Commission ENERGY 2030

Preliminary Report

William D'haeseleer, Chair

P. Klees, Vice-Chair


PRELIMINARY REPORT
November 13, 2006
Belgium's
Energy Challenges
Towards 2030
Commissioned by
Minister Marc Verwilghen
Federal Minister of Energy

PRELIMINARY REPORT

Commission ENERGY 2030

— PRELIMINARY REPORT —

November 13, 2006

Establishment of Commission

CE2030 established by Royal Decree

of December 06, 2005
published in MB/BS of December 19, 2005

Duration of activities 18 months;
→Final report due at the latest June 19, 2007

Process Followed

Delivery of preliminary report mid November 2006

Review procedure with Review Panels

Revision of report

Then final report

Process Followed

Delivery of preliminary report mid November 2007

→ Review procedure with Review Panels

Revision of report

Then final report

Objectives

«To provide the scientific and economic analyses necessary to evaluate Belgium's options with regard to the energy policy up to 2030»

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«*To provide the scientific and economic analyses necessary to evaluate Belgium's options with regard to the energy policy up to 2030*»

…so as to assure an energy system that

- guarantees security of supply
- is environmentally friendly
- at affordable cost for society

Commission ENERGY 2030

1. Permanent Panel

W. D'haeseleer (Chair)

P. Klees (Vice Chair)

J. De Ruyck

P. Tonon

J. Albrecht

JM Streydio

Commission ENERGY 2030

2. Non-Permanent Support Members

L. Dufresne
R. Belmans
B. Leduc
S. Proost
J-P van Ypersele

J-M Chevalier
P. Terzian
W. Eichhammer

Commission ENERGY 2030

3. Advisory Member

F. Sonck

4. Ex-officio Observers

M.-P. Fauconnier (Min Econ Affairs; DG Energy)

H. Bogaert (Fed Planning Bureau)

Commission ENERGY 2030

5. Secretariate

(Min Econ Affairs; DG Energy)

M. Deprez
H. Autrique

6. Special Acknowledgement

(Fed Planning Bureau)

D. Gusbin
D. Devogelaer

Review Process

External Review Panels

- Federal-Regional Consultation Cell (CONCERE/ENOVER)
- Central Council for the Economy (CCE/CRB)
- National Bank (NB/BN) & Ass Belgian Banks
- Regulators (CREG, VREG, CWaPE, IGBE/BIM)
- Fed Council Sust Develop (FRDO/CFDD)
- Academy Council for Applied Science (BACAS)
- DG TREN European Commission
- International Energy Agency (IEA)

Approach of the study

1. Context & Issue to be Addressed
2. Scenario Analysis
3. The Broader Belgian Picture
4. Conclusions & Recommendations

Approach of the study

1. Context & Issue to be Addressed

1. Scope, Setting the Stage
2. Current Situation in Belgium
3. Challenges
4. Demand for Energy & Energy Services

Approach of the study

2. Scenario Analysis

1. Definition of the Scenarios
2. Results of the Scenarios

Approach of the study

3. The Broader Belgian Picture

1. Addl Aspects Beyond the Scenario Analysis
    1. Reality Check & Implementation Challenge
    2. Belgian Liberalized Markets
    3. Security of Supply
    4. Post-Kyoto in Practice
    5. Socio-Econ Consequences
    6. Nuclear Phase Out & Nuclear Option
    7. Energy Efficiency & Nuclear Power

Approach of the study

4. Conclusions & Recommendations

1. Conclusions
2. Comparison Climate Study (Min. Tobback)
3. Recomendations

Practical Implementation (Part 1)

Scenarios to be performed & analyzed by

Federal Planning Bureau

(follow up of earlier scenario studies with Model PRIMES)

Definition of scenarios (objectives, boundary conditions, hypotheses, technical and economic input, etc)

jointly established by permanent members of CE2030 & FPB

Contributions by non-permanent members in area of their specific expertise

Practical Implementation (Part 2)

Evaluation, interpretation and validation of scenario results by FPB and CE2030

Post scenario interpretative analysis by CE2030

Preliminary Report issued by permanent members CE2030

Major Supporting Document by FPB

Important Remark

Study focuses on longer term: **2030**

Global legal tendency taken into account (EU directives etc)

No detailed analysis of current legal & regulatory intricacies

But perceived shortcomings pointed out

Baseline Scenario

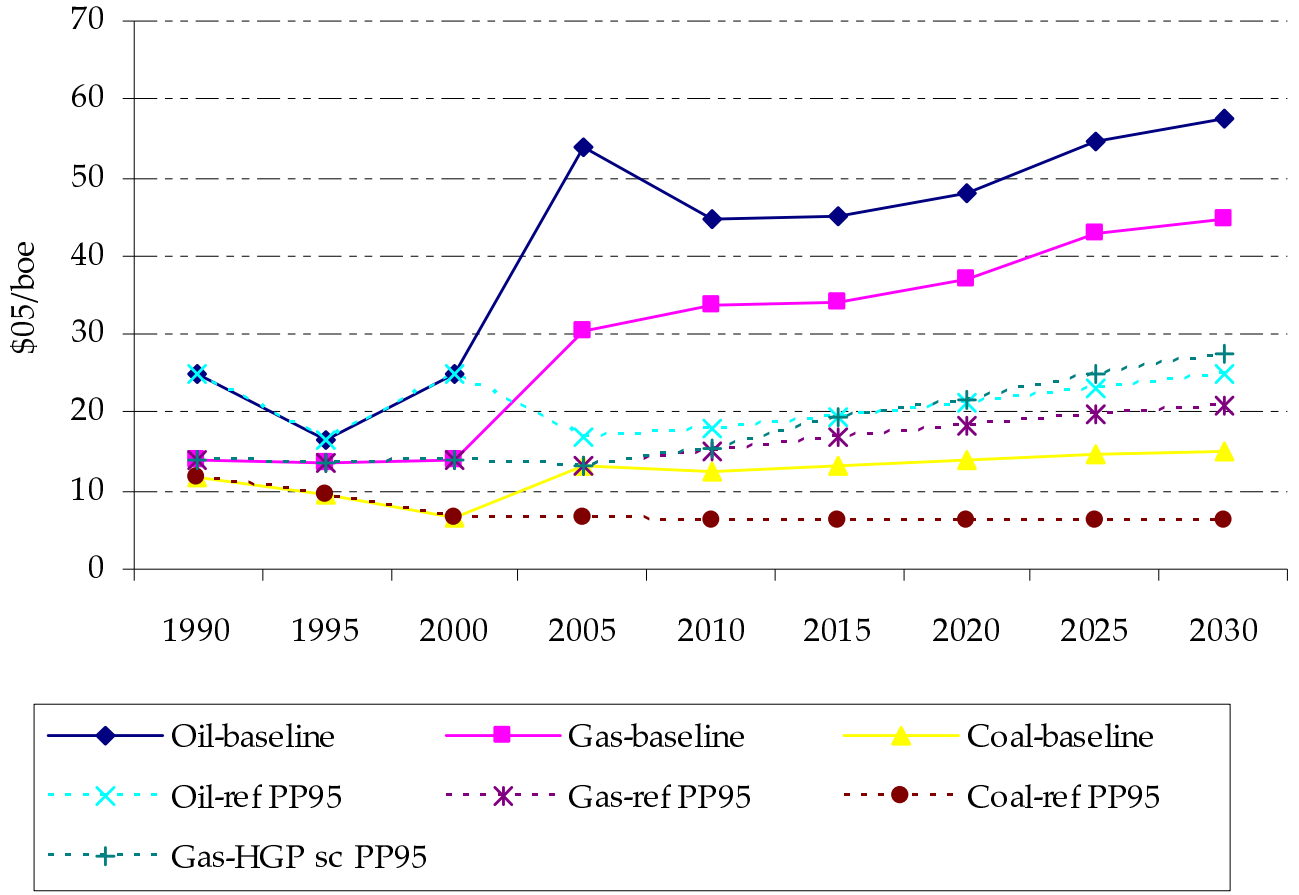
Same baseline as

- DG TREN
- Climate study (Min Tobback) – but till 2030

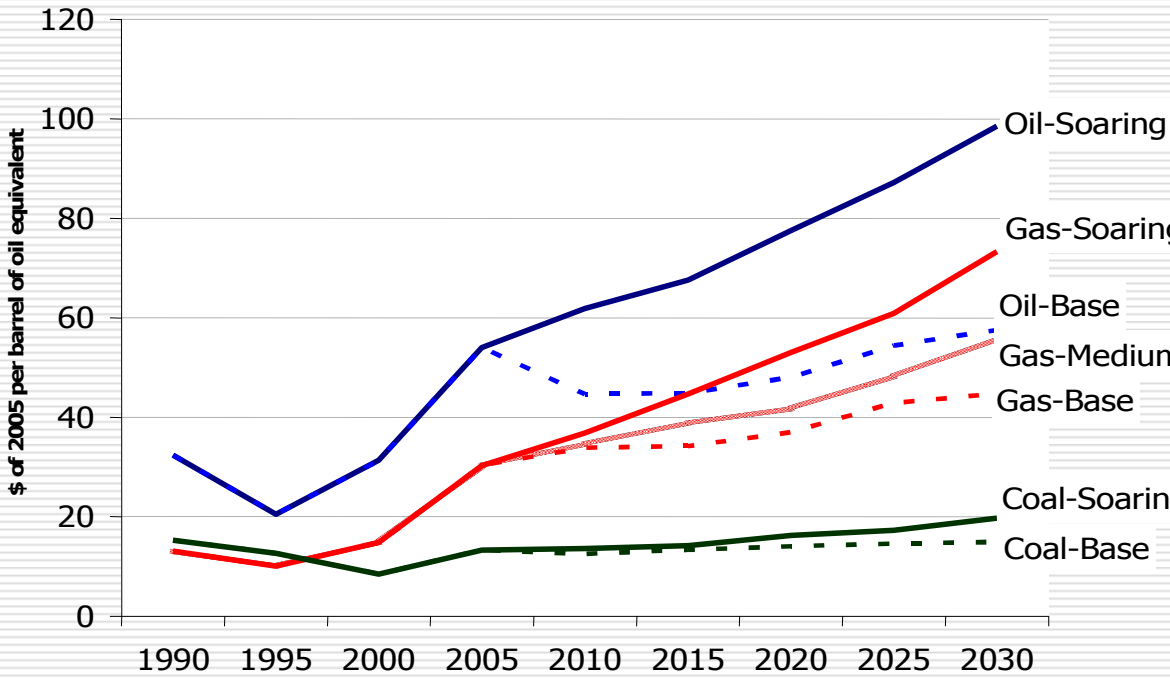
→Current measures implemented

- No-post Kyoto imposed
- Nuclear phase out implemented

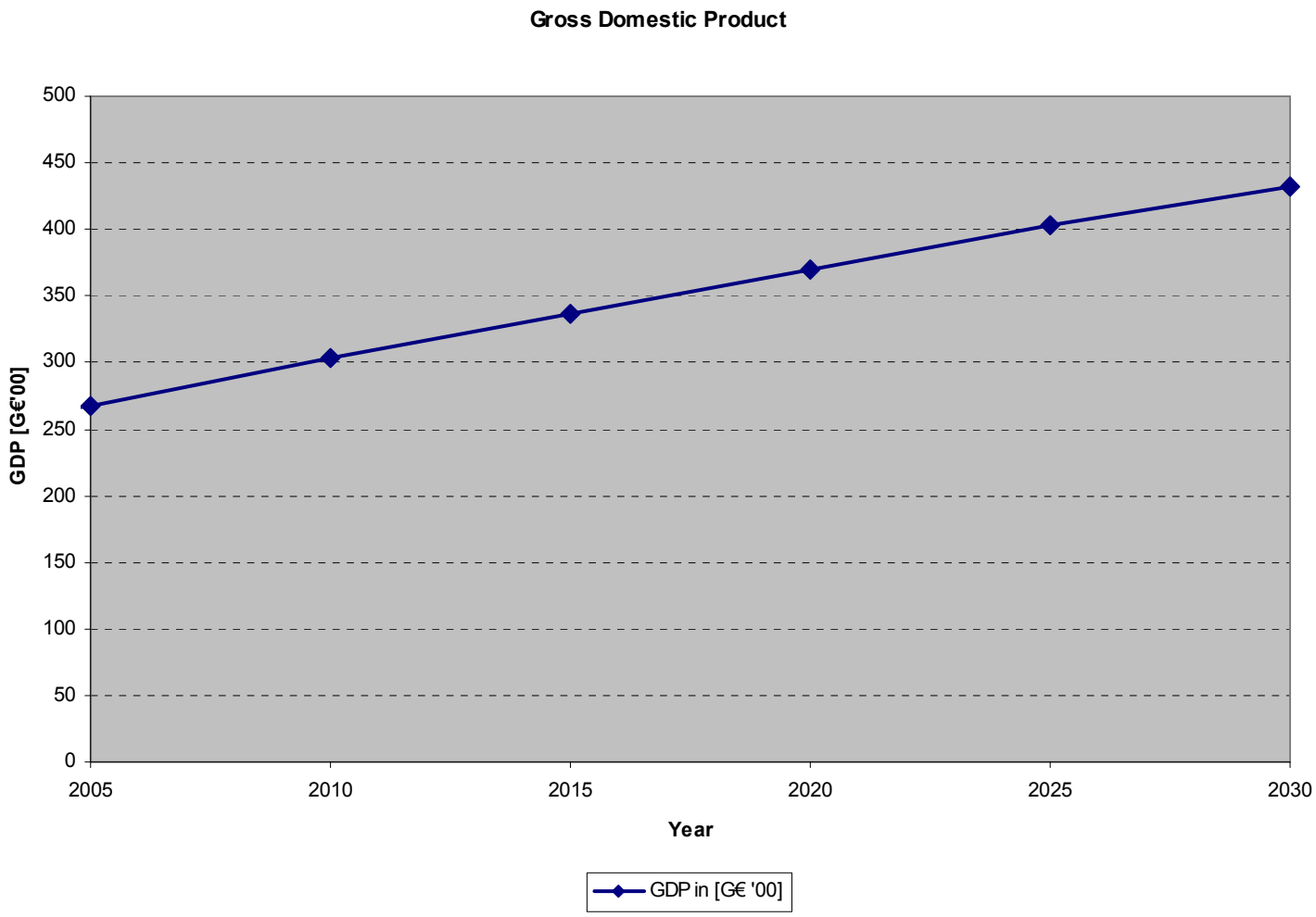
Baseline Scenario Fuel prices



Baseline Scenario – soaring variant



Baseline Scenario – GDP evolution



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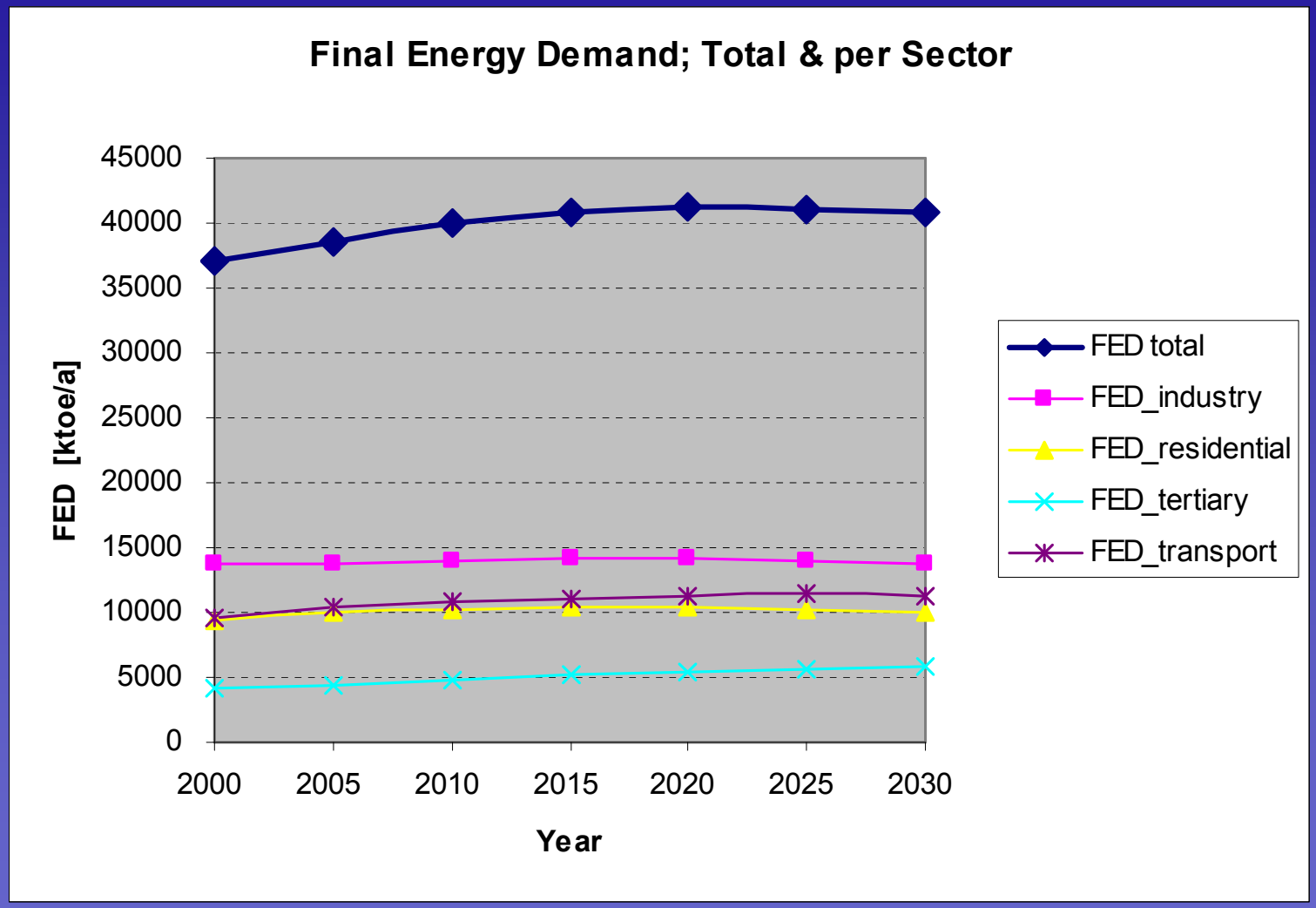

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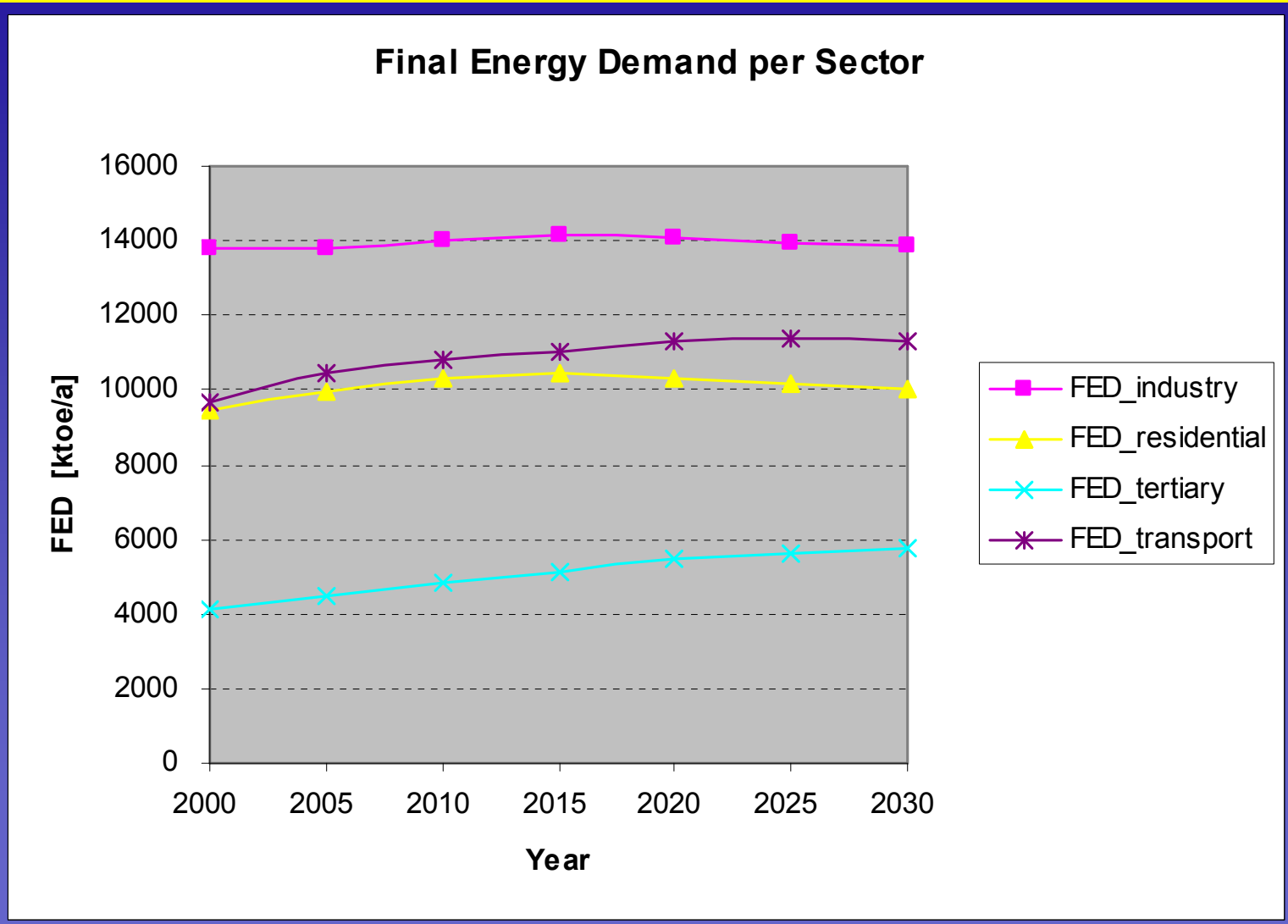

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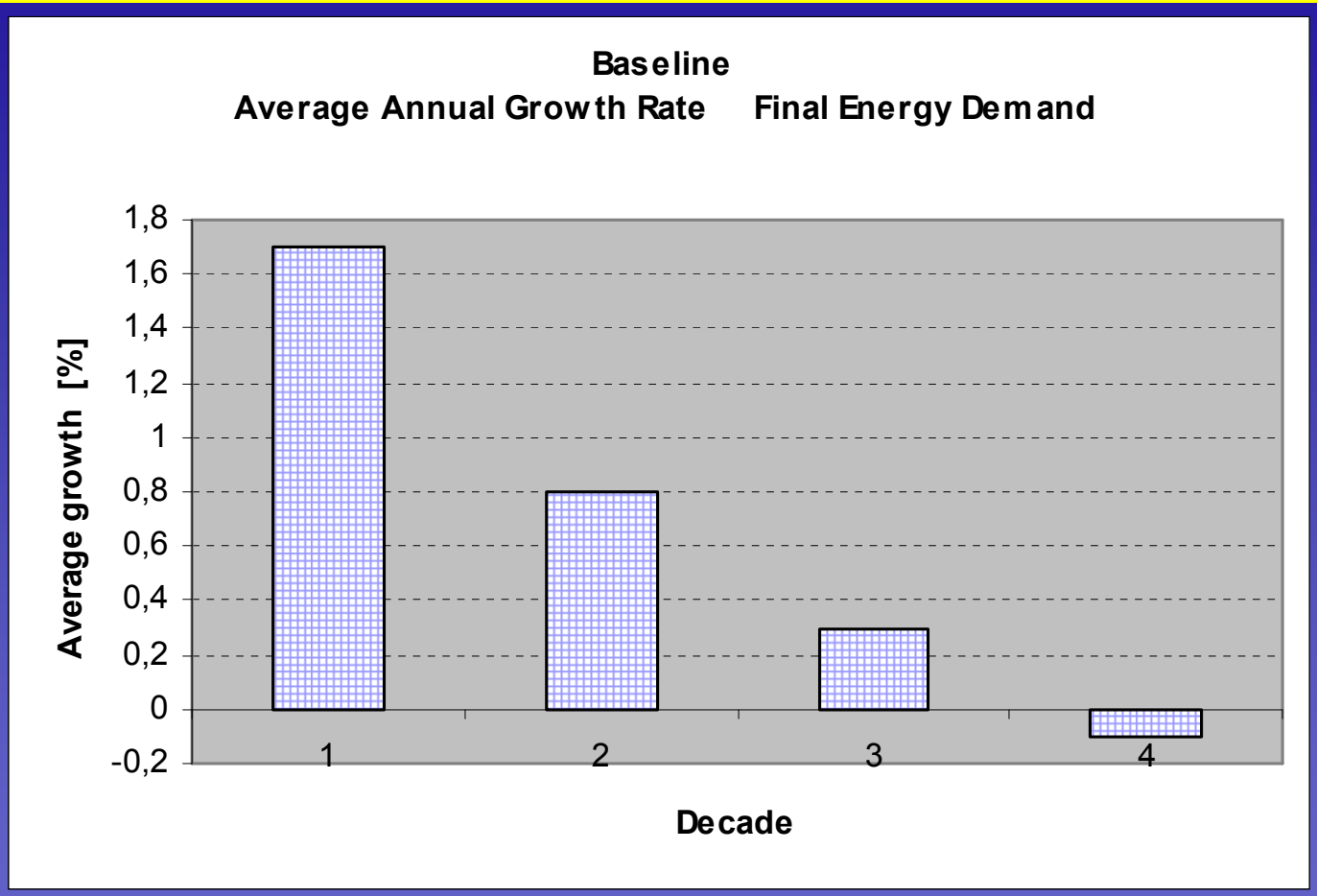
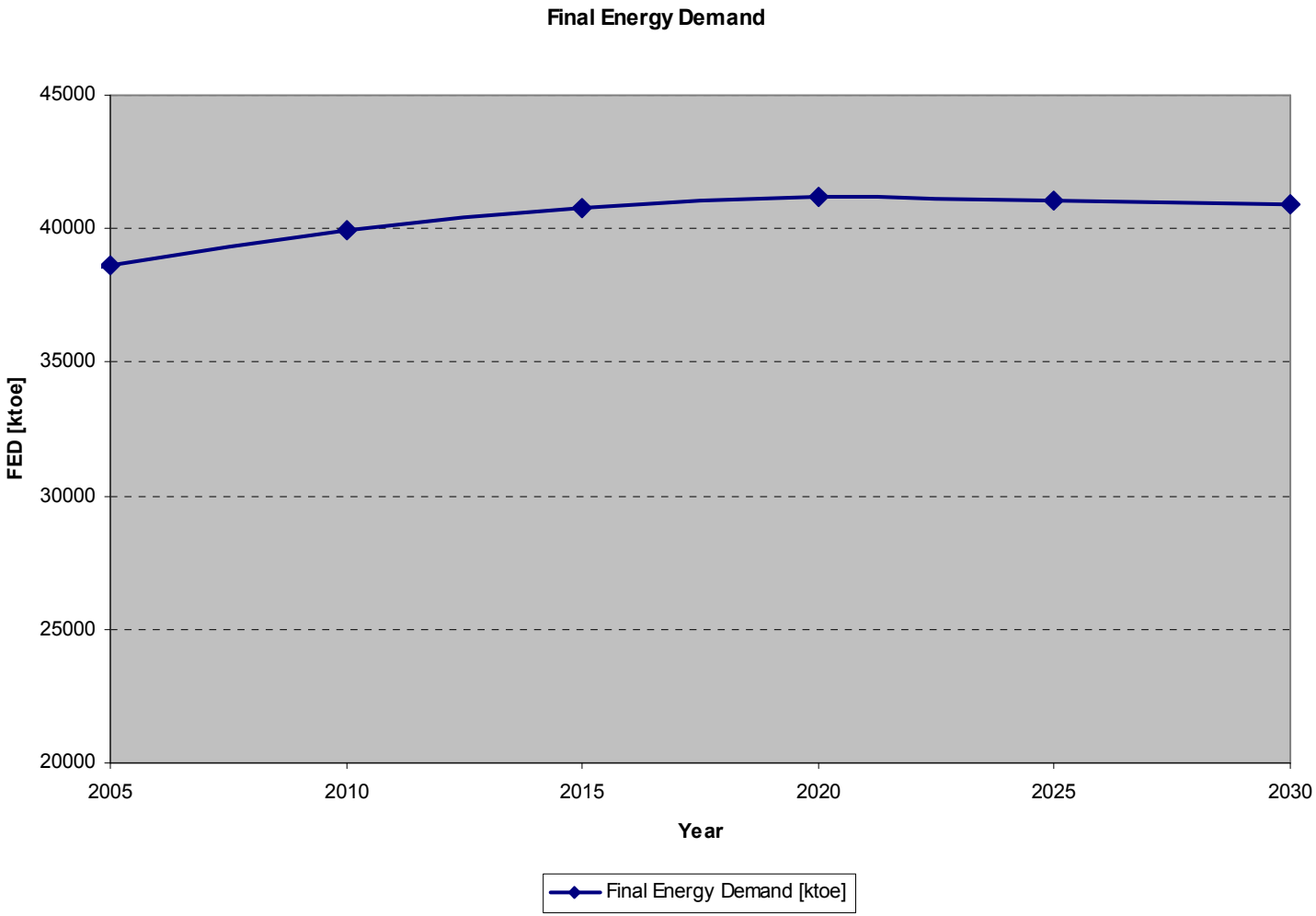
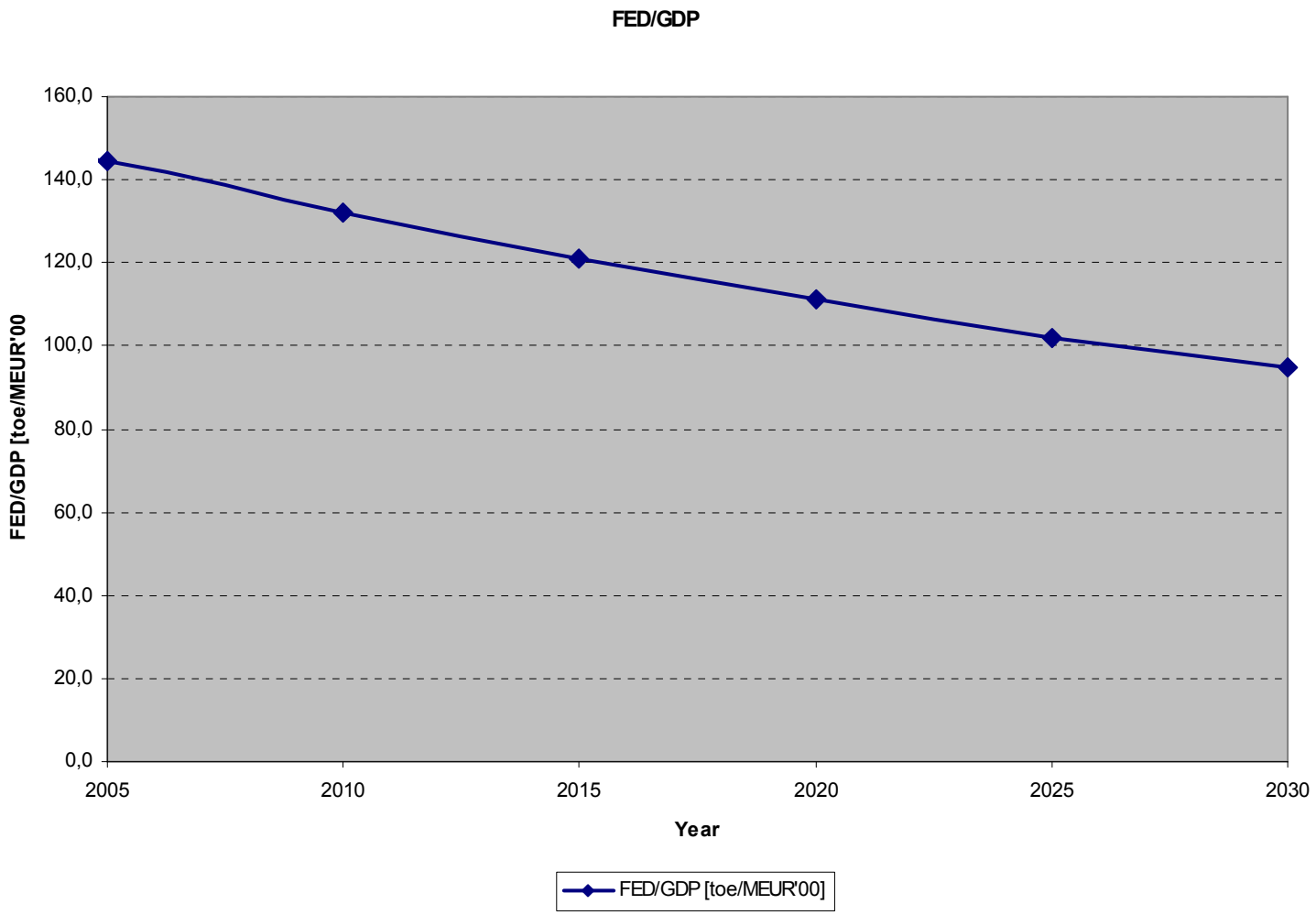


1: 1990-2000 2: 2000-2010 3: 2010-2020 4: 2020-2030

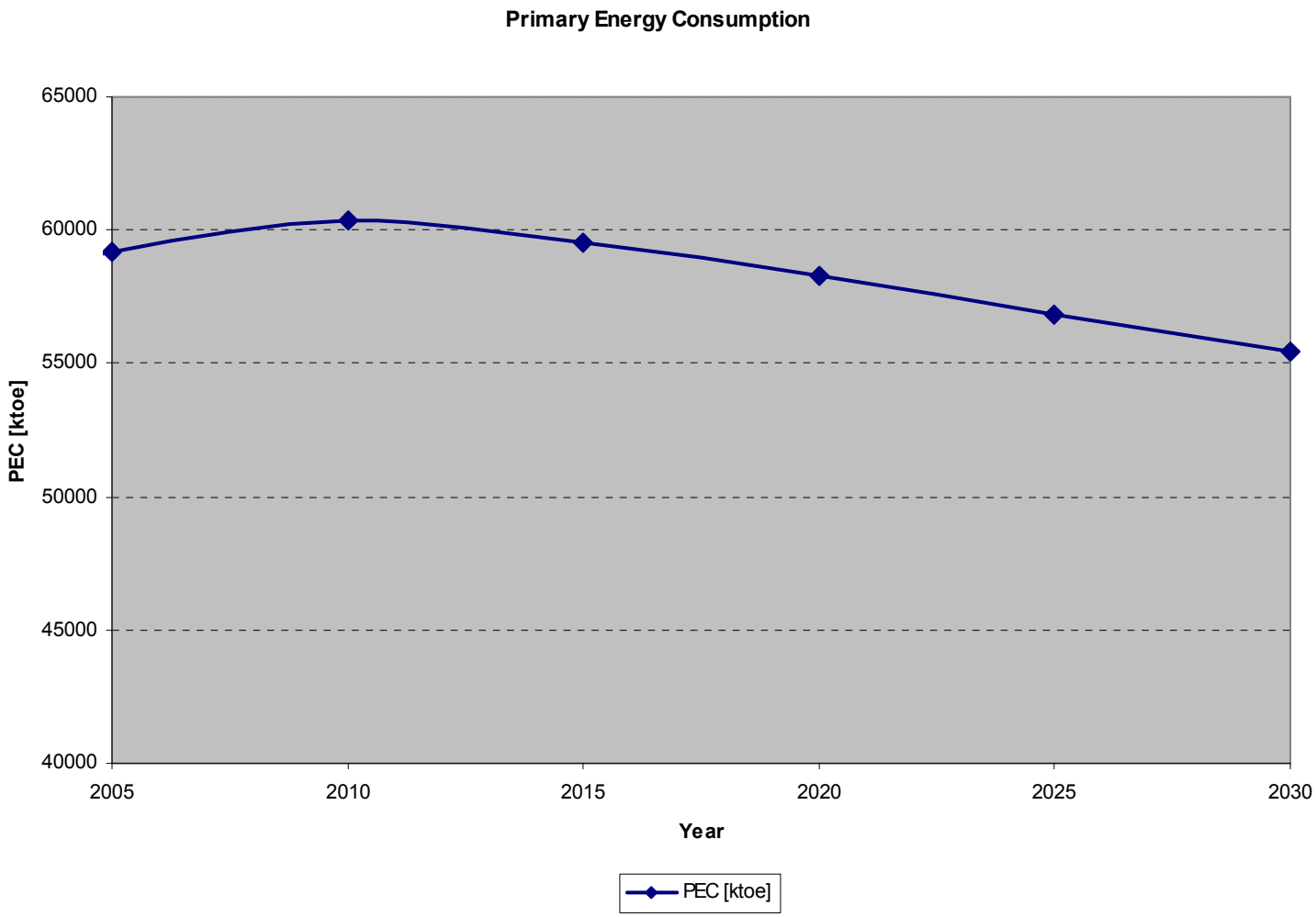
Baseline Scenario – FED *(recall)*



Baseline Scenario – FED Intensity



Baseline Scenario – Prim En Consumption



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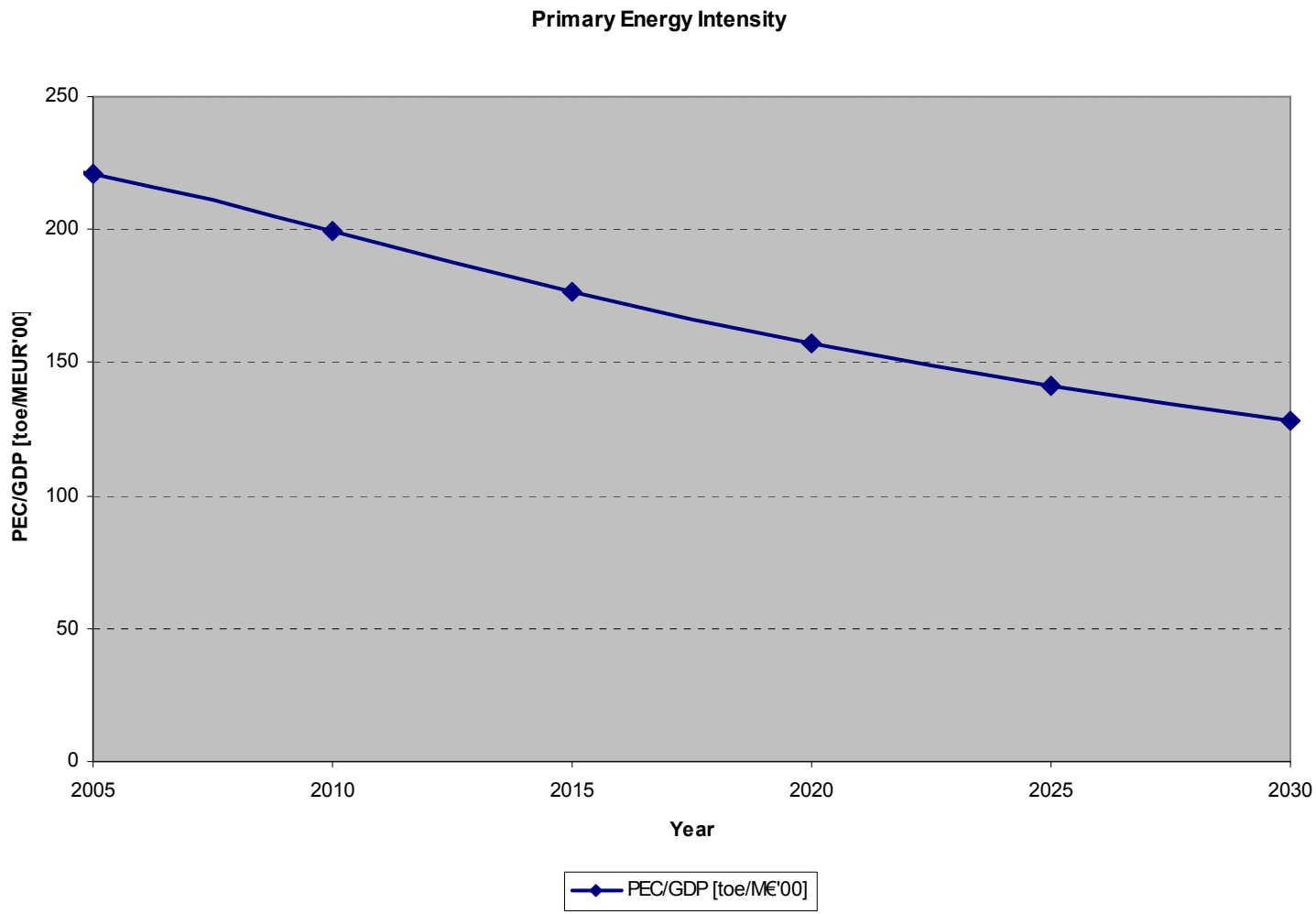
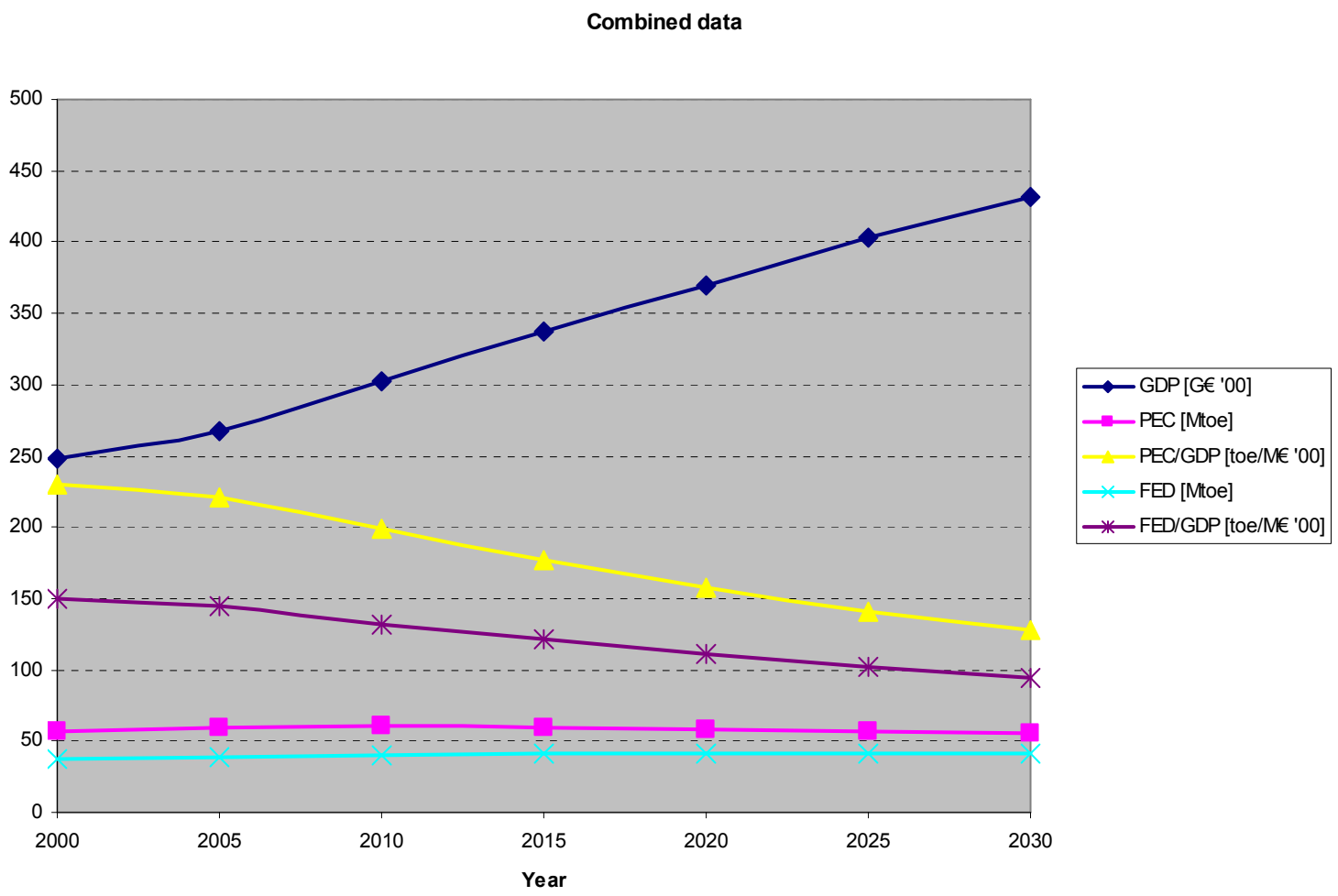


Baseline Scenario – Demand Combi Plot



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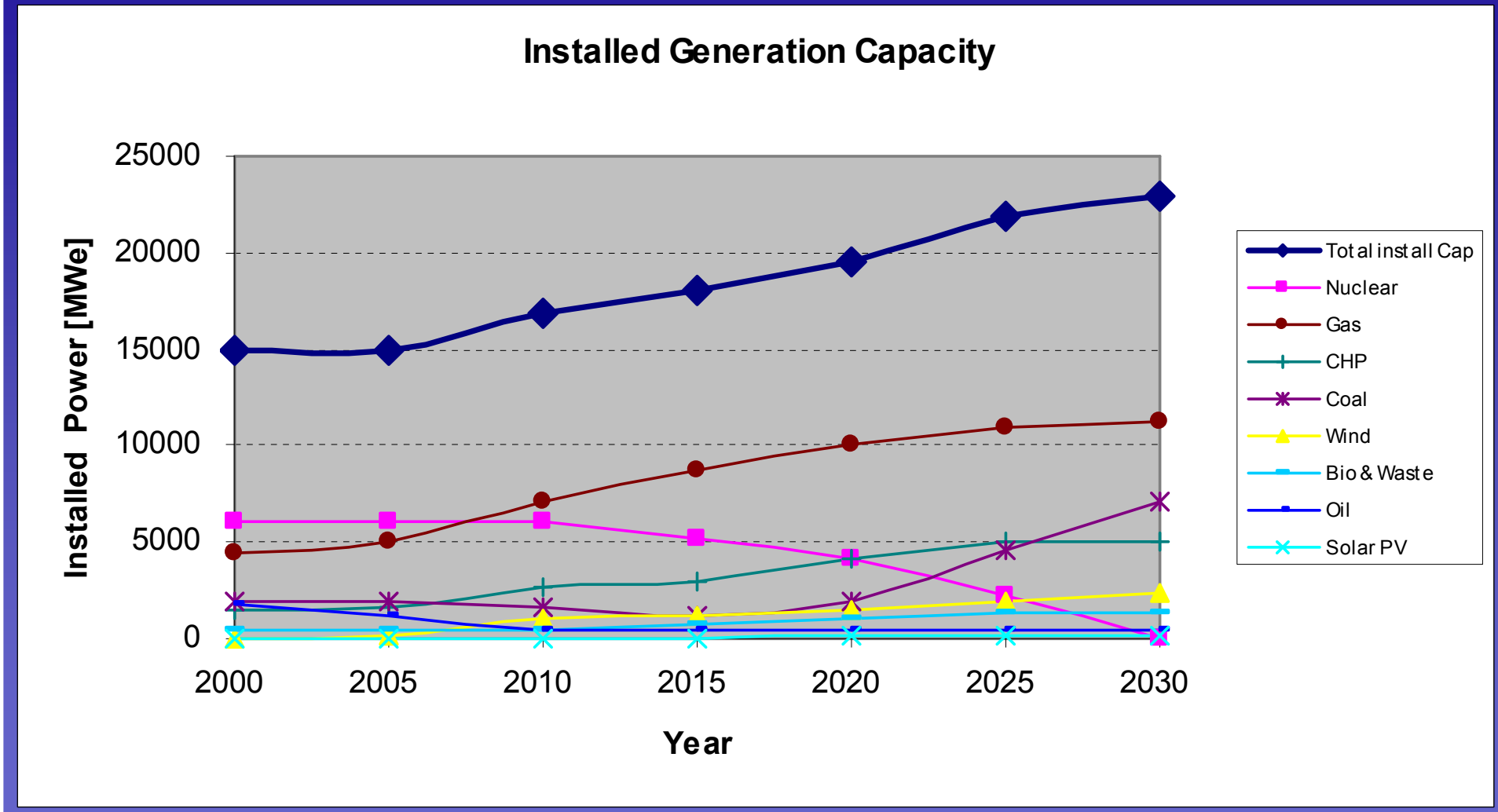
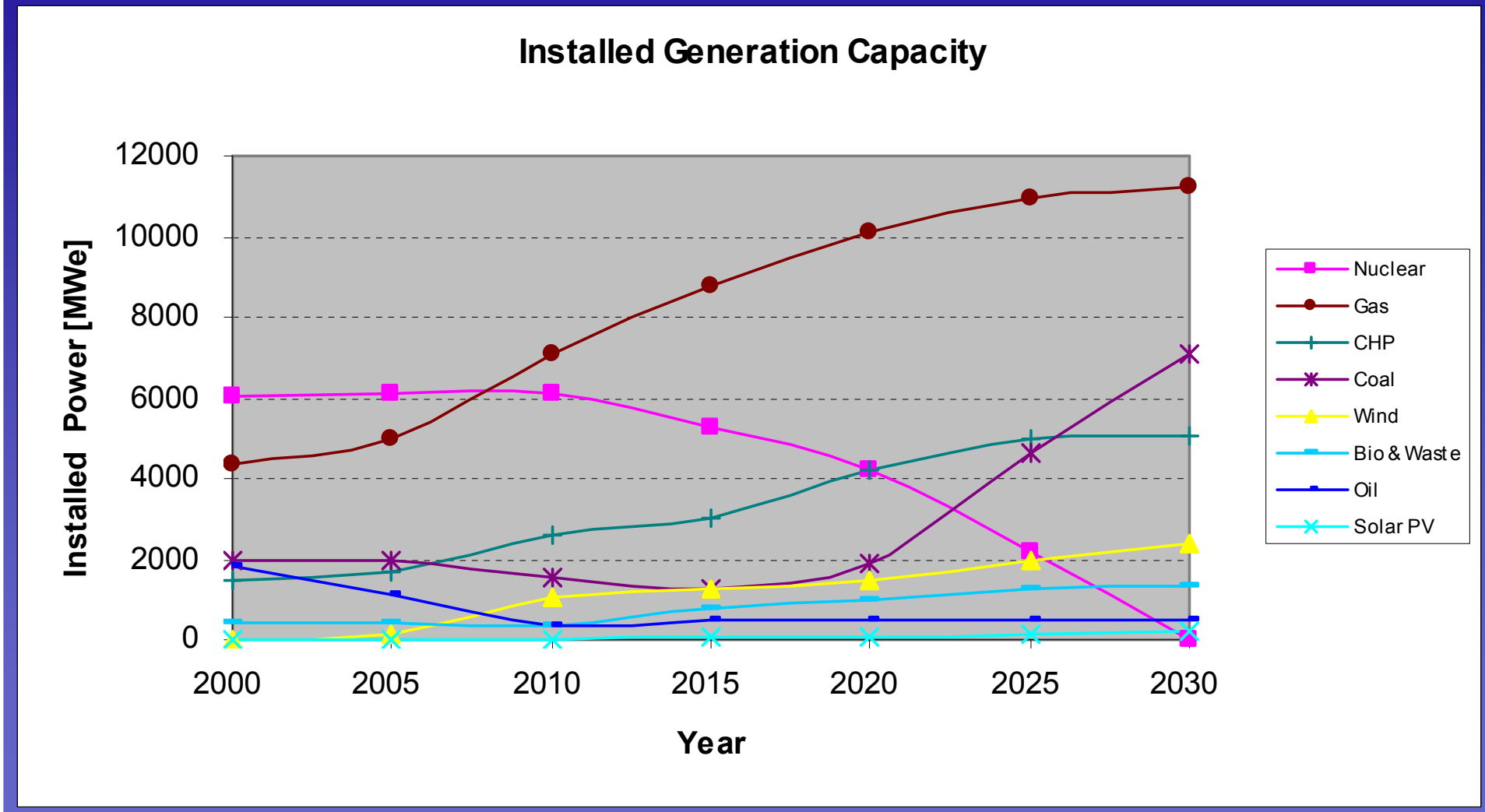


Baseline Scenario -- Results



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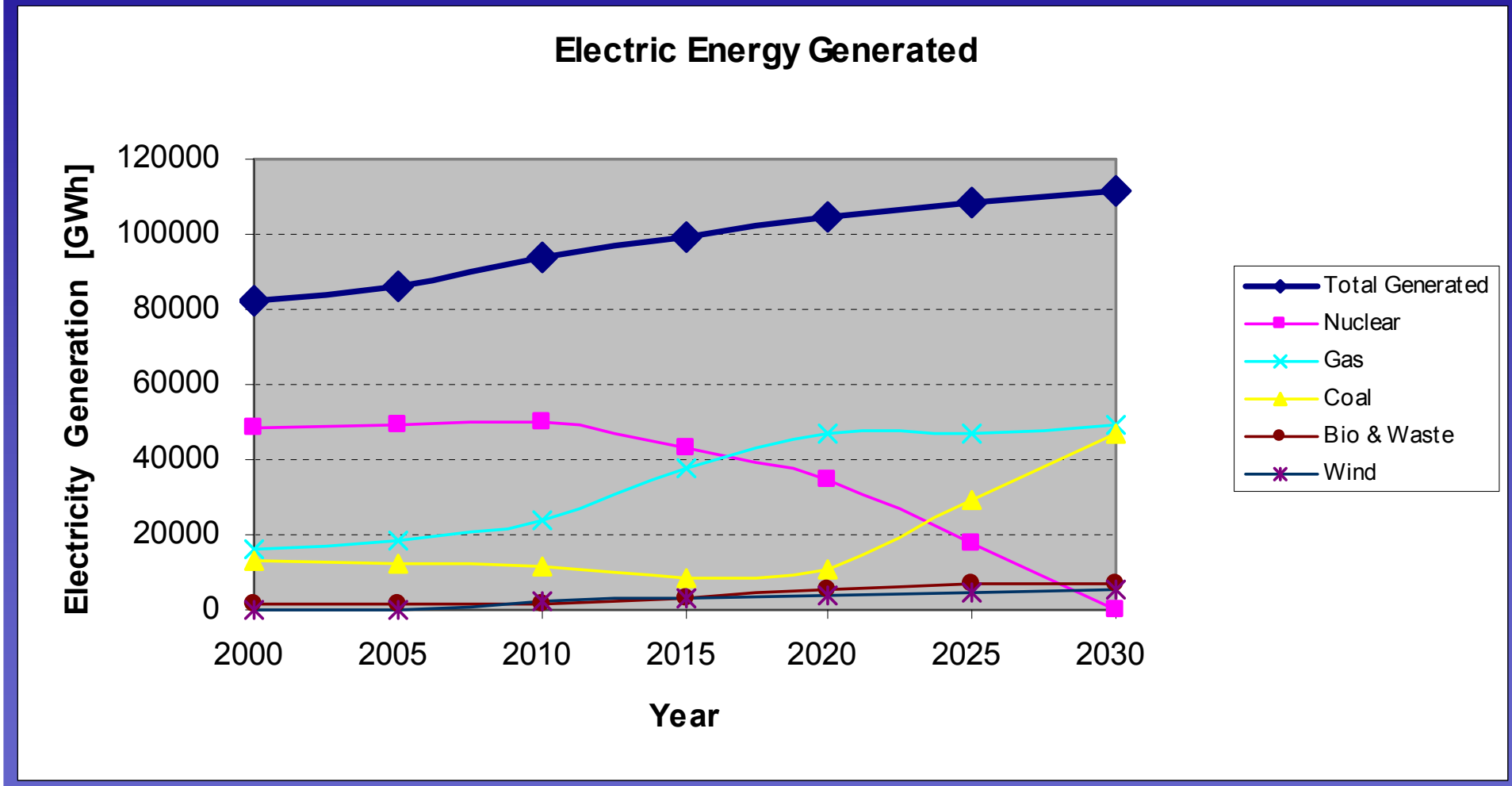

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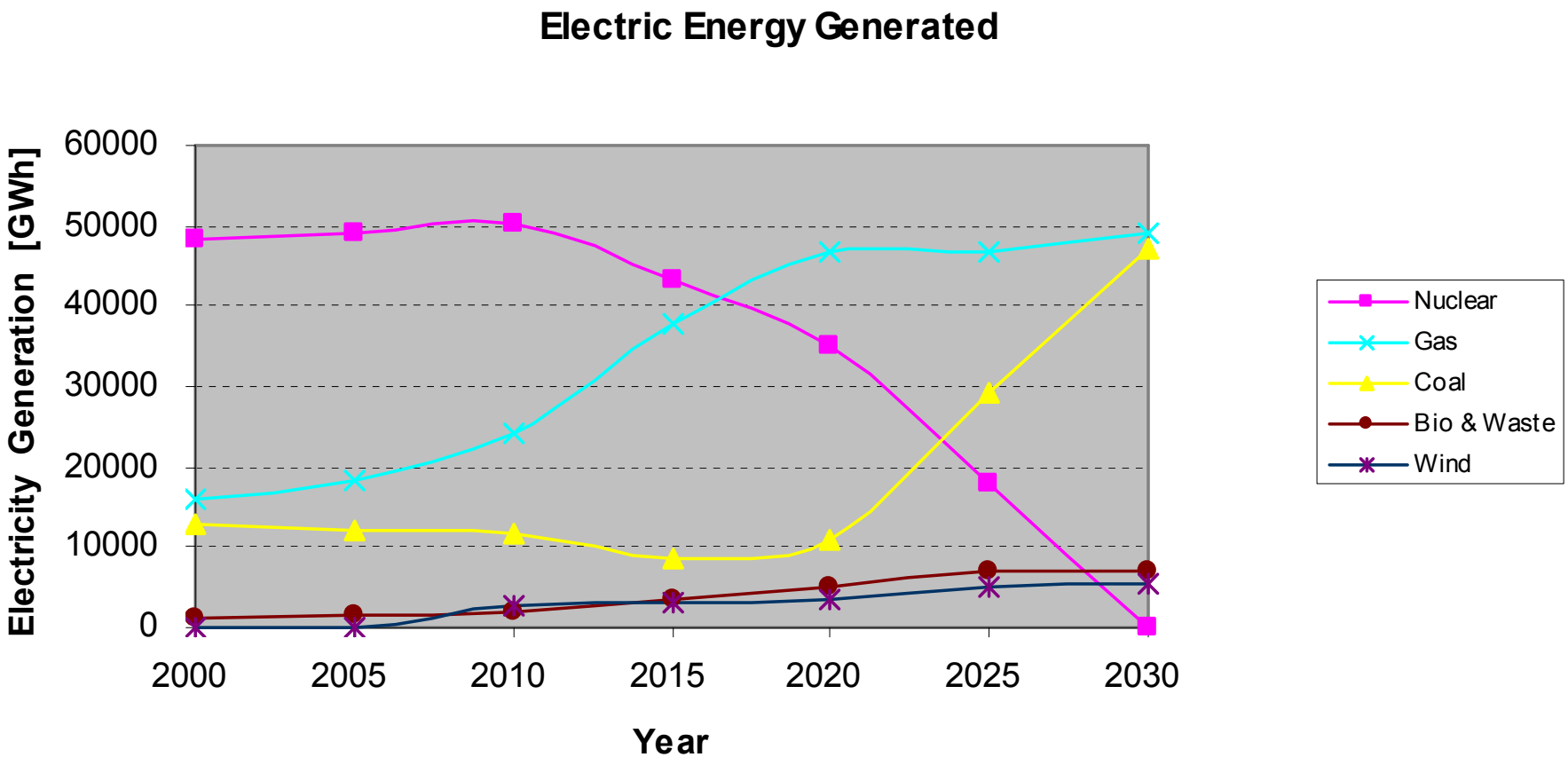

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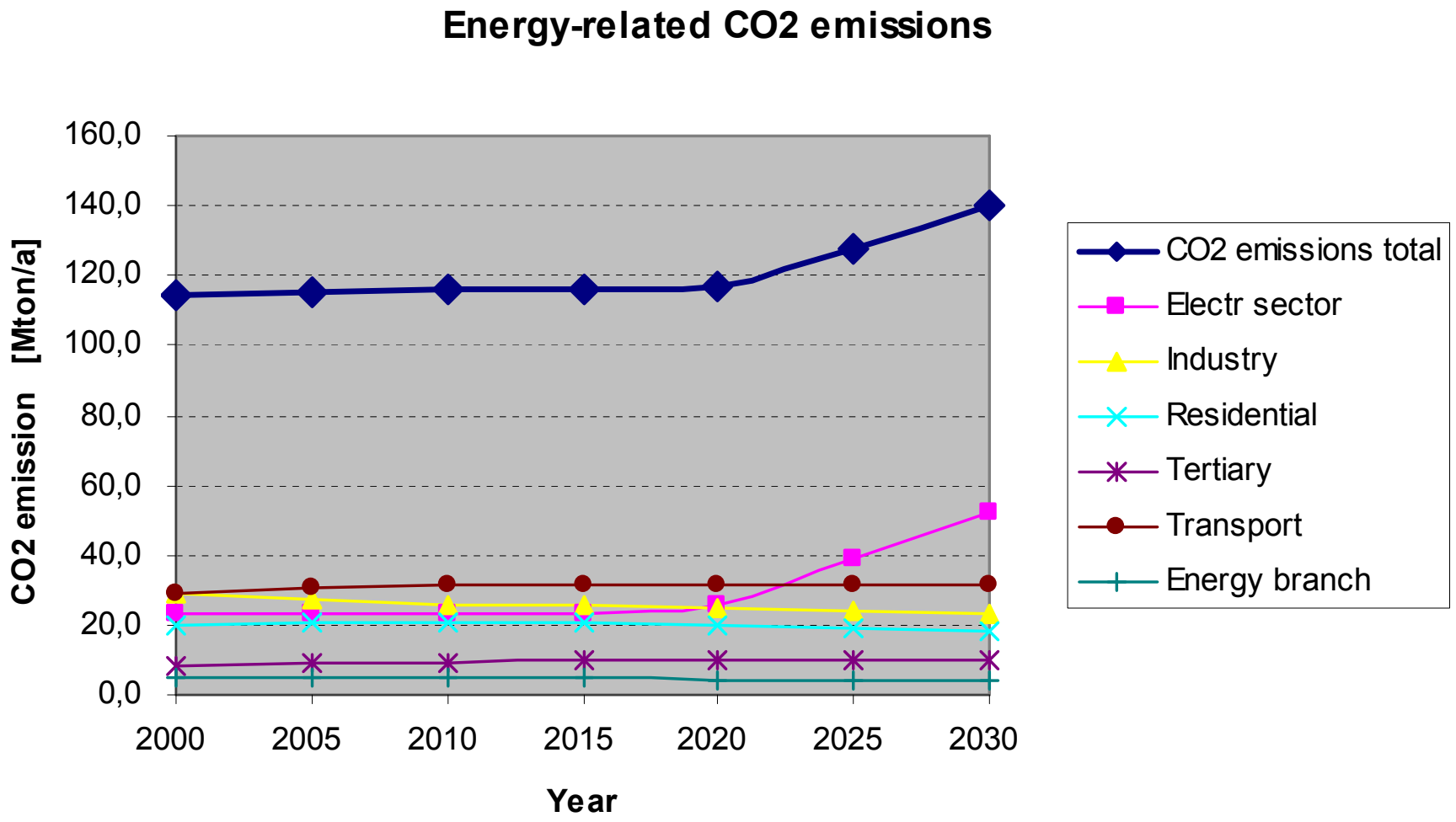

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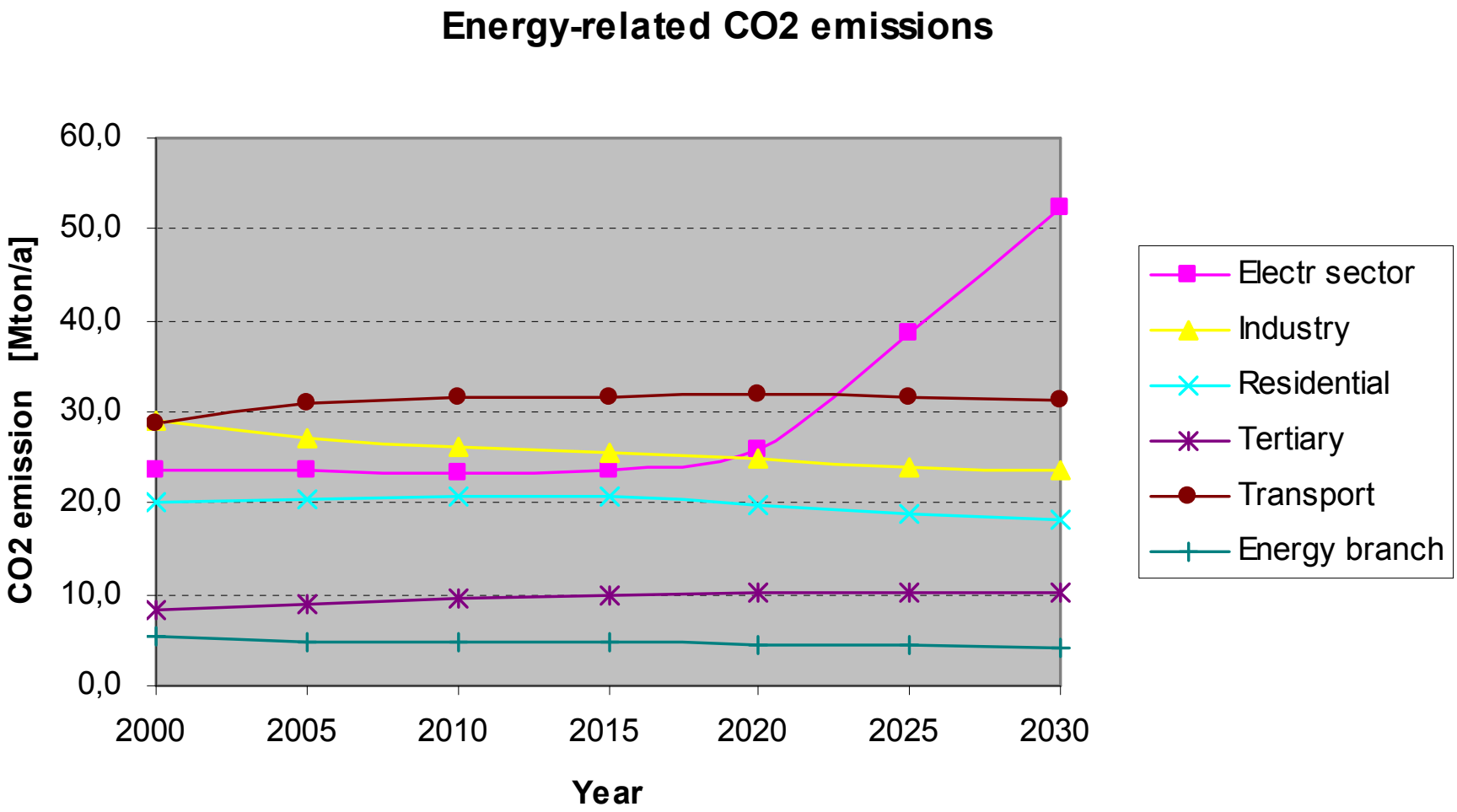

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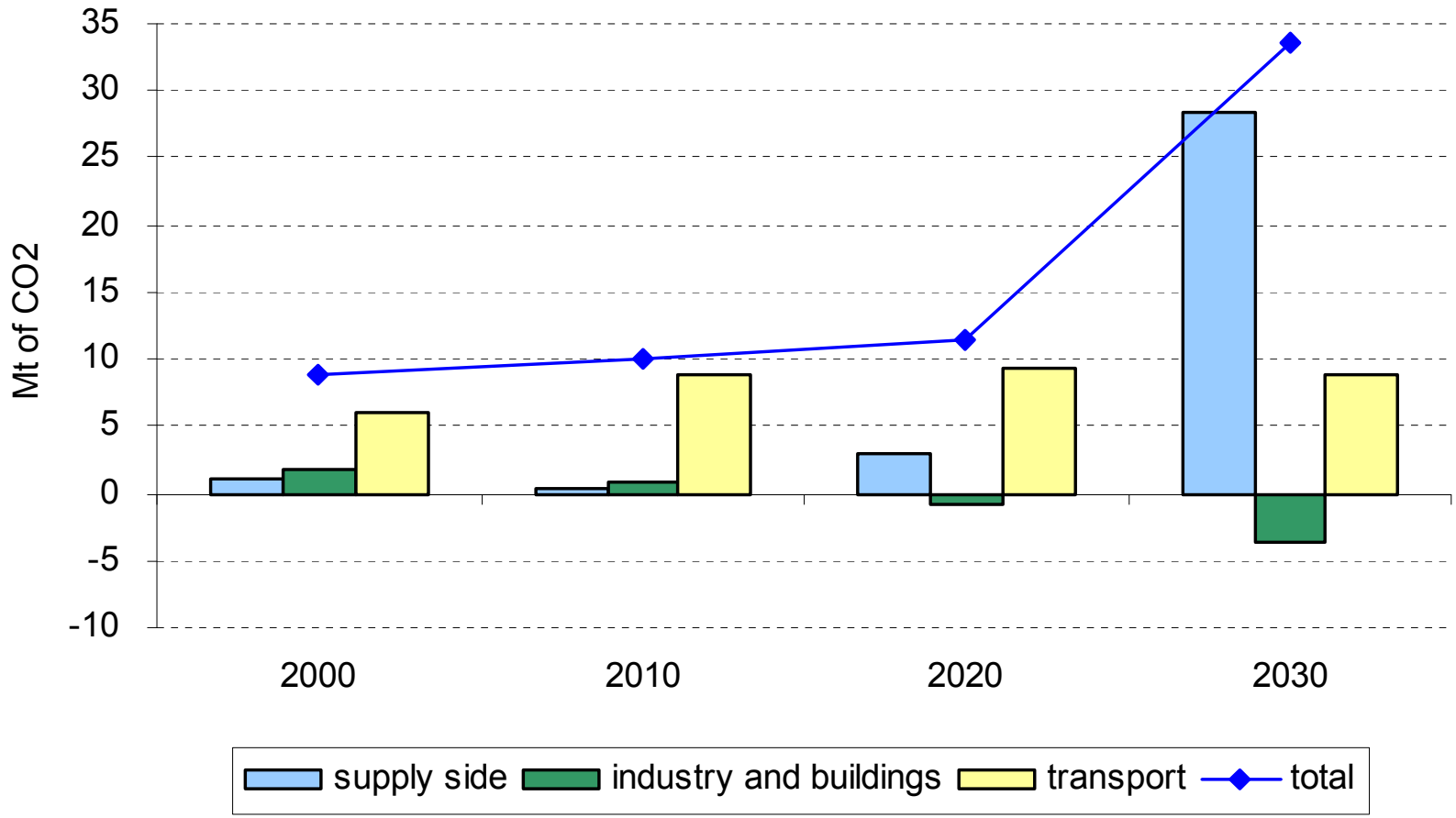


Baseline Scenario -- Results

	Absolute values		Year 2030 % compared to Baseline			
	Baseline 2005	Baseline 2030	-15% no nuc; no CCS	-15% with nuc; no CCS	-30% no nuc; no CCS	-30% with nuc; no CCS
Primary energy consumption (PEC) [Mtoe]	59.2	55.4	-19.5	6.3	-29.2	-2.3
Primary energy intensity of GDP [toe/M€'00]	221.2	128.4	-19.6	6.7	-29.2	-2.3
Overall system cost [% of GDP]		10	16	11.5	31.5	15
Final energy demand (FED) / ***total***	38.6	40.9	-19.3	-5.3	-31.9	-17.3
Industry energy consumption	13.8	13.9	-20.9	-8.6	-29.7	-19.4
Industry energy related costs/toe			99.3	18.8	334.8	76.7
Residential energy consumption	10.0	10.0	-22.0	-5.7	-36.3	-19.9
Residential energy related costs/toe			64.5	9.4	219.8	49.8
Tertiary energy consumption	4.5	5.8	-23.7	-3.5	-40.7	-18.4
Tertiary energy related costs/toe			92.4	9.2	364.8	70.2
Transport energy consumption	10.4	11.3	-12.7	-1.7	-26.2	-12.0

				Year 2030 Other key results			
Structure of PEC (%)							
Coal	11.9	20.8		1.7	2.5	0.8	1.3
Oil	38.9	38.6		39.0	33.1	37.1	31.4
Natural gas	25.0	35.5		48.3	29.5	48.8	28.2
Nuclear	21.4	0.0		0.0	27.9	0.0	30.5
RES	1.7	5.3		11.0	7.0	13.3	8.7
Import dependency (%)	78.8	95.3		90.5	68.7	88.7	65.3
Structure of elec. generation (%)							
Nuclear	57.2	0.0		0.0	50.9	0.0	49.5
RES (incl waste)	2.5	11.8		28.3	20.3	32.8	22.3
Fossil fuels	40.3	88.2		71.7	28.8	67.2	28.2
% of electricity from CHP	9.0	18.2		14.5	15.0	14.1	12.4
Net CO_2 emissions in power sector (Mton)	23.5	52.4		27.0	12.8	18.6	12.7
Installed power capacity (MW)	14 998	22 999		29 998	27 912	32 367	31 913
Renewables total	554	3 926		13 392	7 612	17 299	11 159
Wind onshore	113	1 388		2 058	2 045	2 049	2 049
Wind offshore	0	1 019		3 800	3 800	3 800	3 800
Solar PV	4	209		5 903	209	9 880	3 792
Biomass (incl waste)	437	1 310		1 631	1 575	1 570	1 518
Coal fired	1 955	7 054		0	0	0	0
Gas fired	4 983	11 240		12 562	11 834	11 844	11 992
Nuclear	6 075	0		0	7 775	0	7 775
Carbon value ([€/ton CO_2]	5	5		524	105	2 150	490
Carbon value [$/bbl] - approx.	2	2		202	40	827	188

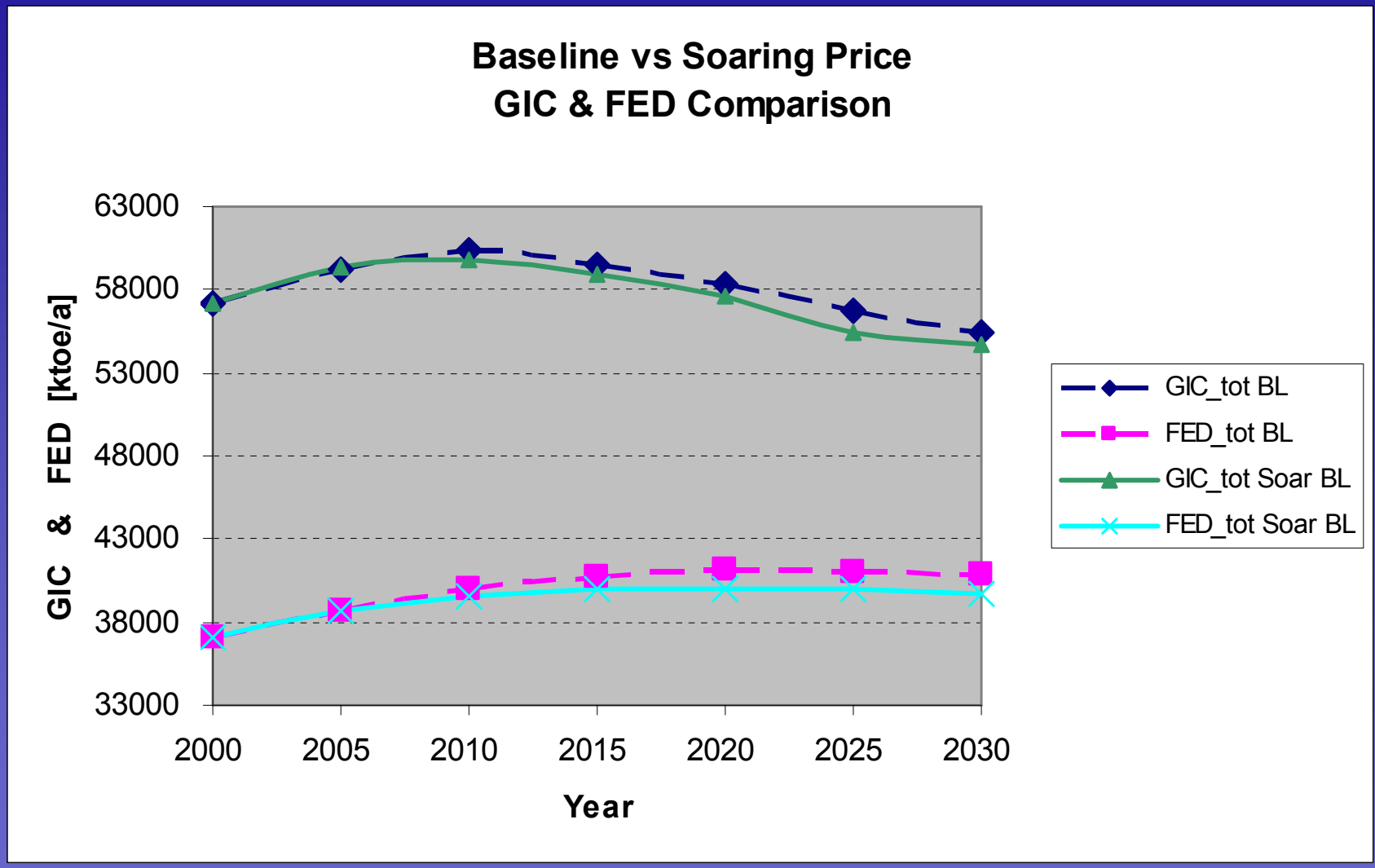
Baseline Scenario -- Results

	Absolute values	
	Baseline 2005	Baseline 2030
Primary energy consumption (PEC) [Mtoe]	59.2	55.4
Primary energy intensity of GDP [toe/M€'00]	221.2	128.4
Overall system cost [% of GDP]		10
Final energy demand (FED) / ***total***	38.6	40.9
Industry energy consumption	13.8	13.9
Industry energy related costs/toe		
Residential energy consumption	10.0	10.0
Residential energy related costs/toe		
Tertiary energy consumption	4.5	5.8
Tertiary energy related costs/toe		
Transport energy consumption	10.4	11.3

Structure of PEC (%)		
Coal	**11.9**	**20.8**
Oil	**38.9**	**38.6**
Natural gas	**25.0**	**35.5**
Nuclear	**21.4**	**0.0**
RES	**1.7**	**5.3**
Import dependency (%)	**78.8**	**95.3**
Structure of elec. generation (%)		
Nuclear	**57.2**	**0.0**
RES (incl waste)	**2.5**	**11.8**
Fossil fuels	**40.3**	**88.2**
% of electricity from CHP	**9.0**	**18.2**
Net CO_2 emissions in power sector (Mton)	**23.5**	**52.4**
Installed power capacity (MW)	**14 998**	**22 999**
Renewables total	**554**	**3 926**
Wind onshore	**113**	**1 388**
Wind offshore	**0**	**1 019**
Solar PV	**4**	**209**
Biomass (incl waste)	**437**	**1 310**
Coal fired	**1 955**	**7 054**
Gas fired	**4 983**	**11 240**
Nuclear	**6 075**	**0**
Carbon value ([€/ton CO_2]	**5**	**5**
Carbon value [$/bbl] - approx.	**2**	**2**

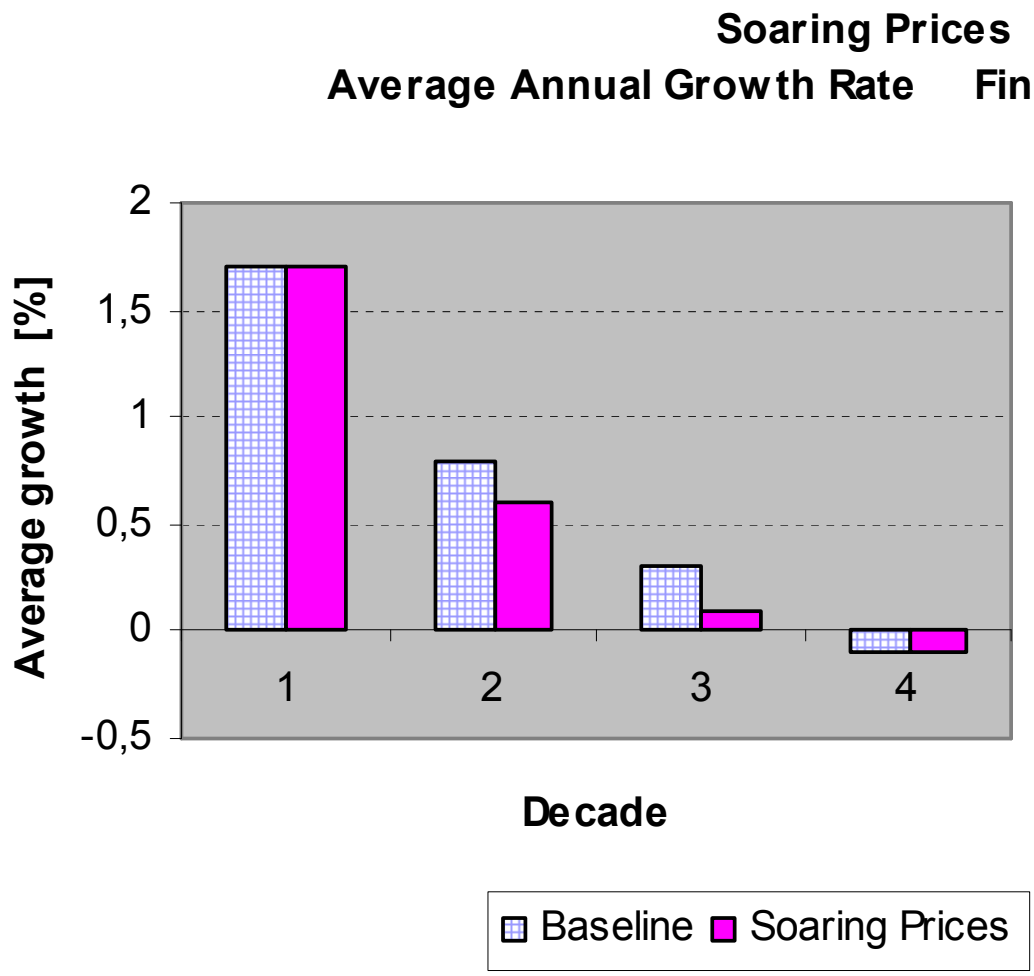
Baseline Scenario Soaring Variant

Results



Baseline Scenario Soaring Variant

Results



Alternative Scenarios

Eight scenarios

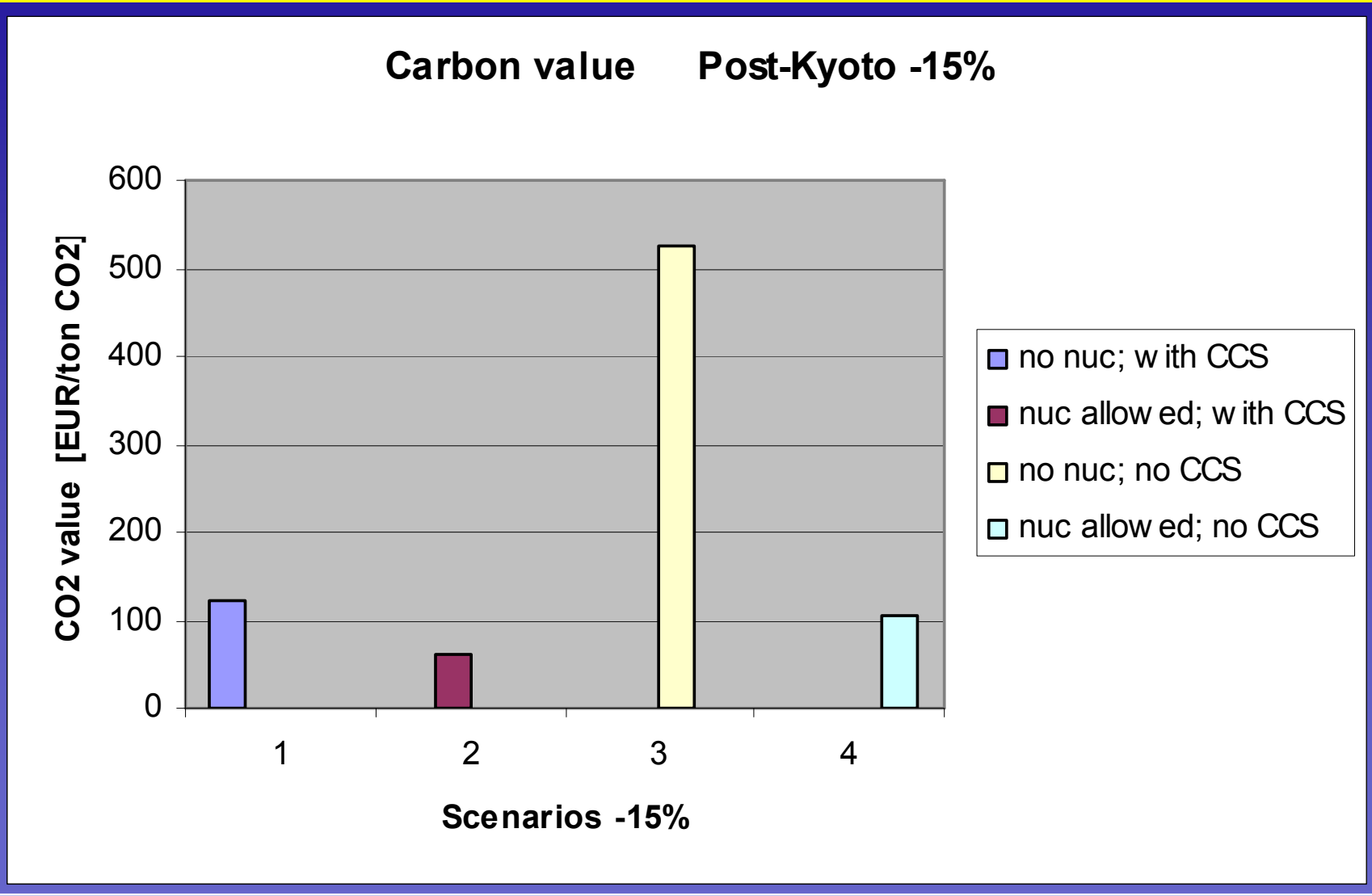
- All same GDP evolution as Baseline
  → Demand for energy services adjusted according to price elasticity
- All same fuel-price evolution as Baseline

Alternative Scenarios

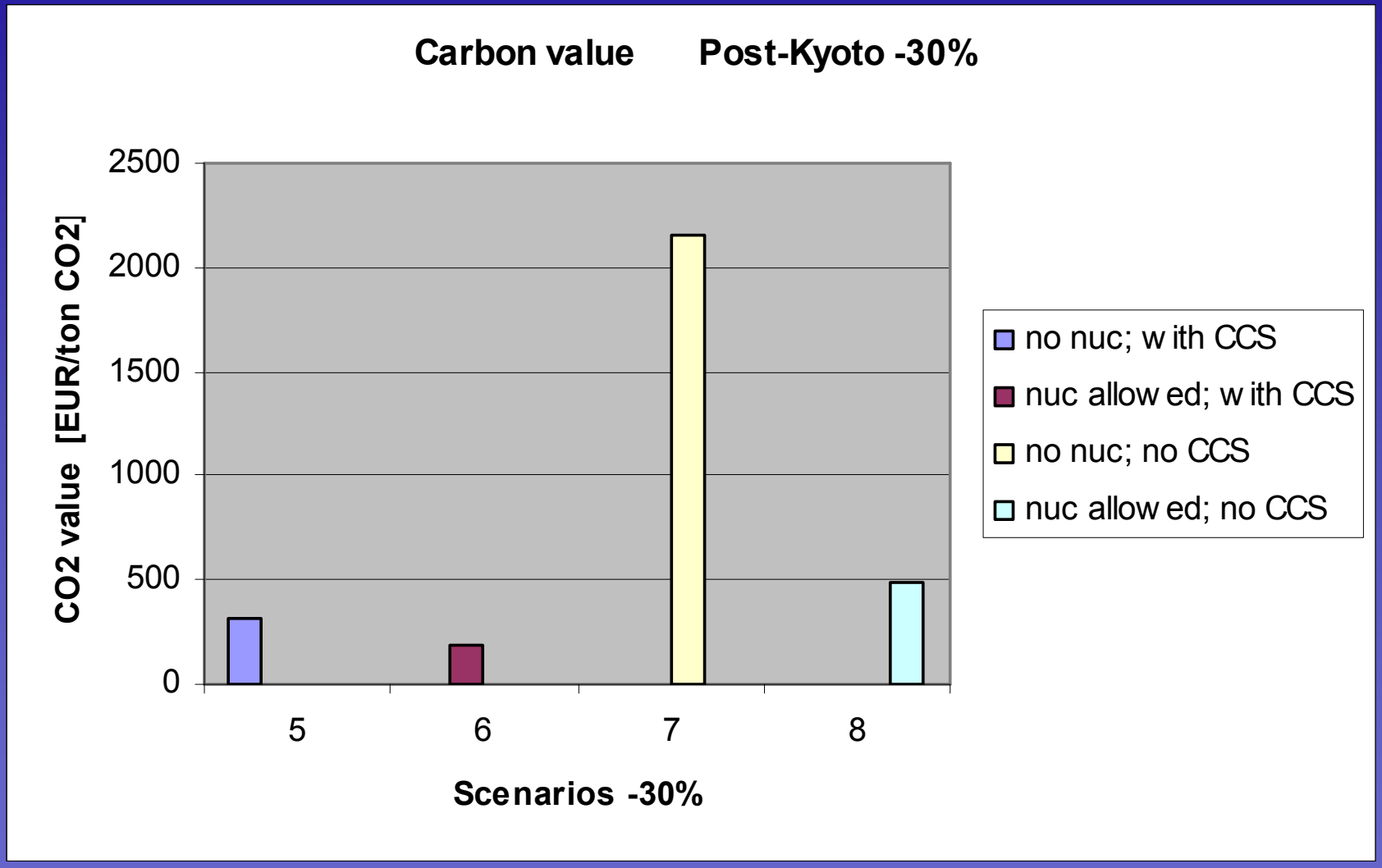
Eight scenarios

- -15% and -30% domestic reduction of energy-related CO_2 in 2030 wrt 1990
- Each time with nuclear phase out on-off
- Each time with CCS and without

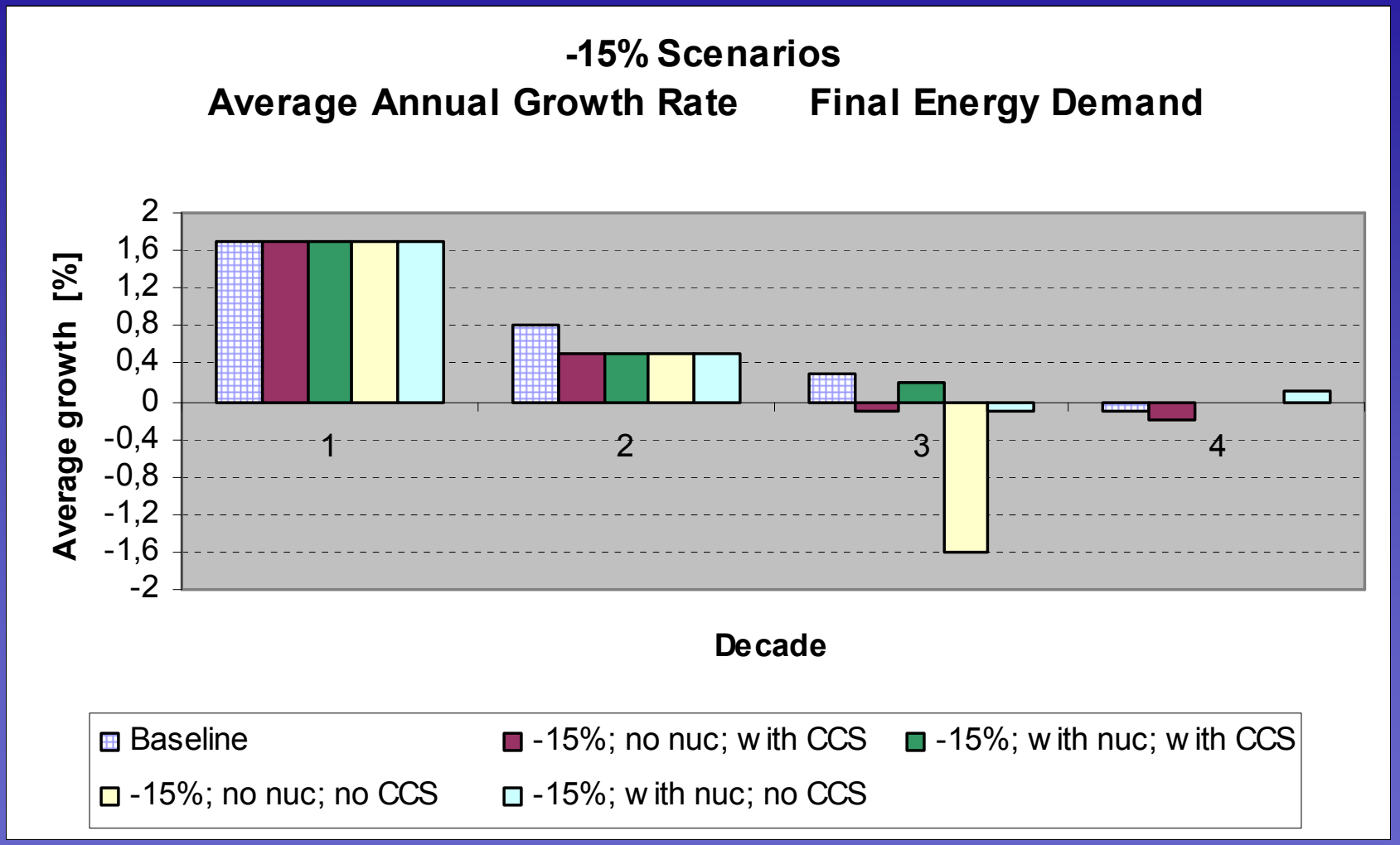
Alternative Scenarios -- Results



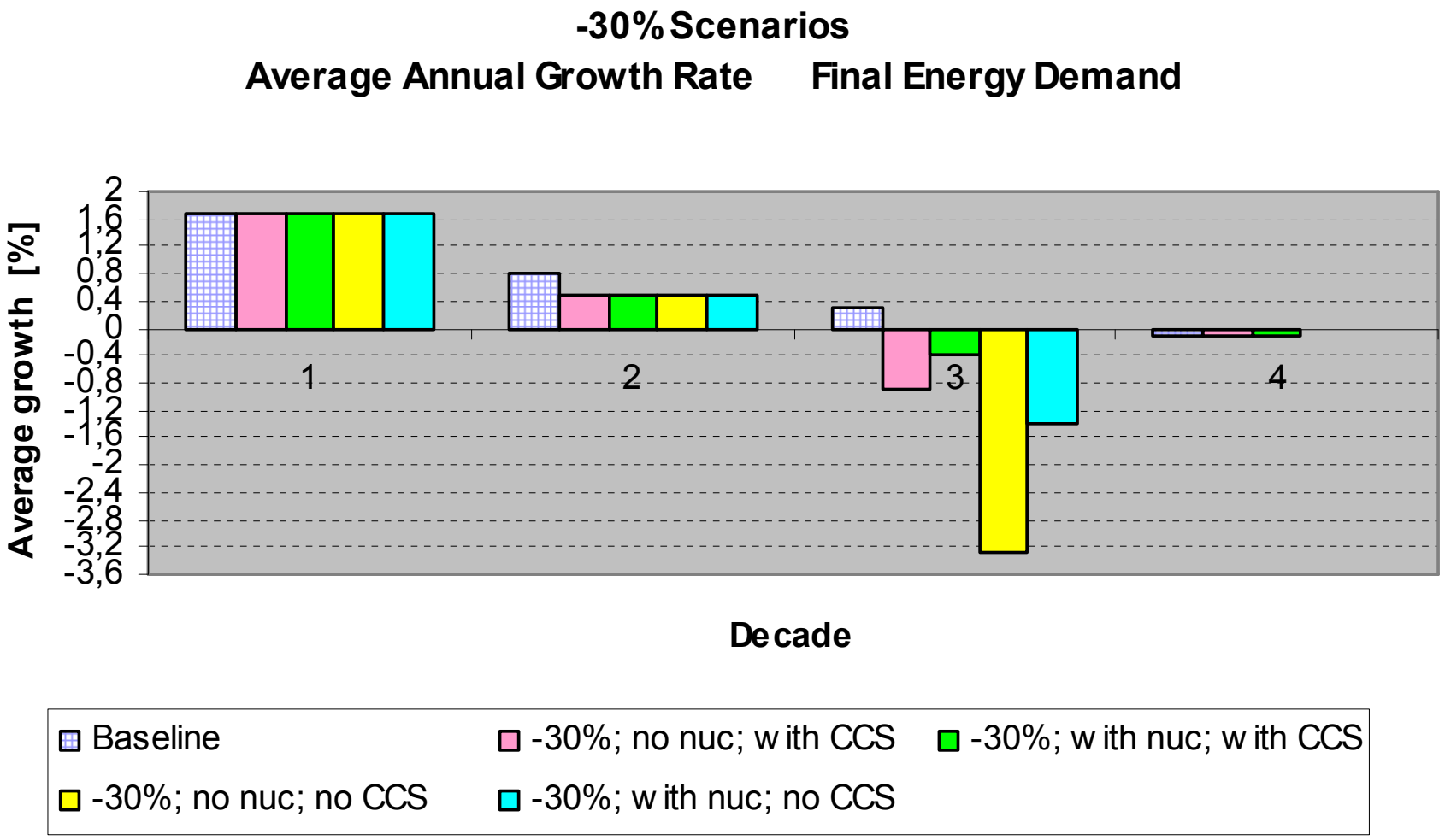
Alternative Scenarios -- Results



Alternative Scenarios -- Results



Alternative Scenarios -- Results



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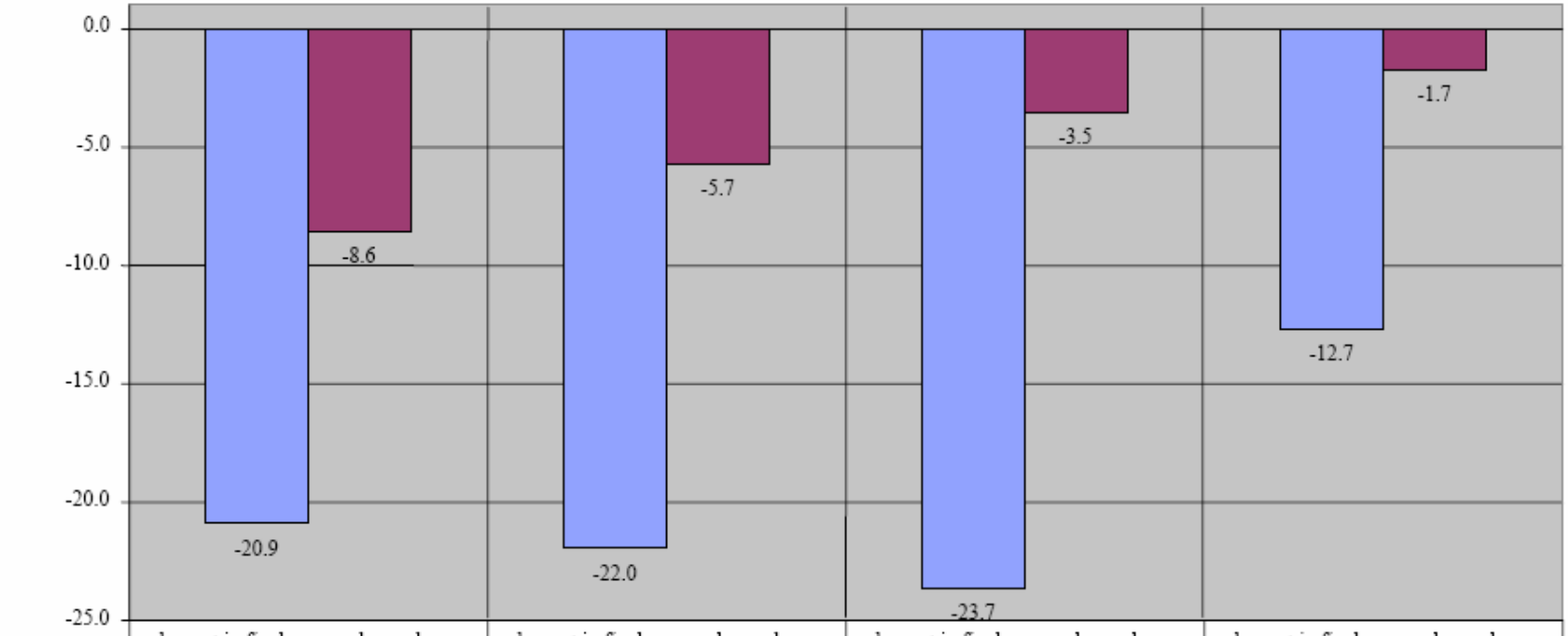
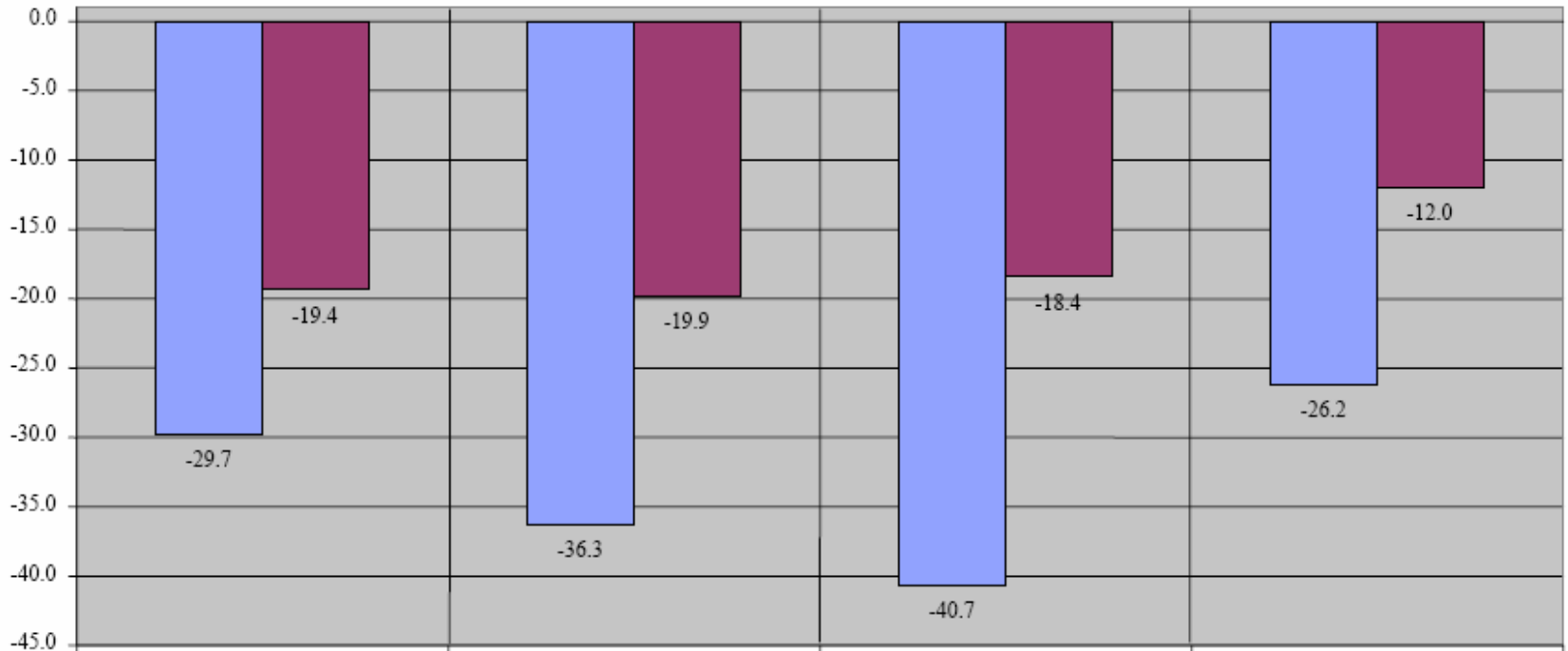


	changes in final energy demand-industry	changes in final energy demand-residential	changes in final energy demand-tertiary	changes in final energy demand-transport
BPK15s	-20.9	-22.0	-23.7	-12.7
BPK15ns	-8.6	-5.7	-3.5	-1.7

***Figure 8.24**. Changes in final energy demand per sector compared to the Baseline for the scenarios -15% and no CCS, but with and without nuclear power. From [FPB, 2006 – Sept].*

Alternative Scenarios -- Results



	changes in final energy demand-industry	changes in final energy demand-residential	changes in final energy demand-tertiary	changes in final energy demand-transport
BPK30s	-29.7	-36.3	-40.7	-26.2
BPK30ns	-19.4	-19.9	-18.4	-12.0

***Figure 8.25**. Changes in final energy demand per sector compared to the Baseline for the scenarios -30% and no CCS, but with and without nuclear power. Note the different scale compared to Figure 8.24. From [FPB, 2006 – Sept].*

Alternative Scenarios -- Results

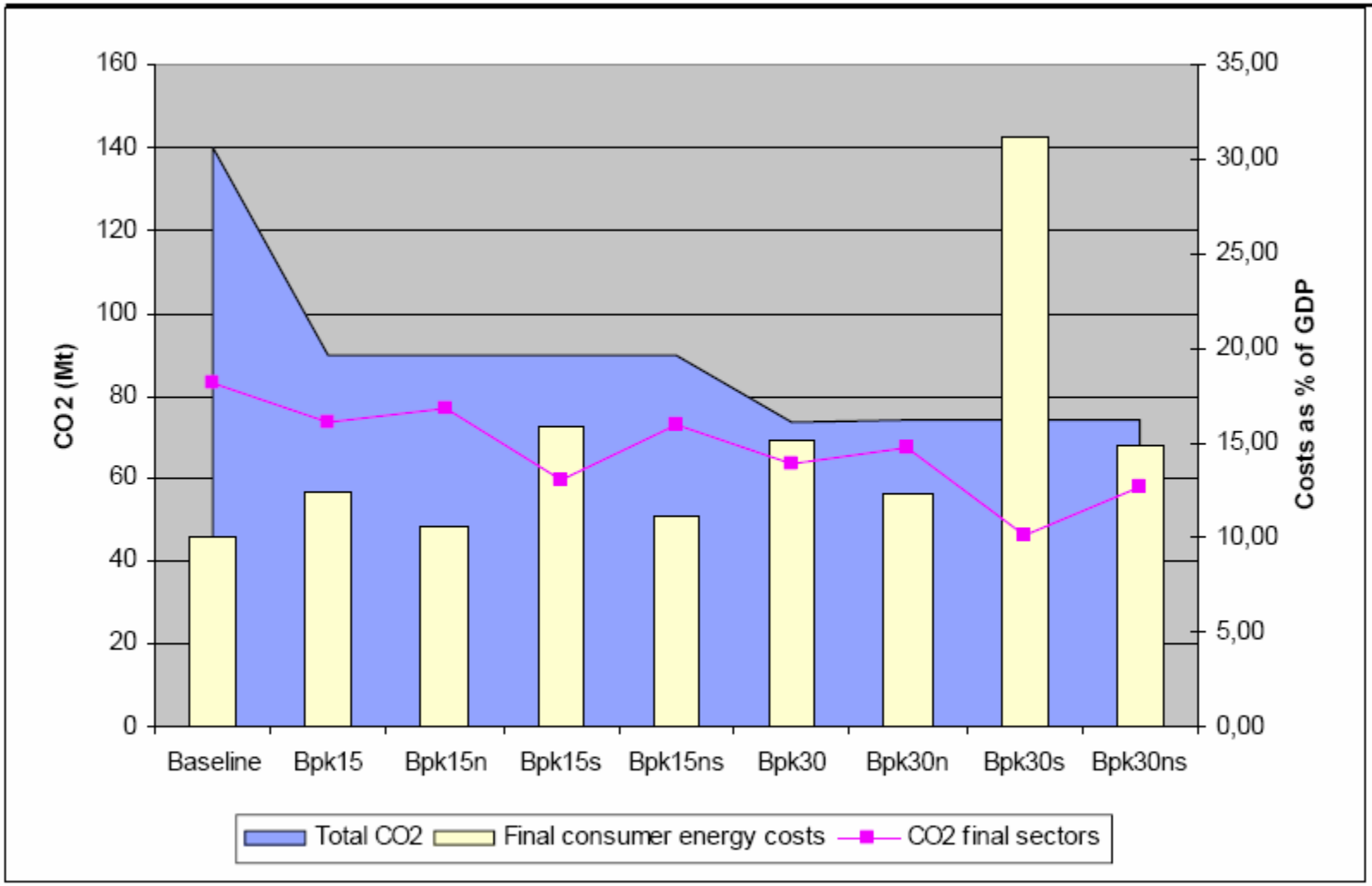


***Figure 8.48**. Total energy related costs of final consumers per unit of GDP vs. CO_2 emissions in 2030. From [FPB, 2006 - Sept]*

Alternative Scenarios -- Results

	Absolute values		Year 2030 % compared to Baseline			
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				Year 2030 Other key results			
Structure of PEC (%)							
Coal	11.9	20.8		1.7	2.5	0.8	1.3
Oil	38.9	38.6		39.0	33.1	37.1	31.4
Natural gas	25.0	35.5		48.3	29.5	48.8	28.2
Nuclear	21.4	0.0		0.0	27.9	0.0	30.5
RES	1.7	5.3		11.0	7.0	13.3	8.7
Import dependency (%)	78.8	95.3		90.5	68.7	88.7	65.3
Structure of elec. generation (%)							
Nuclear	57.2	0.0		0.0	50.9	0.0	49.5
RES (incl waste)	2.5	11.8		28.3	20.3	32.8	22.3
Fossil fuels	40.3	88.2		71.7	28.8	67.2	28.2
% of electricity from CHP	9.0	18.2		14.5	15.0	14.1	12.4
Net CO_2 emissions in power sector (Mton)	23.5	52.4		27.0	12.8	18.6	12.7
Installed power capacity (MW)	14 998	22 999		29 998	27 912	32 367	31 913
Renewables total	554	3 926		13 392	7 612	17 299	11 159
Wind onshore	113	1 388		2 058	2 045	2 049	2 049
Wind offshore	0	1 019		3 800	3 800	3 800	3 800
Solar PV	4	209		5 903	209	9 880	3 792
Biomass (incl waste)	437	1 310		1 631	1 575	1 570	1 518
Coal fired	1 955	7 054		0	0	0	0
Gas fired	4 983	11 240		12 562	11 834	11 844	11 992
Nuclear	6 075	0		0	7 775	0	7 775
Carbon value ([€/ton CO_2]	5	5		524	105	2 150	490
Carbon value [$/bbl] - approx.	2	2		202	40	827	188

Structure of PEC (%)				Year 2030 Other key results			
Coal	11.9	20.8		1.7	2.5	0.8	1.3
Oil	38.9	38.6		39.0	33.1	37.1	31.4
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Structure of PEC (%)						
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RES	1.7	5.3	11.0	7.0	13.3	8.7
Structure of elec. generation (%)						
Nuclear	57.2	0.0	0.0	50.9	0.0	49.5
RES (incl waste)	2.5	11.8	28.3	20.3	32.8	22.3
Fossil fuels	40.3	88.2	71.7	28.8	67.2	28.2
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			Year 2030 Other key results			
Structure of elec. generation (%)						
Nuclear	57.2	0.0	0.0	50.9	0.0	49.5
RES (incl waste)	2.5	11.8	28.3	20.3	32.8	22.3
Fossil fuels	40.3	88.2	71.7	28.8	67.2	28.2
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				Year 2030 Other key results			
Commi	Carbon value ([€/ton CO_2]	5	5	524	105	2 150	490
	Carbon value [$/bbl] - approx.	2	2	202	40	827	188

Beyond the Scenarios

Growth Rate & Market Diffusion

- Wind 13% p.a. ; PV 25% p.a.
  shows that wind OK up to 5850 MW
- But PV limited to 530 MW

Extension of networks

- For HV if off shore > 1000 MW ~ 200-300 M€
  or 2 G€ (cables)
- For distribution grid adaptation ~ 2 G€ over 10 yr

Beyond the Scenarios

Security of supply; see table

- Import dependency on scale ~ 1-2 yr

				Year 2030 Other key results			
Structure of PEC (%)							
Coal	11.9	20.8		1.7	2.5	0.8	1.3
Oil	38.9	38.6		39.0	33.1	37.1	31.4
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RES	1.7	5.3		11.0	7.0	13.3	8.7
Import dependency (%)	78.8	95.3		90.5	68.7	88.7	65.3
Structure of elec. generation (%)							
Nuclear	57.2	0.0		0.0	50.9	0.0	49.5
RES (incl waste)	2.5	11.8		28.3	20.3	32.8	22.3
Fossil fuels	40.3	88.2		71.7	28.8	67.2	28.2
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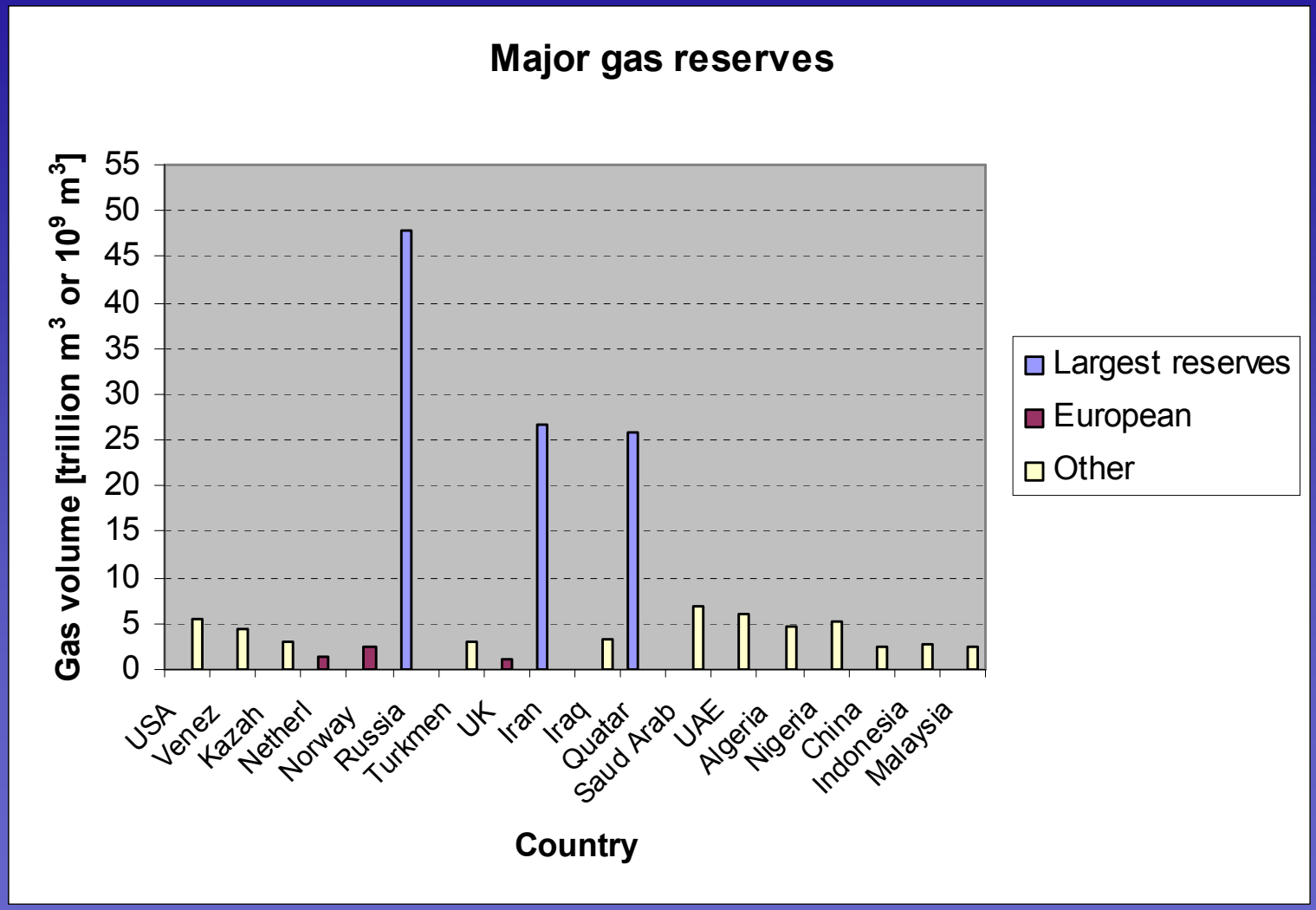
				Year 2030 Other key results			
Import dependency (%)	78.8	95.3		90.5	68.7	88.7	65.3

Beyond the Scenarios



Beyond the Scenarios

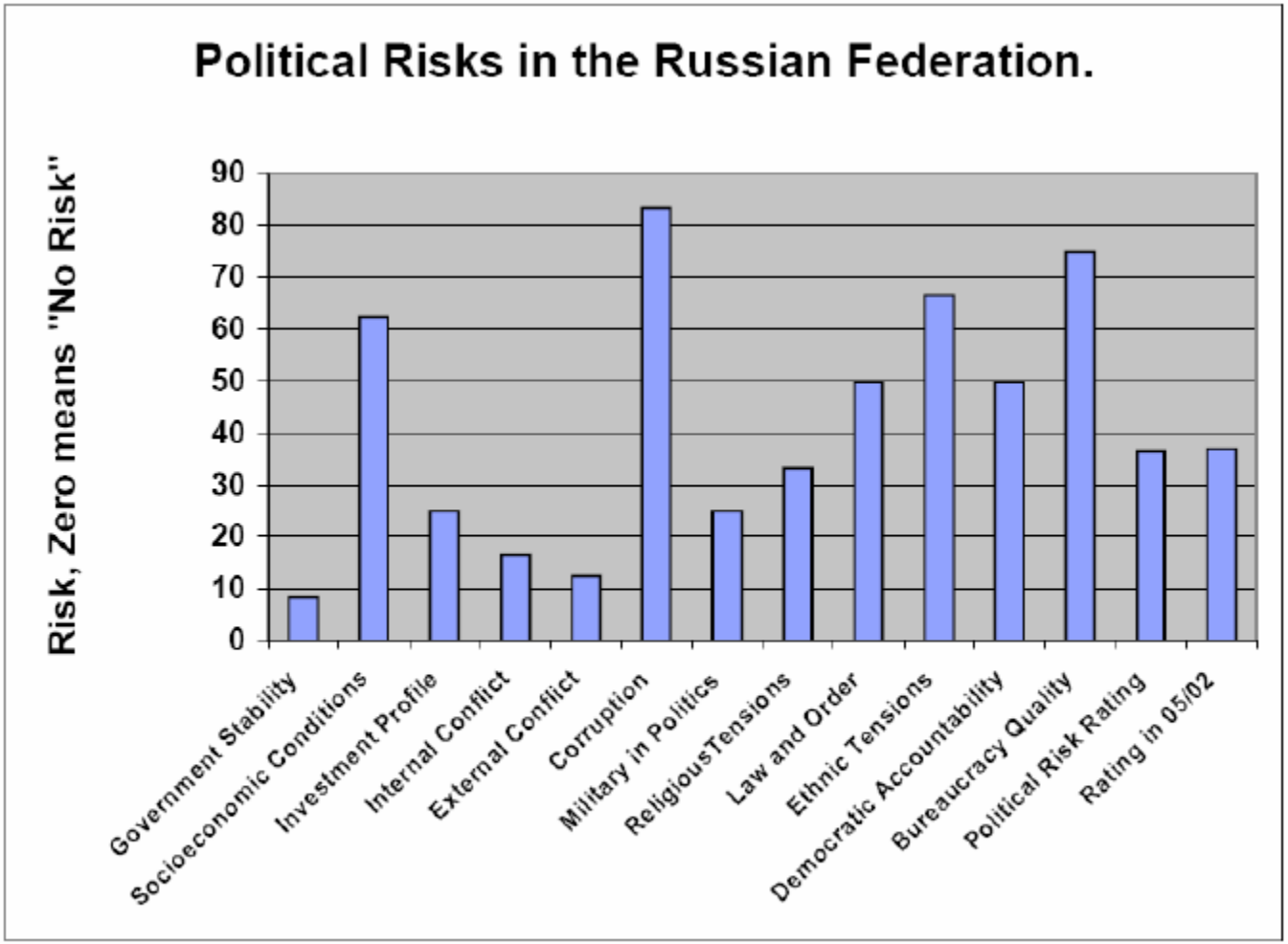
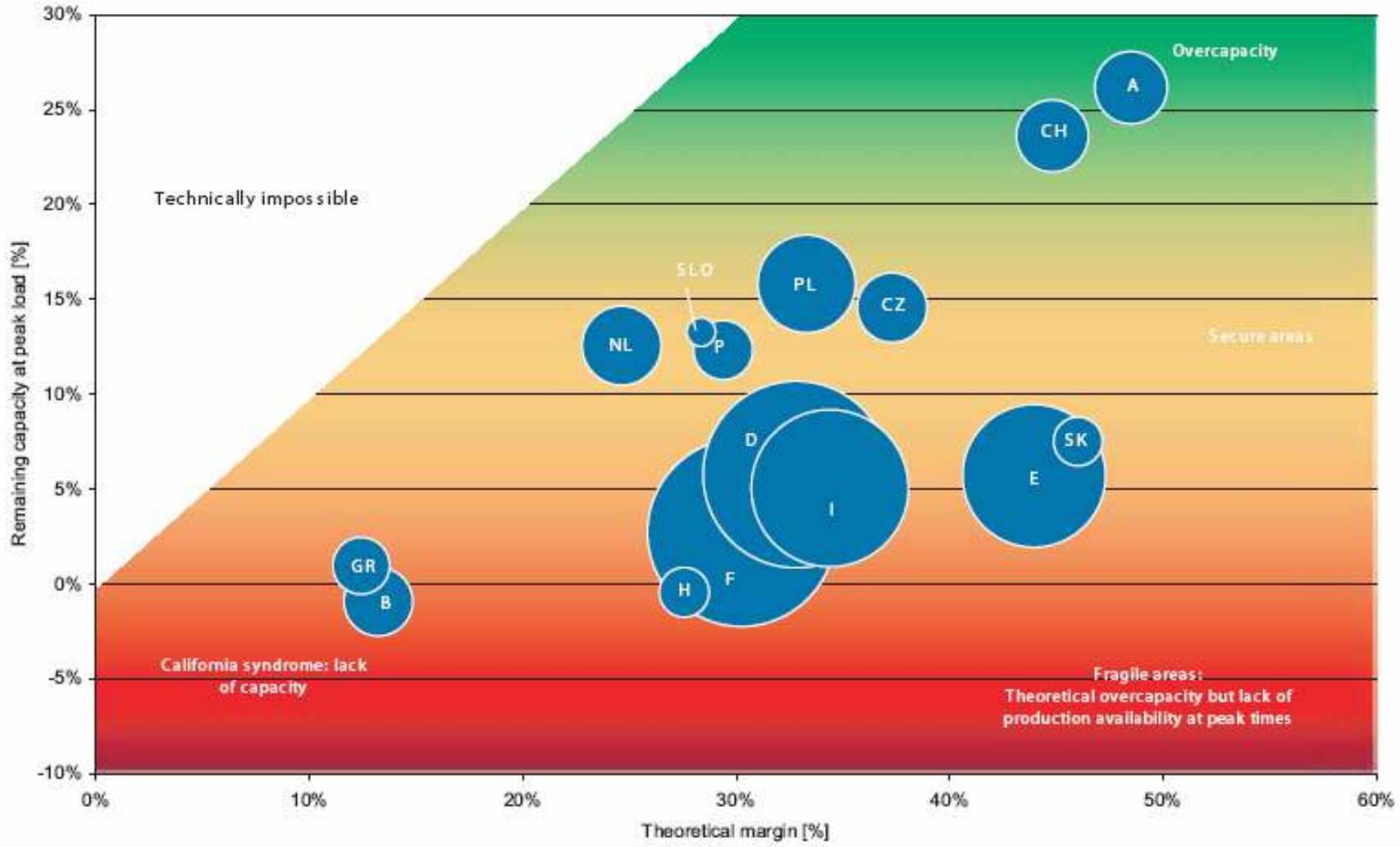


Figure 9.2. Political risk in Russia, related to continuous gas supply. From [Gittus, 2002]

Beyond the Scenarios

Beyond the Scenarios



Beyond the Scenarios

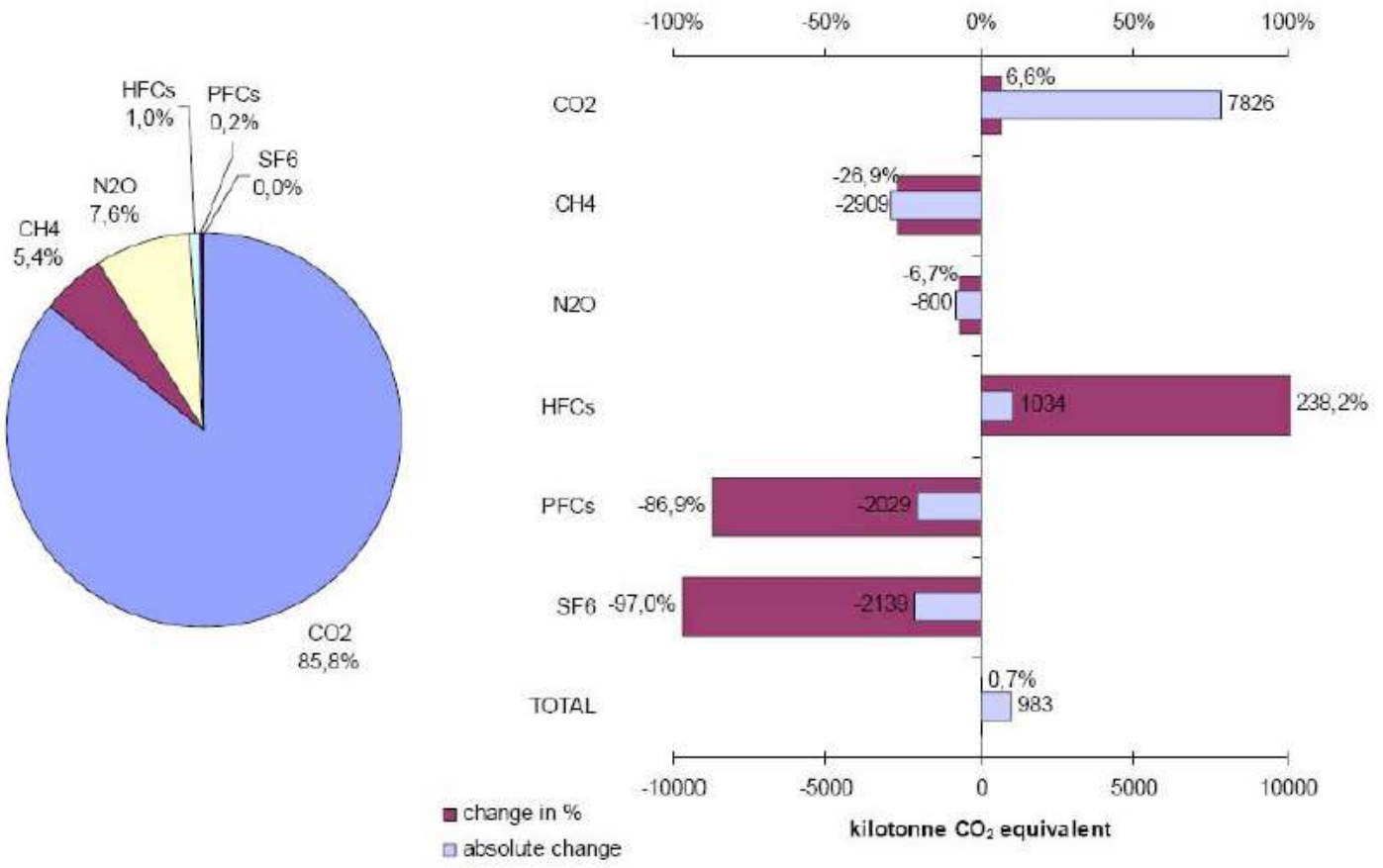


Figure 9.5 *Composition and change of Belgian GHG basket 2004. [NIR, 2006]*

Beyond the Scenarios

How about non-CO_2 GHG, Flexible Mechanisms?

Simple estimate: "guestimate"

- EU ~ 30% reduction GHG
- B ~ 25% reduct GHG (bubble EU; burden sharing)
- B ~ 20% reduction CO_2
- B ~ 15% domestic reduction ener-related CO_2

→ Likely -15% to …-20%...CO_2 reduction in B to be expected

Conclusions

- Reliable, clean & cheap energy provision daunting challenge !
- Belgium must fully subscribe to EU philosophy
- Baseline: nuclear replaced by coal → CO_2
- CCS very unlikely by 2030 (storage in B?)
-15% to 30% reduction CO_2 ; give substantial demand reductions & renewable energy expansion, but likely very expensive w/o nuclear
- Security of supply endangered → diversity

General Recommendations

Belgium must keep a EU perspective;
quick transposition of directives is called for

Need stable legislation & regulatory framework

Belgian energy responsibilities to be harmonized

Do not put all eggs in same basket; need diverse set of contributing elements

Belgium should prepare for a substantial post-Kyoto reduction (no ostrich attitude)

Concrete Recommendations

Do all that is reasonable for reducing energy demand

…start with EU directives quickly

…go perhaps beyond

Pass on energy prices to consumers

Concrete Recommendations

Should keep the nuclear option open:

…use Borssele scenario; reinject in DSM & renew; amount to be negotiated

… continued operation under strict safety rules

(regulators, IAEA, EURATOM, WANO…)

Concrete Recommendations

Renewable obligation (quota) best on supply; local production to be carefully considered via penalties

Off shore wind to be pursued

… reconsider earlier rejected sites

… develop far off-shore sites meticulously

Concrete Recommendations

Make commitment for one CCS pilot plant no later than 2030

Security of supply

… diversity of prim sources & technologies

… stable investment climate

… transmission & distribution networks

Concrete Recommendations

Liberalization of electricity & gas

…stable regulatory framework

…one wholesale NW-EUR region with sufficient cross border capacity; efficient & strict regulatory supervision

…retail market access to be developed over time

…vertical unbundling needed (grids outside, at least legally)

…guarantee for B: golden share in Suez/GdF?

Concrete Recommendations

Research & development

…do preferentially in a EU framework

…R&D for energy efficiency

…off shore wind development

…systems integration

…one CCS plant by 2030

…nuclear energy-system development

…energy-system model development

Concrete Recommendations

Sustained Strategic Watching Brief

…permanent follow up of recommendations

…supervised by independent core group

…statistics to be improved

Information

As of 16.00h Friday Nov 17, 2006,
Available on web site:

http://www.ce2030.be

- Executive Summary (C & R)
- Preliminary report
- Extra comments & reflections non-permanent members
- Supporting documents:
  - Contributions members
  - Report FPB

Conclusion

Please do not judge
based on emotion or sentiment!

Study the report carefully in all its aspects:

→Security of supply (LT & ST)

→Clean energy provision (climate & other)

→At reasonable prices and cost

We wish to be judged based on facts & figures;
Then draw conclusions and define policy!

Additional information

Cost of Nuclear Fuel

for

Electricity Generation

Additional information

Price Nuclear Fuel (SNT – G. Pauluis)

- Price nuclear fuel cycle ~ 15% of electricity cost
- Price of nuclear raw material U_3O_8 ~ 15% of nuclear fuel cycle cost
  - 50% - 50% upstream / downstream
  - ~ 1/4 to 1/3 of upstream is fuel element manufacturing
  - of other 70% ; 40% is for resource (other conversion UF_6 & enrichment)
    - → raw material cost is about ~ 0.5 x 0.7 x 0.4
      ≈ 14 % of fuel cycle cost

► Cost nuclear raw material ~ 0.15 x 0.14 ~ **2 %** electricity cost

Additional information

Price Nuclear Fuel (IAEA June 01 2006)

- Price nuclear fuel ~ 15% of electricity cost
- Price of nuclear raw material U_3O_8 ~ 33% of nuclear fuel element cost

► Cost nuclear raw material ~ 0.15 x 0.33 ~ 5 % electricity cost

w/o taking into account waste management cost

Assume 50% - 50% upstream / downstream fuel cycle cost

► Cost nuclear raw material ~ 0.05 x 0.5 ~ **2.5 %** electric cost

Additional information

Price Nuclear Fuel

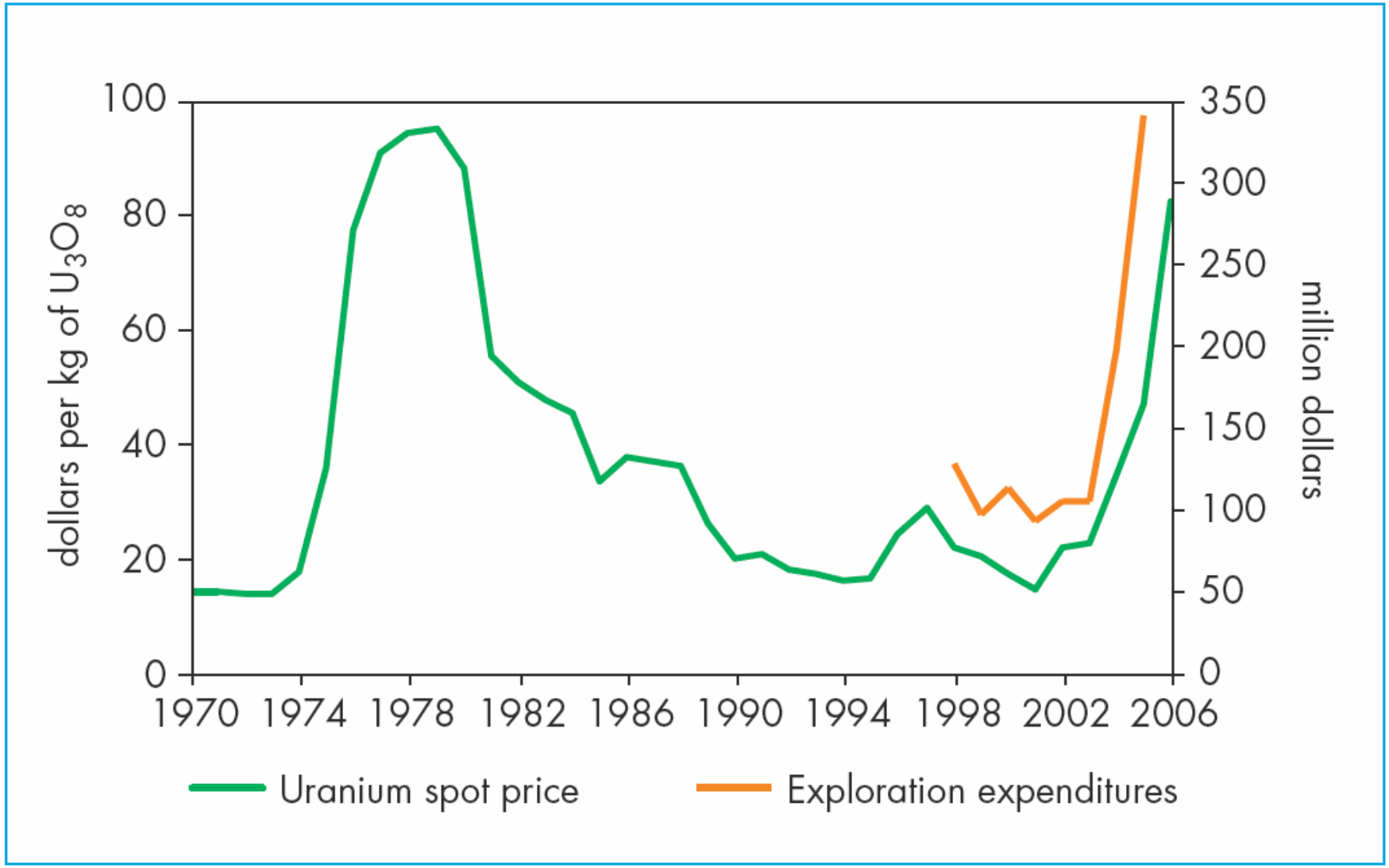
-Order of Magnitude Summary-

Cost of nuclear raw material U_3O_8

~ a few percent of electricity cost;

~ anyway less than 5% of nuclear-generated electricity cost

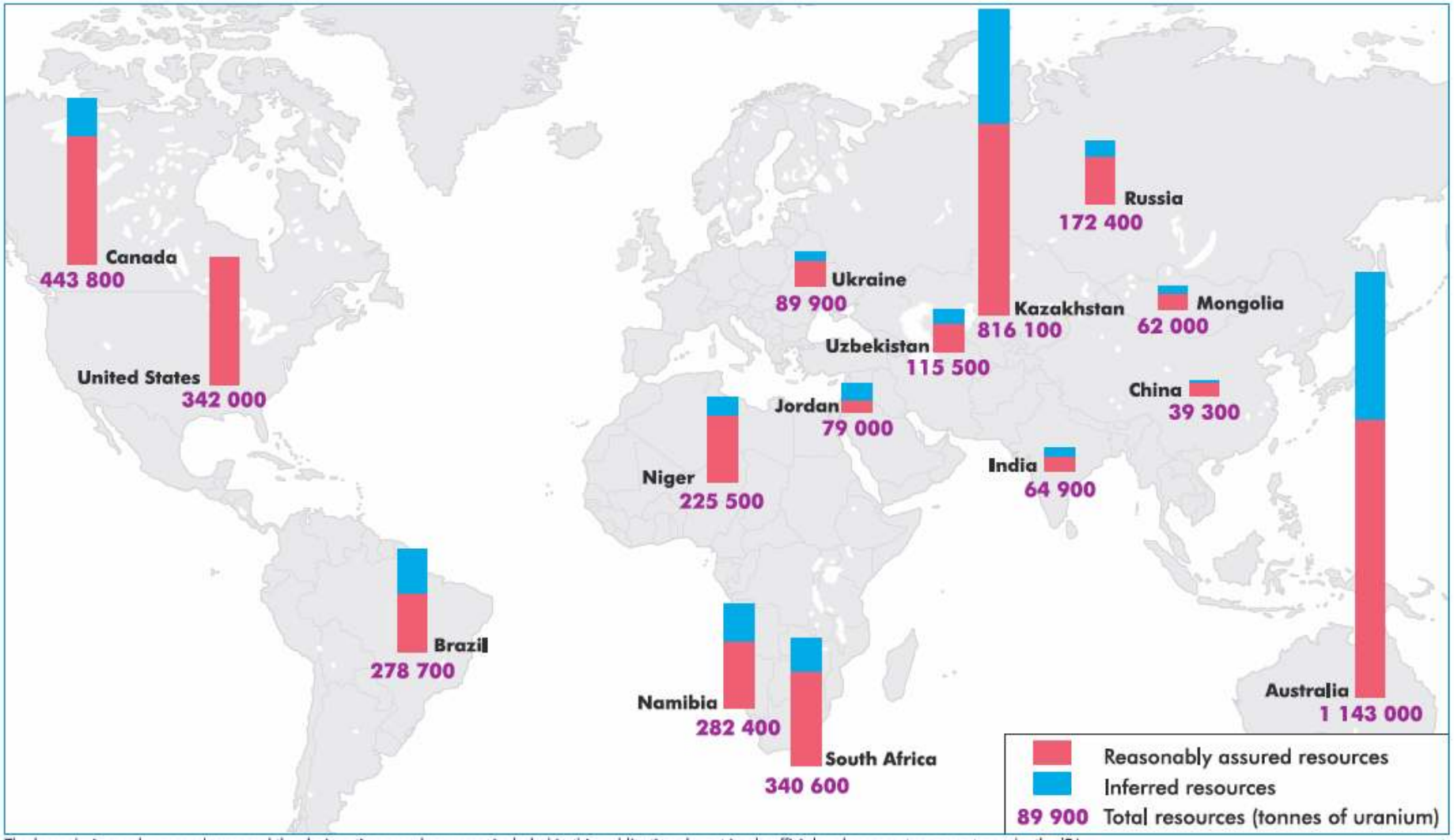
Figure 13.16: **Uranium Oxide (U_3O_8) Spot Prices and Exploration Expenditures**



Note: Prices are in current dollars.
Sources: TradeTech for uranium prices (www.uranium.info); NEA/IAEA (2006) for exploration expenditure.

Additional information

Figure 13.13: **Identified Uranium Resources in Top Twenty Countries** (tonnes U as of January 2005)



The boundaries and names shown and the designations used on maps included in this publication do not imply official endorsement or acceptance by the IEA.

Source: Based on NEA/IAEA (2006).

Additional information

Cost after Recycling

of CO_2 Revenues

for Reduction of Labor Charges

Additional information

Recycling of revenues to lower labor charges only applies when revenues are effectively collected:

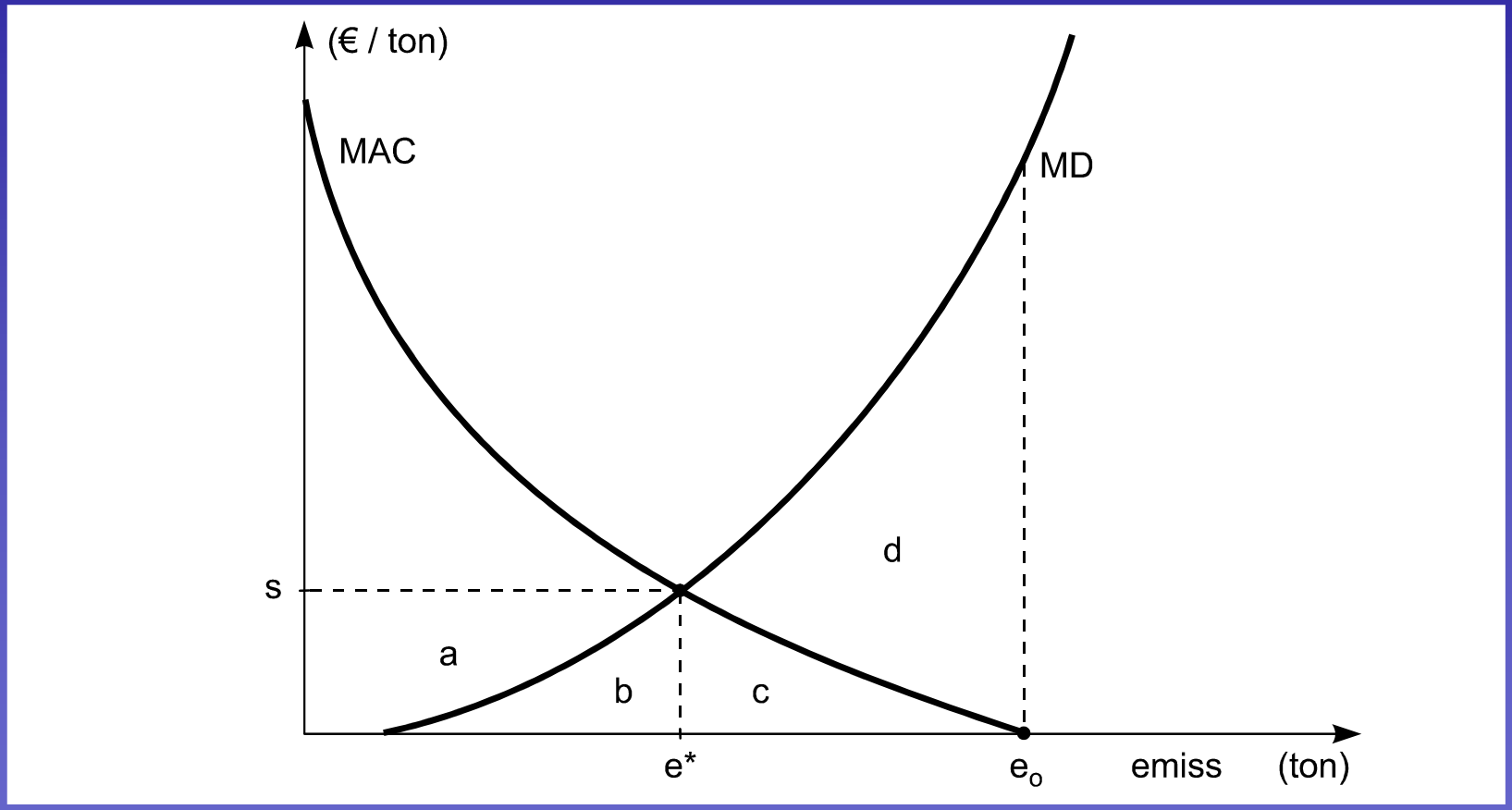
→CO_2 taxes imposed and collected;

→CO_2 allowances auctioned

Additional information

Marginal Abatement Cost (MAC) vs Marginal Damage Cost (MD)

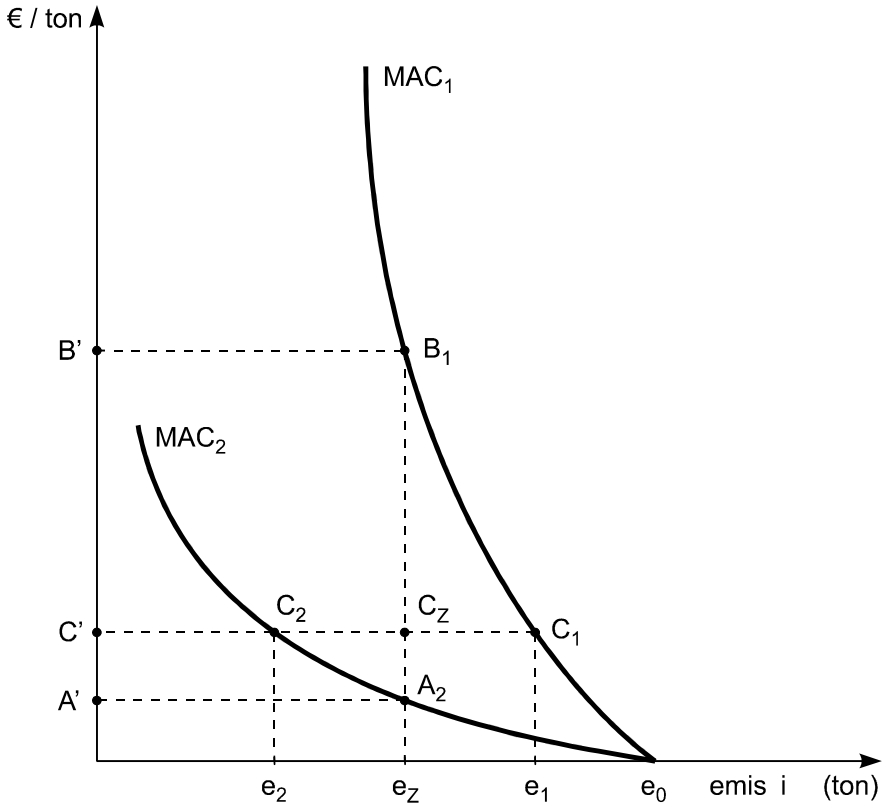
Report Pg 66 – Fig. 3.1



Additional information

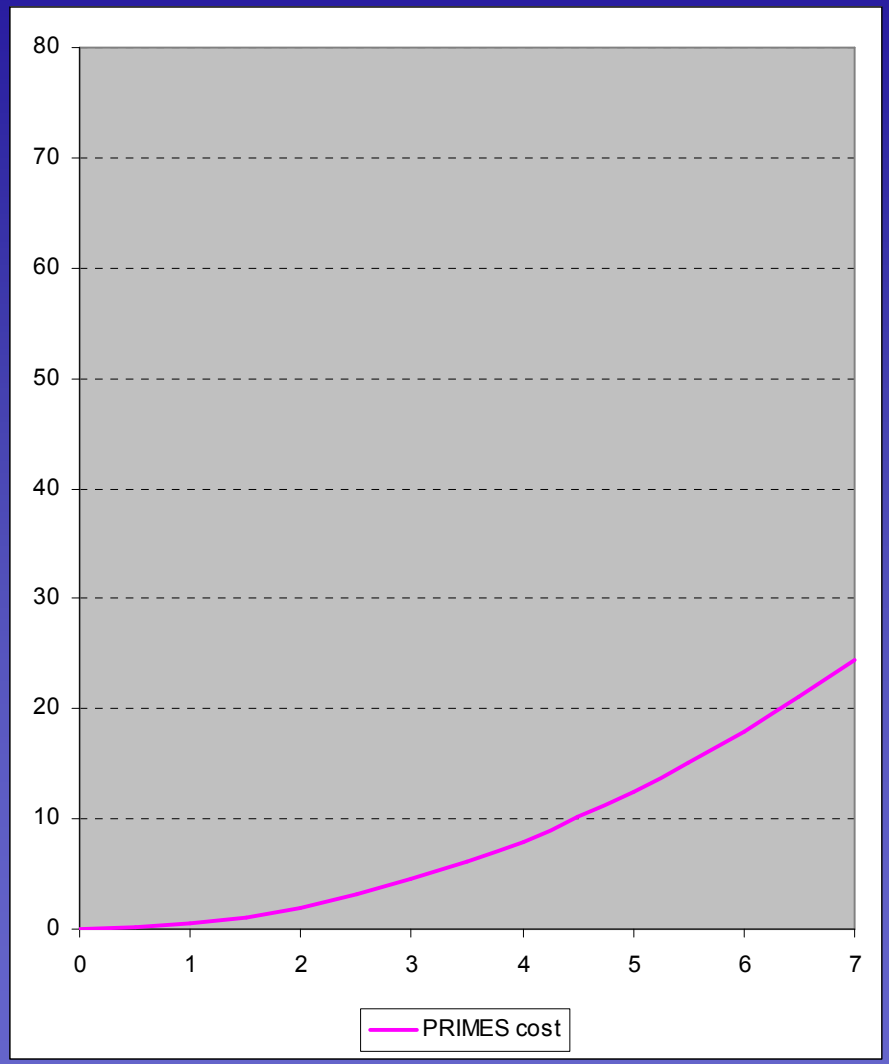
Equi-marginal abatement cost

Report Pg 67 – Fig. 3.2



Additional information *(schematic)*

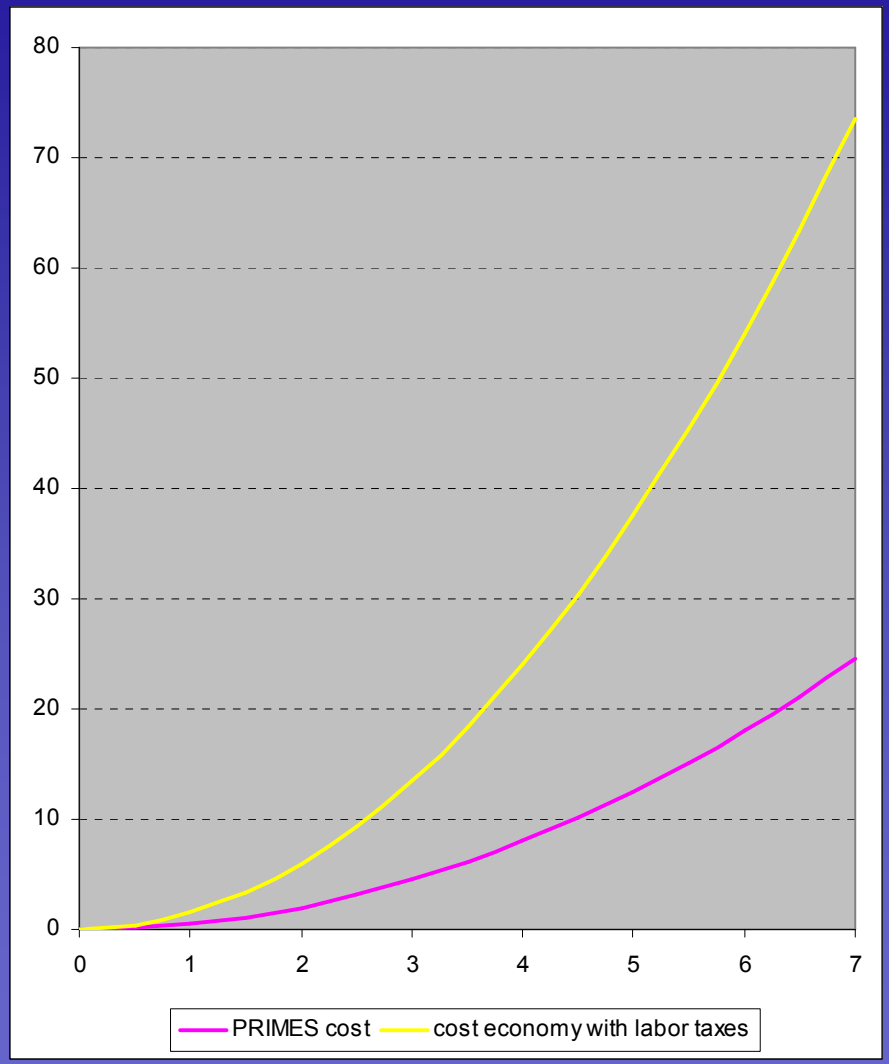
MAC as projected by PRIMES



Additional information *(schematic)*

MAC as projected by PRIMES

MAC when labor taxes present in rest of economy

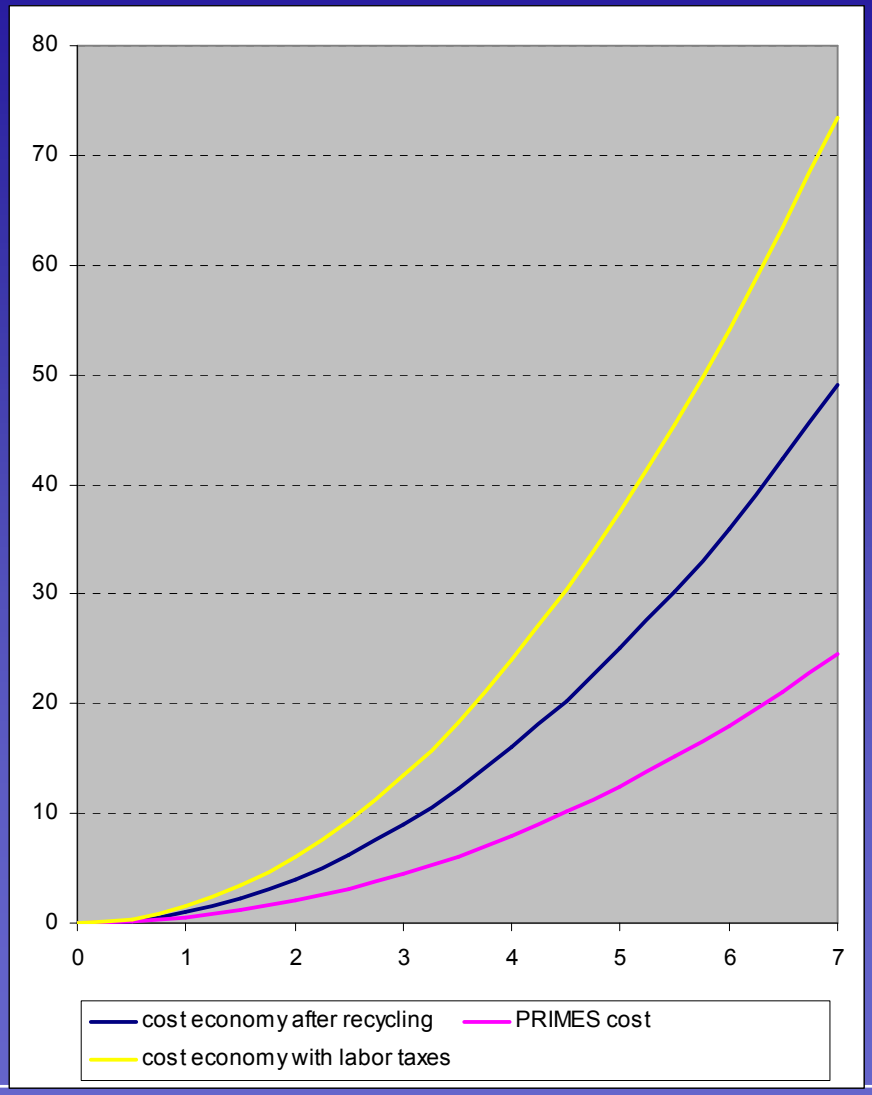


Additional information *(schematic)*

MAC as projected by PRIMES

MAC when labor taxes present

MAC after recycling via lower labor taxes

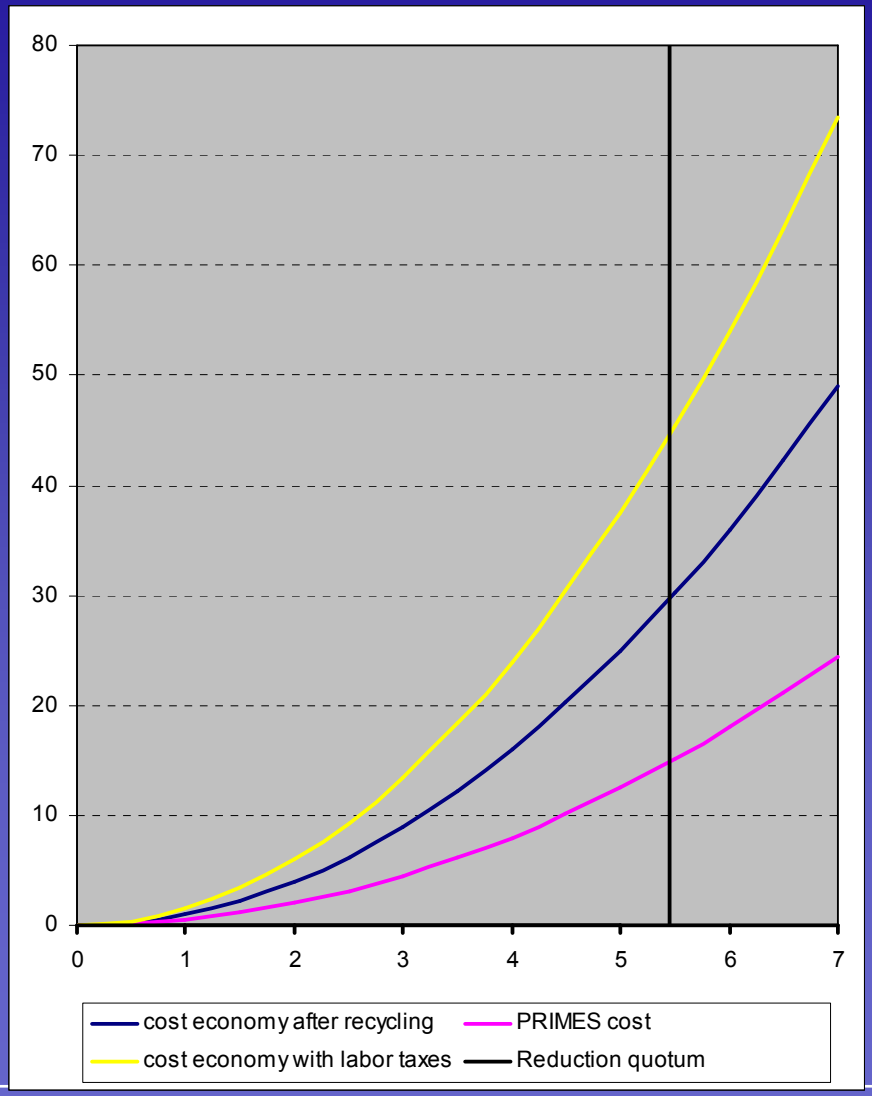


Additional information *(schematic)*

MAC as projected by PRIMES

MAC when labor taxes present

MAC after recycling via lower labor taxes



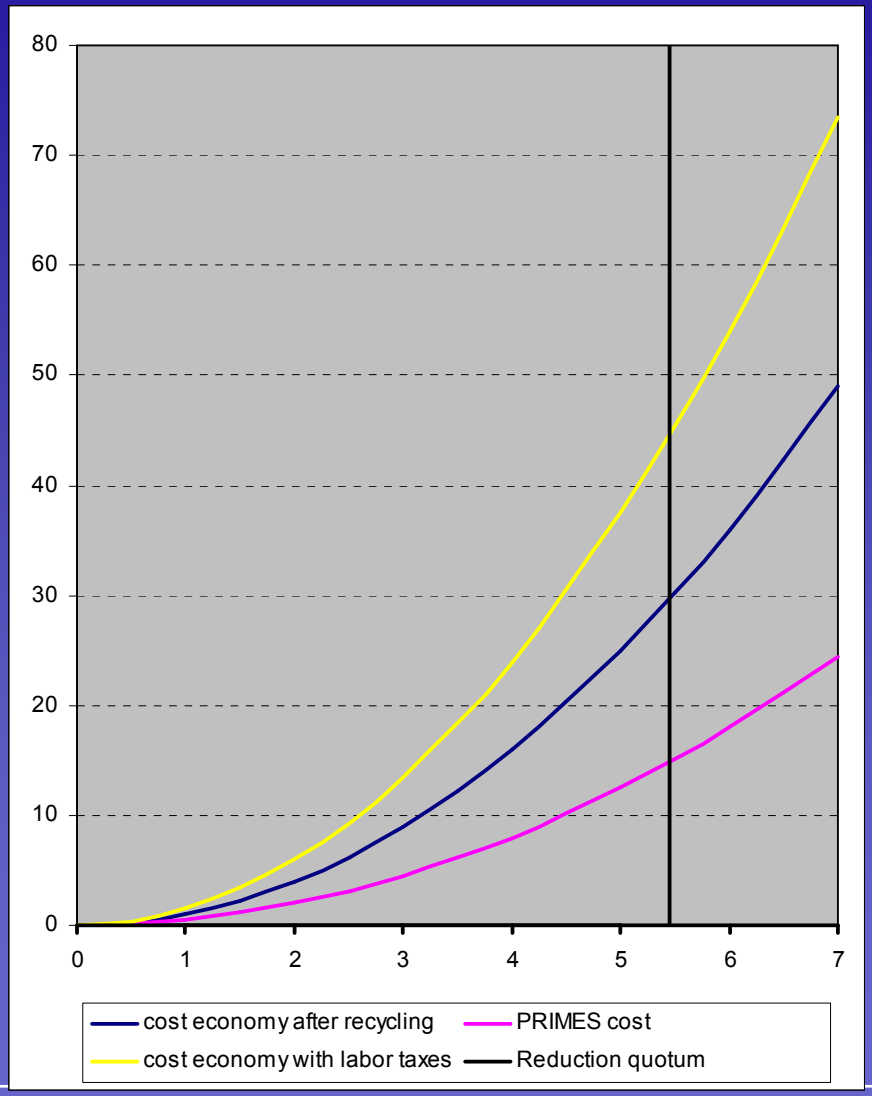
MAC with fixed reduction target

Additional information *(schematic)*

MAC as projected by PRIMES

MAC when taxes present

MAC after recycling



MAC with fixed reduction target

Cost PRIMES is NOT overestimate real costs!