PRIMES MODEL

IMPACT ASSESSMENT OF THE NEW POLICY OBJECTIVES OF THE EU

By Prof. Pantelis CAPROS
E3MLab/NTUA

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NEW ENERGY POLICY OF THE EU

- Head of States Decision of March 8, 2007
  - GHG Emissions of the EU in 2020 : 20% (mandatory) and under world conditions 30% down from 1990
  - Renewables as % of Final Energy Demand in 2020: 20%
  - Biofuels in 2020 : 10% of total liquids in transport
  - Energy Efficiency (-20% energy consumption) but not a binding objective
- European Commission proposed, 23-Jan-2008, legislation to enforce and distribute the targets by Member-State
  - EU ETS reinforced and based on full auctioning for power generation
  - Specific emission reduction targets by Member-State for non EU ETS sectors
  - Specific targets for Renewables binding each Member-State, trading among MS is allowed

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USE OF THE MODEL

- The energy model PRIMES of E3MLab has been used as the main tool in the preparation of the proposal of the European Commission
- Each burden sharing scheme has been fully quantified with PRIMES as an energy system scenario 2005 – 2030 with full details by sector (demand – supply) and by Member-State
- The E3MLab models have been used to evaluate also the impacts in terms of prices and costs, investment, GDP and employment per Member-State
- A major novelty is that emission permits to power generation are now based entirely on auctioning of allowances, revenues being recycled by the governments in the economy

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METHODOLOGY FOR BURDEN SHARING

- Three different objectives (-20% GHG, 20% RES, 10% biofuels) but interrelated since meeting one objective facilitates meeting the others
- The burden sharing aims at defining specific targets per Member-State and per sector (EU ETS only EU wide, non ETS by MS)
- The starting point is the "cost-efficient" burden sharing which corresponds to imposing the three targets as constraints at the EU level and let the EU-wide markets determine the allocation to countries and sectors

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COST-EFFICIENT BURDEN SHARING

- This is based on optimal allocation of abatement effort and RES deployment. All sectors and all countries face exactly the same marginal costs corresponding to the three constraints, namely lower GHG, higher RES, higher biofuels
- Equalizing the marginal costs leads to least cost allocation of GHG abatement and RES deployment by country and by sector
- The cost-efficient Burden Sharing minimises incremental energy system cost for the EU but leads to asymmetric impacts on the Member-States compared to GDP per capita

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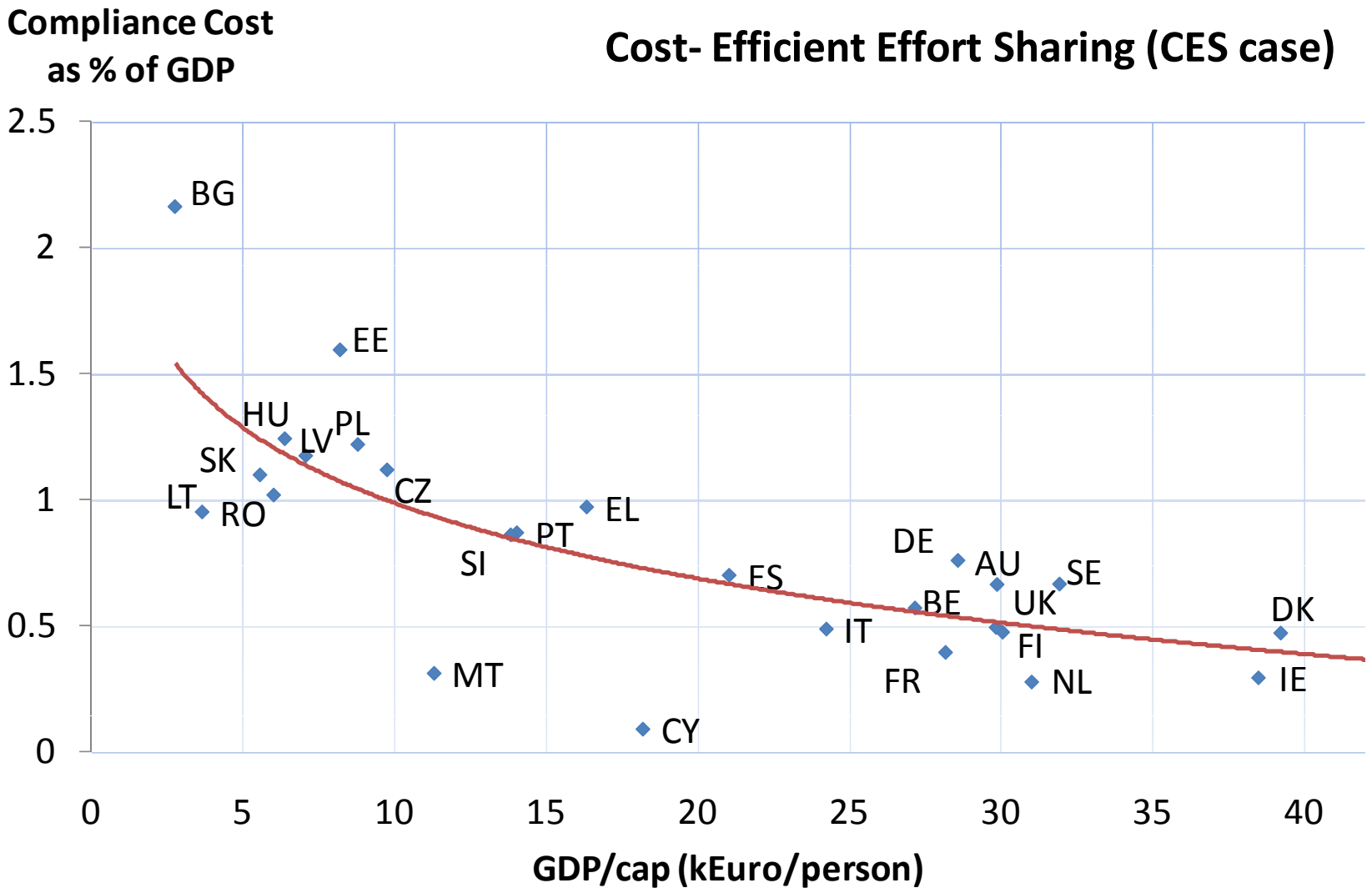
Minimum Compliance Cost but poor Distributional Equity



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EQUITY AND BURDEN SHARING

- The idea is to accept higher total compliance costs at the EU level, but improve the distributional equity of the burden sharing scheme in terms of Incremental Cost per unit of GDP across Member-States
- ETS remains a EU-wide market with a single market clearing price: a specific target is defined for ETS carbon abatement
  - -21% from 2005 for current sectors under EU ETS
  - -18% from 2005 if aviation is also part of the EU ETS
- The remaining GHG abatement is allocated to each country's Non-ETS
- RES are not allowed to trade (except biofuels) so RES target is differentiated by country

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Proposed Burden Sharing

Obligations for 2020		non EU ETS target (*)	RES target (**)
Austria	AT	-16%	34%
Belgium	BE	-15%	13%
Bulgaria	BG	20%	16%
Cyprus	CY	-5%	13%
Czech Republic	CZ	9%	13%
Denmark	DK	-20%	30%
Estonia	EE	11%	25%
Finland	FI	-16%	38%
France	FR	-14%	23%
Germany	DE	-14%	18%
Greece	EL	-4%	18%
Hungary	HU	10%	13%
Ireland	IE	-20%	16%
Italy	IT	-13%	17%
Latvia	LV	17%	42%
Lithuania	LT	15%	23%
Luxembourg	LU	-20%	11%
Malta	MT	5%	10%
Netherlands	NL	-16%	14%
Poland	PL	14%	15%
Portugal	PT	1%	31%
Romania	RO	19%	24%
Slovakia	SK	13%	14%
Slovenia	SI	4%	25%
Spain	ES	-10%	20%
Sweden	SE	-17%	49%
United Kingdom	UK	-16%	15%

Explanations:

(*) reduction of GHG by 2020 compared to 2005

(**) Share of renewables in final energy demand by 2020

- EU ETS emissions cap in 2020:
  - -21% from 2005 for current sectors under EU ETS
  - -18% from 2005 if aviation is also part of the EU ETS

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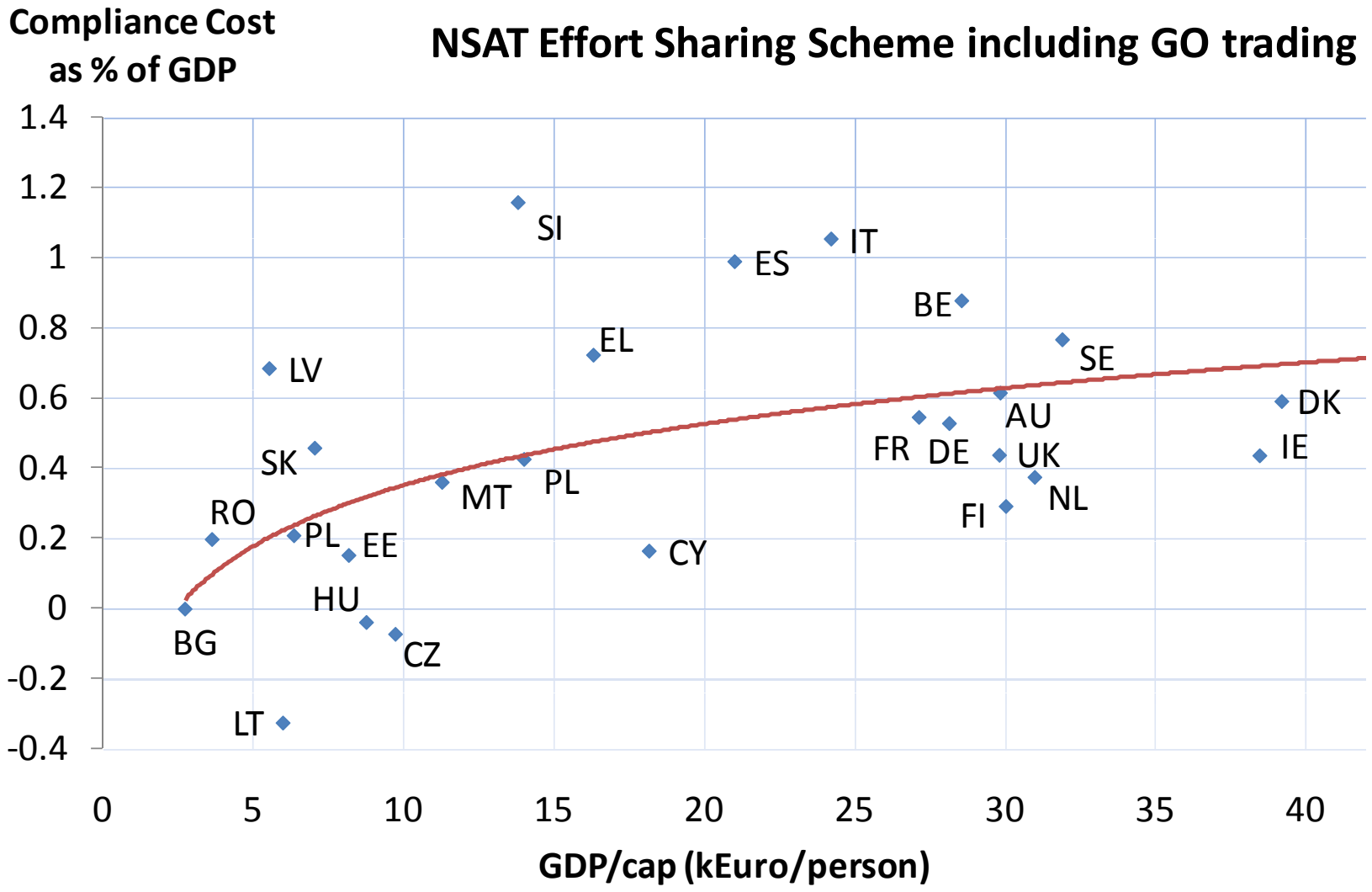
Higher Compliance Cost but Better Distributional Equity



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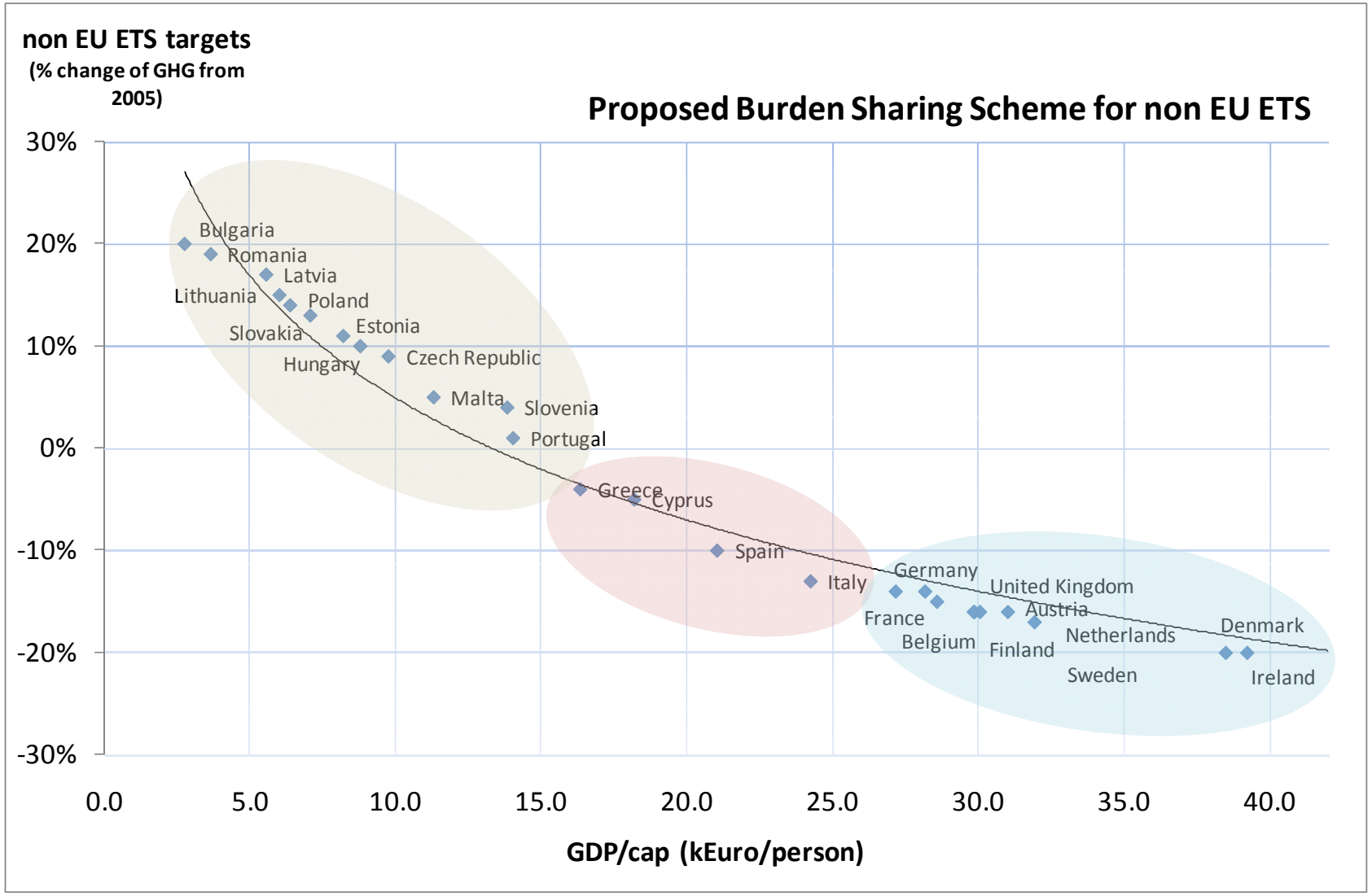
BURDEN SHARING PROPOSAL FOR THE GHG AND GDP SORTING OF THE MS



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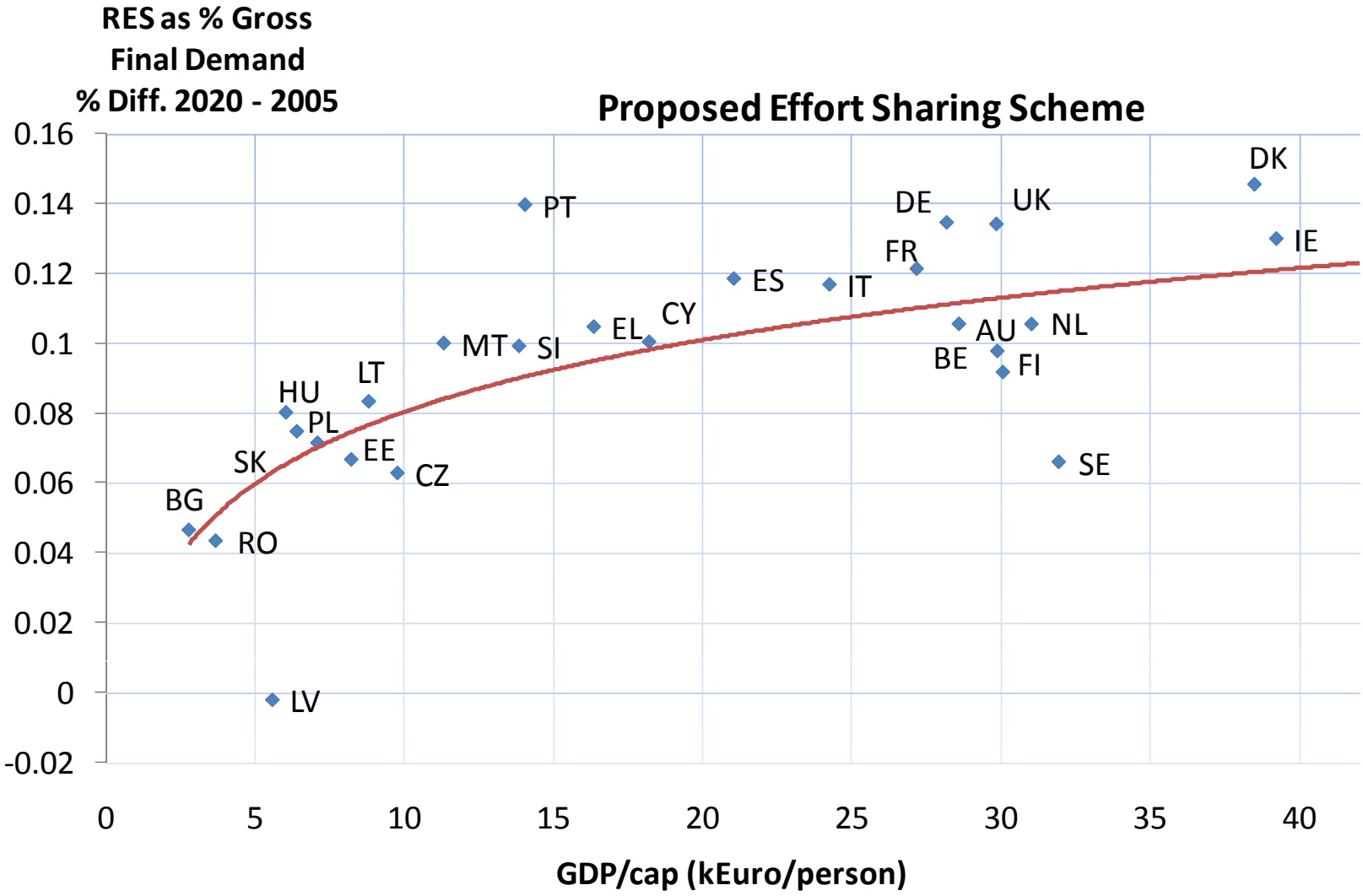
BURDEN SHARING PROPOSAL FOR RES AND GDP SORTING OF THE MS



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PRIMES SCENARIOS

- A large number of scenarios constructed for the period 2010 – 2020 – 2030, starting from Baseline of November 2007
- Sensitivity Analysis issues:
  - Doing only GHG reduction versus both GHG and RES
  - Doing only RES versus both GHG and RES
  - Using JI/CDM versus not abating only in the EU
  - Allowing trade of GO for RES versus not doing RES by MS
  - Auctioning EU ETS versus grandfathering (as today)
  - What if Baseline involved high oil and gas prices ?

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Comparison of Scenarios

Scenarios	*Name*	Compliance Cost (*) (billion €)	Compliance Cost as % of GDP	% change from Cost Efficiency (CES)
RSAT	EC Proposal without RES trading	111.2	0.71	22.5
RSAT-CDM	EC Proposal with CDM without RES trading	93.2	0.59	2.7
NSAT	EC Proposal with RES trading	94.1	0.60	3.7
NSAT-CDM	EC Proposal with CDM and with RES trading	70.1	0.45	-22.7
CES	Cost-Efficiency Scenario	90.8	0.58	
CES-CDM	Cost-Efficiency Scenario with CDM	75.2	0.48	-17.1
pure-GHG	Pure Carbon case	78.9	0.50	-13.0
pure-RES	Pure RES case	29.1	0.19	-67.9
HOG-BL	Baseline scenario with high oil & gas prices (**)	275.5	1.76	
HOG-CES	Cost Efficiency scenario with high prices (***)	59.8	0.38	

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Scenarios	CES	RSAT	NSAT	CES-CDM	RSAT-CDM	NSAT-CDM	HOG-CES
ETS Carbon Price (€/tCO2)	39.2	47.0	42.7	30.0	30.0	30.0	34.5
Auction Revenues (bill. €)	38.8	44.6	40.3	32.3	33.9	32.7	39.3
Avoided auction payments relative to Baseline scenario							
Total	22.0	28.2	25.9	14.2	12.6	13.8	14.2
- from carbon intensity	16.1	20.1	19.1	10.5	9.0	10.3	9.8
- from lower electricity demand	5.9	8.1	6.9	3.7	3.6	3.5	4.4

Comparison of Scenarios

Scenarios	Name
RSAT	EC Proposal without RES trading
RSAT-CDM	EC Proposal with CDM without RES trading
NSAT	EC Proposal with RES trading
NSAT-CDM	EC Proposal with CDM and with RES trading
CES	Cost-Efficiency Scenario
CES-CDM	Cost-Efficiency Scenario with CDM
pure-GHG	Pure Carbon case
pure-RES	Pure RES case
HOG-BL	Baseline scenario with high oil & gas prices (**)
HOG-CES	Cost Efficiency scenario with high prices (***)

Scenarios	BL	RSAT	NSAT	CES
GHG compared to 1990 in %	-1.5	-20	-20	-20
RES Share in Gross Final Energy	12.7	20	20	20
Carbon Price EU-ETS €/tCO2	22.0	47.0	42.7	39.2
Carbon Value non-ETS €/tCO2	0	35.2	37.2	39.2
RES value - energy supply €/MWh	0	49.6	44.5	44.8
RES value - energy demand €/MWh	0	49.9	44.5	44.8
RES value - biofuels €/MWh	0	69.5	44.5	44.8
Scenarios		RSAT-CDM	NSAT-CDM	CES-CDM
GHG compared to 1990 in %		-14.8	-15.2	-16.8
RES Share in Gross Final Energy		20	20	20
Carbon Price EU-ETS €/tCO2		30.0	30.0	30.0
Carbon Value non-ETS €/tCO2		20.9	22.2	30.0
RES value - energy supply €/MWh		53.0	49.5	48.2
RES value - energy demand €/MWh		52.2	49.5	48.2
RES value - biofuels €/MWh		82.9	49.5	48.2
Sensitivity Analysis	pure-GHG	pure-RES	HOG-BL	HOG-CES
GHG compared to 1990 in %	-20	-9.3	-7.1	-20
RES Share in Gross Final Energy	15.9	20	14.9	20
Carbon Price EU-ETS €/tCO2	48.5	22.0	22.0	34.5
Carbon Value non-ETS €/tCO2	48.5	0	0	34.5
RES value - energy supply €/MWh	0	56.0	0	36.8
RES value - energy demand €/MWh	0	56.0	0	36.8
RES value - biofuels €/MWh	0	56.0	0	36.8

DISTRIBUTIONAL EQUITY

	Compliance Cost as % of GDP in 2020				
	NSAT without flows from RES trading	NSAT with auction rights redistributed and without RES trading	Same as previous, but in addition RES trading	NSAT-CDM but auction rights redistributed	Same as previous, but in addition RES trading
Bulgaria	1.09	-0.35	-1.44	0.14	-1.22
Romania	0.38	0.30	0.12	0.29	0.06
Latvia	1.56	1.47	0.59	1.02	-0.01
Lithuania	0.52	0.36	-0.48	0.43	-0.70
Poland	0.48	0.32	0.05	0.38	0.06
Slovakia	0.77	0.72	0.40	0.60	0.29
Estonia	1.10	0.43	-0.52	0.59	-0.53
Hungary	0.46	0.29	-0.21	0.36	-0.39
Czech Rep.	0.49	0.03	-0.53	0.20	-0.50
Malta	0.17	-0.36	-0.17	-0.21	0.01
Slovenia	1.08	0.92	0.99	0.74	0.81
Portugal	0.48	0.54	0.49	0.57	0.48
Greece	0.74	0.53	0.52	0.60	0.59
Cyprus	0.07	-0.04	0.05	-0.03	0.07
Spain	1.20	1.07	0.86	0.62	0.41
EU27	0.60	0.60	0.60	0.45	0.45
Italy	0.96	1.02	1.11	0.51	0.66
Germany	0.47	0.60	0.67	0.49	0.56
France	0.39	0.37	0.51	0.32	0.47
Belgium	0.86	0.97	0.98	0.69	0.70
UK	0.36	0.36	0.43	0.34	0.42
Austria	0.86	0.82	0.57	0.58	0.34
Finland	0.53	0.56	0.32	0.52	0.19
Netherlands	0.34	0.43	0.46	0.28	0.32
Sweden	0.70	0.72	0.78	0.74	0.81
Denmark	0.56	0.48	0.36	0.22	0.13
Ireland	0.62	0.64	0.61	0.47	0.45
Luxembourg	0.88	0.90	0.97	0.59	0.70

Clearing Price of GOs = 44.5 €/MWh	RES Target (%)	Cost-Effec-tive RES - % (NSAT)	Purchase (-) or Sale (+) of GOs in TWh	Cost (-) or Revenue (+) from GOs in bill. €	Gain (+) or Loss (-) as % of GDP
Bulgaria	16	24	12.1	0.5	1.1
Romania	24	26	7.5	0.3	0.2
Latvia	42	52	6.3	0.3	0.9
Lithuania	23	35	8.5	0.4	0.8
Poland	15	18	28.7	1.3	0.3
Slovakia	14	18	5.5	0.2	0.3
Estonia	25	37	5.0	0.2	1.0
Hungary	13	20	16.5	0.7	0.5
Czech Rep.	13	19	22.7	1.0	0.6
Malta	10	6	-0.3	0.0	-0.2
Slovenia	25	24	-0.7	0.0	-0.1
Portugal	31	32	2.6	0.1	0.1
Greece	18	19	0.9	0.0	0.0
Cyprus	13	11	-0.5	0.0	-0.1
Spain	20	26	66.0	2.9	0.2
EU27	20	20	0.0	0.0	0.0
Italy	17	15	-37.2	-1.7	-0.1
Germany	18	16	-47.8	-2.1	-0.1
France	23	19	-76.8	-3.4	-0.1
Belgium	13	13	-1.0	0.0	0.0
UK	15	13	-45.8	-2.0	-0.1
Austria	34	40	18.7	0.8	0.2
Finland	38	42	12.0	0.5	0.2
Netherlands	14	13	-5.5	-0.2	0.0
Sweden	49	48	-6.2	-0.3	-0.1
Denmark	30	35	7.7	0.3	0.1
Ireland	16	18	1.9	0.1	0.0
Luxembourg	11	10	-0.8	0.0	-0.1

ENERGY SYSTEM IMPACTS OF EC PROPOSED EFFORT-SHARING SCENARIO

PRIMES Model
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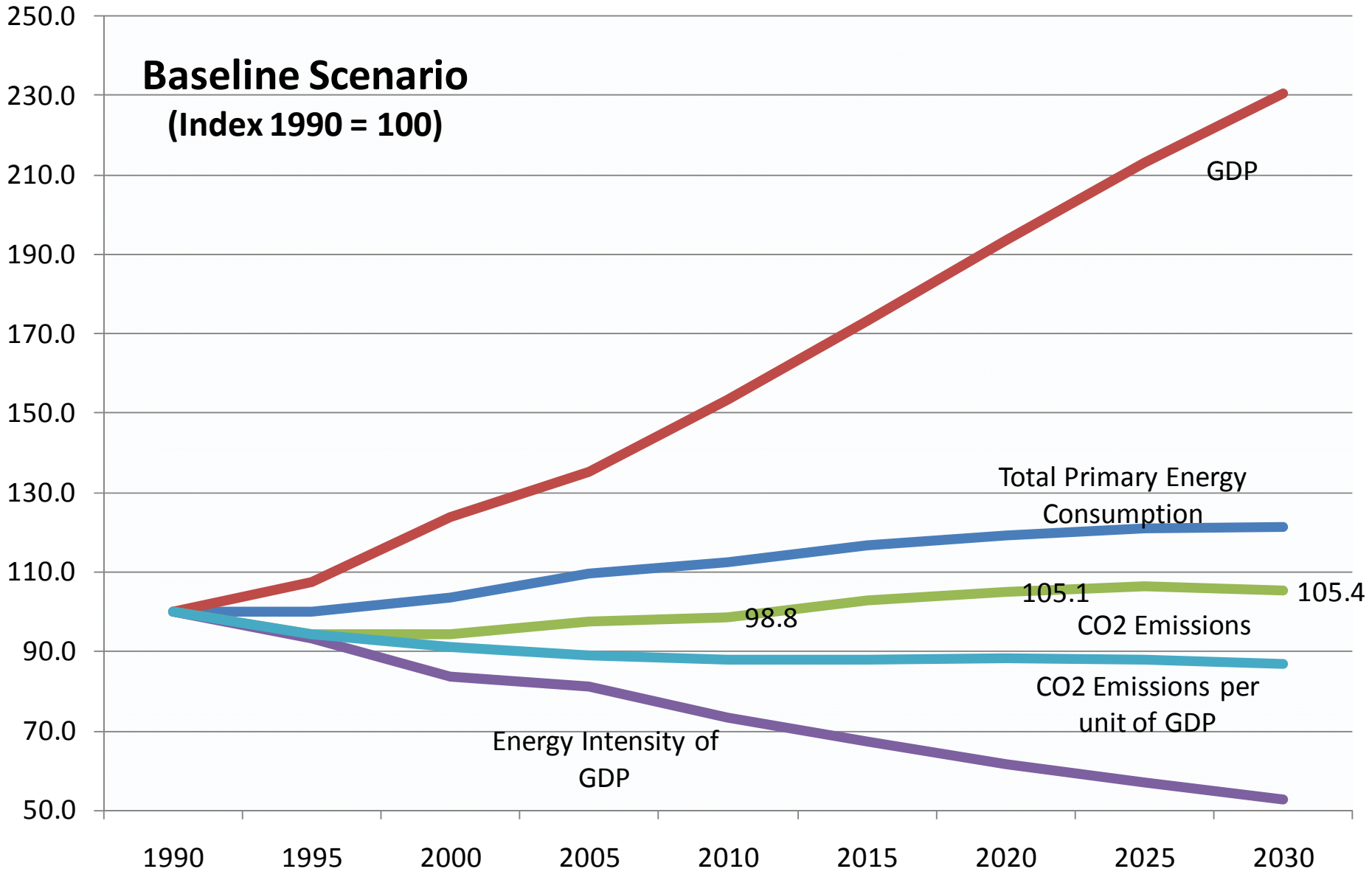
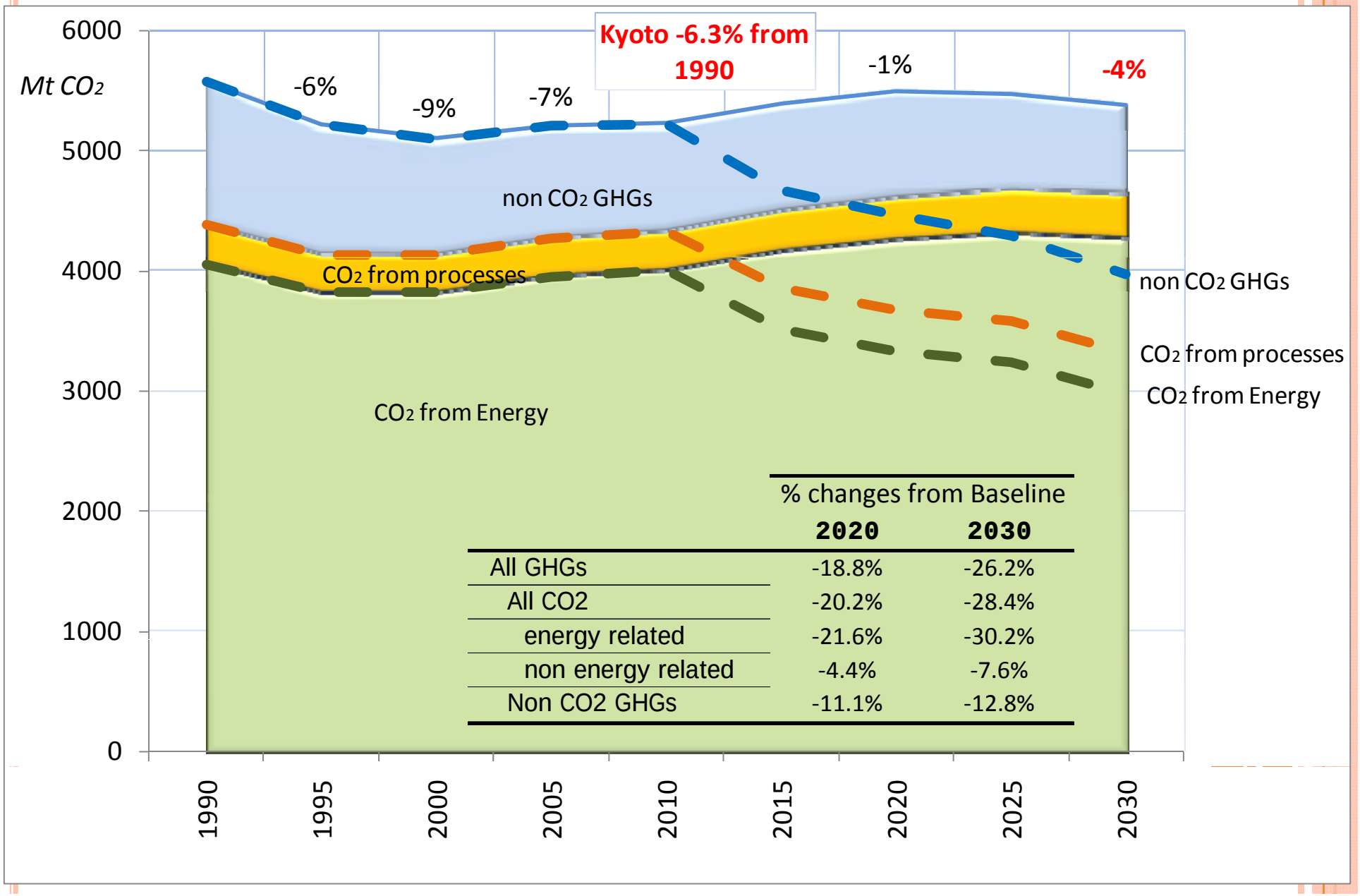
Baseline Trends in the EU (PRIMES)

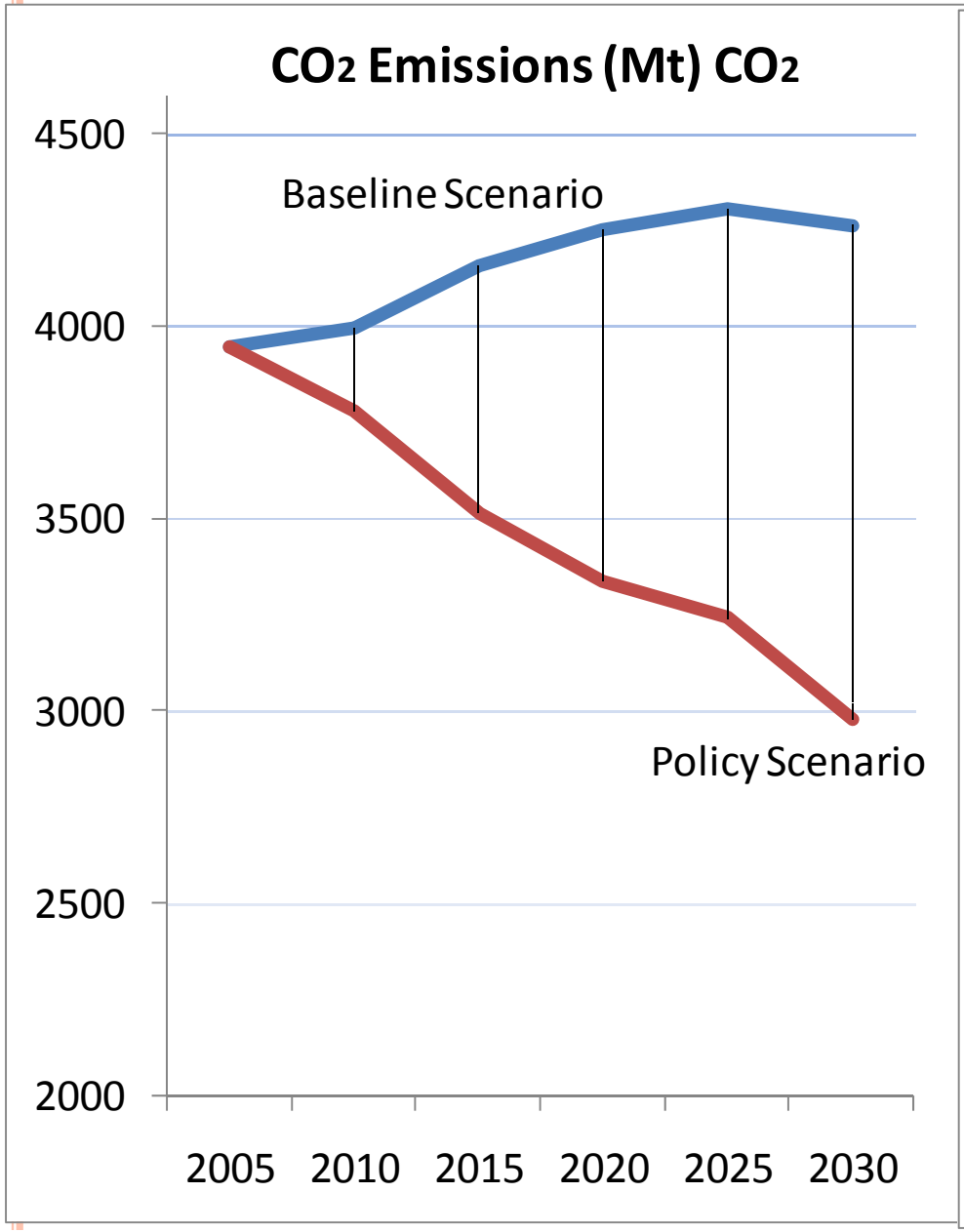


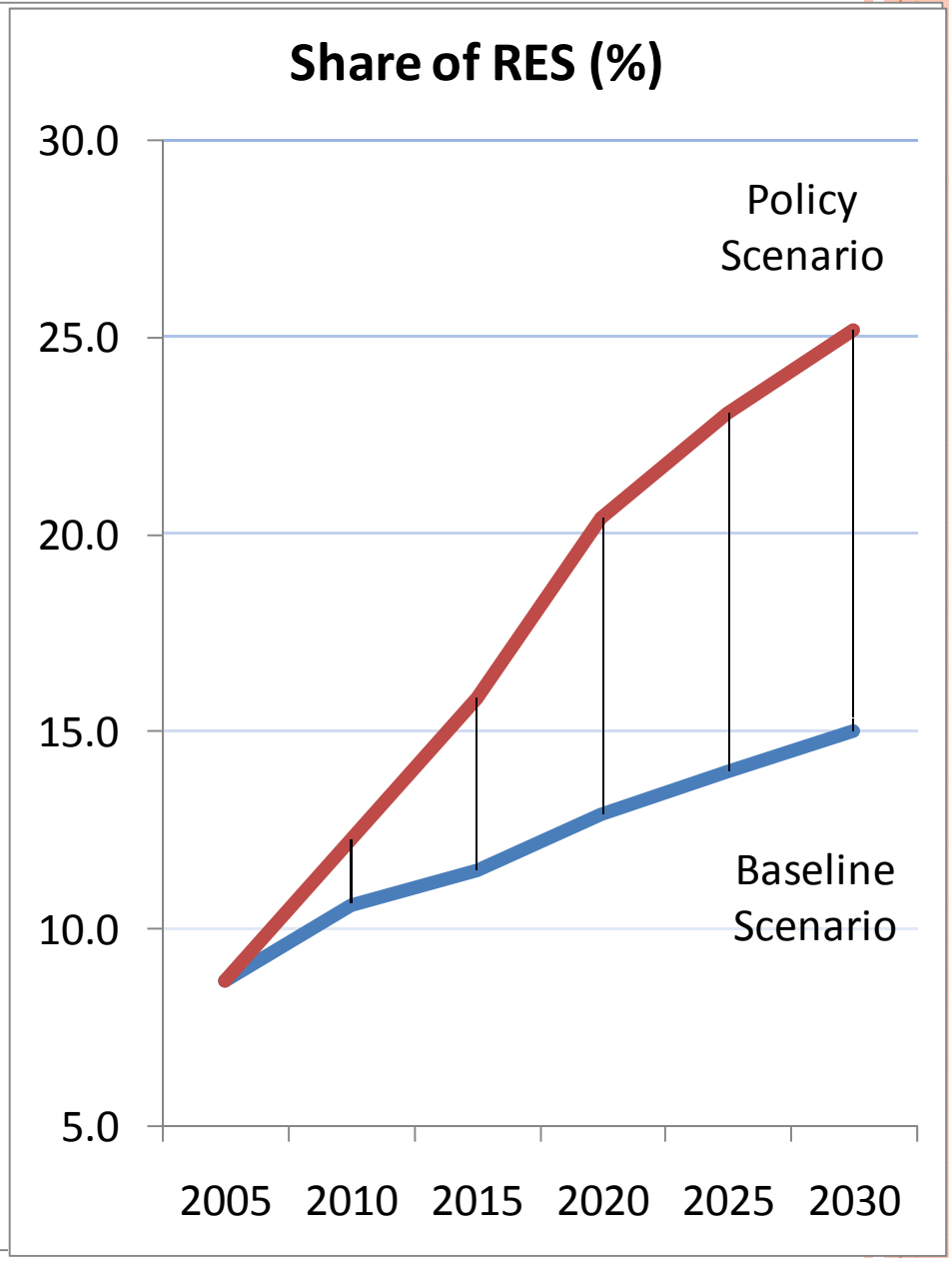
ALL GHGS VERSUS BASELINE



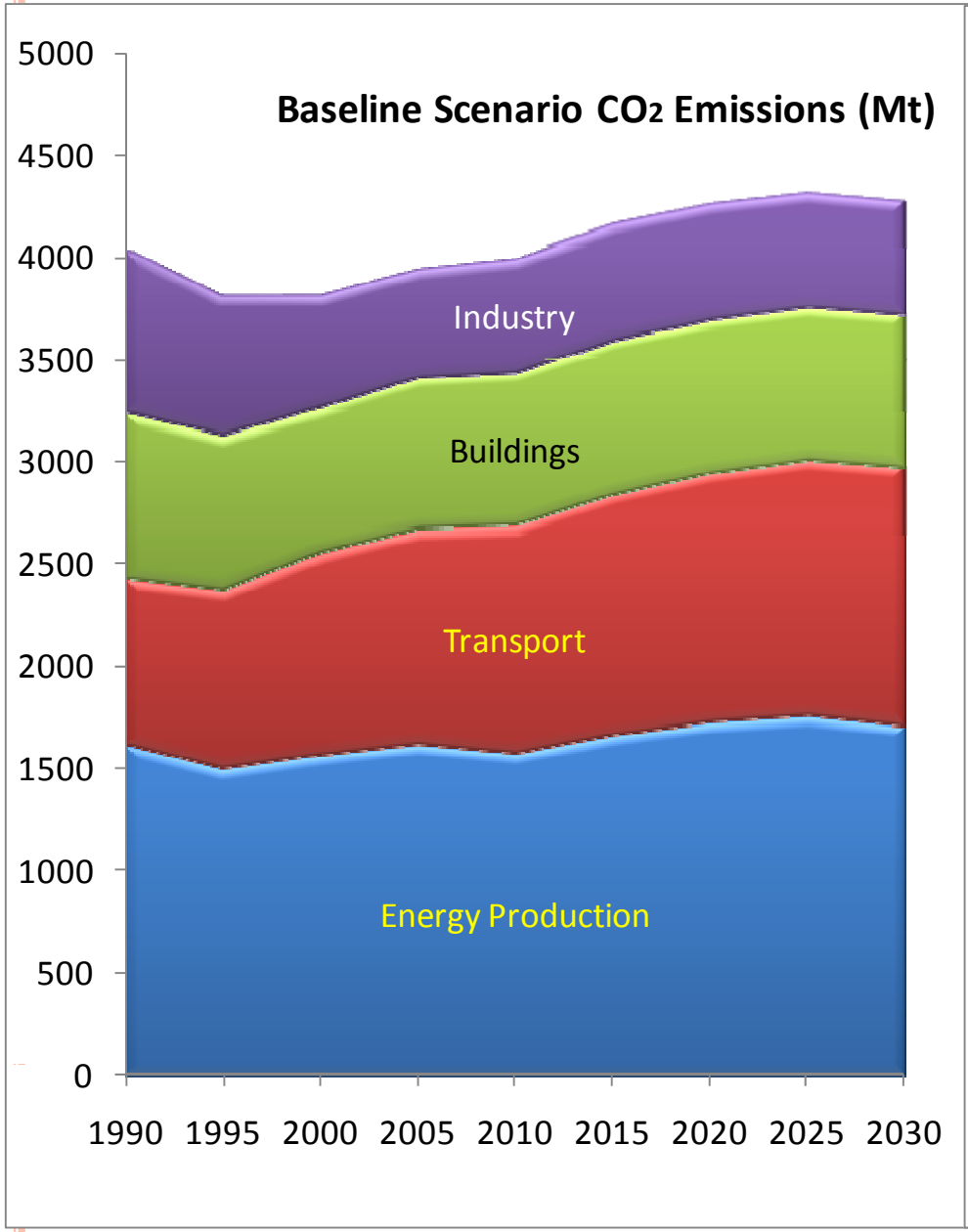
	% changes from Baseline	
	2020	**2030**
All GHGs	-18.8%	-26.2%
All CO2	-20.2%	-28.4%
energy related	-21.6%	-30.2%
non energy related	-4.4%	-7.6%
Non CO2 GHGs	-11.1%	-12.8%

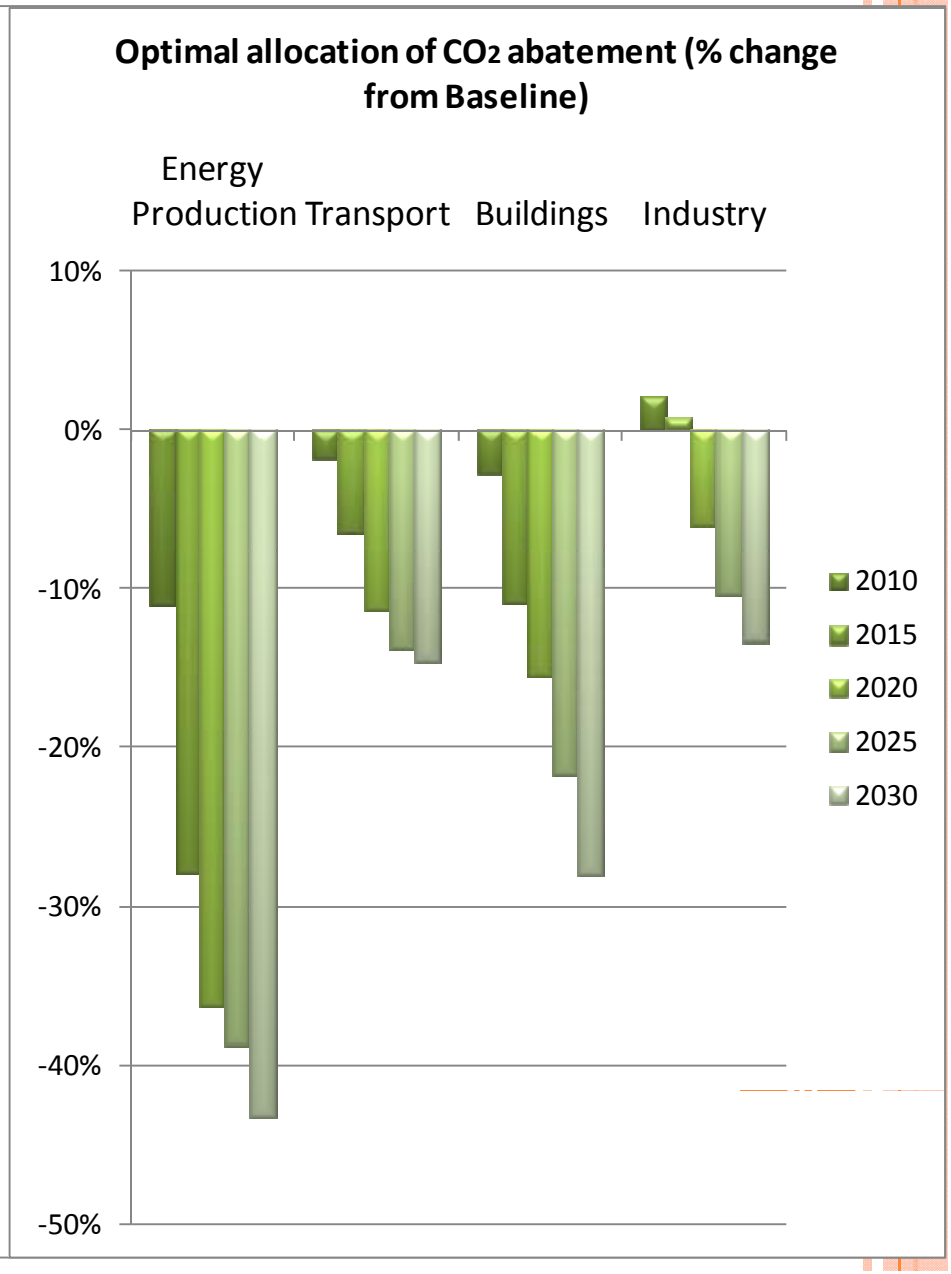
New targets versus Baseline for EU27



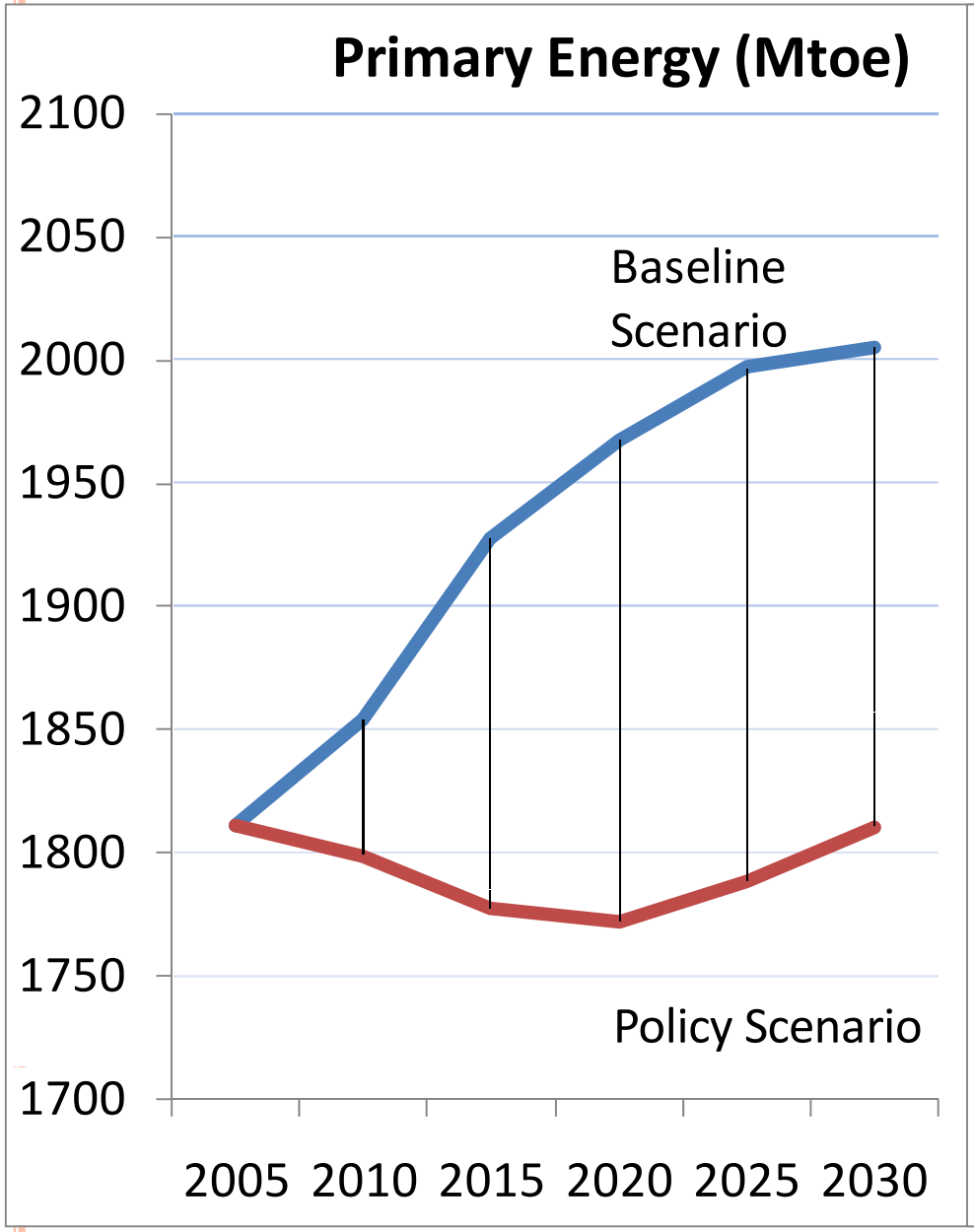


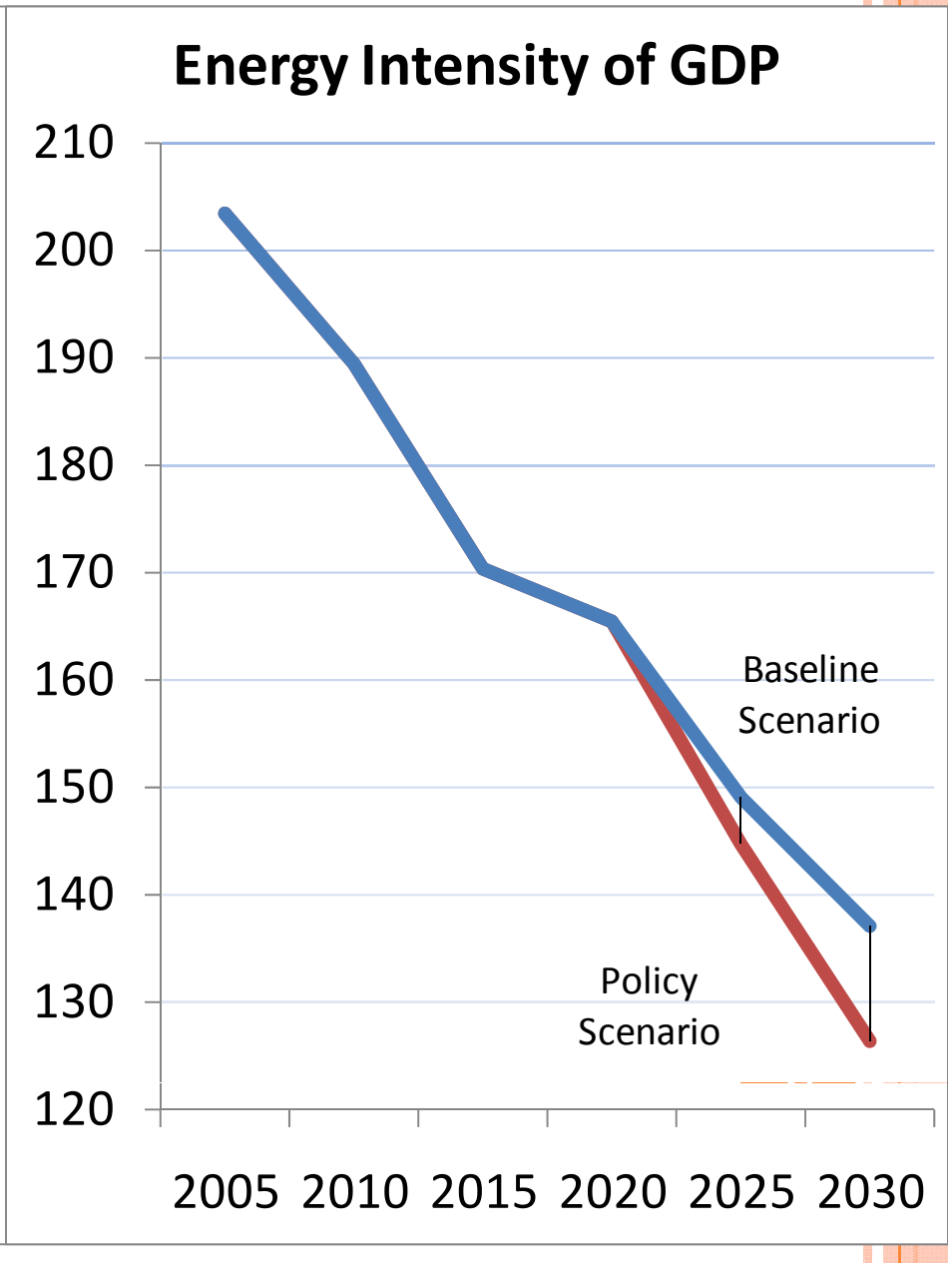
Optimal allocation of CO_2 abatement



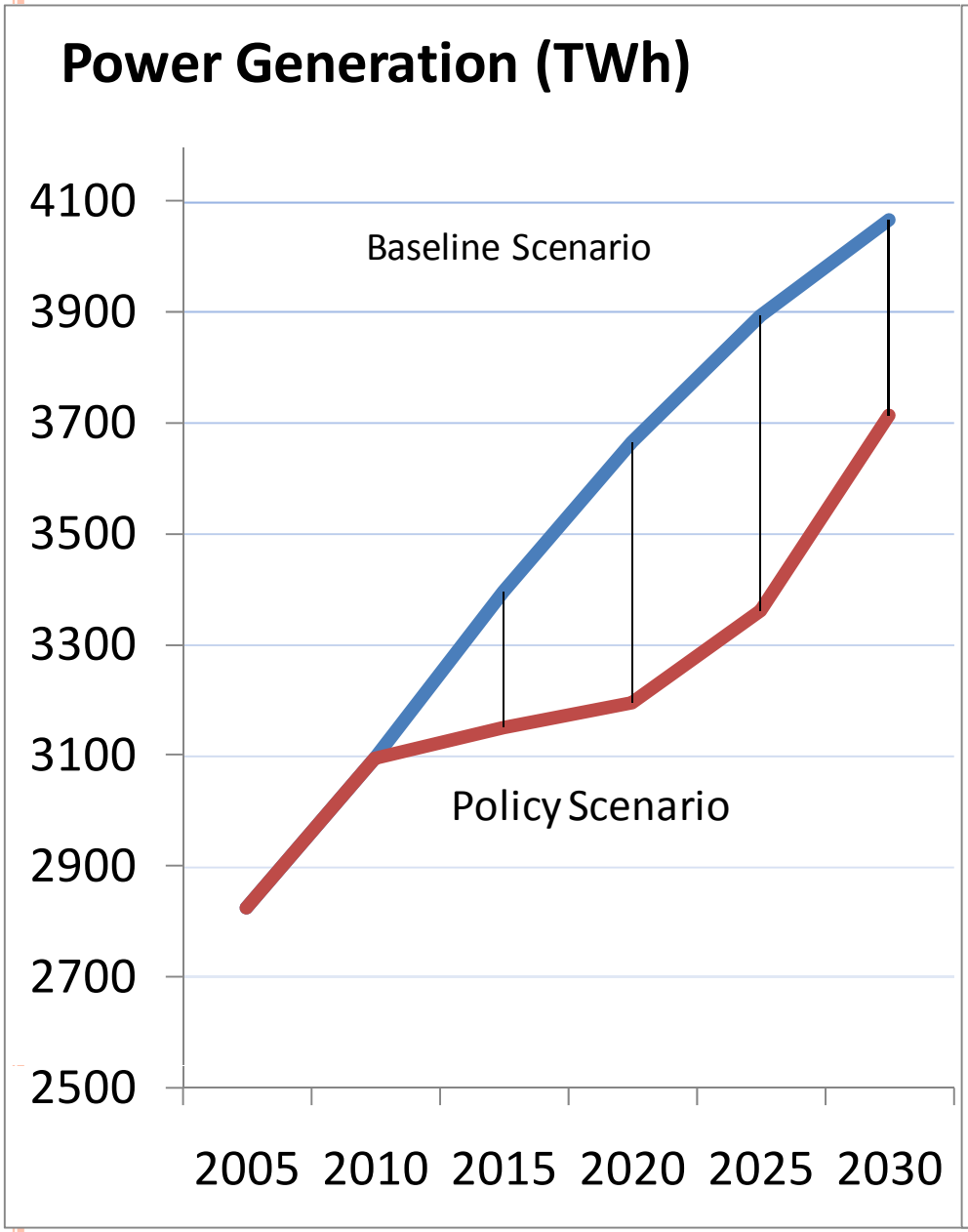


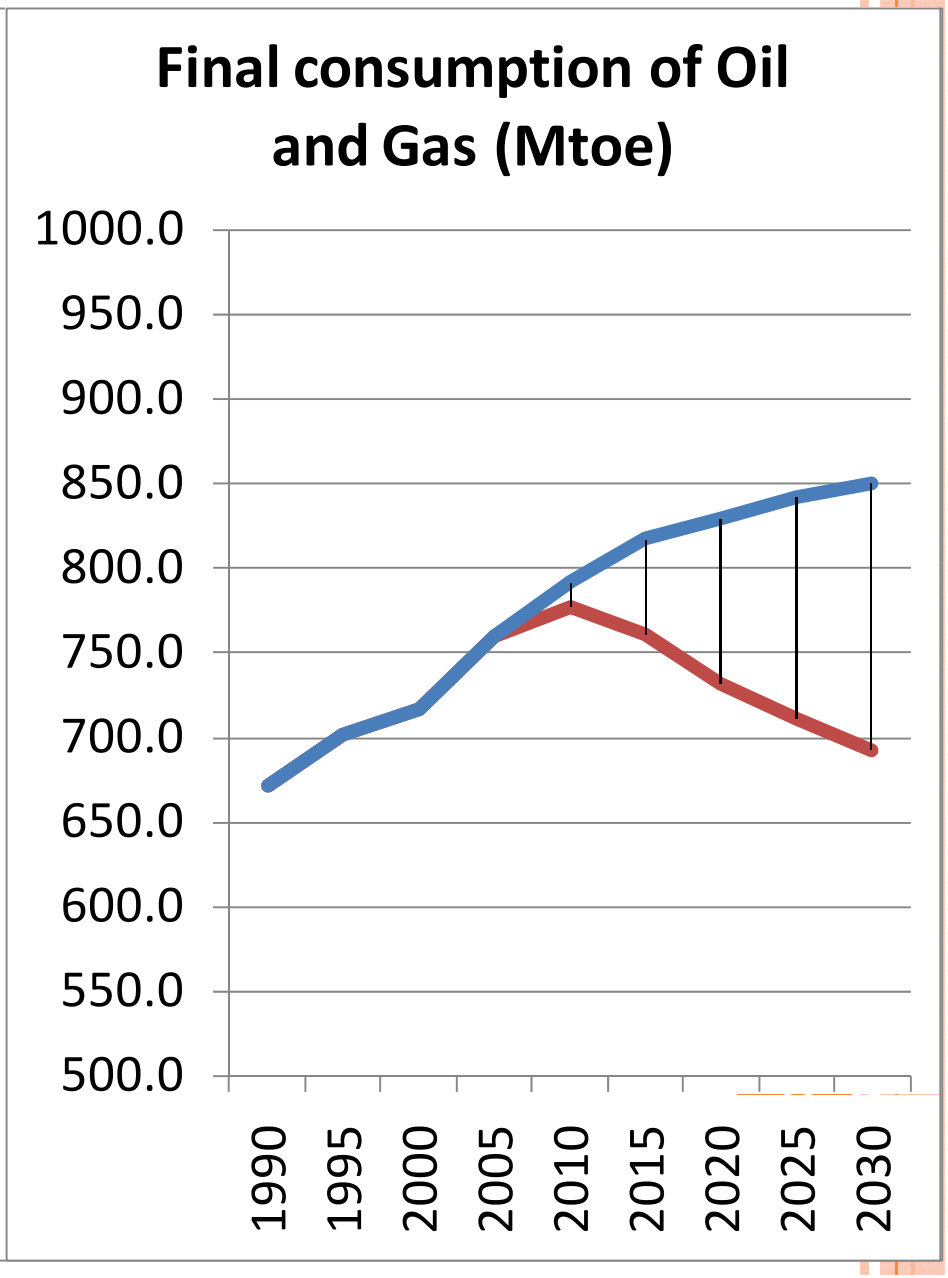
Indirect effects on Energy Intensity



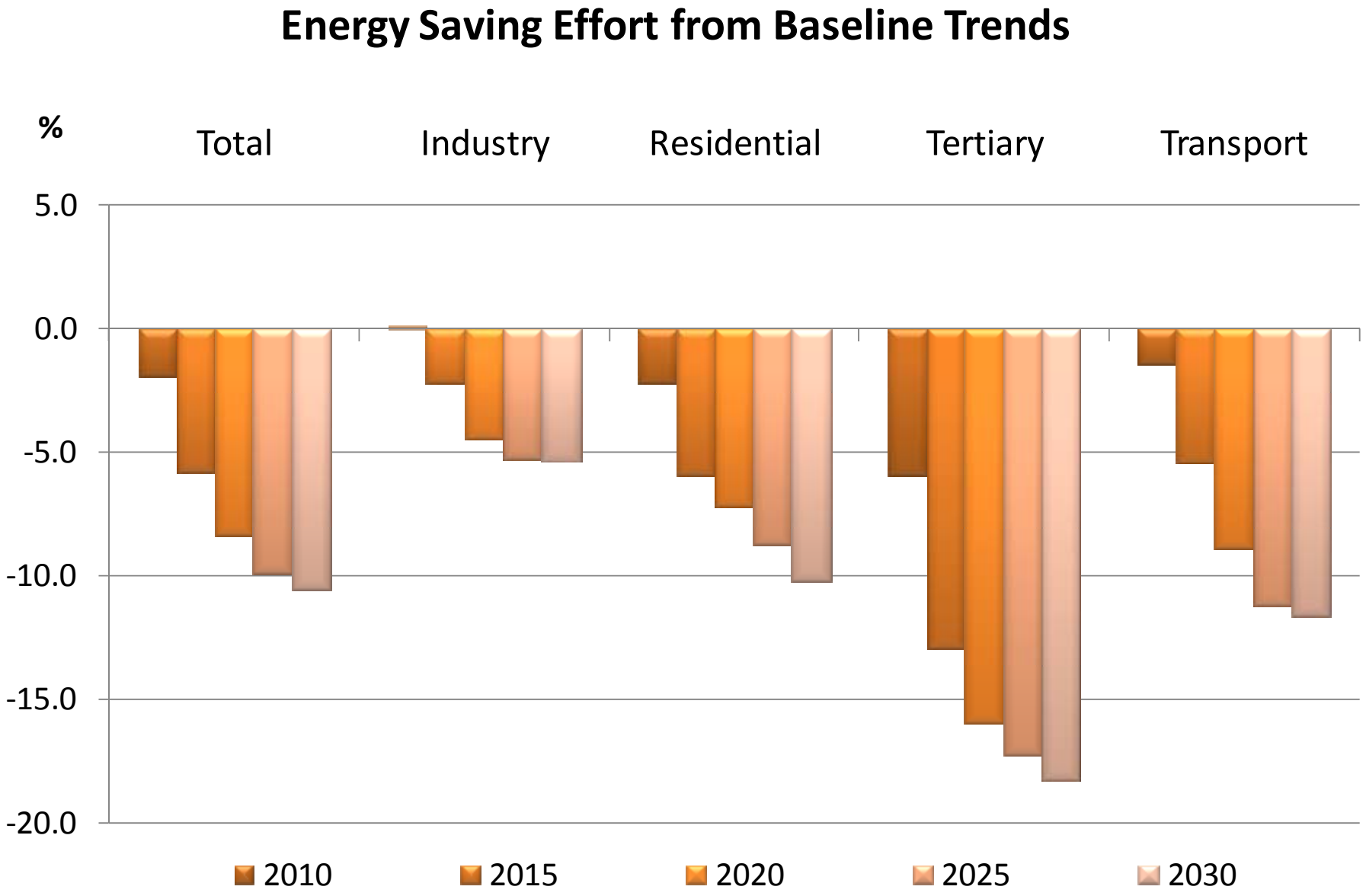


Changes in Final Energy Consumption

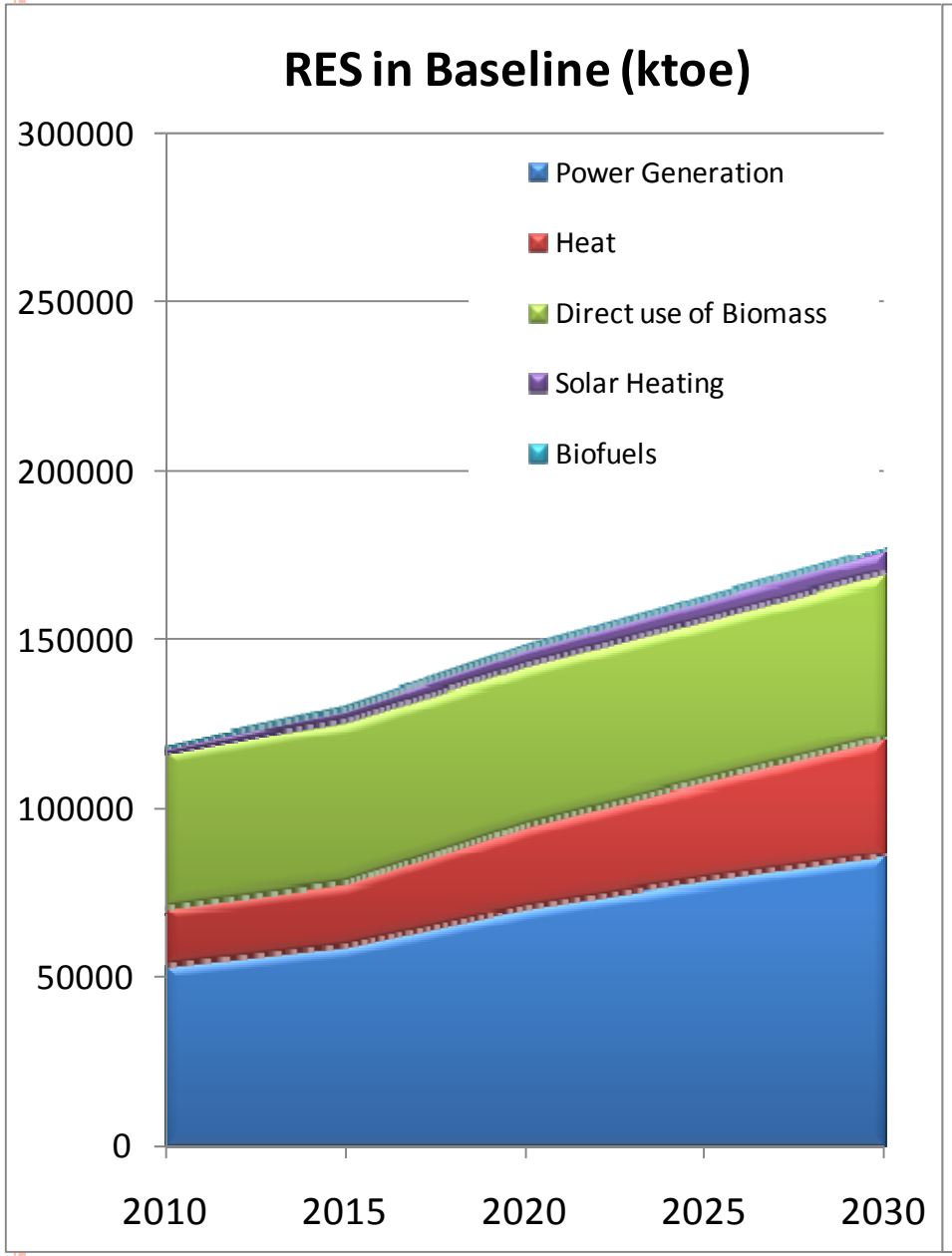


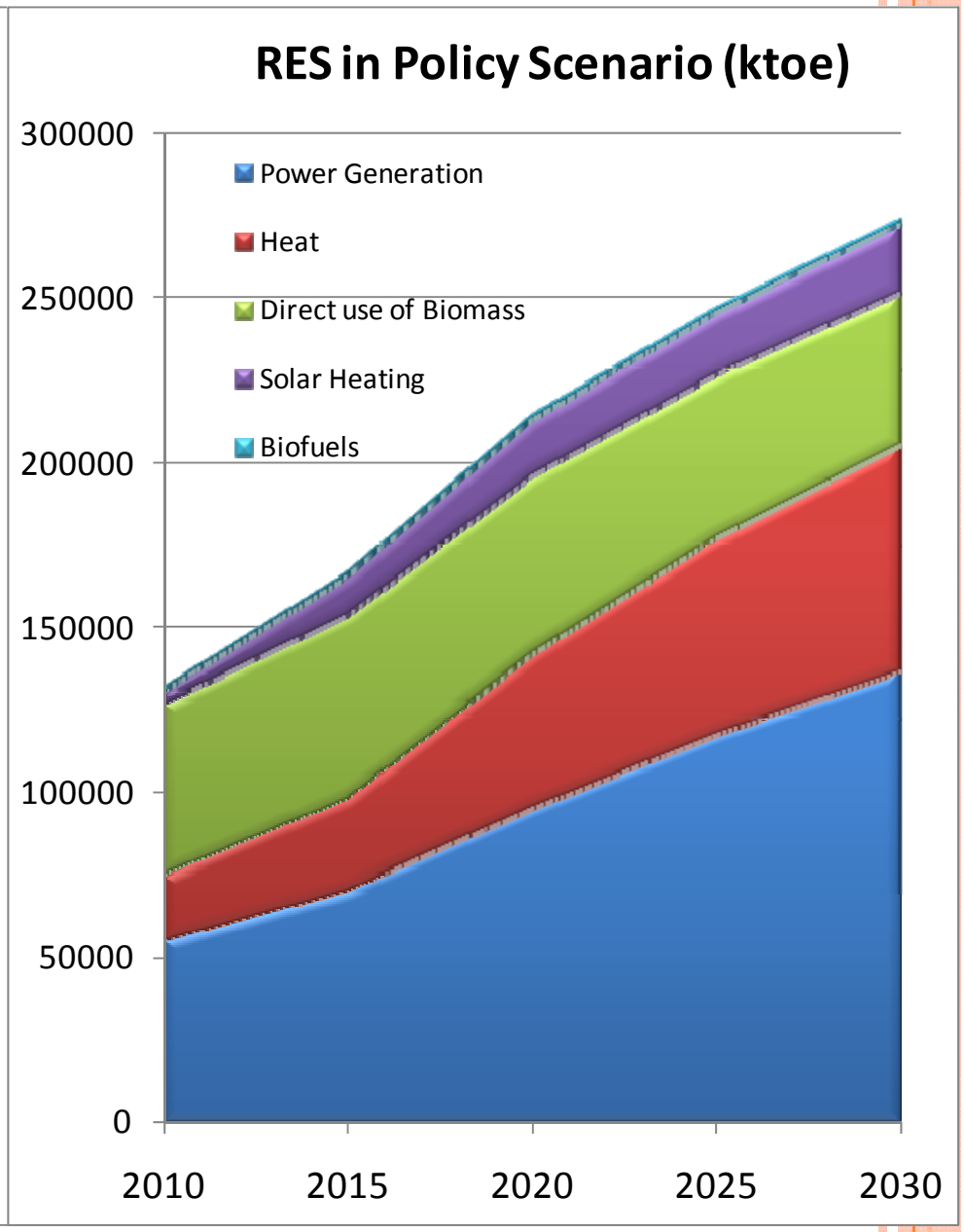


ENERGY SAVINGS NEEDED PER SECTOR

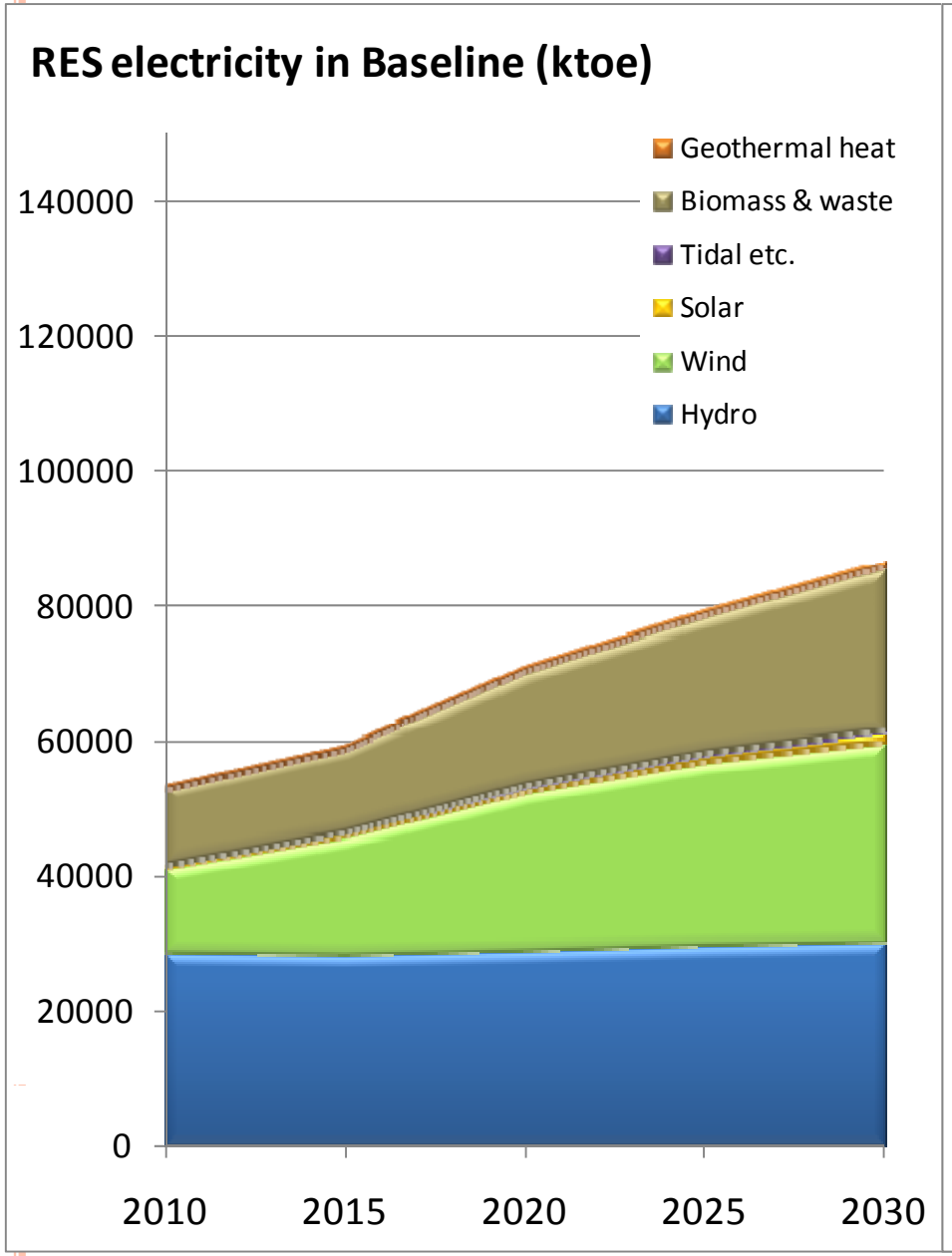


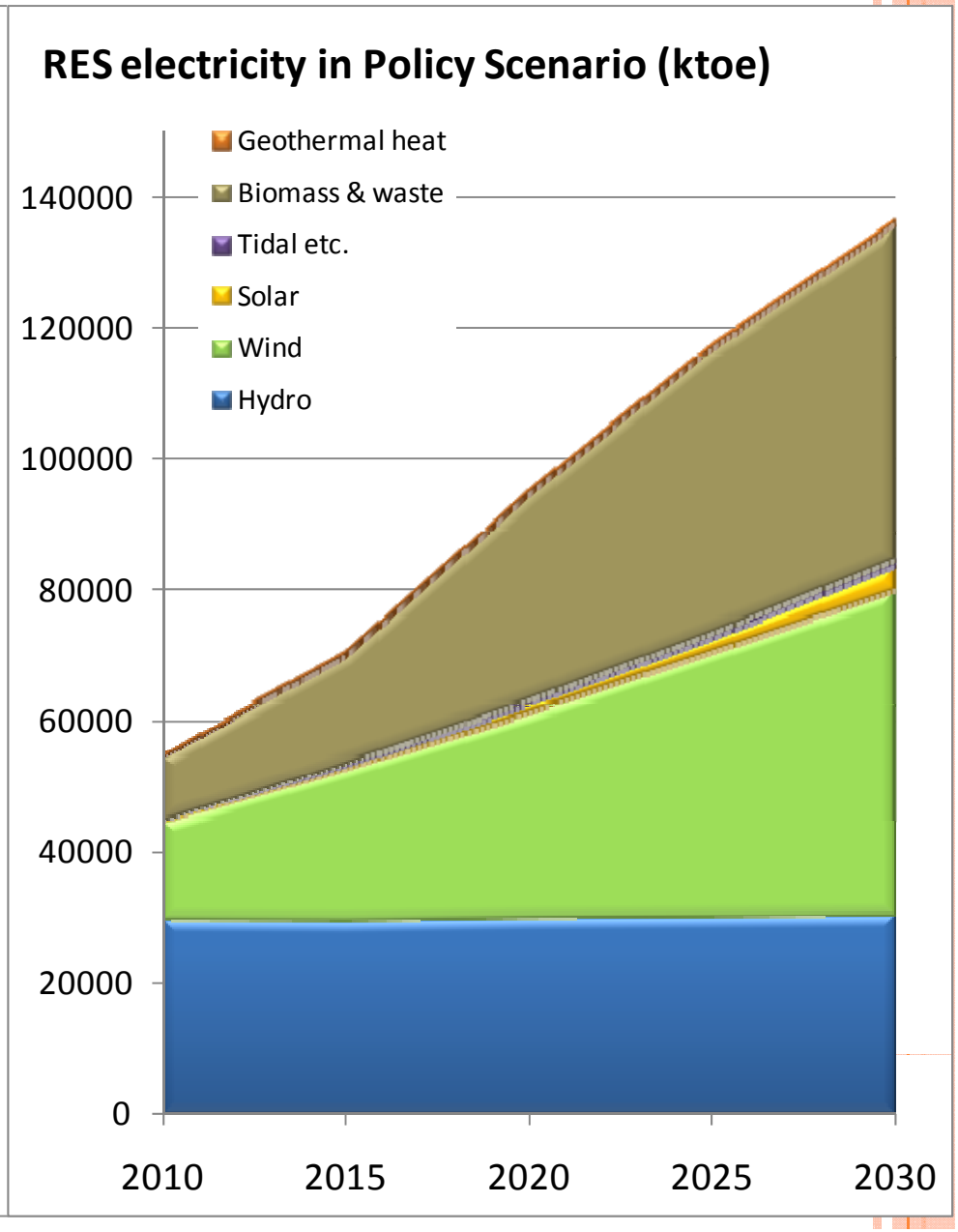
Optimal Allocation of RES development



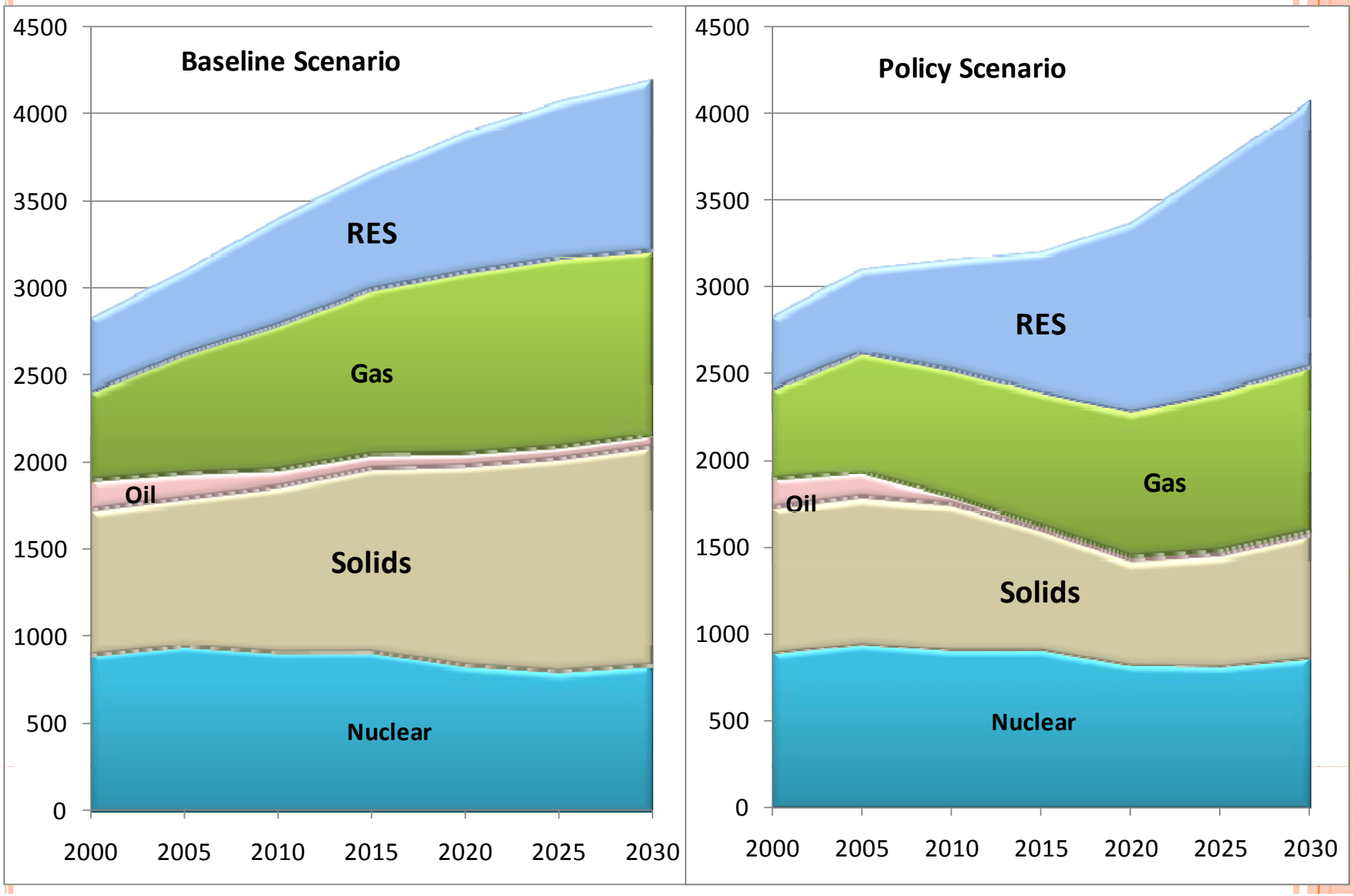


Optimal Allocation of RES development

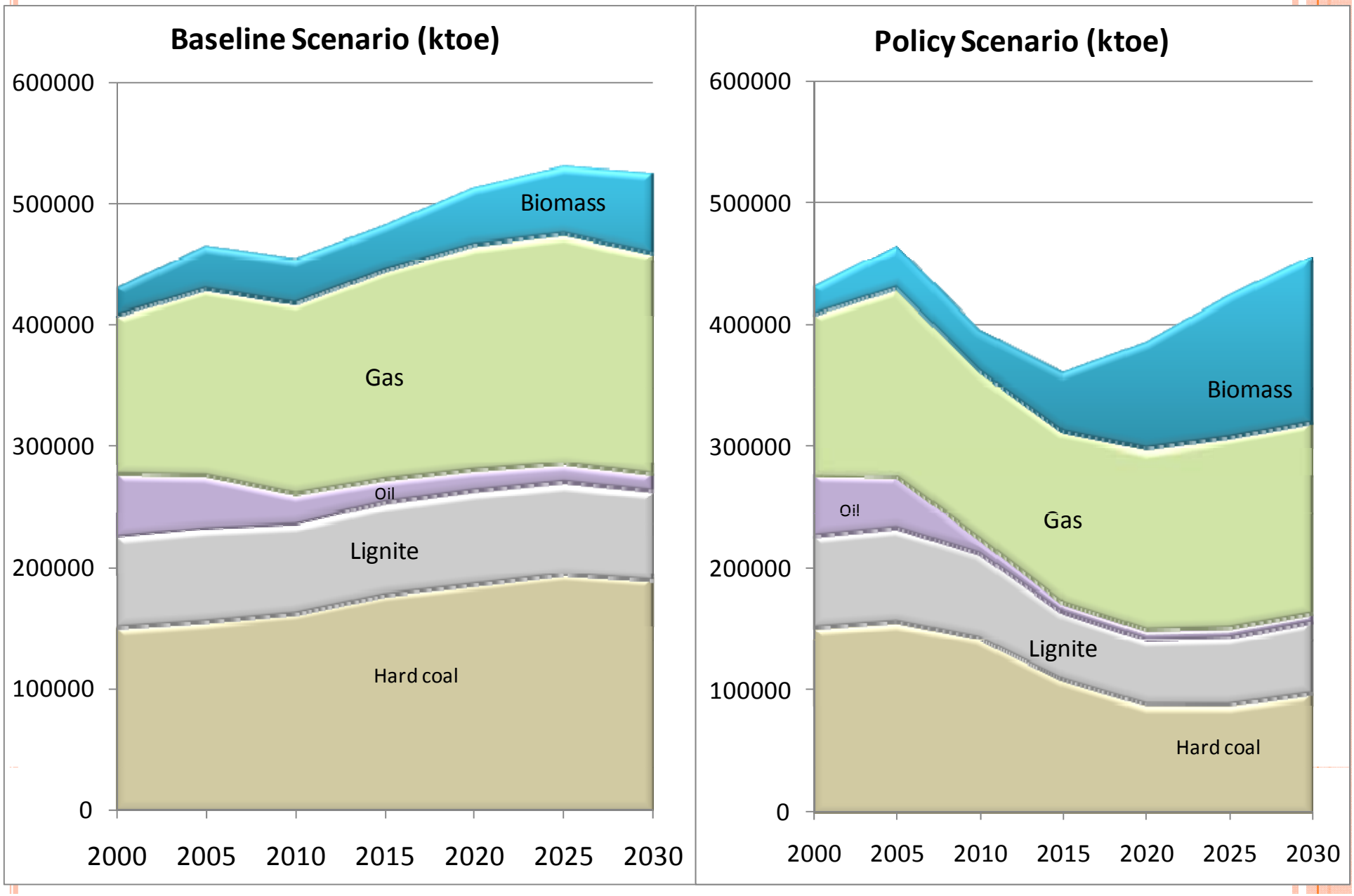




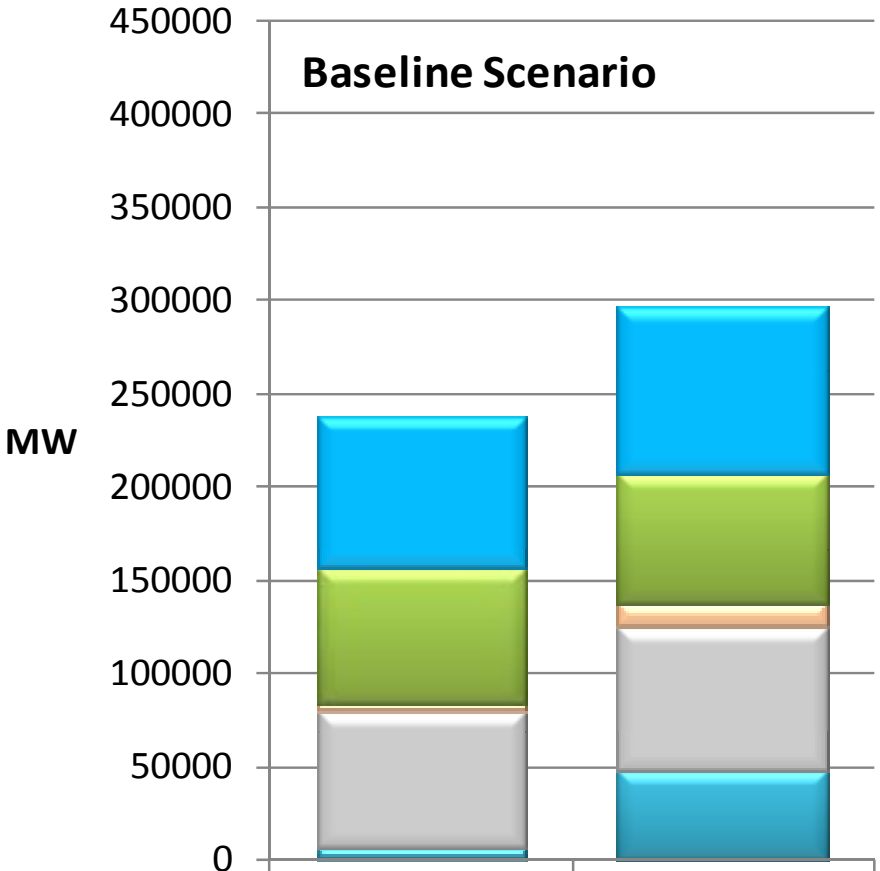
Structure of Power Generation(TWh)



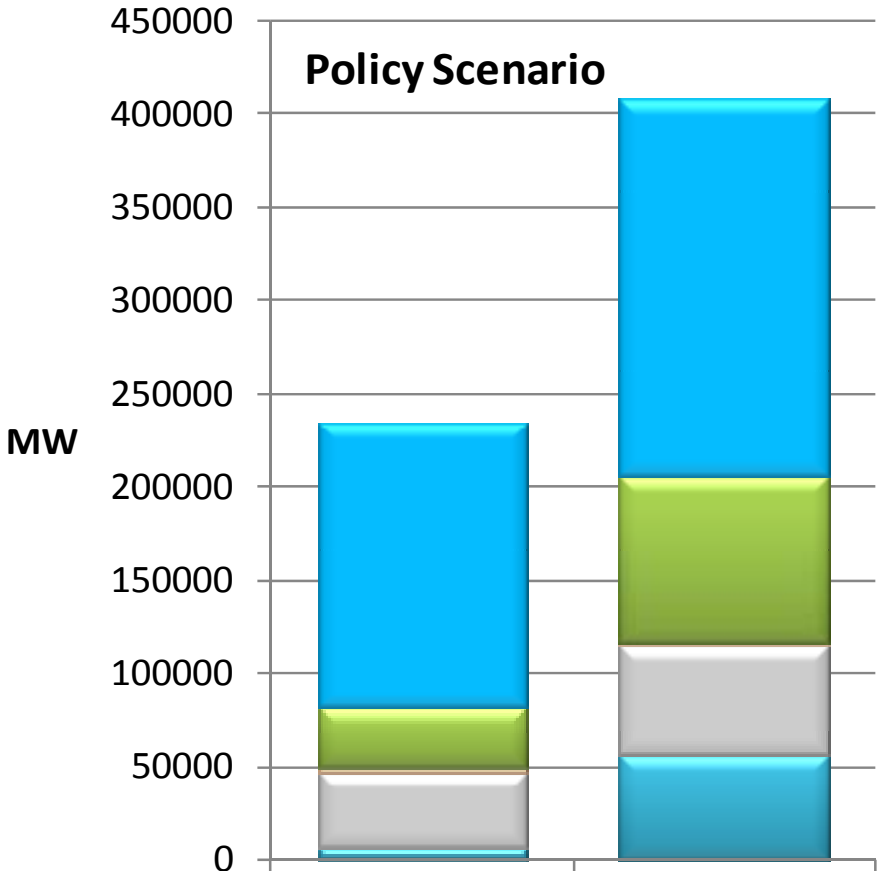
Fuels used in Power Generation



New Power Generation Units

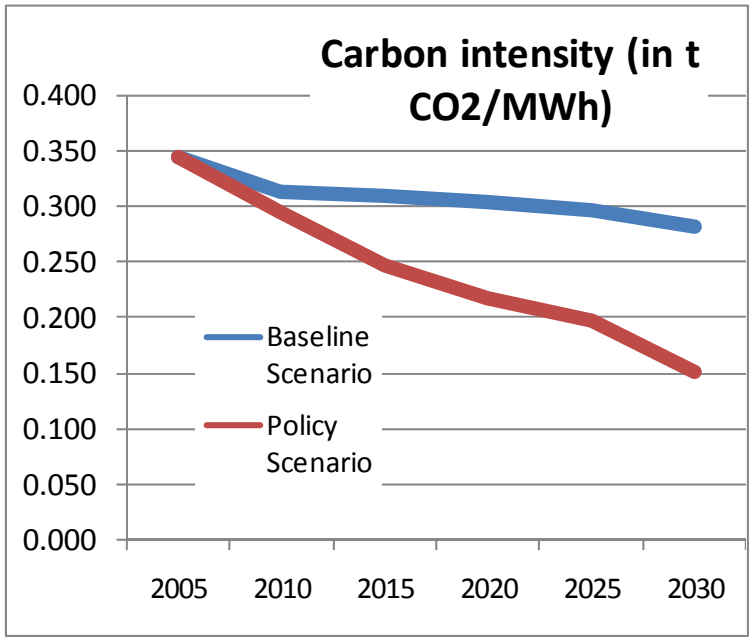


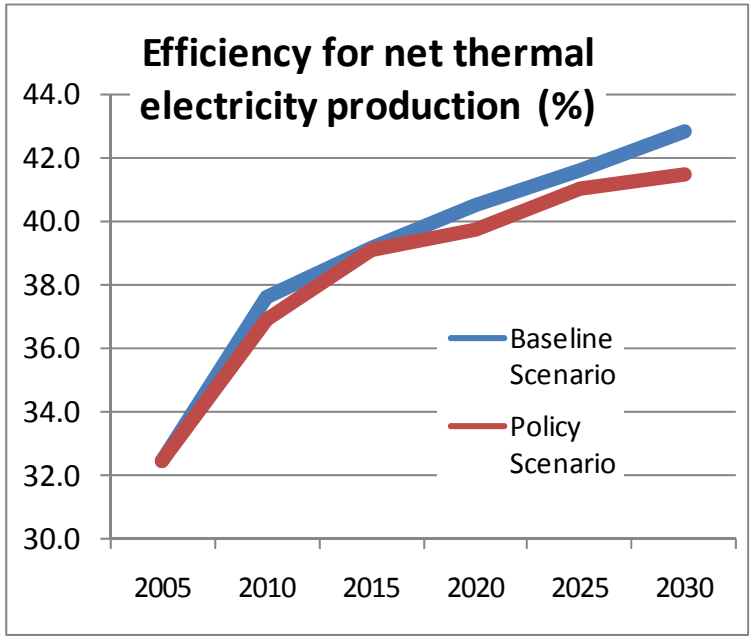
	2010-2020	2020-2030
RES	80530	90636
Gas	73818	69343
Oil	4073	13404
Solids	72708	75841
Nuclear	6709	48364

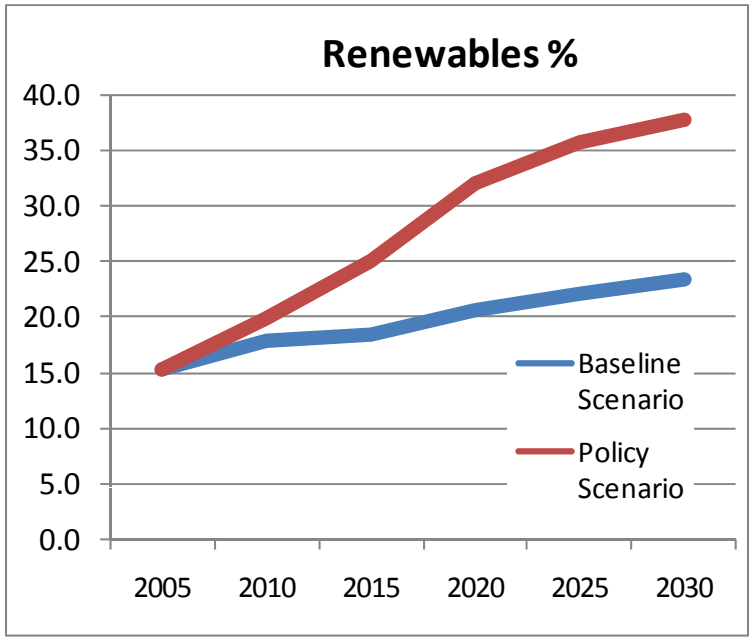


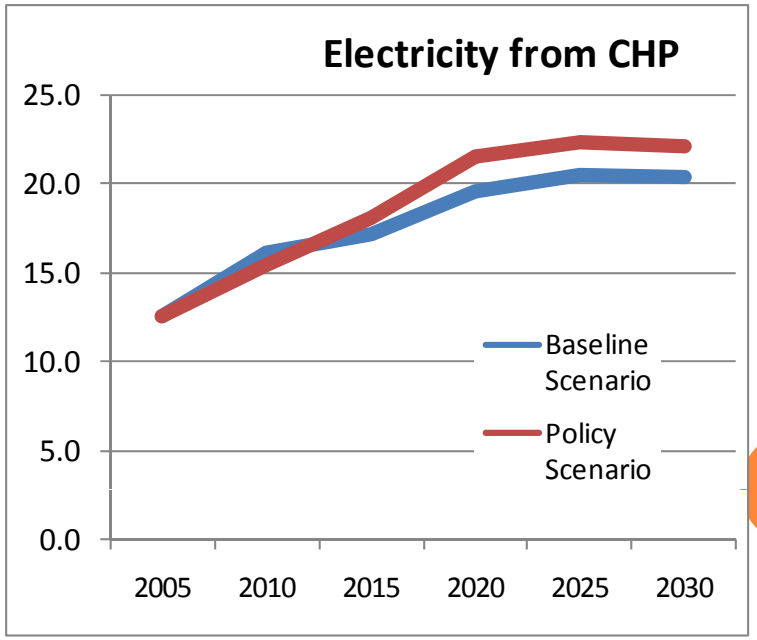
	2010-2020	2020-2030
RES	152040	201753
Gas	31365	89074
Oil	3454	1611
Solids	39842	58362
Nuclear	7165	56481

Power Generation Indicators









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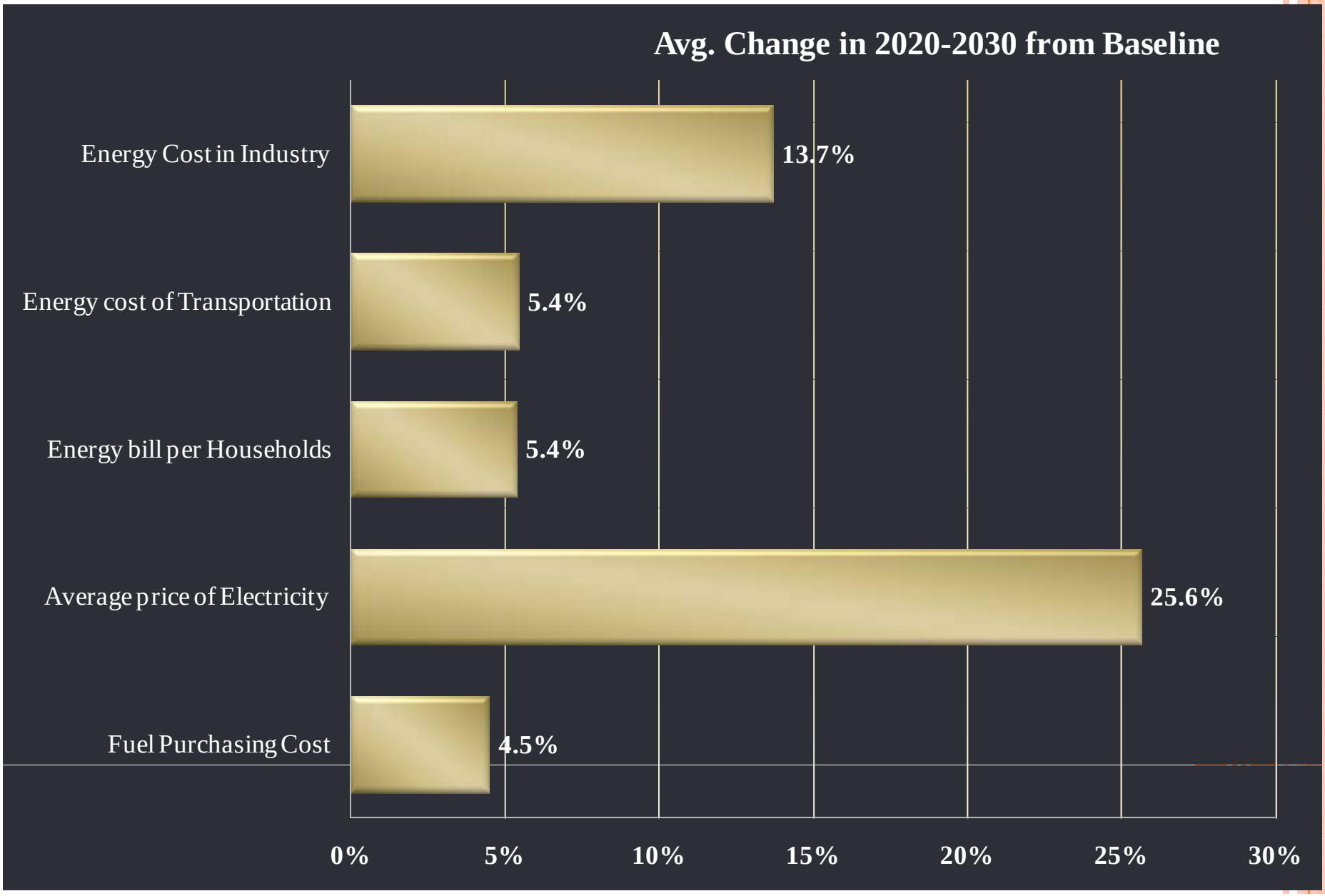
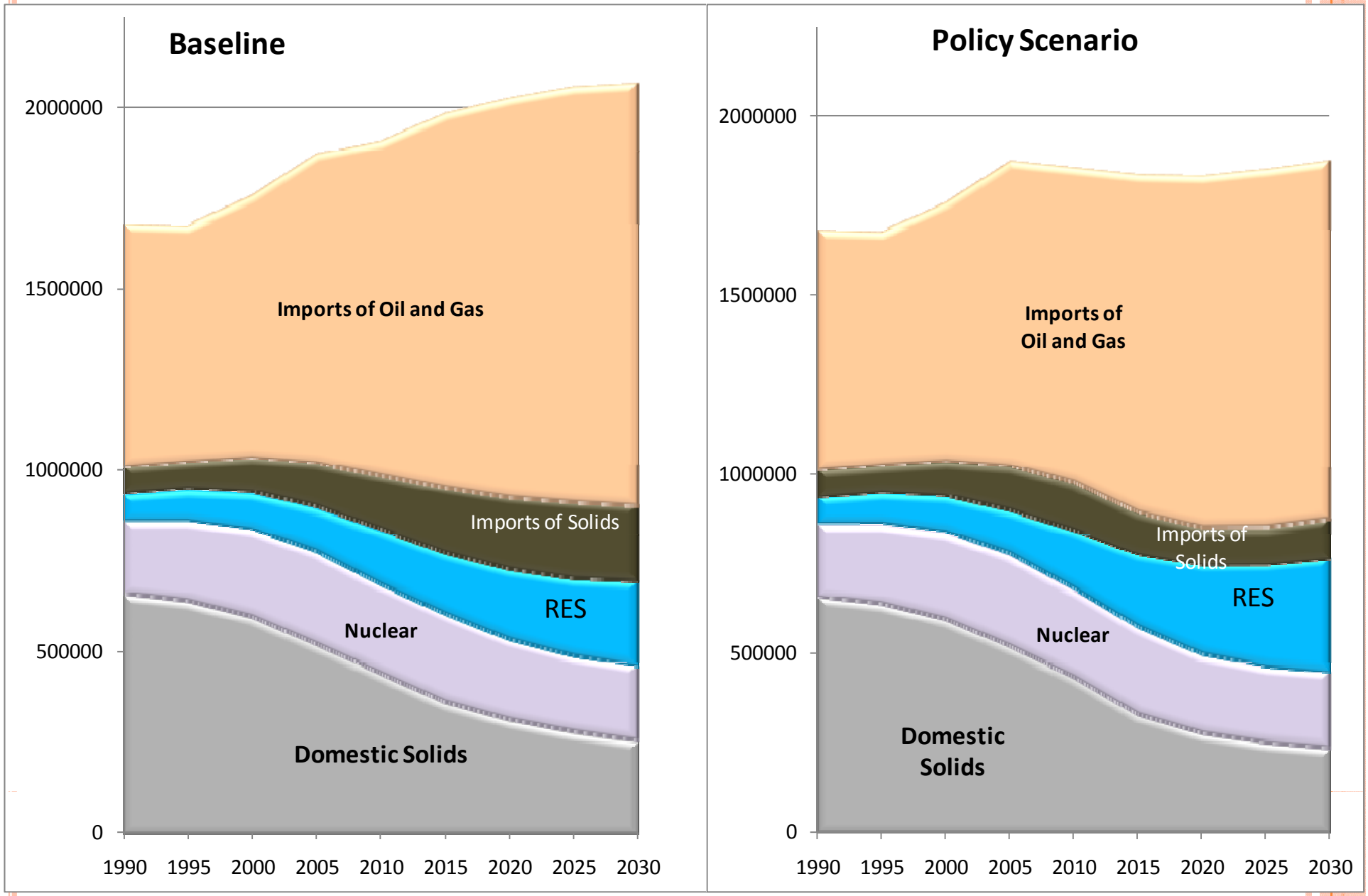
Change in Prices and Costs



Dependence on Energy Imports



Decomposition of GHG reduction Effort by type of change

2008

%	Activity	Energy Efficiency	Use of Carbon Free Energy	Fossil Fuel Mix	Shift to Electricity/ Steam	SUM
Proposed Scenario	4.7	36.1	49.4	4.9	5.0	100
Cost - Efficiency Scenario	4.7	37.5	50.4	3.8	3.6	100
Pure Carbon	5.6	47.7	35.6	10.6	0.6	100
Pure RES	1.6	8.3	82.1	-2.4	10.4	100

CONCLUSIONS

The new binding GHG and RES targets of the EU including the auctioning of ETS allowances imply considerable restructuring of the EU energy systems

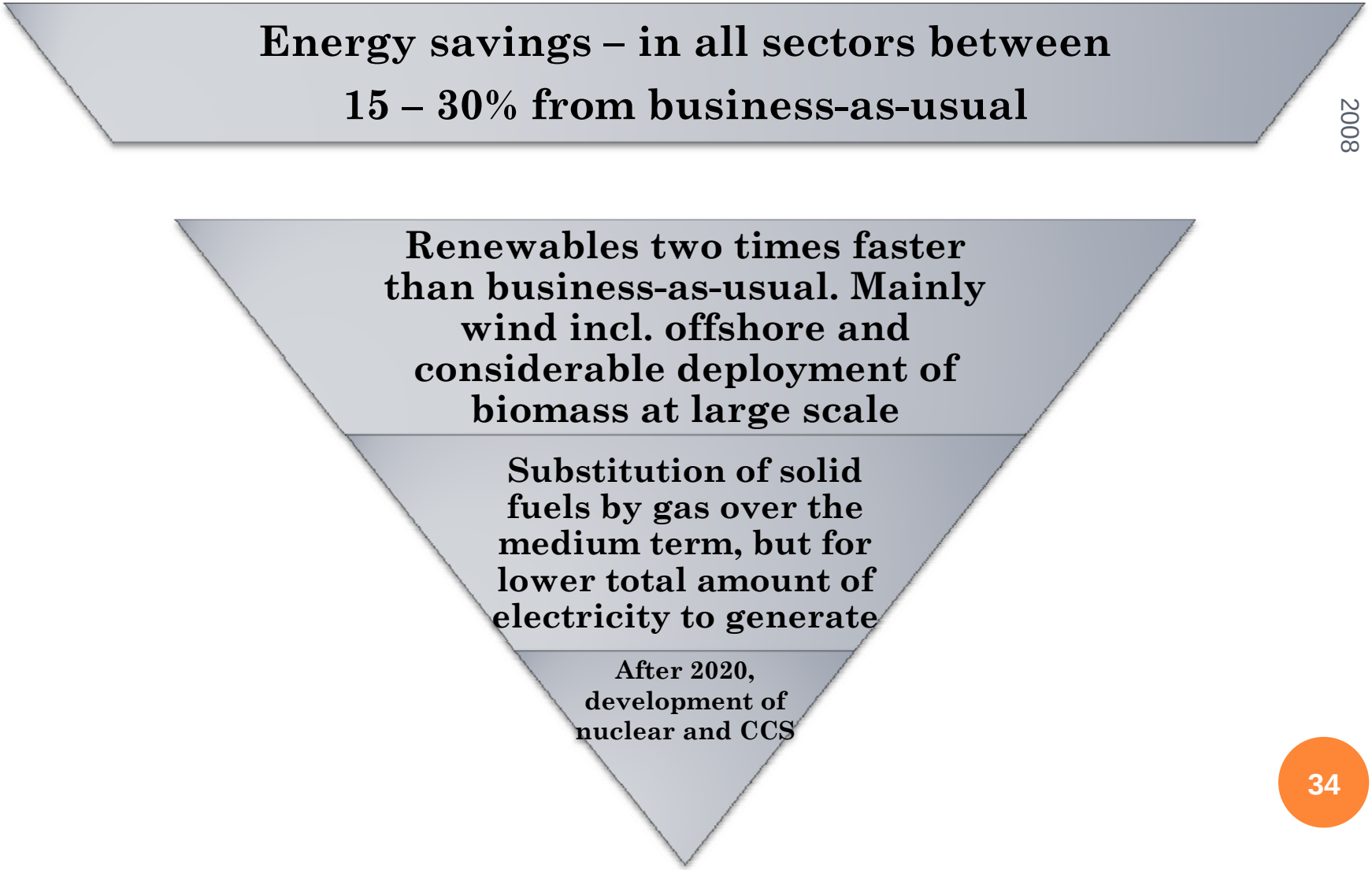
The policy package calls upon urgent policy actions in all Member-States since time left is short (less than 12 years) and lead time of energy system restructuring is long

Implementation requires considerable investments in both demand and supply sectors and entails significant costs to consumers, but

Benefits for the Environment (global and local) and Improvement in terms of Security of Supply (less dependence on oil and gas imports)

2008

Priorities of Energy System Changes



CONCLUSIONS

Large impact on centralized systems (power sector) but also considerable changes at consumer level towards energy efficiency

Total direct and indirect energy system cost is around 0.70% of GDP per year

Reduces to less than 0.5% with DM

EU-ETS Carbon Price: 35 – 45 €/t CO_2

Electricity prices will increase considerably

(15-25% from business-as-usual)

Capital turnover is accelerated and the demand for new technology equipment is seen as a new growth opportunity of the EU

2008