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THE IMPACT OF CLIMATE CHANGE MITIGATION OPTIONS ON AIR POLLUTANTS EMISSIONS IN PORTUGAL

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INTRODUCTION

Climate change (CC) and air pollution (AP) are serious threats to sustainable development, causing a variety of adverse impacts on human health and the environment;
INTRODUCTION

Strong linkages between greenhouse gases (GHG) and traditional air pollutants:

- Common emissions sources: Petróleo, Natural Gas, Coal
- Atmospheric interactions
- Environmental impacts local, regional and global scales

Growing field of research addressing the linkage between GHG and atmospheric pollutants.

Elevated potential at policy levels because strategies that simultaneous address AP and GHG can lead to more efficient control of both pollutant emissions.

INTRODUCTION

Climate change policies implemented to achieve the EU climate objectives are estimated to reduce the costs of existing air pollution abatement policies in 10 billion € per year and to reduce emissions by 10% for SO$_2$ and 8-10% for NO$_x$ and PM (EEA, 2006).

Study the impact of the different mitigation strategies to enhance synergies and avoid negative trade-offs.

Present the modeling approach and respective results on the evaluation of the impacts of different levels GHG mitigation options on the SO$_2$, NO$_x$ and PM$_{2.5}$ emissions by 2030.
**Validated:**
- 2005 energy consumption
- 2005 GHG and AP emissions

**Acidifying pollutants SO\textsubscript{2} and NO\textsubscript{x} (Dias, 2009)**

**Particulate matter PM\textsubscript{2.5} (Maurício, 2009)**

- Introduction of control technologies (data from GAINS, IIASA)
- Introduction of emission factor (combustion and process) per technology per fuel consumption (data from GAINS, IIASA)

**Baseline Portuguese policy assumptions**

**Hydro installed capacity** included in the National Plan for High Potential Hydropower Infrastructures (PNBEPH) (9700 MW)

>10% **biofuels** in diesel and gasoline in road transport consumption, from 2010 onwards;

>5% **electric private** cars from 2015 onwards;

**Accomplishment** of **energy efficiency targets** from the National Action Plan for Energy Efficiency (PNAEE, 2008) in the year 2015;
**METHODOLOGY**

**Emissions Restrictions**

**Air pollutants**

2010 National Emissions Ceilings
- 250 Gg NO\textsubscript{x}
- 160 Gg SO\textsubscript{2}

**GHG**

- 0
- -10%
- -15%
- -20%
- -25%
- -30%
- -35%
- -40%
- -45%
- -50%

REF Scenario
GHG_35 Scenario
GHG_50 Scenario

**RESULTS**

The REF scenario indicates a **reduction of 7%** in GHG by 2030 when comparing with 2005 values. Consequence of the **Portuguese policies and measures** and increase of **efficiency** in energy supply and demand.

<table>
<thead>
<tr>
<th>Main Sectors</th>
<th>GHG_35</th>
<th>GHG_50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry</td>
<td>-44%</td>
<td>-54%</td>
</tr>
<tr>
<td>Transport</td>
<td>-62%</td>
<td>-60%</td>
</tr>
<tr>
<td>Electricity generation</td>
<td>-4%</td>
<td>-11%</td>
</tr>
</tbody>
</table>
RESULTS

GHG marginal abatement cost curve for the Portuguese energy system in 2030

Power sector: the most cost-effective options are similar in all scenarios, the introduction of renewable is proportional to the increase of the restrictions of the GHG emissions.

Solar energy (PV plant size and solar thermal)

Wind energy rising 26% to 28% comparing to REF
RESULTS

► Coal: an option considered differently, comparing with the REF scenario:
   Increase by 81% in the GHG_35 scenario \( \rightarrow \) CCS
   Decrease by 100% in the GHG_50 scenario \( \rightarrow \) Renewable energy

► At -50%, the increase of the share of renewable is more cost-effective than to implement CCS technology

RESULTS

De-carbonization of the electricity production higher efficiency of electric equipments
► key elements for high electricity share in the final energy consumption.

Residential sector: more 19% electric consumption in GHG_50 scenario than in the ref scenario
Industry sector: natural gas is replaced by biomass

Extremely high cost (importation)
RESULTS

Impact on Air Pollutants Emissions in 2030

The introduction of a CCS thermoelectric power plant increase AP emissions as a consequence of an increase of coal use.

SO2 emissions reaches, in all scenarios, the ceiling.

The use of some specific fuels neutralize the expected benefits of the measures and options for the mitigation of GHG. Ex: Use of black liquors in Co-generation (paper and pulp)
**RESULTS**

PM emissions in 2030 in all scenarios are below the ceilings, → GHG mitigation options have a co-benefit in the reduction of this pollutant.

However, it should be noted that the reduction is minimized be the increase of the consumption of biomass and black liquors.

NOx emissions: The compliance with the ceiling in GHG_35 and GHG_50 scenarios → NOx abatement technologies:

- **Combustion modifications**  
  - Selective (non) Catalytic Reductor (SCR)

  **Cement and Glass industry**

**Conclusions**

- Main option to comply with the GHG constraints is the increase of electricity from renewable resources, manly solar and wind energy;
- The introduction of CCS abatement technology in less restrictive scenarios shows that is more cost-benefit to increase renewable electricity production than invest in end-of-pipe solutions, at more restrictive GHG levels;
- The improvement of energy efficiency and fuel switches are sufficient in all scenarios to comply with the SO2 and PM emissions ceilings for 2020 without using control technologies;
- NOx emissions comply with the ceiling through the introduction of abatement technologies in the industry sector;
Conclusions

Generally, options to mitigate air pollution and GHG tackle the same sources, but do not result always in win-win situations.

For Portugal, specific cost-effective choices for fuel switches lead to negative trade-offs, weakening the reduction of both air pollutants and GHG emissions.

Thank you for the attention