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“Emission Scenarios for Bulgaria using the Integrated Model GAINS”

Why integrated models and modelling?

GAINS, EC4MACS and NIAM

- GAINS (Greenhouse Gas Air Pollution Interactions and Synergies) – an integrated model developed by IIASA (www.iiasa.ac.at).
- Project EC4MACS (European Consortium for the Modelling of Air Pollution and Climate Change) (www.ec4macs.eu).
  Model suite: GAINS, PRIMES, TREMOVE, CAPRI, GEM-E3, EMEP, ExternE, etc.
- NIAM - Network for Integrated Assessment Modelling (www.niam.scarp.se).

GAINS methodology

- GAINS considers the following air pollutants and GHGs: SO_2, NO_x, VOC, NH_3, PM, CO_2, O_3, CH_4, N_2O and F-gases (CFCs, HFC, SF_6S). They have the common sources.
- GAINS energy database – components of energy system:

  - Electricity and district heat generation (PP)
  - Energy for primary fuel production, energy conversion, energy delivery (CON)
  - Final energy use in: industry (IN), Domestic Sector (DOM – residential, commercial, agriculture, fishing, services), transport (TRA), non-energy use (NONEN)
- Works in two modes: scenario and optimization

In Scenario Mode

- ✓ Creation of emission and cost scenarios
  Scenario – combination of activity pathway and control strategy.
  - Emission=Activity*Emission factor* Technology implementation
  - Cost= Activity*Unit Cost*Technology Implementation
- ✓ Assessment of the impact on ecosystems and human health (health impact, excess of critical levels, ambient concentrations and depositions).

In Optimization Mode

- ✓ The model specifies cost-efficient emission reductions for each country that enable to meet policy targets simultaneously for air quality and greenhouse gases in a cost-efficient way.
- ✓ Exploring of synergies – application of individual measures to reduce one or more pollutants (e.g. fuel substitution and structural changes).
- ✓ Enables development of multi-pollutant, multi-effect control strategies.

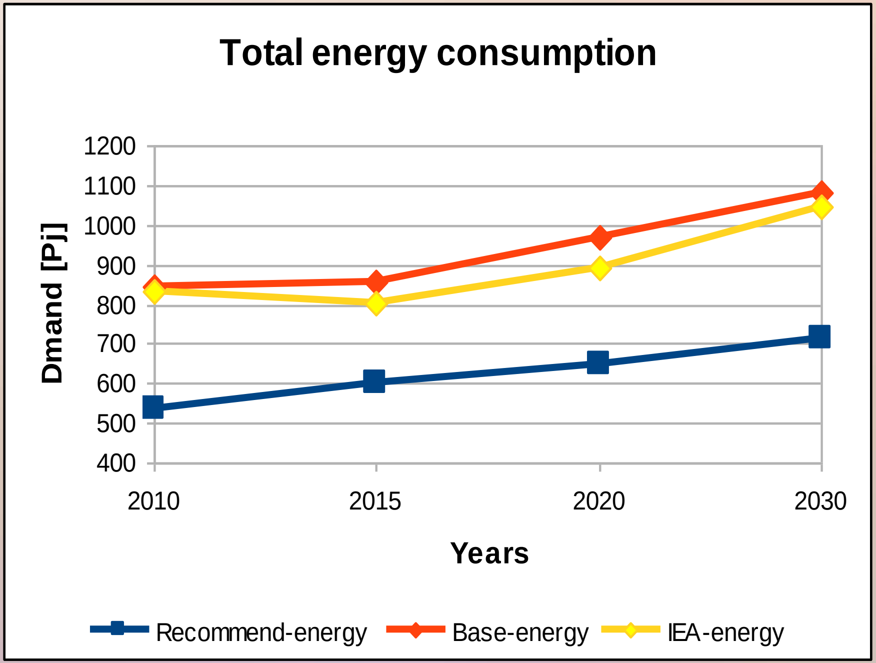
Scenarios considered

1. IEA WEO (IIASA scenario)
2. Baseline (based on the prognosis of NEK)
3. Recommended (based on the results of the project CASES)

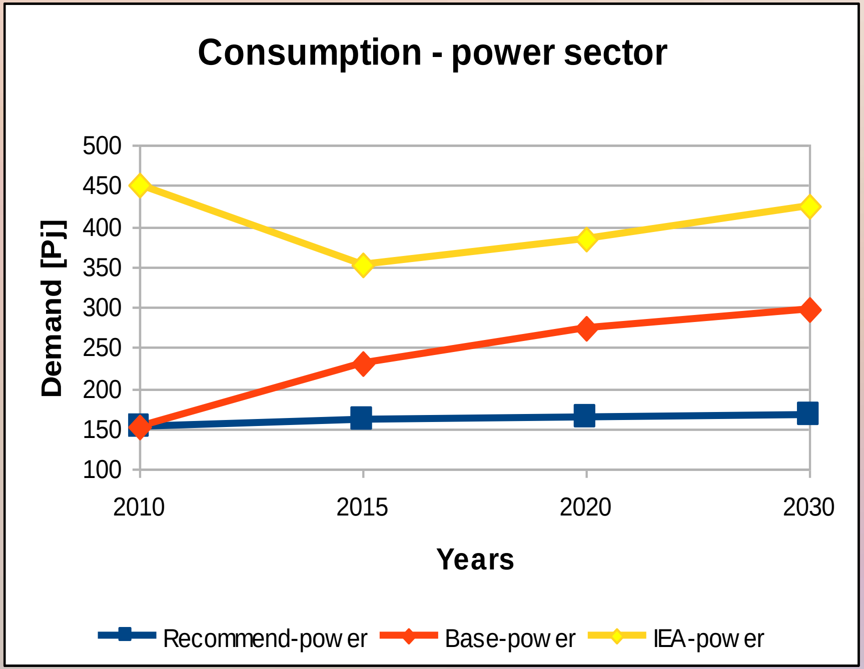
   Used different energy pathways and equal control strategy.

   Time period 2010-2030 in 5 year interval

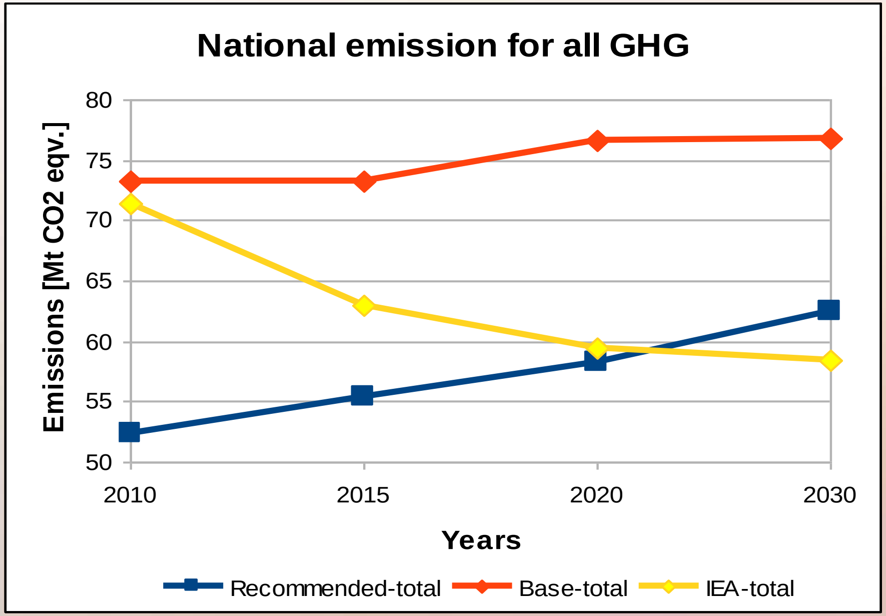
Results

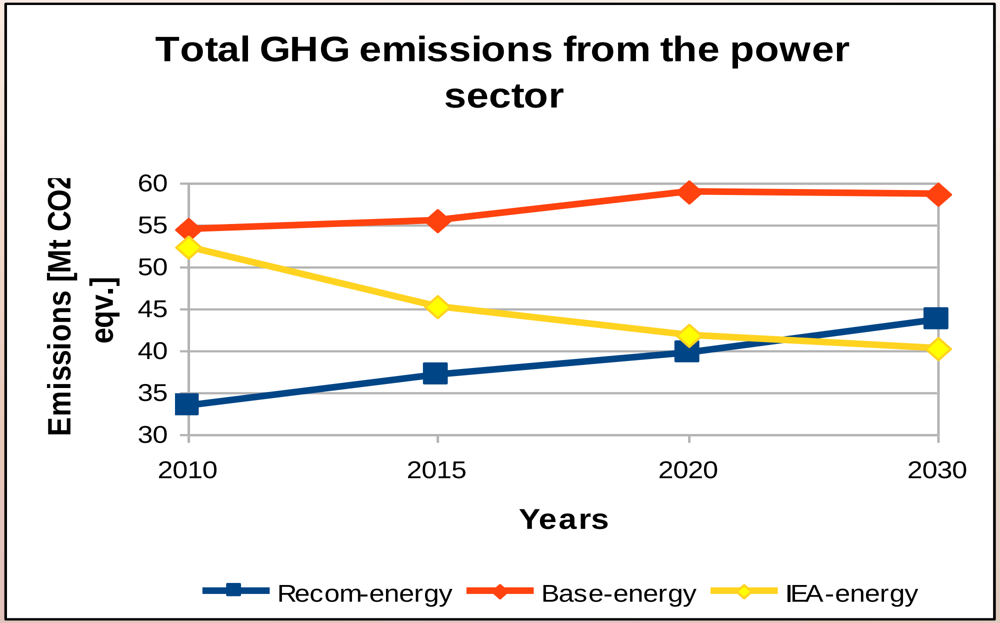


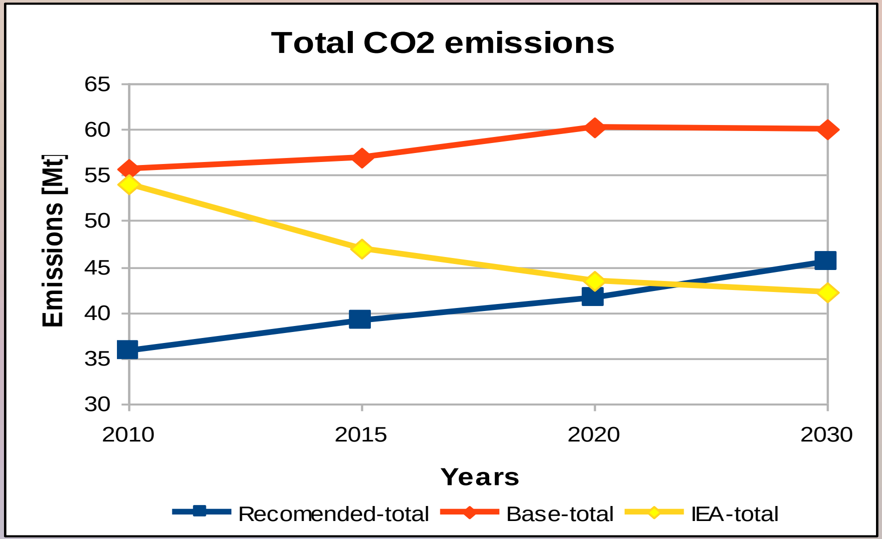
Total energy consumption
Dmand [Pj]
1200
1100
1000
900
800
700
600
500
400
2010
2015
2020
2030
Years
Recommend-energy
Base-energy
IEA-energy

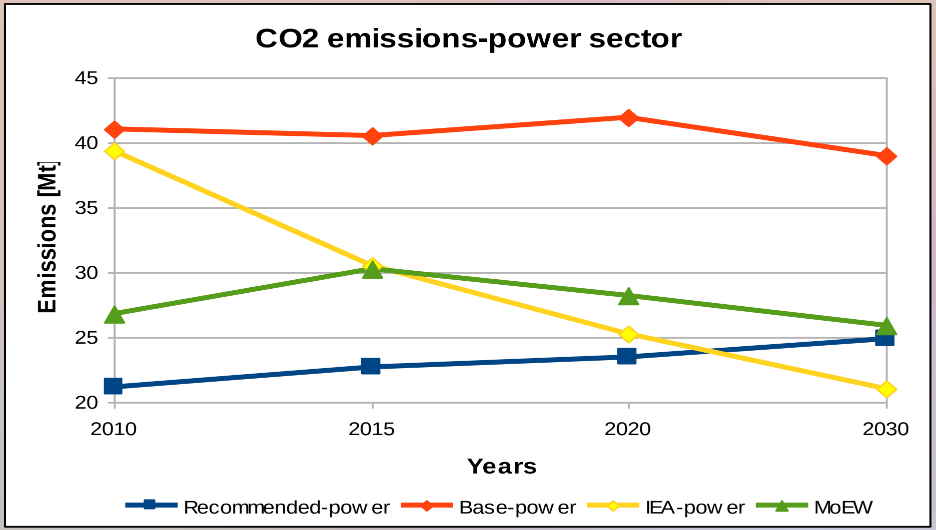


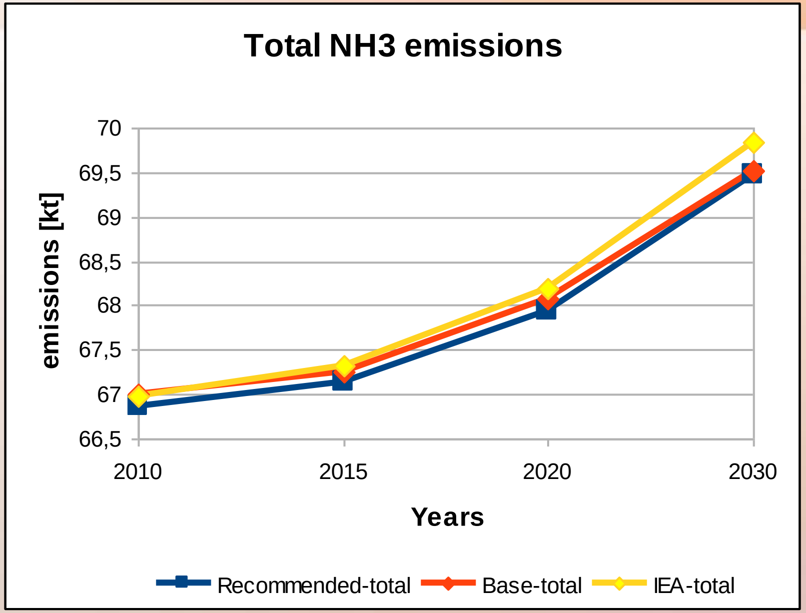
Consumption - power sector
Demand [Pj]
500
450
400
350
300
250
200
150
100
2010
2015
2020
2030
Years
Recommend-pow er
Base-pow er
IEA-pow er

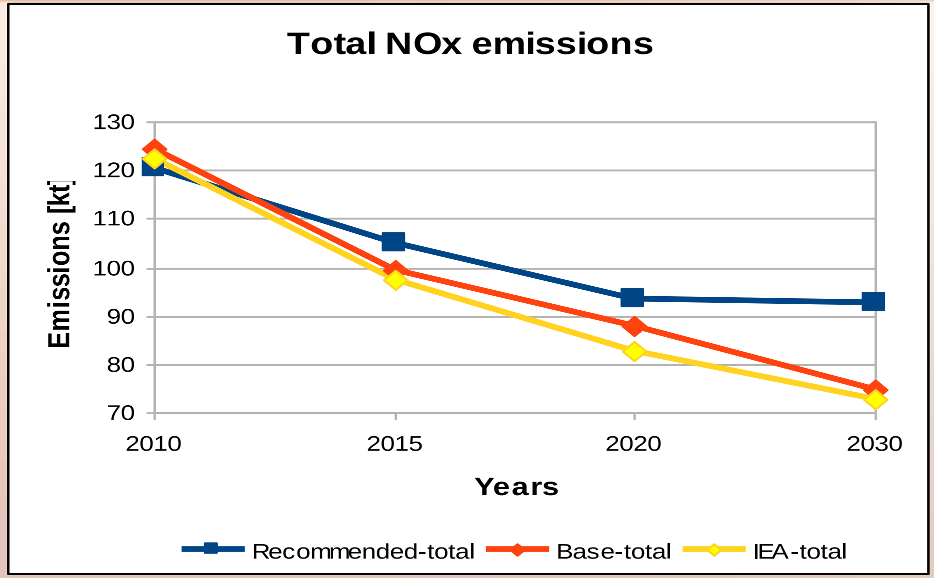

National emission for all GHG
Emissions [Mt CO2 eqv.]
80
75
70
65
60
55
50
2010
2015
2020
2030
Years
Recommended-total
Base-total
IEA-total

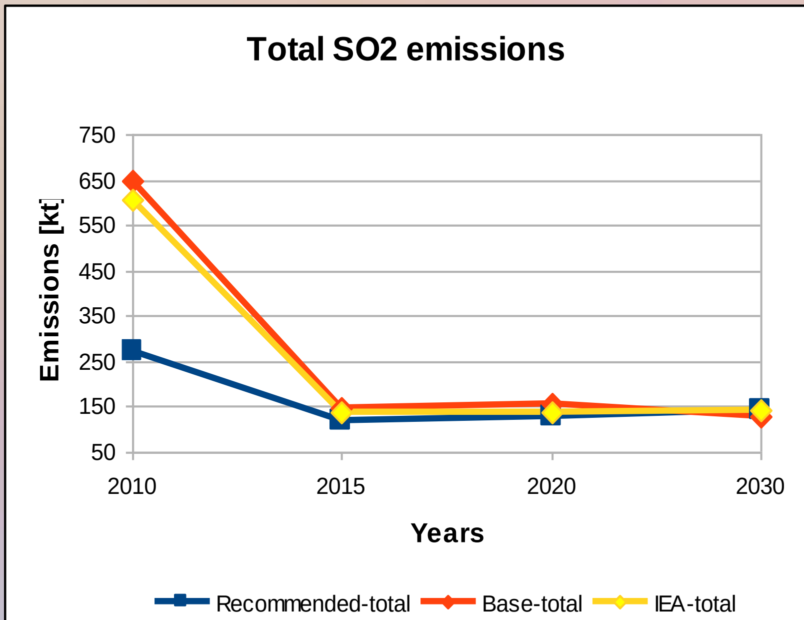

Total GHG emissions from the power sector
Emissions [Mt CO2 eqv.]
60
55
50
45
40
35
30
2010
2015
2020
2030
Years
Recom-energy
Base-energy
IEA-energy

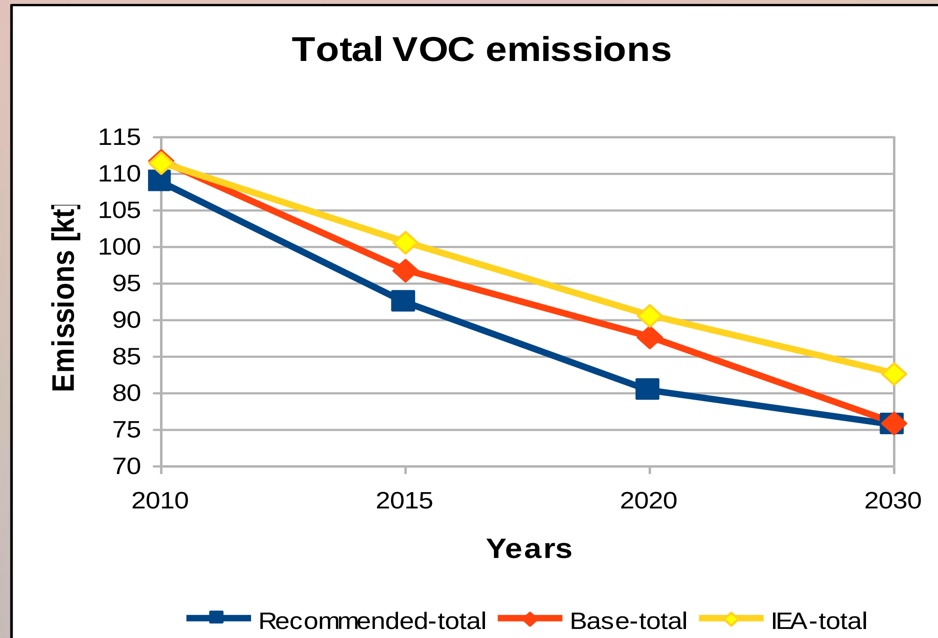

Total CO2 emissions
Emissions [Mt]
65
60
55
50
45
40
35
30
2010
2015
2020
2030
Years
Recomended-total
Base-total
IEA-total

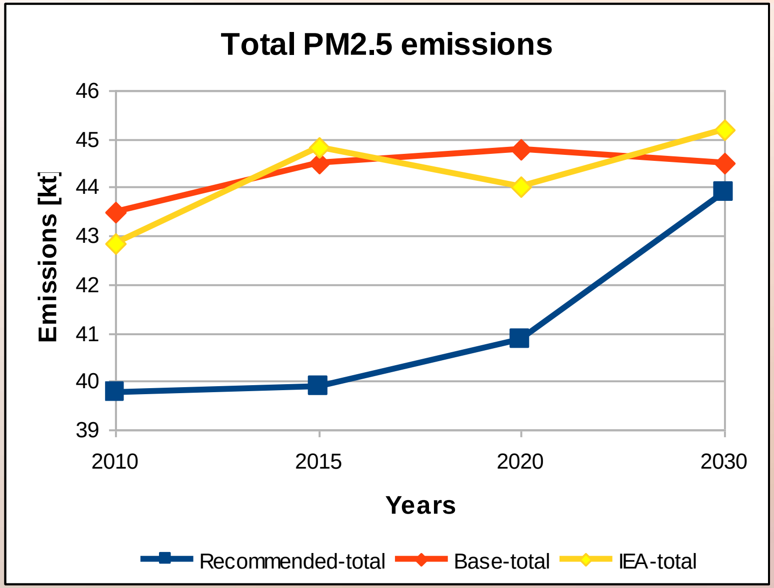

CO2 emissions-power sector
Emissions [Mt]
45
40
35
30
25
20
2010
2015
2020
2030
Years
Recommended-pow er
Base-pow er
IEA-pow er
MoEW


Total NH3 emissions
emissions [kt]
70
69,5
69
68,5
68
67,5
67
66,5
2010
2015
2020
2030
Years
Recommended-total
Base-total
IEA-total

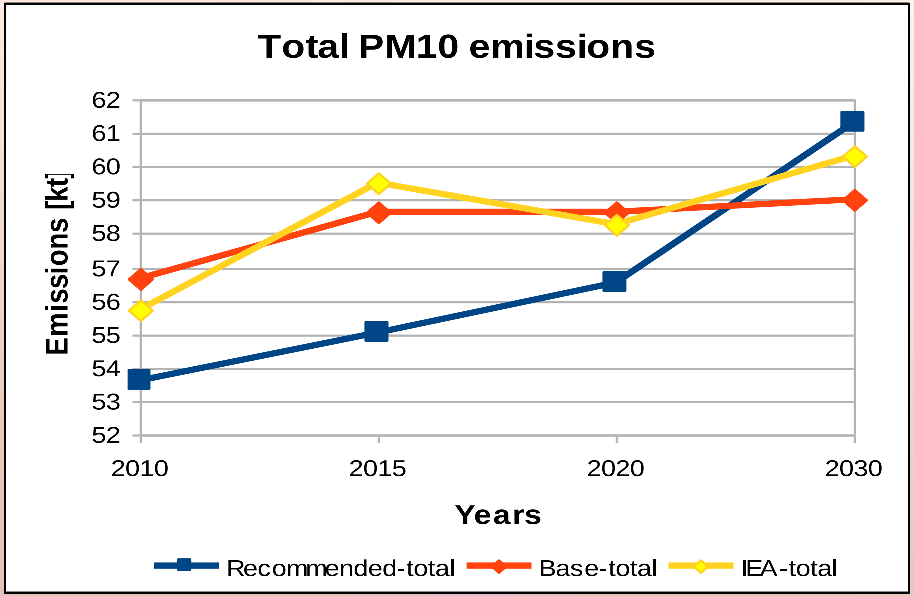

Total NOx emissions
Emissions [kt]
130
120
110
100
90
80
70
2010
2015
2020
2030
Years
Recommended-total
Base-total
IEA-total


Total SO2 emissions
Emissions [kt]
750
650
550
450
350
250
150
50
2010
2015
2020
2030
Years
Recommended-total
Base-total
IEA-total

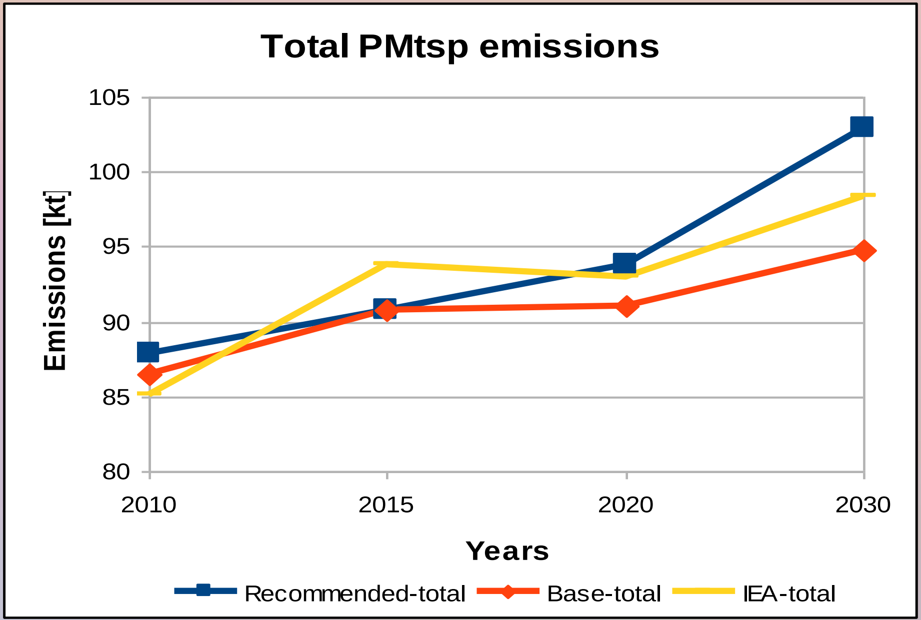

Total VOC emissions
Emissions [kt]
115
110
105
100
95
90
85
80
75
70
2010
2015
2020
2030
Years
Recommended-total
Base-total
IEA-total



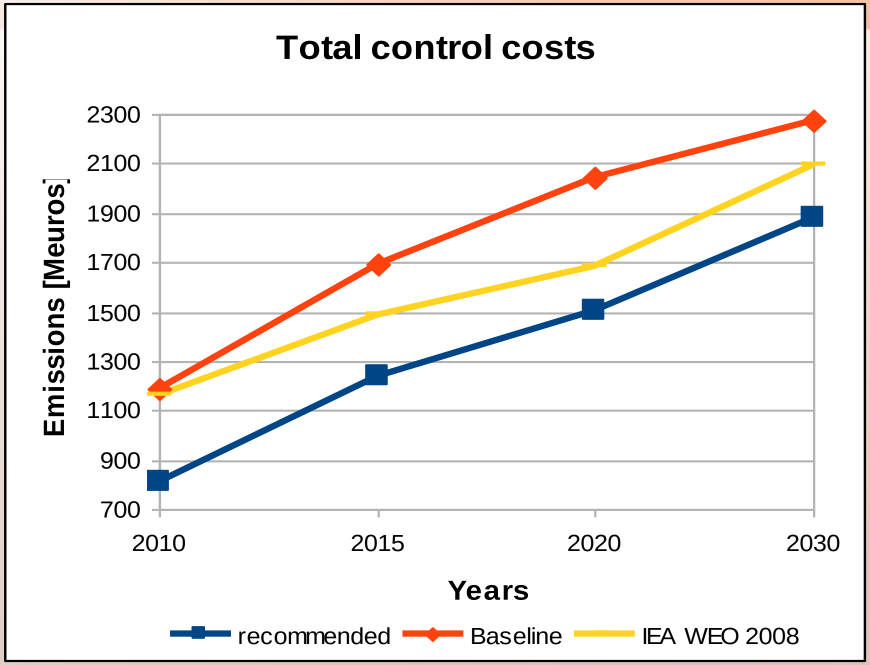
Total PM2.5 emissions
Emissions [kt]
46
45
44
43
42
41
40
39
2010
2015
2020
2030
Years
Recommended-total
Base-total
IEA-total

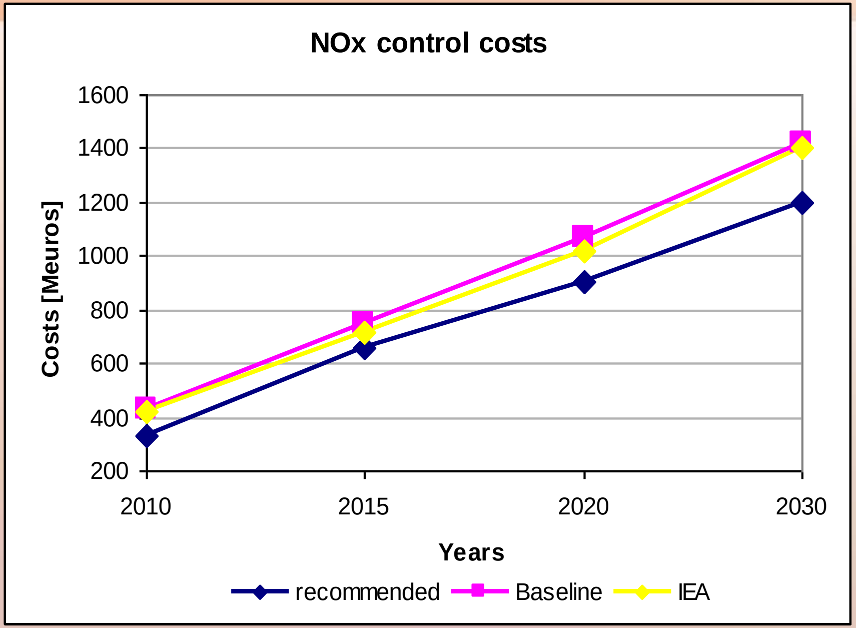


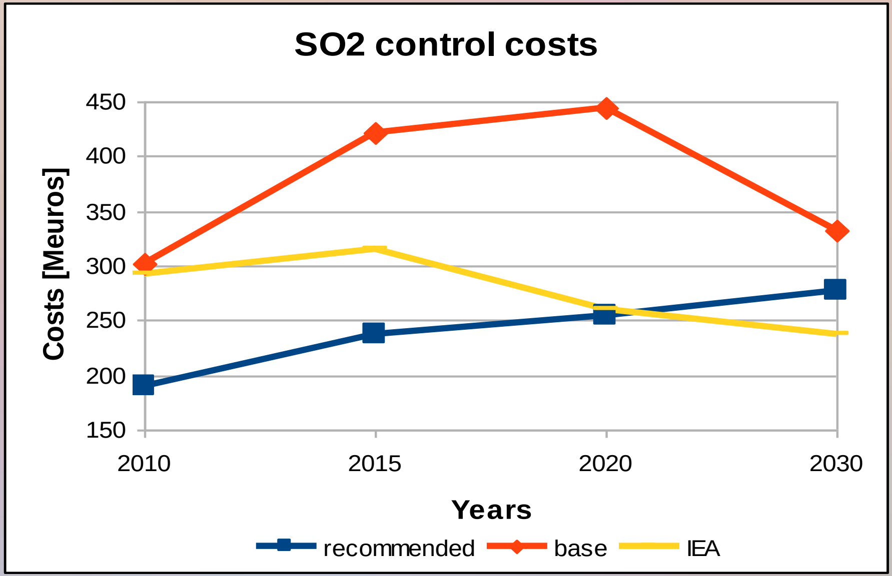
Total PM10 emissions
Emissions [kt]
62
61
60
59
58
57
56
55
54
53
52
2010
2015
2020
2030
Years
Recommended-total
Base-total
IEA-total

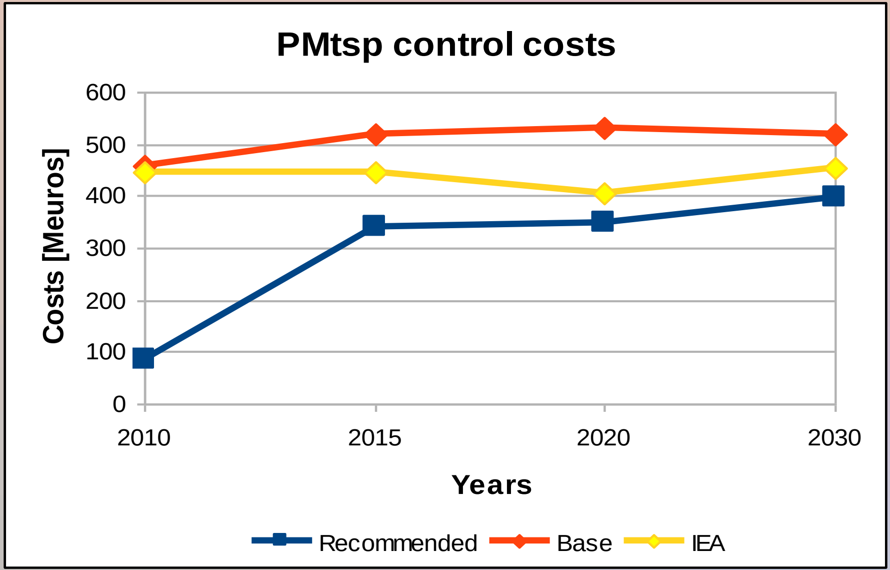


Total PMtsp emissions
Emissions [kt]
105
100
95
90
85
80
2010
2015
2020
2030
Years
Recommended-total
Base-total
IEA-total

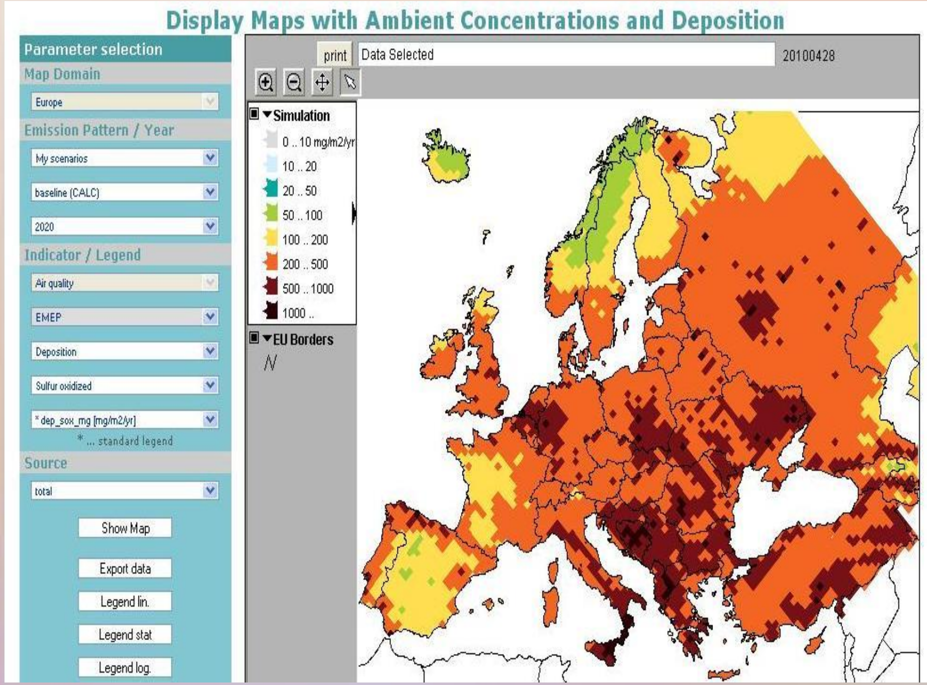

Total control costs
Emissions [Meuros]
2300
2100
1900
1700
1500
1300
1100
900
700
2010
2015
2020
2030
Years
recommended
Baseline
IEA WEO 2008

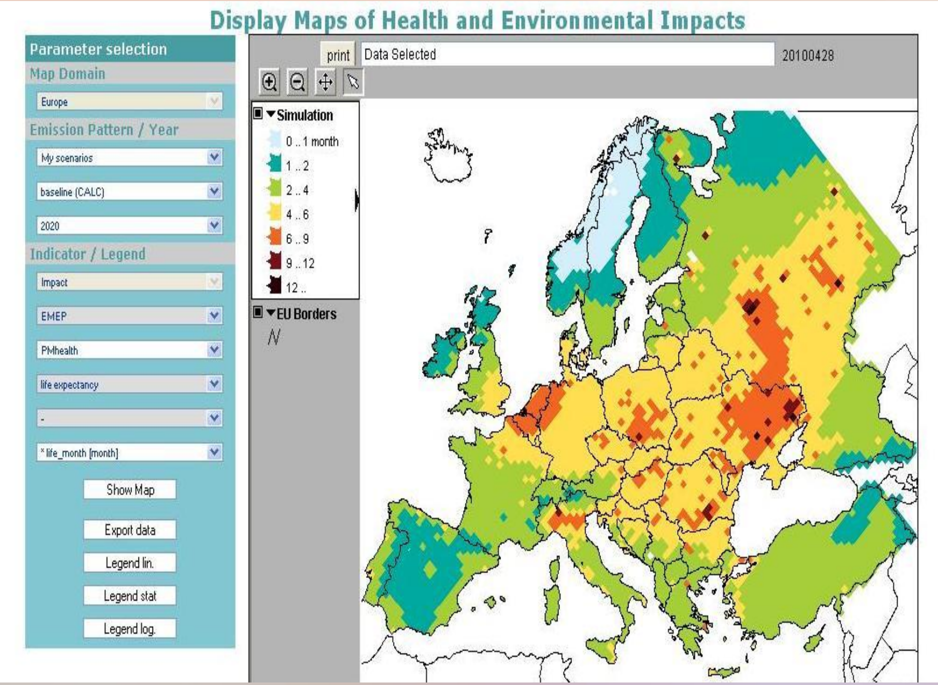

NOx control costs
Costs [Meuros]
1600
1400
1200
1000
800
600
400
200
2010
2015
2020
2030
Years
recommended
Baseline
IEA


SO2 control costs
Costs [Meuros]
450
400
350
300
250
200
150
2010
2015
2020
2030
Years
recommended
base
IEA


PMtsp control costs
Costs [Meuros]
600
500
400
300
200
100
0
2010
2015
2020
2030
Years
Recommended
Base
IEA

Impacts – baseline scenario, year 2020





Conclusions

- ✓ Scenarios comparison
- ✓ Future work
- ✓ Energy and climate change