Retos-AIRE: AiR pollution mitigation actions for EnvironmenTal pOlicy Support. AIR quality multiscale modelling and evaluation of hEalth and vegetation impacts ***RTI2018-099138-B-100 Plan Nacional I+D+i***

50th TFIAM meeting 21-23 April 2021

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

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(2) *Energy Systems Analysis Unit*

(3) *Software Development and Computing Systems Unit*

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)*

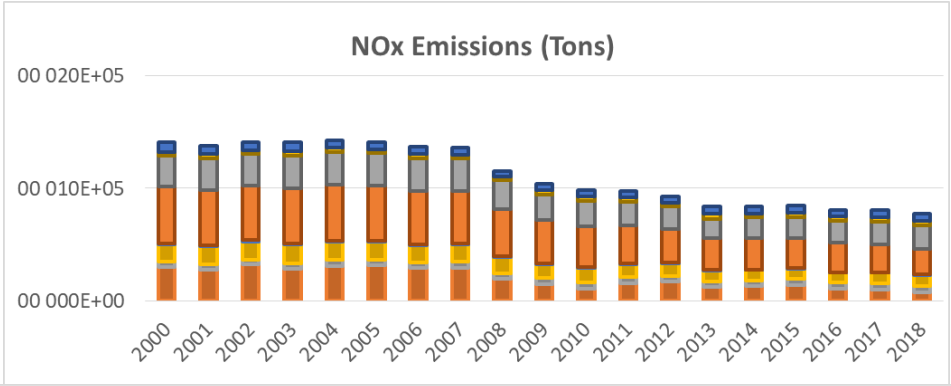
Outline

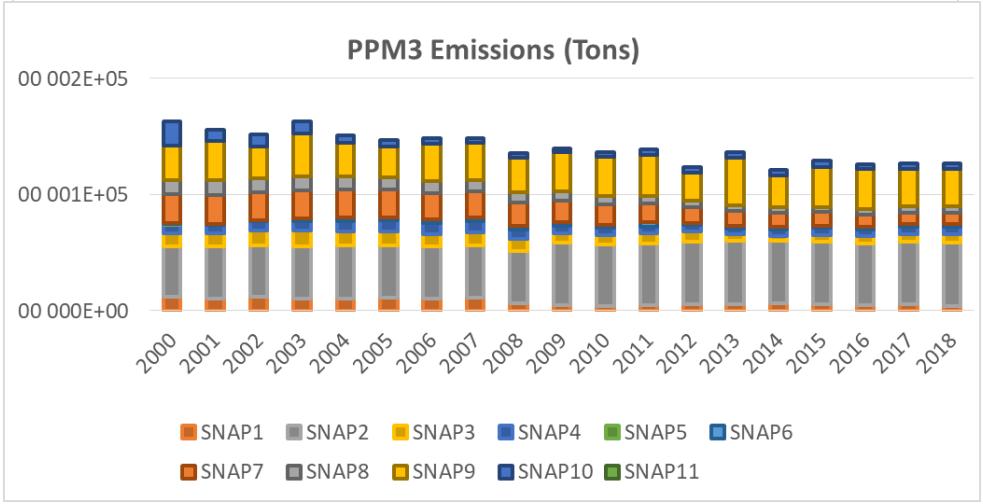
- **Measures and reductions**
- **Impacts on air quality**
- **Impacts on health and cost**
- **Conclusions**

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**

PRELIMINARY





Source: INE 2020 edition

Residential Sector

2 Individual Measures

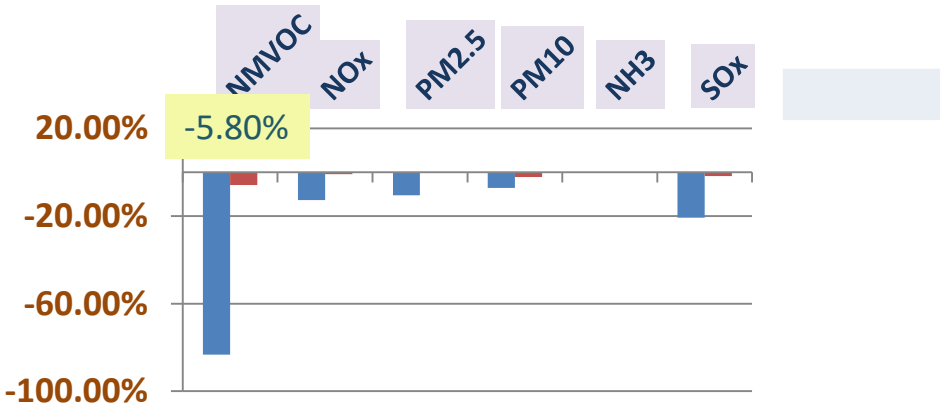
EF-HEAT: Substitution of traditional heating by more eficient systems

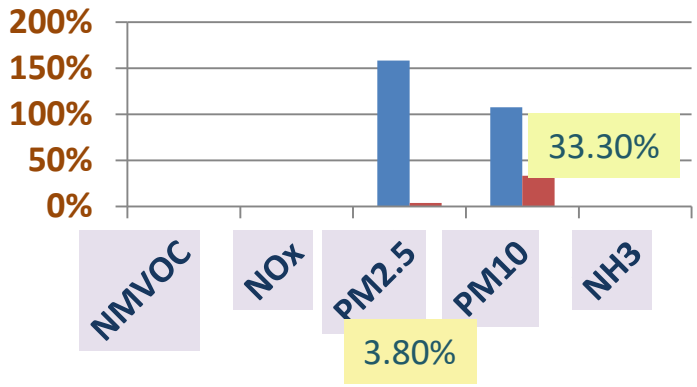
CERT-BIOM: Substitution of traditional diesel and coal heating by certified biomass systems

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

% (SNAP2)

% (TOTAL)





On road Transport

Advanced biofuels for transport	More efficient use of transport
Changes in mode of transportation	Fleet renewal
Promotion of electric cars	Refueling/recharging points for alte

Measures mentioned in the 1st-Spanish National Air Pollutuion Control Programme, WAM30 scenario, for the tranport sector

5 Individual Measures

W Waiver scenario

Waiver: Reduction of vapour pressure from 68kPa to 60 kPa in gasoline E5 (more evaporative emissions)

E Substitution of all non-hybrid cars by electric cars

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)

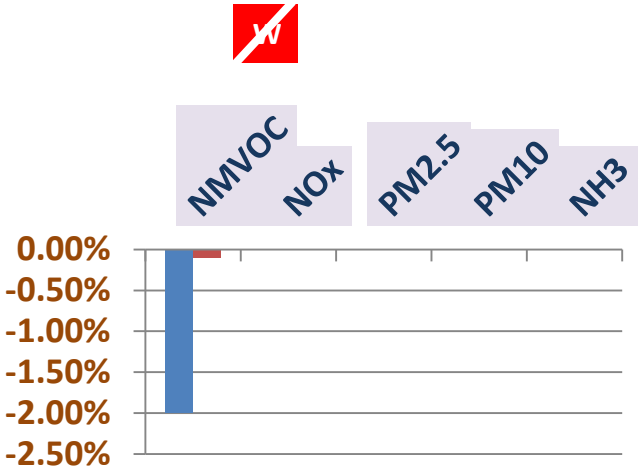
B(ET+D) Promotion of advanced biofuels: bioethanol (E85 for passenger cars and motorcyles (→ Petrol fleet renewal) and E10 for the rest of petrol vehicles)+ biodiesel B20

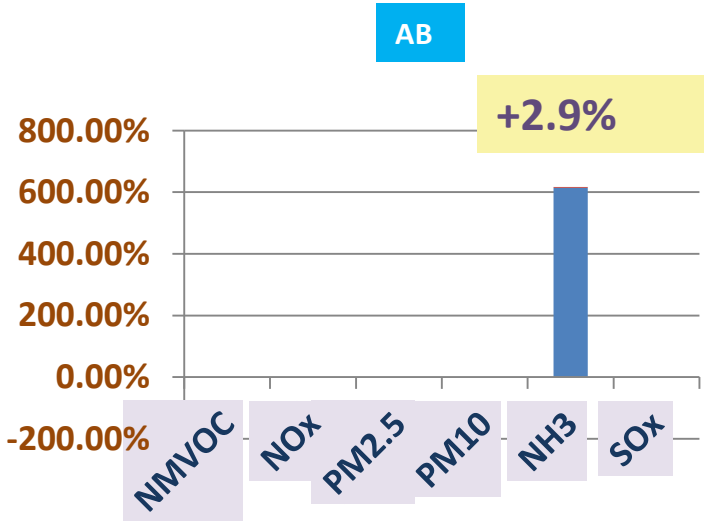
: Waiver scenario

AB Introduction of Adblue technology in diesel motors (cars and goods vehicles)

% (SNAP7)

% (TOTAL)

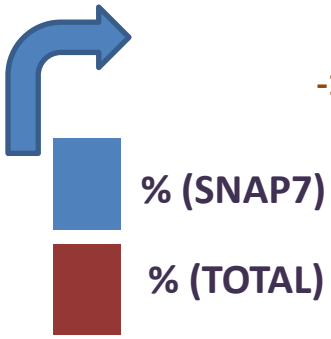


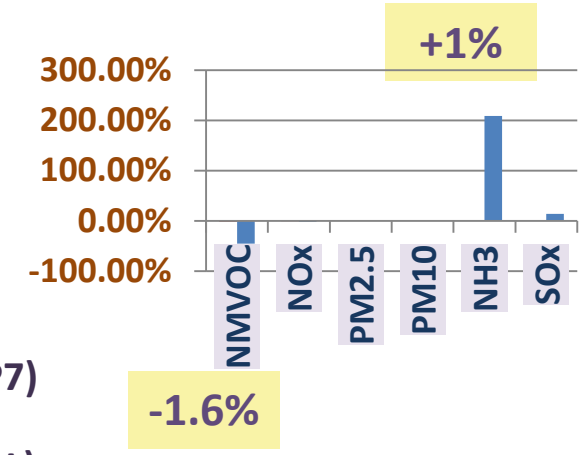


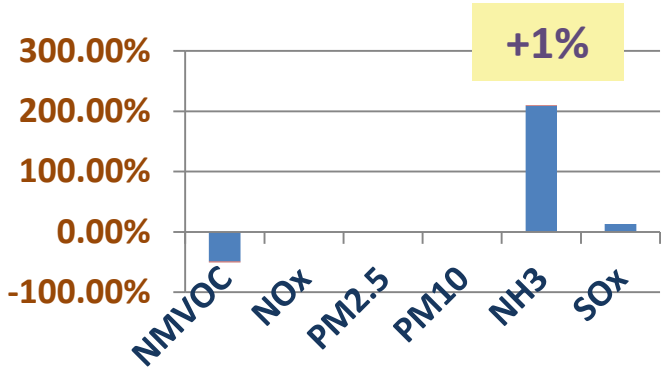
- Advanced biofuels for transport
- Fleet renewal

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 motcyles (→ Petrol fleet renewal) and E10 for the rest of petrol vehicles)+ biodiesel B20



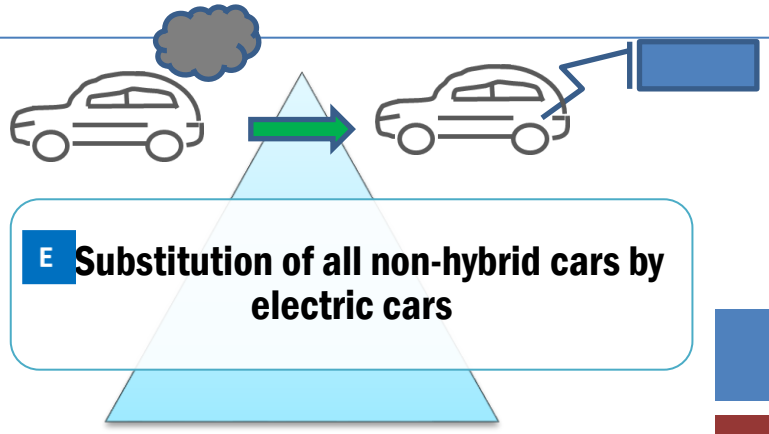




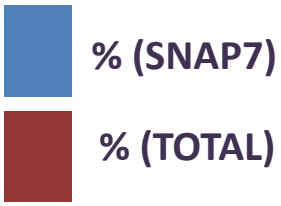
Promotion of electric cars (100 % of petrol and diesel)

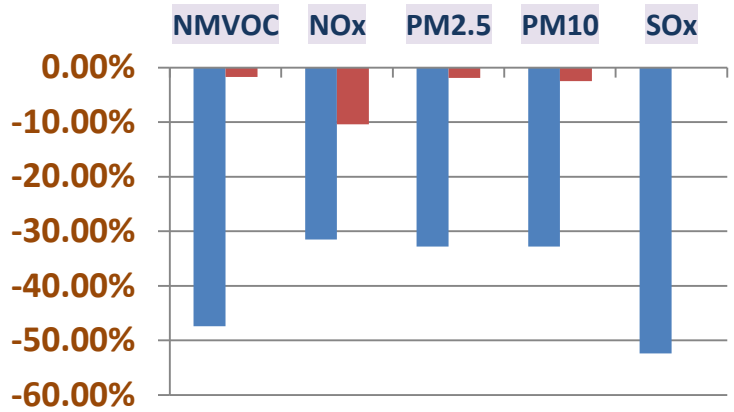
E

D+G



E Substitution of all non-hybrid cars by electric cars



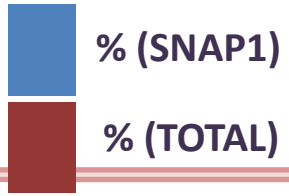


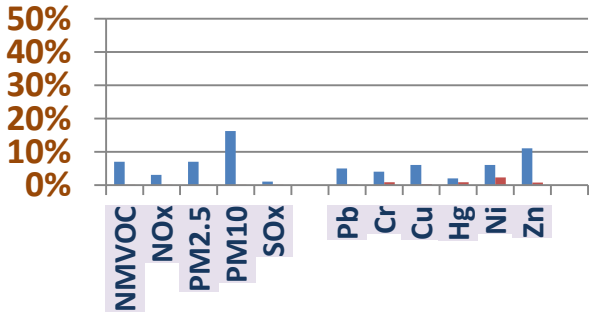
1

No consideration of additional electricity consumption

2

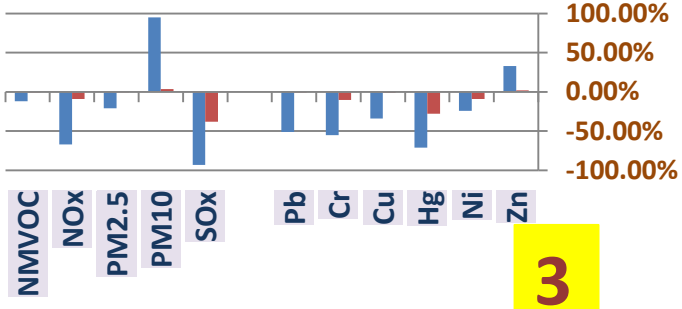
- Addition of electricity consumption to SNAP1
- Energy mix projected to 2030





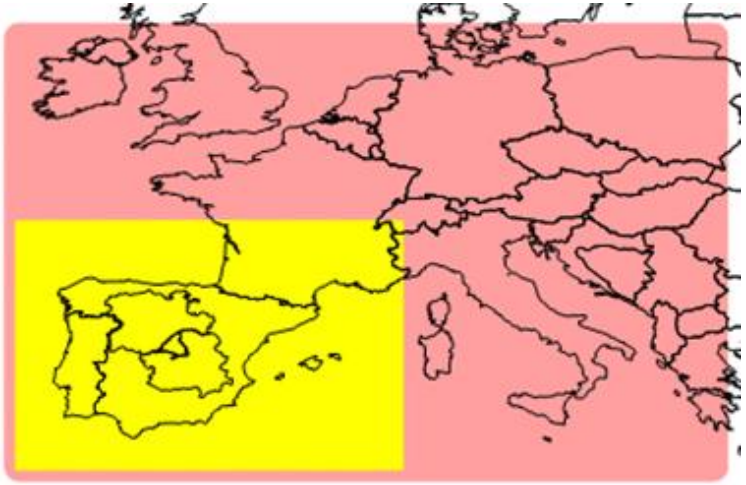
3

- Energy mix projected to 2030
- Increased renewable energy



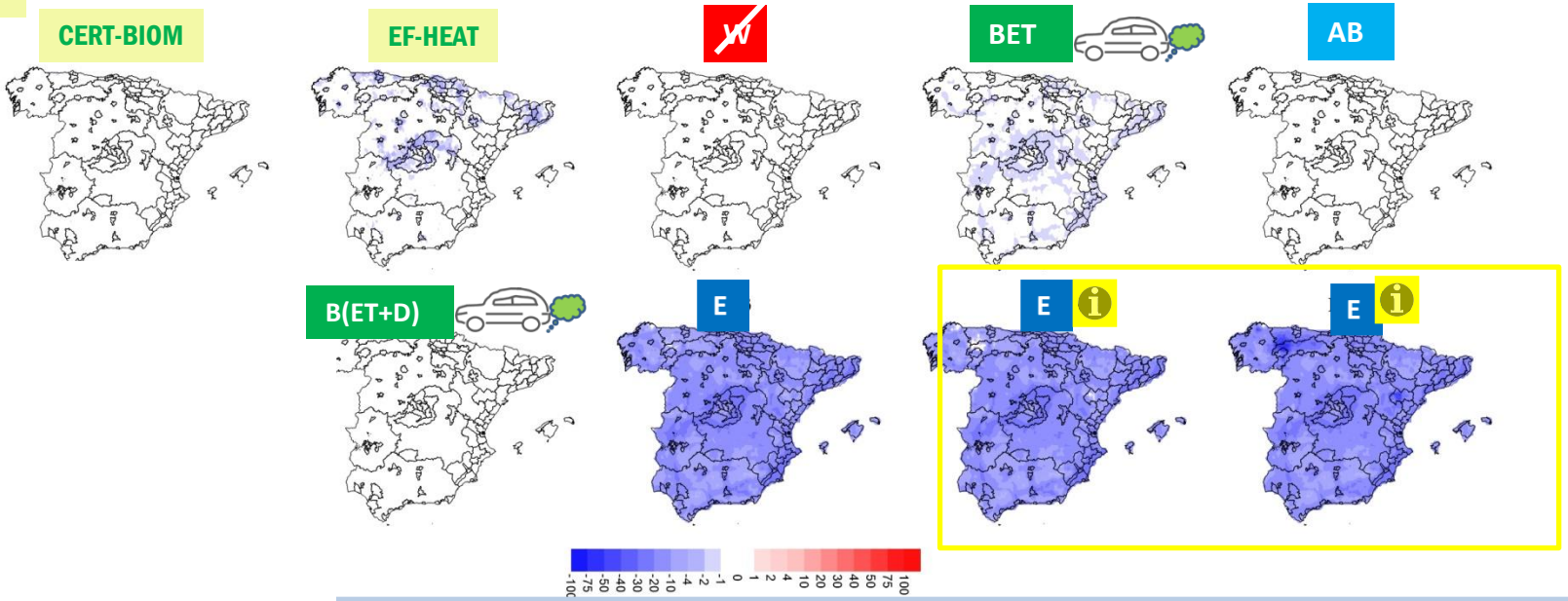
Methodology

- **CHIMERE air quality model**. Domain covering the Iberian Peninsula at **0.1 ° x 0.1 °** nested in a European domain at 0.15° x 0.15°
- Simulation of **2017 (base)**
- ECMWF-IFS meteorology for 2017
- **Correction of model results**



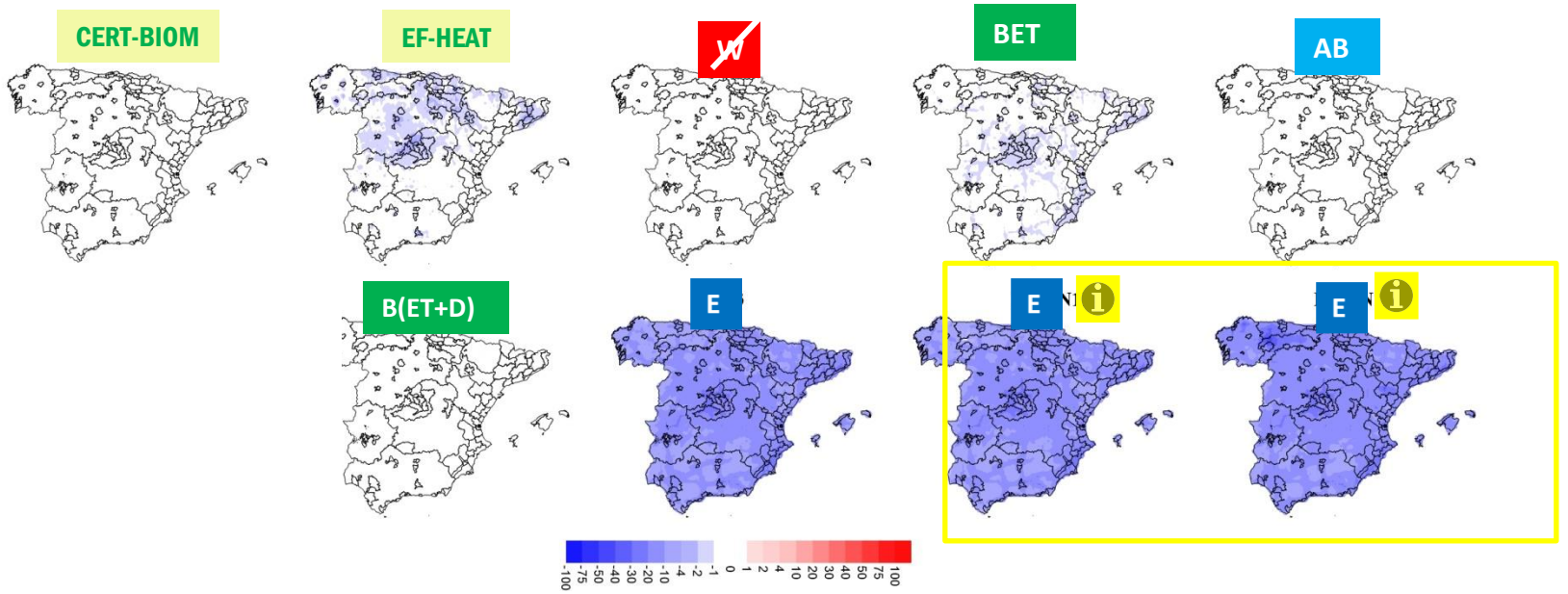
NO2

MAXIMUM HOURLY (19th) - RELATIVE DIFFERENCES %



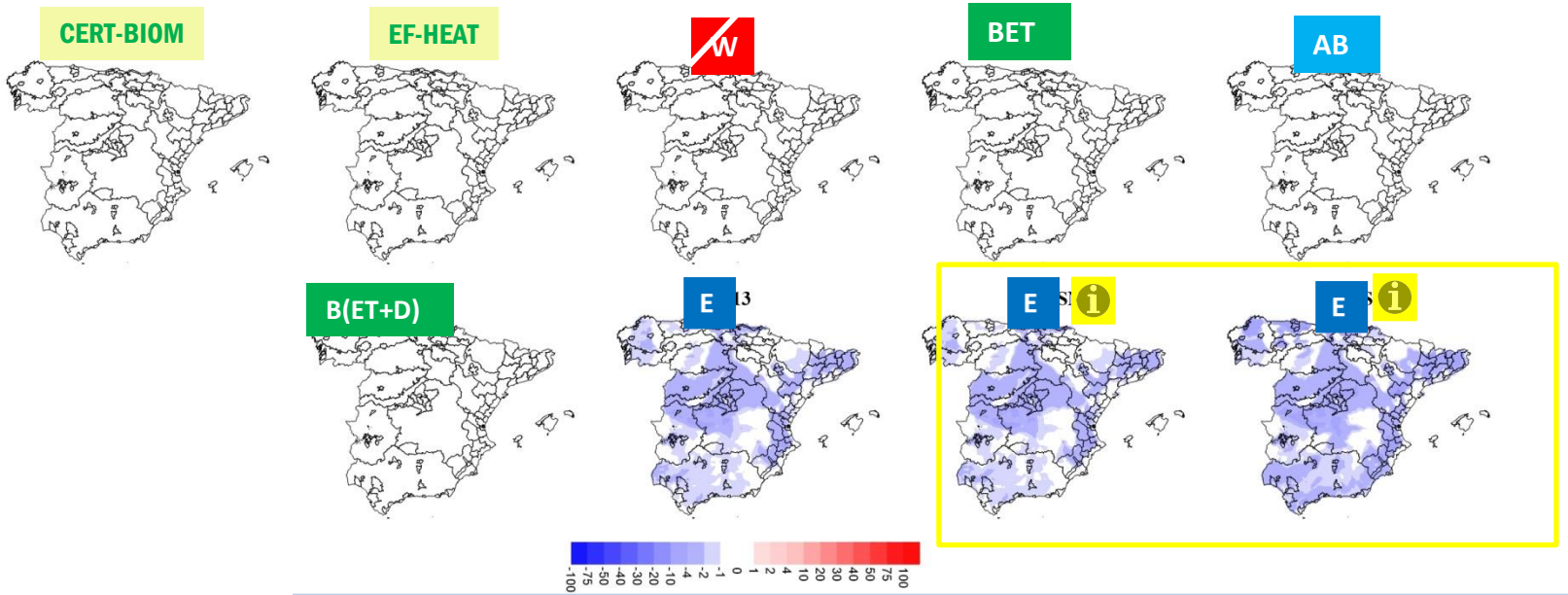
NO2

ANNUAL MEAN - RELATIVE DIFFERENCES %



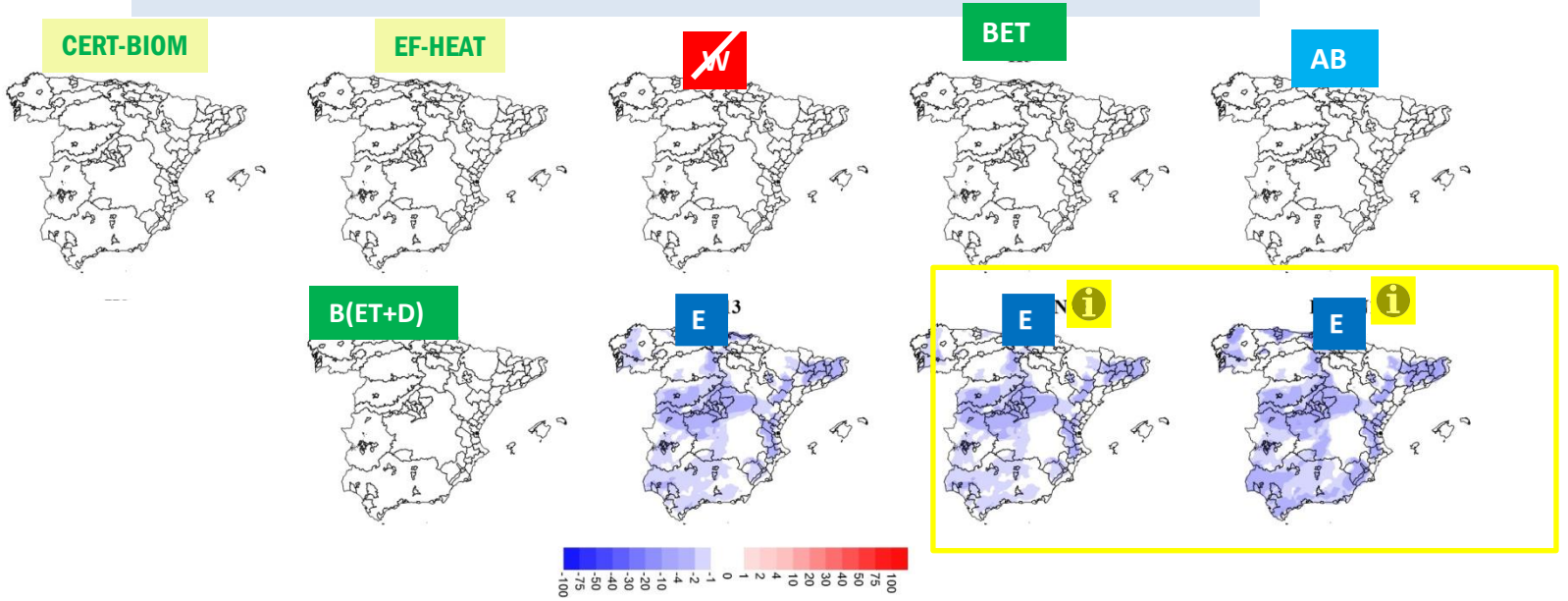
03

MAXIMUM HOURLY - RELATIVE DIFFERENCES %



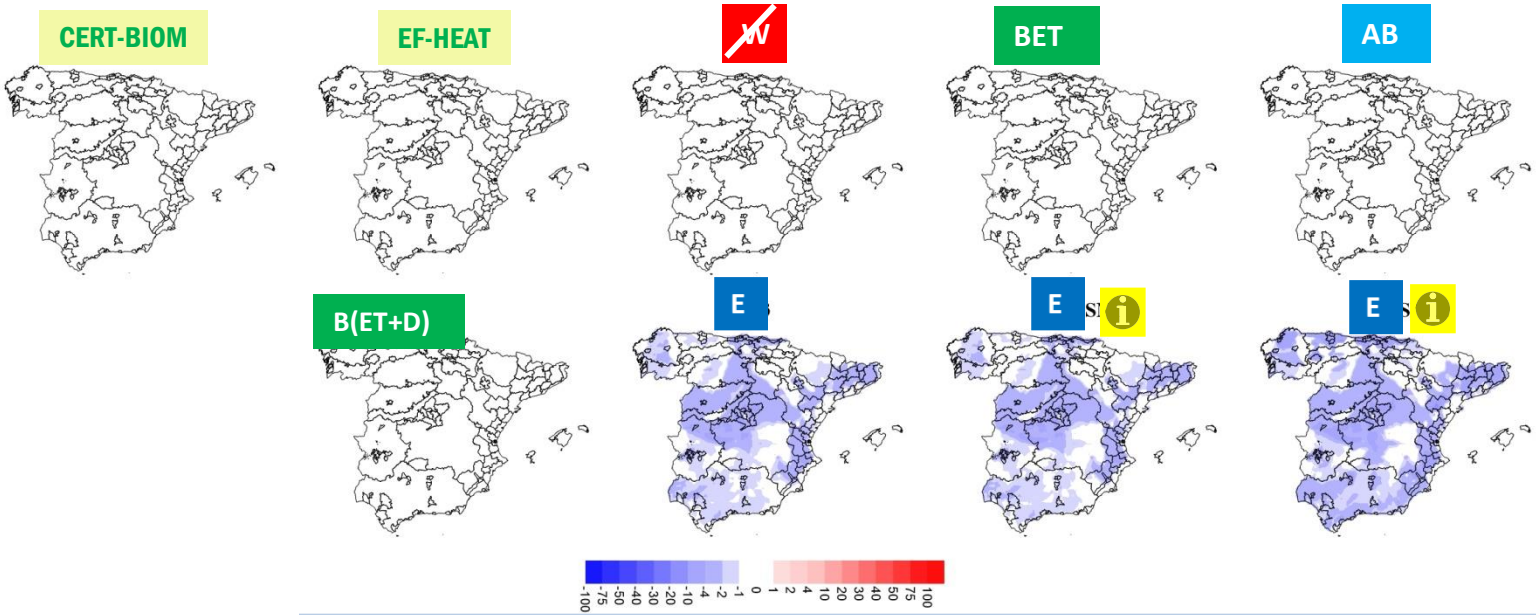
03

MAXIMUM DAILY 8 HOUR MEAN - RELATIVE DIFFERENCES %

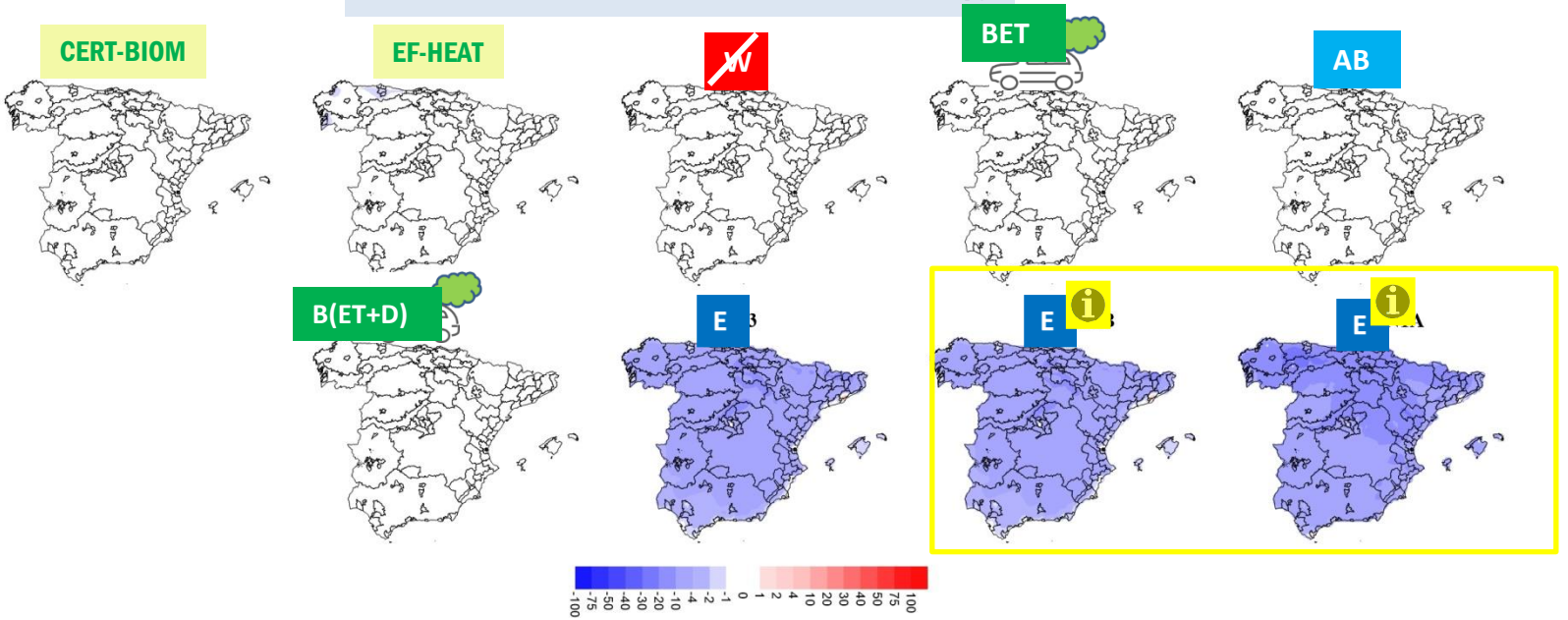


03

SOMO 35 - RELATIVE DIFFERENCES %

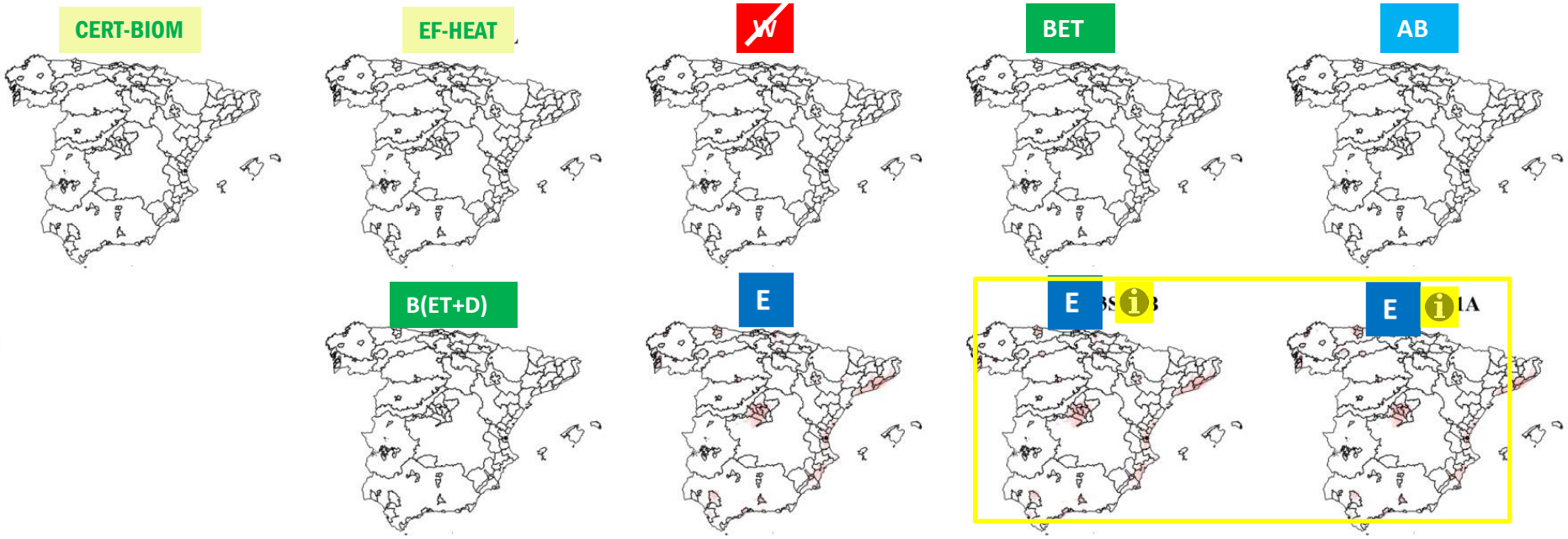


AOT40 - RELATIVE DIFFERENCES %



O3

ANNUAL MEAN - RELATIVE DIFFERENCES %



W $O_3 + NO \rightarrow NO_2 + O_2$ NO ↓ O3 ↑

$NO_2 + h\upsilon \rightarrow NO + O$

$O + O_2 + M \rightarrow O_3 + M$

NO2 ↓ O3 ↓

- In general, no change in annual mean
- For **electric vehcicles** some **increases of annual O3 in large urban areas** (mainly Madrid, Barcelona). In line with the results for the application of the NAPCP

PM10

ANNUAL MEAN - RELATIVE DIFFERENCES %

CERT-BIOM

EF-HEAT

BET

AB

B(ET+D)

E

E

E

RELATIVE DIFFERENCES PM25 ANNUAL MEAN

BIOMC ECOCAL H1 H5 H7

H8 H10

CERT-BIOM

EF-HEAT

ANNUAL MEAN - RELATIVE DIFFERENCES %

BET

AB

B(ET+D)

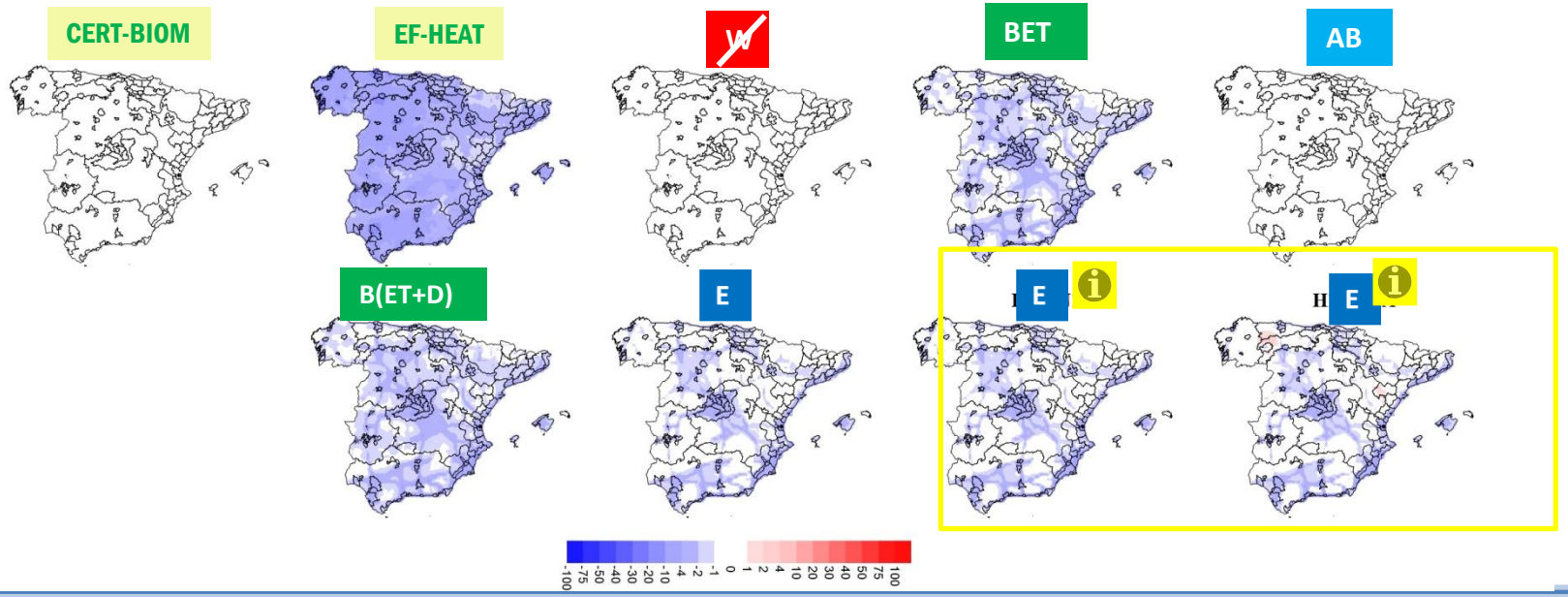
E

E

E

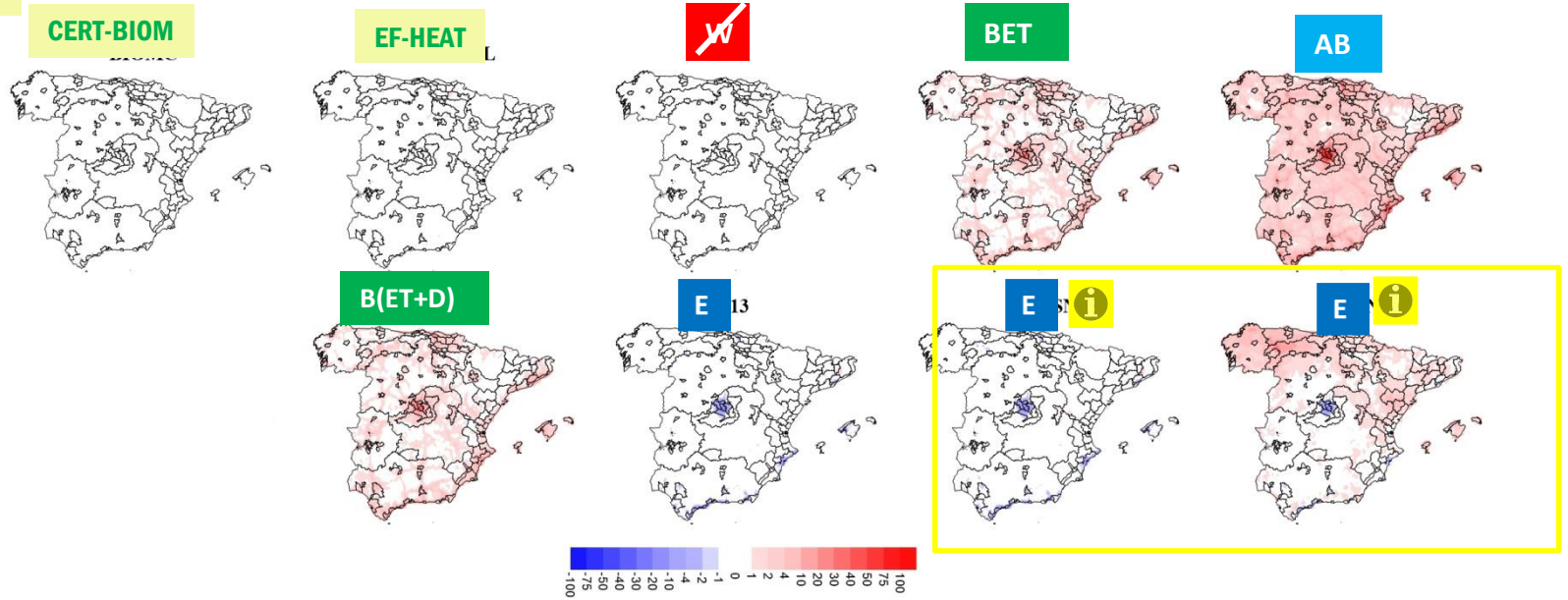
NMVOCS

ANNUAL MEAN - RELATIVE DIFFERENCES %

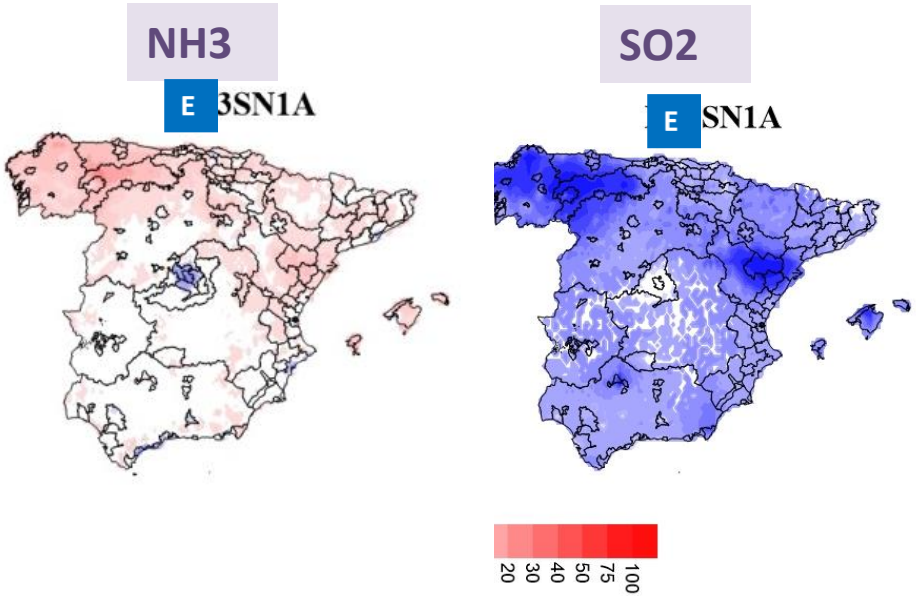


NH3

ANNUAL MEAN - RELATIVE DIFFERENCES %



Increase of NH3 with reductions of SOx



SO_2 ↓ ⇨ H_2SO_4 ↓

⇒ **Less formation** of $(NH_4)_2SO_4$

⇒ 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)

MODEL
Pollutants concentration
PM, NO2, O3

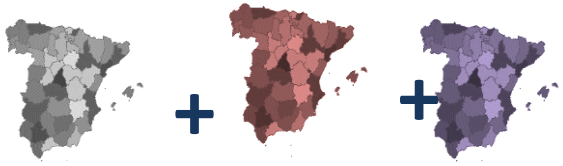
Estimation of effects
Concentration Response Functions
(HRAPIE & WHO)

External Costs
€2020

AVOIDED Impacts

AVOIDED External Costs

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

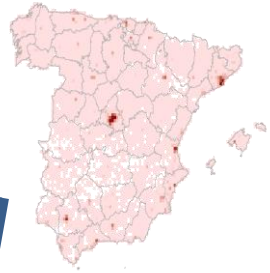


Mortality >30 years + Mortality, all + Mortality, <12 month age

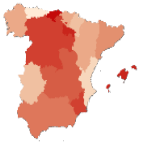
Health Staticstics & National Health Survey
(INE, 2026), data by NUT3, NUT2

GIS model

Spatial distribution/allocation
(model grid 0,1˚x0,1˚)

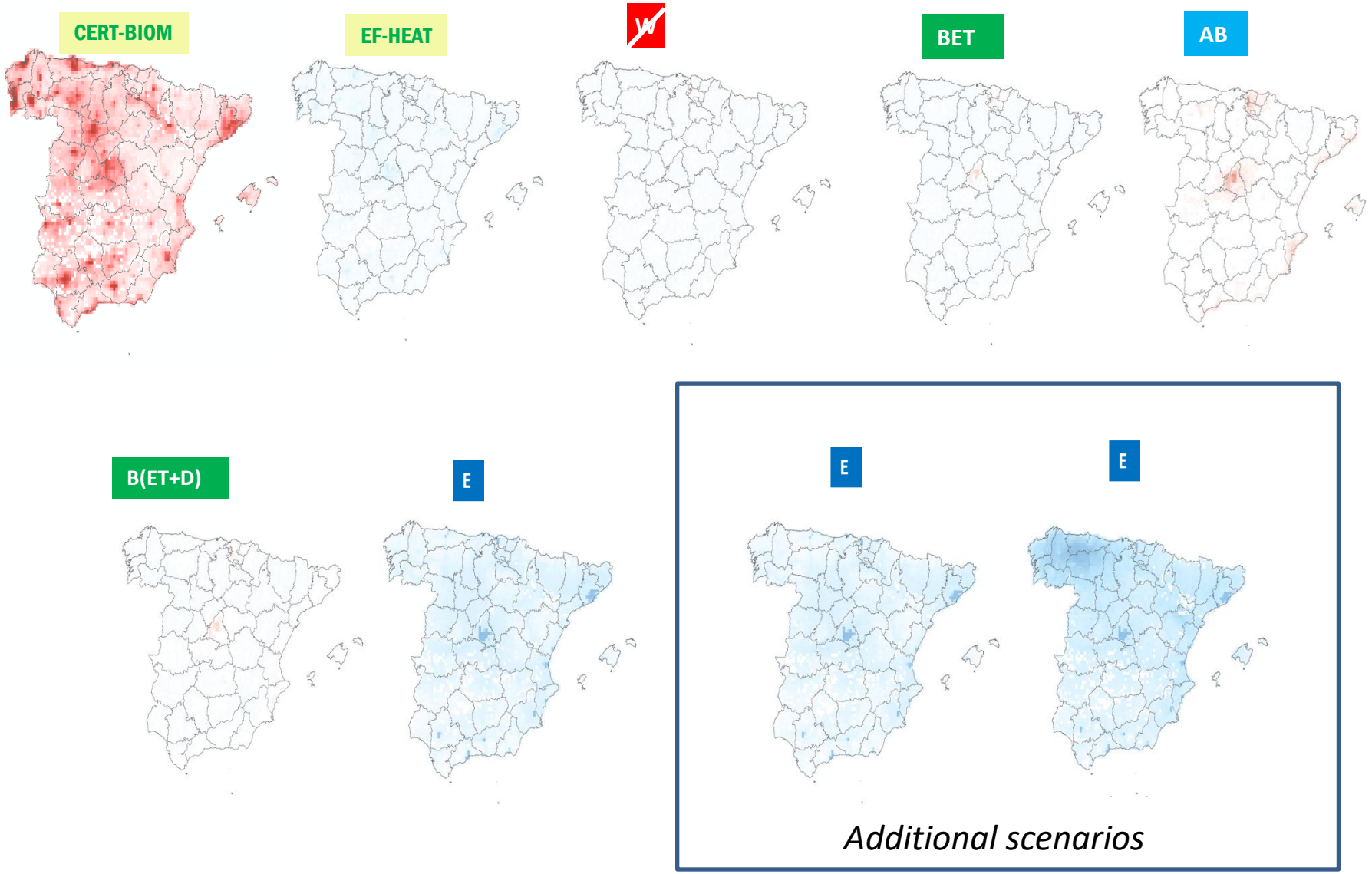


Population and ages distribution by city/village (spatial distribution)

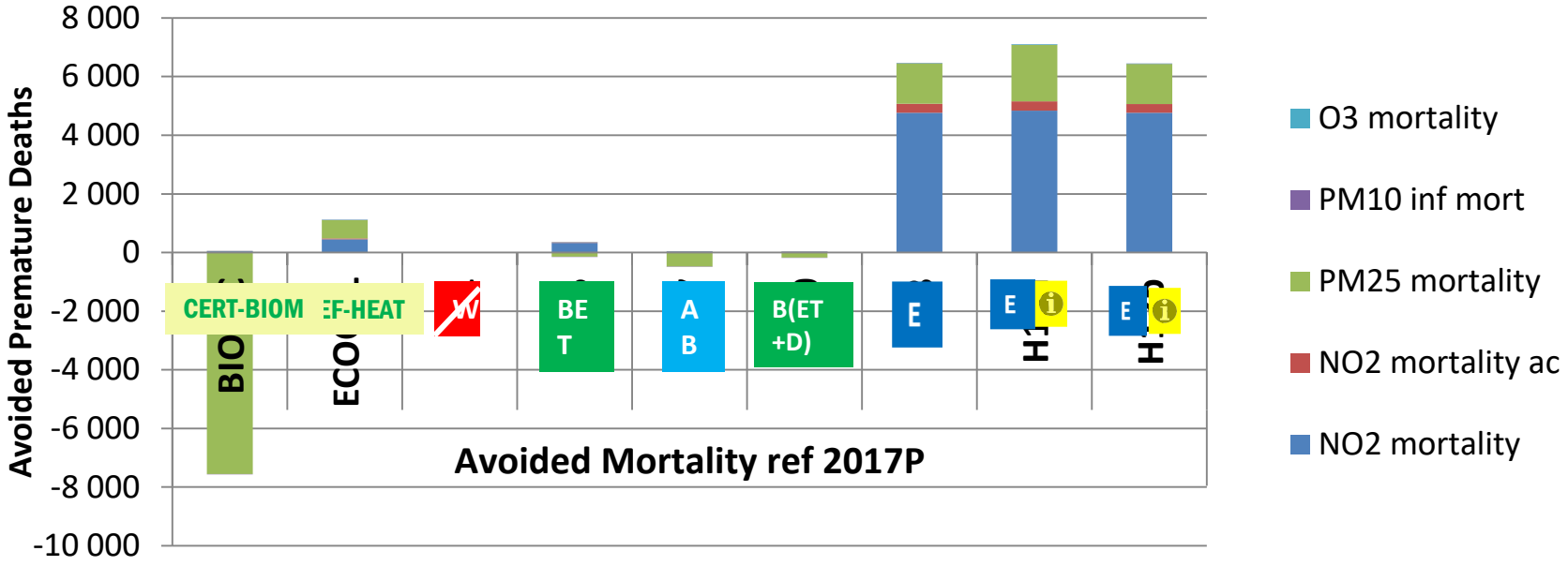


\+ Population growth projection 2030

Health Impact Assessment: Total Premature Deaths



Avoided Premature Mortality and External Costs



	Avoided EC mortality (Millions Euro 2020)								
	CERT-BIOM	EF-HEAT		BET	AB	B(ET+D)	E	E	E
NO2 mortality	147	1,776	5	1,299	109	70	18,732	18,998	18,724
NO2 mortality ac	8	101	0	74	5	2	1,176	1,230	1,173
PM25 mortality	-29,651	2,466	3	-552	-1,864	-665	5,445	7,582	5,369
PM10 inf mort	-39	3	0	-1	-2	-1	8	10	8
O3 mortality	14	10	1	18	3	19	32	111	28
Total Avoided	-29,521	4,355	9	839	-1,749	-574	25,392	27,930	25,302
% reduc ref2017P	16.80%	-2.48%	0.00%	-0.48%	1.00%	0.33%	-14.45%	-15.90%	-14.40%

Additional scenarios

***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 VW (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