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Energy strategies and environmental impacts: a many spatial scales approach.

D.B. Giaiotti

Environment Protection Regional Agency (ARPA), Palmanova
Italy

Cover

Energy strategies and environmental impacts: a many spatial scales approach.

by
S. Del Frate, I. Gallai, **D. B. Giaiotti**, E. Gianesini, F. Montanari, A. Petrini, A. Pillon, T. Pinat, F. Stel,

Regional Agency for Environmental Protection of Friuli Venezia Giulia (ARPA FVG)
Regional Center for Environmental Modeling (CRMA)

Trieste, October 02, 2012

Outline

- An example of large scale energy strategy implementation and its environmental consequences at the regional and sub-regional scales. (Biomass for household heating, firewood in particular).

- A computational approach to evaluate quantitatively the environmental effects produced by energy strategies at the regional scale and the definition of a tactical action to reduce the environmental pressure.

- General considerations on how to predict and to analyze environmental impacts of energy strategies at all time and spatial scales.

- Suggestion for implementing Rio+20 commitments by means of regional and sub-regional environmental research projects.

The European strategy to achieve the 20-20-20 objective

The EU is working to reduce the effects of climate change and to establish a common energy policy.
By 2020 renewable energy should account for 20% of the EU's final energy consumption. To achieve this objective specific EC Directives have been issued.

Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources

The EU counts on heat and power from biomass to play a very important role in meeting its "20-20-20"

In the EU, around 5% (2010) of final energy consumption is from bio-energy. The projections made for the Renewable Energy Road Map (2007) suggested that the use of biomass can be expected to double, to contribute around half of the total effort for reaching the 20% renewable energy target in 2020 [1].

[1] Report from the Commission to the Council and the European Parliament on sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling SEC(2010) 65 final SEC(2010) 66 final, COM/2010/0011 final, Brussels, 25.2.2010

Renewable energy, biomass then firewood

Definition of biomass: it is "*the biodegradable fraction of products, wastes, and residues from biological origin from agriculture (including vegetable and animal substances), forestry, and related industries including fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste*" (Renewable energy directive, 2009/28/EC).

Firewood is included in biomass definition so it is considered as a suitable replacement of fossil fuels to achieve the 20-20-20 objective

Down to the regional and sub-regional scales consequences: Italian example

To comply with the 2009/28/EC directive, Italy brought into force a national law:

Decreto Legislativo 03 marzo 2011, n. 28

The usage of firewood for domestic heating is stimulated through tax relief when new generation heathers installation.

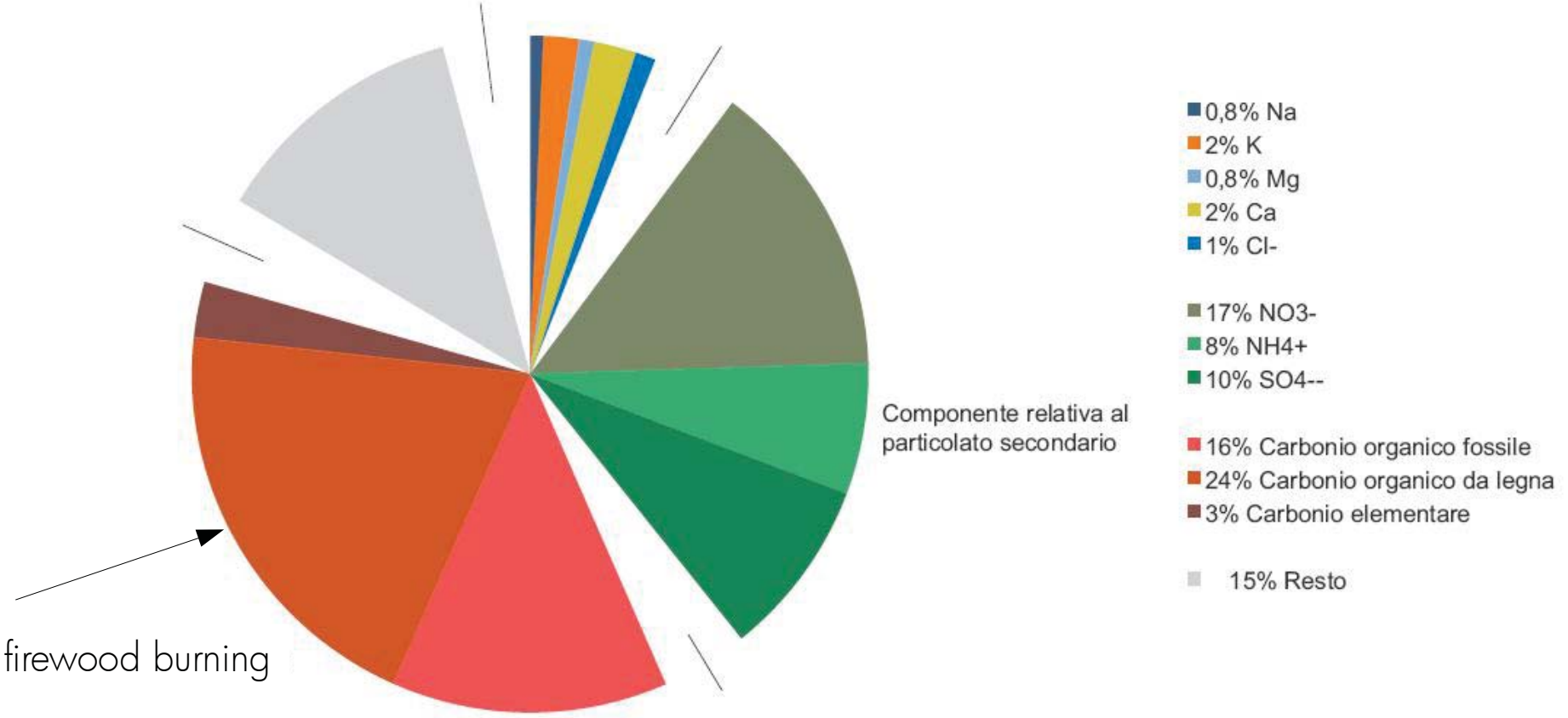
Observation

Household firewood heating devices have smaller capacity in reducing emissions with respect industrial biomass plants.

The fingerprint of firewood fuel on particulate matter suspended in the air

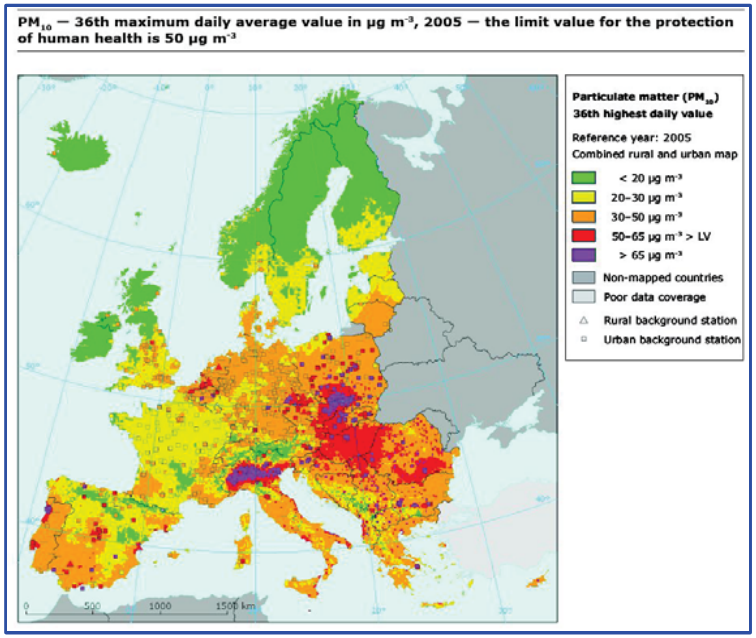
Speciation analysis (2011), of fine particulate matter suspended in the air (PM10) in the northeastern Italy, show that at least 24% is produced by firewood burning [1],[2]

[1] Rapporto sullo Stato dell'Ambiente 2012 http://www.arpa.fvg.it.
[2] iMONITRA! EU funded project. http://imonitraf.org/



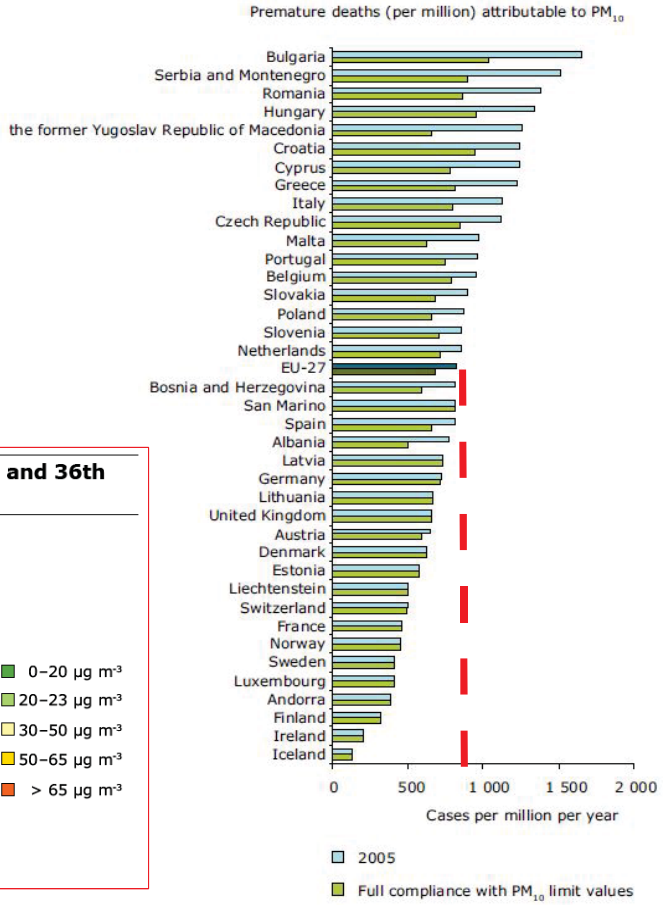
High concentration of PM10 is a problem for air quality standards: why?

Health is strictly related to PM10 concentration in the air

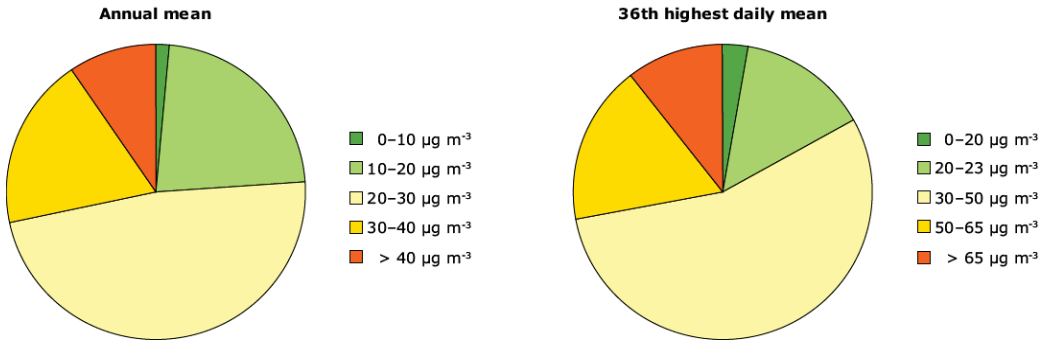


From: Spatial assessment of **PM10** and ozone concentrations in Europe (2005) [EEA technical Report No 1/2009]

Figure 3.4 Number of premature deaths per million inhabitants attributable to PM_{10} exposure in the reference year 2005



Exposure of the European population to PM_{10} concentrations, annual average (left) and 36th highest daily average (right), 2005



The European strategy to preserve air quality

The EU is working to combat emissions of pollutants at source and to identify and to implement the most effective emission reduction measures at local, national and Community level.

In order to protect human health and the environment as a whole, emissions of harmful air pollutants should be avoided, prevented or reduced and appropriate objectives set for ambient air quality taking into account relevant World Health Organisation standards, guidelines and programmes. [1]

[1] Directive 2008/50/EC of the European Parliament and of the Council

Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe

HUMAN HEALTH	Limit or target (t) value					Assessment threshold values	
Pollutant	Averaging period	Value	Maximum number of	Margin of tolerance	Date applicable	Upper	Lower
PM_{10}	Day Year	50 μgm^{-3} 40 μgm^{-3}	35 0	50% 20%	2010 2010	35 μgm^{-3} 28 μgm^{-3}	25 μgm^{-3} 20 μgm^{-3}
$PM_{2.5}$	Year	25 μgm^{-3} 25 μgm^{-3} (t)	0 0	20% in 2008 to 0% in 2015	2015 2010	17 μgm^{-3}	12 μgm^{-3}

Down to the regional and sub-regional scales consequences: Italian example

To comply with the 2008/50/EC directive, Italy brought into force a national law:

Decreto Legislativo 13 agosto 2010, n. 155

Sub-regional action plans **have to** be defined and implemented to reduce the acute air pollution episodes.

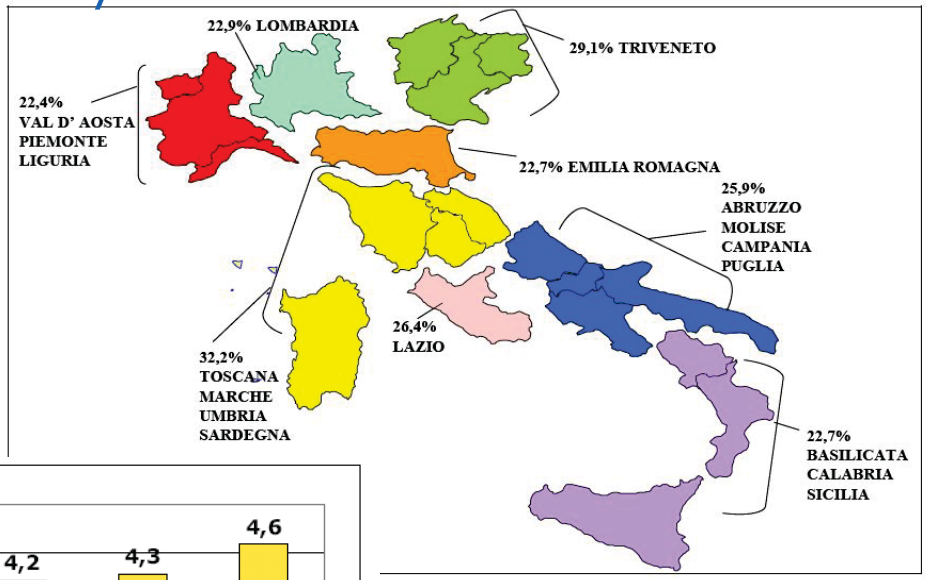
Observations

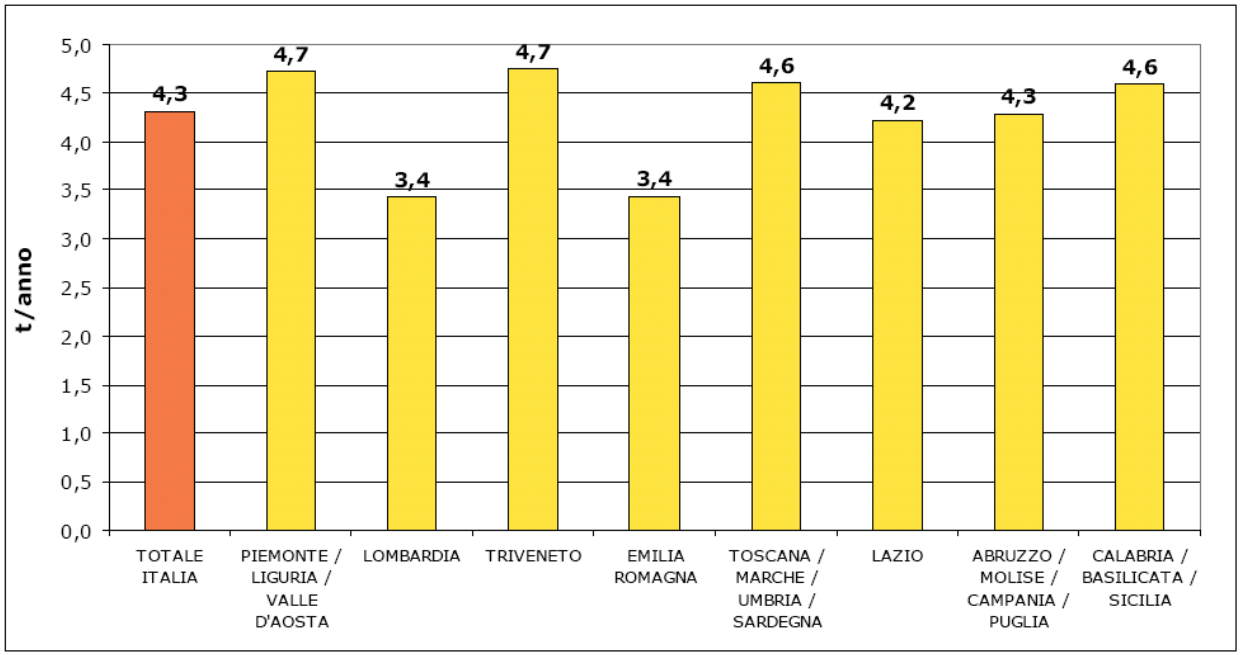
To define action plans:

- the **actual state** of pollutants sources at sub-regional scale should be assessed;
- **projection for emission** trends have to be generated;
- quantitative **evaluations of actions efficiency** have to be carried out.

Some figures on the state of firewood usage in Italy

Fraction of families using firewood for domestic heathers [1]



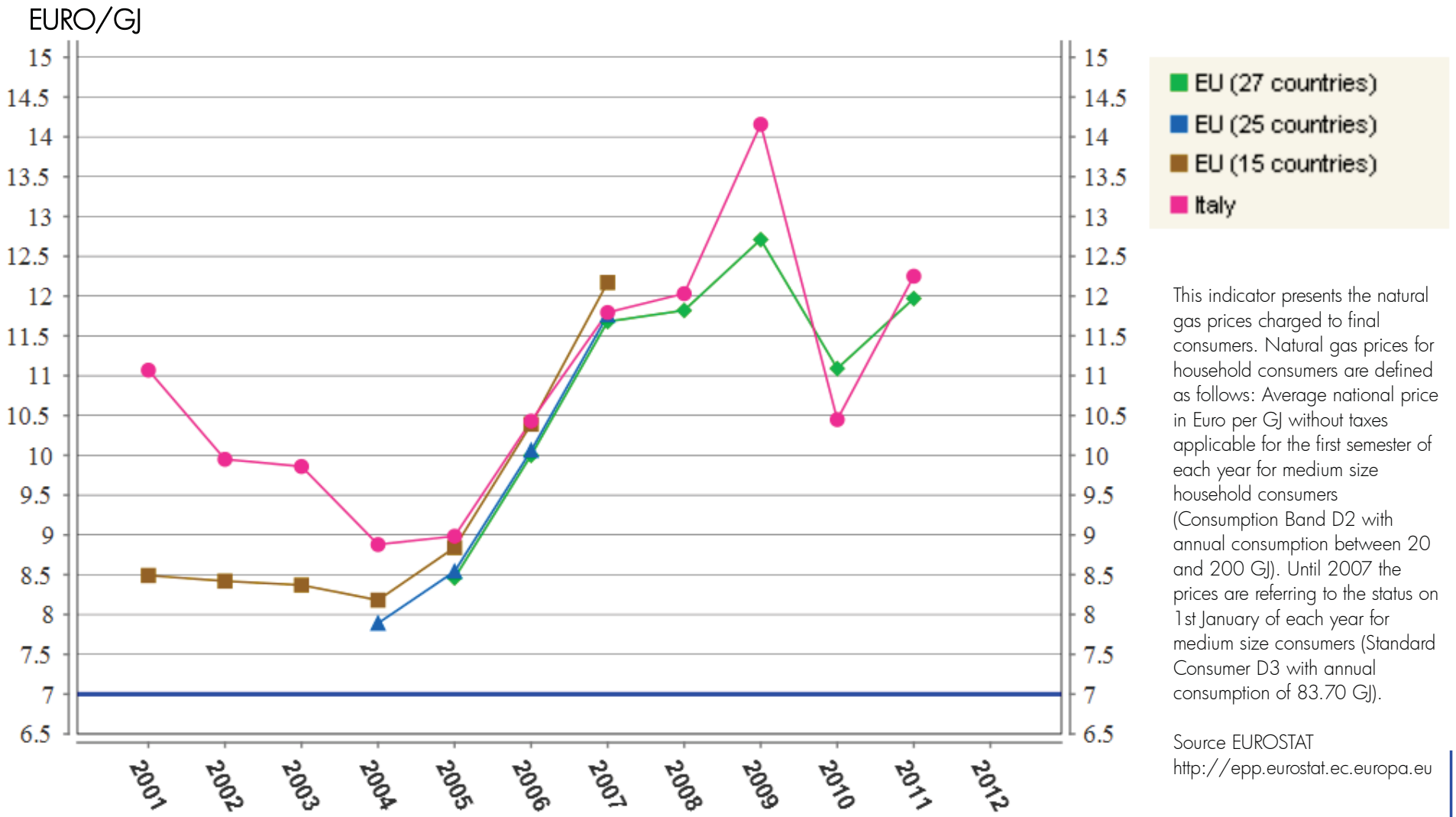


Family average yearly firewood requirement in tons/year [1]

[1] Source: ISPRA and ARPA Lombardia 2008 (Stima dei consumi di legna da ardere per riscaldamento e uso domestico in Italia)

Considerations on projection for emission trends related to firewood: the gas price

Natural gas prices to final consumers is expected NOT to decrease in the near future



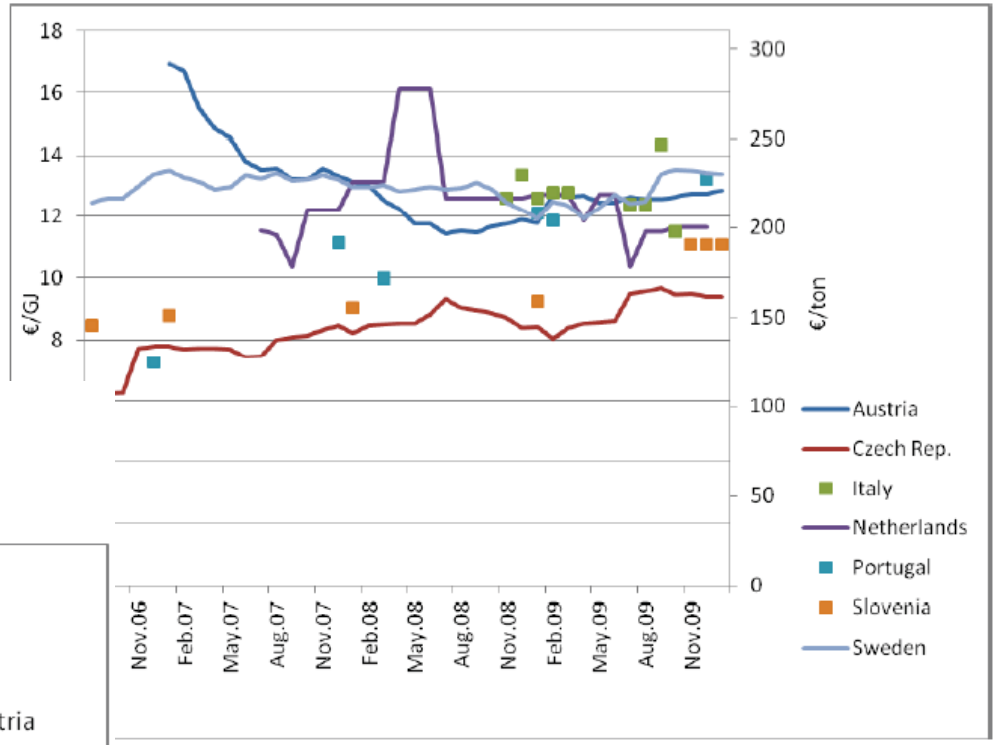
This indicator presents the natural gas prices charged to final consumers. Natural gas prices for household consumers are defined as follows: Average national price in Euro per GJ without taxes applicable for the first semester of each year for medium size household consumers (Consumption Band D2 with annual consumption between 20 and 200 GJ). Until 2007 the prices are referring to the status on 1st January of each year for medium size consumers (Standard Consumer D3 with annual consumption of 83.70 GJ).

Source EUROSTAT
http://epp.eurostat.ec.europa.eu

Firewood and wood pellets supply costs are comparable with natural gas costs

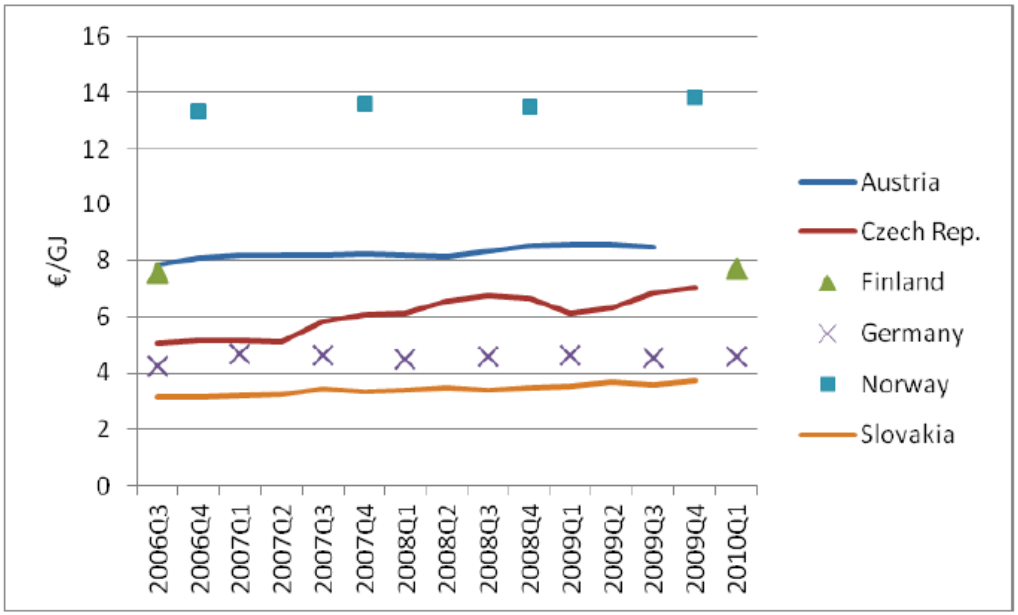
Natural gas prices expected in the range from 10 to 15 Euro/GJ

4.1.2 Delivery in small (≈15 kg) bags, €/GJ and €/ton



4.7 Firewood (residential market)

4.7.1 Broadleaved, €/GJ



Wood fuel price statistics in. Europe – D 3.1.
O. Olsson, J. Vinterbäck & C. Porsö ..
EUBIONET Uppsala nov 2010

Projections for gas prices in the next decades

Natural gas price trend for an Italian household consumers

Supply conditions for a family with household heater device and annual volume supply of 1.400 m3 values expressed in c€/m3

Source:

Italian Energy Authority http://www.autorita.energia.it

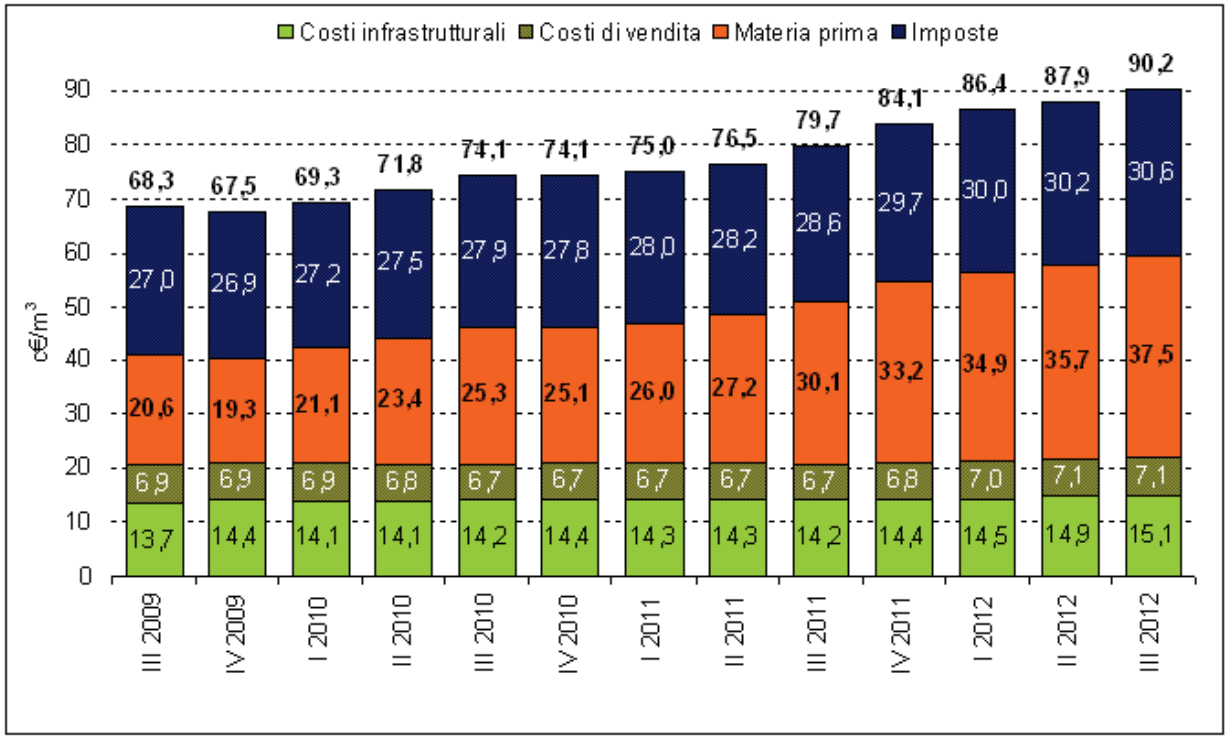
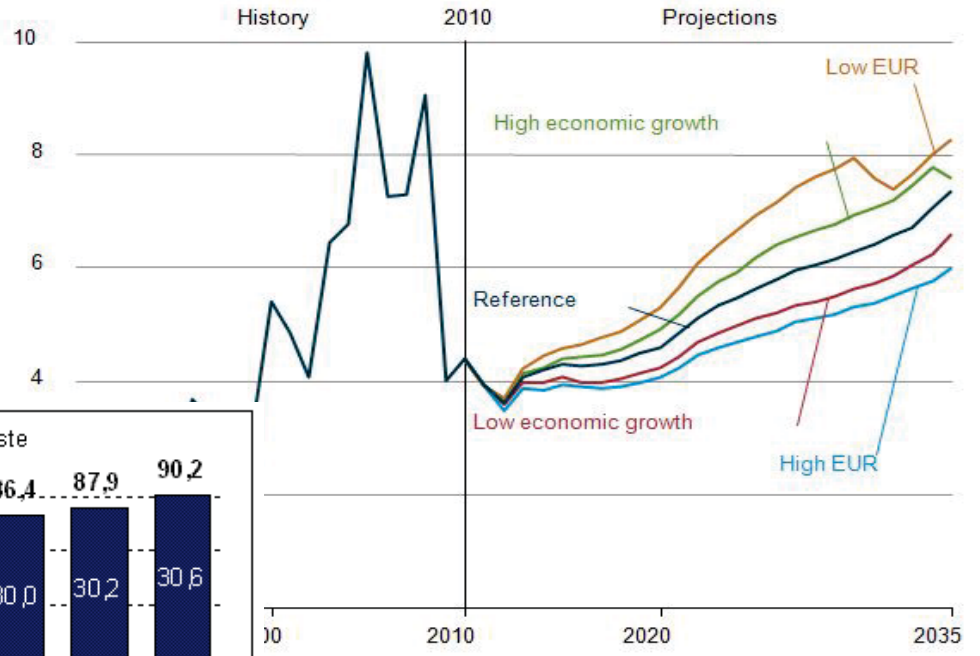


Figure 105. Annual average Henry Hub spot natural gas prices in five cases, 1990-2035
(2010 dollars per million Btu)



Market Trends
Natural Gas By Annual Energy Outlook 2012
Release Date: June 25, 2012

U.S. Energy Information Administration
http://www.eia.gov/

Summary of household biomass related particulate emissions projections

- EU and national laws will continue in stimulating biomass usage for domestic heating.
- Natural gas costs for household consumers will be at least comparable with or higher than firewood and wood pellets.

- Biomass fuel usage, in particular firewood and wood pellets, will increase in the next future.

Environmental consequences of the increase of biomass usage for household heating

Since a significant fraction of energy supply for domestic heaters, is attributable to biomass, the increase of wood fuel usage for domestic heaters will:

- Contribute to achieve the 20-20-20 objective, then reduce the green house gases **at the global scale.**
- Increase or keep constant particulate matter emissions (PM10) **at the regional and sub-regional scale**

Regional and sub-regional action plans for reduction of the acute air pollution episodes should consider the application of tactical actions focused on domestic biomass usage.

Computational approach to assess environmental impacts

Model

Chemical transport model (dispersion, transport and removal of pollutants from air)

Emissions

Whole regional inventory (point sources, traffic, diffuse, etc)

Meteorology

Meteorological model simulations and mesonetwok measurements at least for one year long

Boundary conditions

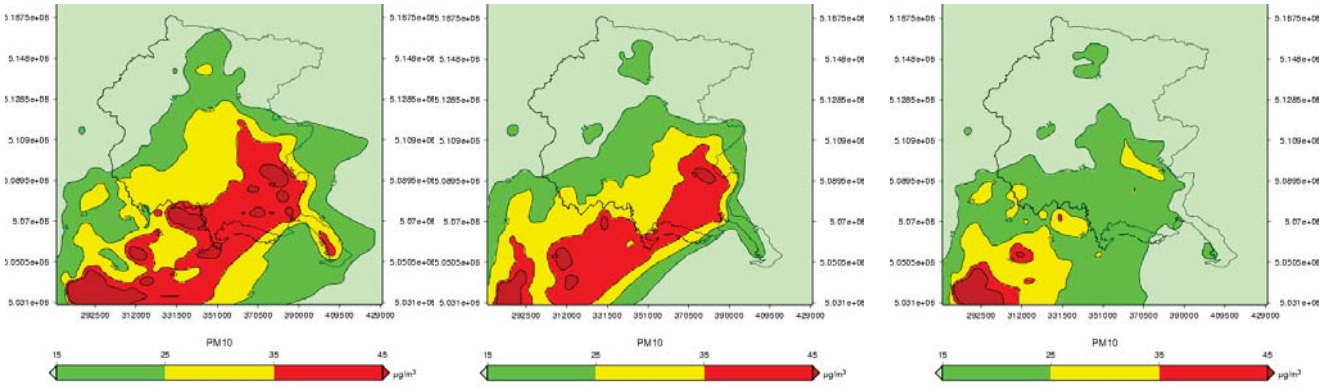
National data set + continental data set

Computing facilities

High Performance Computing (parallel computing on computer cluster or GRIDs)

No huge resources are required: 10 people,100 core cluster, three years of start up.

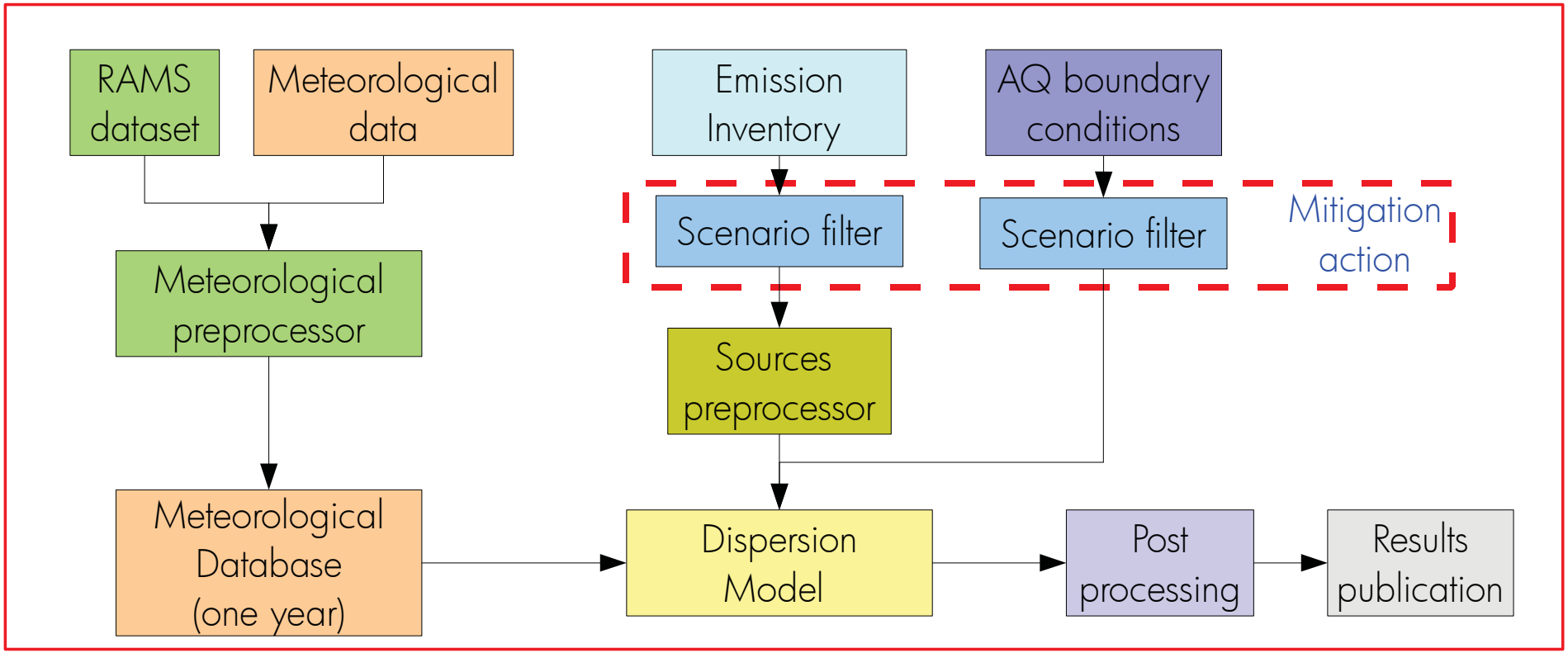
To simulate environmental impacts is better (and safer) than to experience them in reality



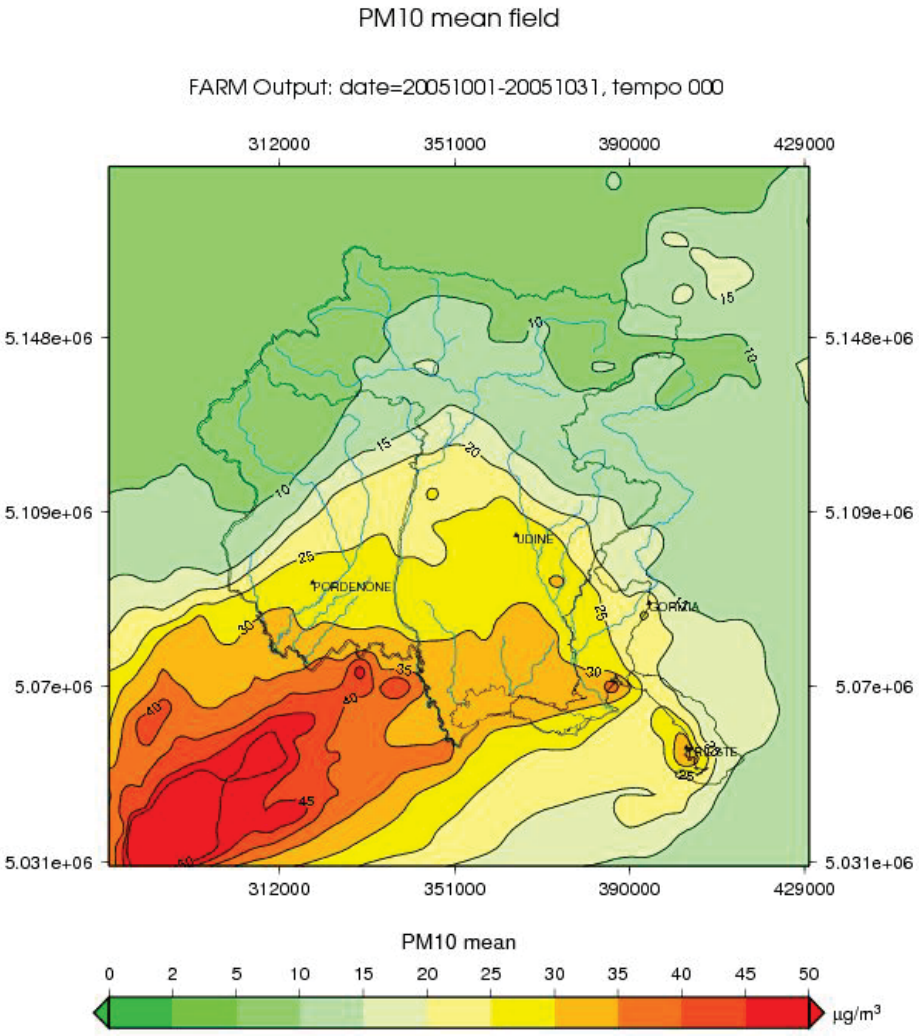
J=300 J=301 J=302

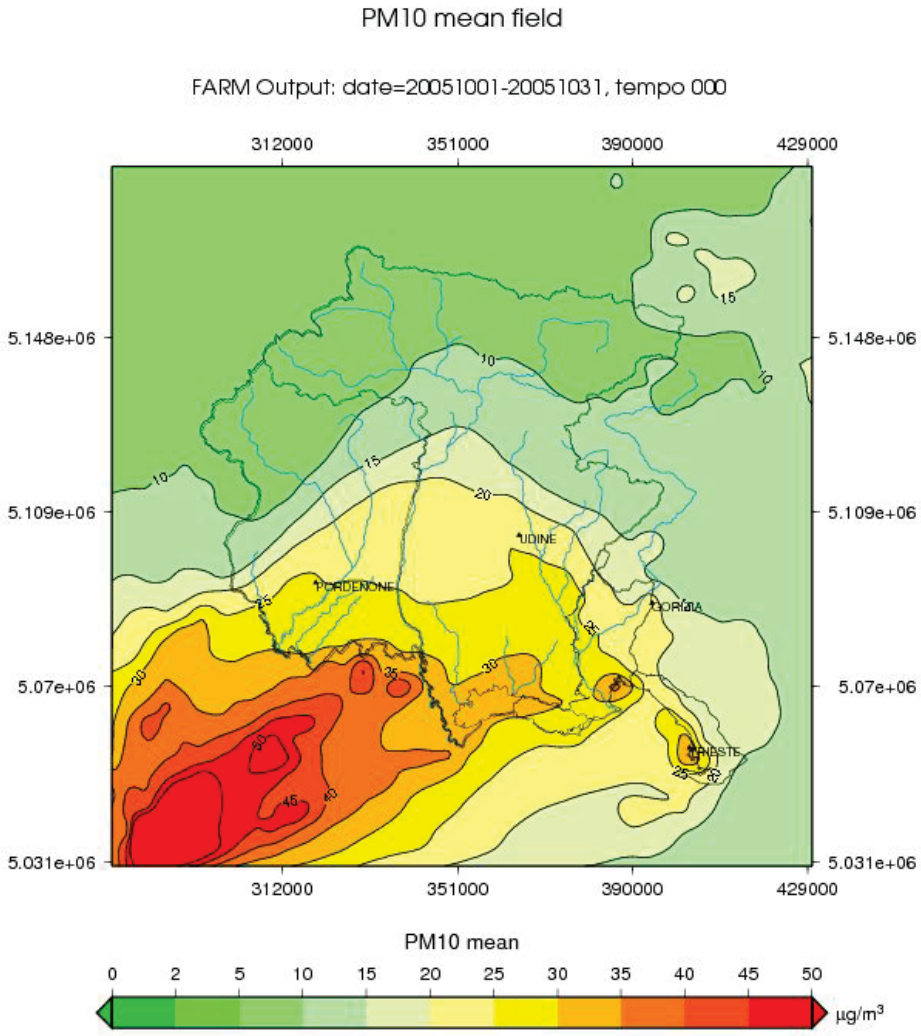
Generation of air quality scenario for mitigation actions - Workflow

Off-line model simulations are suitable for air quality evaluations in regional domains

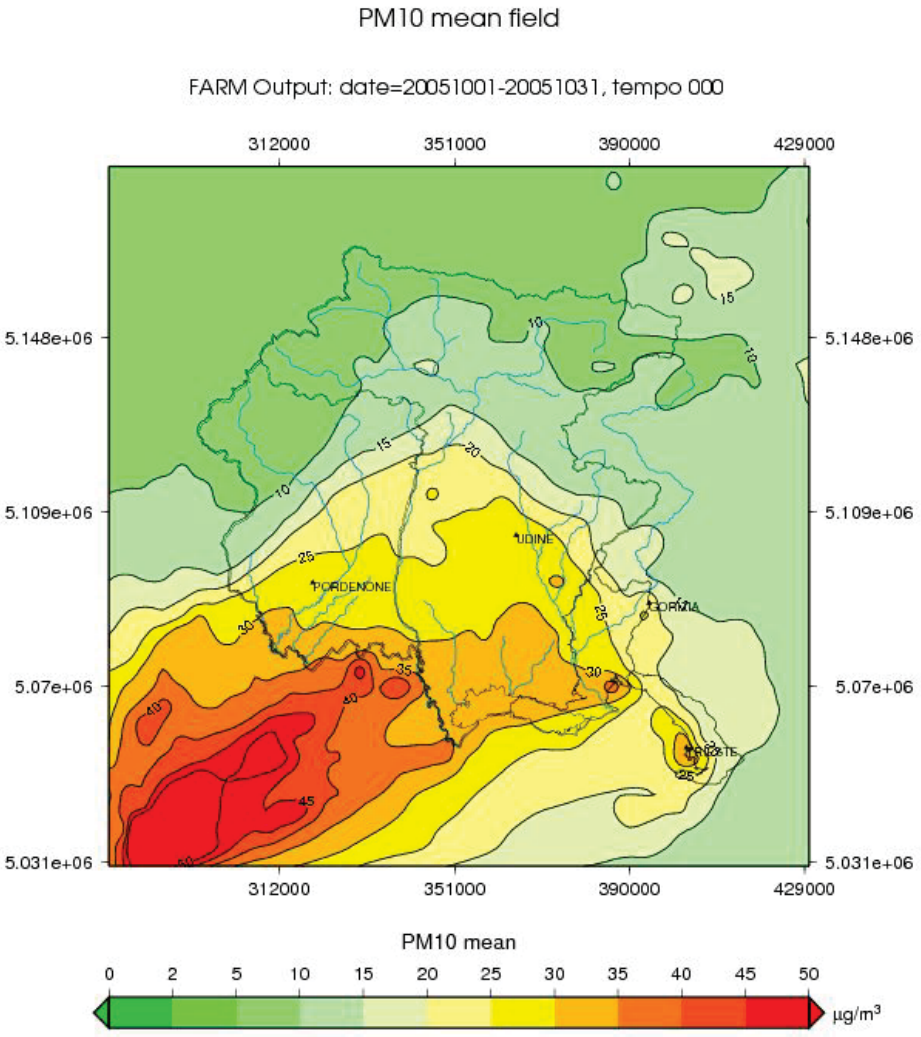


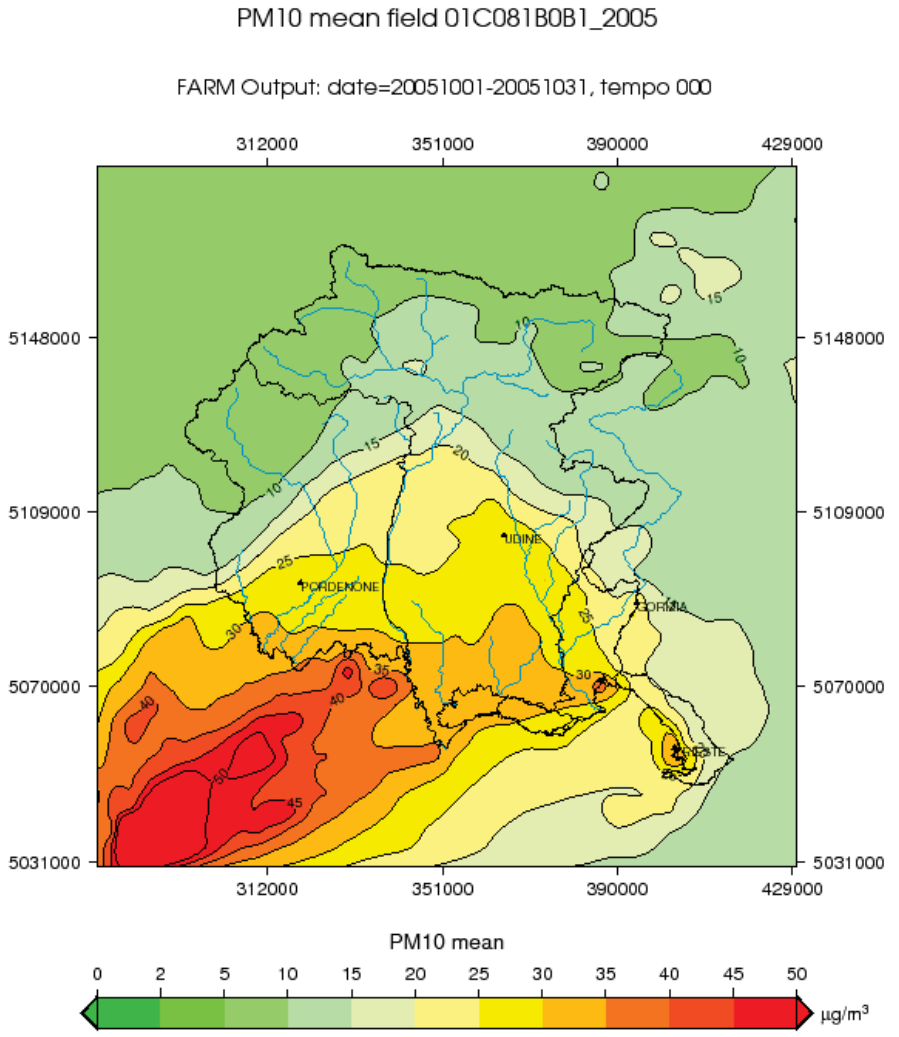
Air quality scenario for mitigation actions – domestic wood fires removed



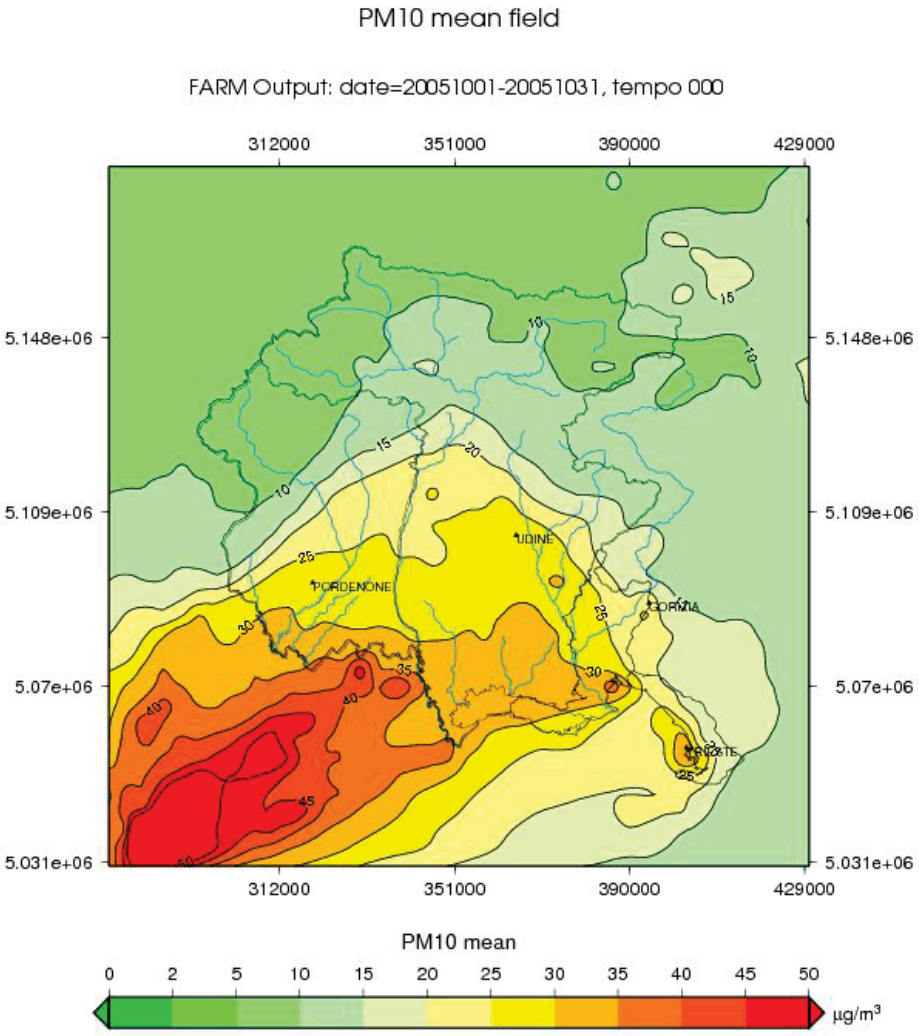


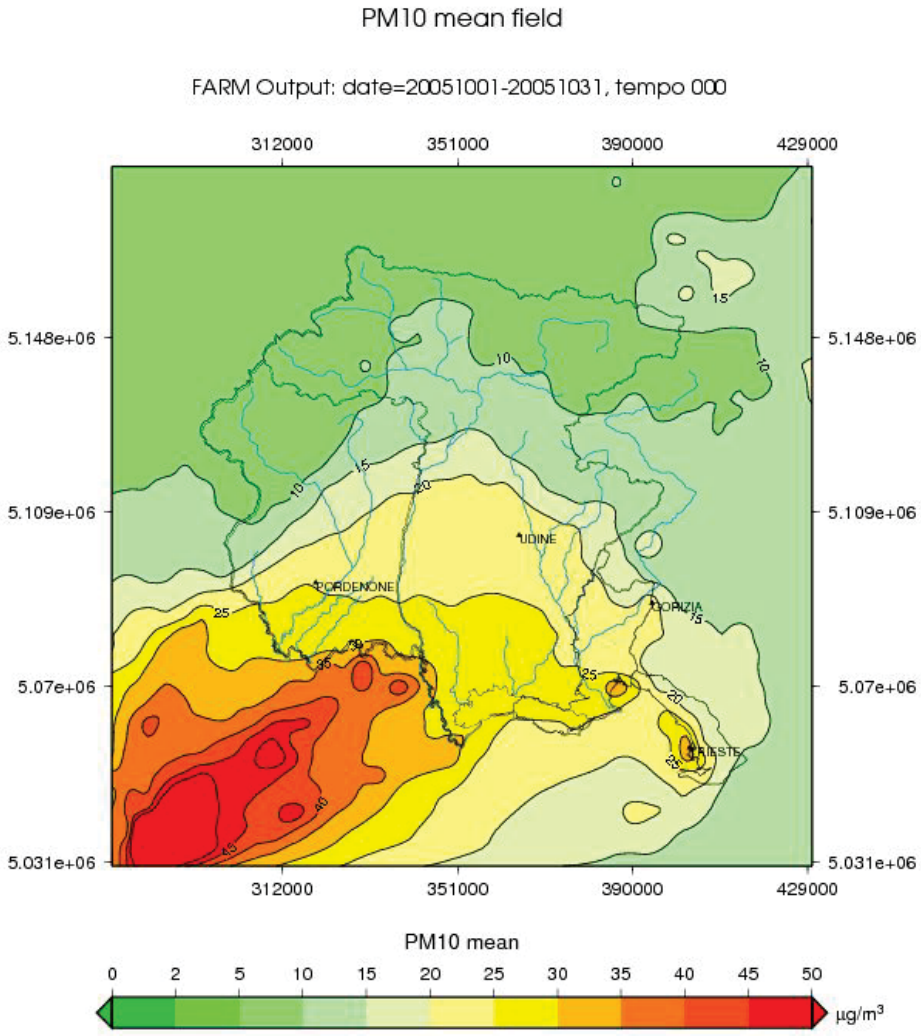
Air quality scenario for mitigation actions – house heating reduced by 2C



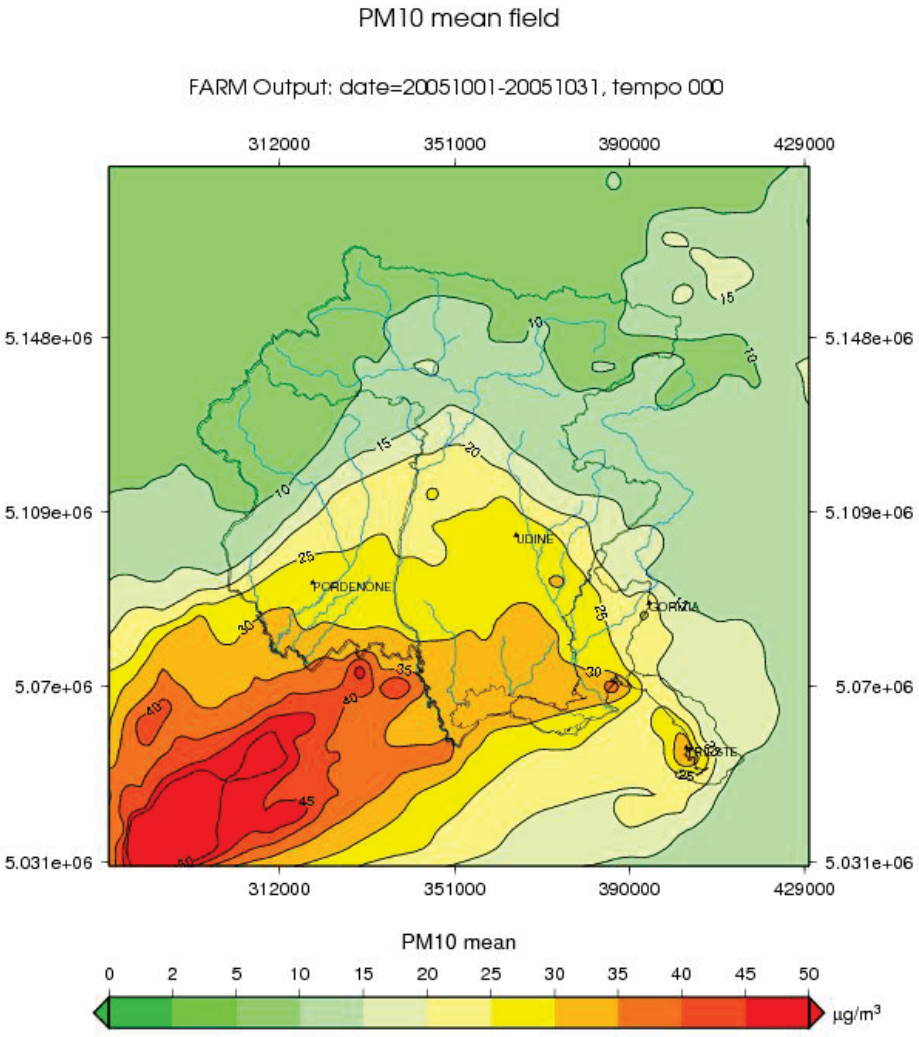


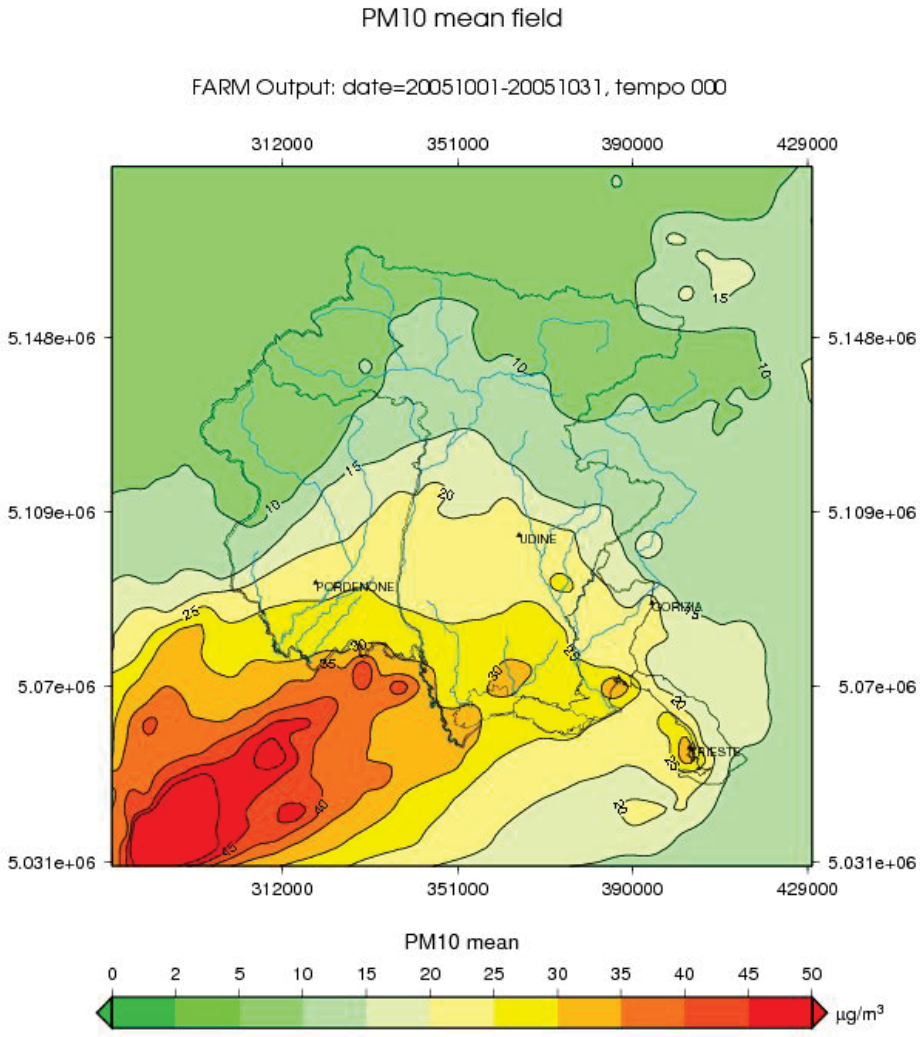
Air quality scenario for mitigation actions – industries removed



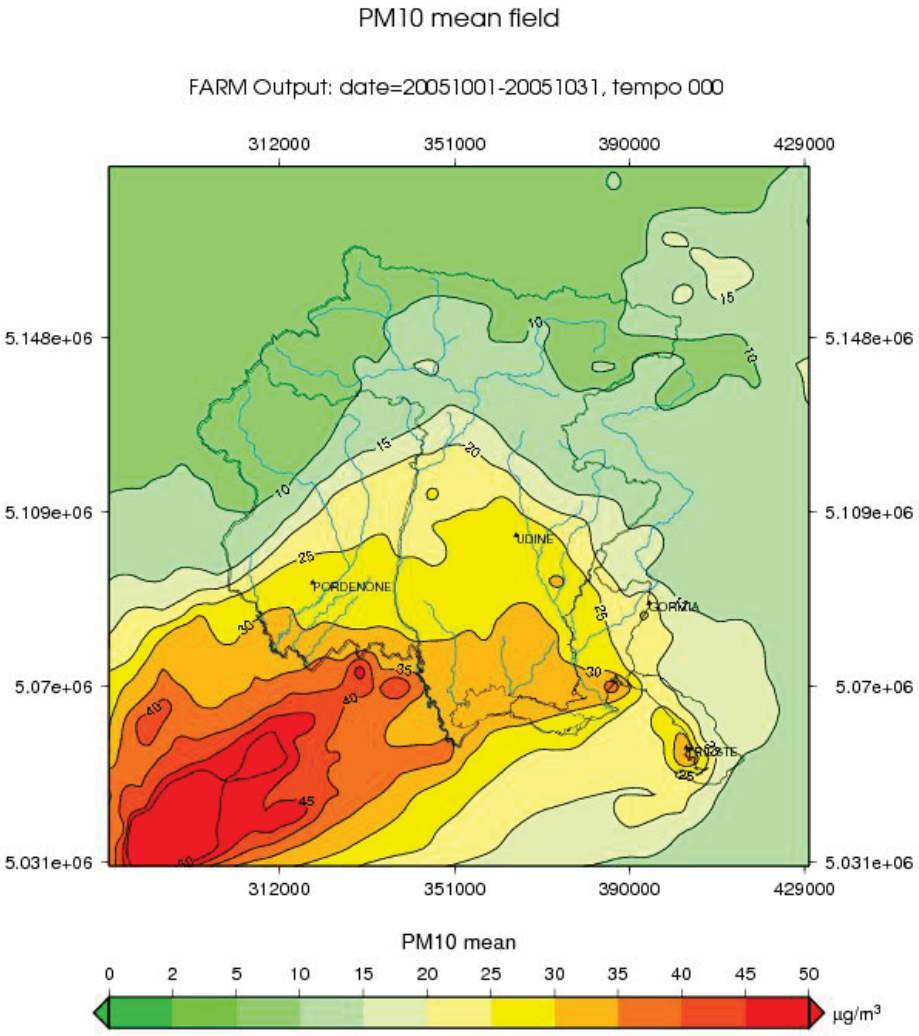


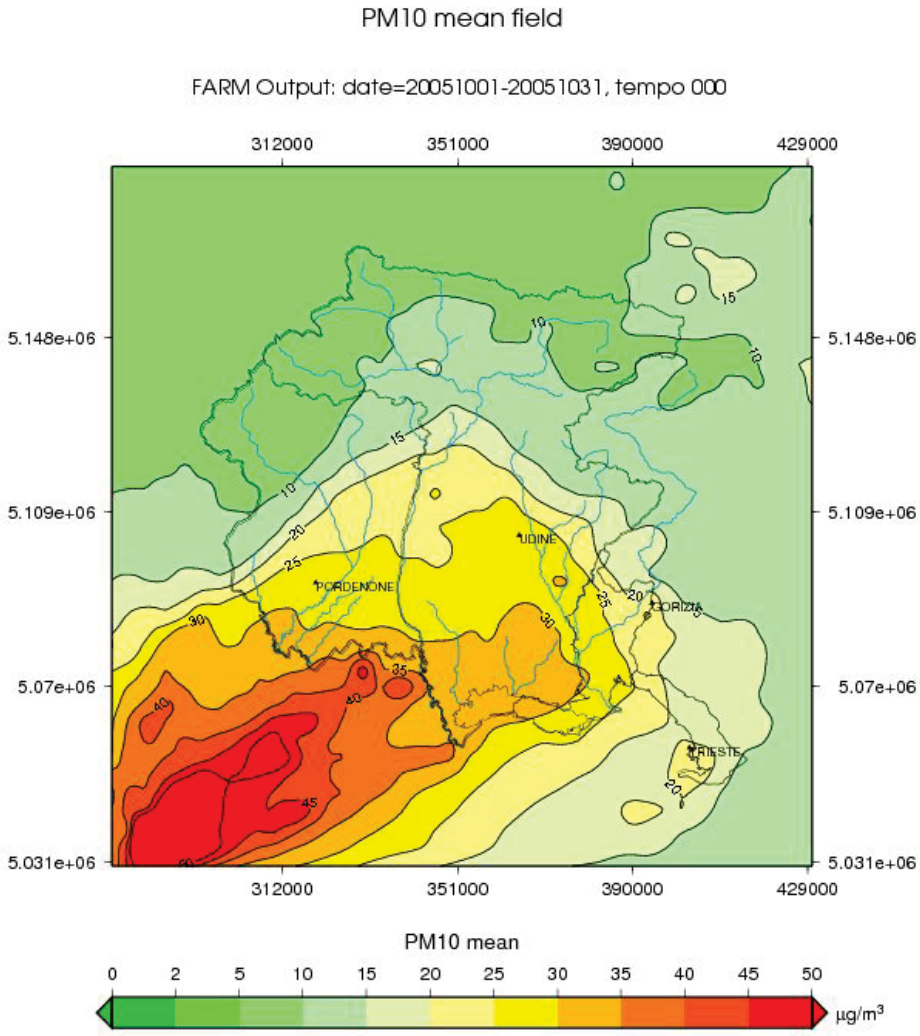
Air quality scenario for mitigation actions – traffic on all roads removed



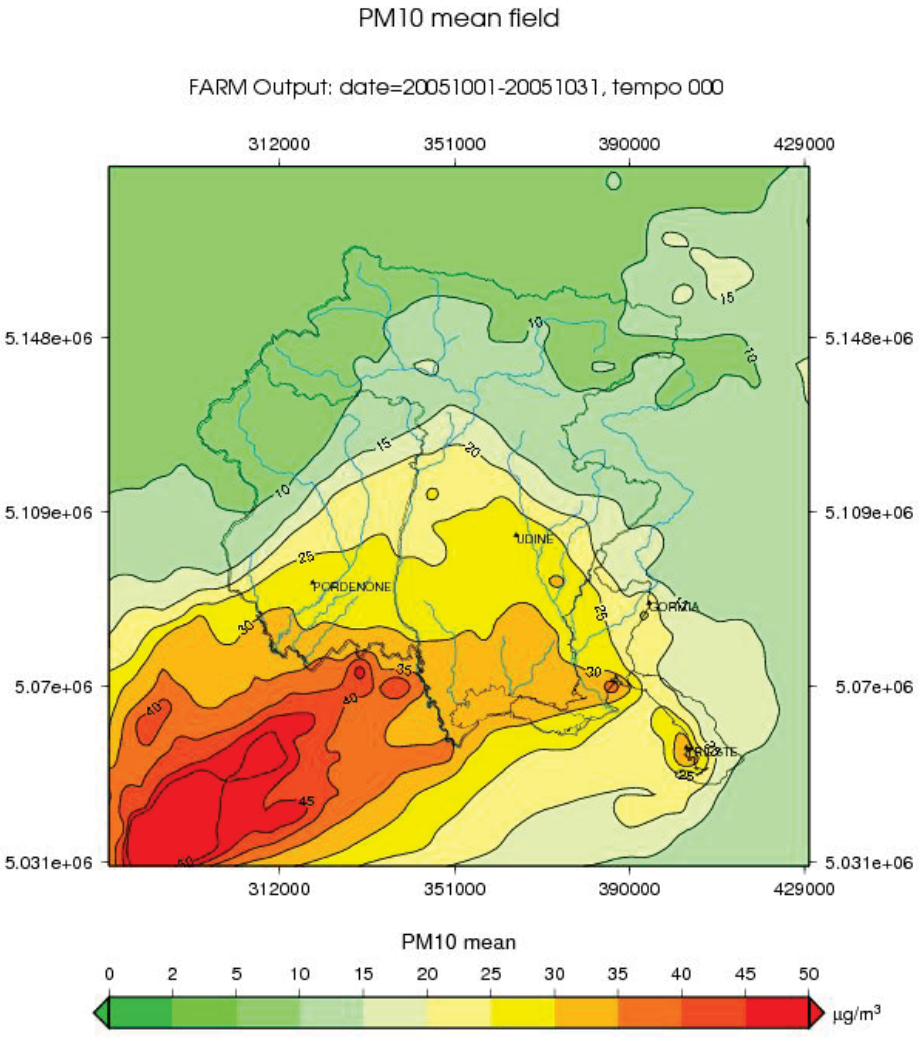


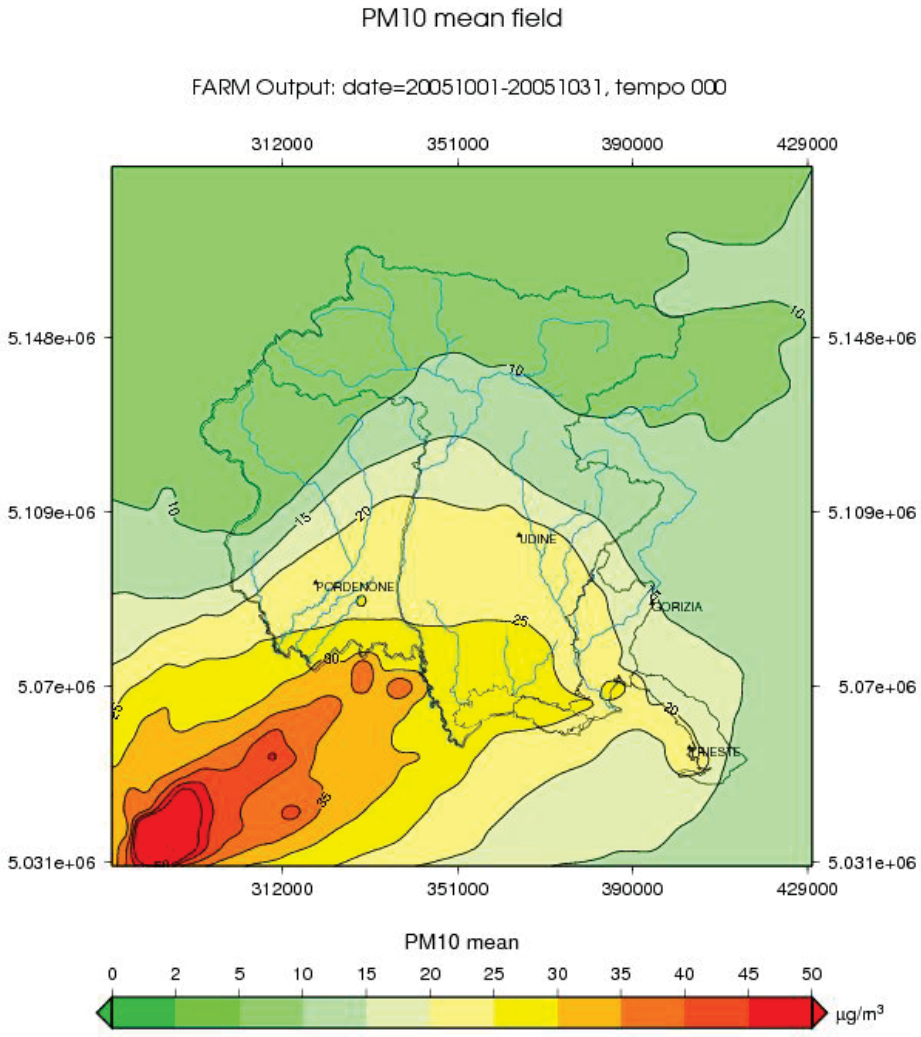
Air quality scenario for mitigation actions – without harbors emissions





Air quality scenario for mitigation actions – primary particulate emissions removed





Summary of air quality scenarios and tactical action to achieve air quality objectives

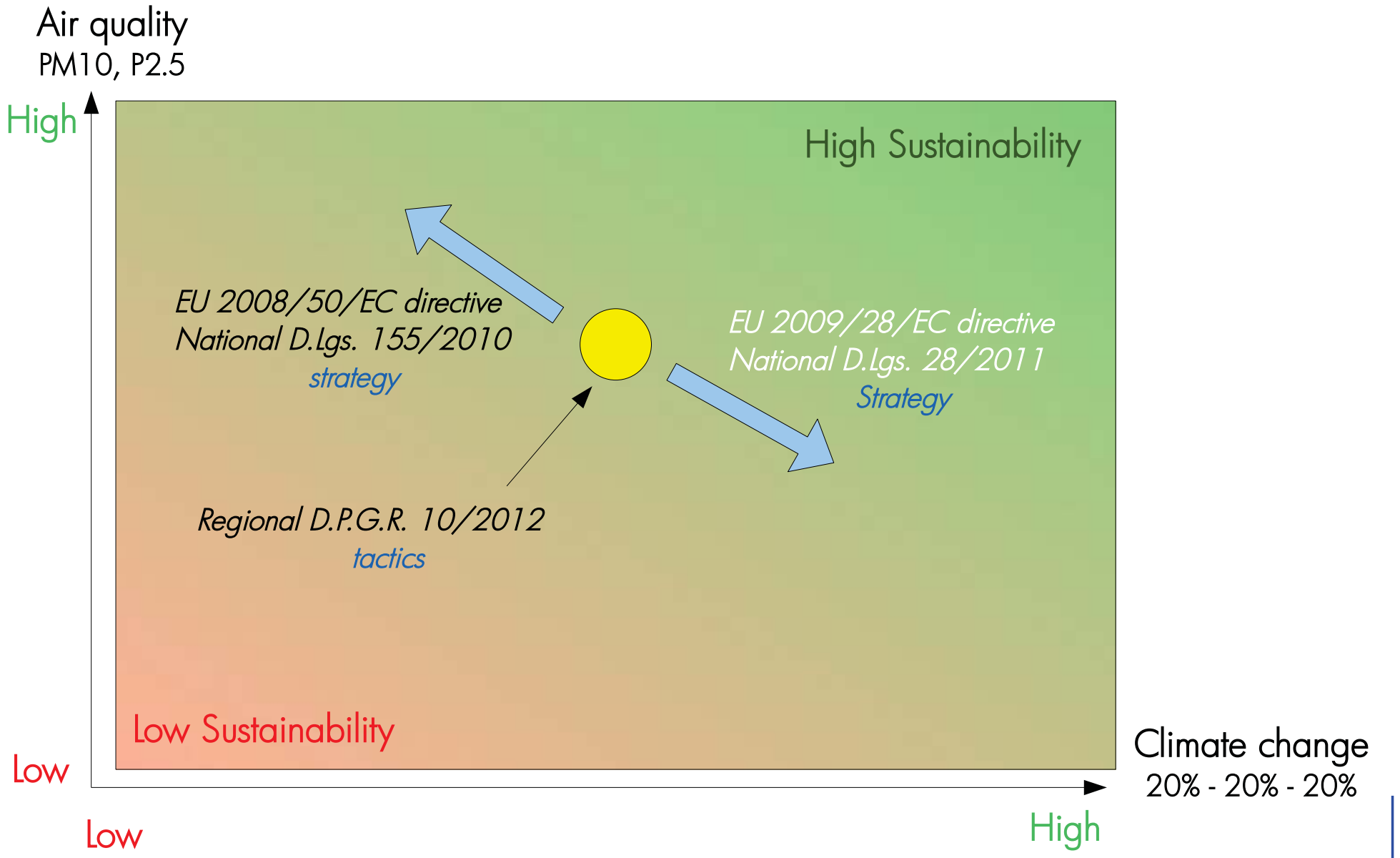
To minimize the number of acute episodes of particulate matter pollution, simulated scenarios induce to act as follow:

- Firewood usage for household heaters (temporary replace with gas)
- Traffic in and close to urban areas. (temporary reduce vehicles usage)
- Industrial emissions (as an immediate response, when possible) long term to decrease the average background (adopt best available techniques)
- The actions have to be taken with the support of air quality forecasts, issued every day and covering the next 5 days.

According to the results produced by simulations a **Regional Action Plan** was developed and brought into force by means a regional law (D.P.G.R. 16 gennaio 2012, n. 10) and local (**Municipality Action Plans**).

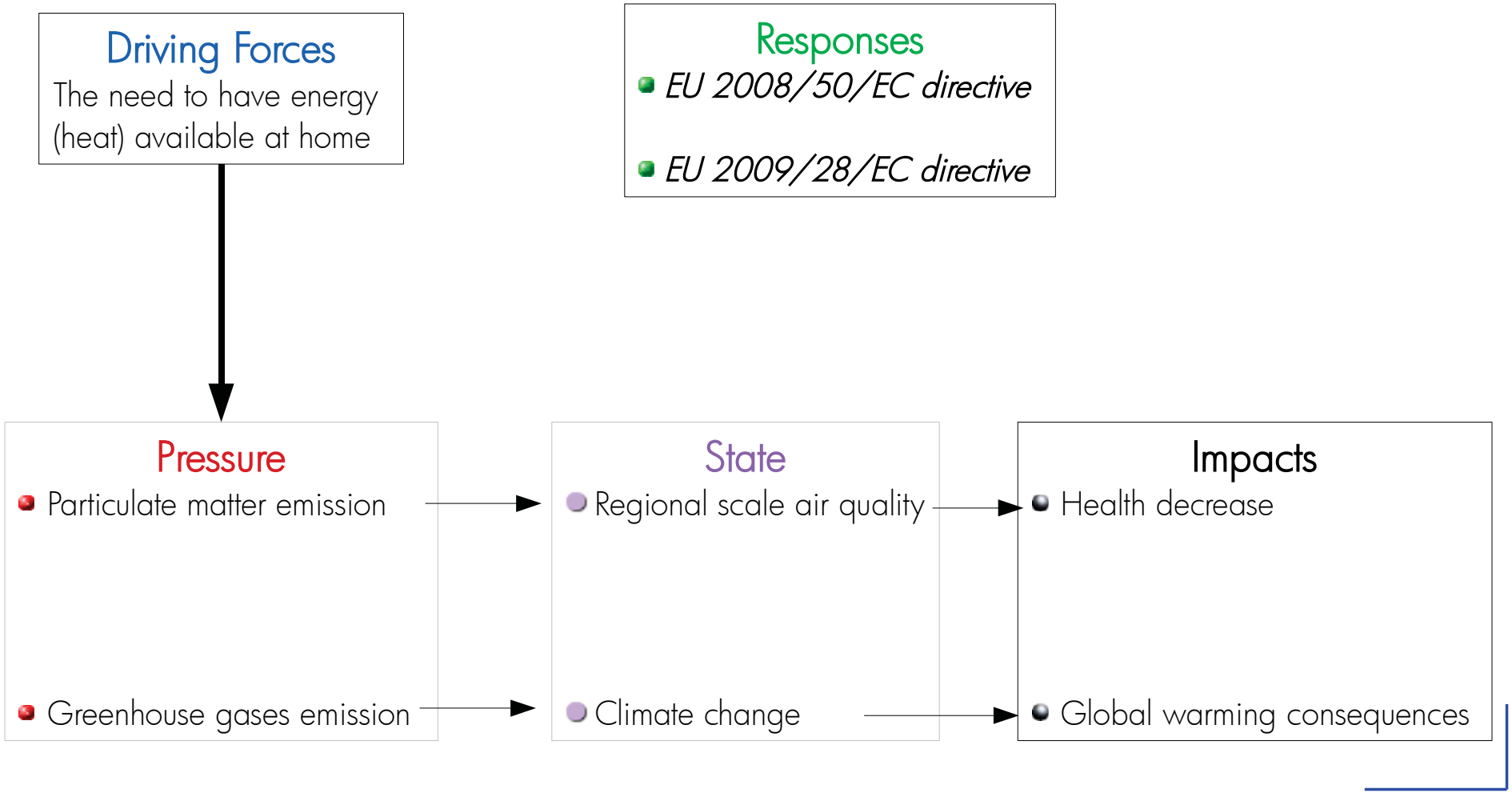
The actions are compliant with the 2008/50/EC directive, and the national law DLgs 155/2010

Summary of "actors" and forces involved in the Firewood fuel affair (NE Italy)



Why a tactical action is required to get equilibrium?

The key to the answer comes using the causal framework **DPSIR** (EEA adopted)



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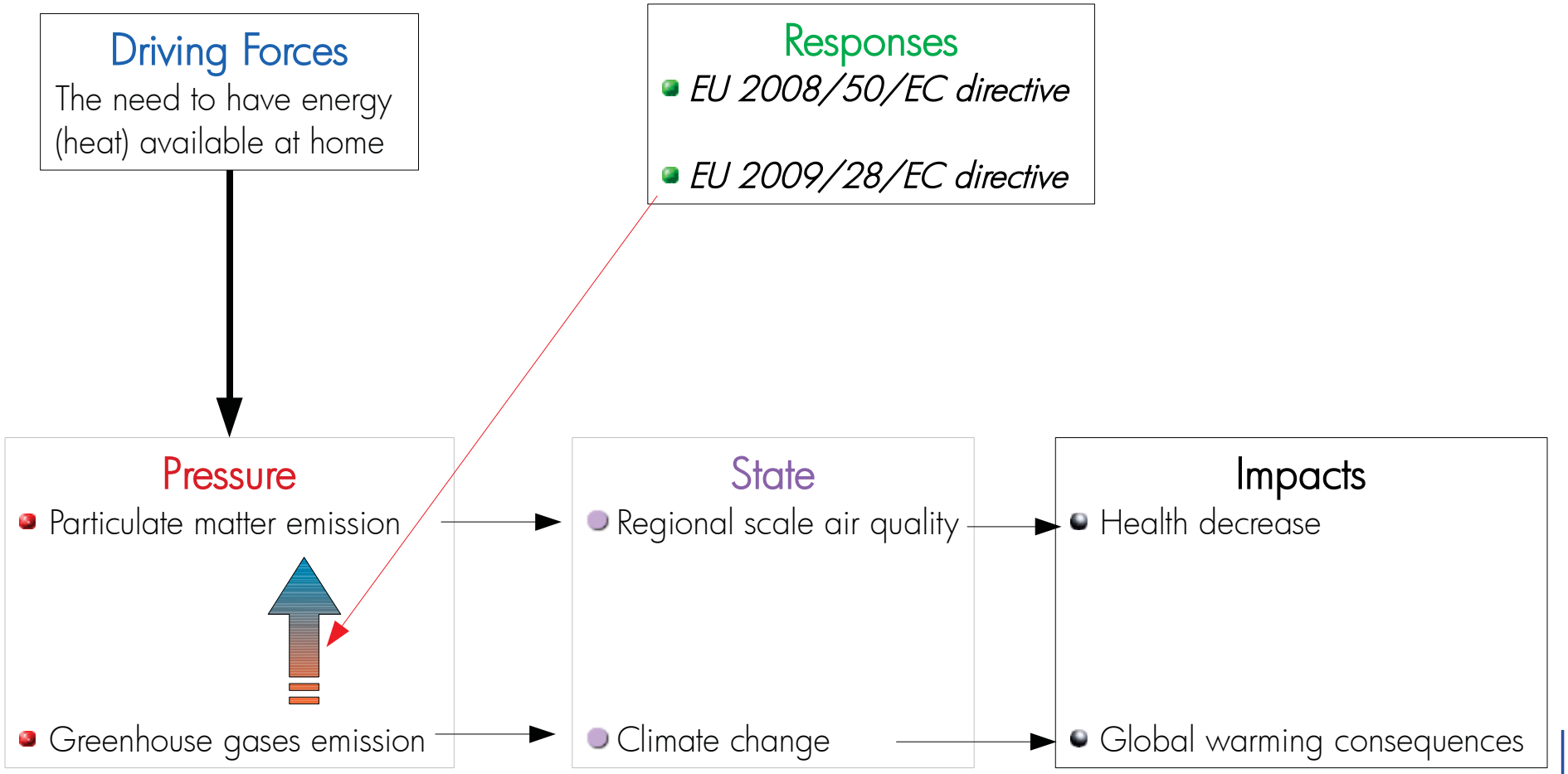

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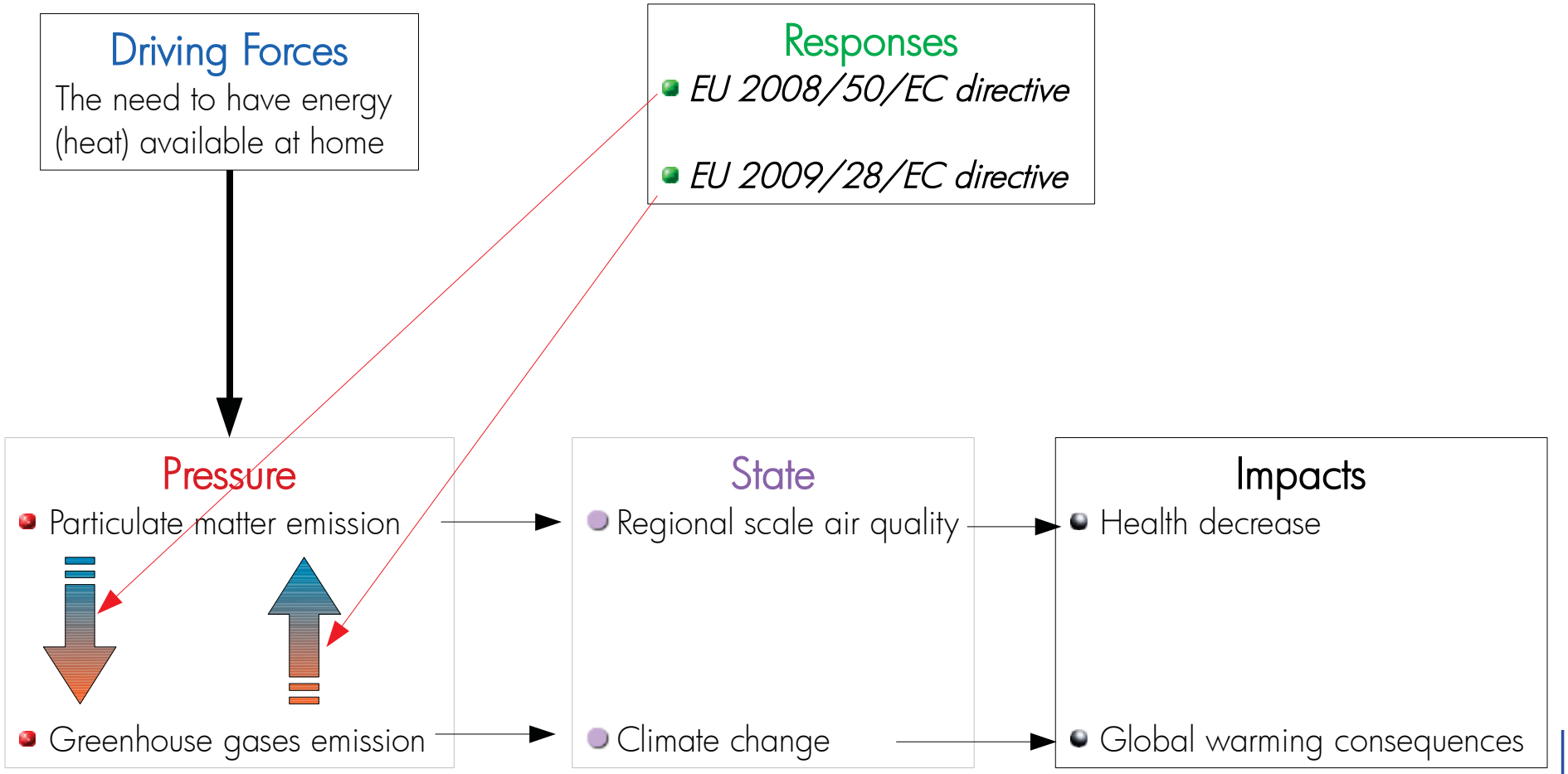
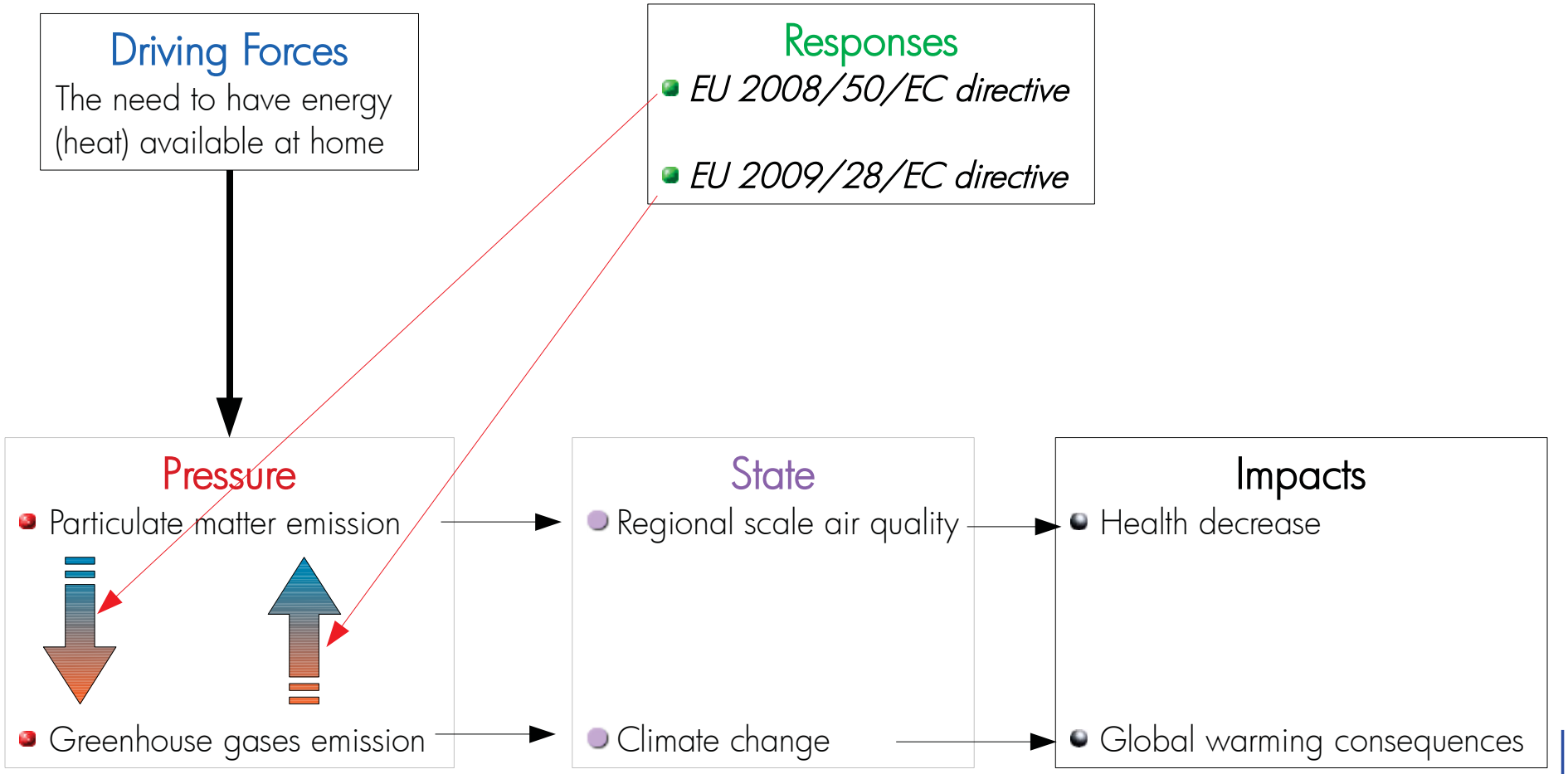


Why a tactical action is required to get equilibrium?

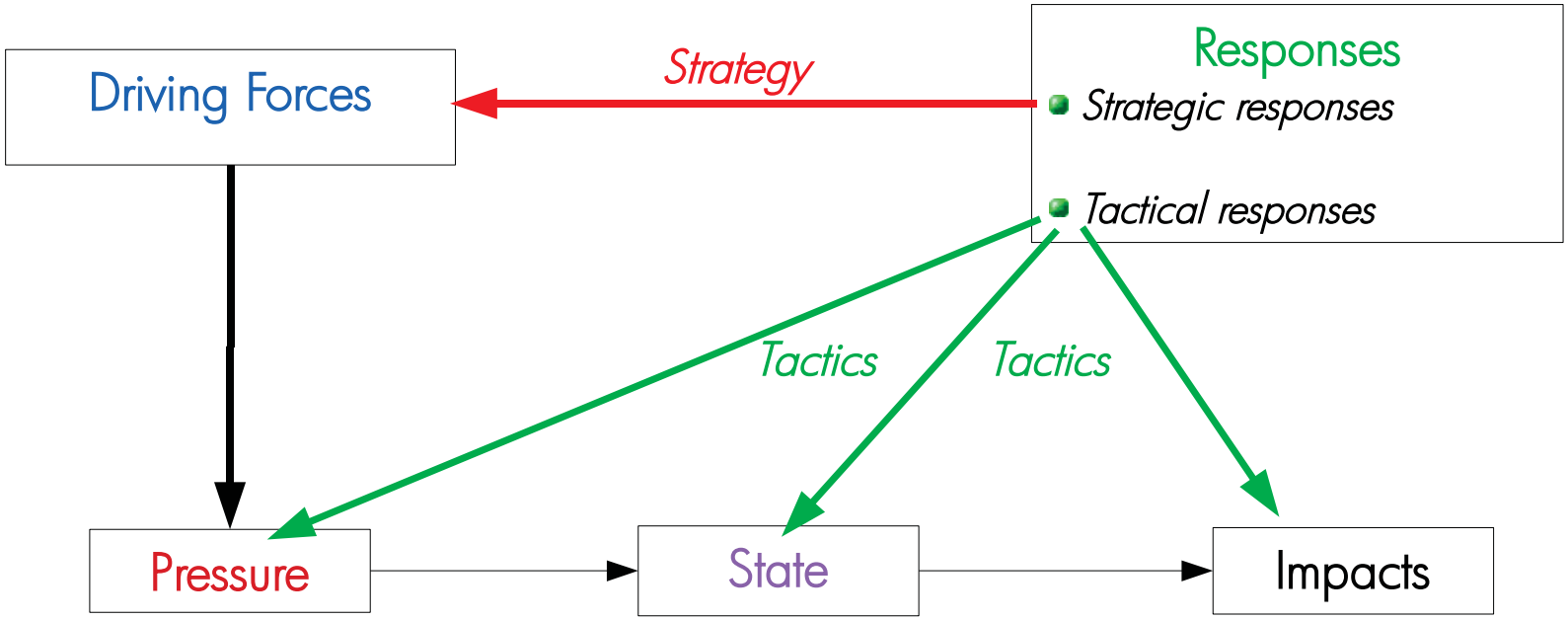
The key to the answer comes using the causal framework **DPSIR** (EEA adopted)

Both responses are working mainly on pressures



A general approach on environmental impacts fo energy strategies

The key to the answer comes using the causal framework **DPSIR** (EEA adopted)



Conclusions and suggestions for Rio+20 commitments implementation

- From the environmental point of view, a sustainable energy strategy has to be evaluated with respect all the spatial and time scales.
- Acting on environmental pressures is a tactic for short term actions, but strategies require actions on the driving forces.
- Maintaining the same standards of life quality without chancing infrastructures may lead to move the anthropogenic pressure from one environmental scale to another.
- Acting on driving forces means also to convince people to accept standards of energy availability compatible with the pressures the environment can accept without generating negative impacts
- The example shows also that, nowadays, the many scales environmental impacts of energy strategies applications can be evaluated within small research groups.

<u>To implement Rio+20 commitments, suggestions are:</u>

- to face the environmental sustainability of an energy strategy with the many spatial scales approach;
- To stimulate and sustain the the many scales environmental evaluation of energy strategy supporting the regional and sub-regional environmental research projects and research groups.

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