OUTLINE

1.- Introduction
2.- Scenario without Natural Gas
3.- Future scenarios (up to 2020)
4.- Conclusions
1. INTRODUCTION

Emission Transport/chem. react. Effects/impacts

<table>
<thead>
<tr>
<th>Electricity generation</th>
<th>Non-industrial comb. plants</th>
<th>Industrial Combustion</th>
<th>Production processes</th>
<th>Extraction and distrib. of fossil fuels</th>
<th>Solvent use</th>
<th>Road transport</th>
<th>Other mobile sources</th>
<th>Waste treatment</th>
<th>Agriculture</th>
<th>Other sources and sinks</th>
</tr>
</thead>
</table>

Atmospheric pollutants

- CO, NOx, SOx, NH3, 
- VOC, PM

O3, PM

Greenhouse Effect Gases

- CO2, CH4,
- N2O, HFC,
- PFC, SF6

Effects/impacts

- Acid rain
- Eutrophication
- Air Quality

- Health
- Ecosystems
- Cult. Heritage

Climate Change:

- Temperature
- Sea level
Emissions from energy sector vs. Spanish total (MARM, 2008)

- Energy and transformation industries
- R&C&I
- Industry
- Transport

Percentage of energy sector emissions from total Spanish emissions for 2006

2.- SCENARIO WITHOUT NATURAL GAS
Reference scenario (2006 official) vs. scenario without Natural Gas

Assumptions under scenario without Natural Gas:

- Energy & transformation: fuel/gas to the historic maximum and coal growth
- RCI: substitution by petroleum products, mainly diesel
- Industry: dependant on the activity and technology:
  - co-generation: petroleum derivatives
  - process kilns and boilers: petrol products, coal and waste fuels.
- Transport: without any change

### Emissions:

<table>
<thead>
<tr>
<th>Sector</th>
<th>CO₂ equiv.</th>
<th>SO₂</th>
<th>NOₓ</th>
<th>NMVOC</th>
<th>PM₂.₅</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy and transformation industries</td>
<td>+32%</td>
<td>+69%</td>
<td>+38%</td>
<td>+10%</td>
<td>+63%</td>
</tr>
<tr>
<td>Non-industrial combustion</td>
<td>+10%</td>
<td>+90%</td>
<td>+7%</td>
<td>-1%</td>
<td>+7%</td>
</tr>
<tr>
<td>Industrial combustion</td>
<td>+16%</td>
<td>+168%</td>
<td>+18%</td>
<td>-17%</td>
<td>+64%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>+13%</td>
<td>+77%</td>
<td>+12%</td>
<td>-1%</td>
<td>+14%</td>
</tr>
<tr>
<td>NG segment</td>
<td>+23%</td>
<td>+81%</td>
<td>+27%</td>
<td>-5%</td>
<td>+38%</td>
</tr>
</tbody>
</table>
Comparison with Kyoto Protocol target

Co-benefits on air pollutants
Co-benefits on air quality (sulphur dioxide, $\text{SO}_2$)

Difference between reference scenario and scenario without NG for the $\text{SO}_2$ daily percentile

Co-beneficios on air quality (nitrogen dioxide, $\text{NO}_2$)

Difference between reference scenario and scenario without NG for the $\text{NO}_2$ Hourly 99.8 percentile
Co-benefits on air quality (fine particulate matter, PM$_{2.5}$)

Difference between reference scenario and scenario without NG for the PM$_{2.5}$ annual average

3.- FUTURE SCENARIOS (up to 2020)
Consistent Emission Projection (CEP) Model applied to Spain

Future scenarios:

- **Reference** scenario: most likely considering official energy prospective from the Ministry for Energy including sectoral and national legislation and planning.

- **Fossil** scenario without NG: energy demand increase with respect to 2006 is satisfied by fossil fuels different than NG (assuming NG total consumption as in 2006).

- **Natural Gas** scenario: same energy demand as in the reference scenario but assuming higher NG penetrations.
Natural Gas scenario assumptions (up to 2020):

- Energy and transformation industries: coal substitution with NG
- RCI:
  - co-generation with NG,
  - increase of solar/gas solutions to $15\times10^6 \text{ m}^2$ of solar panels
  - domestic use of NG in every town of more than 10,000 inhabitants
- Industry: co-generation with NG
- Transport:
  - CNG used in 5% of mileage from passenger cars and buses
  - 13% LNG consumption in the national fishing fleet

Total results:

<table>
<thead>
<tr>
<th>Sector</th>
<th>Scenario comparison</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>CO$_2$</td>
</tr>
<tr>
<td>National Total</td>
<td>Fossil vs. Ref.</td>
<td>4,0%</td>
</tr>
<tr>
<td></td>
<td>Natural Gas vs. Ref.</td>
<td>-8,2%</td>
</tr>
<tr>
<td></td>
<td>Natural Gas vs. Fossil</td>
<td>-11,8%</td>
</tr>
<tr>
<td>NG sector</td>
<td>Fossil vs. Ref.</td>
<td>7,1%</td>
</tr>
<tr>
<td></td>
<td>Natural Gas vs. Ref.</td>
<td>-13,6%</td>
</tr>
<tr>
<td></td>
<td>Natural Gas vs. Fossil</td>
<td>-19,4%</td>
</tr>
<tr>
<td>Energy sector</td>
<td>Fossil vs. Ref.</td>
<td>4,7%</td>
</tr>
<tr>
<td></td>
<td>Natural Gas vs. Ref.</td>
<td>-9,6%</td>
</tr>
<tr>
<td></td>
<td>Natural Gas vs. Fossil</td>
<td>-13,7%</td>
</tr>
</tbody>
</table>
**Kyoto Protocol accomplishment**

<table>
<thead>
<tr>
<th>Year 2006</th>
<th>Reference Scenario</th>
<th>Fossil Scenario</th>
<th>Natural gas Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>140</td>
<td>145</td>
<td>138</td>
</tr>
</tbody>
</table>

- **Base year**
- **Kyoto Protocol Target 2008-2012**
- **NAP-2 target**

**2020 targets**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>2005 emission related to 2005 emission level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference Scenario</td>
<td>96</td>
</tr>
<tr>
<td>Fossil Scenario</td>
<td>100</td>
</tr>
<tr>
<td>Natural gas scenario</td>
<td>88</td>
</tr>
</tbody>
</table>

- **2005**
- **Decision 406/2009 target**
### Sectoral results:

<table>
<thead>
<tr>
<th>Sector</th>
<th>Scenario comparison</th>
<th>2020</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy and transformation industries</td>
<td>Fossil vs. Ref.</td>
<td>4.3%</td>
<td>19.4%</td>
<td>21.2%</td>
<td>6.1%</td>
<td>9.4%</td>
</tr>
<tr>
<td></td>
<td>Natural Gas vs. Ref.</td>
<td>-32.8%</td>
<td>-42.3%</td>
<td>-36.0%</td>
<td>0.0%</td>
<td>-49.6%</td>
</tr>
<tr>
<td></td>
<td>Natural Gas vs. Fossil</td>
<td>-35.6%</td>
<td>-51.6%</td>
<td>-47.2%</td>
<td>-5.7%</td>
<td>-53.9%</td>
</tr>
<tr>
<td>RCI</td>
<td>Fossil vs. Ref.</td>
<td>7.0%</td>
<td>72.7%</td>
<td>7.3%</td>
<td>0.2%</td>
<td>5.8%</td>
</tr>
<tr>
<td></td>
<td>Natural Gas vs. Ref.</td>
<td>-10.5%</td>
<td>-50.8%</td>
<td>-7.0%</td>
<td>-0.3%</td>
<td>-3.8%</td>
</tr>
<tr>
<td></td>
<td>Natural Gas vs. Fossil</td>
<td>-16.4%</td>
<td>-71.5%</td>
<td>-13.3%</td>
<td>-0.5%</td>
<td>-9.1%</td>
</tr>
<tr>
<td>Industry</td>
<td>Fossil vs. Ref.</td>
<td>9.3%</td>
<td>139.5%</td>
<td>8.9%</td>
<td>-8.9%</td>
<td>24.2%</td>
</tr>
<tr>
<td></td>
<td>Natural Gas vs. Ref.</td>
<td>-0.3%</td>
<td>-3.7%</td>
<td>-0.5%</td>
<td>1.5%</td>
<td>-1.9%</td>
</tr>
<tr>
<td></td>
<td>Natural Gas vs. Fossil</td>
<td>-8.8%</td>
<td>-59.8%</td>
<td>-8.6%</td>
<td>11.4%</td>
<td>-21.0%</td>
</tr>
<tr>
<td>Transport</td>
<td>Fossil vs. Ref.</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td></td>
<td>Natural Gas vs. Ref.</td>
<td>-2.2%</td>
<td>-1.0%</td>
<td>-0.8%</td>
<td>-1.0%</td>
<td>-0.2%</td>
</tr>
<tr>
<td></td>
<td>Natural Gas vs. Fossil</td>
<td>-2.2%</td>
<td>-1.0%</td>
<td>-0.8%</td>
<td>-1.0%</td>
<td>-0.2%</td>
</tr>
</tbody>
</table>

### Graphical representation:

- **Variation**
  - **CO₂ eq**
  - **SOx**
  - **NOx**
  - **NMVOC**
  - **PM₂₅**

- **Sectors**
  - National Total
  - Energy Transformation
  - RCI
  - Industry
  - Transport

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4.- CONCLUSIONS

• GHG emissions are lower for NG versus other fossil fuel:
  • electricity production: 47%-63%
  • RCI: 17%-53%
  • industry: 14%-49%

• There are important co-benefits:
  • SO$_2$ emission reductions: less acid rain
  • NOx emission reductions: lower effects on vegetation, crops, eutrophication, acid rain, etc.
  • Fine PM emission reduction: less mortality and morbidity

• These benefits are shown for a hypothetical situation for 2006 without NG:
  • GHG emissions would have increased in a 13%
  • Other emissions would have raise: SO$_2$ (77%), PM$_{2.5}$ (14%) y NO$_2$ (12%)
  • Annual average PM$_{2.5}$ concentrations would have augmented in urban areas
  • NO$_2$ concentration would be higher than AQ limit values for some regions (Asturias, Comunidad Valenciana and Cataluña)
Future scenarios show that:

- a greater NG penetration would:
  - close KP fulfilment
  - reach 2020 targets
  - reduce SO$_2$, NO$_x$ and PM$_{2.5}$ emissions

- an increase in fossil fuels with the same NG consumption would:
  - prevent KP fulfilment
  - distance 2020 targets
  - increase air pollutant emissions