Exploring the Italian energy future: a comparison between models

by

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Research Targets

To draw some energy and CO2 **scenarios** for Italy

To measure the **distance** from the Kyoto target

To study the results of
the **CEPRIG** and the **MARKAL** models
understanding

- **how much they differ**
- **where they differ**
- **why they differ**

The CEPRIG Model

CEPRIG: Calculation of Emissions and Policies for the Reduction of Italian GHGs

A System Dinamics Model

4 Main "Boxes":

A) Industry, Residences, Services, Agriculture
B) Electric Sector
C) Transportation
D) Non Fuel Combustion GHGs

CEPRIG Structure

3 Key variables:

Activity Level
Energy Intensity
Energy Mix

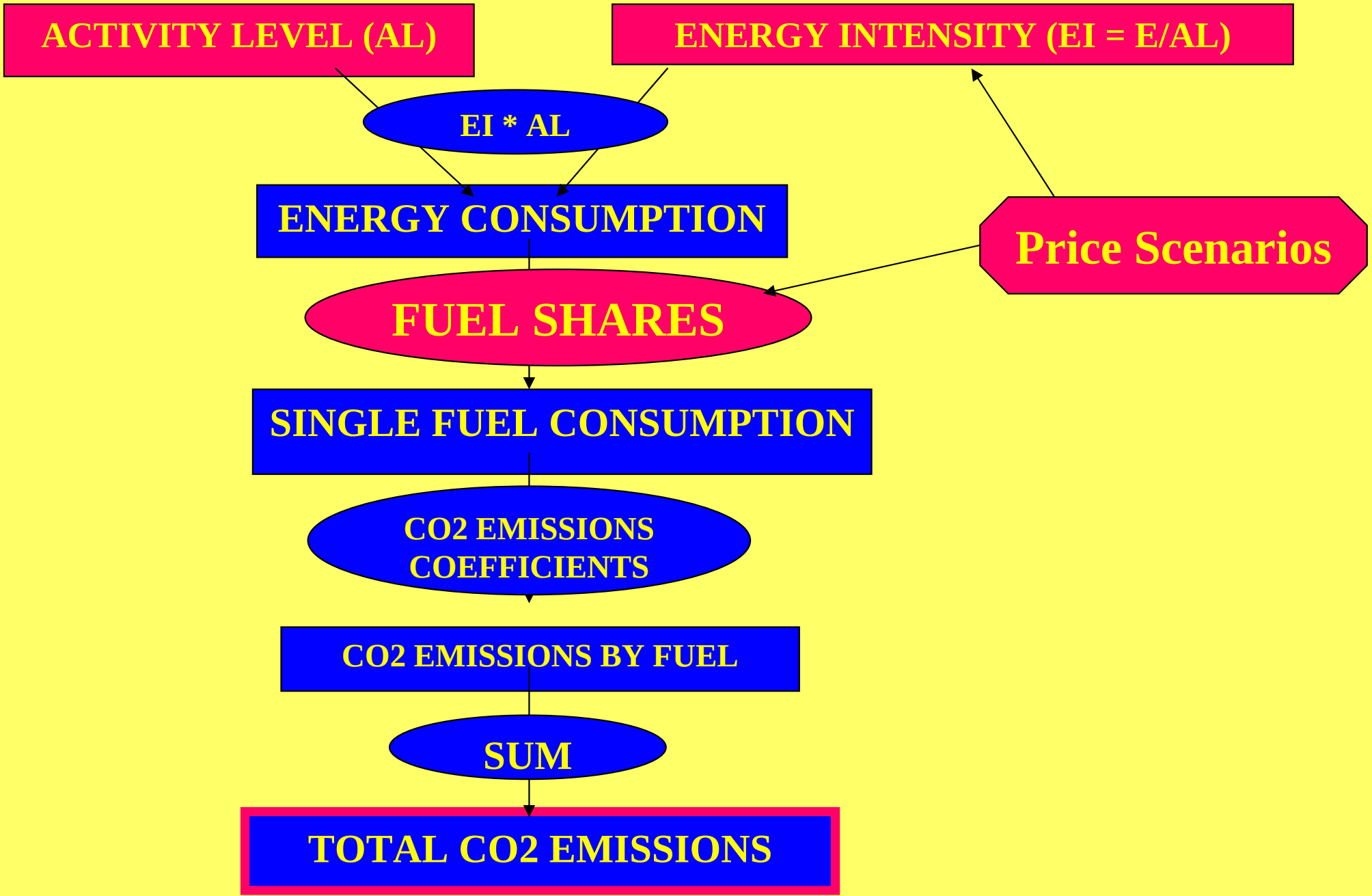
modelled on the basis of:

Statistics and econometrics Analysis
(Italian Energy Balances:1965-1998)

Interact with:

Energy price scenarios

CEPRIG Structure



ELECTRIC SECTOR

Considers more than 200 power generation plants, grouped by technology (14 kinds of plants: CCGT, Gas Turbines, Coal, Hydro, Renewables, etc.)

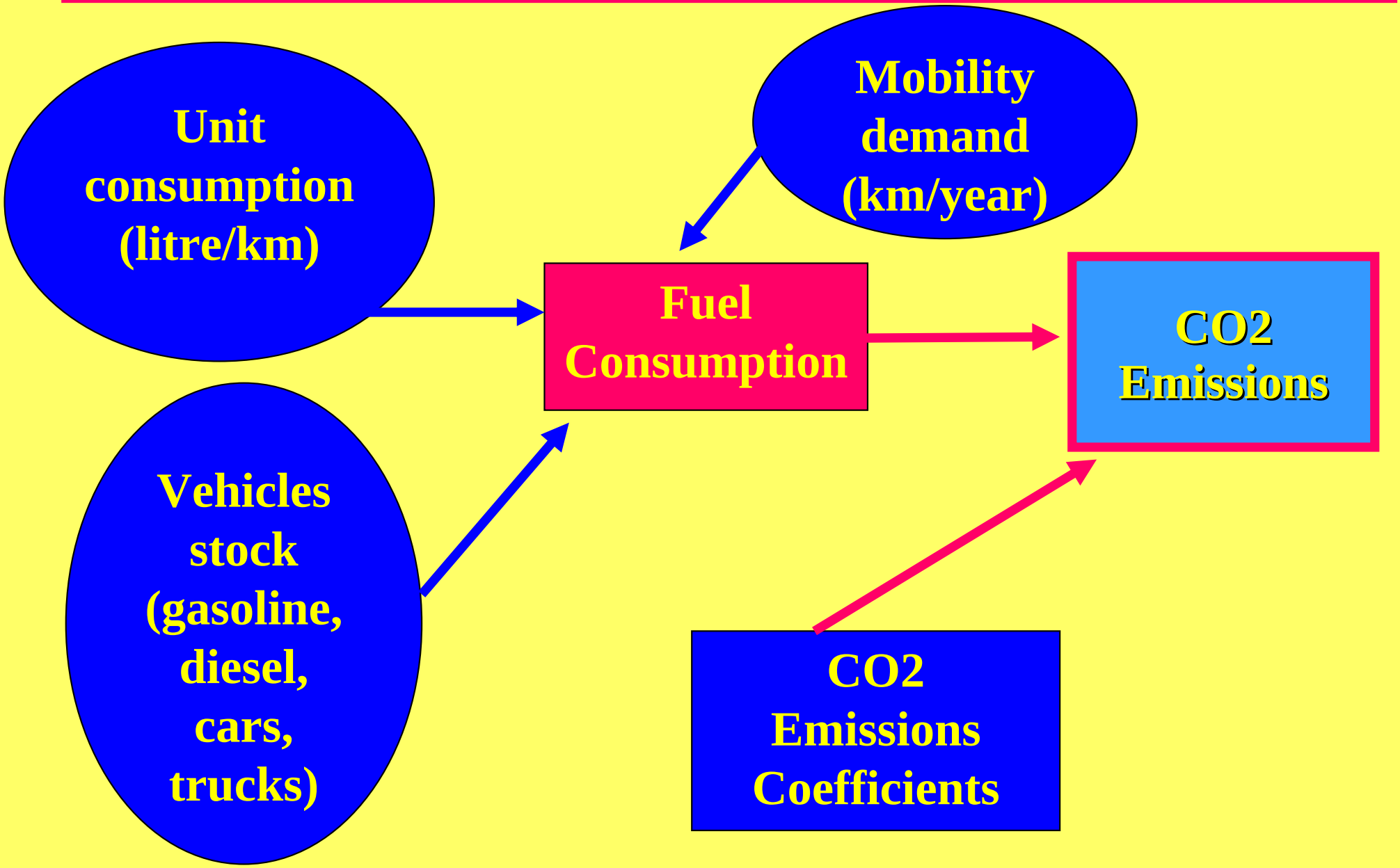
Traditional Fuels: Natural Gas, Coal, Fuel Oil

Virtual Fuels: MEF (Most Economic Fuel), GT (MEF + natural gas)

Efficiency and load: available or estimated

Functioning: given an electric demand, plants are activated according to an electric stock market

TRANSPORTATION



The MARKAL Model

MARKet ALlocation

BOTTOM - UP technical economic model developed in its general form by IEA

The present version of the Markal-Italy model evaluates potential and costs of reducing CO_2, NO_x and SO_x emissions

METODOLOGY

The model contains variables representing material and energy flows and emissions.

A certain environmental constraint has to be reached by the model, regardless of its costs.

Traditional Fuels: coal, oil and natural gas, production of biomass and biodiesel

Renewable Fuels: solar thermal, photovoltaic and wind energy

METODOLOGY

GHGs EMISSIONS

Emissions **associated with fuel use are also calculated and a detailed representation of abatement technologies is also included in the fuel flows representation**

The model is constrained to respect the total national emission ceilings for SO_2 **and** NO_x **by 2010 negotiated in the Gothenburg and Sofia Protocols on transbundary air pollution**

Main parameters

- **GDP: 2% till 2010, thereinafter 1.6%**
- **Population stable**

Industry and civil sectors

The industrial sector has a rather complete representation of the production processes and the available technological options of the main energy intensive materials

Industry and civil sectors

- **Markal: based on the growth of production indicators, a miscellanea of industrial production index and energy services demands in the civil sector linked with the production/use of physical goods.**

- **The civil sector: detailed breakdown of all used technologies. The driving demand is the requirement of a certain energy service: heating, cooling, washing, hot water...**

Transport

- **Average yearly increase from 2000 to 2010: 1.8% passenger - 1.6% freight (according to the updated version of the general EU forecast)**

- **vehicle efficiency is supposed to increase: MARKAL uses as reference the agreement between FIAT and Italian Environment Ministry (around +12% efficiency by 2010)**

CEPRIG GHGs Scenarios

3 scenarios, al 2005, 2010, 2020:

- **» Base (GDP: +2% year),**
- **» High (GDP: +3% year),**
- **» Low (GDP: +1% year),**

Italian GHGs Emissions:

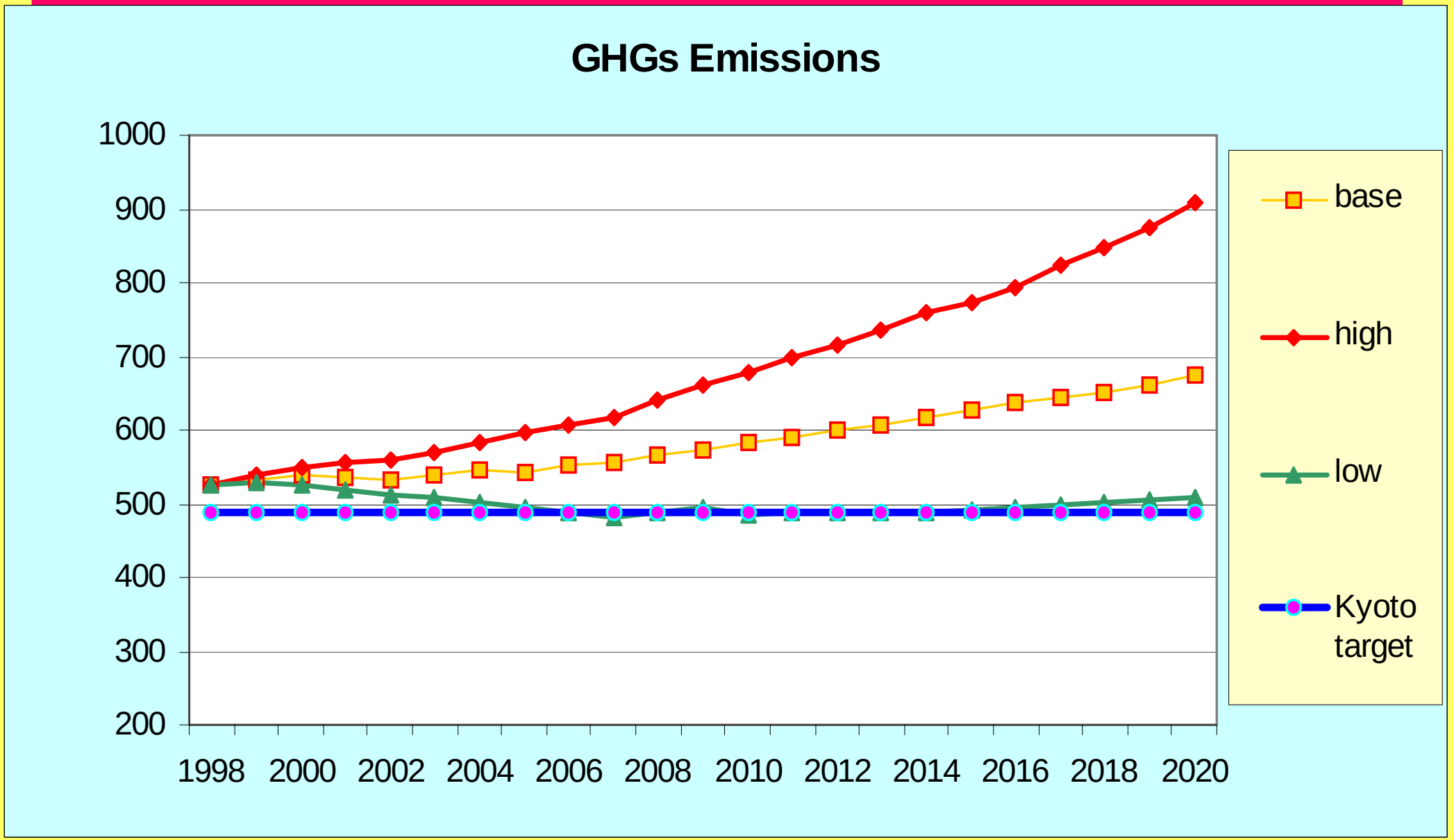
1990: 520.71 Mt CO2 Eq.

Kyoto Target : 486.73 Mt CO2 Eq.

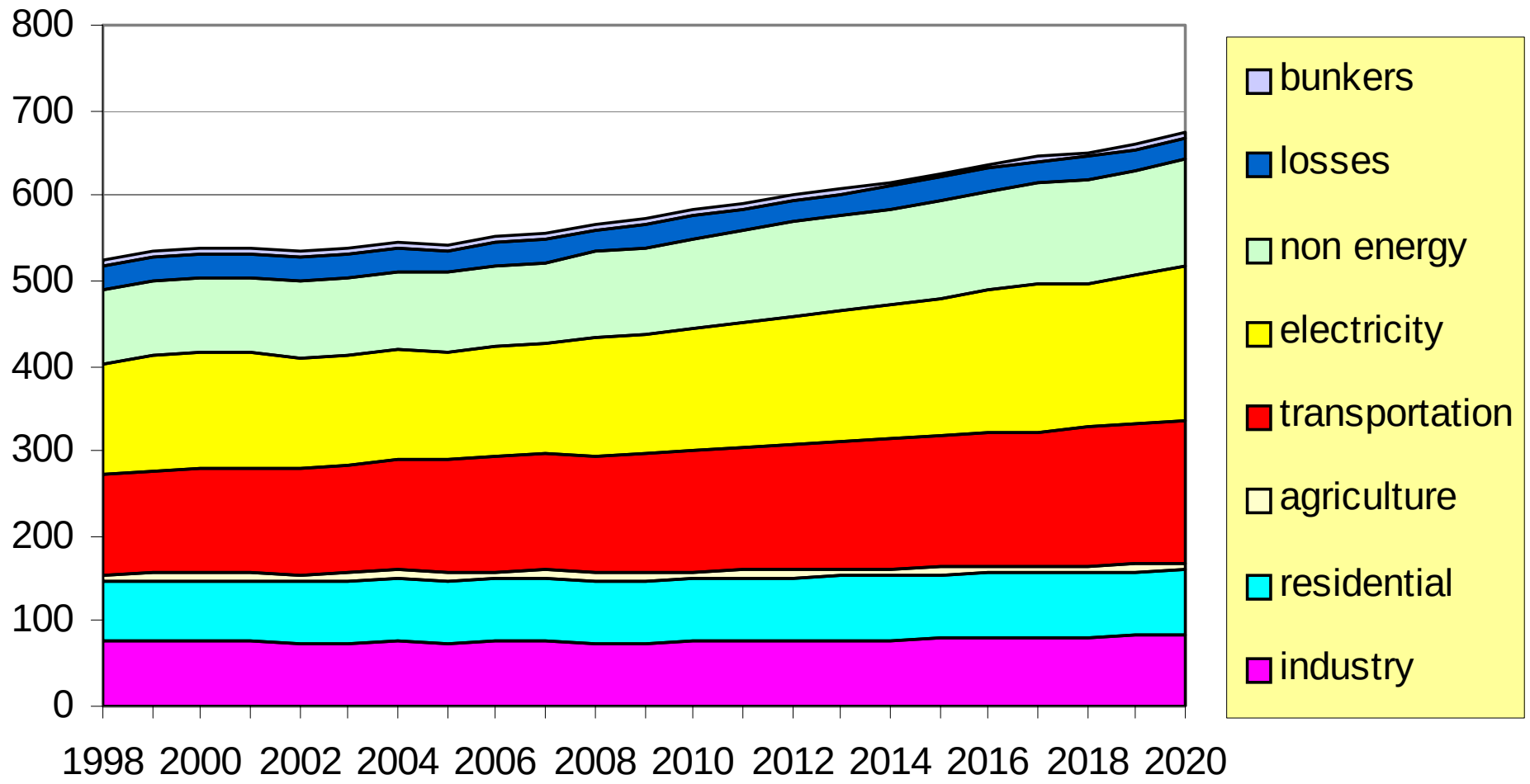
	Base	High	Low
Year 2010	581.90	677.60	485.39
Distance	95.17	190.87	-1.34

CEPRIG GHGs Scenarios

(Mton. CO_2 eq.)



CEPRIG Base Scenario
GHGs by sectors (Mton. CO2 eq)



CEPRIG
GHGs Average Annual Growth to 2010

Base Scenario :

average: + 0,8%

- **» trasportation: + 1,4%**
- **» electricity: + 1,5%**
- **» residential: +0,9%**
- **» industry: +0,66%**

Low Scenario:

average : -0,6%

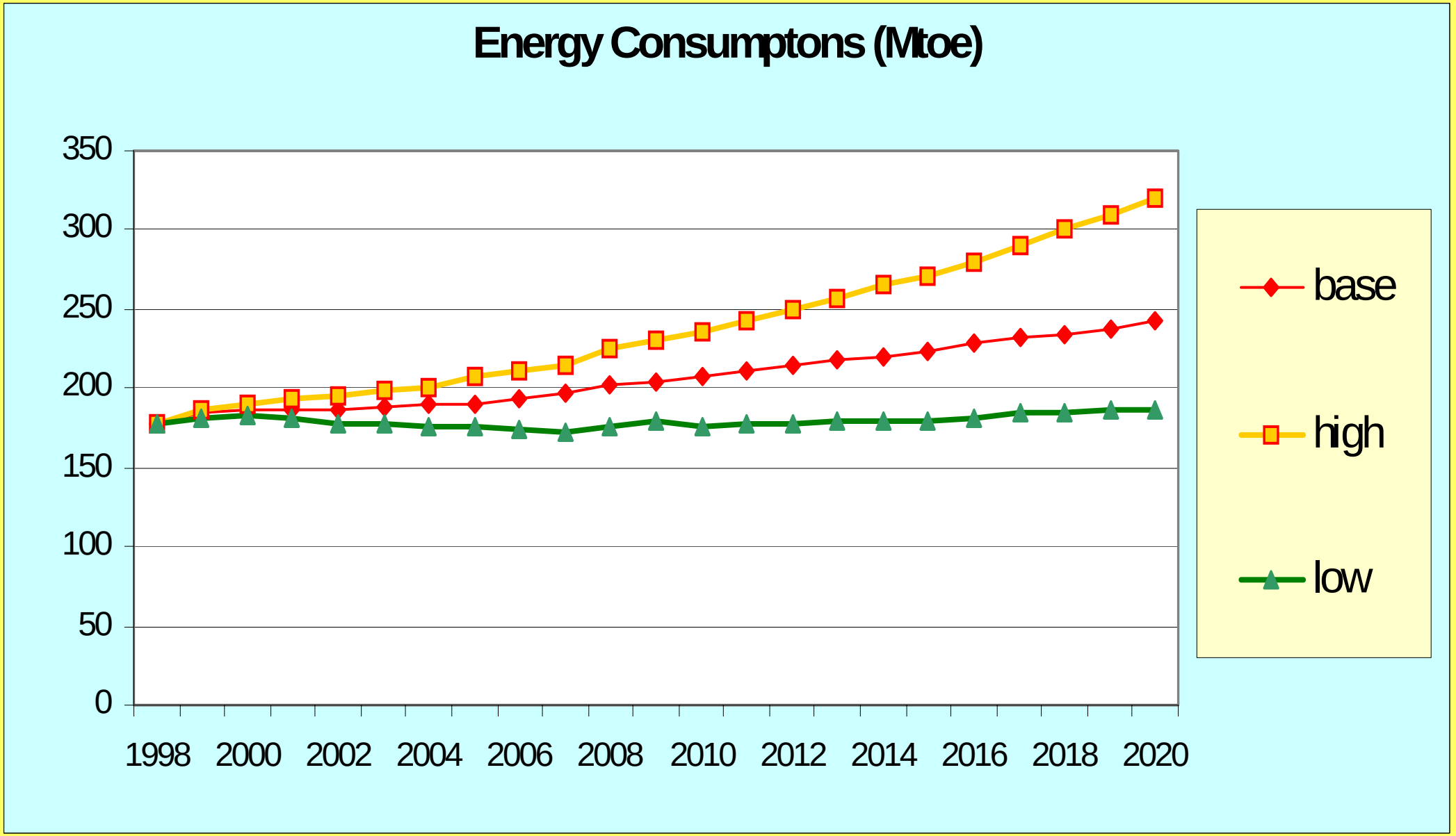
- **» trasportation: + 0,08%**
- **» electricity: -1,8%**
- **» residential: +0,02%**
- **» industry: -1,4%**

High Scenario:

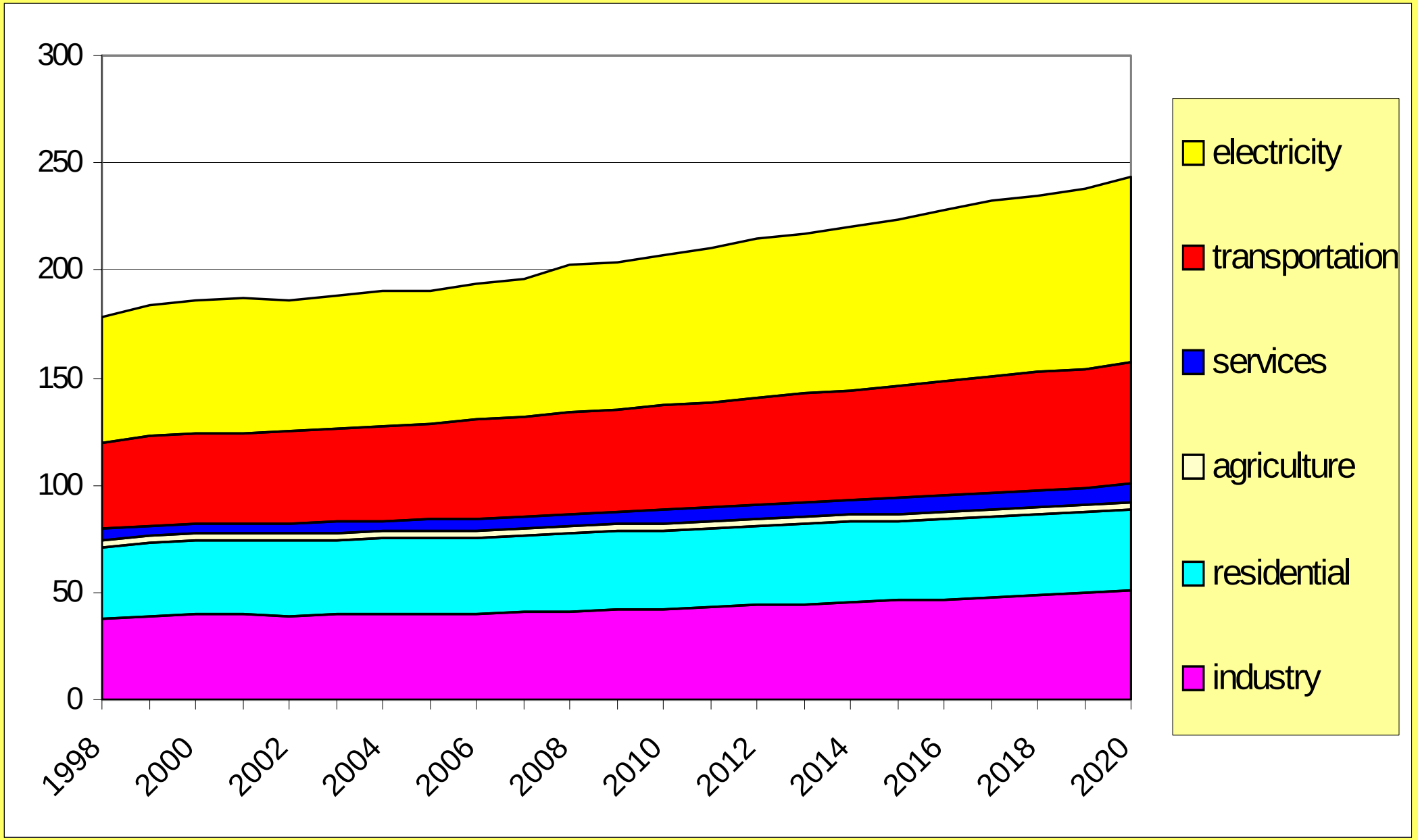
average: + 1,98%

- **» trasportation: + 2,5%**
- **» electricity: + 2,5%**
- **» residential: +1,2%**
- **» industry: +2,4%**

CEPRIG Energy Scenarios



CEPRIG Base Scenario (Mtoe)



CEPRIG
Energy Average Annual Growth to 2010

Base Scenario:

average: + 1,1%

» **trasportation: + 1,4%**

» **electricity: + 1,5%**

» **residential: +0,7%**

» **industry: +0,9%**

Low Scenario:

average: -0,06%

» **trasportation : + 0,08%**

» **electricity : - 0,13%**

» **residential : +0,2%**

» **industry: -0,6%**

High Scenario:

average: + 2,2%

» **trasportation: + 2,4%**

» **electricity: + 2,5%**

» **residential : +1,2%**

» **industry : +2,4%**

2000-2010 ceprig

	Renewables	Coal	Gas	Oil	Electricity	**Total**
Industry		-1,56%	5,55%	-8,59%	18,60%	6,60%
Transport			25,99%	15,97%	14,29%	16,37%
Agricolture			116,67%	-12,28%	-7,32%	-4,94%
Civil	-0,93%		25,95%	-51,91%	13,22%	9,88%
Non energy uses		-29,41%	-39,02%	27,93%		20,61%
Bunkers				-12,39%		-12,39%
total	**-0,93%**	**-4,67%**	**17,34%**	**5,88%**	**12,20%**	**10,27%**

2000-2010 markal

	Renewables	Coal	Gas	Oil	Electricity	**Total**
Industry	100.0%	30.9%	9.4%	-31.5%	11.2%	7.1%
Transport			164.3%	7.3%	29.1%	9.5%
Agricolture				11.8%	4.9%	10.9%
Civil	20.7%	60.0%	13.3%	-37.3%	19.8%	7.8%
Non energy uses		0.0%	-32.7%	6.5%		3.9%
Bunkers				23.4%		23.4%
total	**7.3%**	**28.5%**	**37.8%**	**-13.8%**	**-3.3%**	**5.6%**

CEPRIG-Markal Syntesis

CEPRIG Vs. Markal fuel variations.

In Ceprig

- **Stronger growth (+10.27% vs. 4.1%)**
- **More oil (+5.88% vs. - 12.4%)**
- **More electricity (+12.20% vs. -0.5%)**
- **Less gas (+ 17.34% vs. +36.4%)**
- **Less Coal (-4.67% vs. +28.5%)**

CEPRIG Vs. Markal sectors variations:

- **Industry (+6.60% vs. 9.2%)**
- **Transport (16.37% vs.7.8%)**
- **Civil (9.88% vs. 0.9%)**

CEPRIG-Markal Syntesis

- **Markal is clearer in explaining what happens and why happens**
- **Ceprig is simpler in reasoning about past-future relationships**
- **Main problem: aggregate similarities hide sectoral and fuel differences (sometimes very strong)**
- **Differences can be explained by efficiency trends, technology improvements, delocalization**

CEPRIG-Markal Syntesis

- **Case by case explanations are necessary.**
  E.g.:
- **Iron and Steel Sector: lower growth rate in Markal, but similar energy consumptions level because of losses in Markal**
- **Buildings Sector: Lower growth rate in Markal but higher energy consumptions level**
- **Chemical Sector: higher growth rate in Ceprig because of “technical” constraint in Markal**

Further investigation is needed

Thank you very much for your kind attention!