Impacts of individual emission-reduction measures on air quality and health

Emission reductions estimated by: Subdirección General de Aire Limpio y Sostenibilidad Industrial. Ministerio para la Transición Ecológica y Reto Demográfico. In collaboration with TRAGSATEC
Motivation

• To provide information that can be useful for policy makers when designing emission reduction plans

Past actions

• Evaluation of impacts on air quality and health for the 1st-Spanish National Air Pollution Control Programme (presented last year in TFIAM; Vivanco et al. 2021, Atmosphere)

Outline

• Measures and reductions
• Impacts on air quality
• Impacts on health and cost
• Conclusions
Measures

• 2 measures affecting the combustion in the residential sectors (SNAP2).
• 5 measures affecting on road transport (SNAP7)
• Analysis of the measures applied to their maximum extent

Source: INE 2020 edition
Residential Sector

2 Individual Measures

**EF-HEAT**: Substitution of traditional heating by more efficient systems

**CERT-BIOM**: Substitution of traditional diesel and coal heating by certified biomass systems

- Same mix of biomass fuels as base case
- No emissions from diesel and coal

<table>
<thead>
<tr>
<th>% (SNAP2)</th>
<th>% (TOTAL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-5.80%</td>
<td>33.30%</td>
</tr>
<tr>
<td>20.00%</td>
<td>3.80%</td>
</tr>
<tr>
<td>-60.00%</td>
<td></td>
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<tr>
<td>-100.00%</td>
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</table>
On road Transport

<table>
<thead>
<tr>
<th>Measures mentioned in the 1st-Spanish National Air Pollution Control Programme, WAM30 scenario, for the transport sector</th>
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<tbody>
<tr>
<td>Advanced biofuels for transport</td>
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<tr>
<td>Changes in mode of transportation</td>
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<tr>
<td>Promotion of electric cars</td>
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</tbody>
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5 Individual Measures

- **Waiver scenario**
- **AB**: Introduction of AdBlue technology in diesel motors (cars and goods vehicles)
- **BET**: Promotion of biofuels: bioethanol (E85) → Petrol fleet renewal (passenger cars and motorcycles) to flex-fuel. The rest of petrol vehicles: E5 → E10 (with waiver)
- **B(ET+D)**: Promotion of advanced biofuels: bioethanol (E85 for passenger cars and motorcycles → Petrol fleet renewal and E10 for the rest of petrol vehicles)+ biodiesel B20
- **E**: Substitution of all non-hybrid cars by electric cars

Waiver: Reduction of vapour pressure from 68 kPa to 60 kPa in gasoline E5 (more evaporative emissions)
• **Advanced biofuels for transport**

• **Fleet renewal**

- **Promotion of biofuels:** *bioethanol* (E85) → **Petrol fleet renewal** (passenger cars and motorcycles) to flex-fuel. The rest of petrol vehicles: E5 → E10 (with waiver)

- **Promotion of advanced biofuels:** *bioethanol* (E85 for passenger cars and motorcycles → **Petrol fleet renewal**) and E10 for the rest of petrol vehicles + **biodiesel B20**
Promotion of electric cars (100% of petrol and diesel):

- Substitution of all non-hybrid cars by electric cars
- No consideration of additional electricity consumption
- Addition of electricity consumption to SNAP1
- Energy mix projected to 2030
- Increased renewable energy

Substitution of all non-hybrid cars by electric cars:
- % (SNAP7)
- % (TOTAL)

Addition of electricity consumption to SNAP1:
- Energy mix projected to 2030
- Increased renewable energy

Substitution of all non-hybrid cars by electric cars:
- % (SNAP7)
- % (TOTAL)
Methodology

• **CHIMERE air quality model.** Domain covering the Iberian Peninsula at $0.1^\circ \times 0.1^\circ$ nested in a European domain at $0.15^\circ \times 0.15^\circ$
• Simulation of **2017 (base)**
• ECMWF-IFS meteorology for 2017
• **Correction of model results**
MAXIMUM HOURLY - RELATIVE DIFFERENCES %

03

CERT-BIOM  EF-HEAT  AB

MAXIMUM DAILY 8 HOUR MEAN - RELATIVE DIFFERENCES %

03

CERT-BIOM  EF-HEAT  AB

B(ET+D)  E  BET

EF-HEAT  B(ET+D)  E  AB
In general, no change in annual mean.

For electric vehicles some increases of annual O3 in large urban areas (mainly Madrid, Barcelona). In line with the results for the application of the NAPCP.
ANNUAL MEAN - RELATIVE DIFFERENCES %

PM10

CERT-BIOM
EF-HEAT
BET
AB

B(ET+D)

RELATIVE DIFFERENCES PM25 ANNUAL MEAN

BROMIC
ECOCAL
H1
H5
H7
H8
H10

ANNUAL MEAN - RELATIVE DIFFERENCES %

CERT-BIOM
EF-HEAT
BET
AB

B(ET+D)
Increase of NH3 with reductions of SOx

NH3

SO2

SO2 $\rightarrow$ H$_2$SO$_4$

Less formation of (NH$_4$)$_2$SO$_4$

More NH$_3$ (gas phase)
Health Impact Assessment & External Costs

Scenarios:
1) 2017 reference
2) 7+2 individual measures
   a. BIOMC
   b. ECOCAL
   c. W/H1
   d. Bioethanol/H5
   e. AdBlue (H7)
   f. H10
   g. E H13 (+ H13A, H13B)

Pollutants, mortality impact CRF and pollution metrics recommended in
*Implementation of the HRAPIE Recommendations for European Air Pollution CBA. M. Holland - EMRC (2014)*

**GIS model**
- Spatial distribution/allocation
  - (model grid 0,1°x0,1°)

**External Costs**
- €2020

**AVOIDED Impacts**

**AVOIDED External Costs**

Population and ages distribution by city/village (spatial distribution)

Population growth projection 2030

Health Statistics & National Health Survey (INE, 2026), data by NUT3, NUT2

Mortality >30 years
Mortality, all
Mortality, <12 month age
Health Impact Assessment: Total Premature Deaths

Additional scenarios
Avoided Premature Mortality and External Costs

*External Costs: OCDE value of mortality (VSL approach) and infant mortality (average low and high value), update to Euro2020.*
Some conclusions

- Strategies that reduce NO2 have the most relevant impact on avoiding premature deaths, mainly the introduction of electric vehicle E (and additional scenarios).
- The increase in electricity production induced by the electric vehicle (and its associated emissions in power plants) does not preclude the benefits of this measure in terms of avoided mortality and external costs. This is mainly due to the expected decarbonisation of the electricity mix in 2030.

- The CERT-BIOM strategy causes a drastic increase in premature deaths due to the PM2.5 and PM10 higher exposition reaching a 17% of increase with respect 2017P.

- The strategy B(ET+D) (combined introduction of E85 and B20 in diesel vehicles) as well as AB (AddBlue addition) produce a small increase in mortality impacts and associated costs due to higher PM2.5 emissions.

- The implementation of the electric vehicle E would reach the 25,400 Millions Euro2020 avoided, while CERT-BIOM would increase the external cost associated to air pollution in more than 29,500 Million Euro2020.

- The strategy with the lowest impact is W (no waiver) that produced a small reduction in mortality impacts and associated external costs.

- The strategy BET (E85) produces an overall reduction in mortality and external costs driven by reductions in NO2 and ozone related impacts although there are increases in particle related impacts and costs.
• More renewable energy, with decarbonisation, could lead to higher NH3 in some areas (less ammonium sulphate)

• The reduce of Nox in the electric vehicles scenario can reduce O3 for some metrics, but not for the annual mean (no change of some increase in large urban areas with high Nox emissions, due to less NO-titration)
Thank you