Renewable energies
what is available and to what extent
in southern Europe:
the NE Italy subregional example

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CRMA – Regional Centre for Environmental Modelling

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Mission of the Regional center for Environmental Modelling

Supply a suited frame of knowledge (Driving Forces, Pressures, Status and Impacts) to Policy Makers for the development and monitoring of suited set of Responses to environmental issues

“The last thing that every Government wants to have is a precise set of numbers”

J. M. Keynes

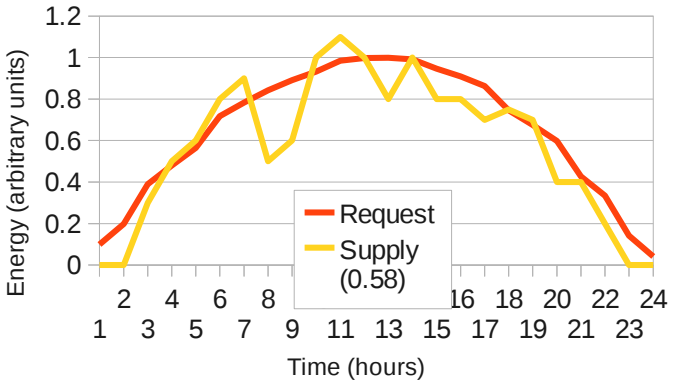
Foreword and definitions

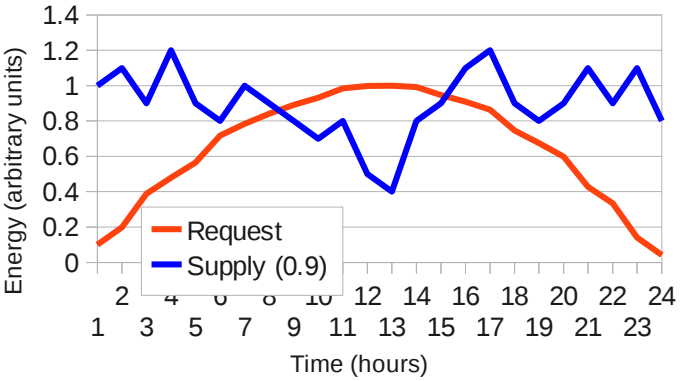
Renewable source of energy: a source of energy which can be regenerated at time scales comparable or smaller than those of its usage

Energy supply (ε_S): the total amount of energy that can be harvest from a source, provided the existence of a suited technology

Energy request (ε_R): the total amount of energy requested by the current life-style

Source reliability (R): the degree of tuning between energy request ($\boldsymbol{\varepsilon_R}$) and energy supply ($\boldsymbol{\varepsilon_S}$)





$$R = \frac{[\epsilon_R]}{\sqrt{\frac{\sum (\epsilon_R - \epsilon_S)^2}{(N)}}}$$

Why renewable energies?

European Climate Policies (2009/28/CE and COM2008(30)-20.20.20) push Member States (and Regions) toward a wide recourse to “renewables”

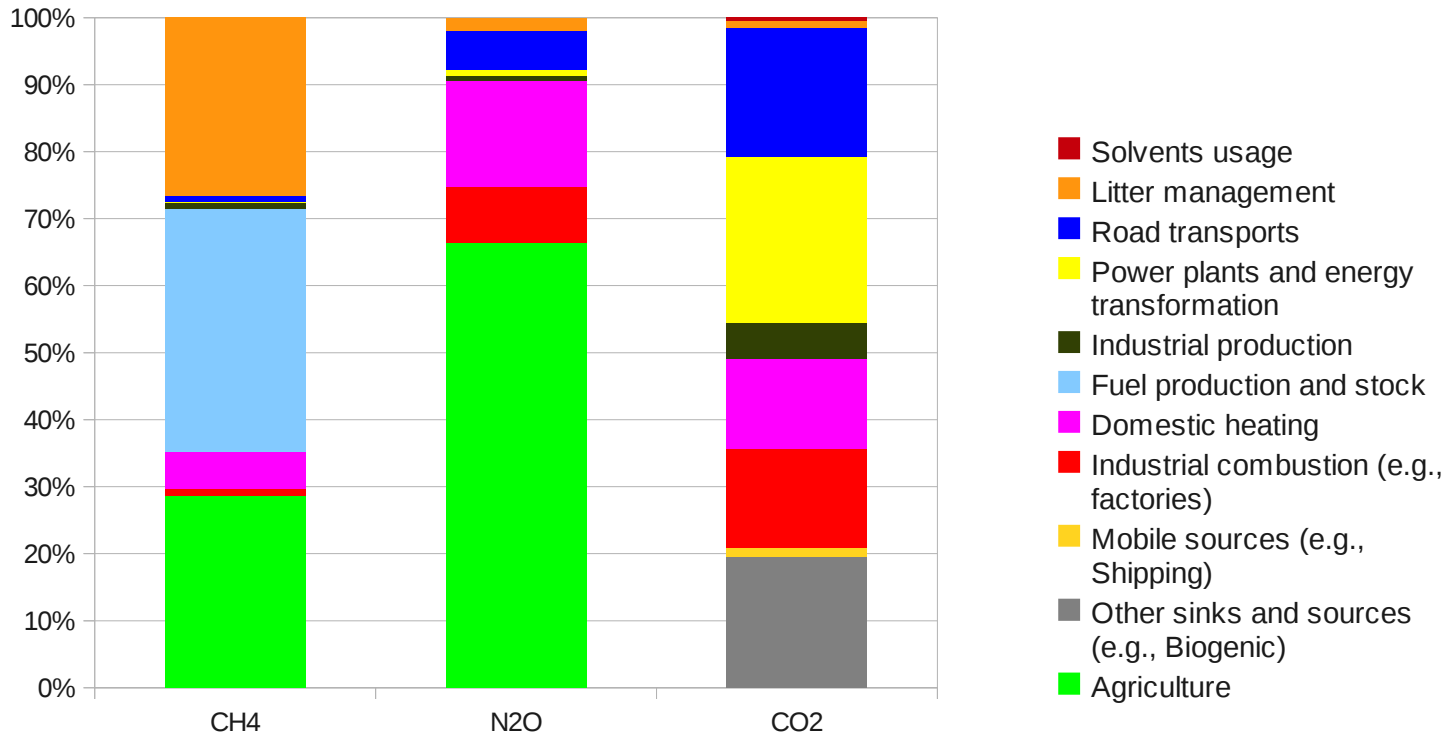
Recently, in Italy, a **negative expression** of popular will (referendum) on **nuclear power plants**, pushed Local Administrators to analyse in deeper detail the renewable energies potential

Pollution pressure related to fossil fuels (NOx, O3 and PM) pushes toward an alternative energy basket, then indirectly toward “renewables”, which are indeed not completely without pollutant emissions

A deep need for **new enteprises** capable to absorb jobless workers or people that have to get into the job market, pushes toward “renewables”

A new **environmental awareness** pushes people toward “renewables”

Is it relevant the regional scale for the energy policies?



5% of CH4, 15% of N2O and 15% of CO2 are related to domestic combustion

Source: INEMAR FVG 2007

24% of power production is needed for domestic usage (light and household devices: roughly **1150 kWh/year** per capita)

Source: GSE

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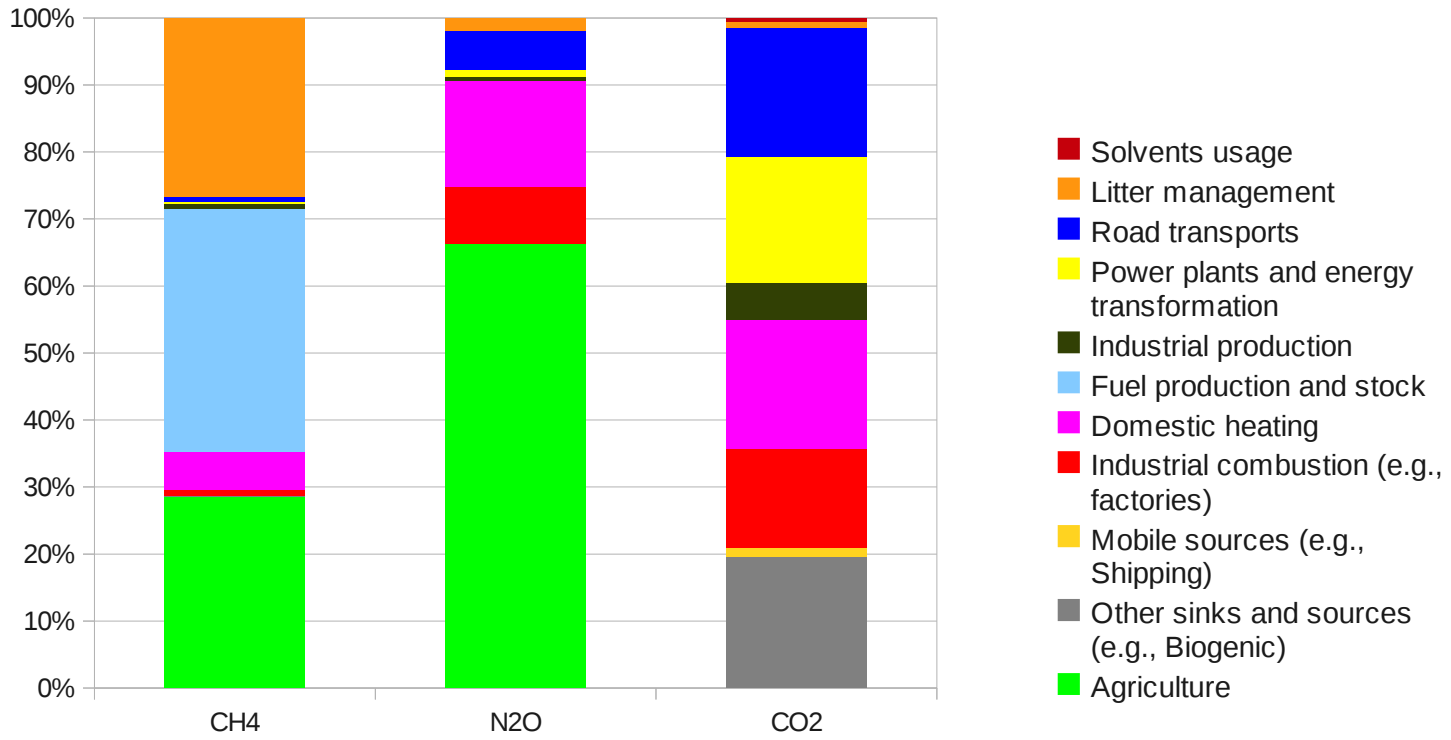

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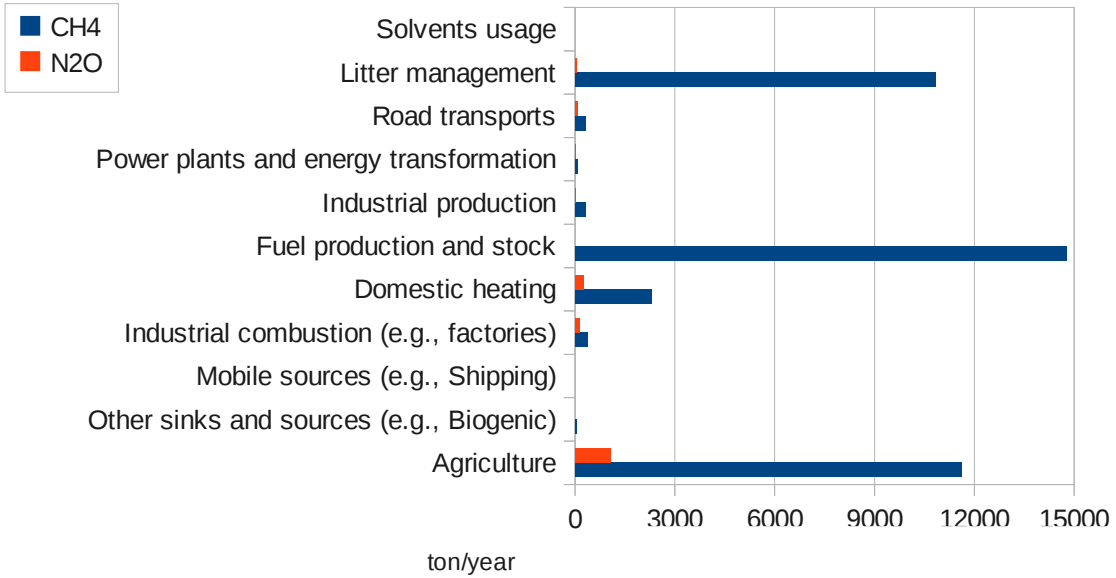
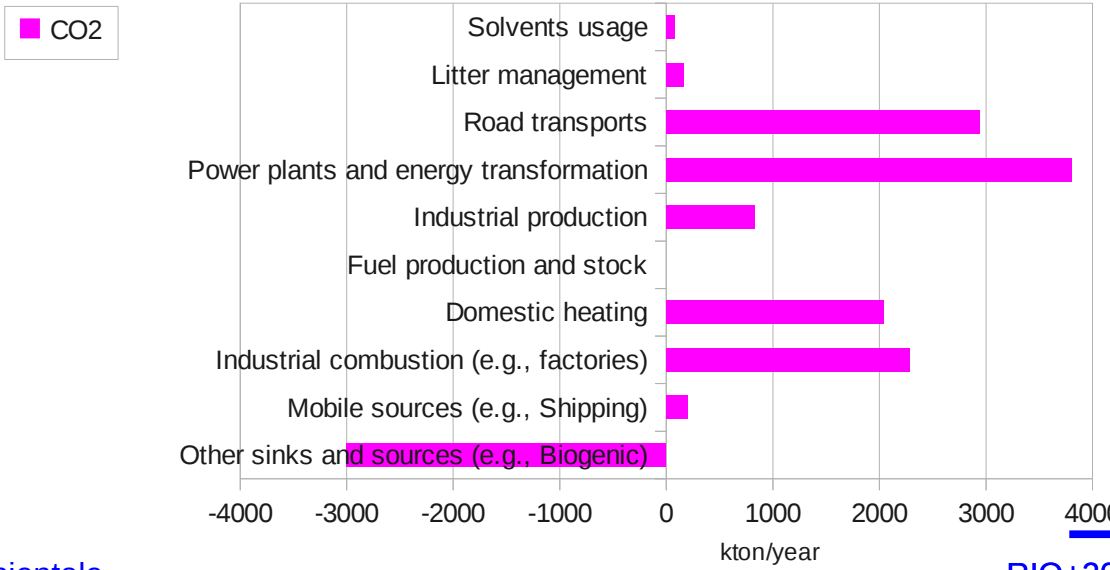




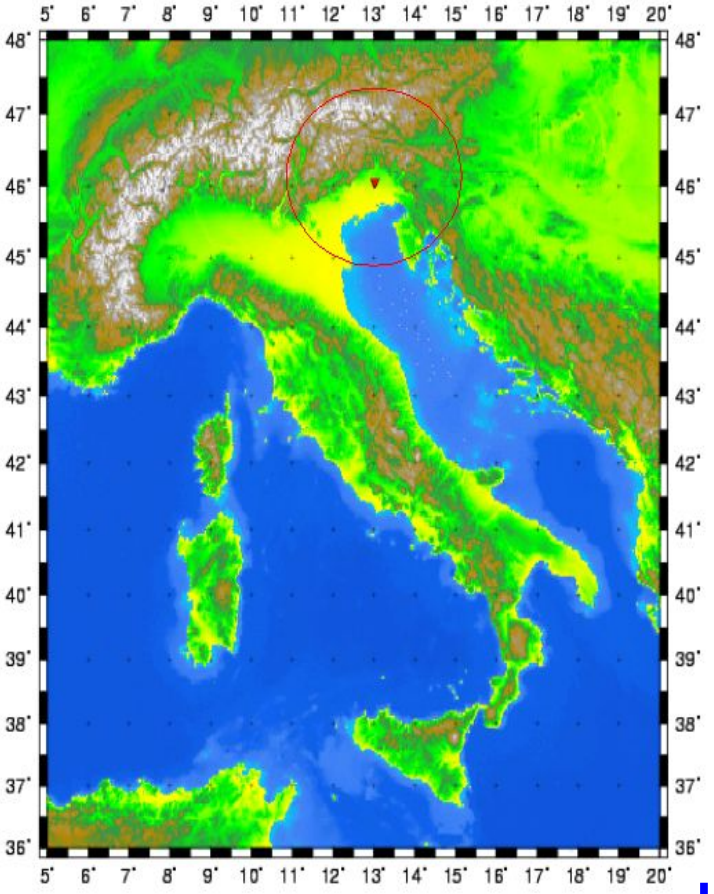
Presentation outline

Different types of renewable energies at local scale

Potentials of the different renewable energies

Caveats and trade-offs

Conclusions



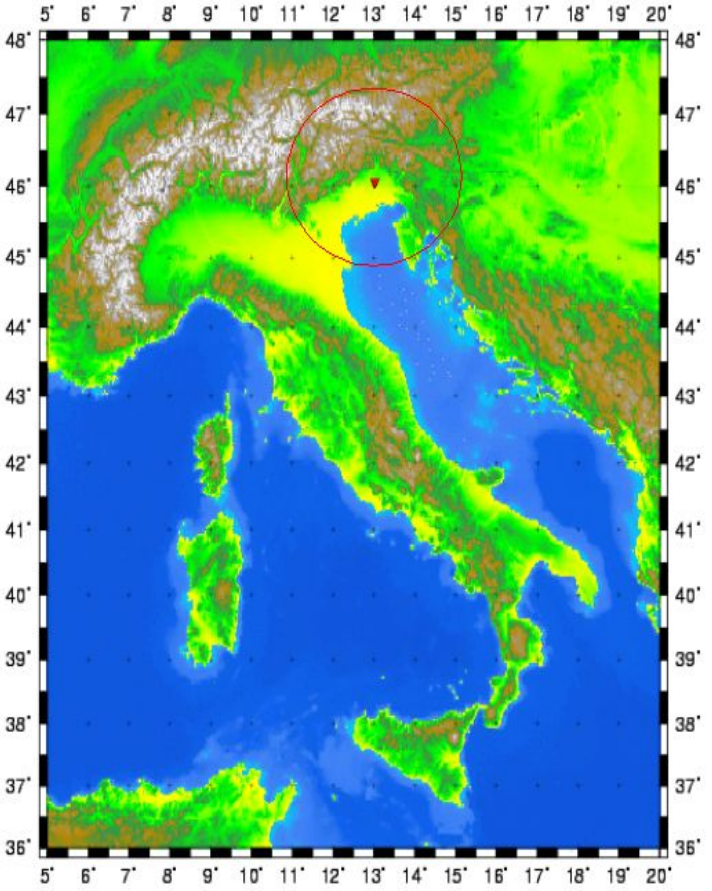
Different types of renewables

Hydroelectric

Wind Energy

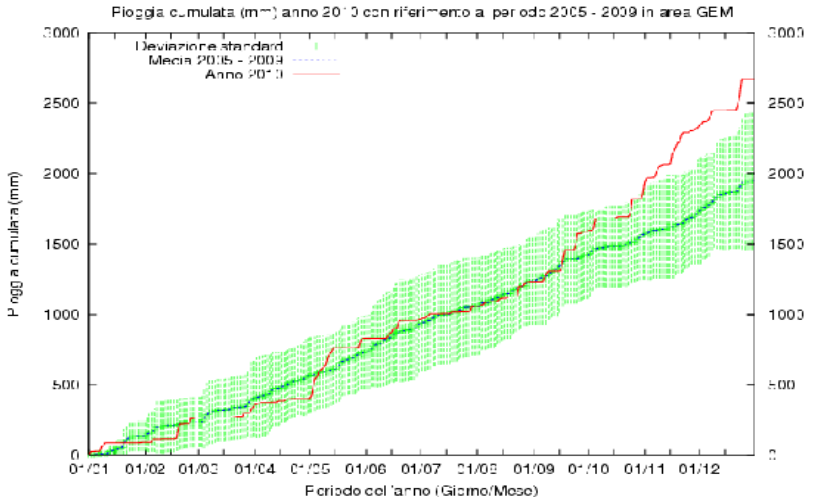
Solar Energy (photovoltaic)

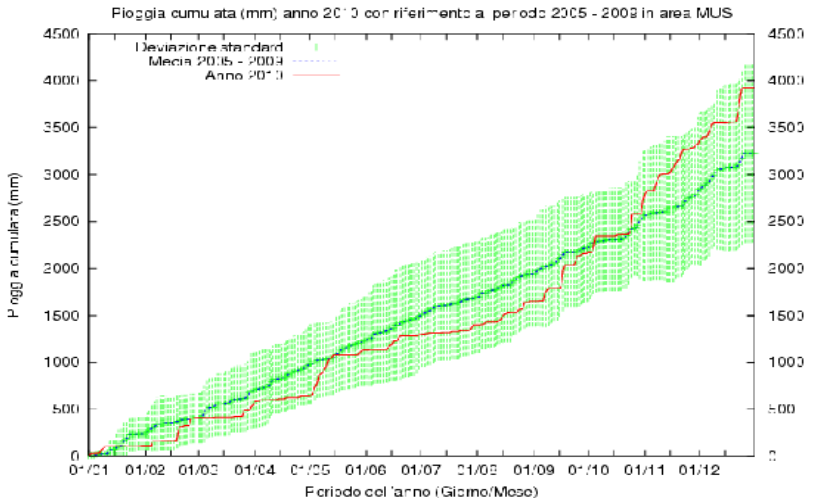
Biomass

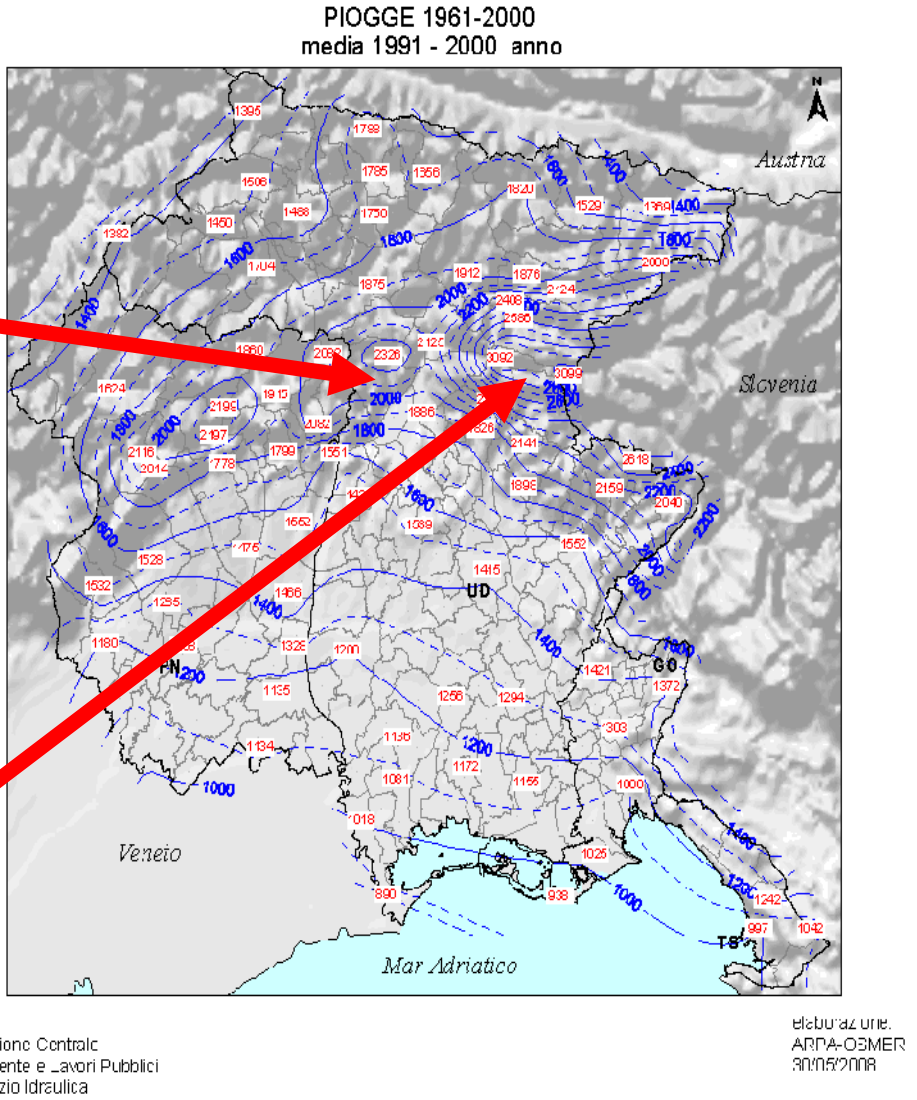


Hydroelectric Power

Hydroelectric

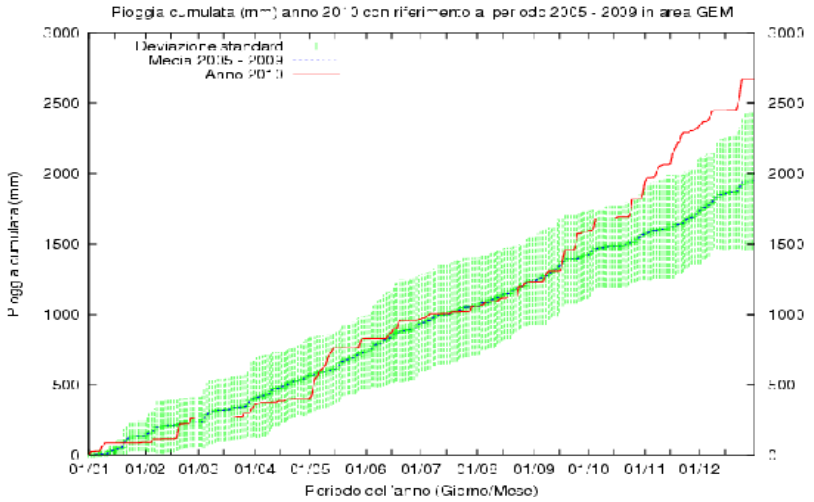






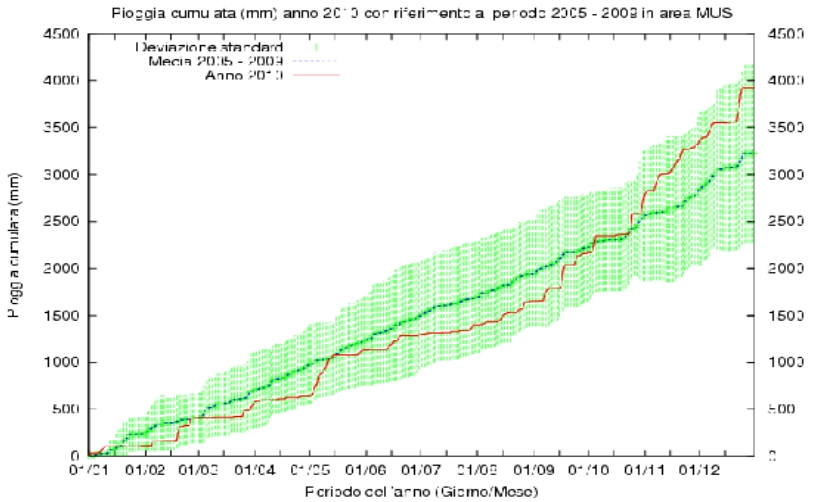
Source: Arpa Osmer and Hydrologic Service

Hydroelectric



There is a huge amount of water yearly available on the prealpine area and the average power production covers roughly 11% of the regional needs (remaining 73% comes from fossil fuels -coal and gas- and 16% is imported)

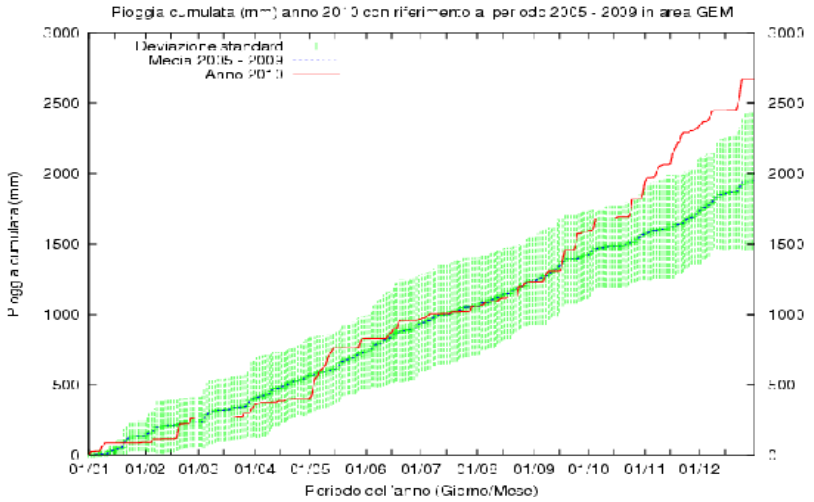
Source: RAFVG – infrastructures department



Principal rivers and watersheds are already used for the power production. There is a residual availability for the microproduction (up to 1 MW) on minor rivers, but with a significant threat for biodiversity

Source: RAFVG – infrastructures department

Hydroelectric



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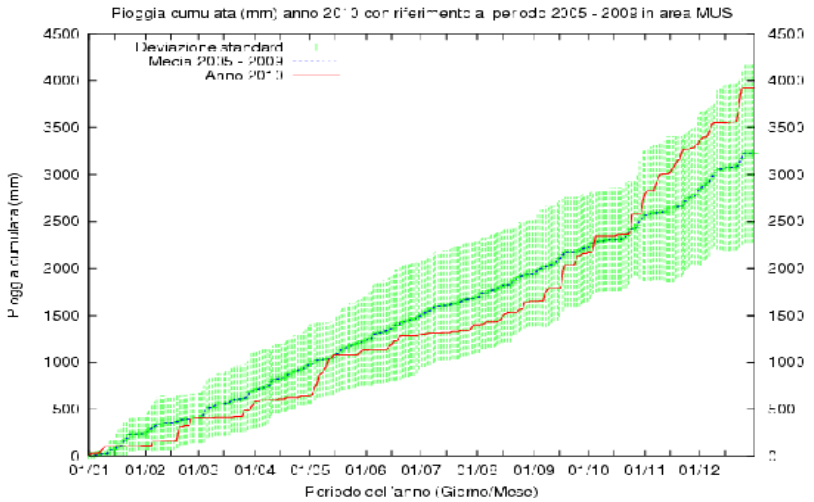
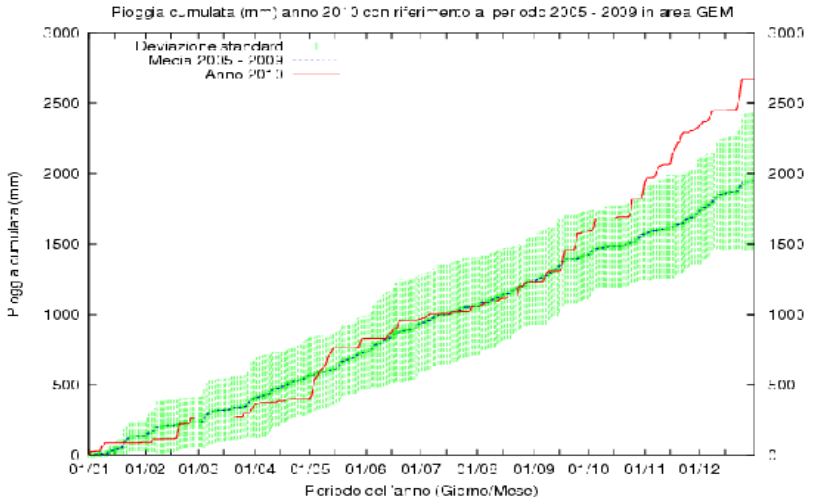
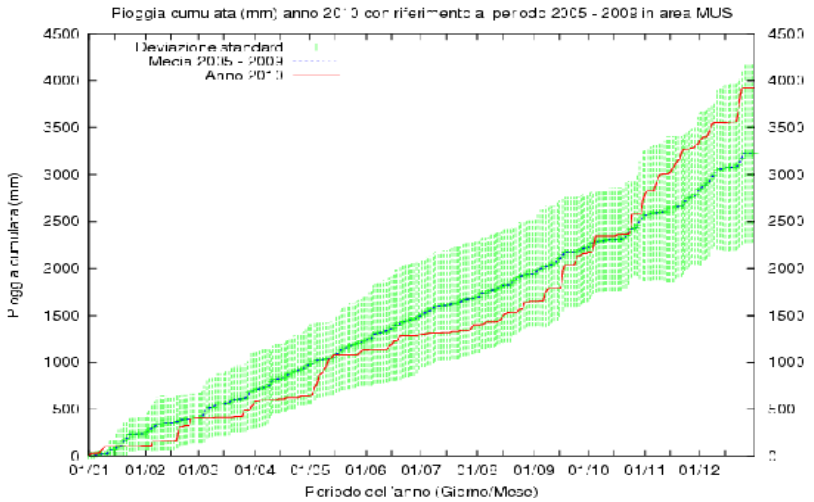


Rivers “cut” for the power production suffer for the fluctuations in the water level, which perturb biological cycles.

Source: ARPA FVG – Environmental signals 2012

Hydroelectric





Strength

Relatively constant supply of water
(but in a slight decreasing trend for the GC)
in particular over the prealpine areas
Highly reliable source of energy

Weakness

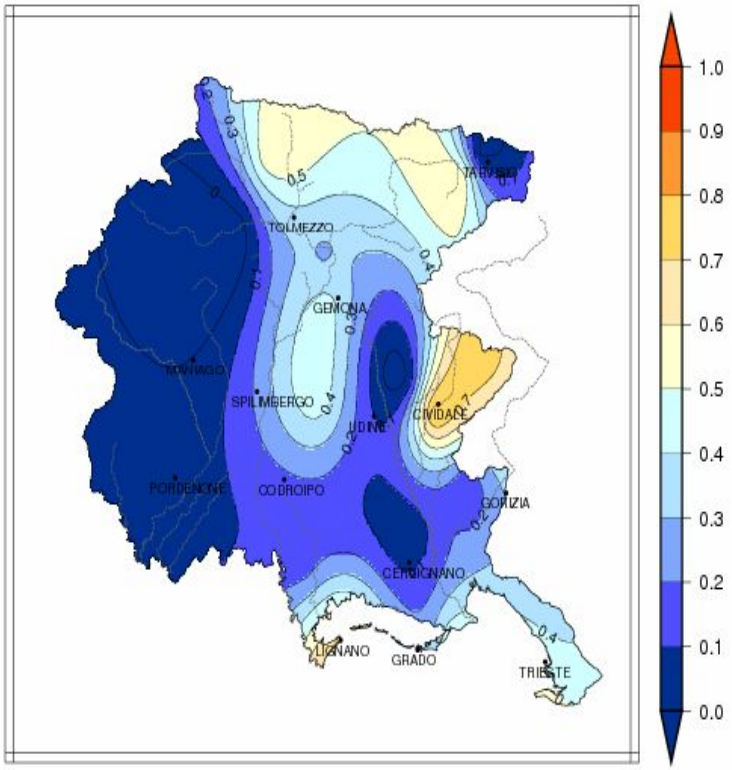
Source already widely used

Problem with the minimum vital flux for rivers
that reduces the biological quality of rivers
and in general biodiversity

Wind Energy

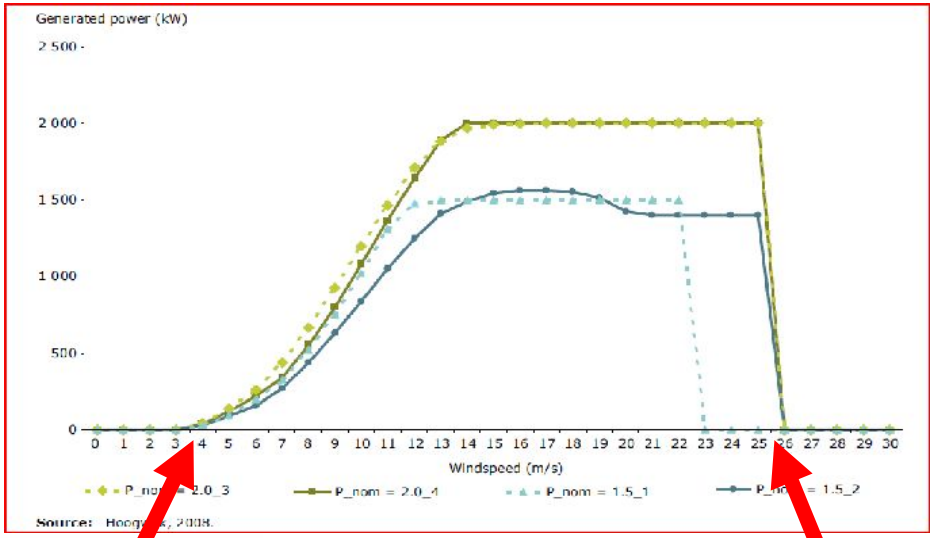
Wind Energy

f_sup 2000–2009 – daily average wind speed at 10m (m/s)



Frequency of days with daily average wind speed larger than 3 m/s

Power curves



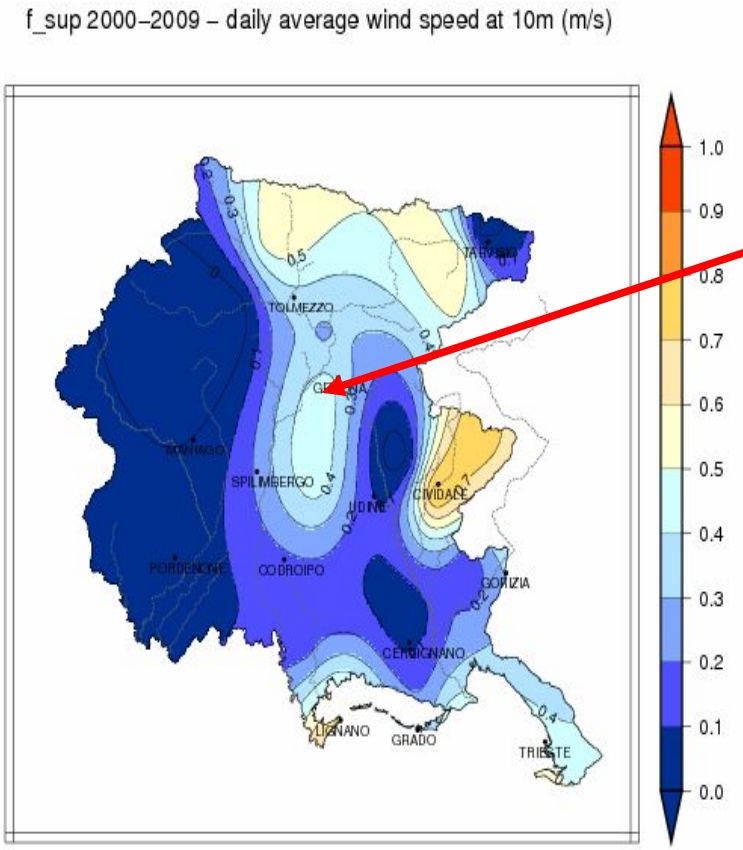
Cut-in = 3 m/s

Cut-off = 25 m/s

This area is mainly characterized by breezes wind regime

Source: Arpa Osmer and Hydrologic Service

Wind Energy



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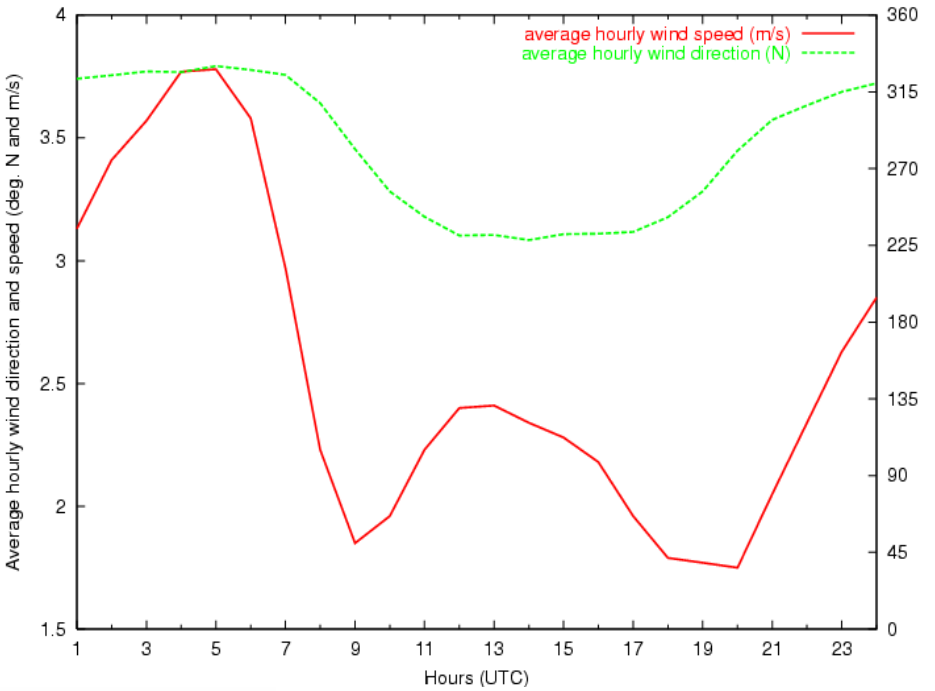
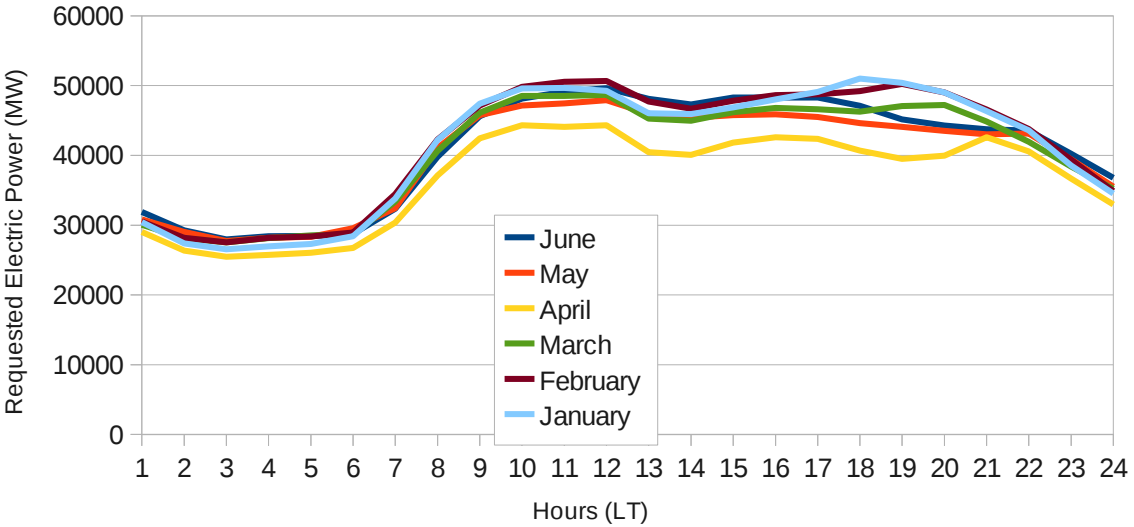


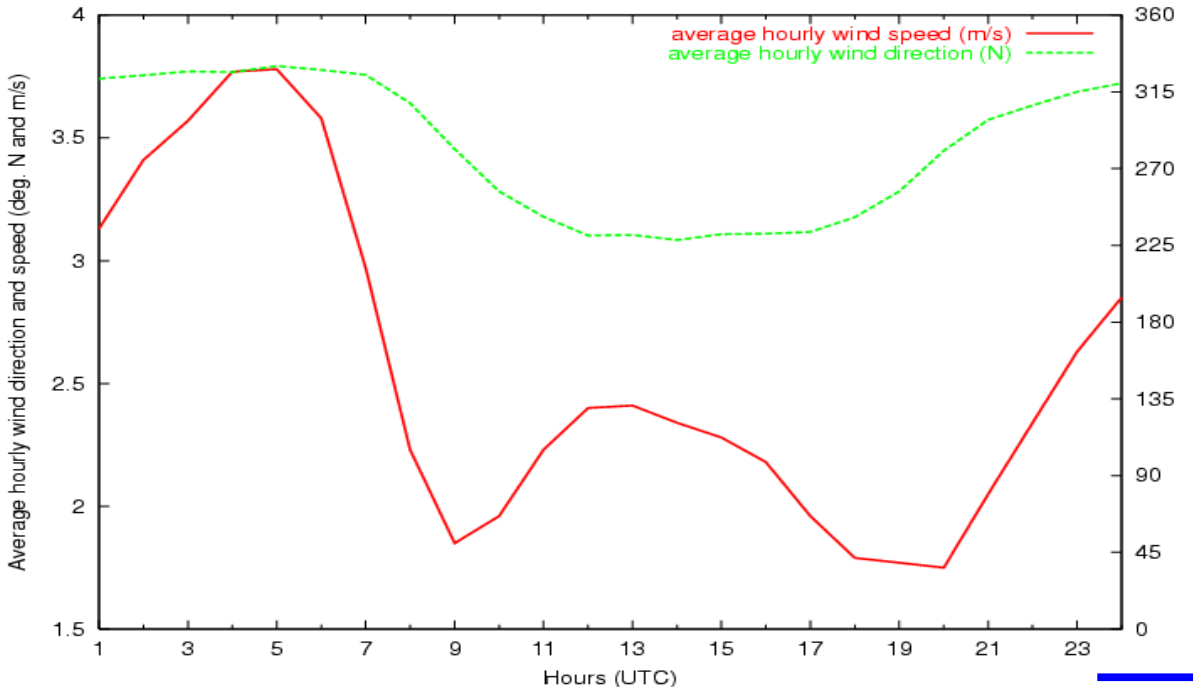
Wind intensity (red curve) in foothills is high during night time and early morning

Wind Energy

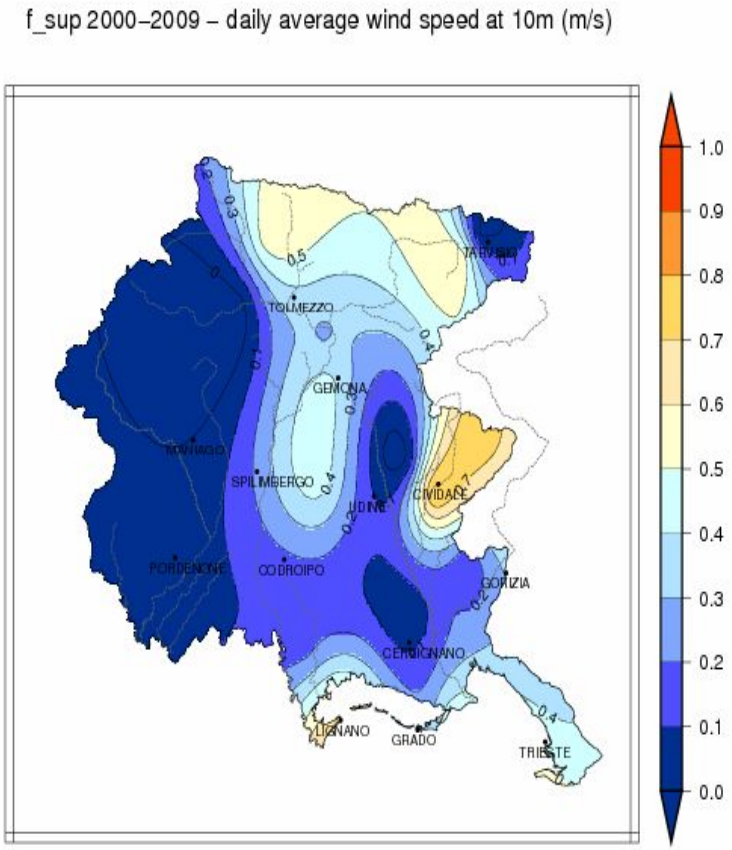
Reliability of Wind Energy related to mountain breezes is relatively low according to the **whole energy request**

Slightly better is the wind energy reliability with the **household energy request**





Wind Energy



Frequency of days with daily average wind speed larger than 3 m/s

Strength

Not in phase with peaks of energy request but relatively more in phase with domestic usage (self-production?)

Weakness

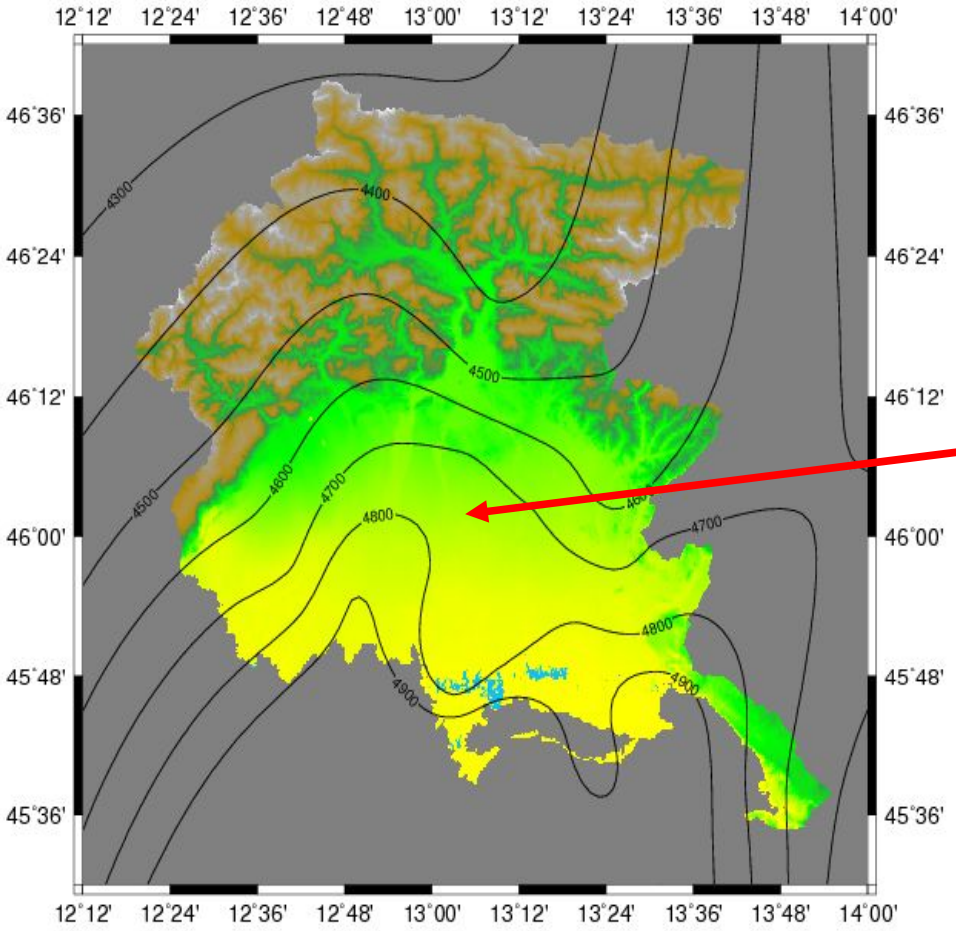
Small areas with sufficient wind speed

Mountainous areas (threat for biodiversity)

Problems with the landscape impact

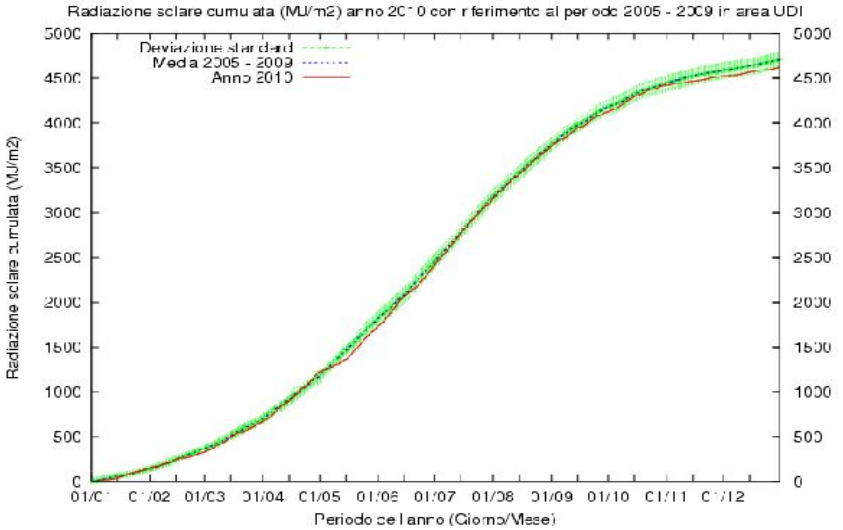
Solar Energy (Photovoltaic)

Solar Energy



Yearly average solar radiation (2006-2009)

Cumulative distribution of solar energy (2006-2009)



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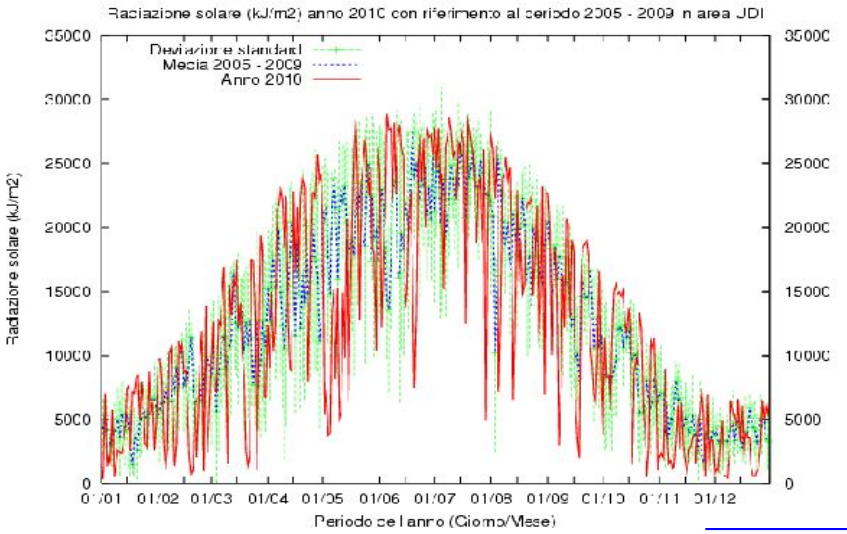
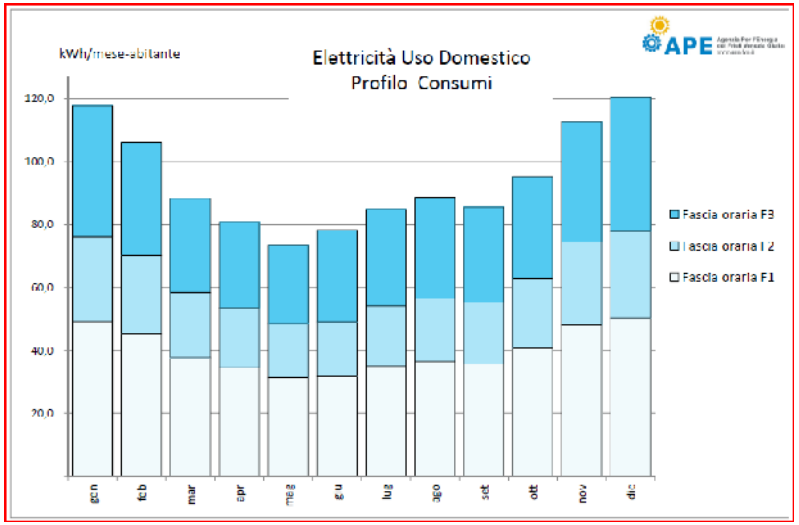


Solar Energy

Average household electrical energy request is of the order of **2600 kWh/year** (**~10300 MJ/year**) then comparable with the energy supply of a few tens of square meters

Small reliability related to the yearly **household energy request**



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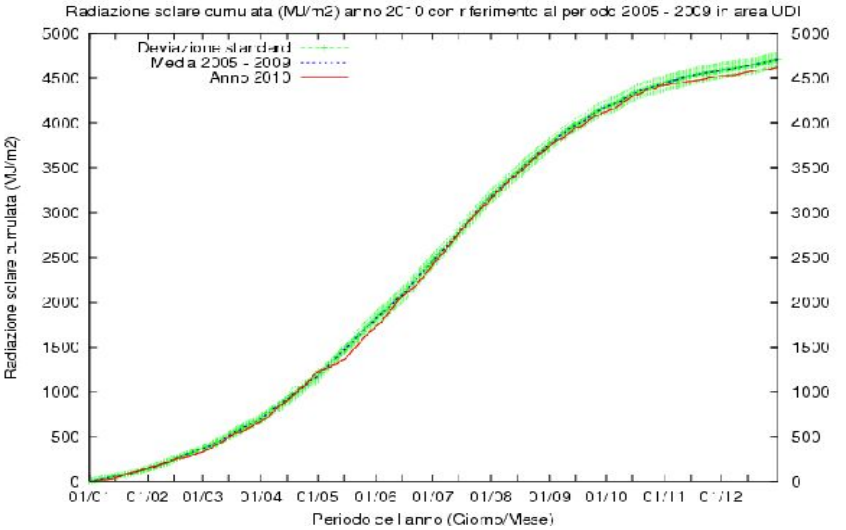

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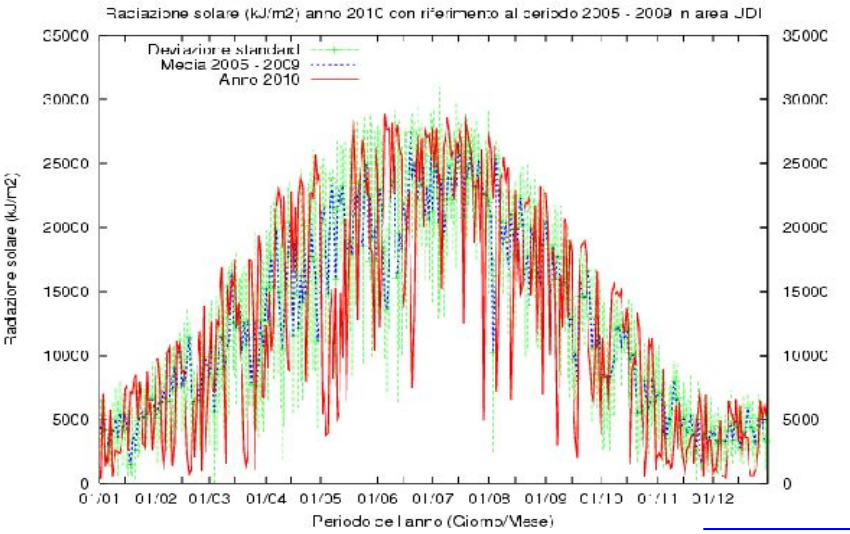

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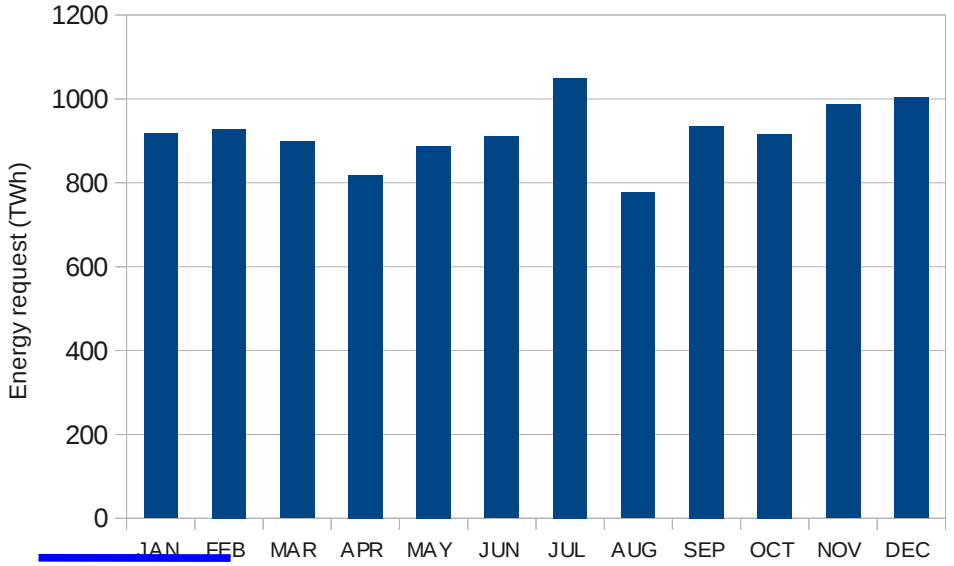
Small reliability related to the yearly **Total energy request**



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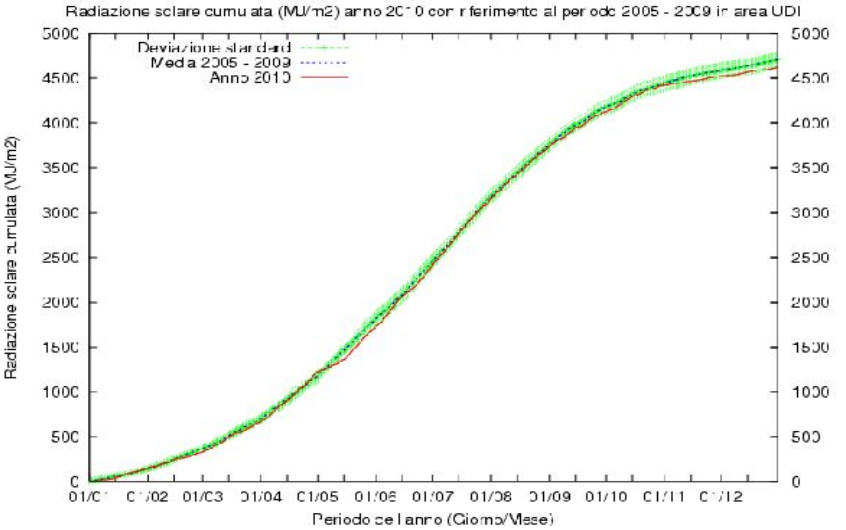

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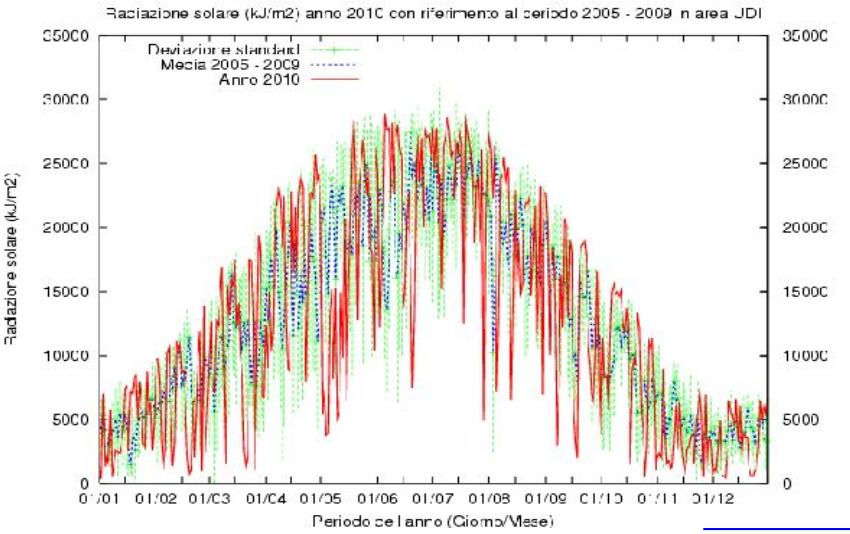

Solar Energy

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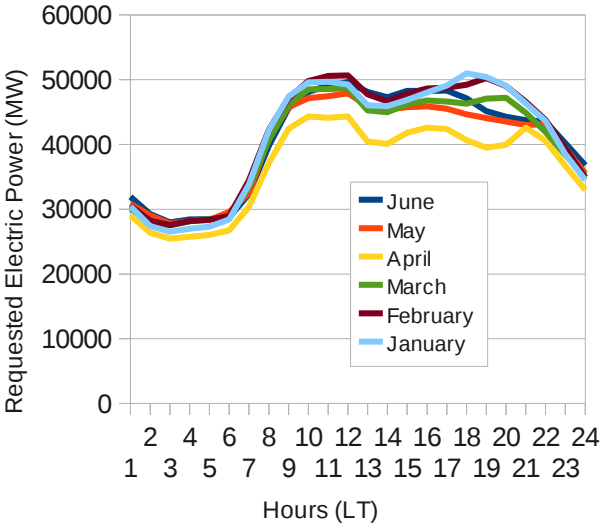
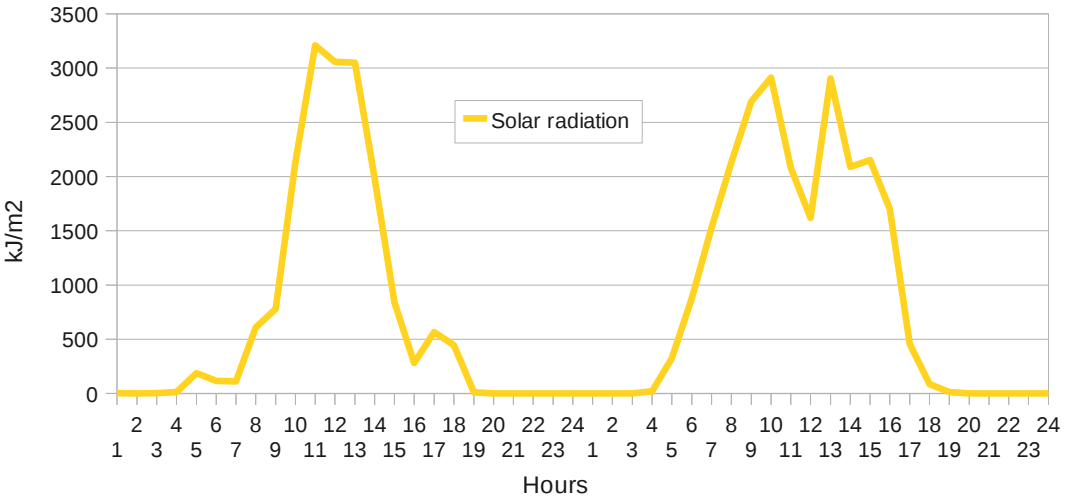
Daily variability reduces dramatically the reliability of this source of energy.

To increase reliability we have to smooth the diurnaly and daily variability.

Average hourly request of electric power (Jan-Jun 2007)

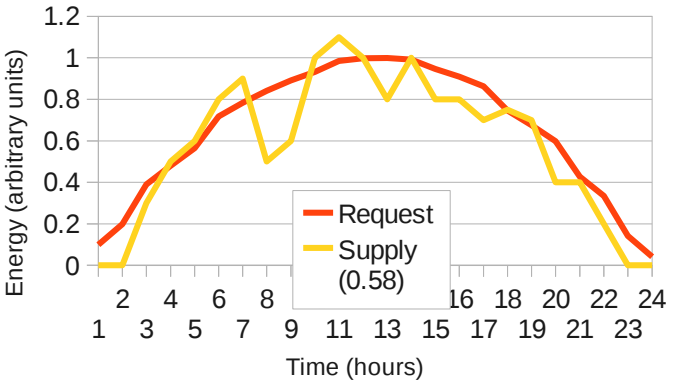


Hourly supply of solar energy (23-24 May 2012)



Solar Energy

Under the mathematical point of view, smoothing of functions can be done through a convolution (e.g., running mean)



Mathematical time convolution of the solar supply is tecnically represented by energy accumulators

Mathematical space convolution of the solar supply is technically represented by smart grids

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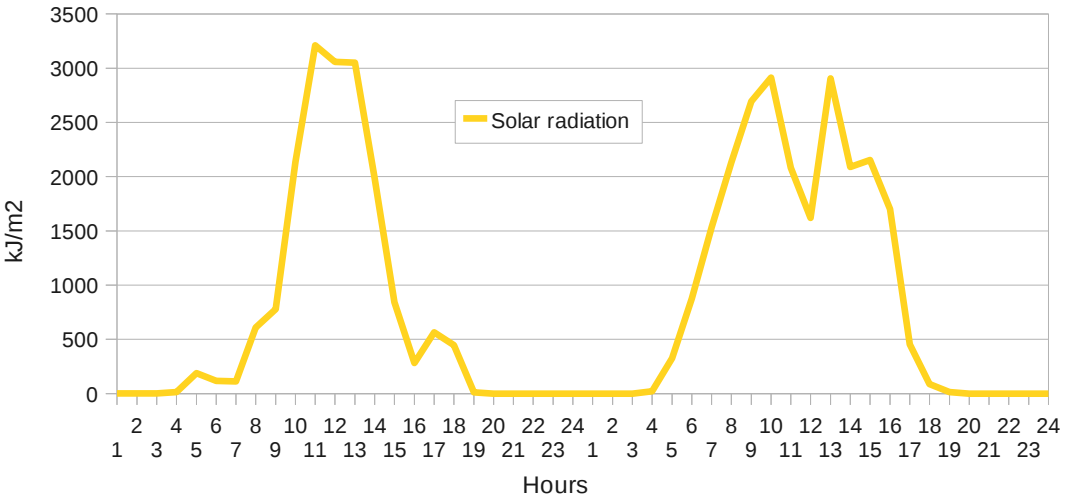
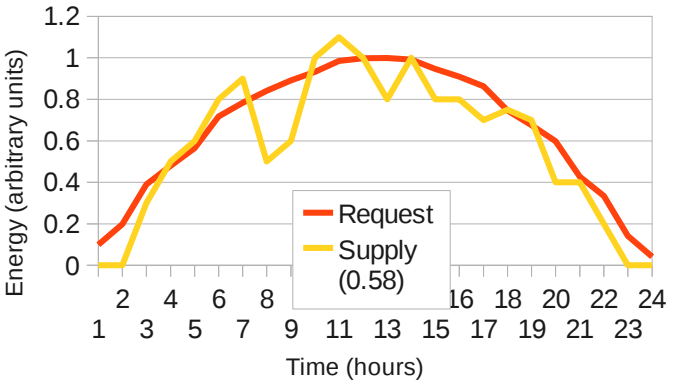
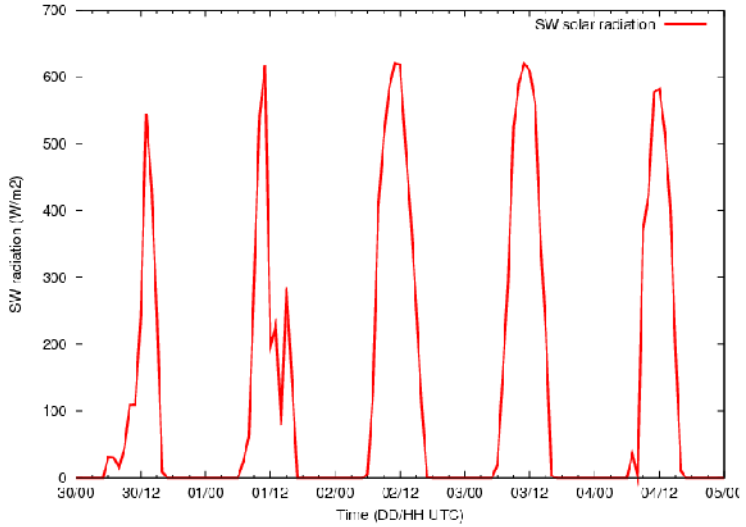


Solar Energy

An alternative and complemental way to increase reliablity of solar energy is that to tune the energy request according to the energy supply

Numerical models can issue reliable forecasts of solar radiation at two or three days, then useful for the houlsehold organization of requests (washing machine, dishwasher, etc.)





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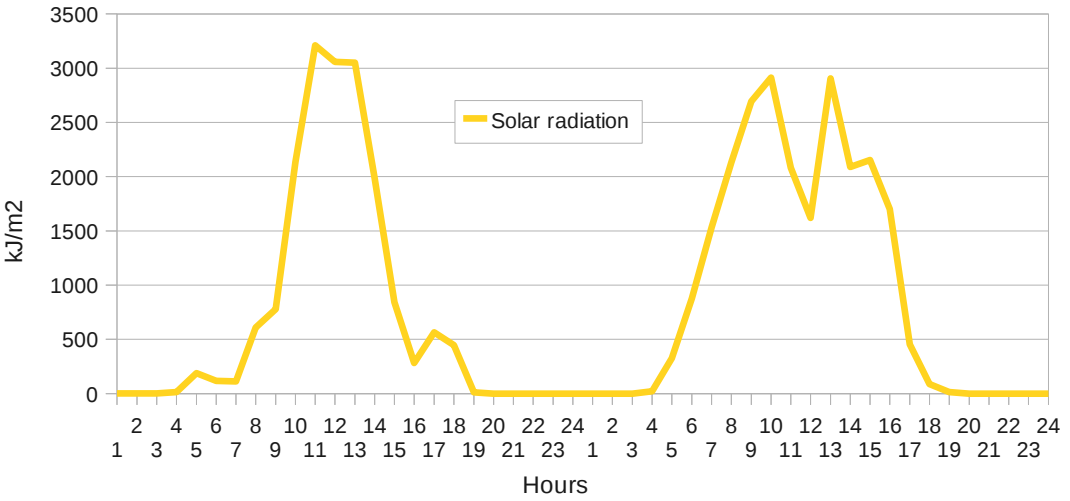
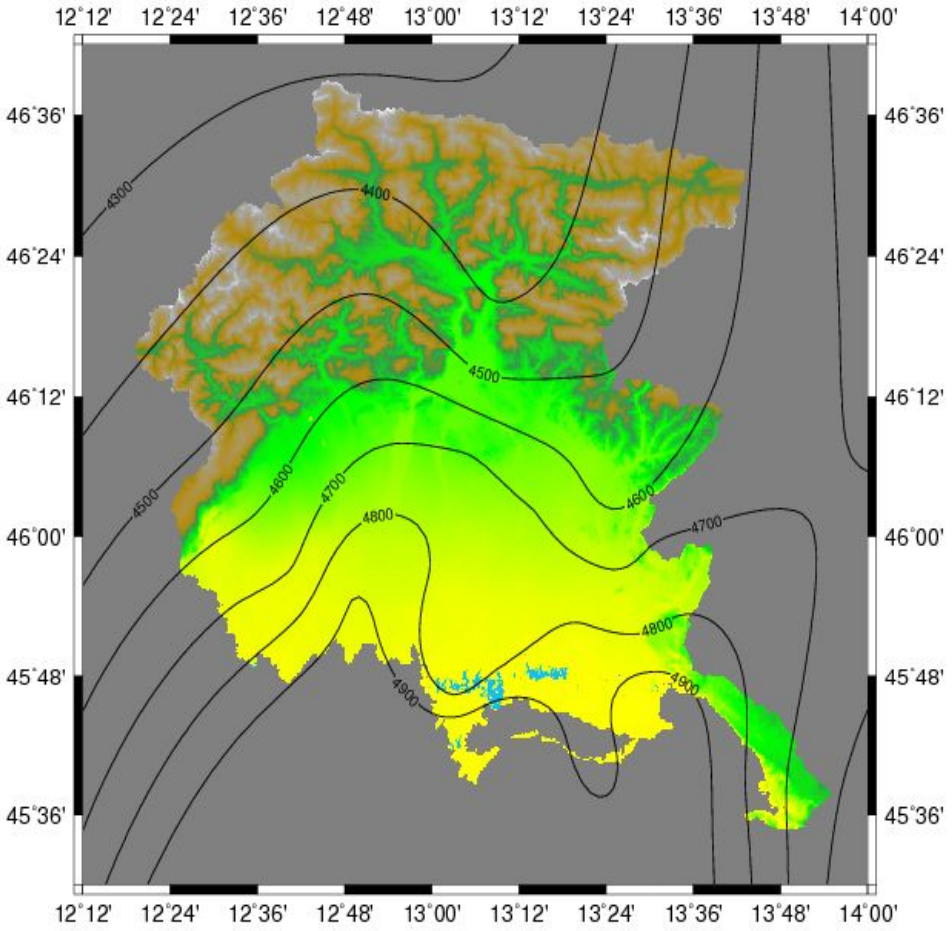


Solar Energy



Yearly average solar radiation (2006-2009)

Strength

Relatively stable from year to year and relatively large availability

Generally reduced reliability

Real efficiency of 10-11 % with state of the art technology

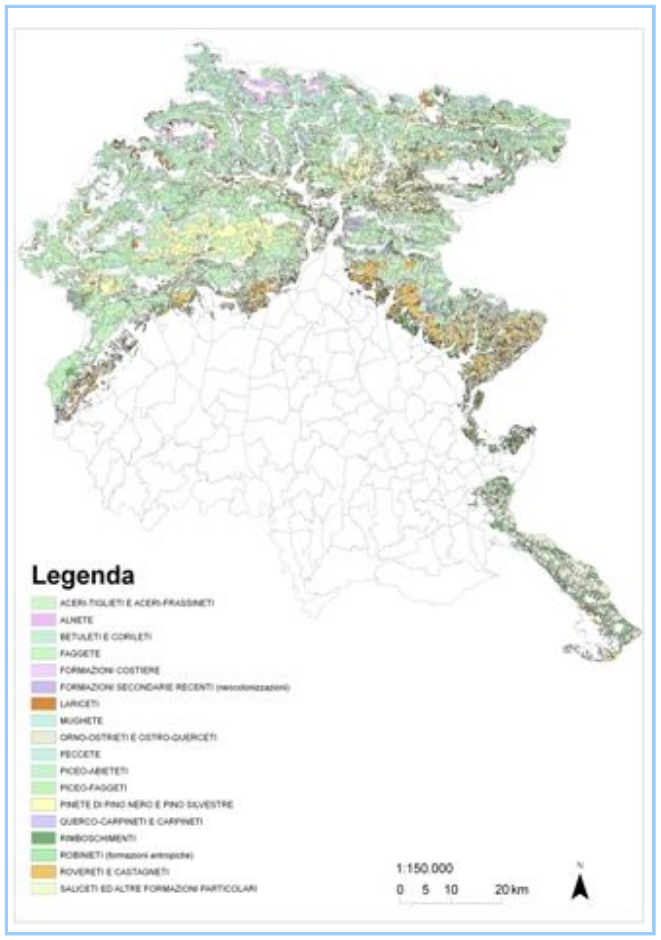
Weakness

Large variability from day to day and in the different periods of the year

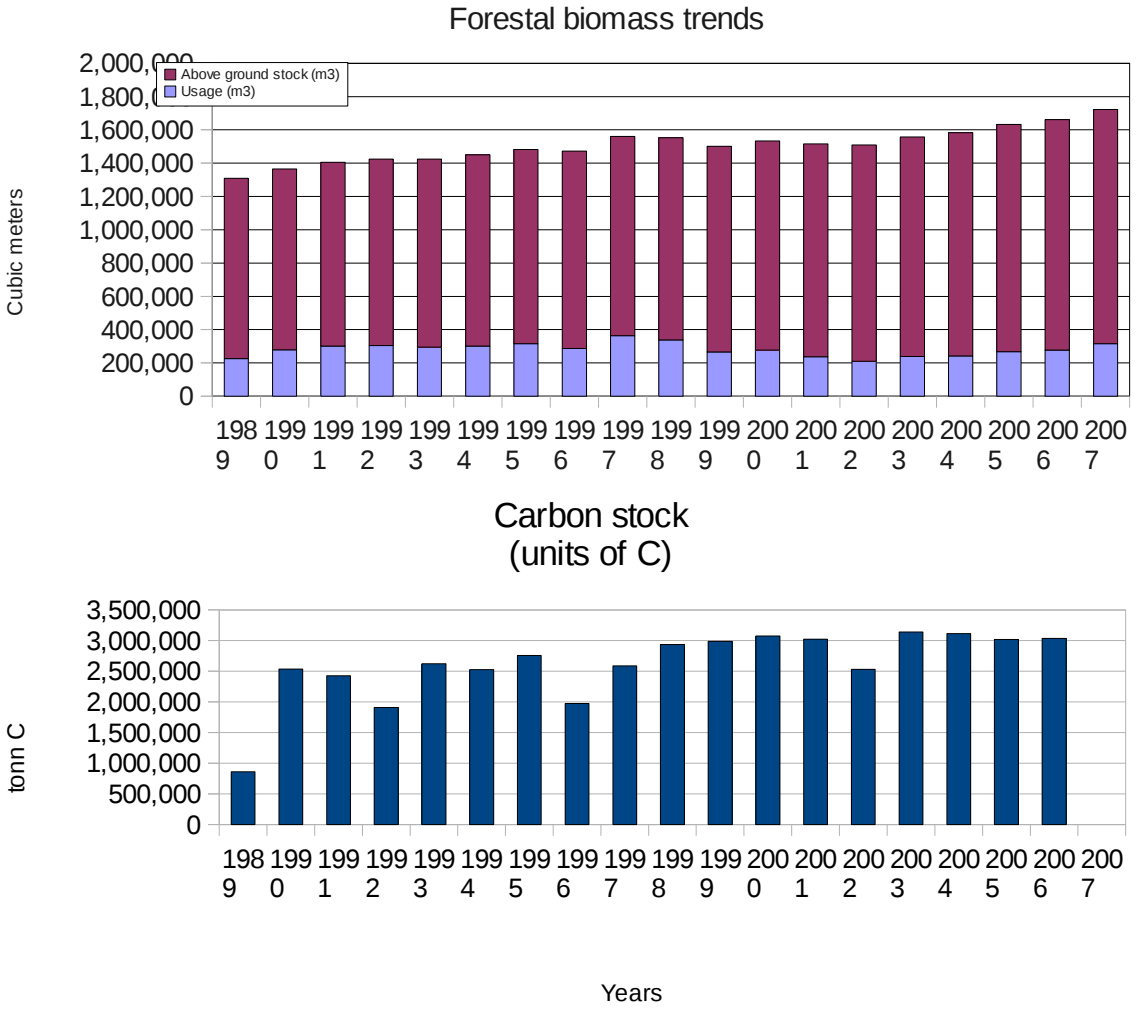
Naturally weak reliability with household requests

Biomass energy (Biofuels)

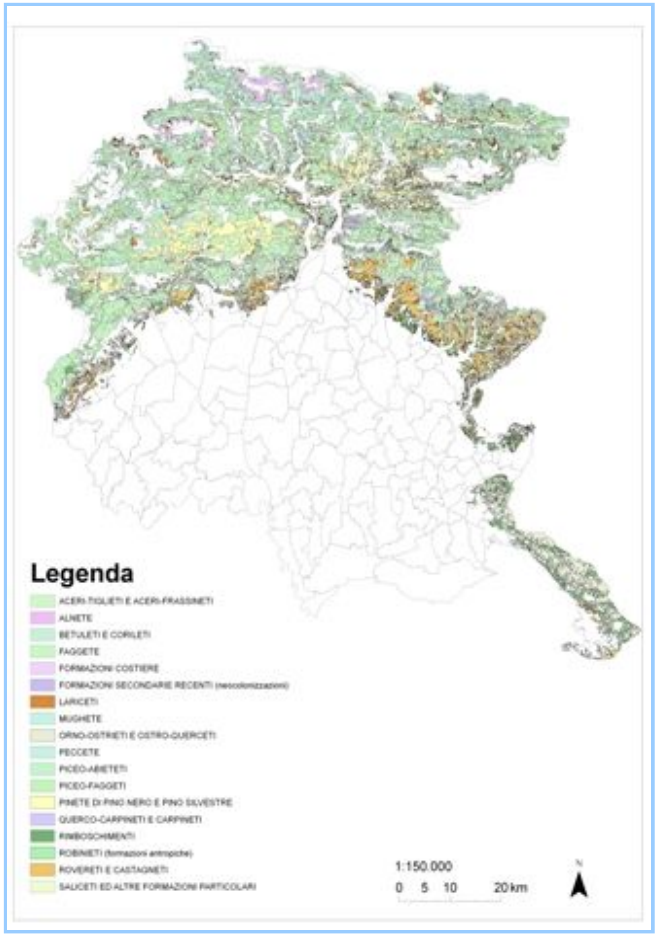
Biomass (forests)



One third of the region is covered by forests



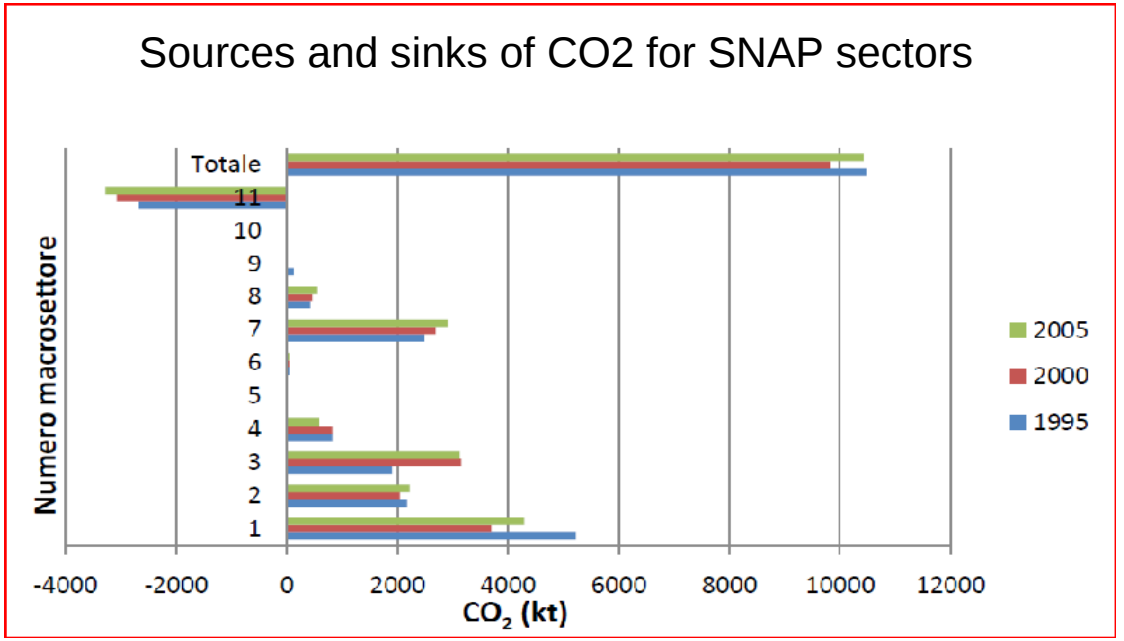
Biomass



One third of the region is covered by forests

Forests represent a significant carbon sink, which is fostered by the EU.

At the same time, forests represent a significant stock of energy.



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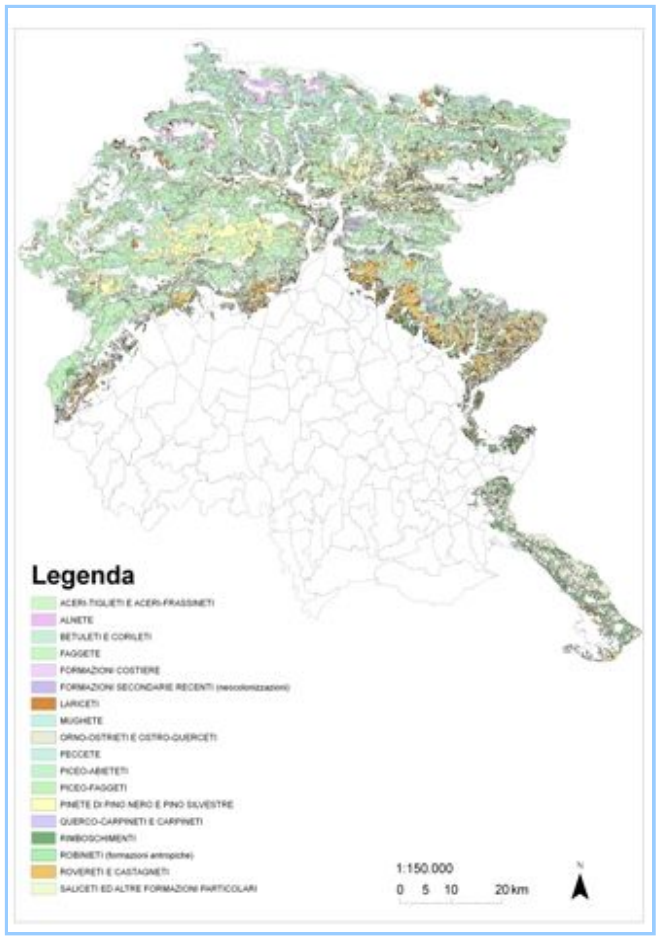
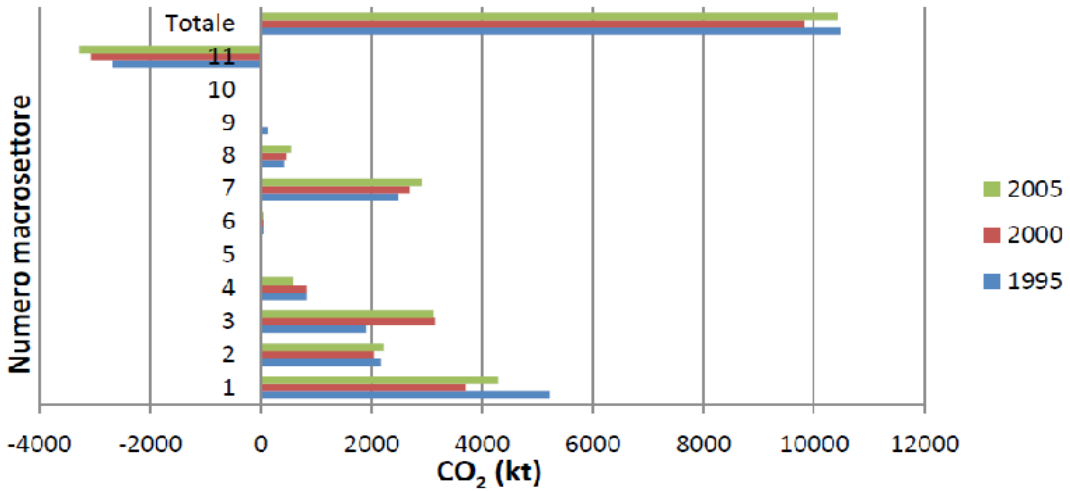


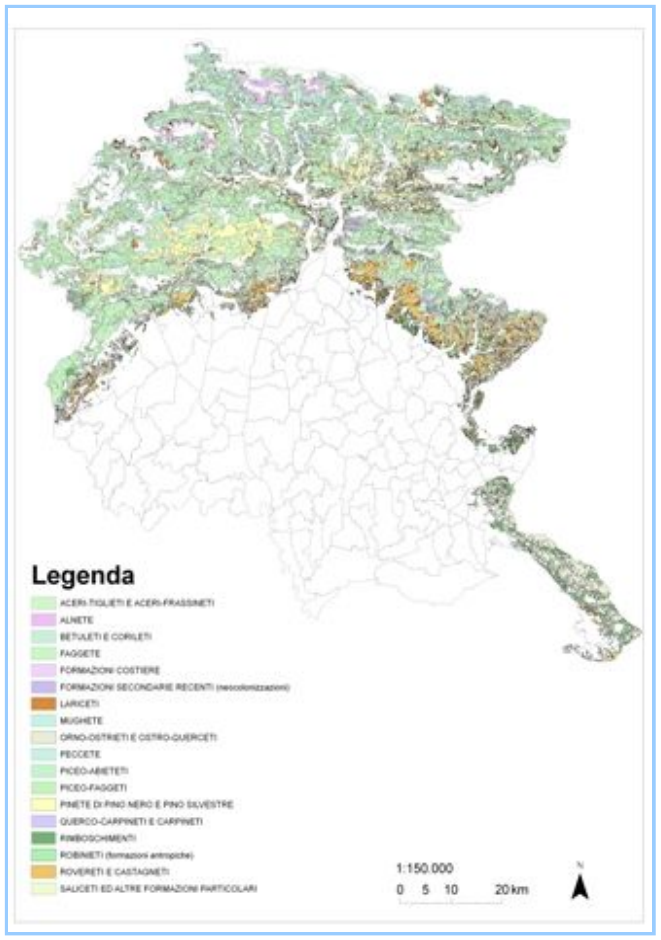
One third of the region is covered by forests

In the **burden sharing** policy, forest carbon stock is ascribed on Member states (e.g., Italy), while energy stock is ascribed to Regions (e.g., Friuli Venezia Giulia)

Sources and sinks of CO2 for SNAP sectors



Biomass (forests)

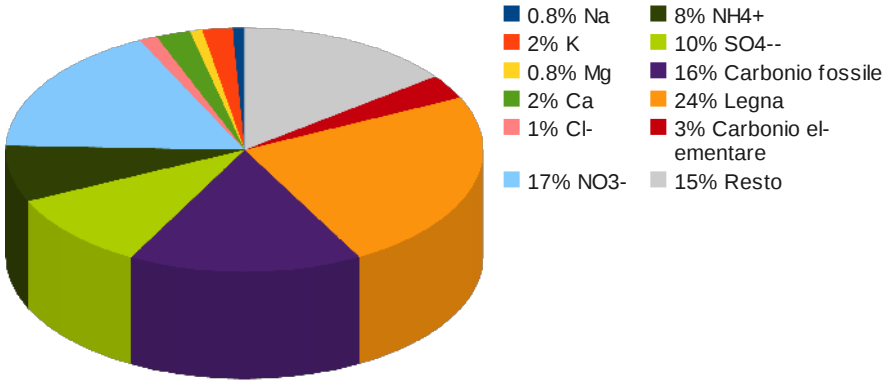


One third of the region is covered by forests

A significant fraction of particulate matter observed in the Po Valley is due to the emissions ascribable to domestic wood combustion.

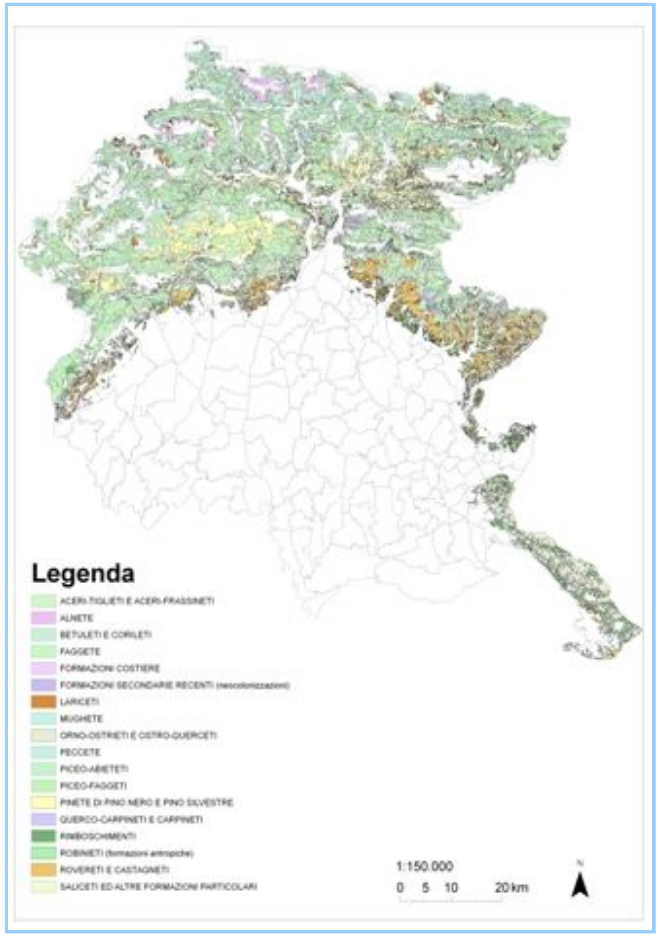
This aspect should increase in the future because of the increased prize of fossil fuels

PM speciation: Friulian plain Gen-Feb 2011



(fonte: progetto EU iMONITRAF!)

Biomass (forests)



One third of the region is covered by forests

Economical support given to “renewable energies” derived from biomasses pushes toward the installation of medium-size power plants (up to 50 Mwt) which are sustainable under the economical point of view (thanks to the National incentives) but not under the EROEI point of view

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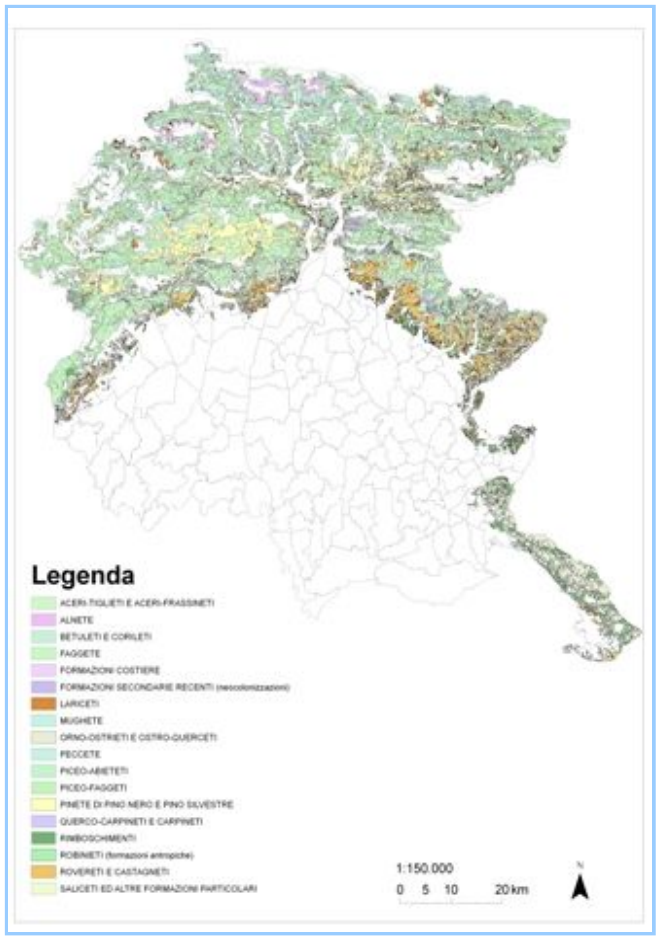
This paradox is essentially due to the fact that economical incentives are given to the **electric power supplied**, while they should be given to the **thermal power supplied** (and used) even because the forest efficiency as a stock of solar energy is extremely low (roughly 0.5 %) and almost all the thermal energy produced by medium-size power plants can not be used at all

Biomass (forests)



One third of the region is covered by forests

Strength

Available and growing renewable energy

Weakness

Low efficiency: only 0.5% of solar energy is converted into wood energy (biomass power plants to produce only electrical energy are extremely ineffective)

Biomass is a sink of CO2: should we keep it as a sink or as a source?

Current domestic biomass devices have an high impact on PM concentrations

Conclusions

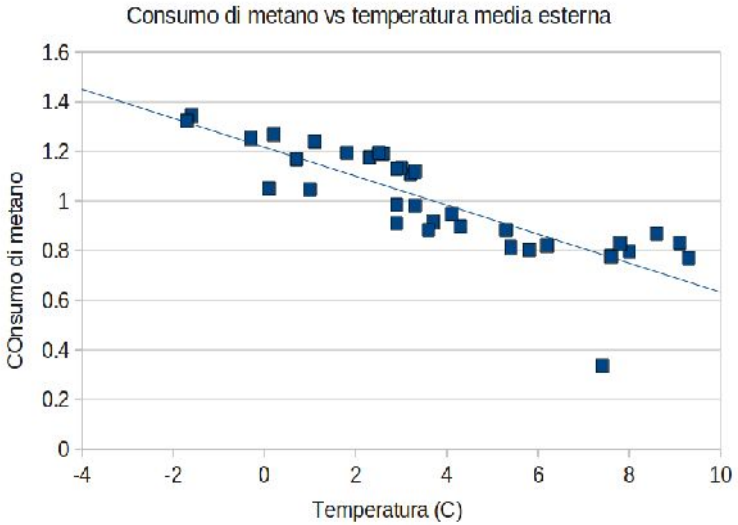
Wind energy is a niche source in Friuli Venezia Giulia: self production and off-shore

Solar energy (photovoltaic) relatively abundant but with a low reliability

Biomass abundant but wise use is only for heat production (small combined plants)

Trade-off of biomass with air-pollution and carbon sink

Do not forget “energy saving”



Thank you for your attention