The European energy sector and the climate-security nexus in the SECURE scenarios

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Energy and climate: twin problems

◆ Between now and 2050, humanity have to face a twin problem:
  - The growing scarcity for oil and gas (not for coal !)
  - The accumulation of GHGs in the atmosphere
◆ These « twin 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 » thus have to deal with the two sides of the problem
The European energy sector in the SECURE scenarios

The SECURE approach

Results of five scenarios

Shocks and variants

Energy dependence & 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 »
Reminder: 5 scenarios +3 exercises with shocks explored 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 outcome of a scenario in which the effort for Europe is more pronounced than in MT.
4. The Europe Alone case represents the outcome of a scenario in which every country is free-riding (almost) … except the Union.
5. The Global Regime explores a new world energy system, under strong emission constraint (EU-type).

**Exercises**
1. Oil and gas shocks.
2. Nuclear accident + phase out.
3. Problems in the diffusion of the CCS.
SECURE scenarios, hypotheses and outcomes

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Carbon Price 2050 (€/tCO2)</th>
<th>Emissions 2050 / 1990</th>
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<td>134%</td>
<td>Type VI (5-6°C) 700 CO2</td>
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<td>Muddling Through</td>
<td>40 in Eur 32 in RoW</td>
<td>72% (EU: -21%)</td>
<td>Type IV (3-4°C) 500 CO2</td>
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<td>MT E+</td>
<td>89 in Eur 32 in RoW</td>
<td>67% (EU: -40%)</td>
<td>Type IV (3-4°C) 500 CO2</td>
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<td>Europe Alone</td>
<td>185 in Eur 32 in RoW</td>
<td>59% (EU: -60%)</td>
<td>Type IV (3-4°C) 500 CO2</td>
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<td>Global Regime</td>
<td>392 in A1 257 in NA1</td>
<td>(2050/2000) -50% (Annex 1: -80%)</td>
<td>Type II (2-3°C) 400 CO2</td>
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</tbody>
</table>
The SECURE approach

The results of four scenarios

The results of three exercises

Energy dependence & vulnerability
International energy prices

- In 2050, international oil and gas prices are about twice lower in the Global Regime than in the Baseline.
Europe primary mix by scenario

- In the Global Regime, fossil fuels are brought down to 69% in 2020, compared to 79% in the Baseline
- In 2050 they are down to 36% compared to 74% in the Baseline
Europe primary mix by scenario

- EU27 primary energy decrease beginning from 2030 in comparison with MT
Europe’s coal and natural consumption in the four scenarios

- Natural gas, as a non CO2 intensive fossil is much less impacted by climate policies than coal.
- Total 2020 supply varies only between 450 and 480 Gm3 between the two extreme cases, while in 2050 the range increases to 265-500 Gm3.
European Gas supply

- Domestic production drop 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
“Muddling Through”

1. Maybe the most probable, but surely not the most desirable scenario from the climate perspective

2. It is a high production-high export case (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 Gm3

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

1. If Europe will persist to maintain the leadership in climate policies without losing in competition this intermediate scenario (between MT and EA), maybe the most probable scenario from the climate perspective for Europe.

2. Similar to MT, MT E+ show a high production-high export case (900-600 Bcm in 2050)

3. Russia continues to have a diversified gas exports: in 2030, 184 Bcm to Europe and 35 Bcm to Asia; in 2050, respectively 210 and 177 Gm3

4. Major uncertainties remain on European supply: after 2030, this scenario supposes 400 Bcm from other regions (mostly Iran and Middle-East).
“Muddling Through E+”
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!
“Europe Alone”
Russian gas production and exports

![Diagram showing Russian gas exports to different regions from 2000 to 2050. The diagram includes bars for RUS, CIS, AFMI, NOAM, ASIA, and EURP. The x-axis represents years from 2000 to 2050, and the y-axis represents Gm3 (billion cubic meters).]
“Global Regime”

1. A desirable 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 more diversified economy
6. It also poses the question of how much new capacities should be developed ? and, given the low hydrocarbon price context, how ?
“Global Regime”
Russian gas production and exports

![Graph showing Russian gas exports from 2000 to 2050, with projections for different regions and time periods.](image)
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 ECT 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…

As for the Energy Charter Treaty, we also do not feel that we are bound by obligations under it. But it is not a matter of binding obligations. 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
European Electricity production

- Total electricity production is almost unchanged in all scenarios because electricity is the carrier of decarbonisation.
European Electricity production

- The share of thermal production w/o CCS decreases as non-fossil and CCS options increase from one scenario to the other.
EU27 share of Light Vehicles

- The share of hybrid and electric vehicles increase from from 27% and 17% in MT to 31% and 21% in GR-FT
Electricity consumption in hybrid and electric vehicles

- In 2050 electricity consumption increase 24% in GR-FT, 14% in EA and 9% in MT E+ compared to BL.
European CO2 Emissions

- CO2 Emissions decrease respectively -7%, -22%, -27% and -14% in 2020 and -28%, -63%, -82% and -72% in 2050 according the scenarios
- Total emissions follow nearly the same trend
EU27 CO2 emissions by sector (energy)

- CO2 Emissions decrease respectively -7%, -22%, and -14% in 2020 and -28%, -63%, and -72% in 2050 according the scenarios.
The SECURE approach

Unsustainability of the Baseline

The results of four scenarios

The results of three exercises

Energy dependence & vulnerability
Impact of Oil&Gas shock

- Assumption: oil & gas price are multiplied by 3 in 2015
- -6% to -8% the impact on primary consumption in Europe in 2020 and from -3% to -7% in 2050
- -8% to -10% for CO2 emissions in 2020 and from -6% to -17% in 2050 for BL sh and EA sh
Impact of Oil&Gas shock

◆ The impact on total EU electricity generation is weak, -2% in 2020 and from -6% to -3% in 2050.

◆ However the impacts on the electricity emissions are more visible, particularly in 2050.

◆ This situation results from important impacts on electricity mix.
Impact of Oil&Gas shock on the electricity mix

- The mix of EU27 electricity generation is impacted significantly promoting nuclear and handicap the others.
Impact of Nuclear accident + Phase-out

- Assumption: nuclear accident in 2015 => no more new capacities + normal phase out
- No significant differences of nuclear production in Europe in 2020, but cutting by more then three in 2050.
- In global level EU27 electricity production decrease slightly (3%, 4% and 3% in BL Sh/BL, MT SH/MT, GR-FT Sh/ GR-FT in 2050)
Impact of Nuclear accident + Phase-out

- Important impact on EU27 electricity mix
- Increase of fossil share (coal & gas), also of CCS (incl bcs).

**EU27 Electricity Production by Renewables by Scenario**

**EU27 Electricity Production by Gas by Scenario**

**EU27 Electricity generation with Coal by Scenario**

**EU27 CCS electricity production by Scenario**
Impact of Nuclear accident + Phase-out

- CO2 emissions from electricity generation increase respectively 6%, 16% and 6% in BL Sh/BL, MT SH/MT, GR-FT Sh/ GR-FT
- While total CO2 emissions increase respectively 3%, 7% and 20% in BL Sh/BL, MT SH/MT, GR-FT Sh/ GR-FT
- Emissions from BCS are deducted, that explains the low increase of the emissions from electricity in GR-FT Sh/ GR-FT in 2050.
Carbon Capture and Storage

- Only 4 full-scale projects exist today
- G8 goal: 20 full-scale demonstrations announced by 2010

Barriers to Safe and Cost Effective Deployment of CCS

- Assumption: No Deployment of CCS.
- In global level, EU27 electricity production does not change.
- In 2050 647, 295 and 1089 TWh must be replaced by other technologies respectively in EA w/o CCS, MT w/o CCS and GR-FT w/o CCS.
Barriers to Safe and Cost Effective Deployment of CCS

- Important impact on EU27 electricity mix
- Fossil fuels decrease considerably, weak impact on renewables, so the increase of nuclear replace the lack of CCS.

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**EU27 Electricity Production by Renewables by Scenario**

- EA
- EA w/o CCS
- MT
- MT w/o CCS
- GR-FT
- GR-FT w/o CCS

**EU27 Nuclear Production by Scenario**

- EA
- EA w/o CCS
- MT
- MT w/o CCS
- GR-FT
- GR-FT w/o CCS

**EU27 Electricity generation with Coal by Scenario**

- EA
- EA w/o CCS
- MT
- MT w/o CCS
- GR-FT
- GR-FT w/o CCS

**EU27 Electricity Production by Gas by Scenario**

- EA
- EA w/o CCS
- MT
- MT w/o CCS
- GR-FT
- GR-FT w/o CCS
Barriers to Safe and Cost Effective Deployment of CCS

- Put away CCS from possible clean technology portfolio, means an increase of +43%, +14% and +67% of the EU electricity CO2 emissions then in respective scenarios with CCS MT, EA and GR-FT by 2050.
- Total emissions increase respectively +11%, +5% and +14%.
- In the scenario GR-FT without CCS, carbon value must be increased 30% in 2050 in order to have the same profile of emissions as in GR-FT with CCS.
The SECURE approach

The results of four scenarios

The results of three exercises

Energy dependence & vulnerability
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.

<table>
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<tr>
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<th>Dependence rate</th>
<th>Baseline</th>
<th>2000</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
<th>2050</th>
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<td></td>
<td>Coal, lignite</td>
<td>30%</td>
<td>33%</td>
<td>39%</td>
<td>48%</td>
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<tr>
<td></td>
<td>Oil</td>
<td>76%</td>
<td>81%</td>
<td>84%</td>
<td>87%</td>
<td>86%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Natural gas</td>
<td>46%</td>
<td>69%</td>
<td>83%</td>
<td>90%</td>
<td>96%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>45%</td>
<td>53%</td>
<td>58%</td>
<td>61%</td>
<td>55%</td>
<td></td>
</tr>
</tbody>
</table>

|                          | Dependence rate | Muddling Through  | 30%  | 32%  | 35%  | 44%  | 53%  |
|                          | Coal, lignite   | 30%               | 32%  | 35%  | 44%  | 53%  |
|                          | Oil             | 76%               | 81%  | 83%  | 86%  | 85%  |
|                          | Natural gas     | 46%               | 69%  | 83%  | 91%  | 96%  |
|                          | Total           | 45%               | 53%  | 57%  | 60%  | 53%  |

|                          | Dependence rate | Europe alone      | 30%  | 31%  | 28%  | 35%  | 42%  |
|                          | 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%  |

|                          | Dependence rate | Global Regime     | 30%  | 32%  | 33%  | 39%  | 42%  |
|                          | Coal, lignite   | 30%               | 32%  | 33%  | 39%  | 42%  |
|                          | Oil             | 76%               | 81%  | 82%  | 85%  | 83%  |
|                          | Natural gas     | 46%               | 61%  | 73%  | 77%  | 78%  |
|                          | 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 vulnerability, importing 40% of 200 Mtoe is not equivalent to 40% of 400 Mtoe.

<table>
<thead>
<tr>
<th></th>
<th>2000</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
<th>2050</th>
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<td><strong>Baseline</strong></td>
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<td>-560</td>
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<td>-260</td>
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## Value of energy imports

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

<table>
<thead>
<tr>
<th></th>
<th>2000</th>
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<th>2030</th>
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<td>303.1</td>
<td>298.3</td>
<td>124.1</td>
</tr>
</tbody>
</table>
The international agreement on climate is not yet granted and the introduction of the climate dimension thus increases the uncertainty in the energy sector.

But it also introduces elements of previsibility, associated to the physical emission constraints.

Strong climate policies bring a significant double dividend in terms of reduced vulnerability to energy shocks, even in a non-cooperative framework.

### Conclusions – 1: risks and policies

<table>
<thead>
<tr>
<th></th>
<th>Risk&lt;sub&gt;c/e&lt;/sub&gt; =</th>
<th>Probability&lt;sub&gt;e&lt;/sub&gt;</th>
<th>x Magnitude&lt;sub&gt;e&lt;/sub&gt;</th>
<th>x Vulnerability&lt;sub&gt;c/e&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Muddling Through</strong></td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td><strong>Europe Alone</strong></td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td><strong>Global Regime</strong></td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

- Risk<sub>c/e</sub> = Probability<sub>e</sub> x Magnitude<sub>e</sub> x Vulnerability<sub>c/e</sub>
Conclusions - 2

- The analysis of the results show that total electricity production is almost unchanged in all scenarios because it is a carrier of the decarbonisation.
- For the same reason electricity generation technology mix change in a very pronounced way between the scenarios: more renewables, nuclear and CCS.
- On the demand side, electricity consumption for hybrid and electric vehicles in the constraint cases increases faster than in the BL showing the trend towards low emission vehicles.
- They show that climate policies are strongly structuring the energy security problem, whether in a cooperative or non-cooperative world.
- Beyond pure modeling and scenarios, many issues should be kept in mind in the storylines and analyses, in particular the institutional dimension for:
  - 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
Conclusions

◆ The SECURE project allows to develop a consistent set of scenarios for policy analysis

◆ 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 Pluriannual Programming of Investments in the energy sector, in a reciprocal perspective