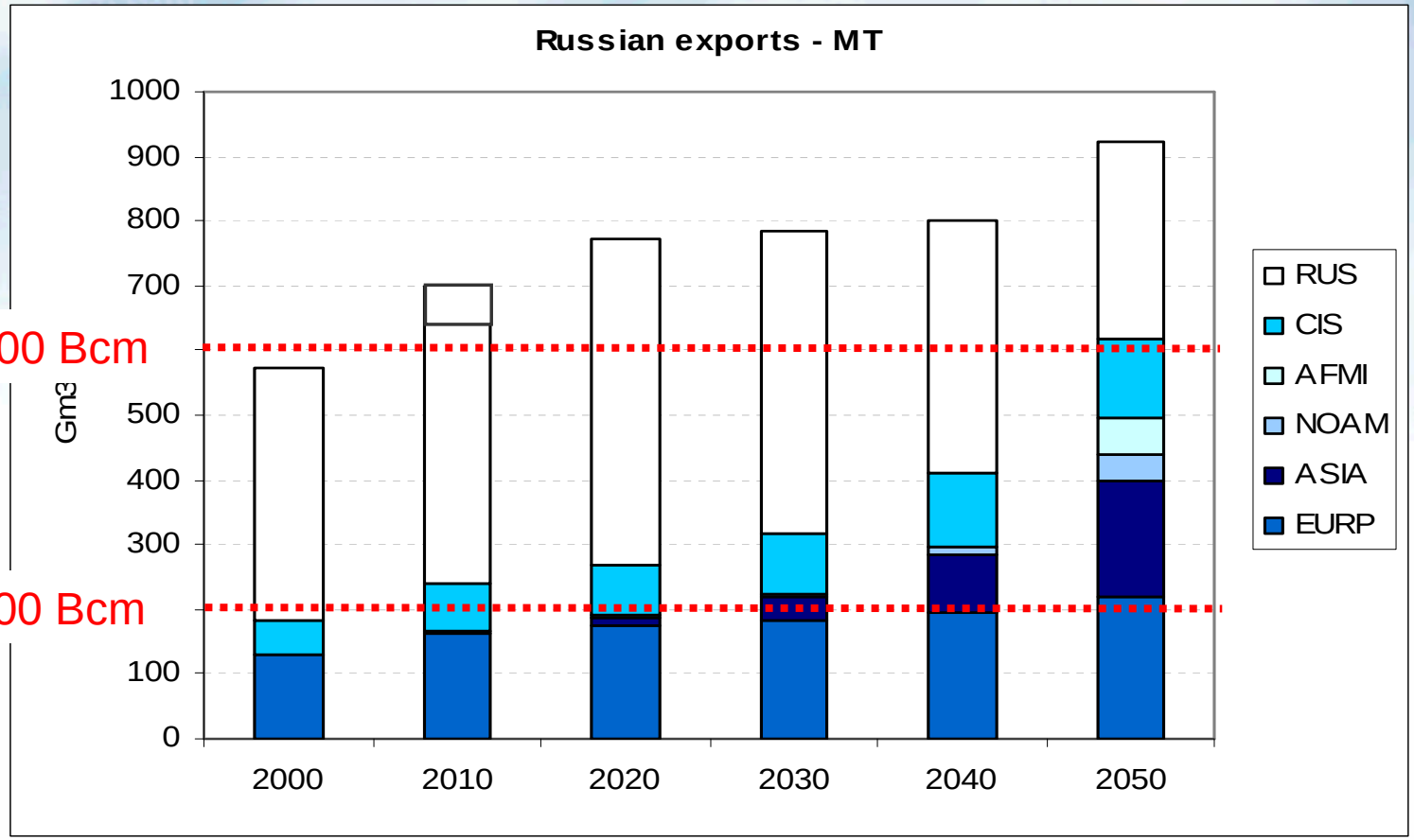
Impacts of scenarios on European energy vulnerability

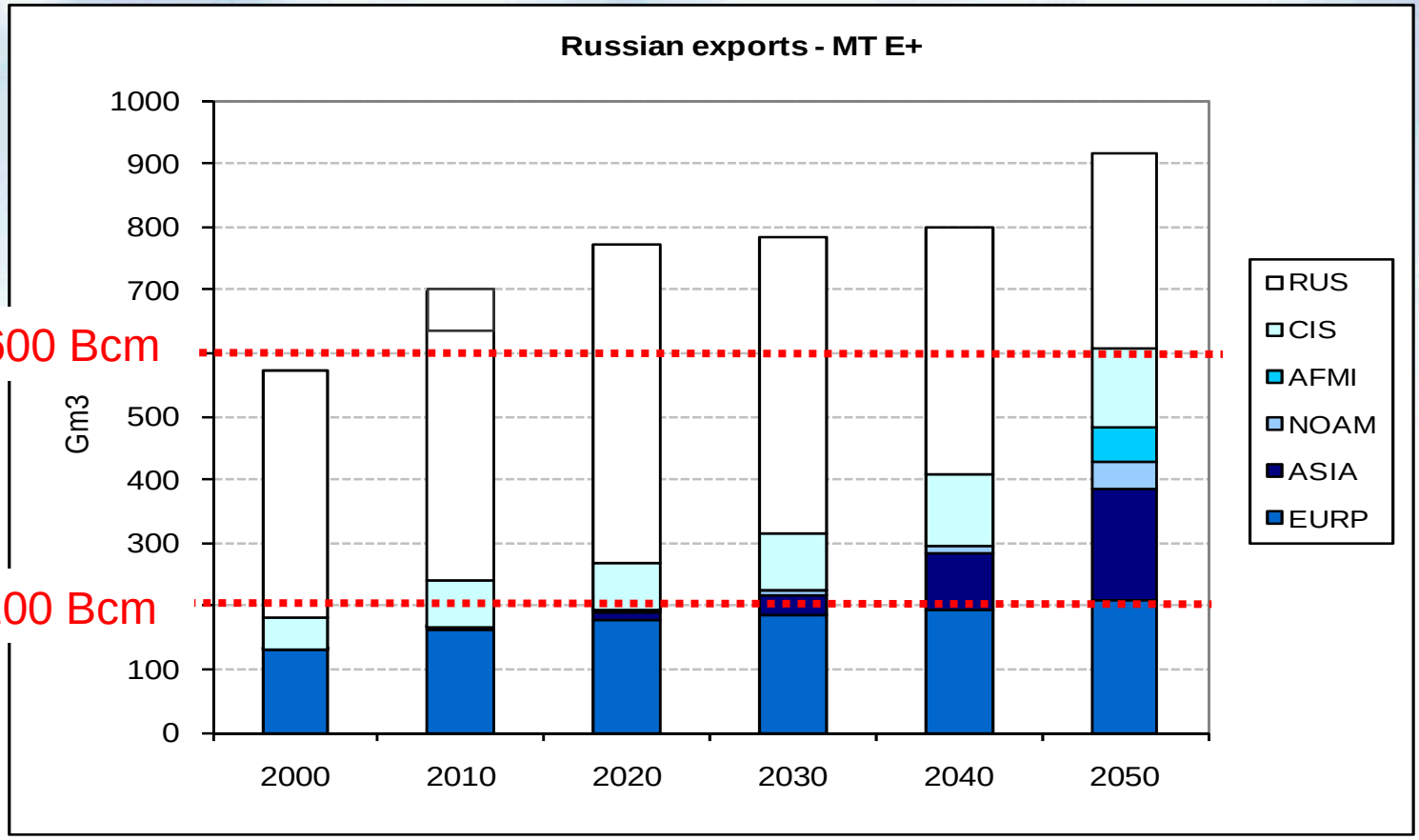
"Muddling Through"
Russian gas production and exports



"Muddling Through"

1. Maybe the most probable, but not the most desirable scenario from the climate perspective
2. It is a high production/high export case for Russia (900/600 Bcm in 2050) => consequences for investment ?
3. It shows a strong diversification of Russian gas exports: in 2030, 190 Bcm to Europe and 40 Bcm to Asia; in 2050, respectively 220 and 180 Bcm
4. Major uncertainties remain on European supply: after 2030, this scenario supposes 400 Bcm from other regions (mostly Iran and Middle-East); other hypotheses may raise dependence problems

“Muddling Through and Europe+”
Russian gas production and exports



"Europe Alone"

1. **Plausible if Europe sticks to its climate policy while the RoW doesn't follow**
2. **In this scenario, Russian exports to Europe are limited to 170 Bcm after 2030. Lower Russian gas exports to Europe are balanced by exports to Asia**
3. **Of the three scenarios, this is probably the most compatible with :**
   - A reasonable growth in gas production (700-800 Bcm)
   - The diversification of gas exports and the globalisation strategy of Gazprom : exports to Asia, amount to 140 Bcm in 2050
   - This scenario may be adequate to both EU and Russia gas policies … but it doesn't solve the climate problem!

"Global Regime"
Russian gas production and exports

"Global Regime"

1. A desirable for climate but low probability scenario
2. As for the other world regions this scenario supposes a « paradigm shift » in the energy system, with low consumption and low fossil production
3. The decrease in Russian gas exports to Europe and Asia is important: total exports do not exceed 300 Bcm
4. And total production would fall to only 360 Bcm in 2050
5. This scenario clearly raises the challenge for Russia of turning from a hydrocarbon export-led to a fully diversified economy
6. It also poses the question of how much new capacities should be developed ? and, given the low hydrocarbon price context, how ?

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Dependence rate, by energy and global

- The dependence rate for each fossil source does not change very much from one scenario to the other
- While global dependence rate (on total GIC) is significantly altered, due to domestic sources

			2000	2010	2020	2030	2050
Baseline	Dependance rate	Coal, lignite	30%	33%	39%	48%	56%
		Oil	76%	81%	84%	87%	86%
		Natural gas	46%	69%	83%	90%	96%
		Total	45%	53%	58%	61%	**58%**
Muddling Through	Dependance rate	Coal, lignite	30%	32%	35%	44%	56%
		Oil	76%	81%	83%	86%	85%
		Natural gas	46%	69%	83%	91%	96%
		Total	45%	53%	57%	60%	**53%**
Europe alone	Dependance rate	Coal, lignite	30%	31%	28%	35%	42%
		Oil	76%	81%	81%	82%	78%
		Natural gas	46%	69%	79%	81%	76%
		Total	45%	52%	51%	45%	**31%**
Global Regime	Dependance rate	Coal, lignite	30%	32%	33%	39%	45%
		Oil	76%	81%	82%	85%	83%
		Natural gas	46%	61%	73%	77%	73%
		Total	45%	50%	51%	47%	**29%**

GIC and volume of fossil imports

- Dependence may be lower and also applied to smaller quantities
- In terms of global vulnerability, importing 40% of 200 Mtoe is not equivalent to 40% of 400 Mtoe

			2000	2010	2020	2030	2050
Baseline	GIC (Mtoe)		1725	1764	1883	2004	2053
	Imports (Mtoe)	Coal, lignite	-94	-102	-130	-191	-285
		Oil	-505	-532	-560	-564	-440
		Natural gas	-180	-293	-393	-473	-475
Muddling Through	GIC (Mtoe)		1725	1759	1820	1911	1981
	Imports (Mtoe)	Coal, lignite	-94	-95	-96	-132	-146
		Oil	-505	-532	-543	-537	-399
		Natural gas	-180	-298	-399	-471	-448
Europe alone	GIC (Mtoe)		1725	1741	1723	1731	1724
	Imports (Mtoe)	Coal, lignite	-94	-88	-50	-58	-61
		Oil	-505	-524	-466	-378	-235
		Natural gas	-180	-292	-365	-350	-245
Global Regime	GIC (Mtoe)		1725	1748	1802	1845	1723
	Imports (Mtoe)	Coal, lignite	-94	-91	-76	-80	-73
		Oil	-505	-526	-497	-428	-218
		Natural gas	-180	-260	-351	-359	-206

Value of energy imports

- From 1.8% of EU GDP (EA) to 2.2% (BL) in 2020 and from 0.5%(GR) to 2.5% (BL) in 2050.

			2000	2010	2020	2030	2050
Baseline	Value of imports (G€05)	Coal, lignite	4.9	8.8	12.3	19.7	34.1
		Oil	96.1	202.6	250.6	310.6	359.1
		Natural gas	24.1	69.0	99.9	139.5	210.2
		Total	125.1	280.4	362.8	469.8	**603.5**
Muddling Through	Value of imports (G€05)	Coal, lignite	4.9	8.2	9.0	13.2	19.4
		Oil	96.1	202.7	240.7	284.4	291.3
		Natural gas	24.1	70.3	101.5	133.8	183.1
		Total	125.1	281.2	351.2	431.5	**490.9**
Europe alone	Value of imports (G€05)	Coal, lignite	4.9	7.5	4.7	5.7	6.8
		Oil	96.1	196.3	201.6	191.9	160.2
		Natural gas	24.1	69.1	94.6	98.1	95.3
		Total	125.1	272.9	300.9	295.7	**262.4**
Global Regime	Value of imports (G€05)	Coal, lignite	4.9	7.8	6.8	7.6	7.9
		Oil	96.1	197.8	208.8	199.8	70.6
		Natural gas	24.1	61.9	87.5	91.0	45.5
		Total	125.1	267.5	303.1	298.3	**124.1**

Risks and climate-energy policies

$Risk_{c/e}$ =	$Probability_e$	x $Magnitude_e$	x $Vulnerability_{c/e}$
Muddling Through	High	High	High
Europe Alone	High	High	Low
Global Regime	Low	Low	Low

- The international agreement on climate is not granted this increases the uncertainty in the energy sector
- But the climate dimension also introduces elements of visibility, associated to the physical emission constraints
- For Europe climate policies bring a significant double dividend in terms of reduced vulnerability to energy shocks, even in a non-cooperative framework

Conclusions: the technical side

- **Beyond modeling exercises, many issues should be kept in mind, in particular the institutional dimension:**
  - Framework and incentives for electricity investment
  - Degree of integration of the European electricity system
  - Institutional factors in new technology chains (scale-up of CCS)
  - Regulatory framework for nuclear development
- **Across the different scenarios total electricity consumption remains strong as it is the main carrier of the decarbonisation**
- **The power generation technology mix changes a lot with more renewables, nuclear and CCS, but natural gas is almost not impacted**
- **From MT to GR, Europe's natural gas consumption is down by 40%, but imports from Russia only lose 20%, a clear sign of competitive advantage**

Conclusions: the political side

- Climate policies strongly impact the energy-security problem and illustrate the type of uncertainties that EU and Russia will have to face in the next decades
- The debate on “Energy Charter Treaty or Pdt Medvedev’s Energy Document … where to start ?” is part of the problem
- But this problem cannot be examined without taking into account the fundamentals of supply and demand in a global policy framework

=> Efforts are needed to combine institutional solutions with a dialog on a Pluriannual Programming of Investments in the energy sector, *in a balanced and mutual understanding perspective*

Thank you for your attention

The EU perspective : « SoS - Security of Supply »

From the EU's perspective, there are four main issues at stake :

1. The rate of growth of Russian gas production according to the investment strategy of Gazprom
2. The question of Russia's market power on the UE gas market (possibility of an OGEC)
3. The downstream strategy of Gazprom on the European market and the consequences on the competition on the wholesale market (forclusion)
4. The access to Russian hydrocarbon resources for European companies, Energy Charter Treaty

The Russian perspective : « SoD - Security of Demand»

From the Russian perspective, also four main issues at stake :

1. The evolution of future EU gas demand: impacts of the EU climate policy and of the diversification of gas suppliers
2. The control of the access to hydrocarbon resources and the national resource depletion policy
3. The possibility to develop a downstream strategy in order to secure market shares in a liberalised market
4. The « Energy Charter Treaty risk »

Energy Charter vs. Pdt. Medvedev's Energy Proposals

The Energy Charter Treaty importance is likely to increase in the context of efforts to build a legal foundation for global energy security, based on the principles of open, competitive markets and sustainable development. The fundamental aim of the ECT is to strengthen the rule of law on energy issues…

A. Konoplyanik, T. Walde (2006)

As for the Energy Charter Treaty, we also do not feel that we are bound by obligations under it. […] The actual issue is that we are suggesting a full-fledged new regulatory base for future energy cooperation. We want for relations to be built on the principles of transparency, clarity, reliability and stability that are satisfactory to all sides: fuel consumers, suppliers, and transit countries. The documents that are currently available do not answer the actual, current state of affairs.

Arkady Dvorkovich, Presidential Aid on New Energy Proposals (2009)