



Regional Energy Planning: a case study

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OUTLINE

- ✓ INTRODUCTION
- ✓ THE CASE STUDY
- ✓ LOCAL *vs* GLOBAL
- ✓ SCENARIOS
- ✓ RESULTS
- ✓ COMMENTS

INTRODUCTION

Question: how does it possible to support the energy planning process taking into account environmental, technological, political and economic issues?

Energy planning → Integrated approach

Stakeholders: Governmental organizations, Local administrative units, local utilities, large energy companies, oil and gas producers,....

INTRODUCTION

Energy policy devolution (March 1998)



Regions and Local Administrative divisions are in charge of energy and environmental issues.



Regional Energy Plans (technical and political document)



Analysis modalities are not formally defined

INTRODUCTION

Regional activities:

- Legal, economic support to the development of renewable energy sources;
- Legal, economic support to the energy efficiency measures;
- Translation of energy national policy into the regional context.

Answer: an useful approach (not the unique) is the development of an Energy Model that is a mathematical simplified description of energy flows of the regional system, able to investigate different energy paths and the interrelations among all included sectors. (Simulator, Optimizator, Accounting Frameworks,...).

INTRODUCTION

Realizing a model means to built the Reference Energy System (RES) structure, to compile technology database and to select scenarios fo analysis.

First step:

- Defining the strucure (RES);
- Defining the links;
- Individuating the final demand (bottom-up approach).

Second step:

- Collecting information about the region (REB);
- Describing the new technology options;
- Defining a set of bounds and the scenarios.

THE CASE STUDY

Approach: Optimization

Problem type: Linear Programming (branch of Operative Research)

Algorithm: Simplex

Analytic tool: TIMES (The Integrated MARKAL-EFOM System)

Programming Language: GAMS (General Algebraic Modelling System)

The TIMES objective is to minimize the total cost of the system taking into account investment costs (+), fixed and variable costs (+) import costs (+), taxes (+), subsidies (-), export (-),...

THE CASE STUDY

Aim of the work:

- Modeling the energy system of Lombardy Region in the Reference Case;
 - Reproduce for the base year (2005) the regional energy balance through the model;
 - Analyse and compare different scenarios.
-
- Time horizon 2005 – 2030
 - Single region



THE CASE STUDY

Demand sectors: Residential, Service (Commercial and Public Administration), Industry, Agriculture, Transport

Supply sectors: Energy production and distribution

Residential

- Space heating;
- Water heating;
- Space cooling;
- Lighting;
- Refrigeration;
-

Industrial

- Iron and steel;
- Chemical;
- Paper and printing;
- Textile;
- Food and drink;
-

Transport

- Passenger (private)
 - Short distance;
 - Medium distance;
 - Long distance
- Public transport
- Freight transport

THE CASE STUDY

The description of sectors inside the model depended on the quality and on the quantity of information collected and on the specific interests of Regional Public Administration according to the Regional Energy Plan.

Detail description

Residential: *high* (large number of techs and energy services modelled);

Service sector: *medium* (large number of techs and few energy services modelled);

Industry: *low* (aggregated description);

Agriculture: *low* (aggregated description);

THE CASE STUDY

Detail description

Transport: *high* (large number of technologies and services modelled);

Generation sector: *high* (large number of existing plants with their specific technical features);

Supply sector (infrastructure): *low* (electricity grid, distribution of natural gas and district heating);

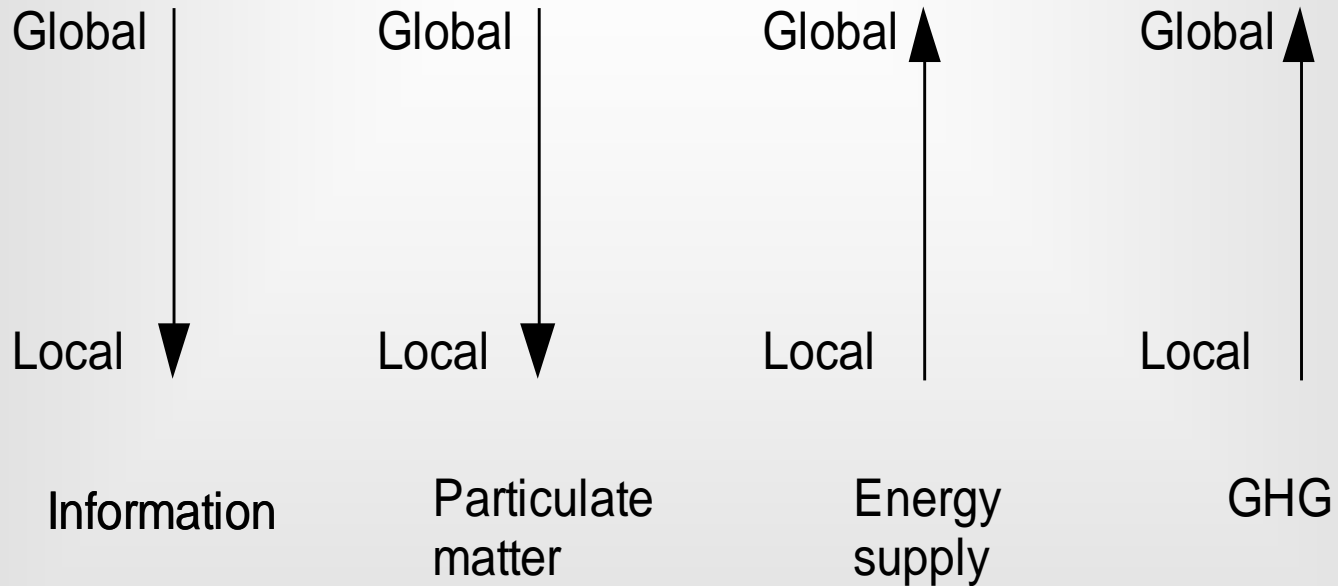
Waste chain: *low* (waste to energy plants have been included).

LOCAL vs GLOBAL

Details

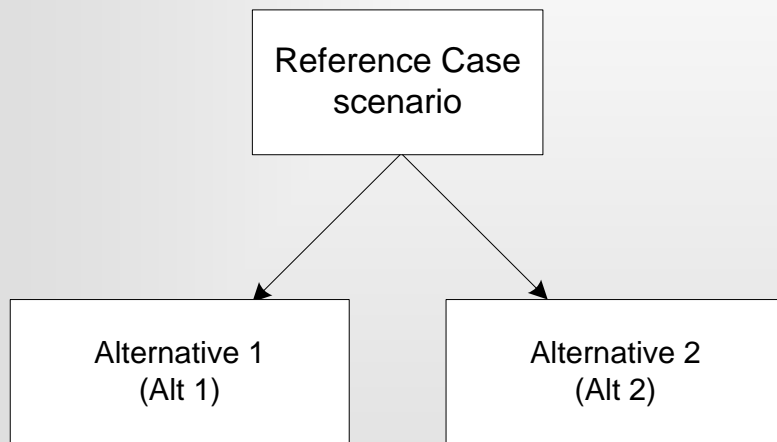
- Electricity import from and electricity export to other Italian regions exogenously set (mono regional approach);
- Electricity import from Switzerland exogenously set:
 - $E_{i,r} \leq$ (upper bound)
 - $E_{e,r} \geq$ (lower bound) (base scenario)
- Import of primary and secondary commodities set as free variables:
 - Certainty of supply
 - No energy competition among regions or countries

LOCAL vs GLOBAL



SCENARIOS

Goal: to compare different evolutions of the local energy system subject to different environmental policies.



Three scenarios:

- Reference Case
- Alt1
- Alt2

SCENARIOS

Scenario BaU: describes a system evolution taking into account the most important new regional regulations *already* scheduled about energy and environmental topics. (No environment constraints);

Scenario Alt1: maintains the same structure and the same assumptions of reference case but includes a constraint on the CO₂ emission according to The Commissions "20 20 by 2020" policy target. (flat rate).

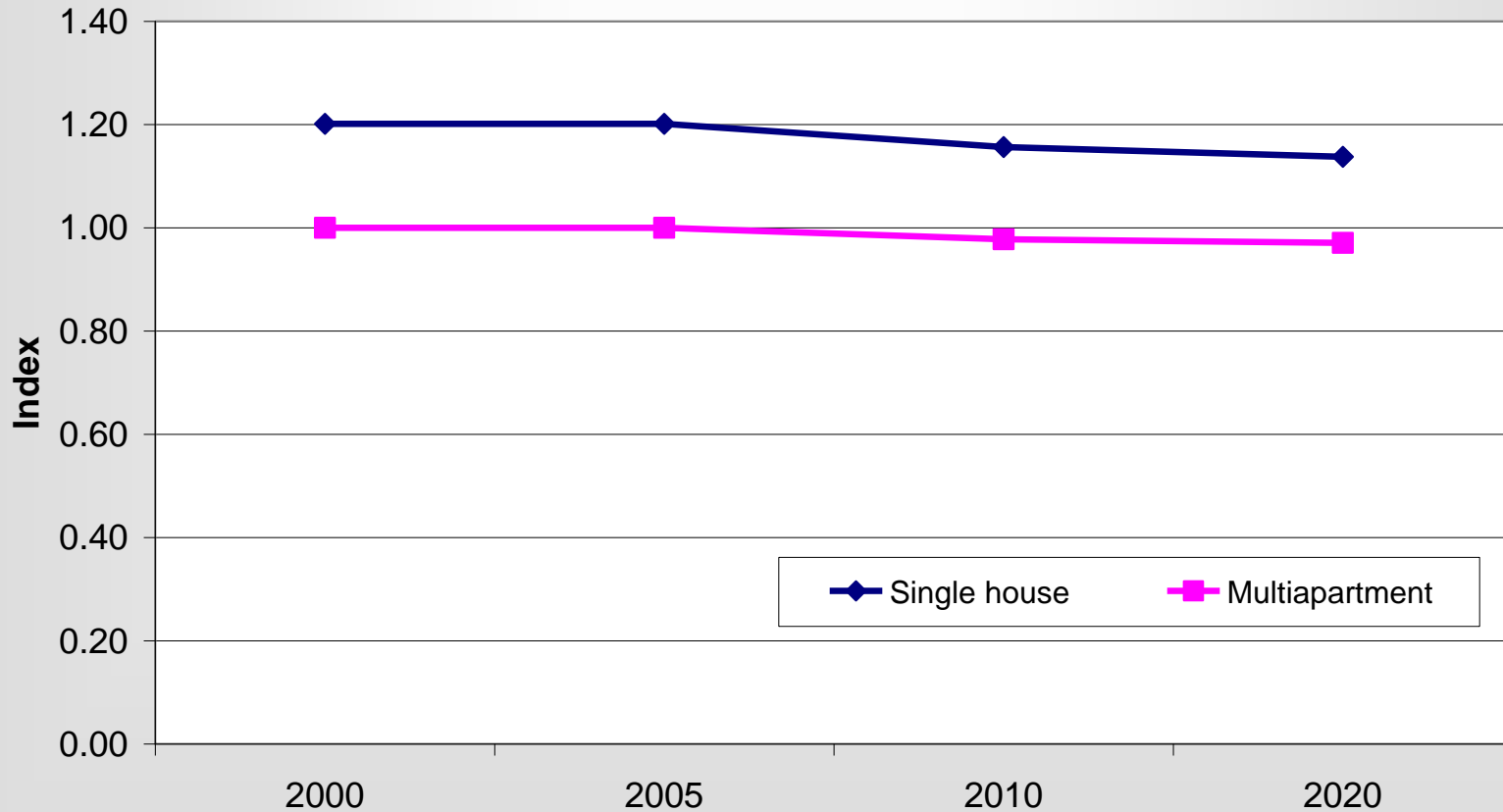
Scenario Alt2: describes the same structure and the same assumptions of BaU but includes a different constraint on the CO₂ emission (wider than the previous one).

SCENARIOS

Target Scenario Alt1	47000 (kt)	
Target Scenario Alt2	ETS	Others
CO ₂ Emissions (2005)	24628	46172
Average European Target / National Target	-21,5%	-13%
Target by 2020	19333	40170
<i>Total</i>	59500 (kt)	

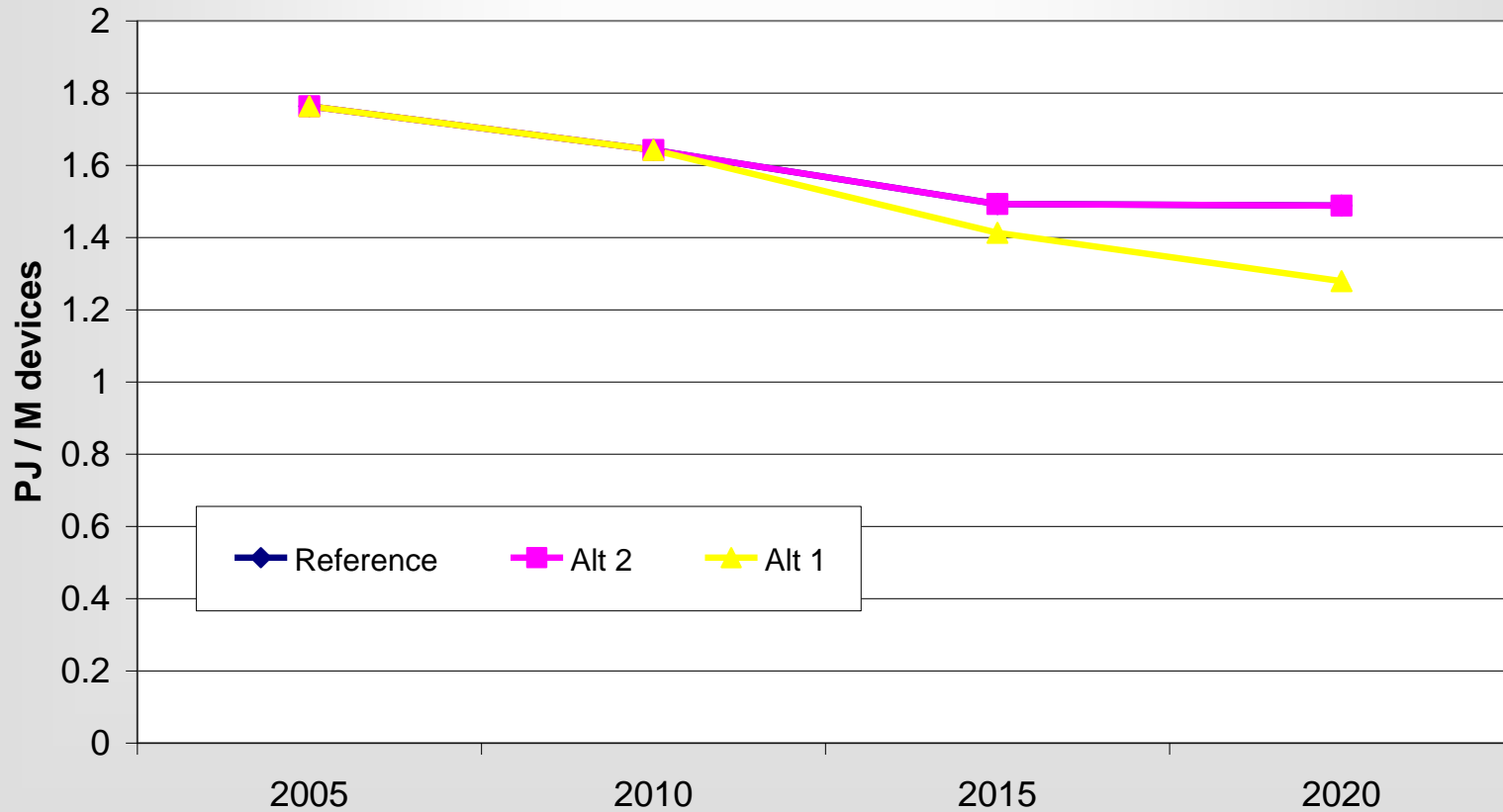
RESULTS

Energy requirements in buildings for space heating



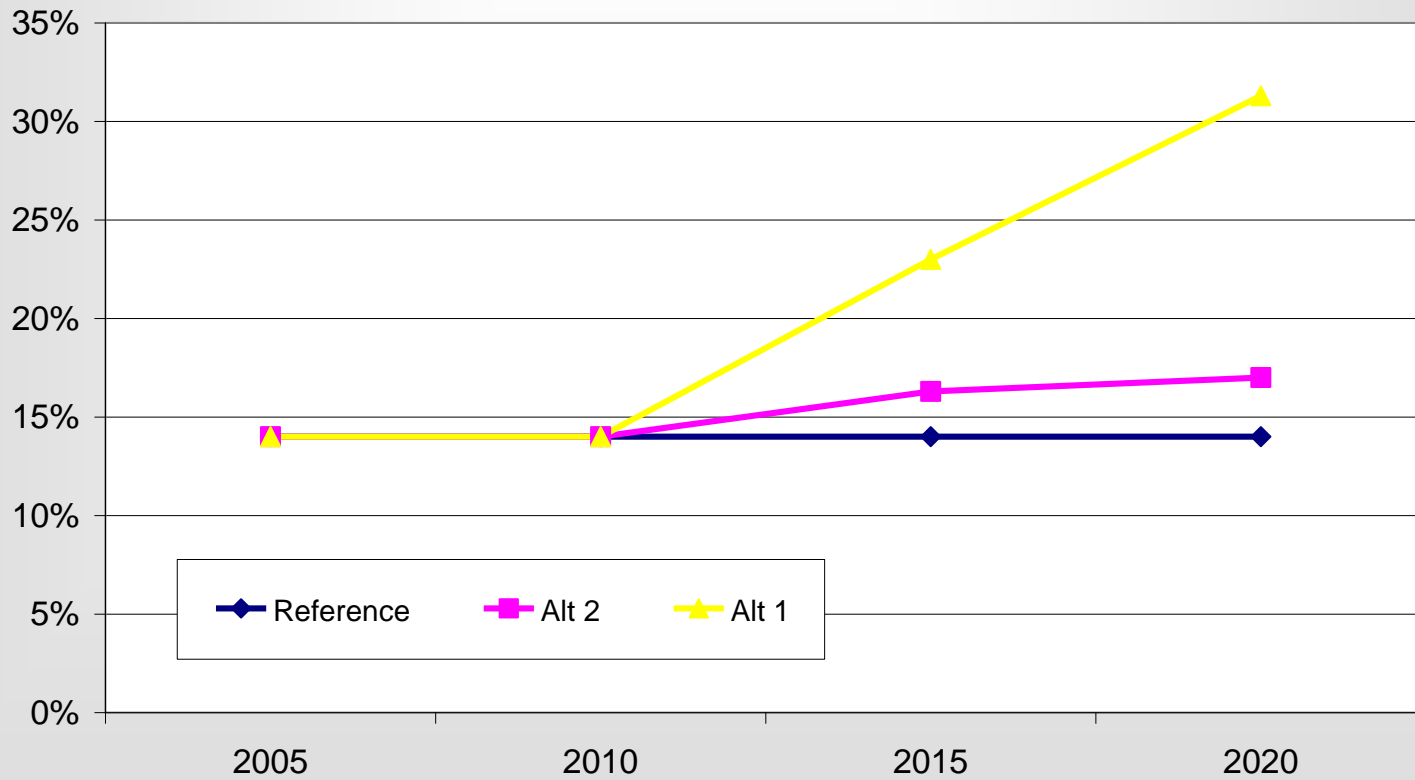
RESULTS

Specific Consumption (dishwashers)



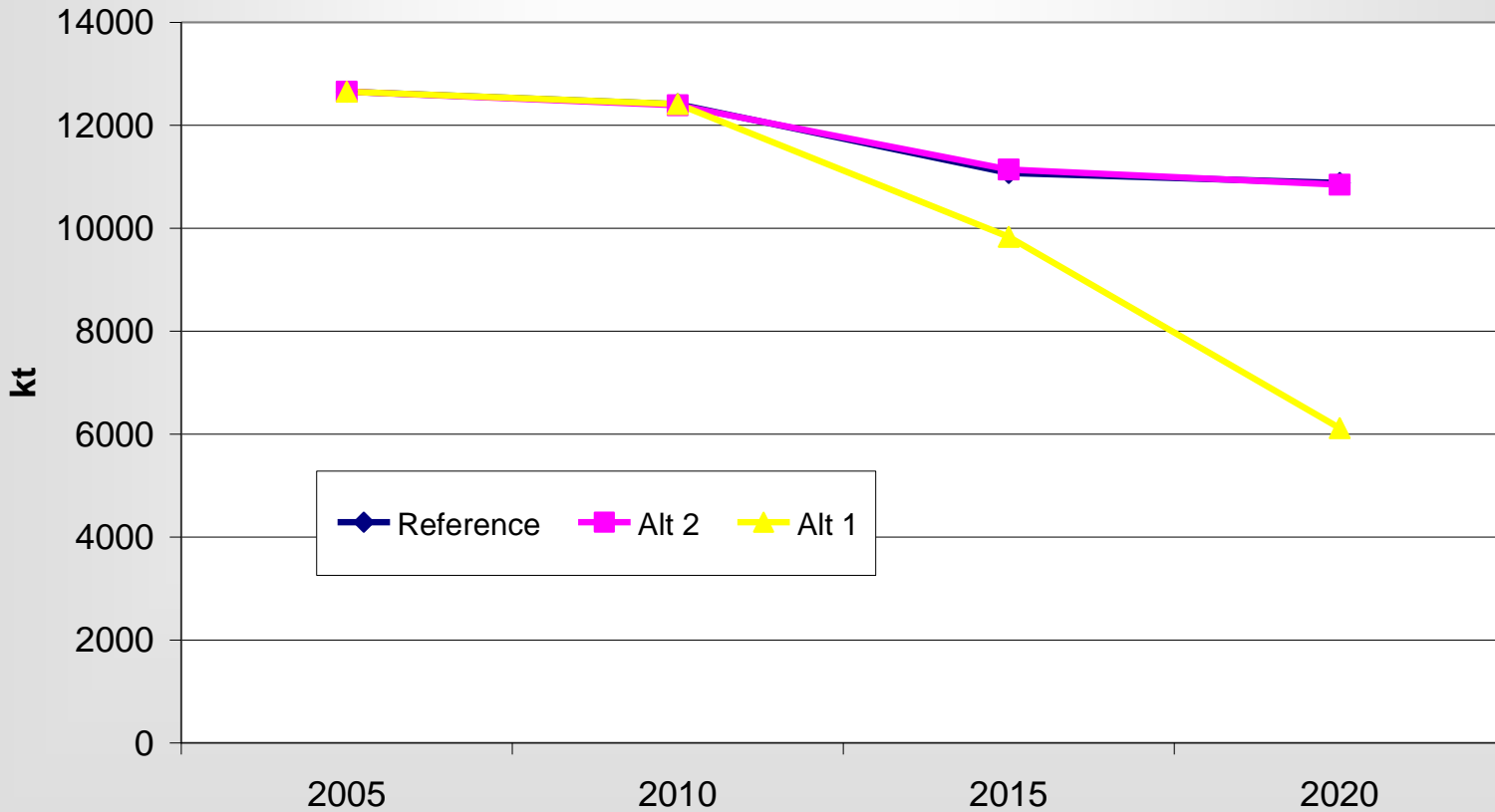
RESULTS

Renewables (Fractions)



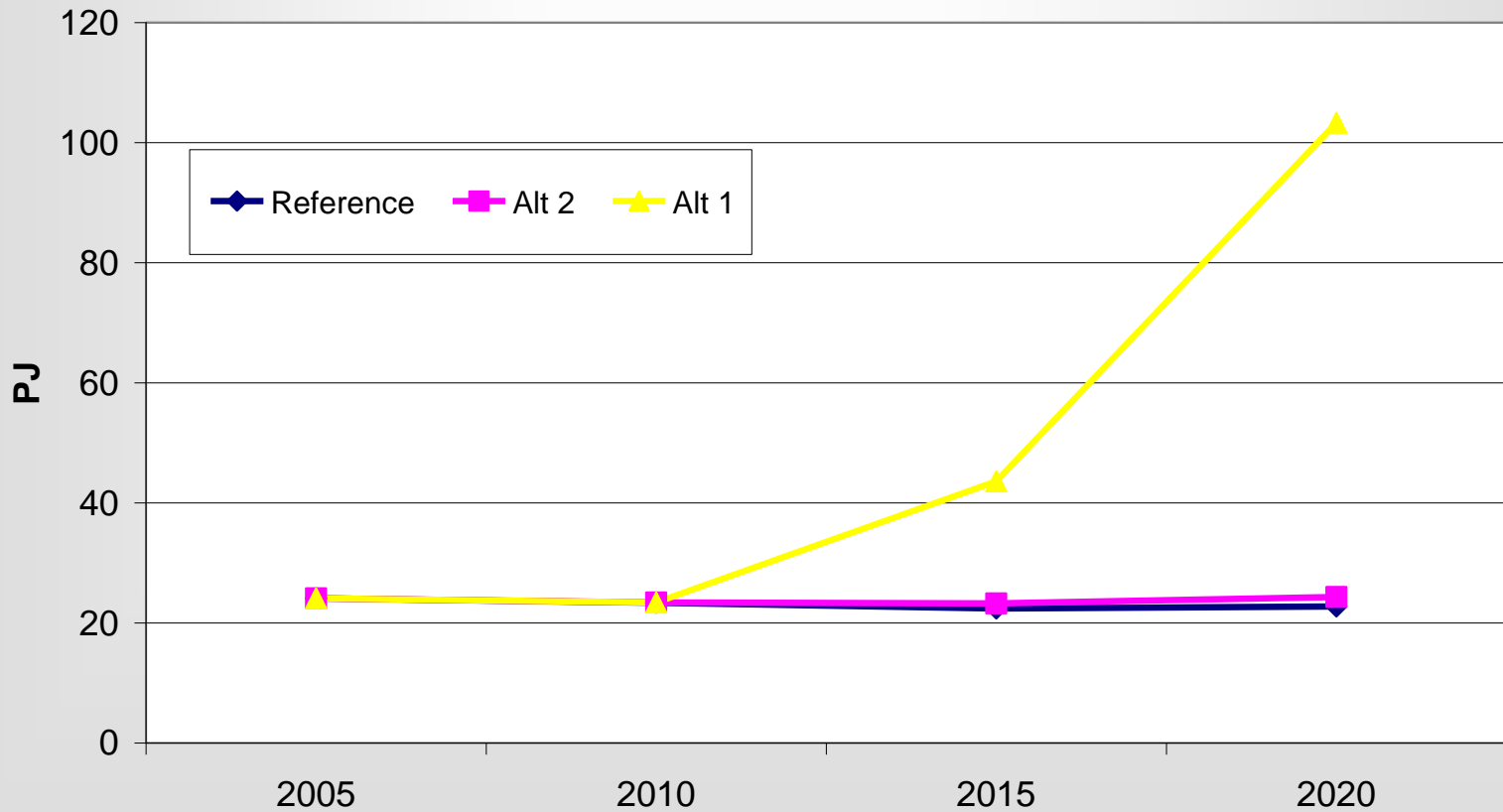
RESULTS

CO2 emissions in residential sector



RESULTS

Biomass consumption in residential sector



COMMENTS

Overconstraining

The environmental target forces the system to use renewable energy sources, as the only way to reduce the CO₂ emissions.

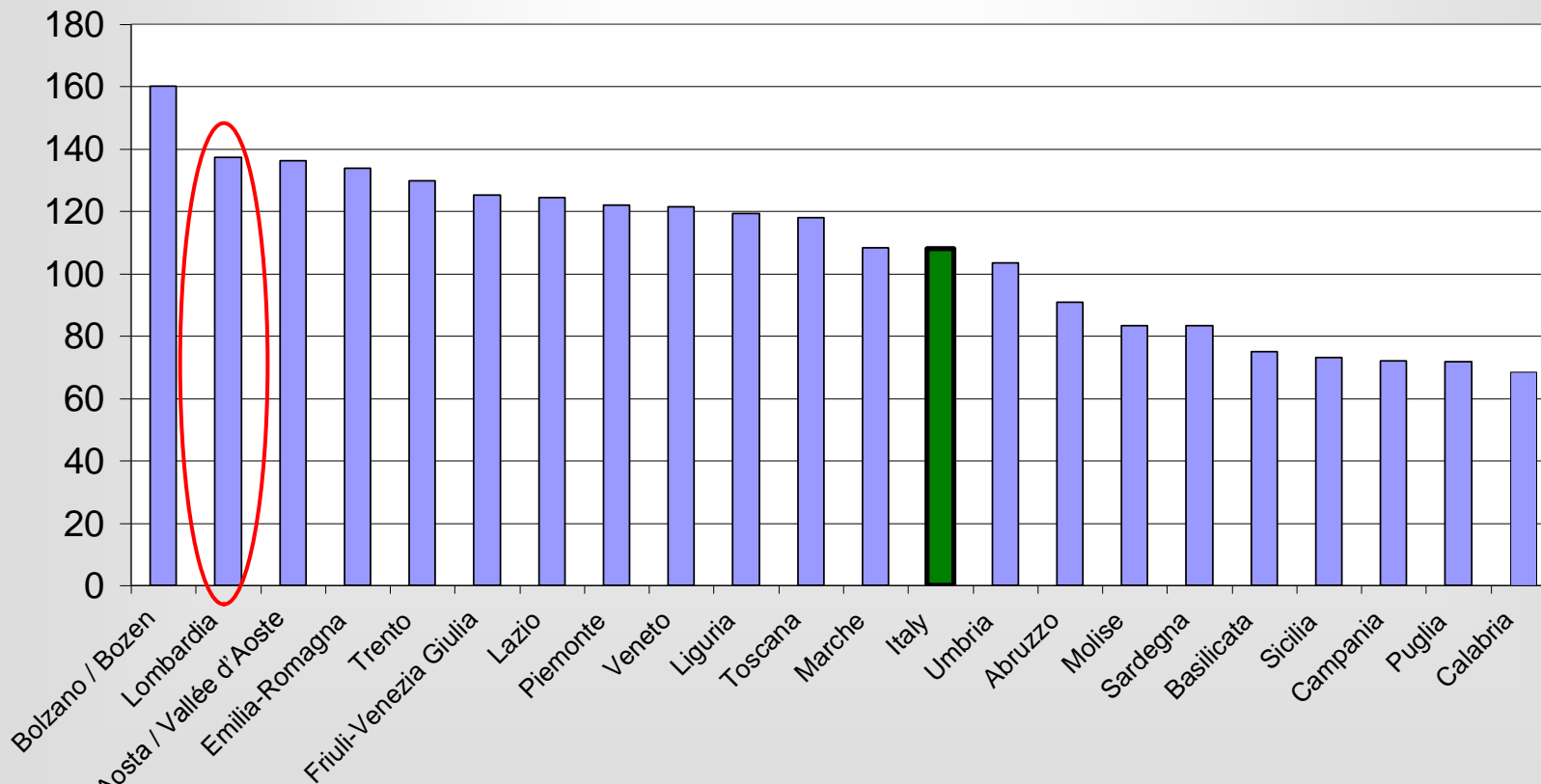
Concurrent legislation

In spite of the modeling of the most optimistic developments for demand sectors, system saturates all the new technologies (new options for each energy service) and also needs important changes in the electricity supply.

(inport/export + 50 PJ in comparison to the Reference scenario)

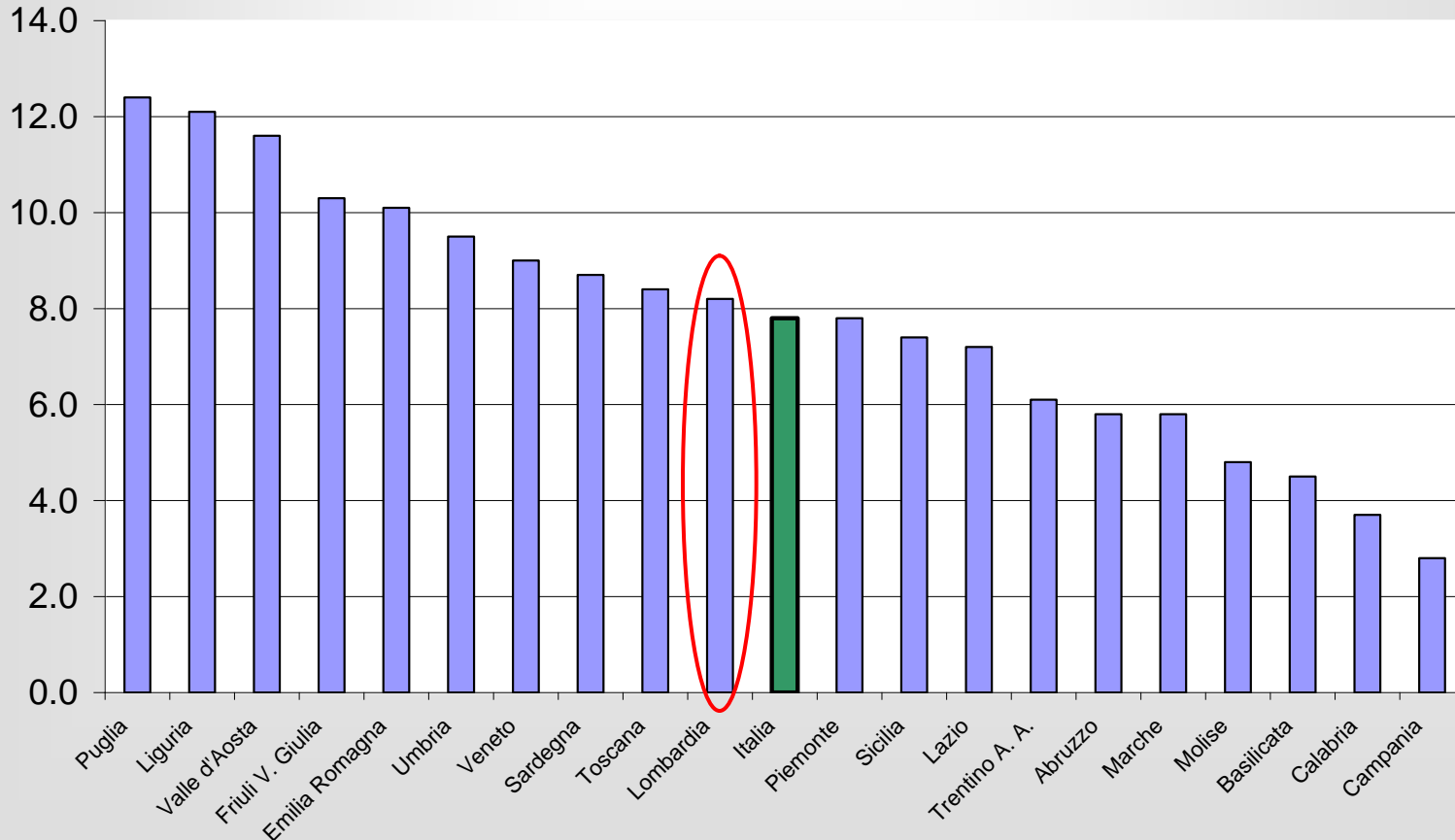
COMMENTS

GDP per inhabitant 2003 [Index (Italy = 107.9)]



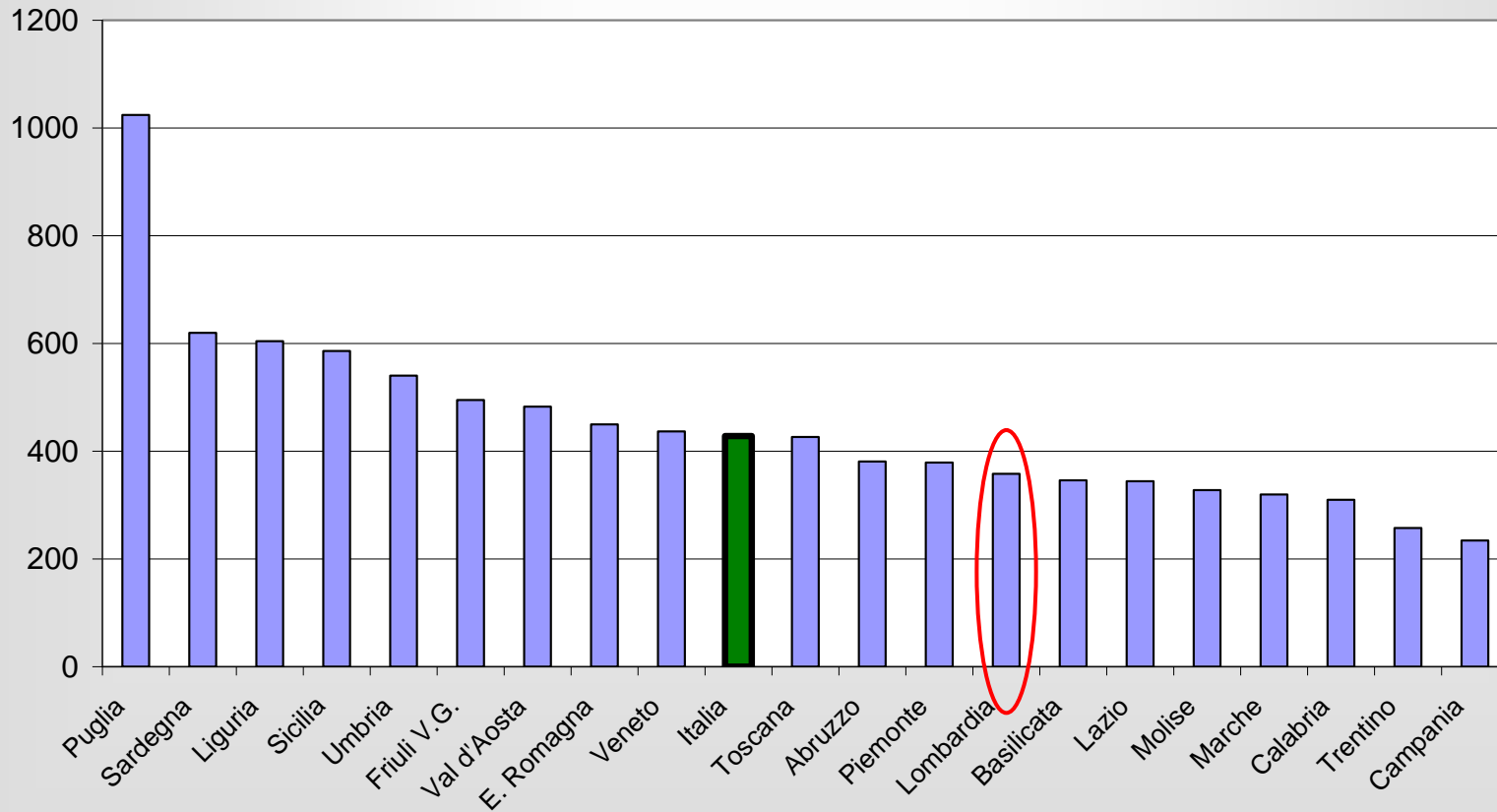
COMMENTS

Regional indexes (tCO₂ per inhabitant)



COMMENTS

tCO₂ / MEuro



COMMENTS

- Analysis of different burden sharing criteria to manage at regional level the national or the European targets (emissions).
- Analysis of supply of primary and secondary commodity trades among Italian regions and European countries.
 - mono-objective optimization of a multiregional model
- Evaluation of technologies characterized by a high capital intensity and/or constrained by a national regulations.

COMMENTS

Next steps:

Merging of two mono-regional models (Piedmont and Lombardy) in order to create a small multiregional model (2) for testing some specific targets in a *cooperative approach* in comparison to the single regional models.

Development of an Italian multiregional model starting from the existing TIMES-MATISSE (electricity system) model in collaboration with CESI Ricerca Spa.

Activity has been developed by:

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Thank you for your attention!