Economic aspects of allocating carbon dioxide allowances

Analysis of results obtained in the context of the CAFE project for Environment DG

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CAFE scenarios

- "Without climate policy measures" scenario ("NCLP")
  - Identical to LREM baseline for EU Member States
  - Small differences exist for EU Acceding countries:
    - Results provided are the output of PRIMES model
    - Developed in the context of the LREM project in the meantime
- "With climate policy measures" scenario ("WCLP")
  - Assumes the existence of an EU wide CO2 emissions trading regime
  - The allowance price ranges from
    - 12 Euro per t of CO2 in 2010 to 16 Euro in 2015 and 20 Euro in 2020
    - Remains constant thereafter
    - Leads to adjustment of the behaviour of economic agents, I.e. producers and consumers of energy, through changes in relative prices
  - Acts as the CAFE baseline scenario

Key issues and findings (1)

- The analysis assumes that all sectors undertake measures in view of a allowance price of 12 Euros per t of CO2 in 2010
  - Emission reduction target by Member State
    - Important to note that PRIMES model results cover only energy related CO2 emissions whereas the EC Directive also covers process related CO2 emissions, non-CO2 greenhouse gasses (CH4, N2O, HFC, PFC and SF6) and sinks
    - Targets for EU15 Member States have been set on the basis of the Burden Sharing agreement
      - a correction factor has been applied on the emission reduction targets imposed by the Burden Sharing agreement so that the Kyoto protocol emission reduction target for EU15 (-8% from 1990 levels) to be achieved as regards CO2 emissions
    - Targets for Acceding countries have been set on the basis of their Kyoto Commitment
      - For Cyprus and Malta it has been assumed that their target equals the projected CO2 emissions growth under NCLP case assumptions
      - Existing flexibility available to some of these countries to set the base year between 1988 and 1990 has not been taken into account, i.e. for all countries 1990 has been assumed as the base year

Key issues and findings (2)

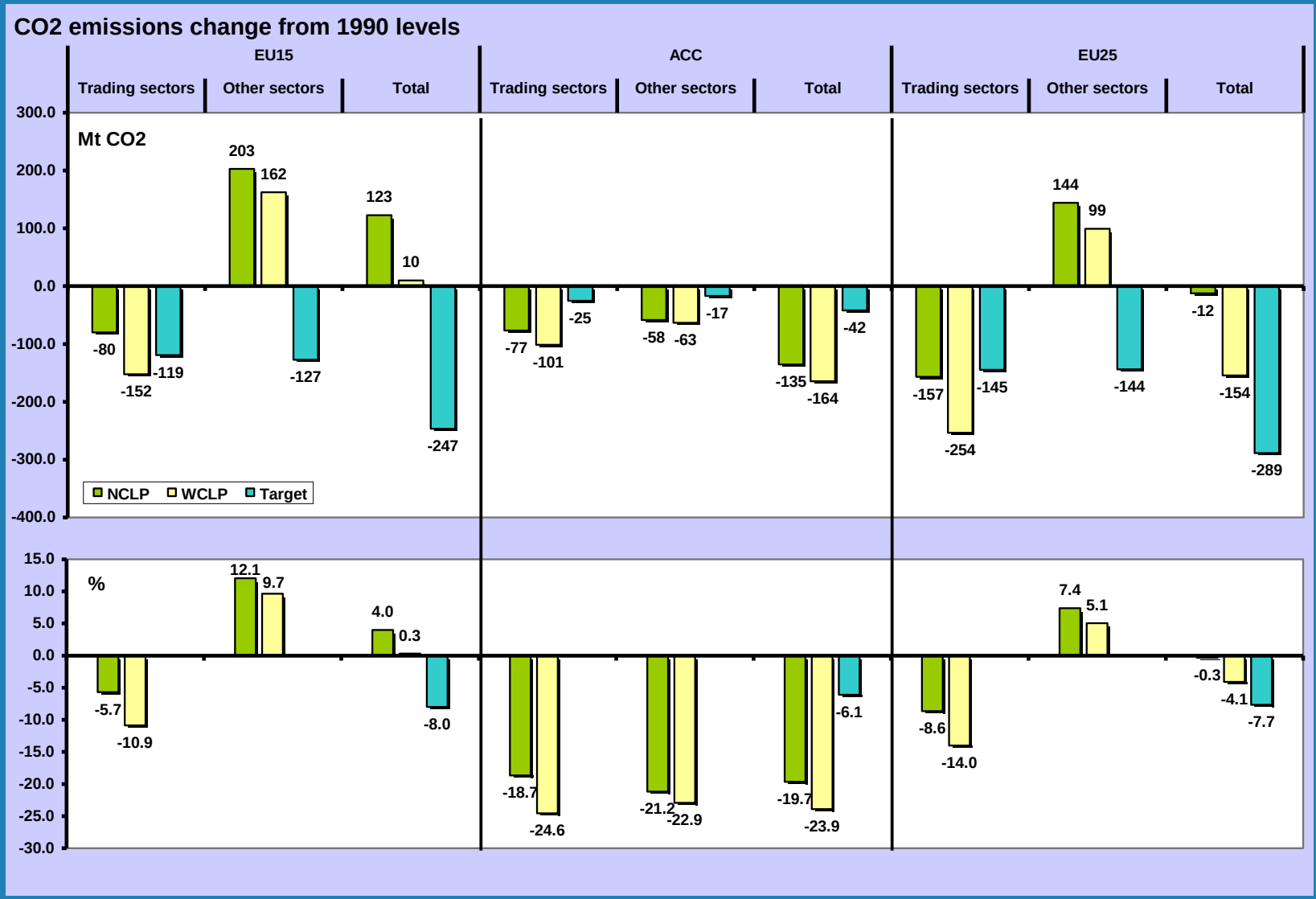
- For each Member State the energy system is assumed to consist of two sectors:
  - "Trading sectors" which include power and steam generation, district heating, refineries, iron and steel, non-metallic minerals and paper and pulp production industrial sectors
    - i.e. the sectors covered by the Emission Trading EC Directive
  - "Other sectors" which include the remaining sectors of the energy system (other industrial sectors, households, tertiary, transport sector, energy branch except refineries)
- For the purposes of the analysis it is assumed that Trading and Other sectors have to comply separately to the country specific emission reduction target
  - In order to achieve the emission reduction target "Trading sectors" can exchange carbon dioxide allowances at a price of 12 Euros per t of CO2 both within the country (for example power generation with iron and steel industry) and at an EU wide level (for example UK's Trading sector with Ireland's Trading sector)
    - i.e. a CO2 emission reduction trading regime as foreseen in the Emission Trading EC directive is established
  - Other sectors can also exchange carbon dioxide allowances at a price of 12 Euros per t of CO2 but only within each country's limits (for example households to transport sector)

Key issues and findings (3)

- The results obtained clearly reflect the much higher flexibility of Trading sectors in reducing CO2 emissions compared to the rest of the energy system
  - At the EU25 level even under the NCLP case Trading sectors more than achieve the CO2 emissions reduction target as a result of
    - Restructuring in power generation sector and energy intensive industries
      - Uplifting of strong inefficiencies in the use of energy existing in the past in Acceding countries
      - Implementation of Renewables Directive in the UK power generation sector
  - Other sectors, especially in the EU15, are faced with much stronger difficulties in complying with the CO2 emission reduction target
    - CO2 emissions growth in the Transport sector more than counterbalances emission reductions achieved in other sectors of the energy system
      - Transport sector is growing fast and with limited potential for fuel switching towards low carbon content fuels
      - However, in Acceding countries the more rational use of energy, fuel switching and the replacement of inefficient equipment leads to a decline of CO2 emissions from Other sectors at levels well below Kyoto targets even under the NCLP case
        - » Despite the fact that CO2 emissions in the transport sector for Acceding countries are projected to grow by more than 53% in 2010 from 1990 levels

CO2 emissions in 2010 – comparison to 1990 levels

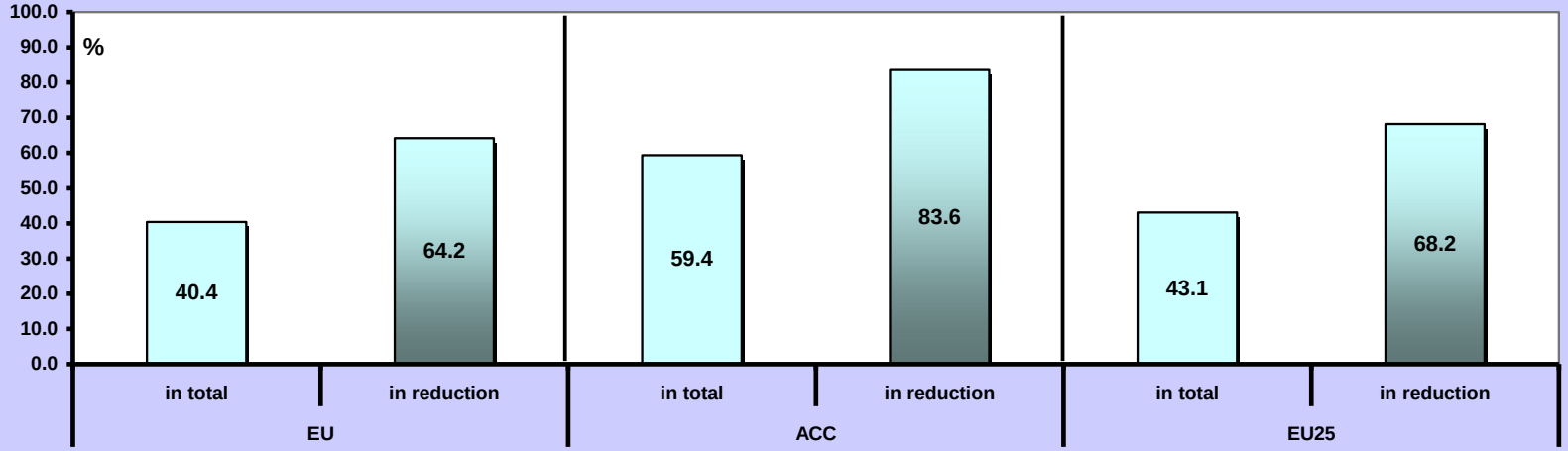
WCPL case versus NCLP case



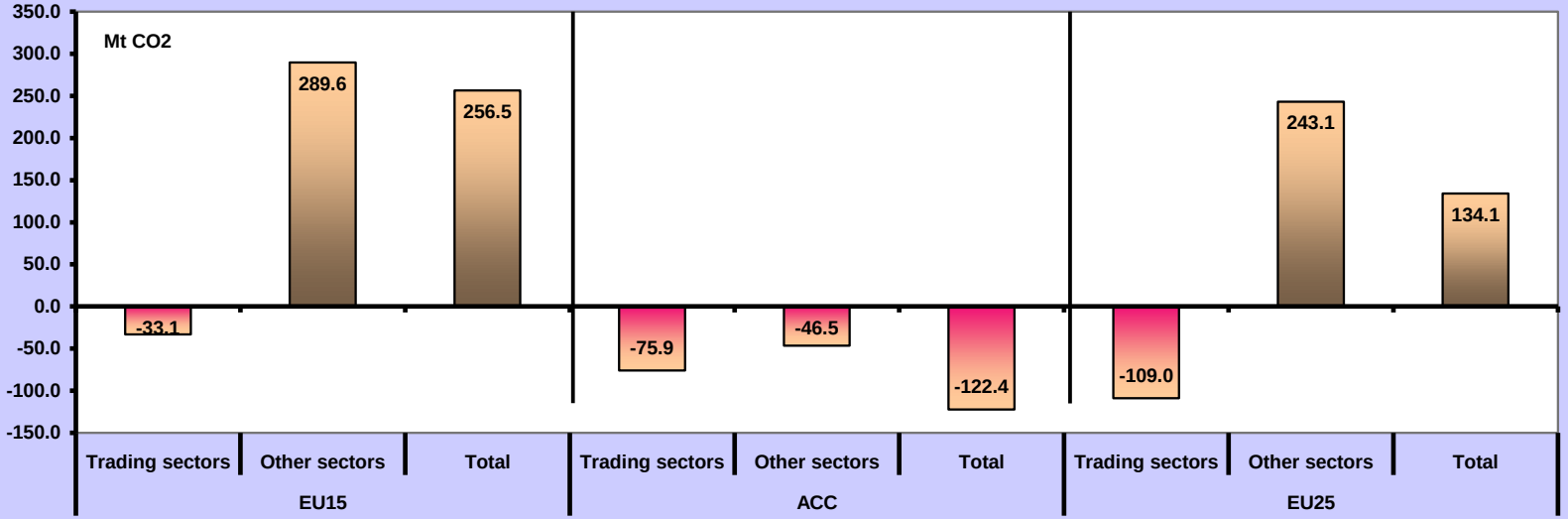
CO2 emissions in 2010 under the WCLP case assumptions

contribution of trading sectors in total CO2 emissions and in CO2 emissions reduction from NCLP case levels
additional emission reduction requirements for trading and other sectors

Share of trading sectors in CO2 emissions



Additional reduction requirements (negative figures imply potential permits selling)



Evolution of CO2 emissions for Emission Trading sectors in 1990-2010

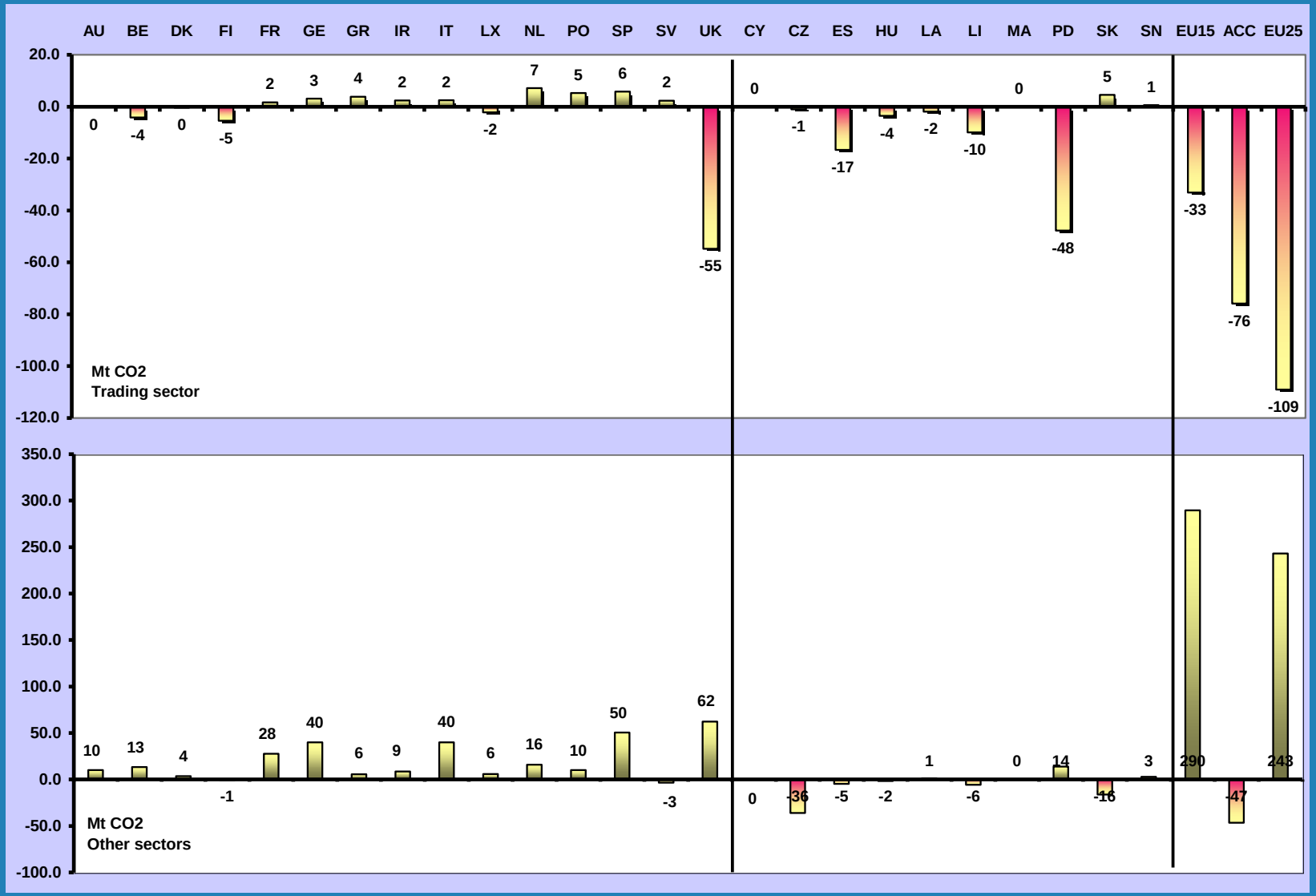
under WCLP case assumptions

	Emission Trading sectors							
	WCLP case						Comparison to NCLP case in 2010	
	Mt CO2			*Index 1990=100*		*% share in total CO2 emissions in 2010*		
	1990	**2000**	**2010**	***2000***	***2010***		**in Mt CO2**	**in % difference**
AU	23.4	20.3	20.3	*-13.1*	*-13.3*	*34.9*	-1.7	-7.7
BE	46.1	47.1	38.9	*2.0*	*-15.8*	*35.9*	-2.1	-5.1
DK	27.4	27.3	21.4	*-0.3*	*-21.8*	*47.3*	-0.8	-3.5
FI	29.2	31.1	24.0	*6.3*	*-17.7*	*50.6*	-3.4	-12.4
FR	95.8	89.8	98.2	*-6.2*	*2.5*	*25.4*	-11.1	-10.2
GE	471.1	396.1	378.1	*-15.9*	*-19.7*	*47.6*	-20.5	-5.2
GR	41.4	51.8	56.0	*25.2*	*35.1*	*56.5*	-6.0	-9.7
IR	11.5	16.4	15.5	*42.3*	*34.8*	*34.6*	-1.1	-6.9
IT	176.3	187.8	168.6	*6.5*	*-4.4*	*41.1*	-8.9	-5.0
NL	64.6	69.5	68.3	*7.6*	*5.8*	*88.0*	-2.9	-4.0
LX	5.9	1.0	2.1	*-83.4*	*-64.1*	*2.1*	-0.1	-4.2
PO	20.8	29.8	31.9	*42.9*	*53.1*	*48.8*	-2.0	-6.0
SP	99.9	135.8	121.6	*35.9*	*21.7*	*41.6*	-8.0	-6.2
SV	15.4	14.7	18.4	*-4.4*	*19.8*	*35.6*	-1.4	-6.9
UK	271.4	214.5	184.5	*-21.0*	*-32.0*	*36.2*	-2.4	-1.3
CY	2.9	3.5	3.6	*20.0*	*24.0*	*45.1*	-0.1	-3.3
CZ	62.3	76.8	56.3	*23.3*	*-9.6*	*60.2*	-3.2	-5.4
ES	28.2	11.1	9.2	*-60.7*	*-67.2*	*72.2*	-0.8	-7.9
HU	29.5	26.8	24.2	*-9.2*	*-17.9*	*43.8*	-2.9	-10.5
LA	5.1	2.7	2.8	*-46.5*	*-45.4*	*37.1*	-0.2	-7.5
LI	19.8	5.4	8.3	*-72.8*	*-58.0*	*54.1*	-0.6	-6.7
MA	1.0	1.6	2.0	*60.7*	*92.8*	*59.1*	-0.1	-6.8
PD	240.7	187.8	178.5	*-22.0*	*-25.9*	*64.3*	-14.2	-7.4
SK	15.2	16.4	18.5	*7.6*	*21.9*	*54.6*	-1.9	-9.4
SN	6.9	6.6	6.9	*-3.2*	*1.1*	*45.1*	-0.4	-5.1
EU15	1400.3	1332.9	1247.9	*-4.8*	*-10.9*	*40.4*	-72.5	-5.5
ACC	411.7	338.7	310.5	*-17.7*	*-24.6*	*59.4*	-24.4	-7.3
EU25	1812.0	1671.7	1558.4	*-7.7*	*-14.0*	*43.1*	-96.9	-5.9

Distance to target in 2010 by country and sector

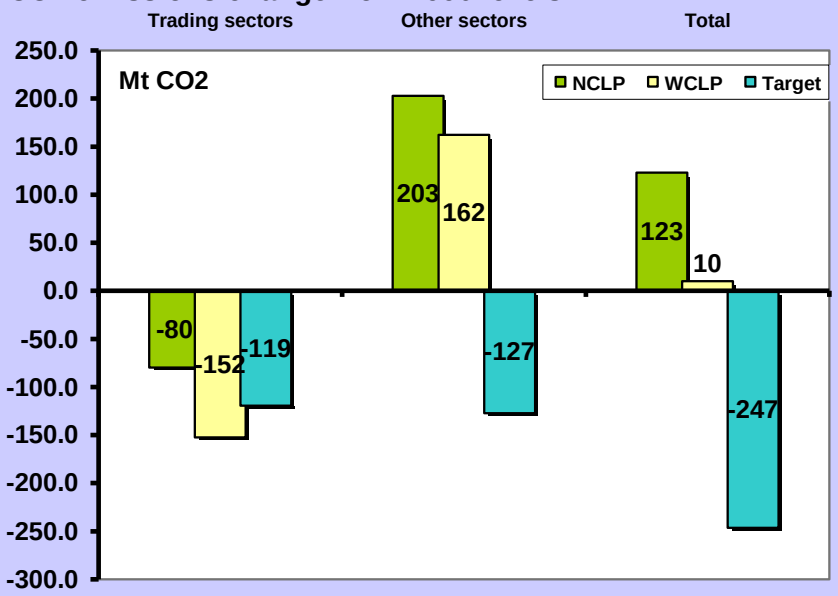
Positive figure implies additional effort / purchase of permits required

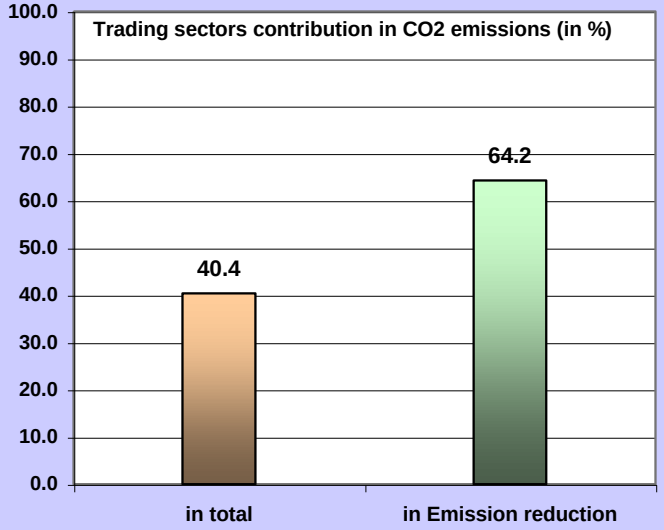
Negative figure implies overachievement of target (availability of permits for sale)

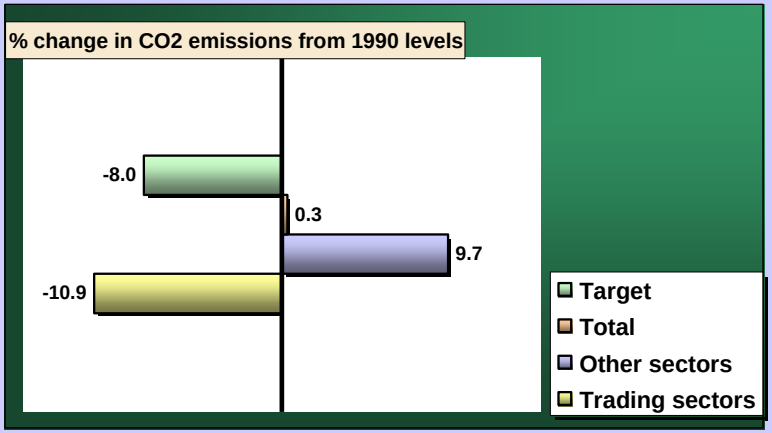


EU15 – Evolution of CO2 emissions under NCLP and WCLP cases

Target for trading and other sectors is defined assuming that they both need to comply to country specific emission reduction target







Distance to target

Negative figure implies potential selling of permits

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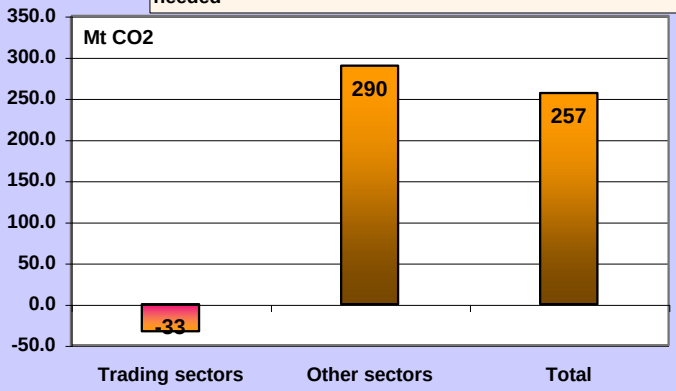
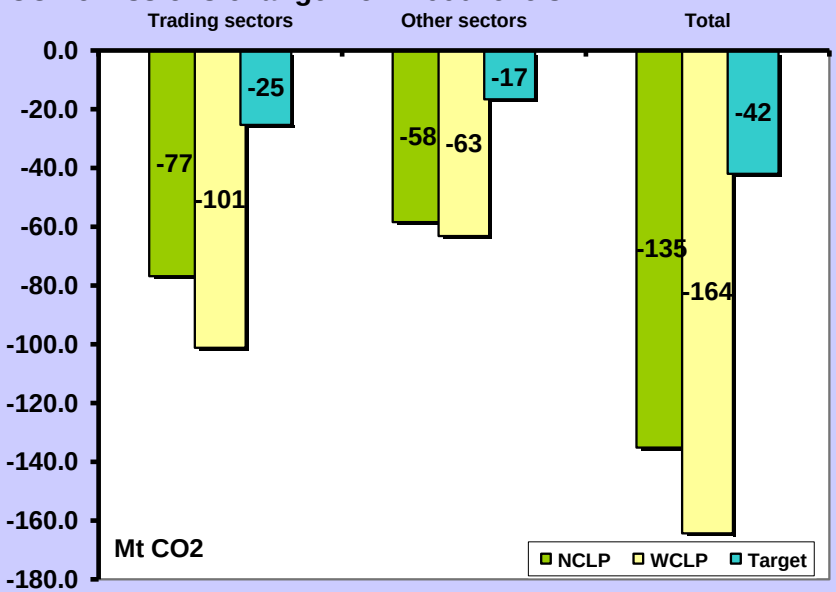
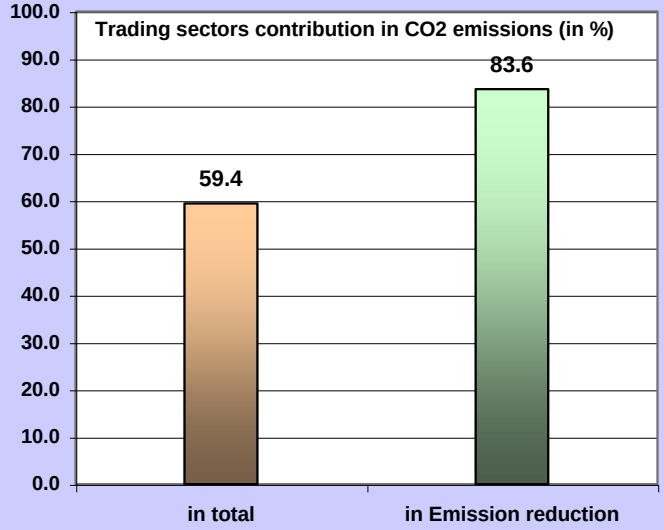
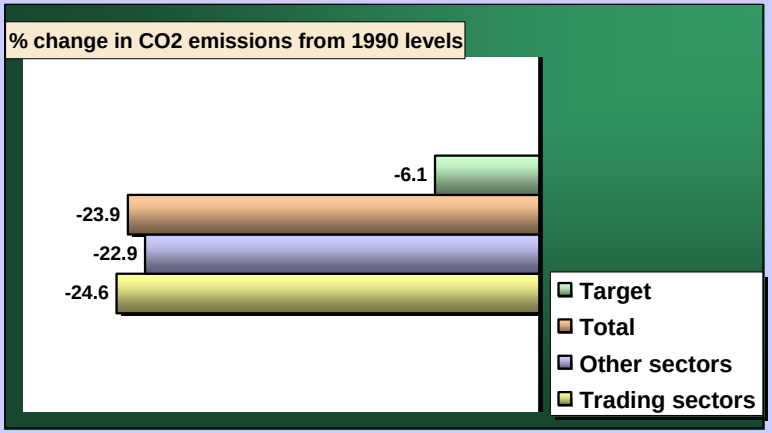


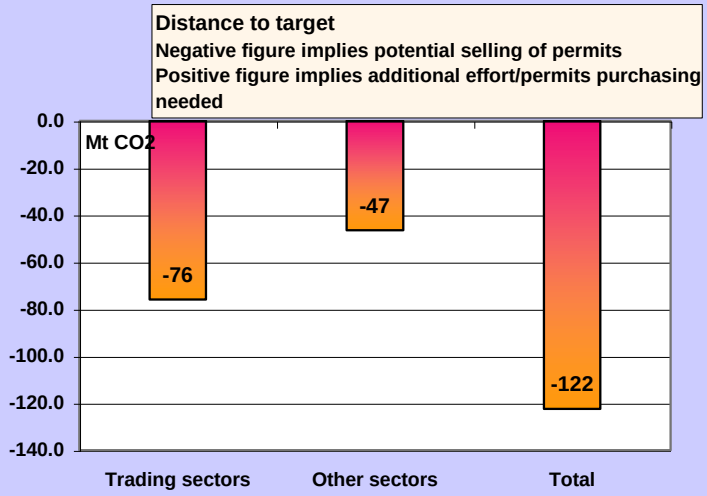
Acceding Countries – Evolution of CO2 emissions under NCLP and WCLP cases

Target for trading and other sectors is defined assuming that they both need to comply to country specific emission reduction target



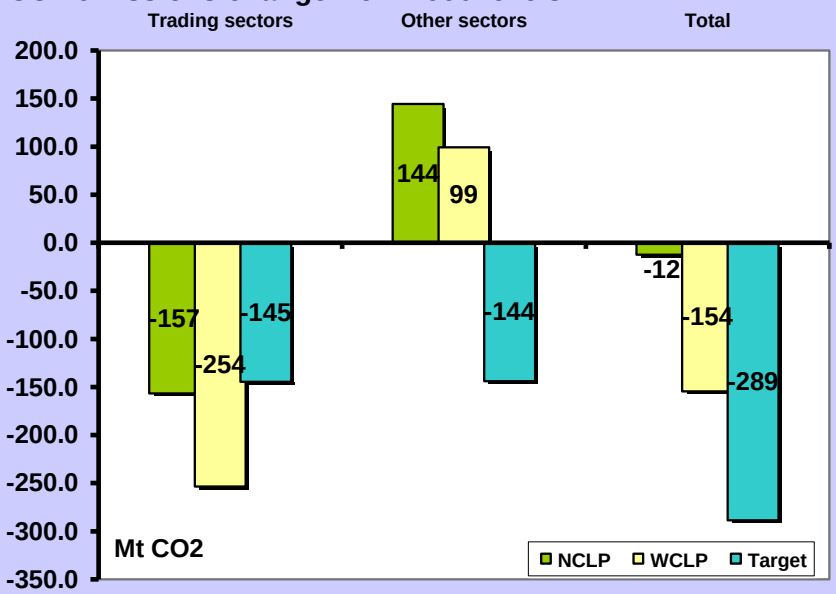


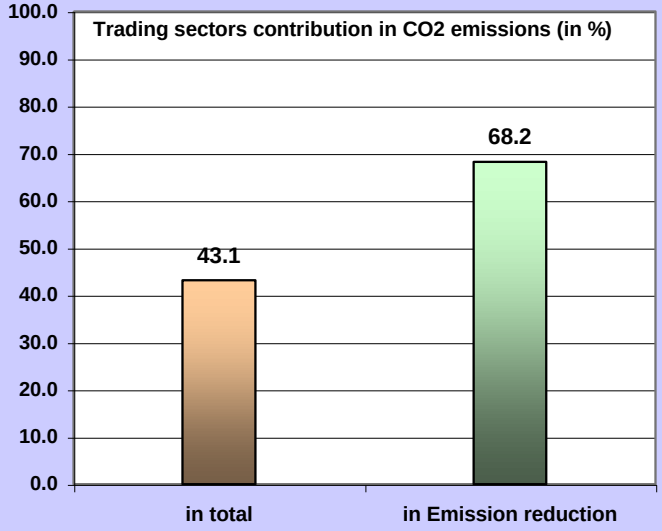


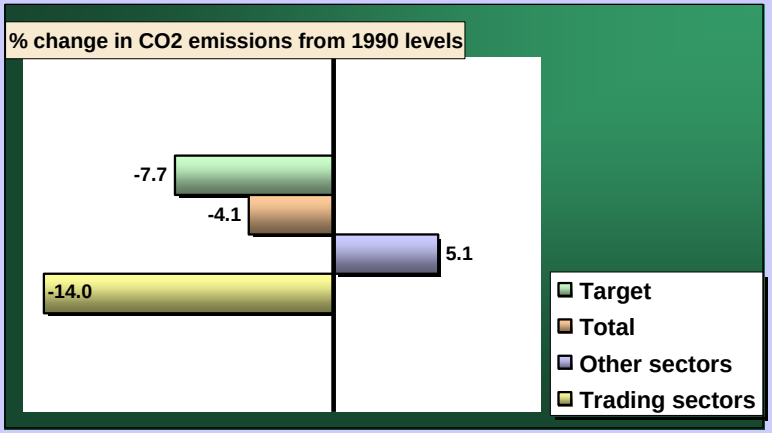


EU25 – Evolution of CO2 emissions under NCLP and WCLP cases

Target for trading and other sectors is defined assuming that they both need to comply to country specific emission reduction target







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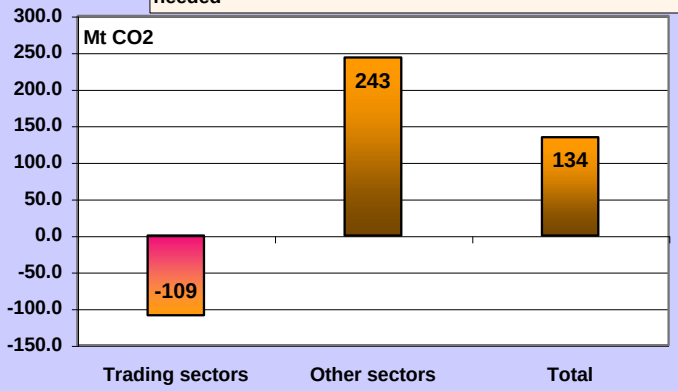


Conclusions

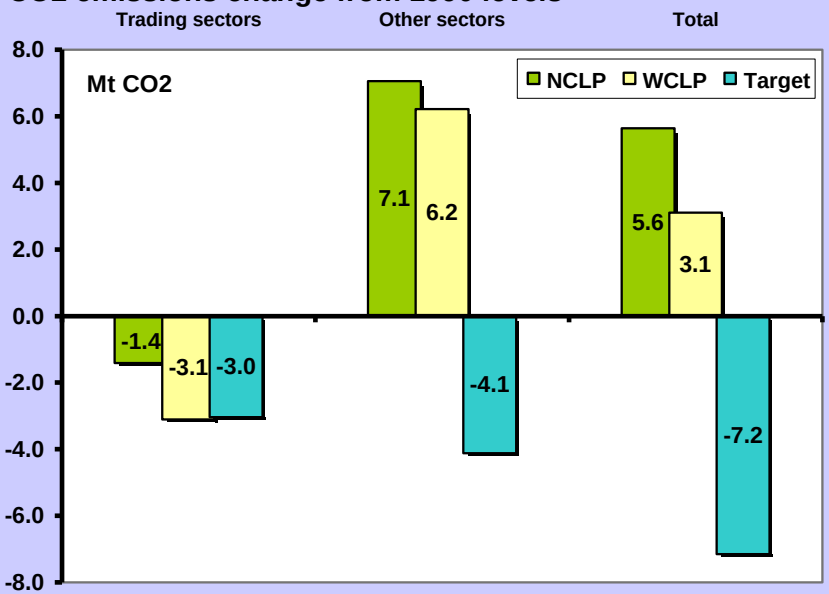
- The results obtained suggest that sectors covered by the Emission Trading EC-Directive should contribute over-proportionally to a MS' burden sharing target
  - In order to take advantage of the much higher flexibility they have compared to the other sectors of the energy system in reducing CO2 emissions through restructuring and changes in the fuel mix
  - Limit strong deviations in terms of economic cost among sectors
- Alternative approaches to allocate
  - Equalise the burden of traders vs. non-traders at national level
  - Anticipate EU allowance price and try to allocate to traders to that level
  - Allocate so that non-trading sectors reach a certain implicit price level

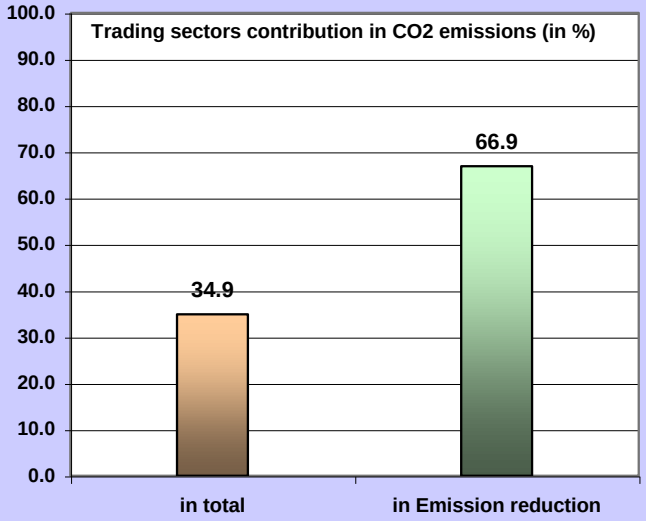
Evolution of CO_2 emissions under NCLP and WCLP cases

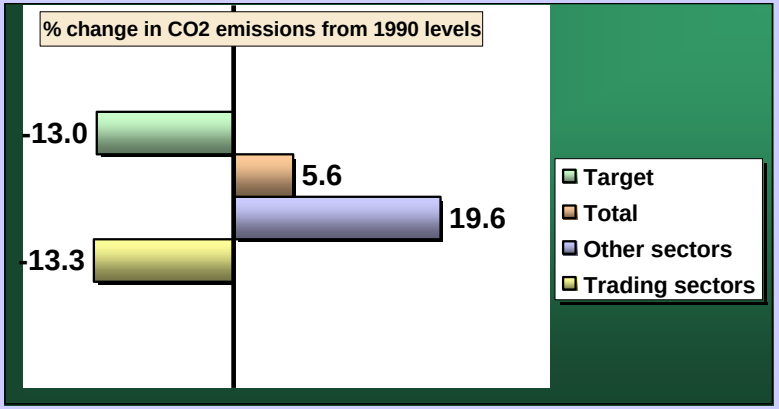
Results per Member State / Acceding Country

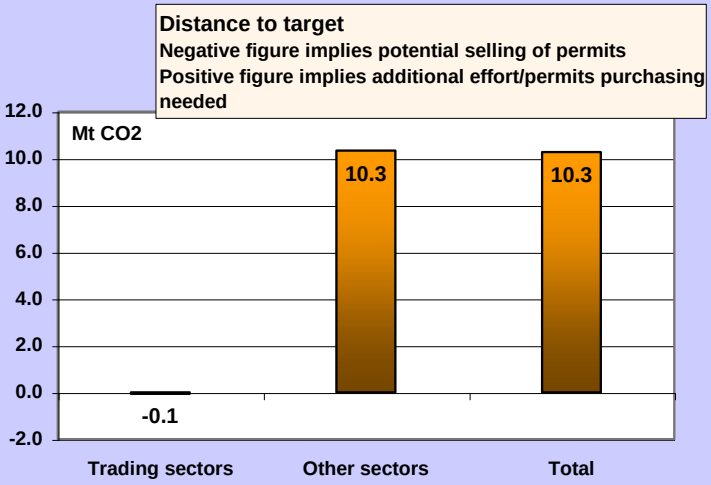
Austria – Evolution of CO2 emissions under NCLP and WCLP cases

Target for trading and other sectors is defined assuming that they both need to comply to country specific emission reduction target



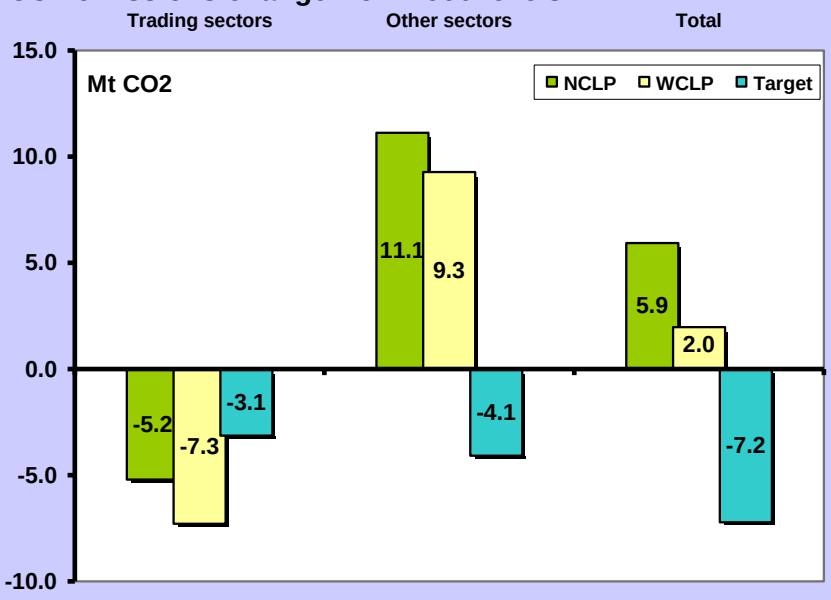


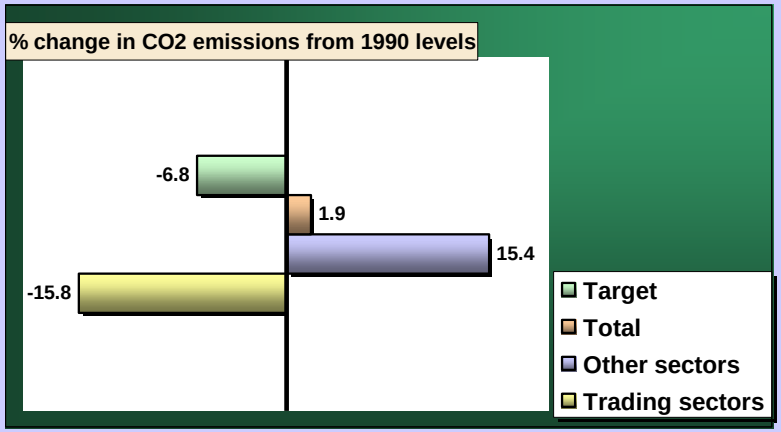


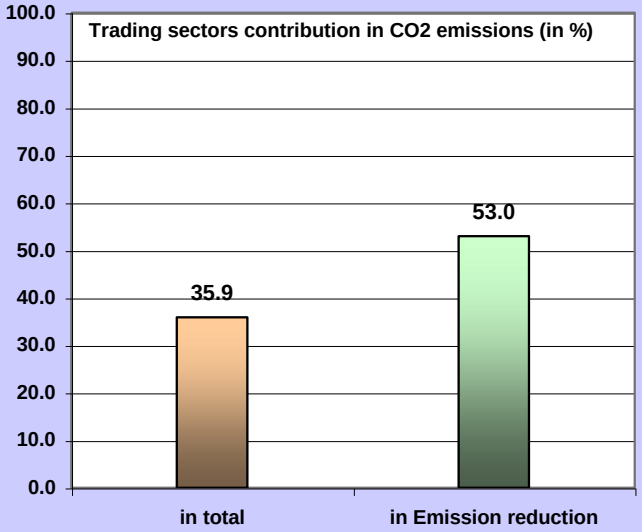


Belgium – Evolution of CO2 emissions under NCLP and WCLP cases

Target for trading and other sectors is defined assuming that they both need to comply to country specific emission reduction target







Distance to target

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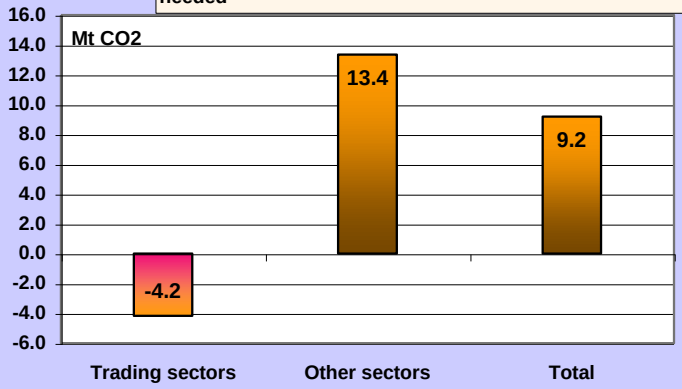
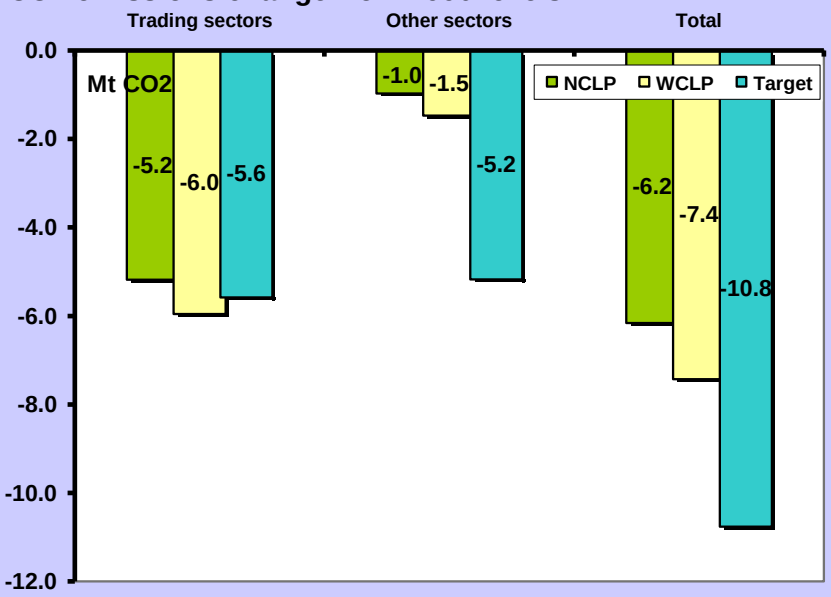
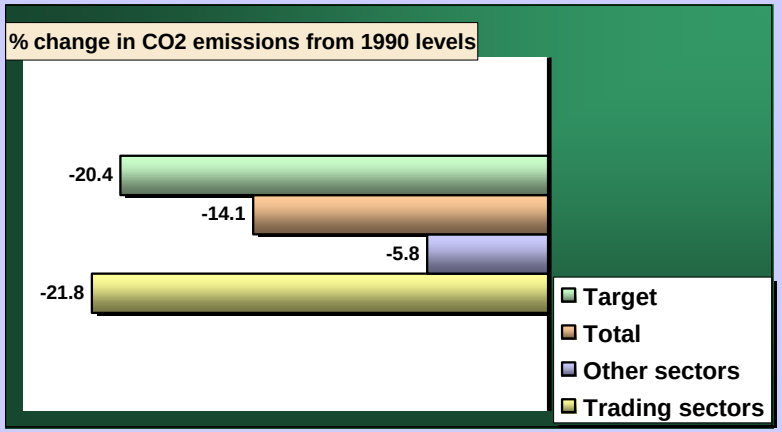
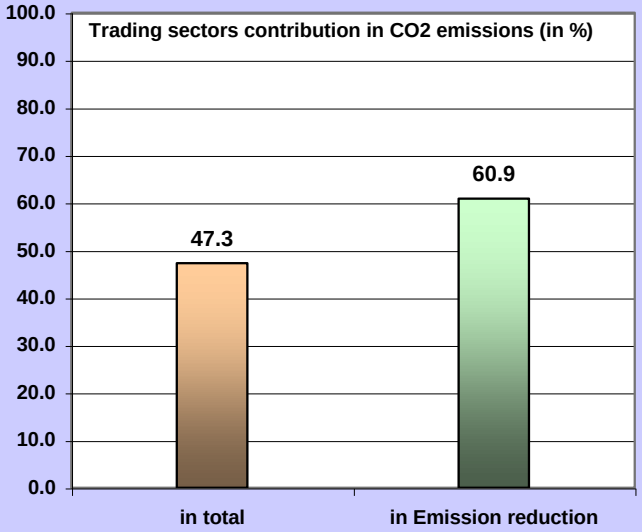


Denmark – Evolution of CO2 emissions under NCLP and WCLP cases

Target for trading and other sectors is defined assuming that they both need to comply to country specific emission reduction target







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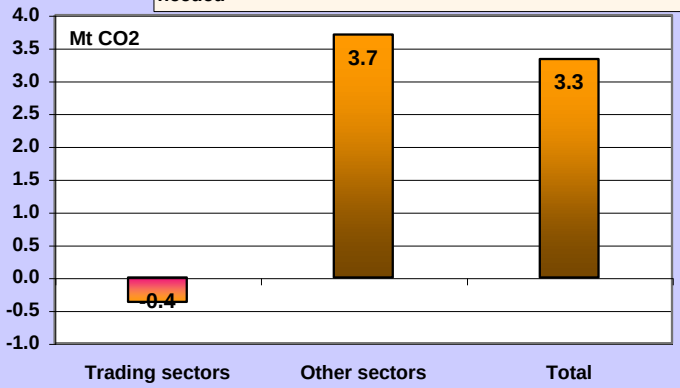
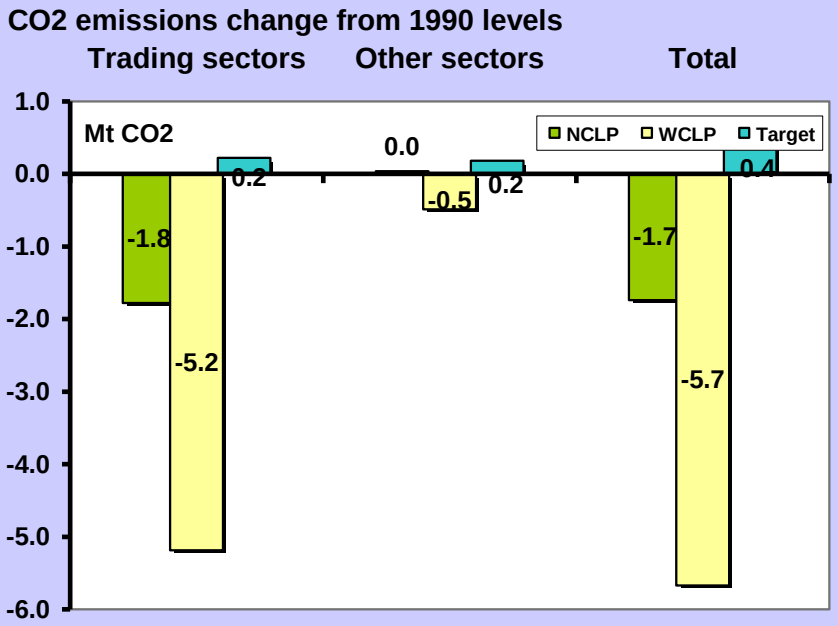
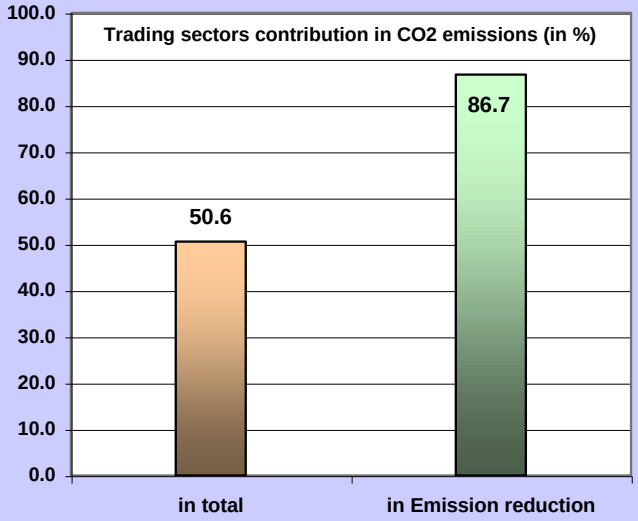
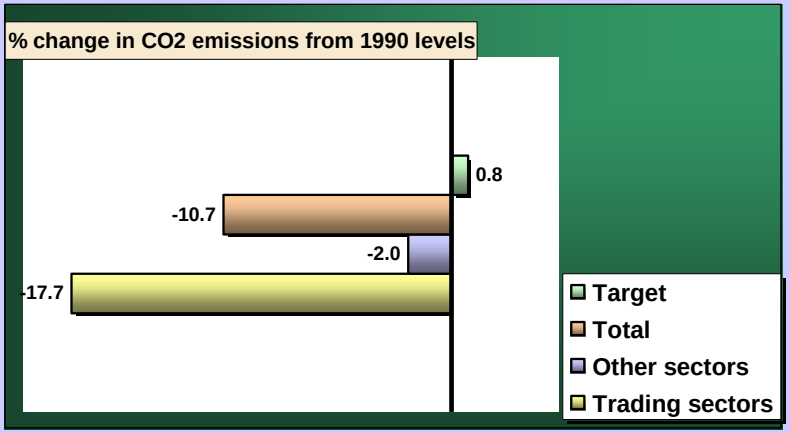


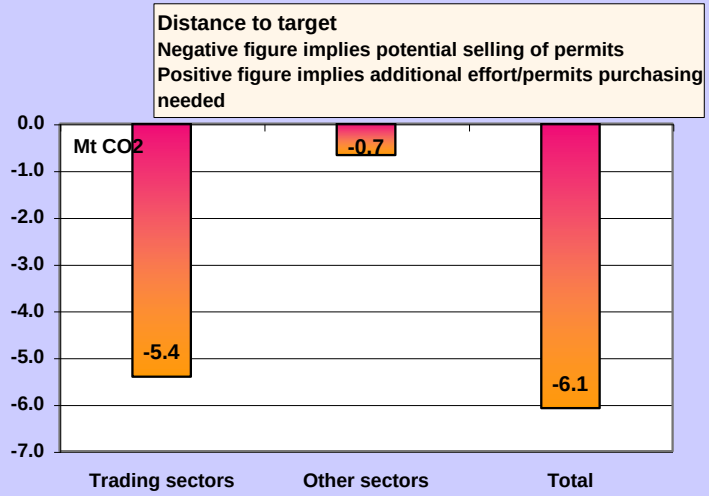
Finland – Evolution of CO2 emissions under NCLP and WCLP cases

Target for trading and other sectors is defined assuming that they both need to comply to country specific emission reduction target









France – Evolution of CO2 emissions under NCLP and WCLP cases

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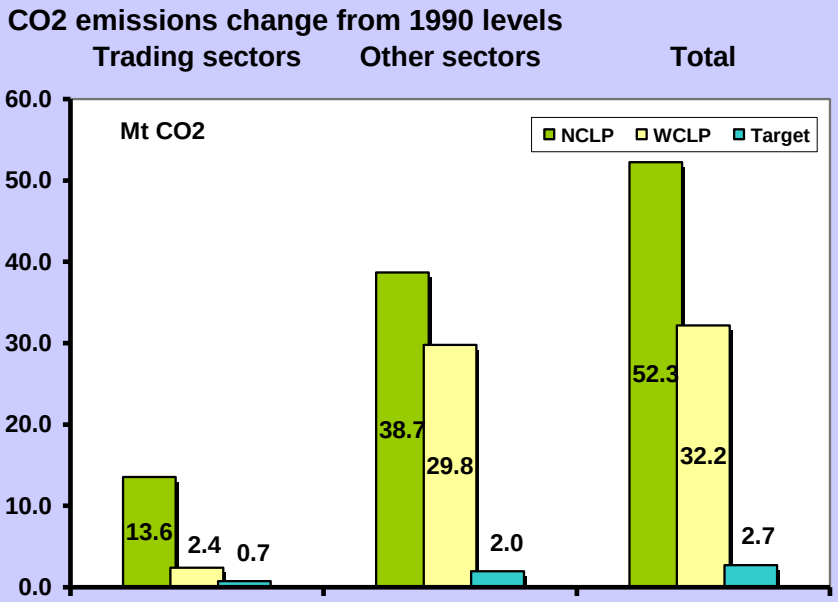

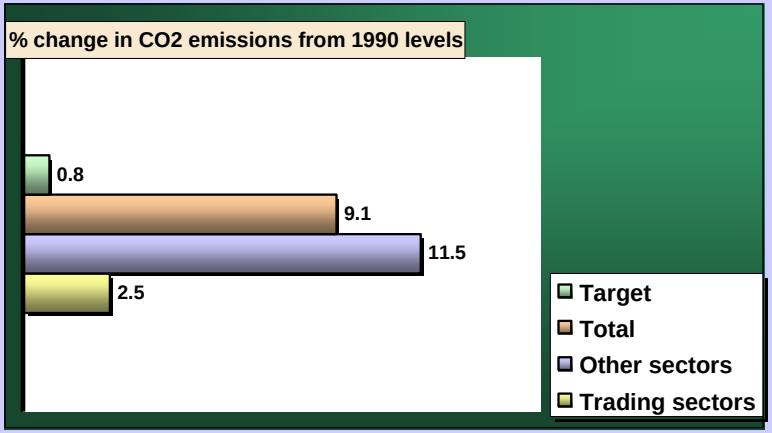

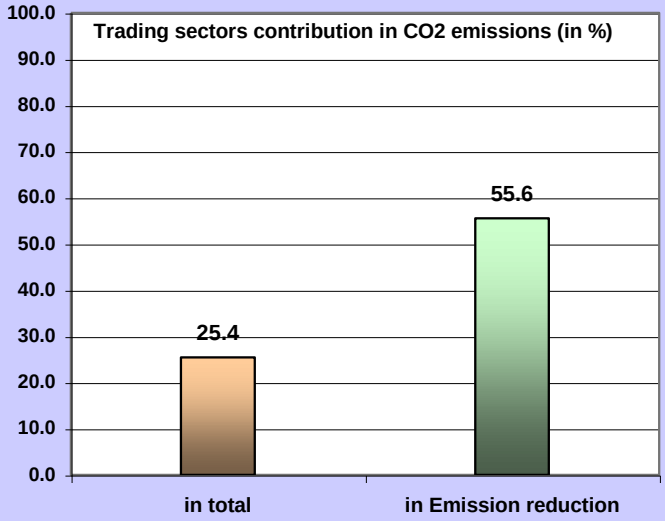

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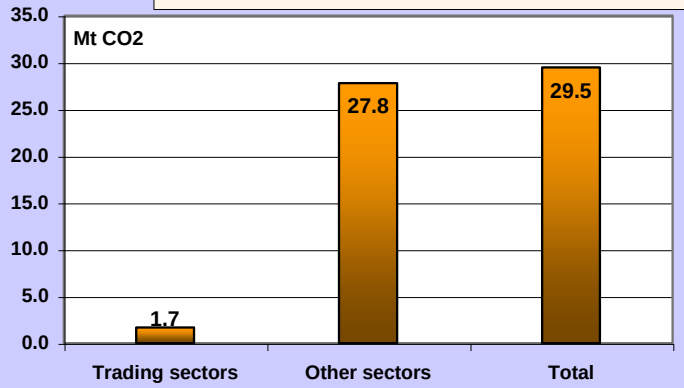

Germany – Evolution of CO2 emissions under NCLP and WCLP cases

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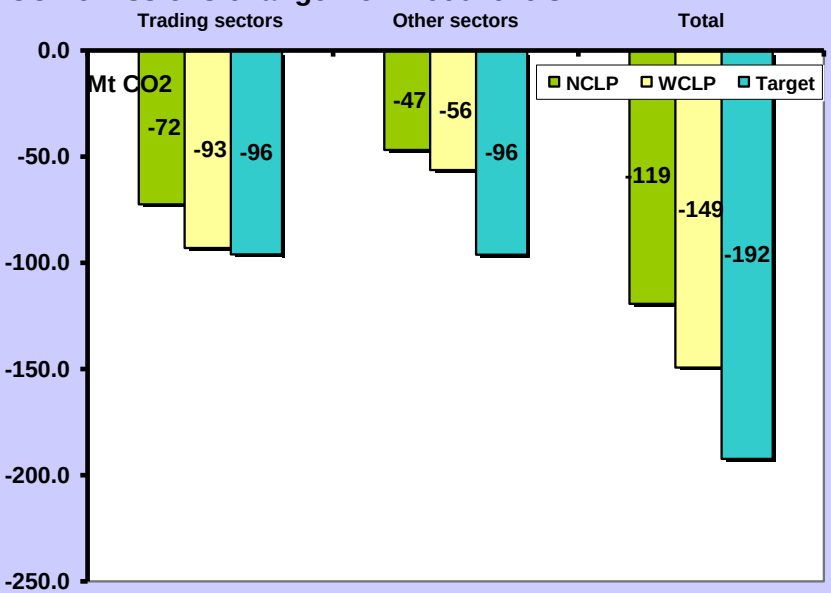
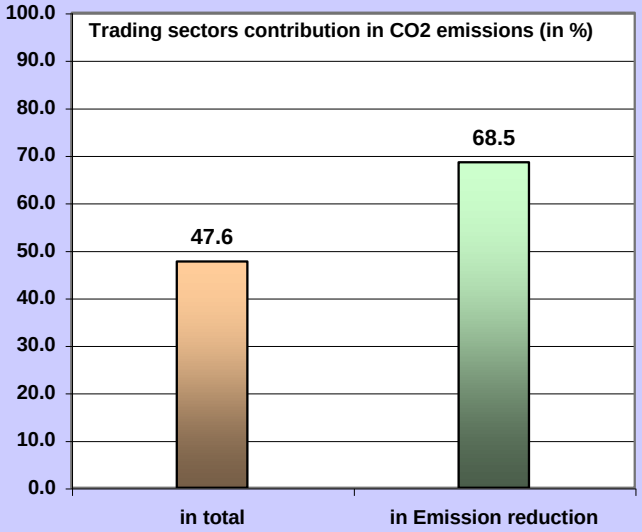
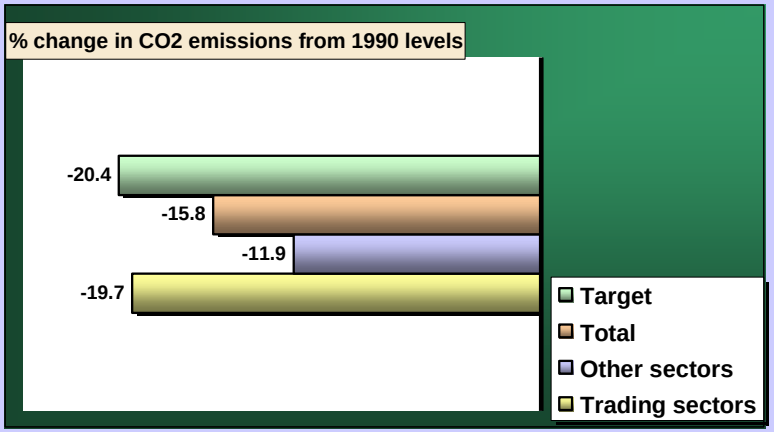


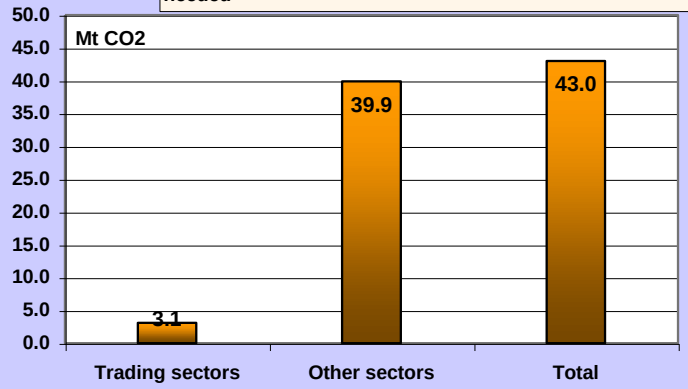




Distance to target

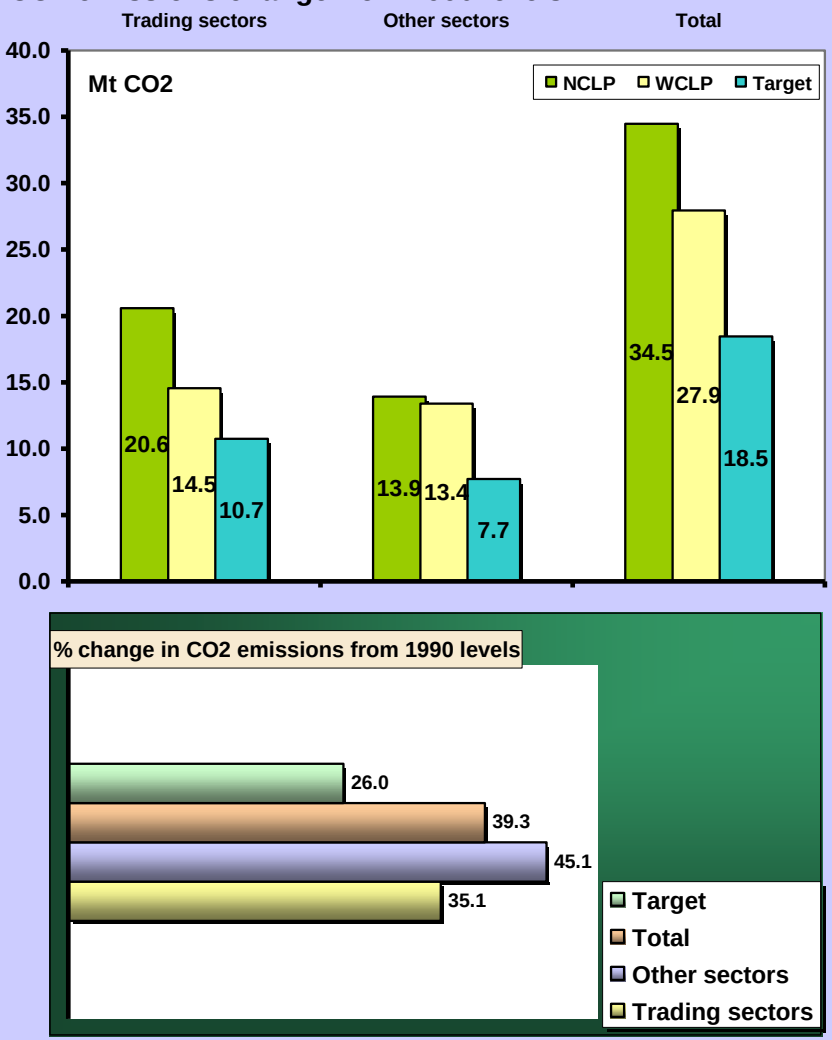
Negative figure implies potential selling of permits

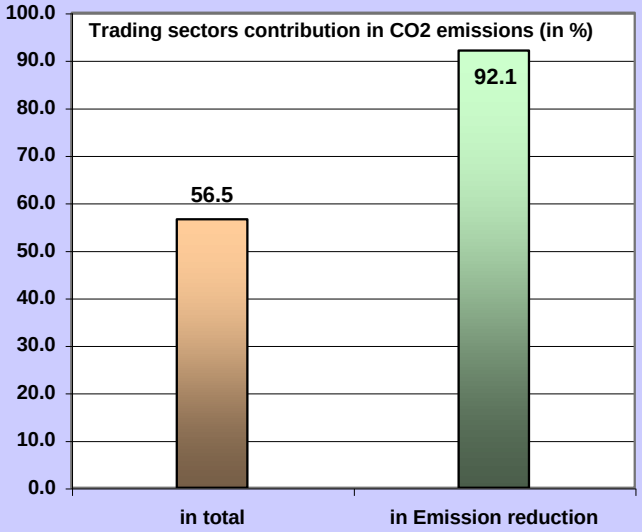
Positive figure implies additional effort/permits purchasing needed



Greece – Evolution of CO2 emissions under NCLP and WCLP cases

Target for trading and other sectors is defined assuming that they both need to comply to country specific emission reduction target





Distance to target

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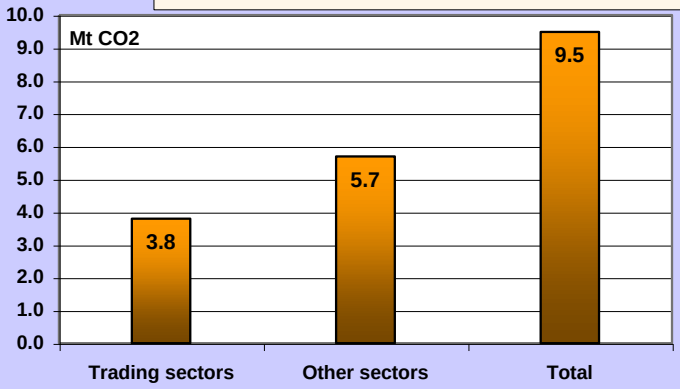
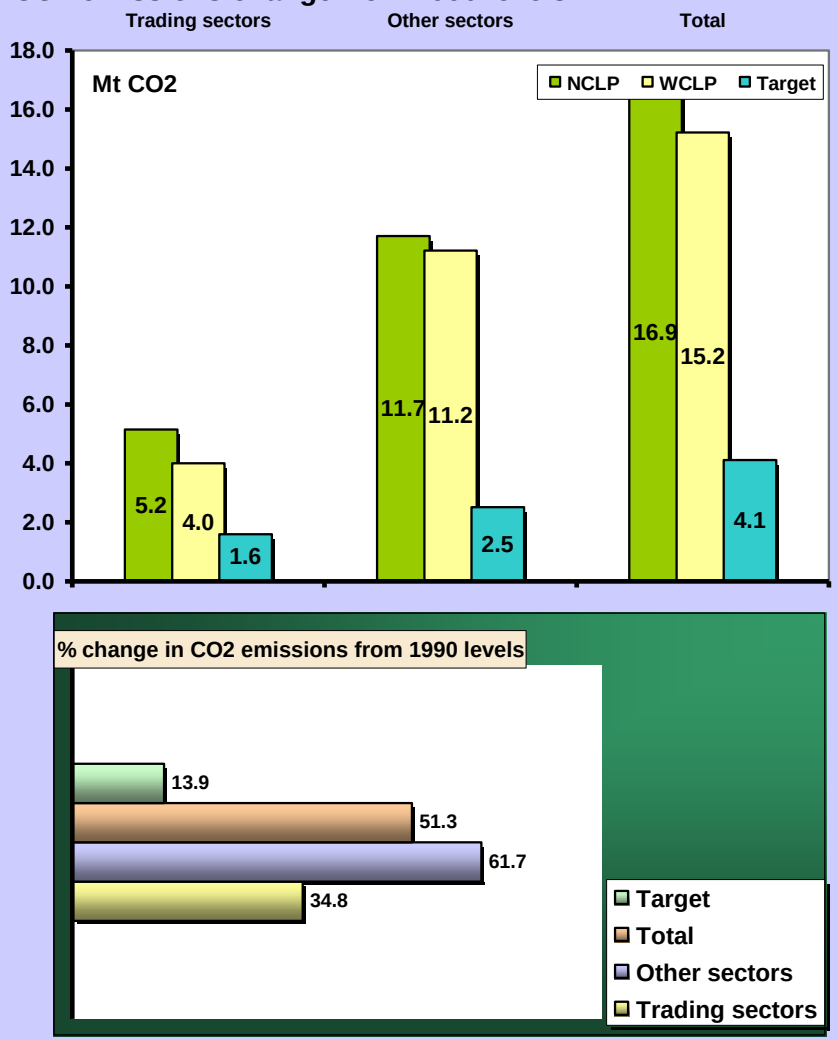
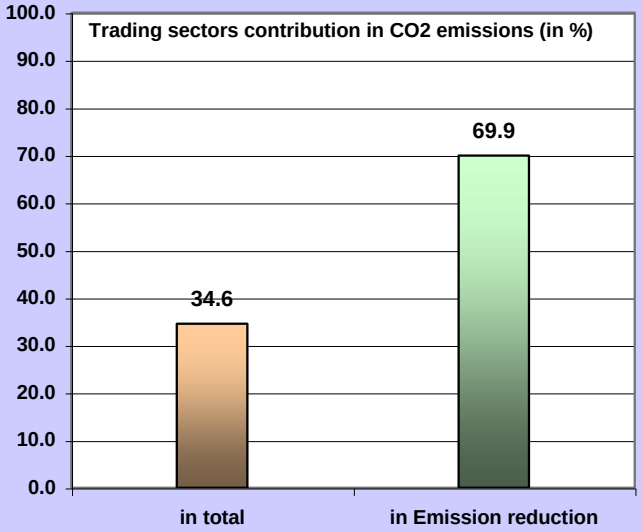
Positive figure implies additional effort/permits purchasing needed



Ireland – Evolution of CO2 emissions under NCLP and WCLP cases

Target for trading and other sectors is defined assuming that they both need to comply to country specific emission reduction target





Distance to target

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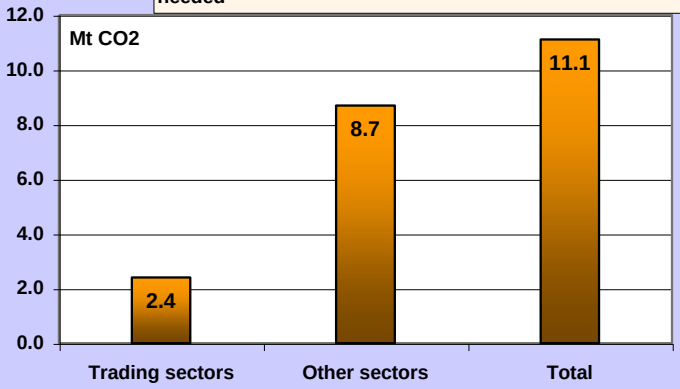
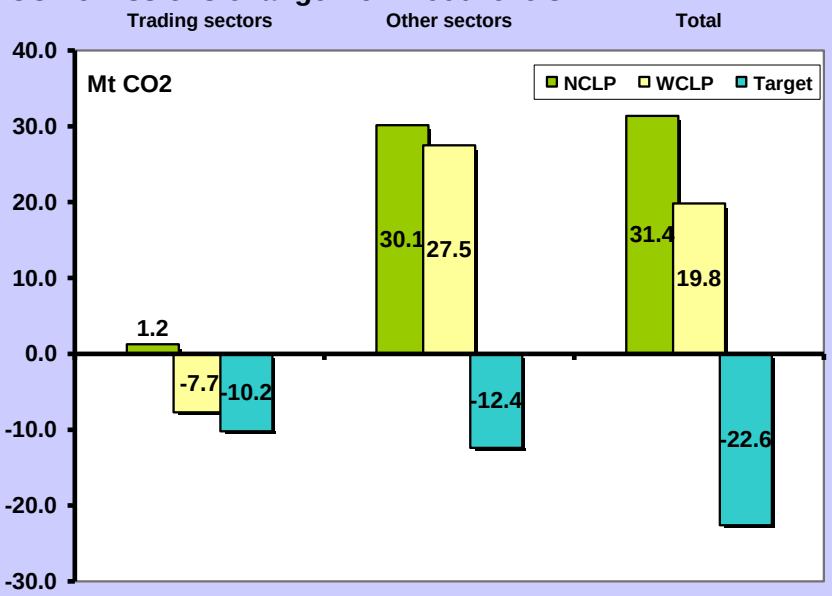
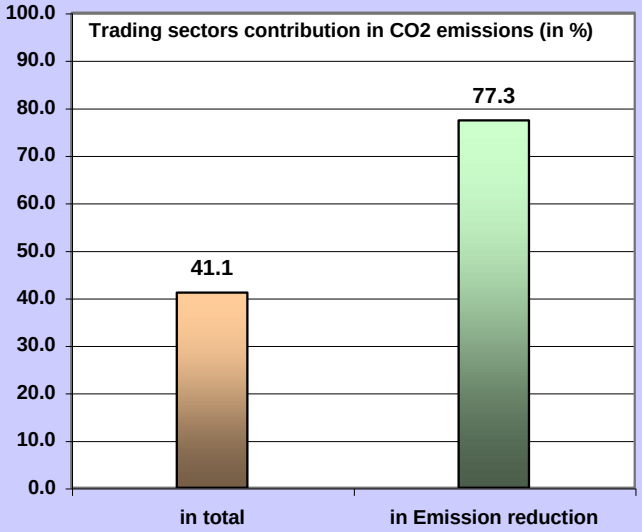
Positive figure implies additional effort/permits purchasing needed

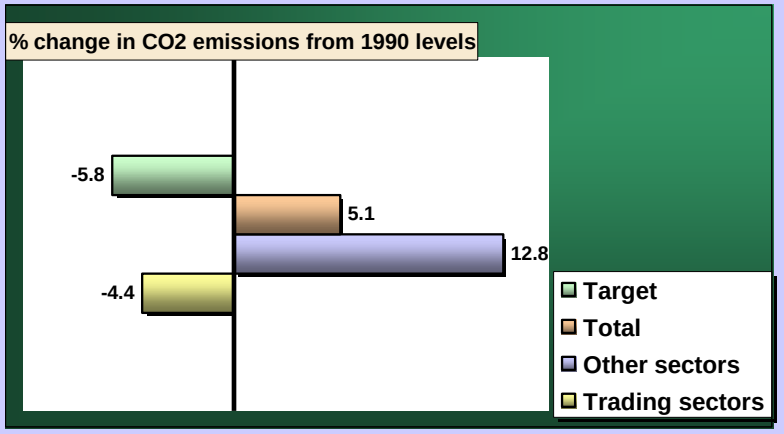


Italy – Evolution of CO2 emissions under NCLP and WCLP cases

Target for trading and other sectors is defined assuming that they both need to comply to country specific emission reduction target







Distance to target

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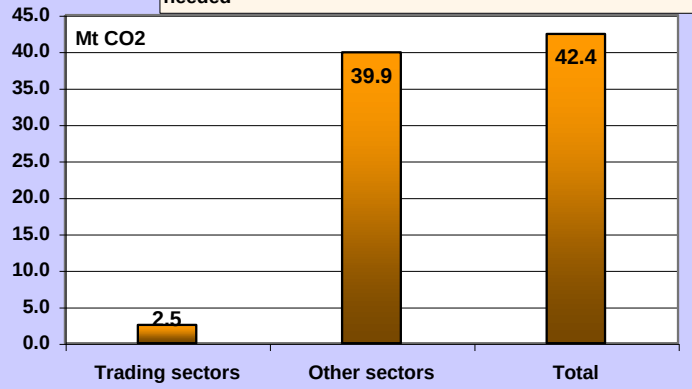
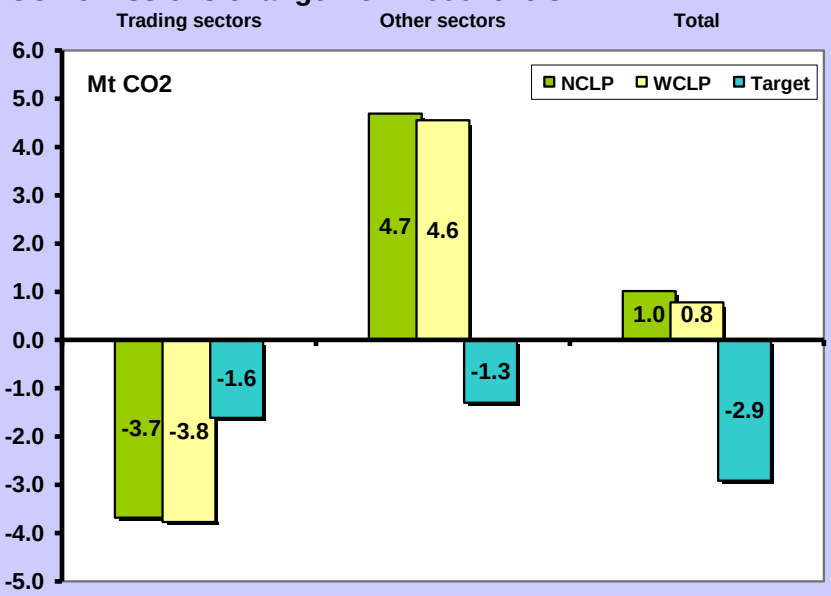
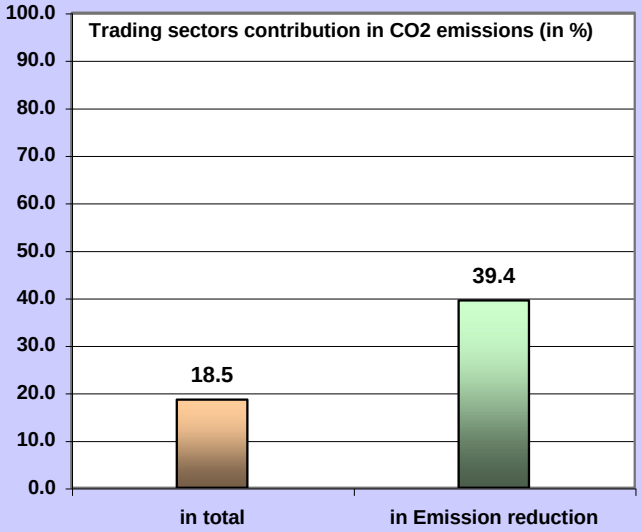
Positive figure implies additional effort/permits purchasing needed

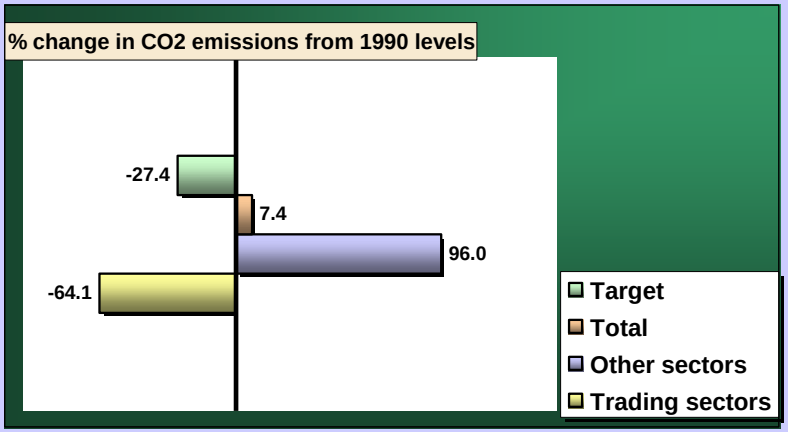


Luxemburg – Evolution of CO2 emissions under NCLP and WCLP cases

Target for trading and other sectors is defined assuming that they both need to comply to country specific emission reduction target







Distance to target

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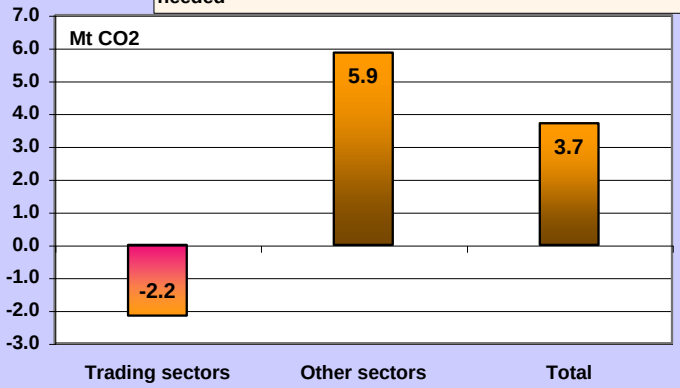
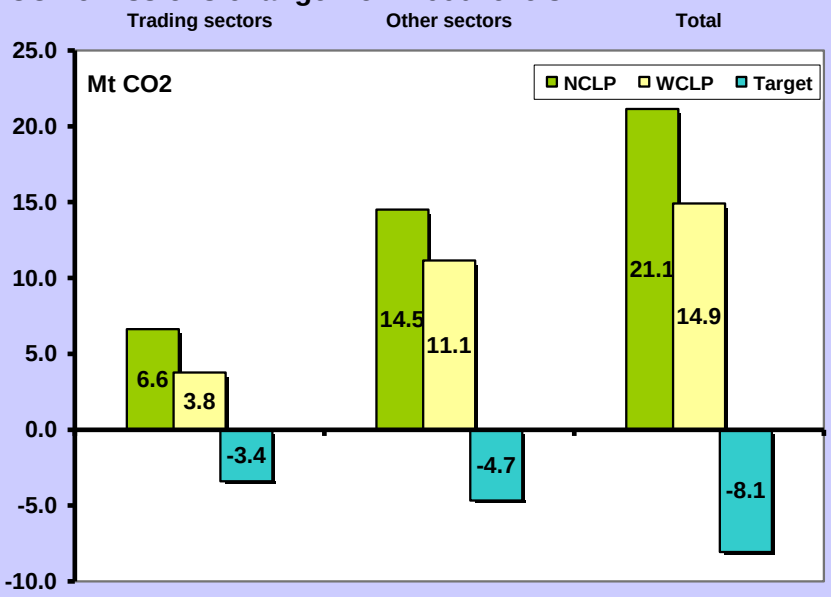
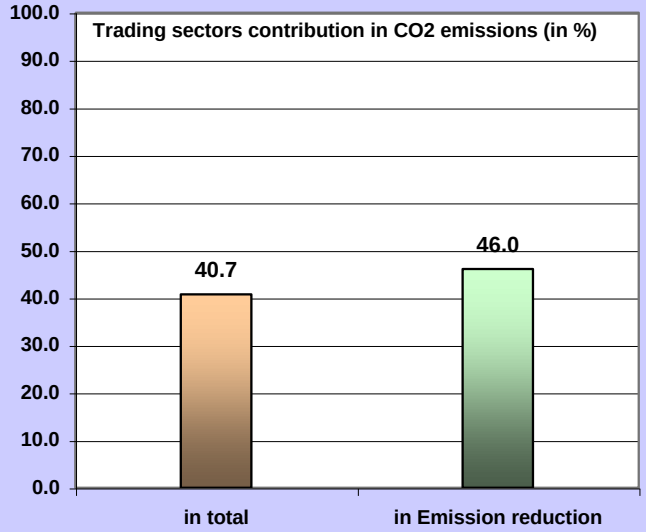
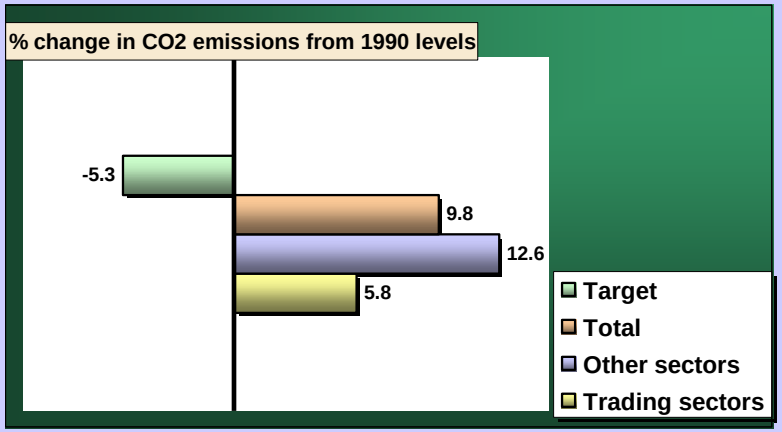


The Netherlands – Evolution of CO2 emissions under NCLP and WCLP cases

Target for trading and other sectors is defined assuming that they both need to comply to country specific emission reduction target







Distance to target

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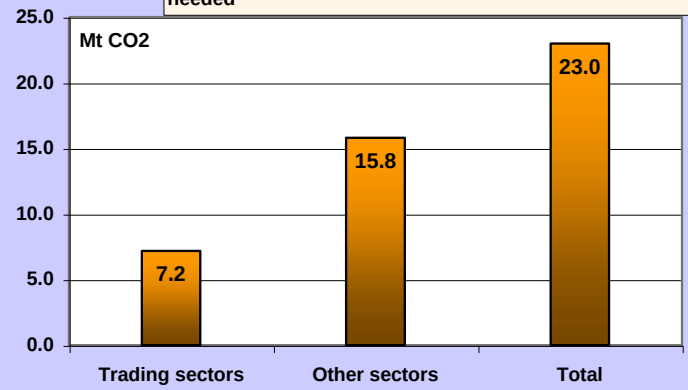
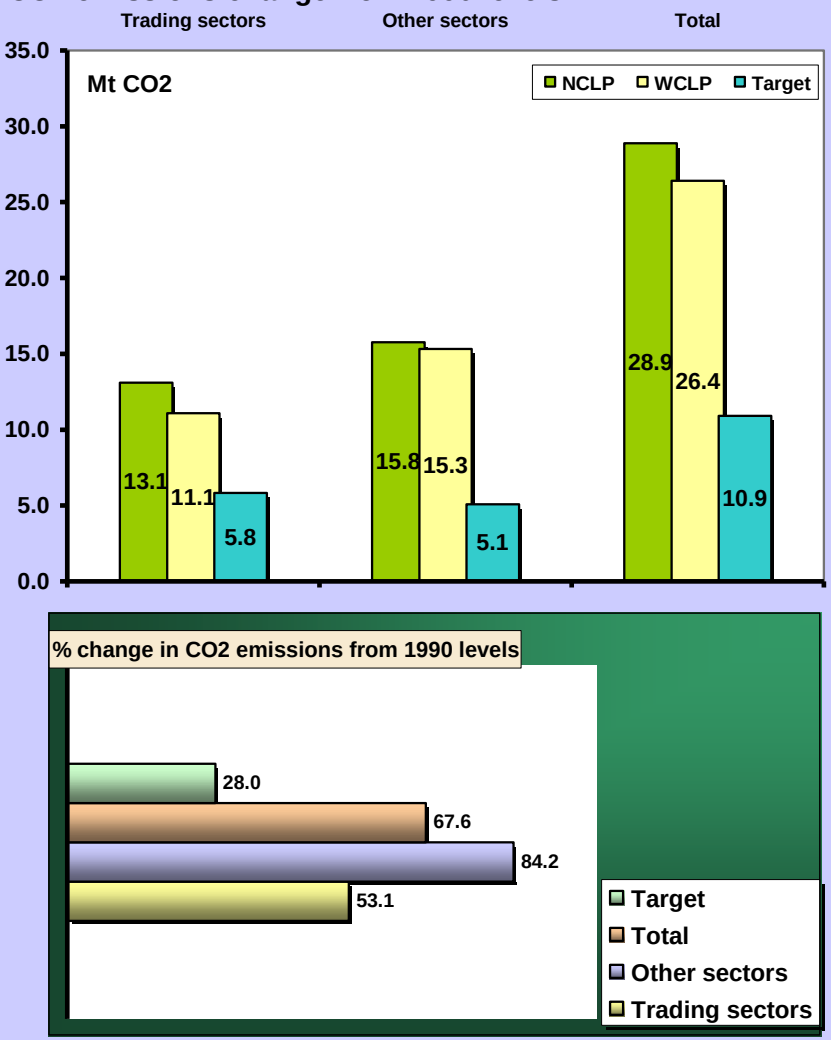
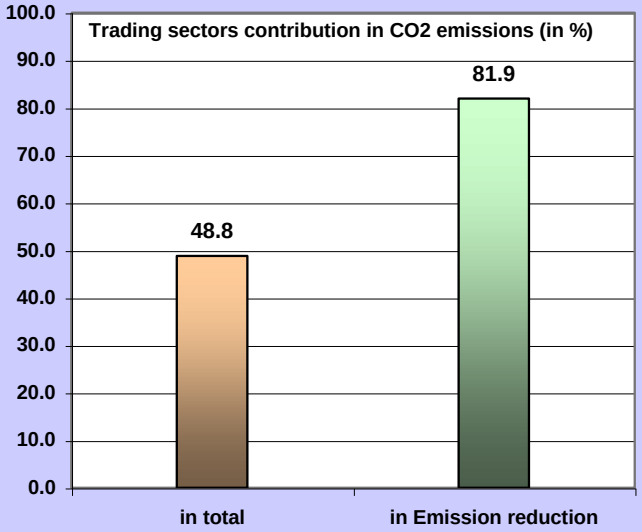


Portugal – Evolution of CO2 emissions under NCLP and WCLP cases

Target for trading and other sectors is defined assuming that they both need to comply to country specific emission reduction target





Distance to target

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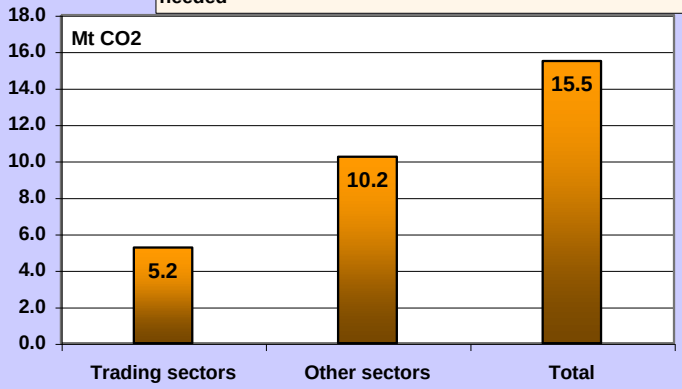
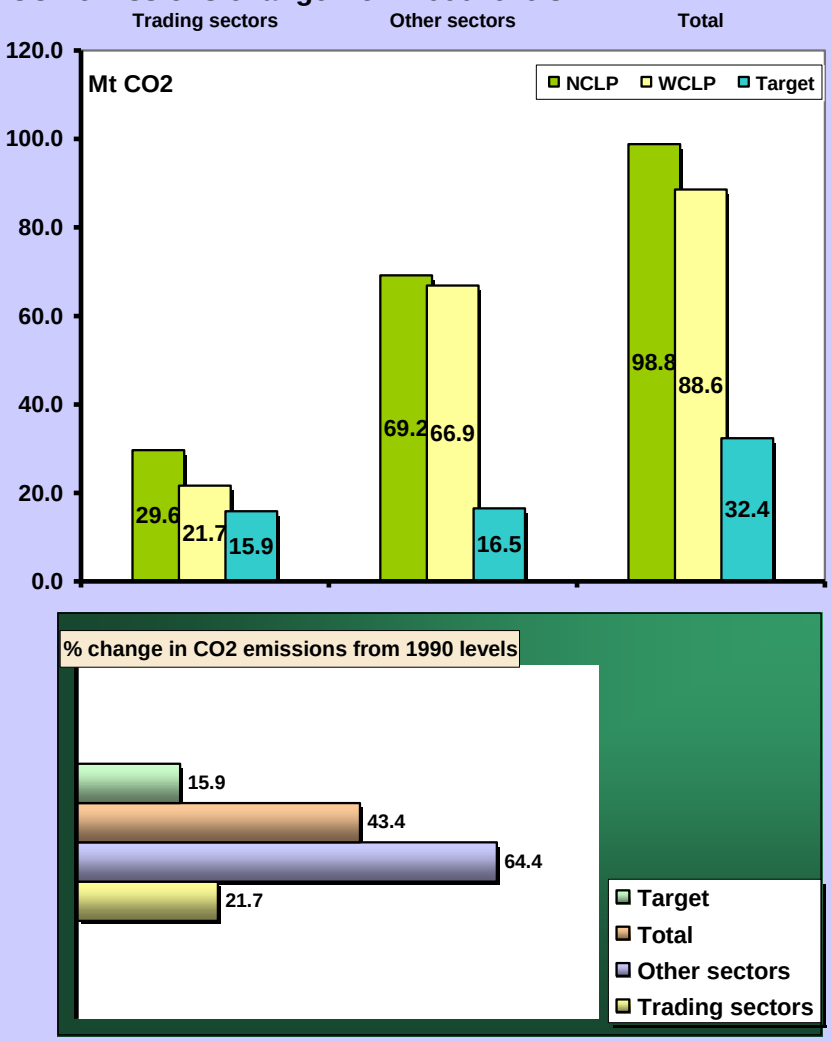
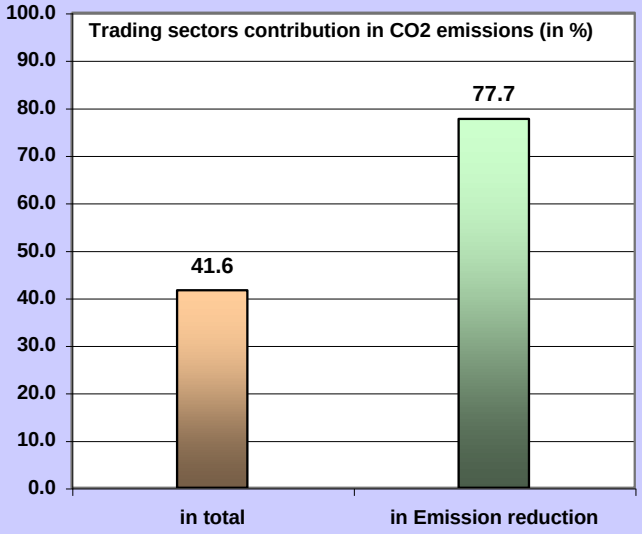
Positive figure implies additional effort/permits purchasing needed



Spain – Evolution of CO2 emissions under NCLP and WCLP cases

Target for trading and other sectors is defined assuming that they both need to comply to country specific emission reduction target





Distance to target

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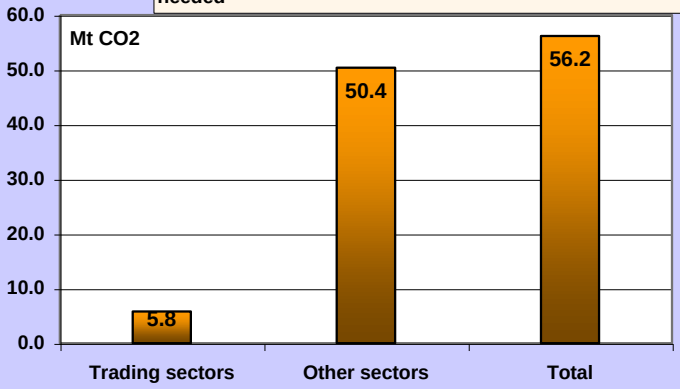
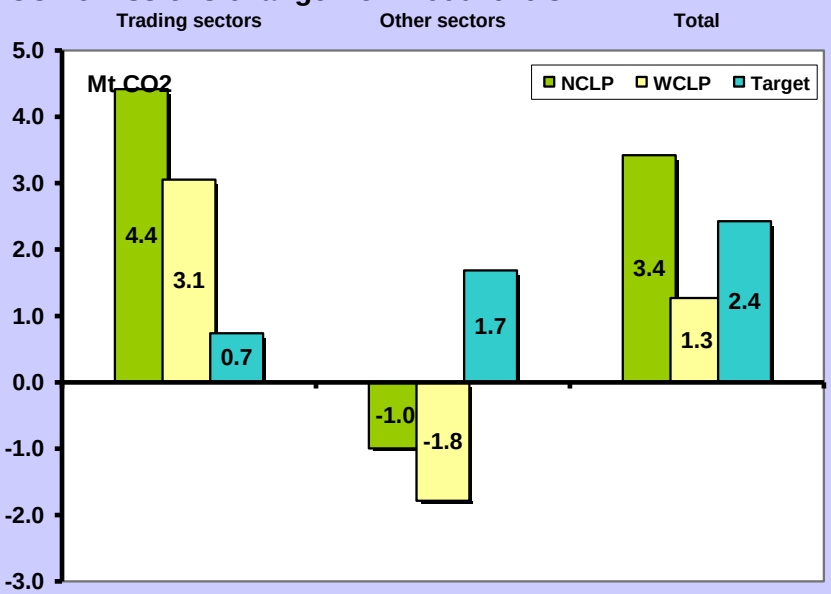
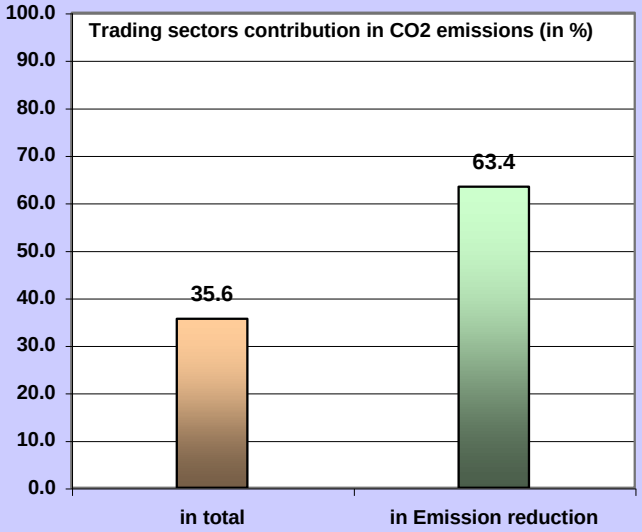
Positive figure implies additional effort/permits purchasing needed

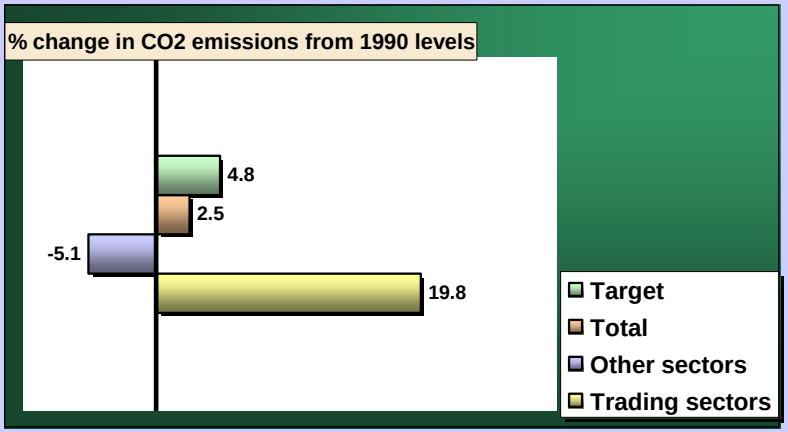


Sweden – Evolution of CO2 emissions under NCLP and WCLP cases

Target for trading and other sectors is defined assuming that they both need to comply to country specific emission reduction target







Distance to target

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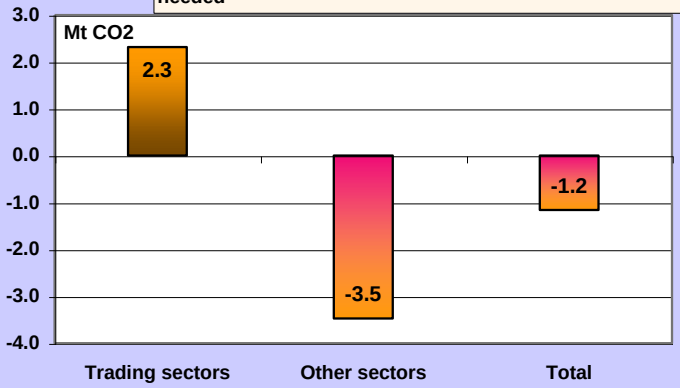
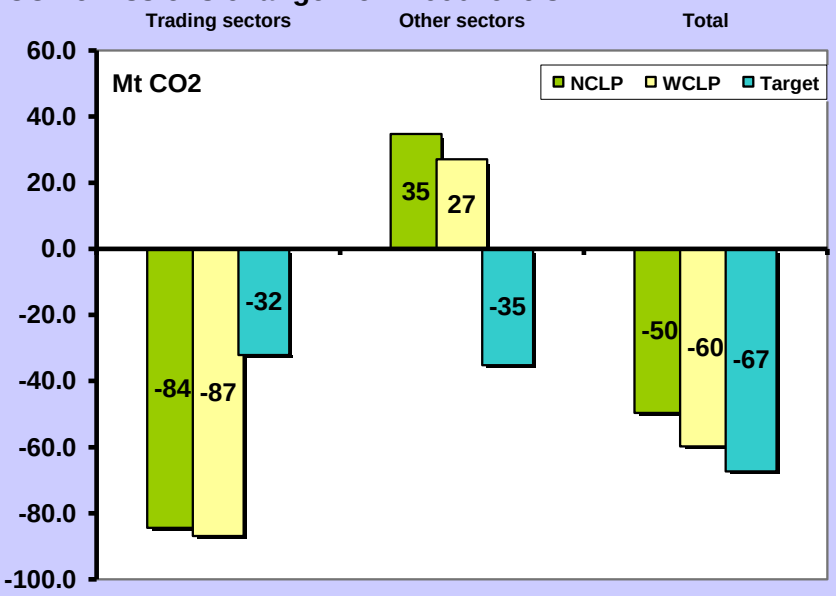
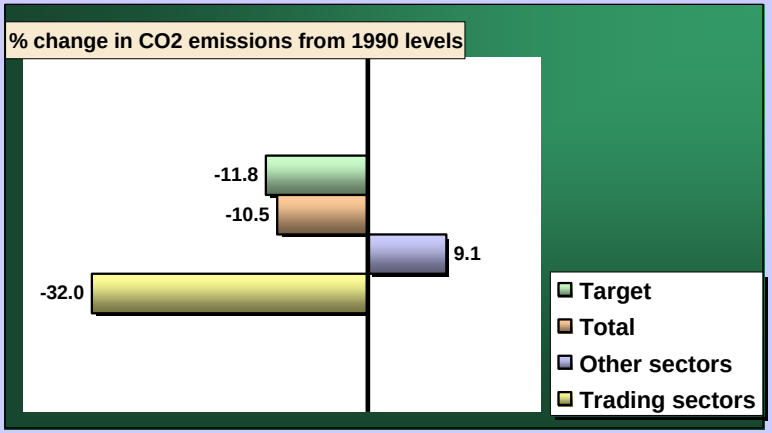
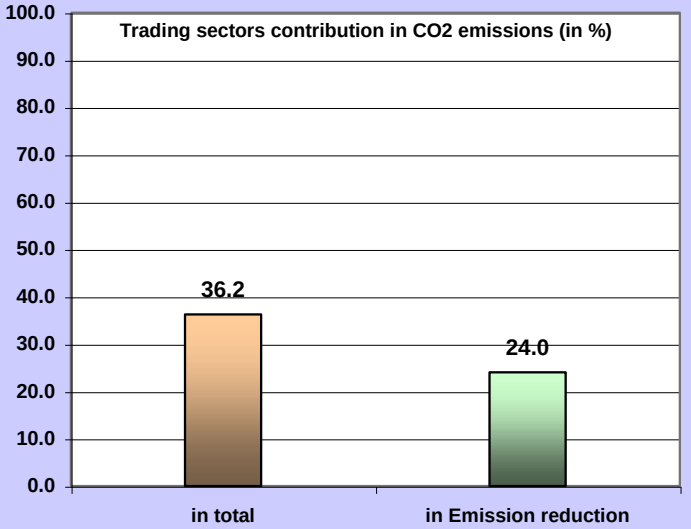


United Kingdom – Evolution of CO2 emissions under NCLP and WCLP cases

Target for trading and other sectors is defined assuming that they both need to comply to country specific emission reduction target







Distance to target

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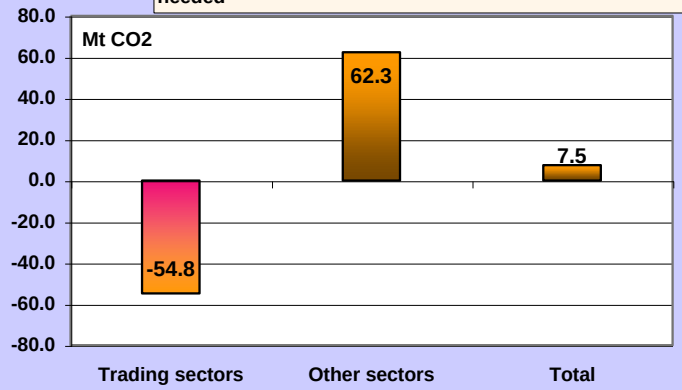
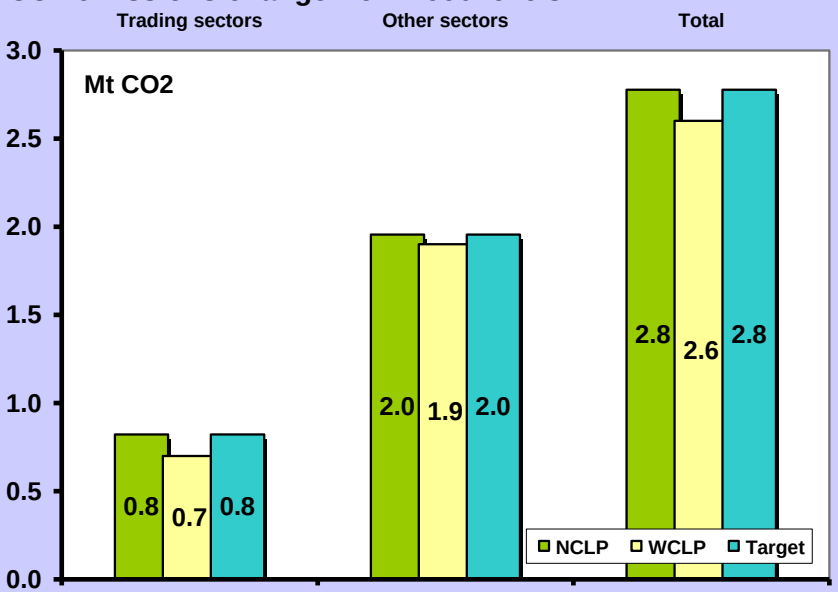
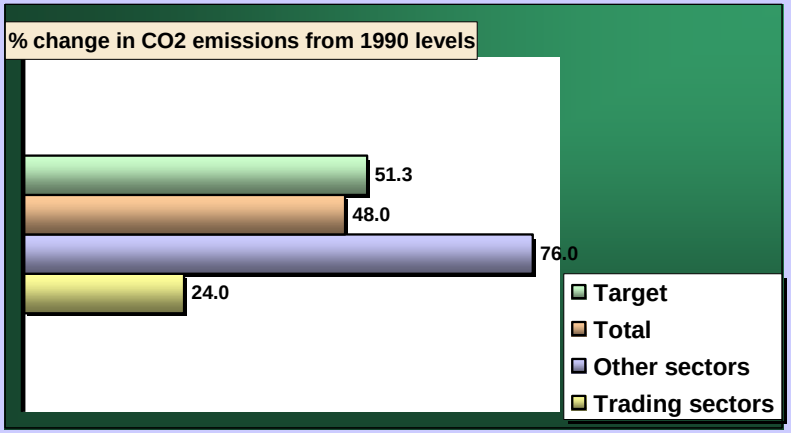
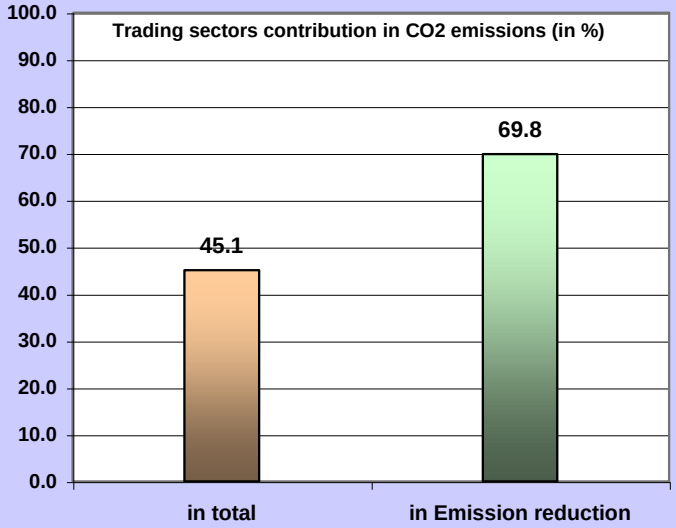


Cyprus – Evolution of CO2 emissions under NCLP and WCLP cases

Target for trading and other sectors is defined assuming that they both need to comply to country specific emission reduction target







Distance to target

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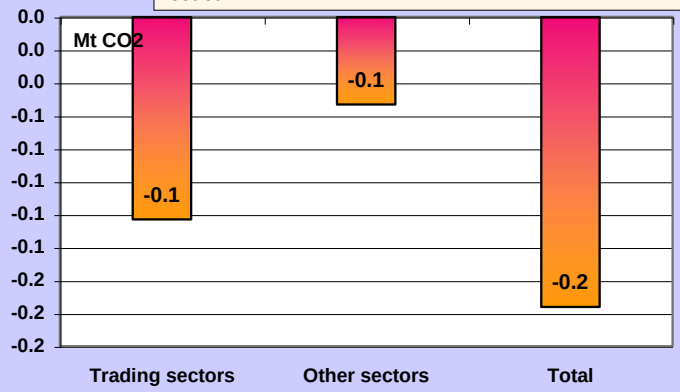
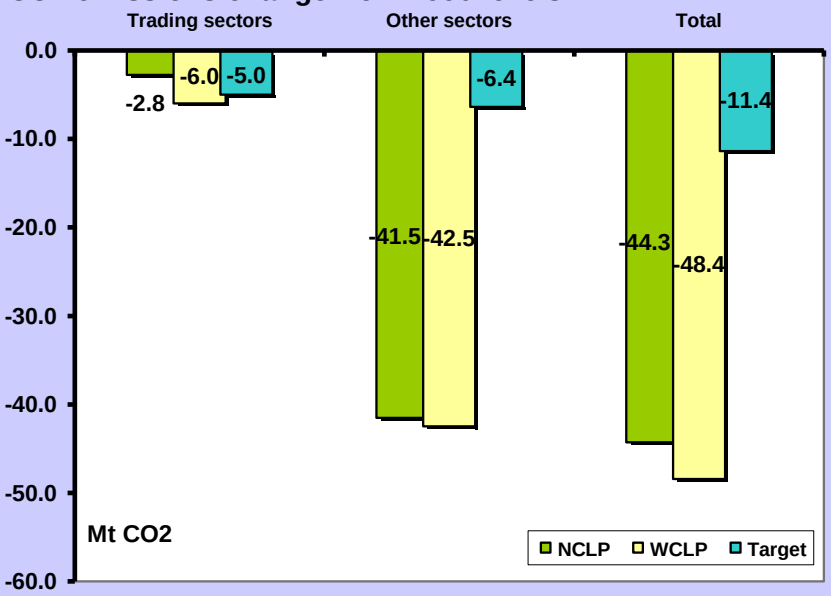
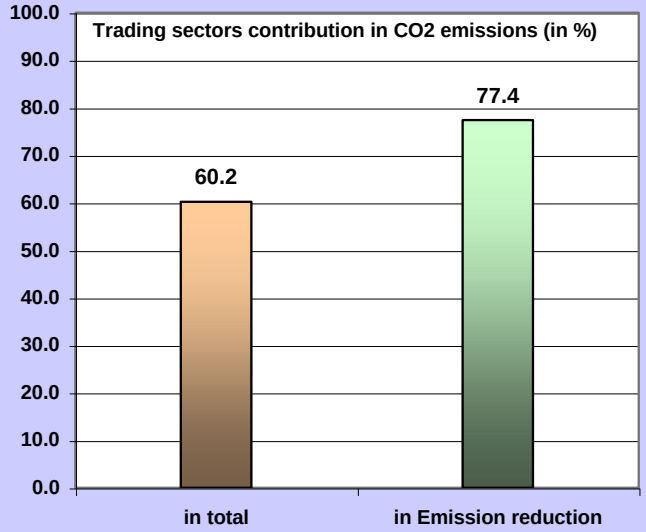
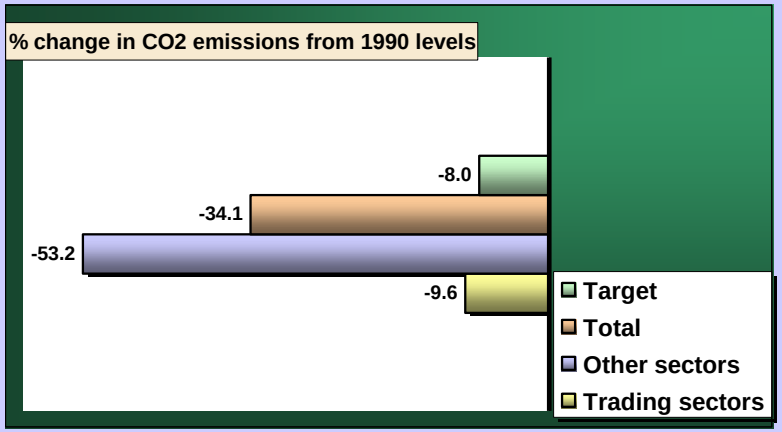


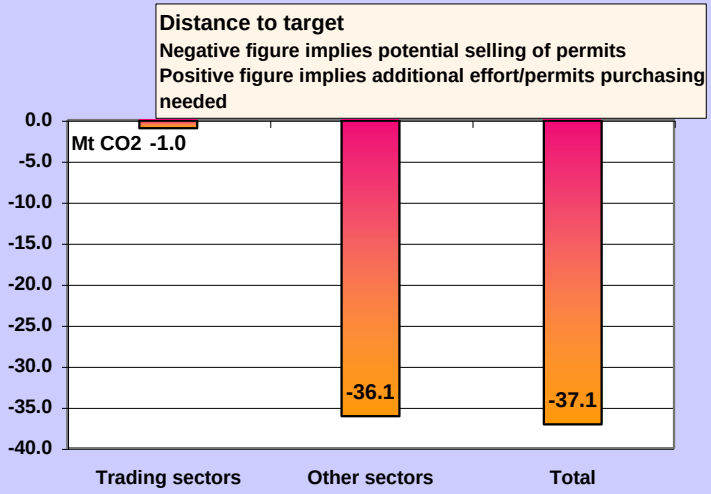
Czech Republic – Evolution of CO2 emissions under NCLP and WCLP cases

Target for trading and other sectors is defined assuming that they both need to comply to country specific emission reduction target



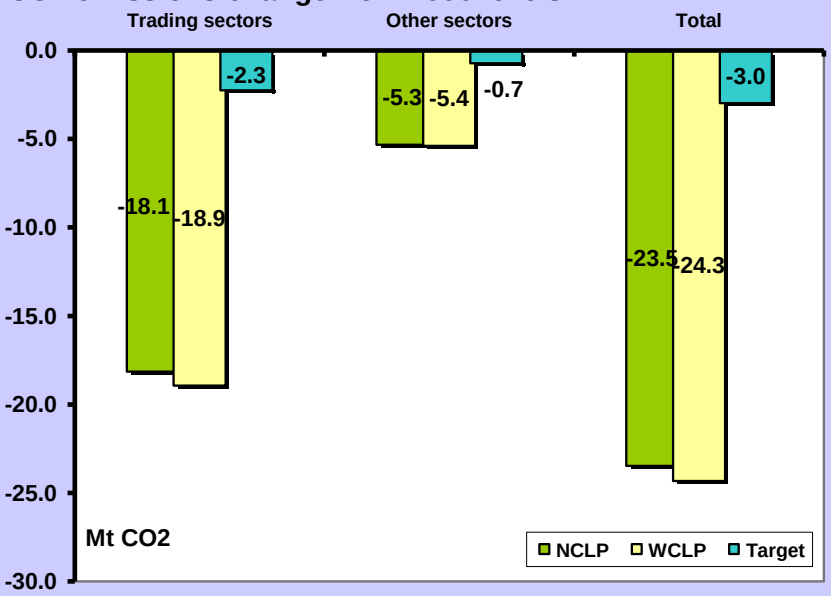


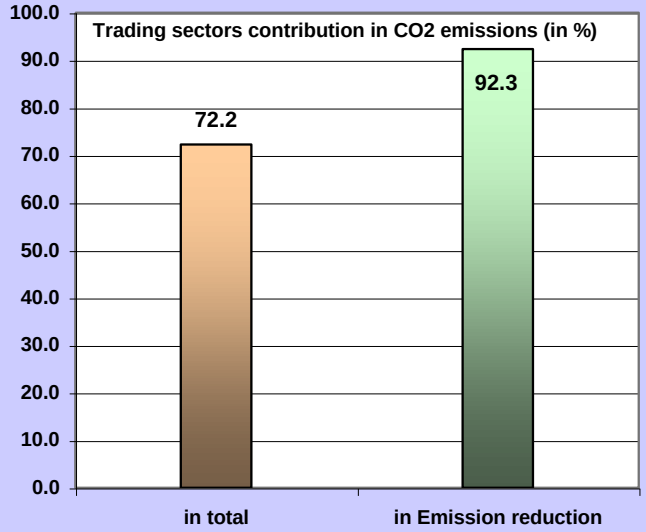


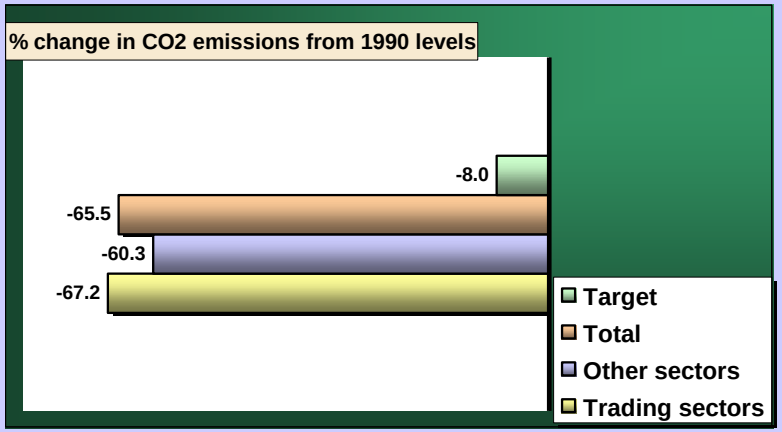


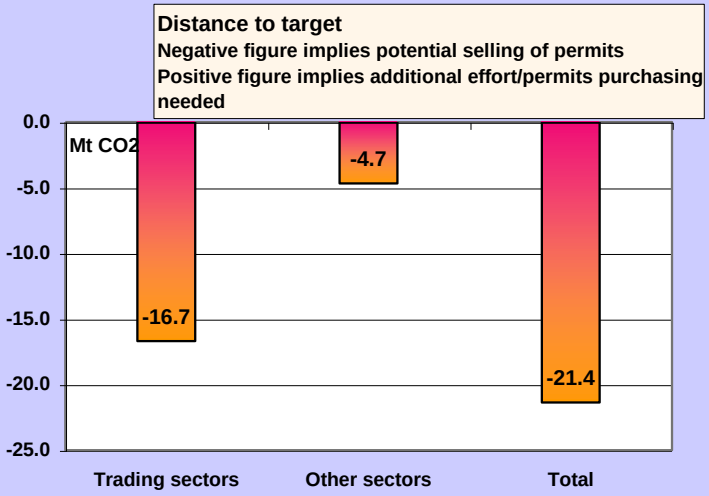
Estonia – Evolution of CO2 emissions under NCLP and WCLP cases

Target for trading and other sectors is defined assuming that they both need to comply to country specific emission reduction target



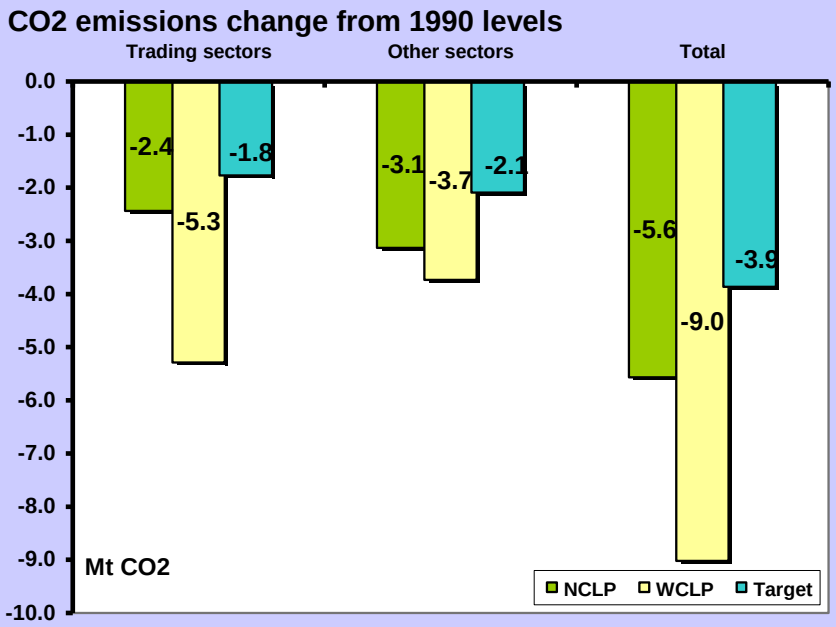


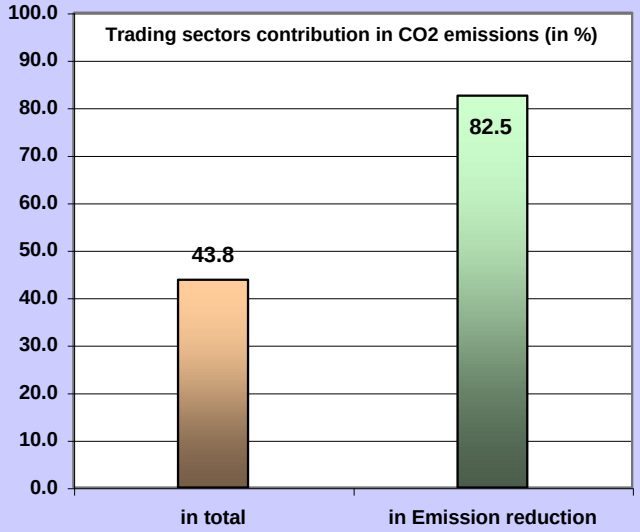


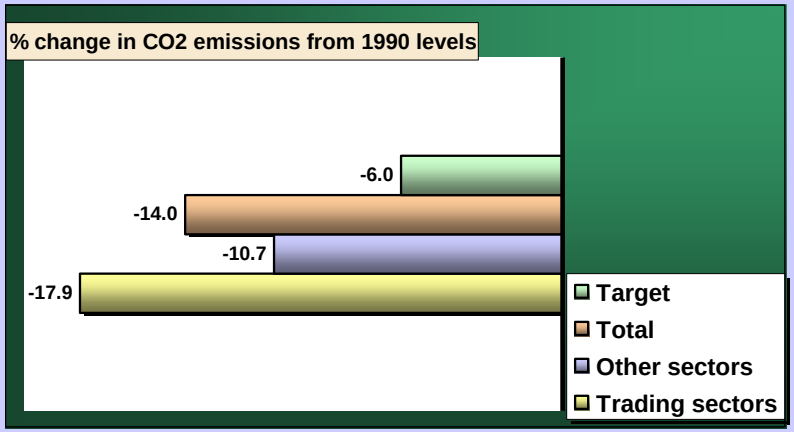


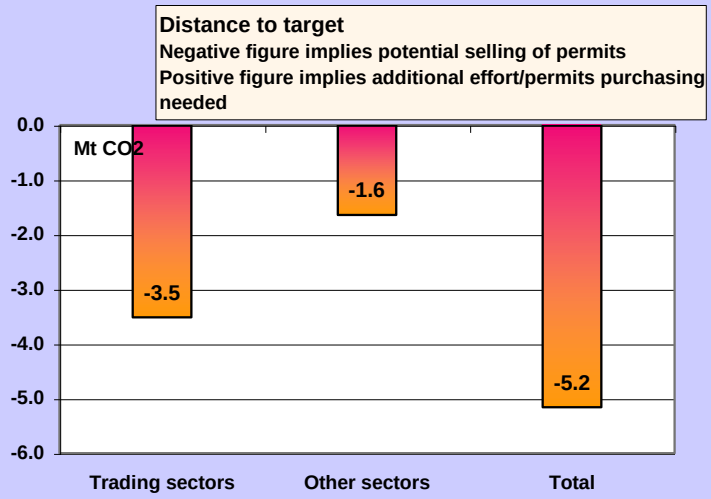
Hungary – Evolution of CO2 emissions under NCLP and WCLP cases

Target for trading and other sectors is defined assuming that they both need to comply to country specific emission reduction target



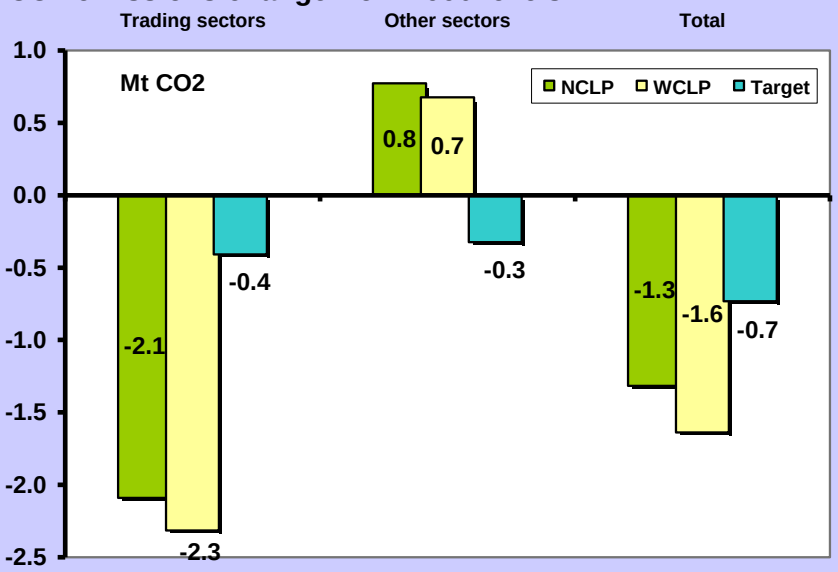


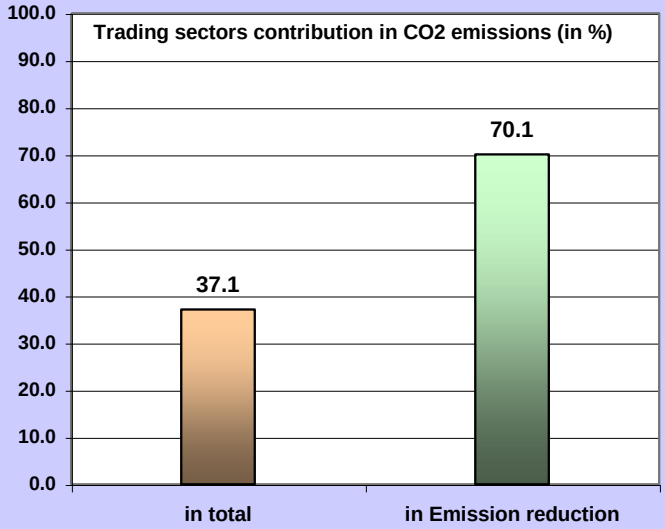


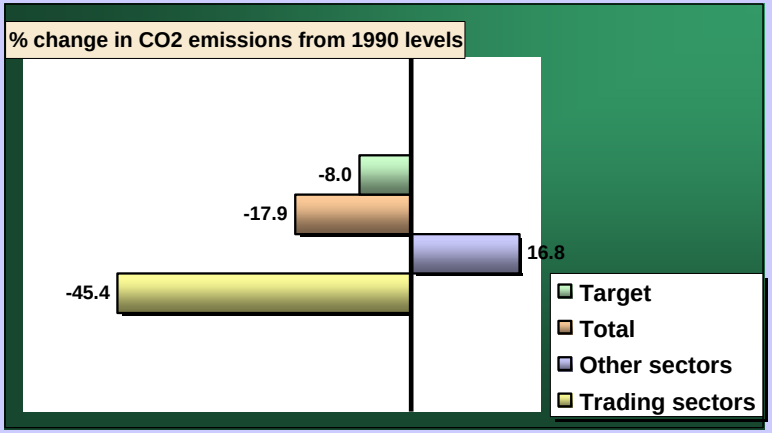


Latvia – Evolution of CO2 emissions under NCLP and WCLP cases

Target for trading and other sectors is defined assuming that they both need to comply to country specific emission reduction target



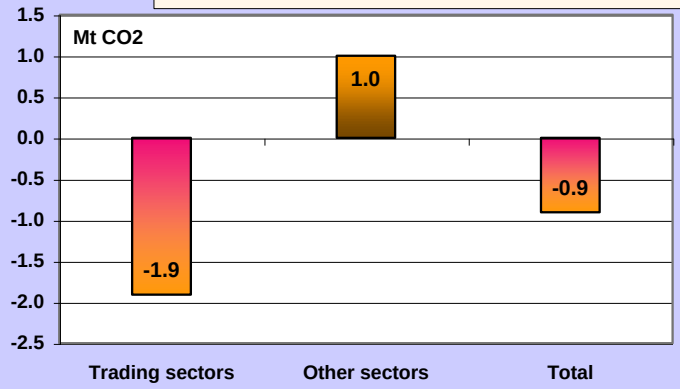




Distance to target

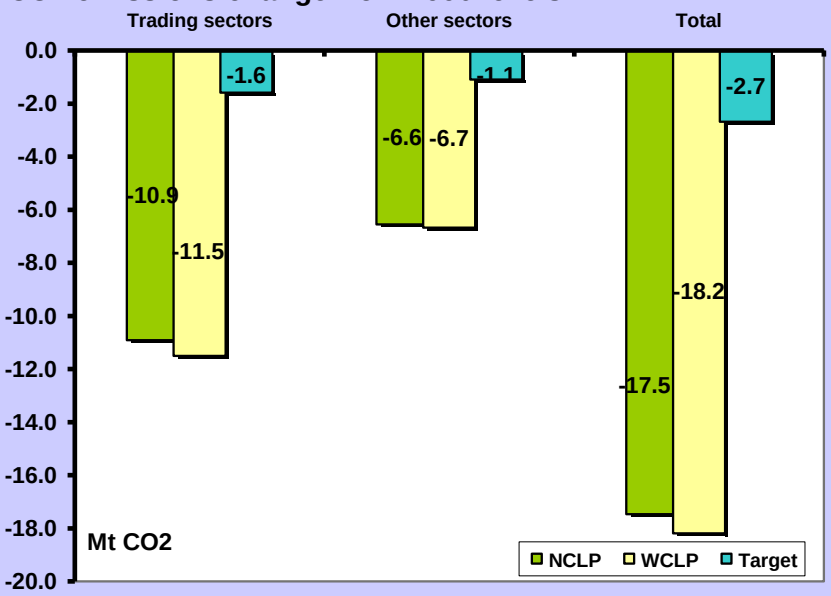
Negative figure implies potential selling of permits

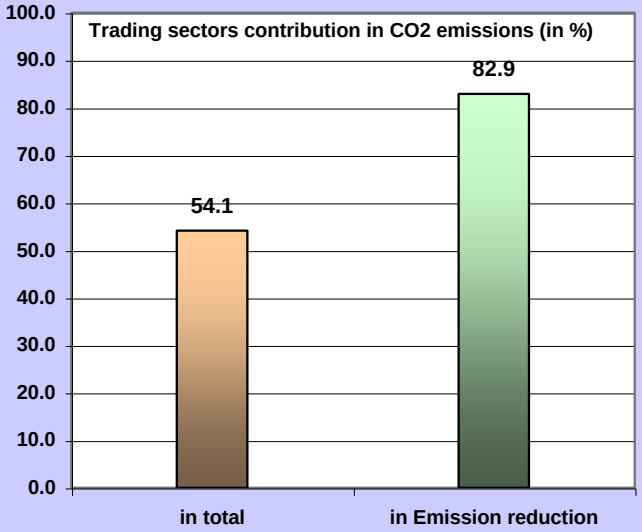
Positive figure implies additional effort/permits purchasing needed

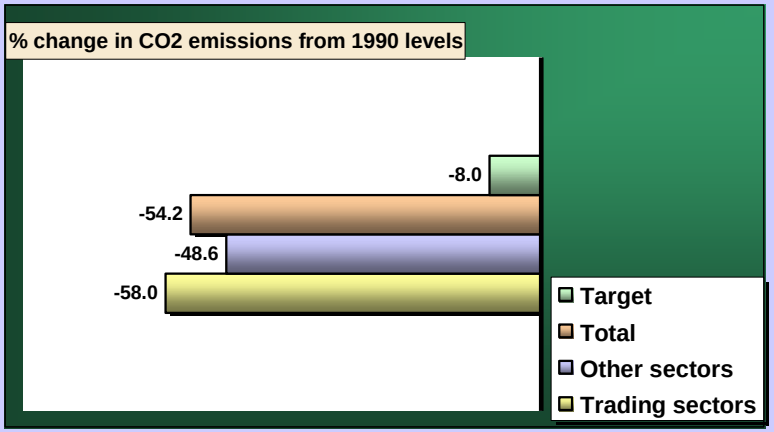


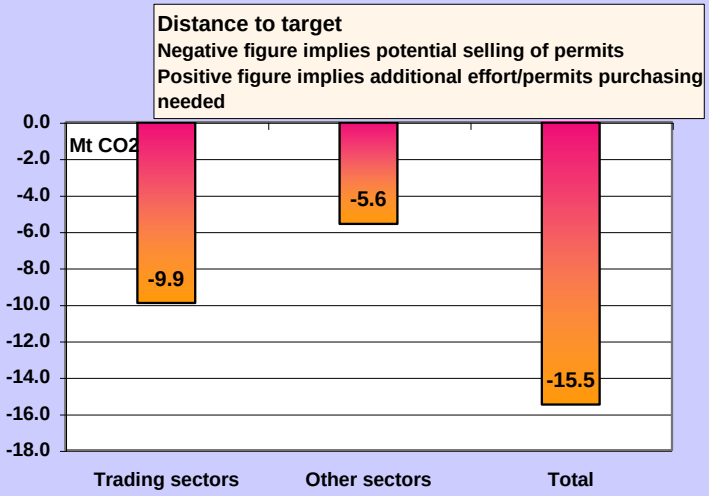
Lithuania – Evolution of CO2 emissions under NCLP and WCLP cases

Target for trading and other sectors is defined assuming that they both need to comply to country specific emission reduction target



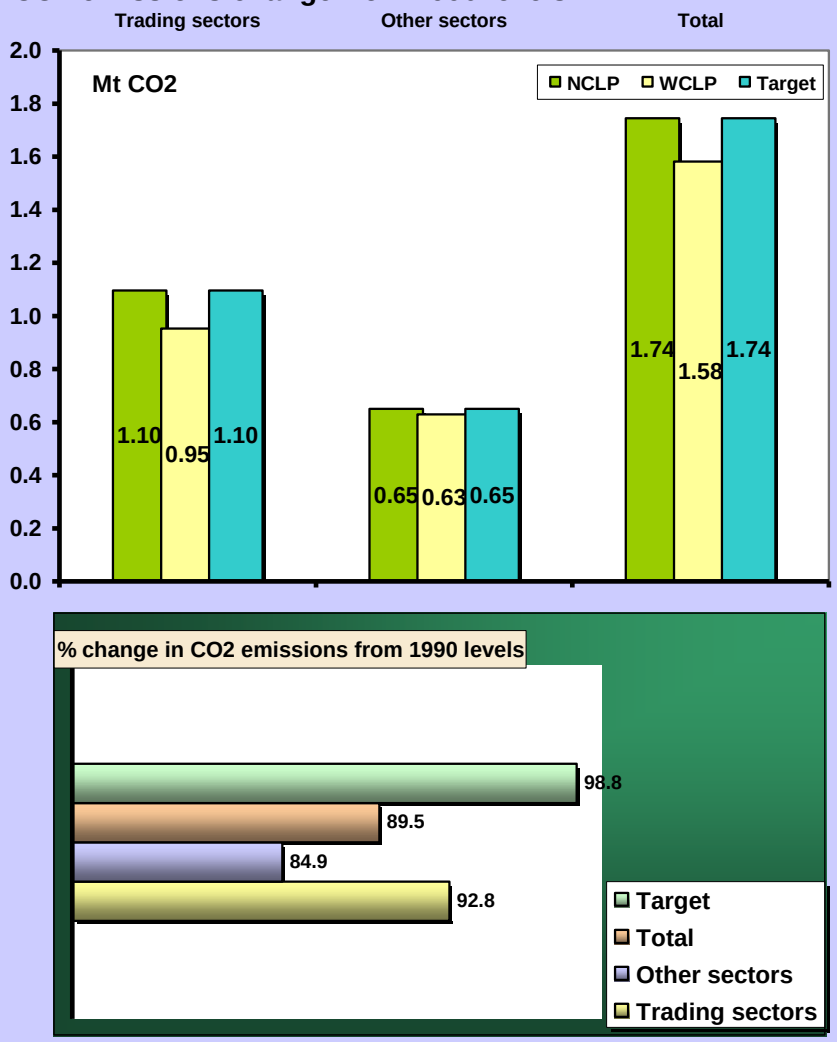


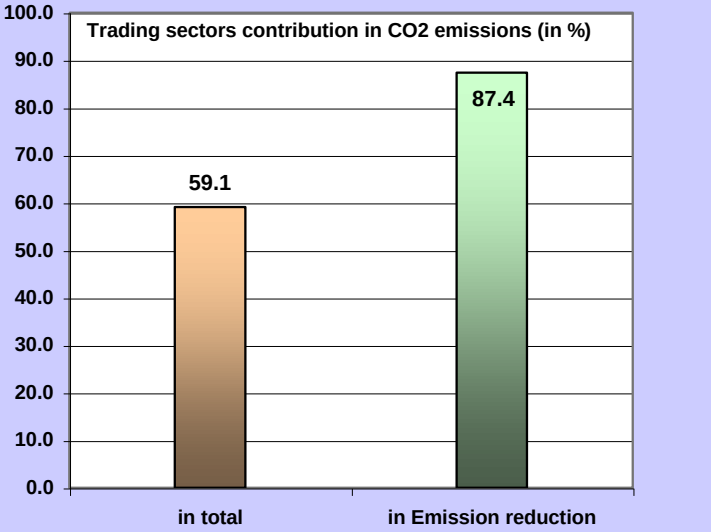


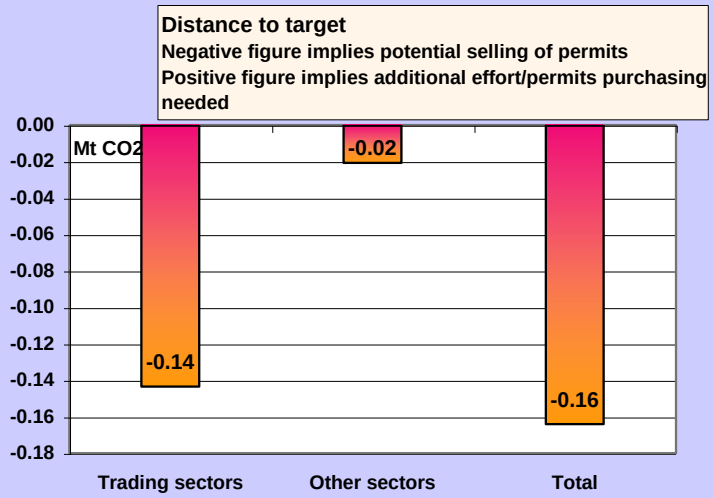


Malta – Evolution of CO2 emissions under NCLP and WCLP cases

Target for trading and other sectors is defined assuming that they both need to comply to country specific emission reduction target

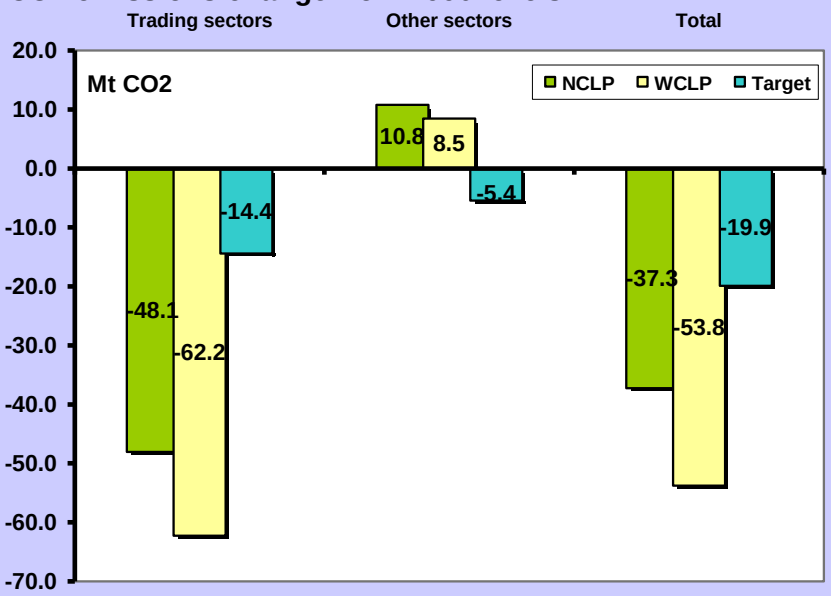


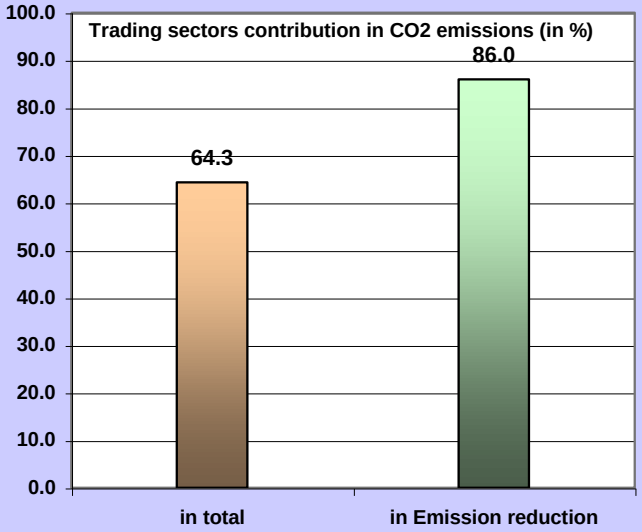


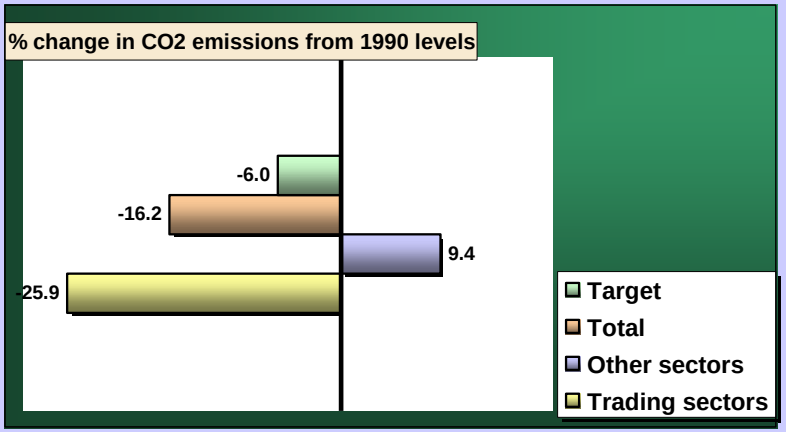


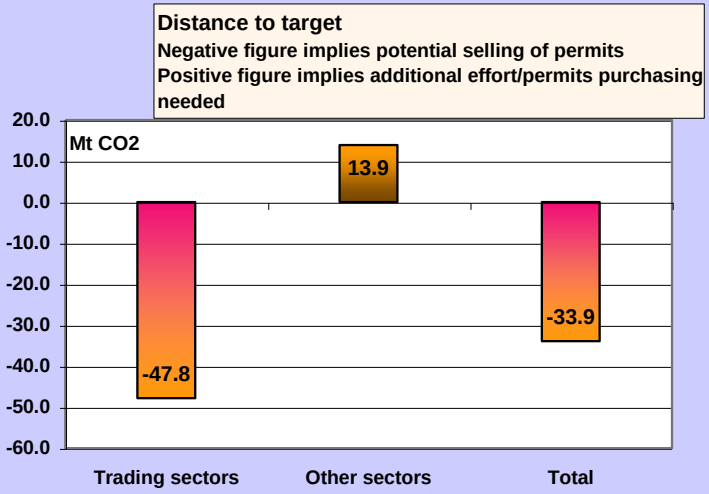
Poland – Evolution of CO2 emissions under NCLP and WCLP cases

Target for trading and other sectors is defined assuming that they both need to comply to country specific emission reduction target



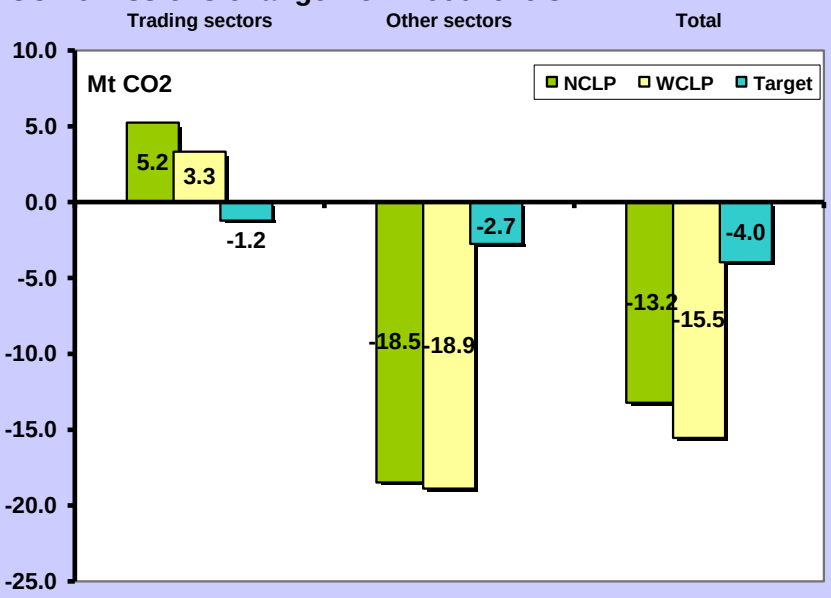


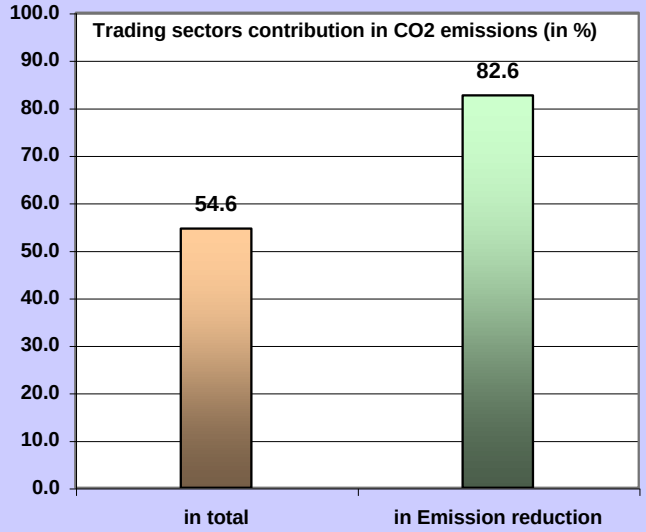


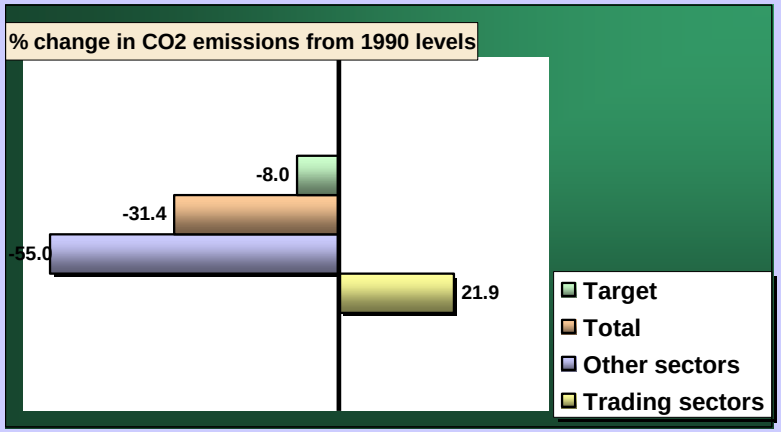


Slovakia – Evolution of CO2 emissions under NCLP and WCLP cases

Target for trading and other sectors is defined assuming that they both need to comply to country specific emission reduction target



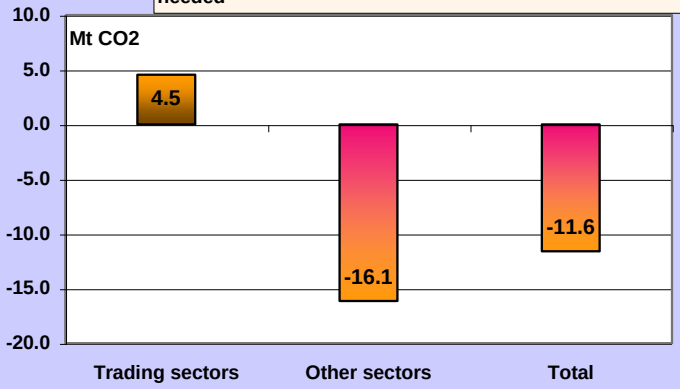




Distance to target

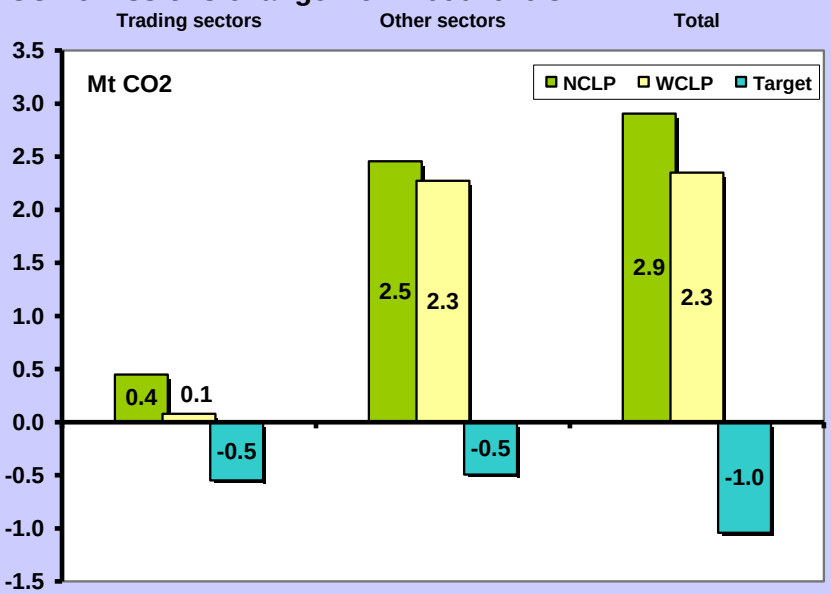
Negative figure implies potential selling of permits

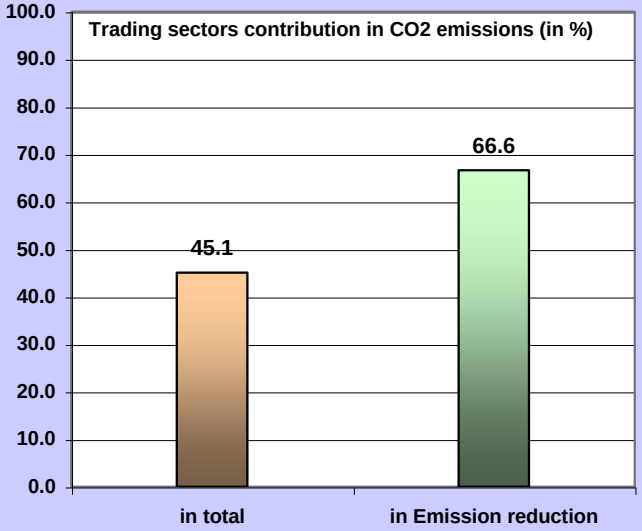
Positive figure implies additional effort/permits purchasing needed

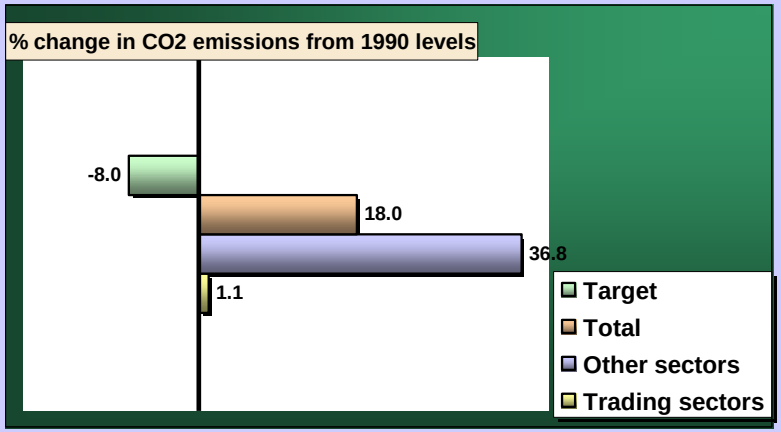


Slovenia – Evolution of CO2 emissions under NCLP and WCLP cases

Target for trading and other sectors is defined assuming that they both need to comply to country specific emission reduction target







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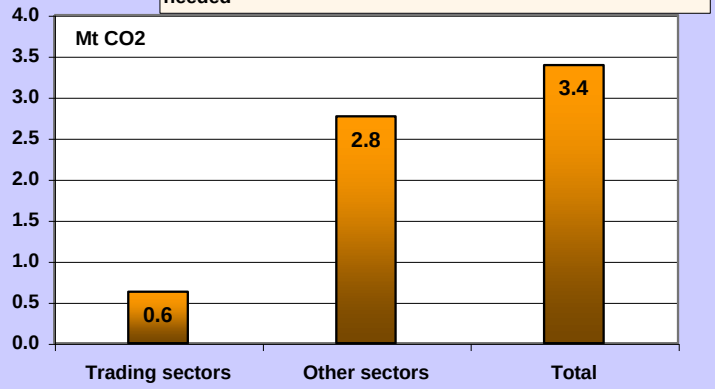


CAFE BASELINE SCENARIO
"With Climate Policies Case"
Background material

Scenario construction

- Starting point:
  - Baseline scenario constructed in the context of the "Long Range Energy Modelling" framework contract by Energy and Transport DG
    - Finalised in December 2002
    - Covers EU Member States (PRIMES model), the 13 EU candidate countries (ACE model), Norway and Switzerland (ACE model)
    - A detailed analysis of assumptions and results can be found in the publication of Energy and Transport DG:

    "European Energy and Transport – Trends to 2030"

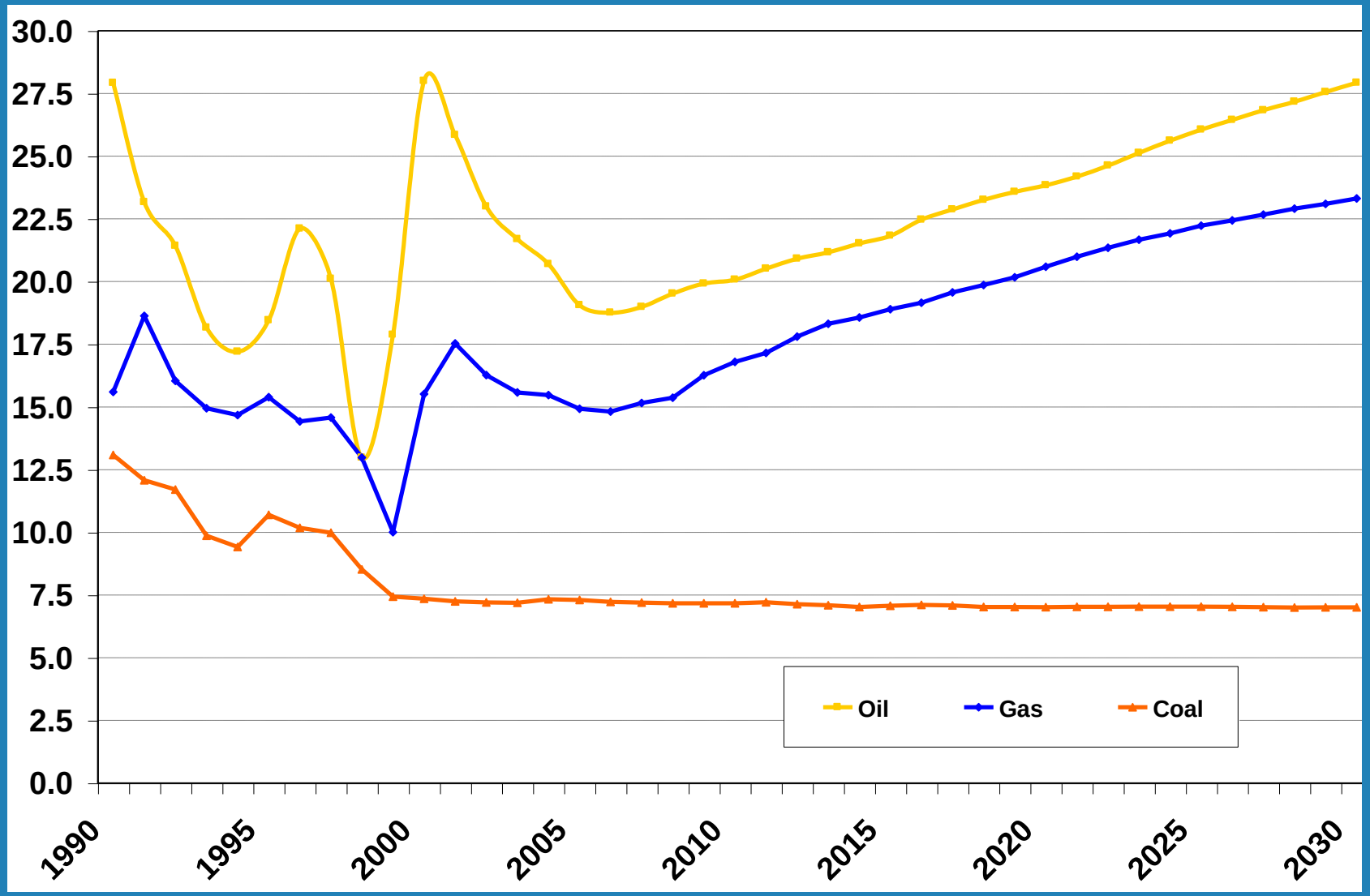
The baseline scenario incorporates

- Updated energy, economic and financial information (2000 acts as the base year)
- Recent trends and policies in place
  - The fuel efficiency agreement with car industry
  - Market liberalisation for electricity and gas
  - Existing policies on energy efficiency and renewable energy forms
  - Ongoing infrastructure projects
  - Nuclear policies by Member State and Acceding country
- For analytical purposes the baseline scenario does **not** include any new policies to reduce greenhouse gas emissions
  - This is to assist in identifying the remaining gaps in the energy and transport sectors with respect to the EU's Kyoto commitment
  - The incorporation of permit prices under the "with climate policy measures" scenario leads to the adoption of policy measures in a cost effective way for the energy system so as to reduce CO2 emissions

Key assumptions for the Baseline scenario (1)

- World energy prices develop moderately over the projection period
  - POLES model results: scenario constructed in the context of the LREM Framework contract assumes
    - Continuation of current world energy market structures
    - Conventional view on fossil fuel reserves / abundant resources in the horizon to 2030
- Demographic assumptions
  - EUROSTAT historical data and projections used for population
  - Projections of the United Nations Global Urban Observatory and Statistics Unit of UN-HABITAT used for household size
    - Also for population growth in Acceding countries beyond 2003
- Weather assumptions: 2000 weather conditions maintained throughout the projection horizon

International fuel prices ($00 per boe)

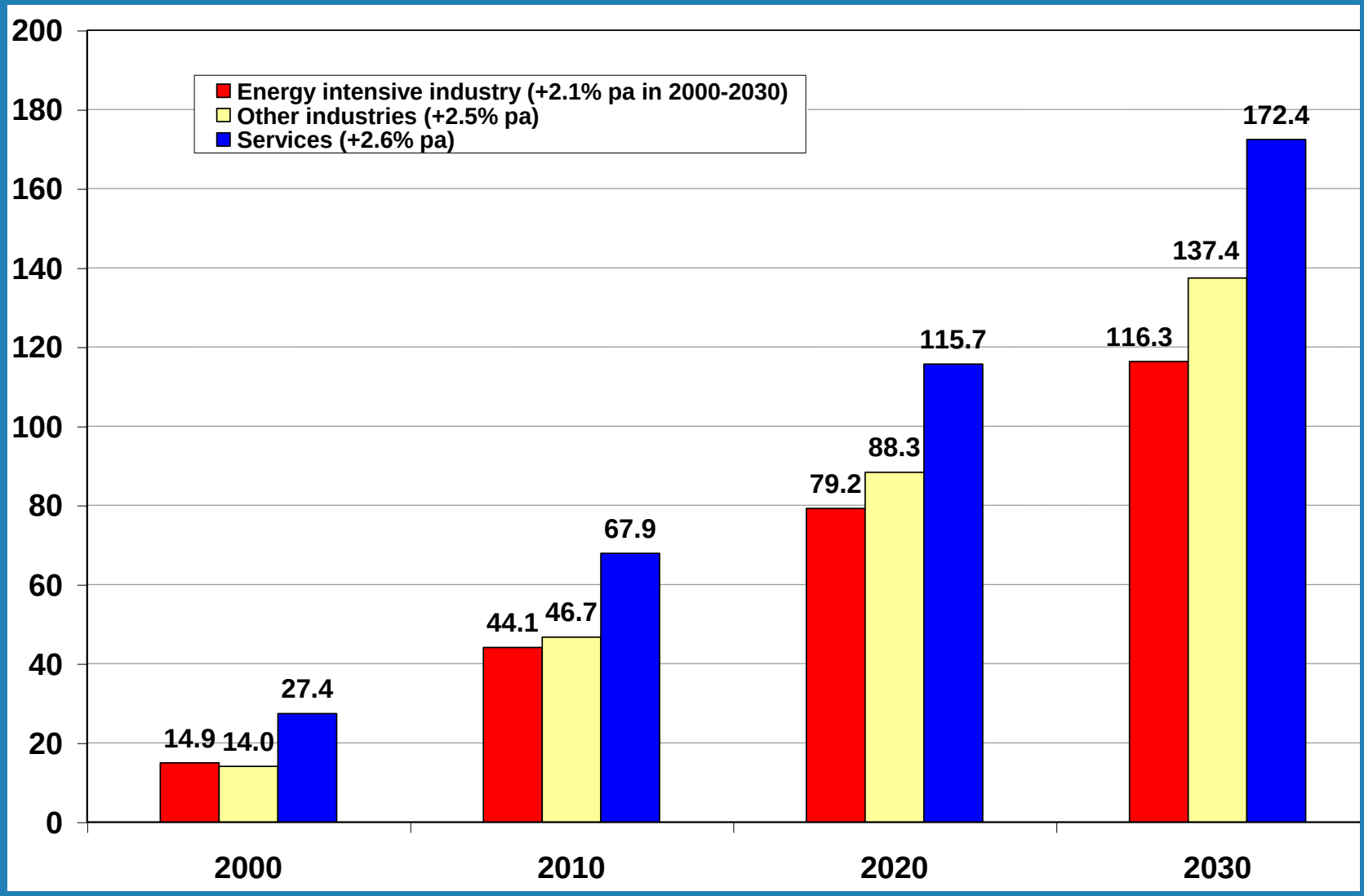


Key assumptions of the baseline scenario (2)

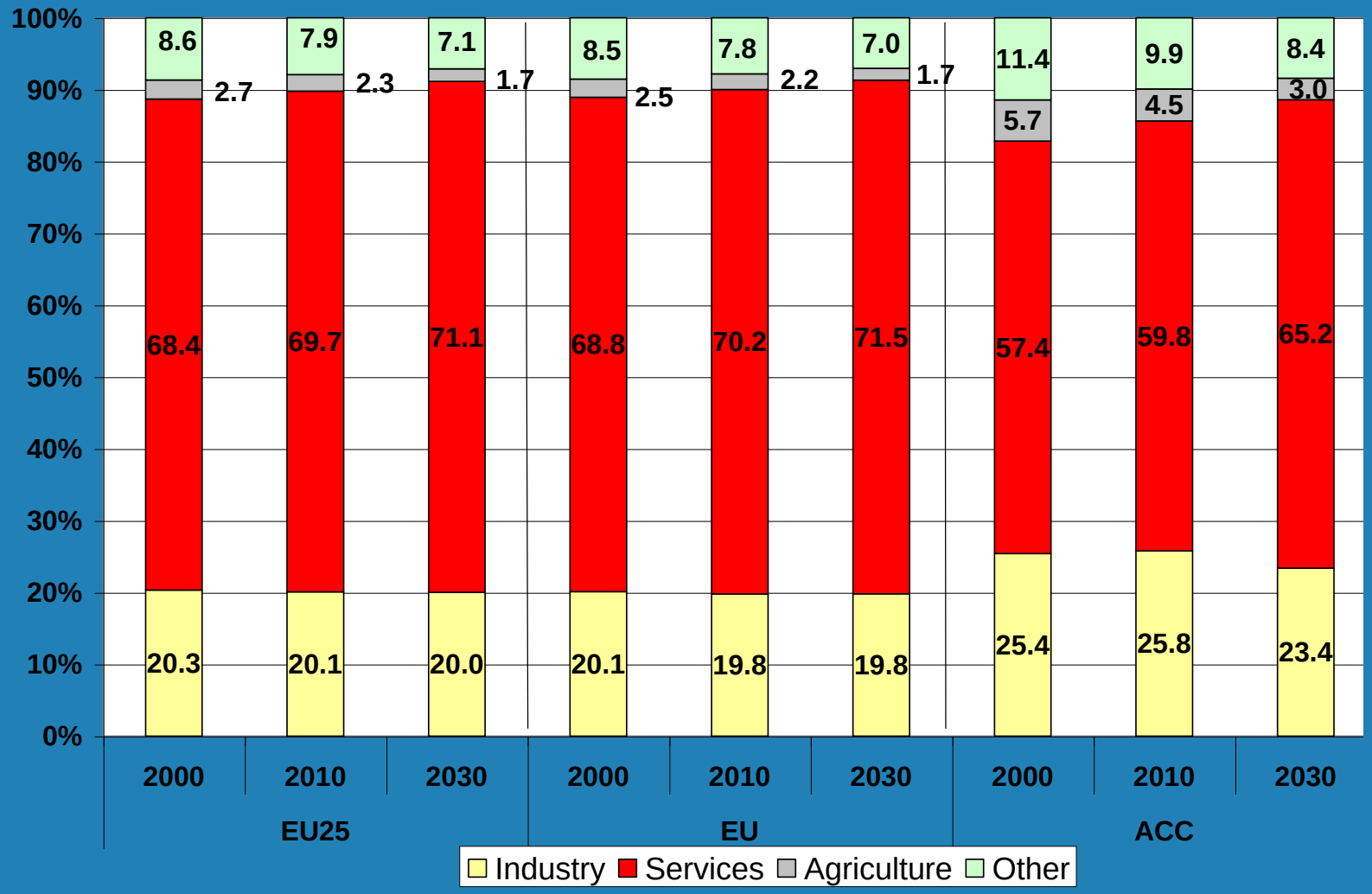
- **Macroeconomic assumptions**
  - GDP growth in the current EU reaches 2.3% pa on average in 2000-2030
    - Modest compared to the ambitions of the Lisbon strategy
    - High compared with the current weak state of the EU economy
  - Faster economic growth in Acceding countries (in the ACC region annual GDP growth reaches 3.5% pa in 2000-2030)
  - Gradual convergence of the EU economies is assumed to continue throughout the projection period
    - However, even by 2030, per capita GDP in acceding countries remains more than 30% lower compared to the EU (from 55.5% lower in 2000)
  - Economic modernisation also continues throughout the projection period involving:
    - Restructuring away of primary and secondary sectors and towards services
    - Dematerialisation of industrial production; a trend driven by a
      - Shift away from energy intensive processes
      - Increasing importance of new industrial activities with high value added and a lower material base (for example pharmaceuticals and cosmetics; computer equipment etc.)

Value added growth in EU-25

% change from 1990 levels

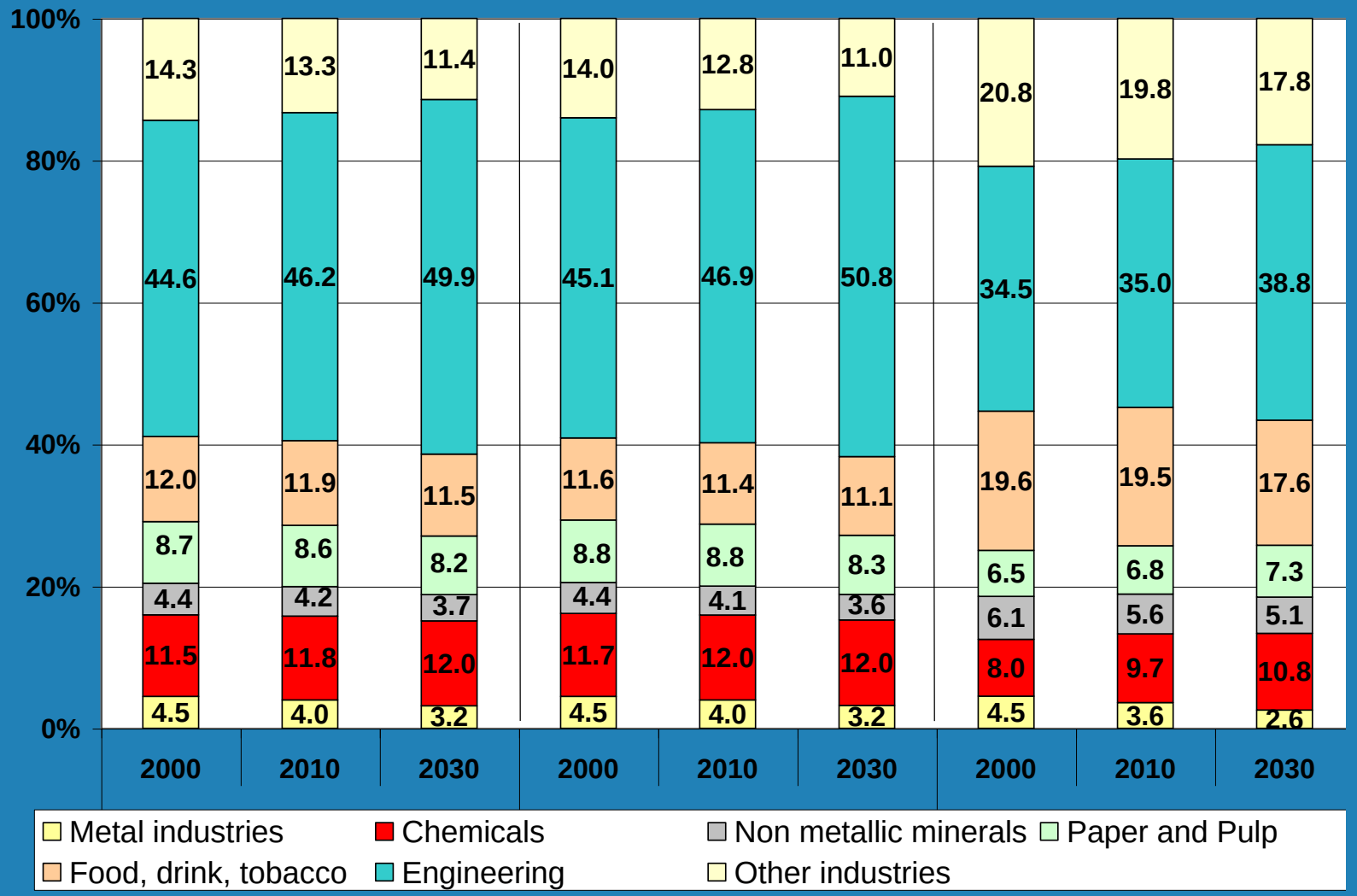


Structure of the EU-25 economy,
shares in gross value added 2000, 2010, 2030



Structure of the EU-25 industrial sector,

shares in gross industrial value added 2000, 2010, 2030



Methodology of defining an emission trading regime with PRIMES (1)

- Baseline scenario considered as the starting point
- In PRIMES the imposition of a global or sectoral constraint on emissions is mathematically strictly equivalent to the inclusion of a shadow variable (named hereafter carbon value)
  - It is the marginal abatement cost that is associated with the emission constraint and represents the economic cost of avoiding the last (marginal) unit of carbon that is required by the constraint
  - This shadow variable is equivalent to the permit price that the market would establish for any given emission reduction target, at which emission trading will occur across sectors and/or countries
  - Furthermore, it can be considered as a proxy of carbon tax or other measures with similar effect
- Carbon value implies changes in the relative prices which economic agents, i.e. producers and consumers of energy, face
  - Reflecting the carbon intensiveness that each activity or commodity involves
  - Leads to adjustments in the behaviour of agents

Methodology of defining an emission trading regime with PRIMES (2)

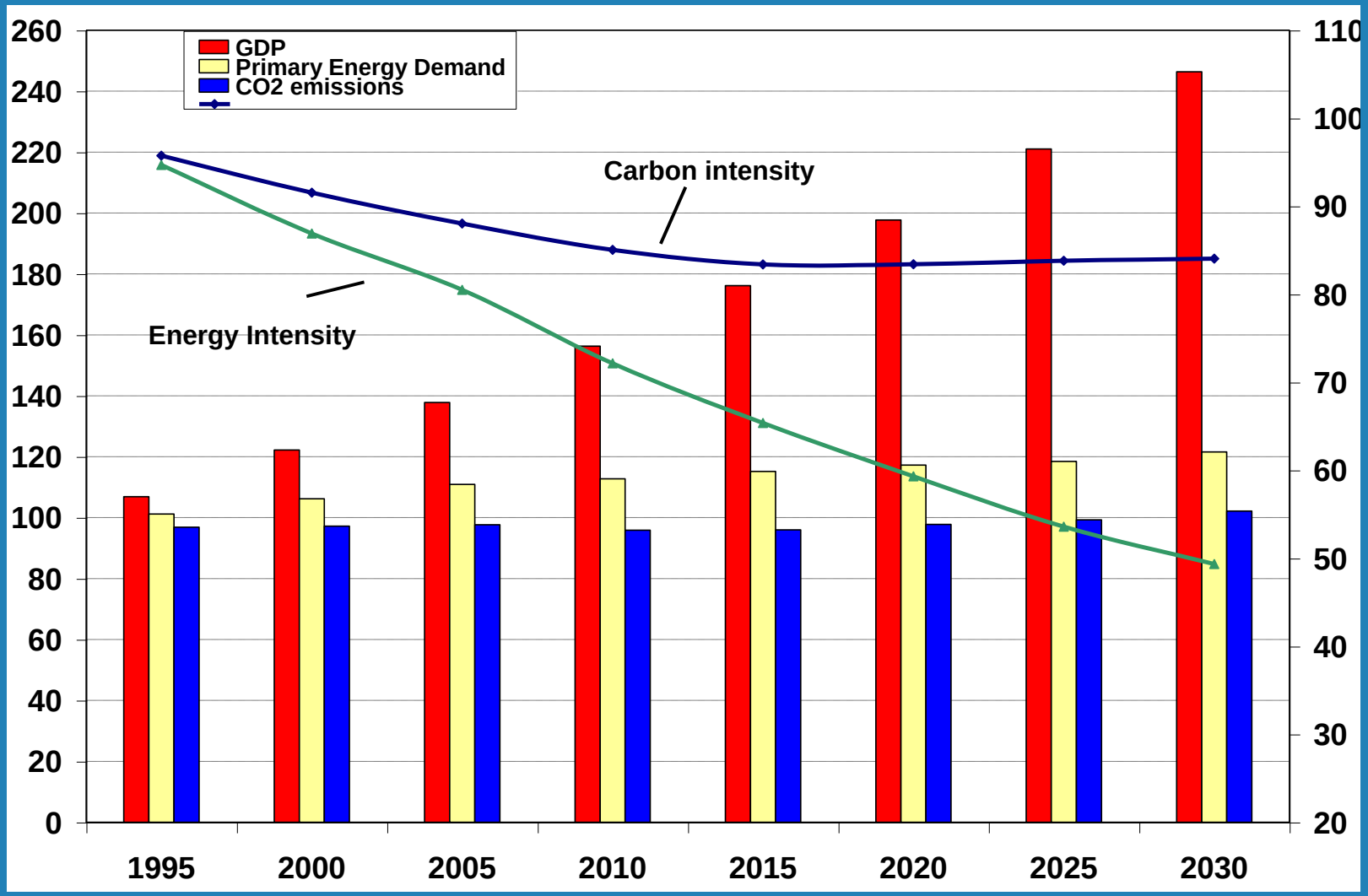
- The model determines the allocation of effort by sector within each Member State
  - Necessary to meet the global constraint
  - Implicitly assuming the existence of a full trading regime of emissions within each country or within the EU
- Results show emission reduction potentials of each sector under EU-wide analysis,
  - Considers the entire energy system e.g. direct and indirect (electricity generation) emissions
- Under systems analysis a demand sector may shift to electricity and/or steam to allow for overall more cost-effective reduction of total emissions.
- Least-cost allocation of CO2 emission reduction effort to all sectors (energy demand and supply) of the European Union as a whole

Key Findings

- Strong de-linking of economic growth from energy
  - Energy intensity improves by 1.9% pa in 2000-2030
- Significant changes occur in the fuel mix of the energy system
  - Strong penetration for natural gas and renewable energy forms
  - The market share of all other energy forms declines over the projection period
- CO2 emissions follow a declining pattern in the horizon to 2010 but grow thereafter
  - -4.1% from 1990 levels in 2010, -2.2 in 2020, +2.2 in 2030
  - Carbon intensity improvement worsens beyond 2015
- Import dependency reaches up to 65.3% in 2030 (52.7 in 2010) from 47.2% in 2000
- Power generation and transport sector are the key drivers as regards the evolution of the energy system

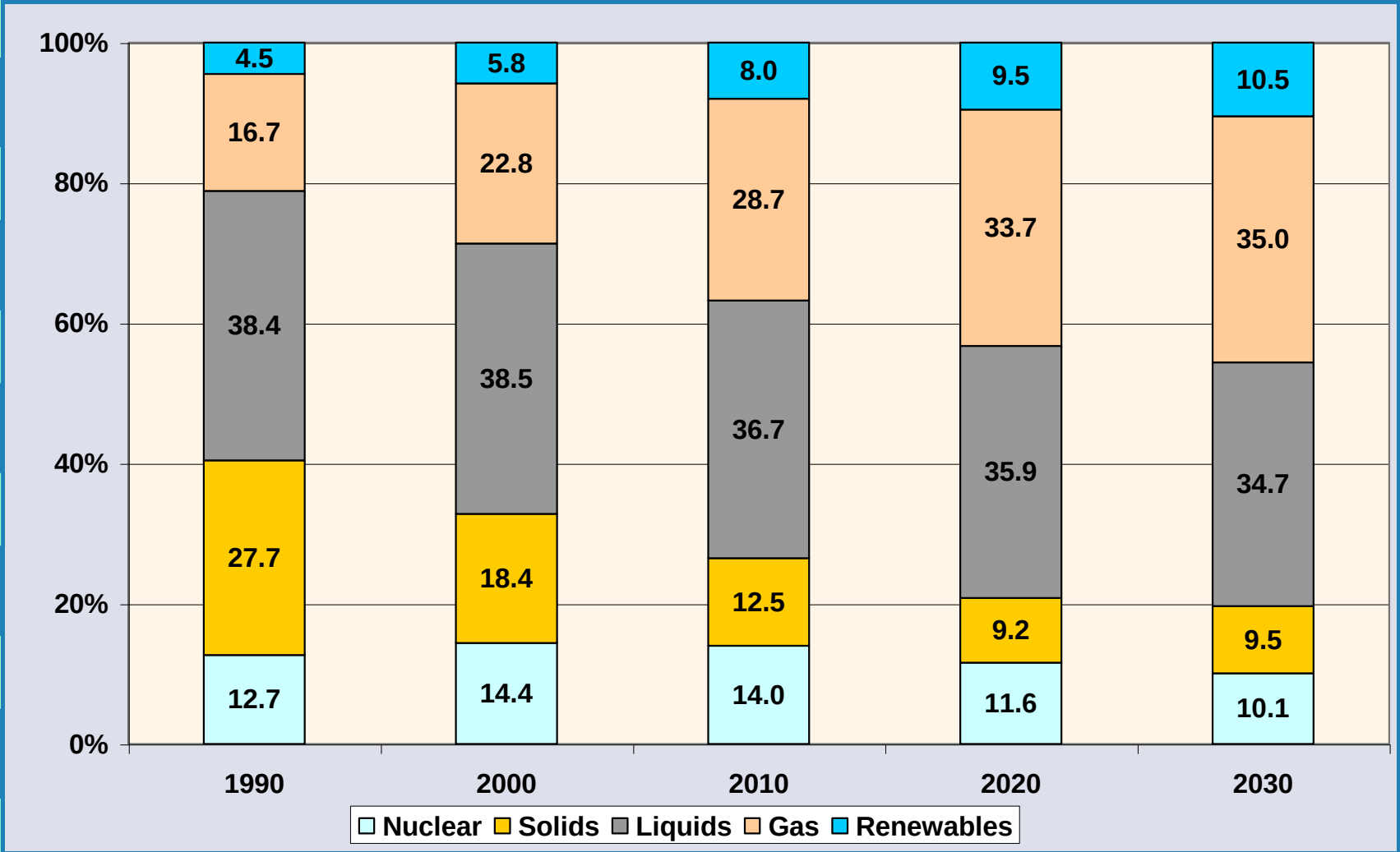
EU-25 Primary Energy Indicators, 1990-2030

Indexed to 1990=100, energy and carbon intensity drawn against the secondary axis



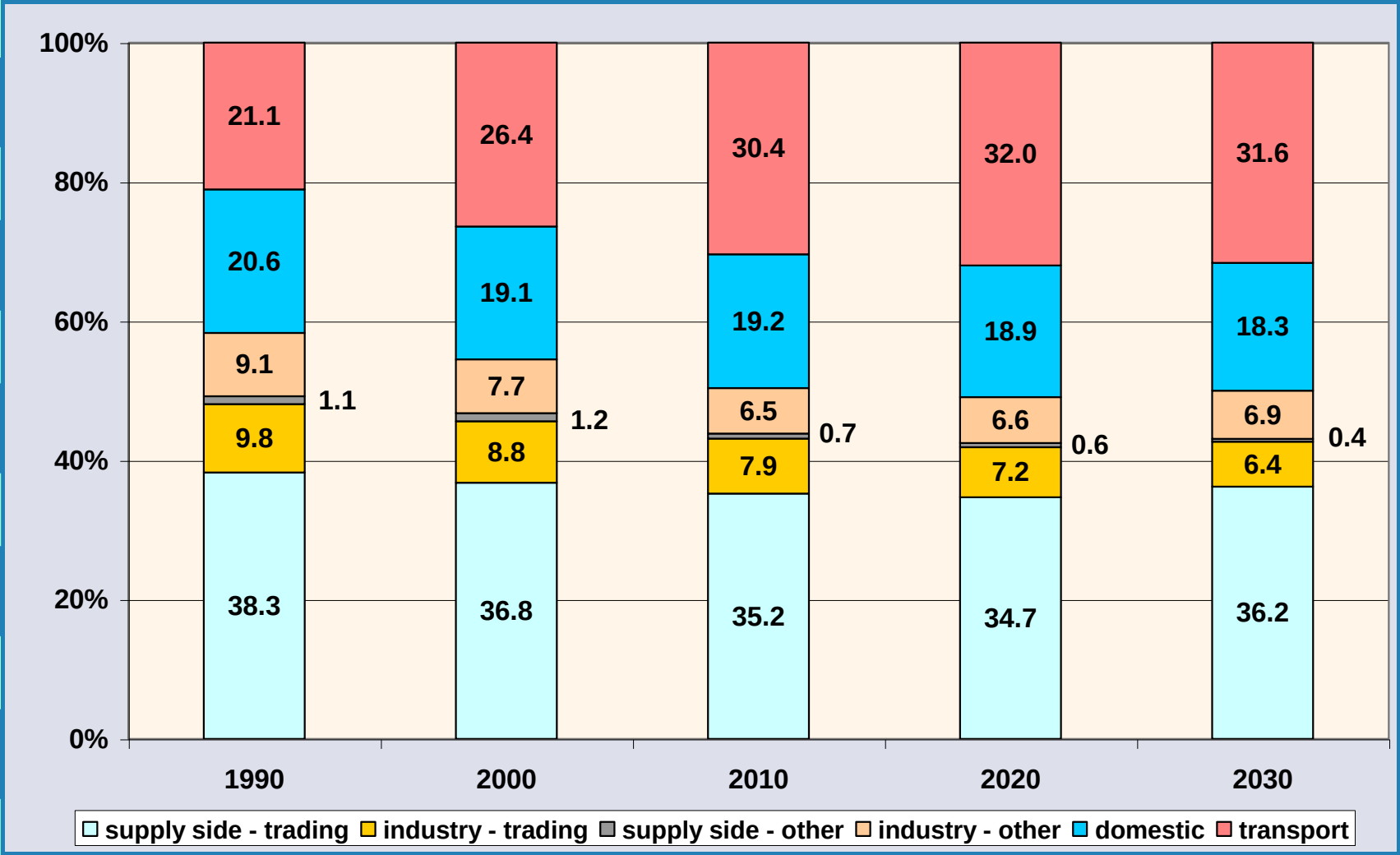
EU-25 Primary Energy Needs by Fuel

% share in Gross Inland Consumption



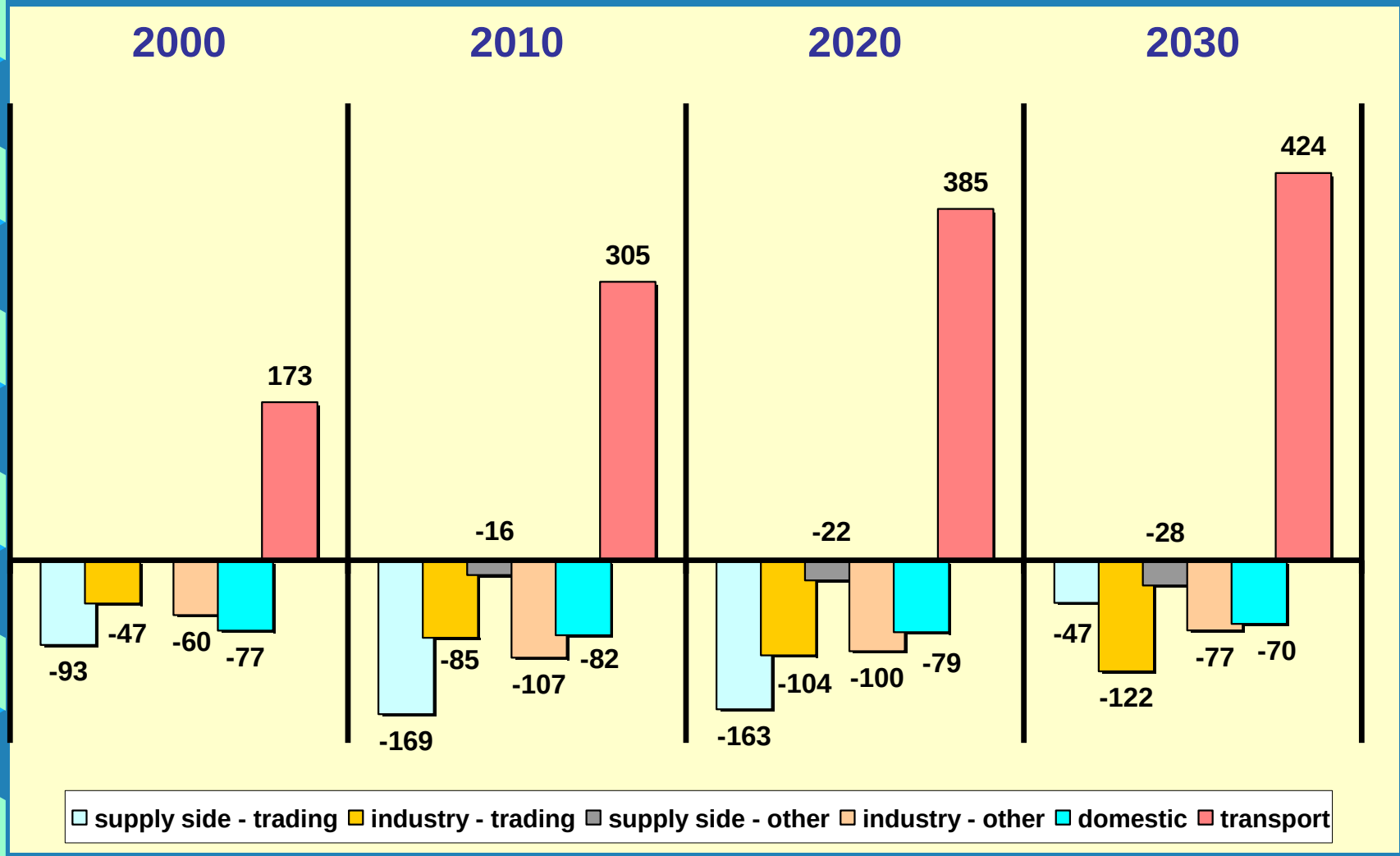
Structure of CO2 emissions by sector in EU-25

% share in total CO2 emissions



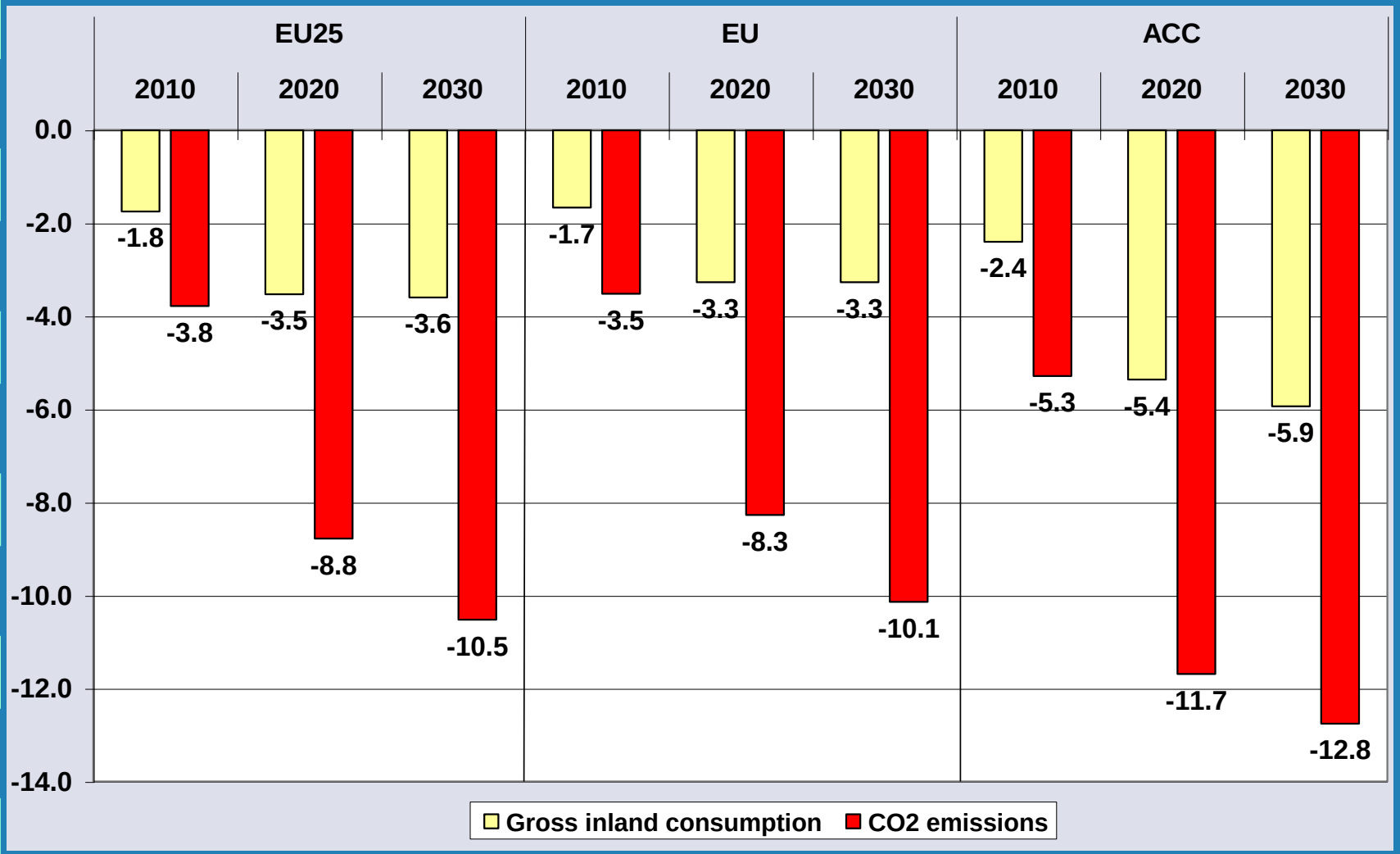
Change in CO2 Emissions from 1990 levels

Mt of CO2



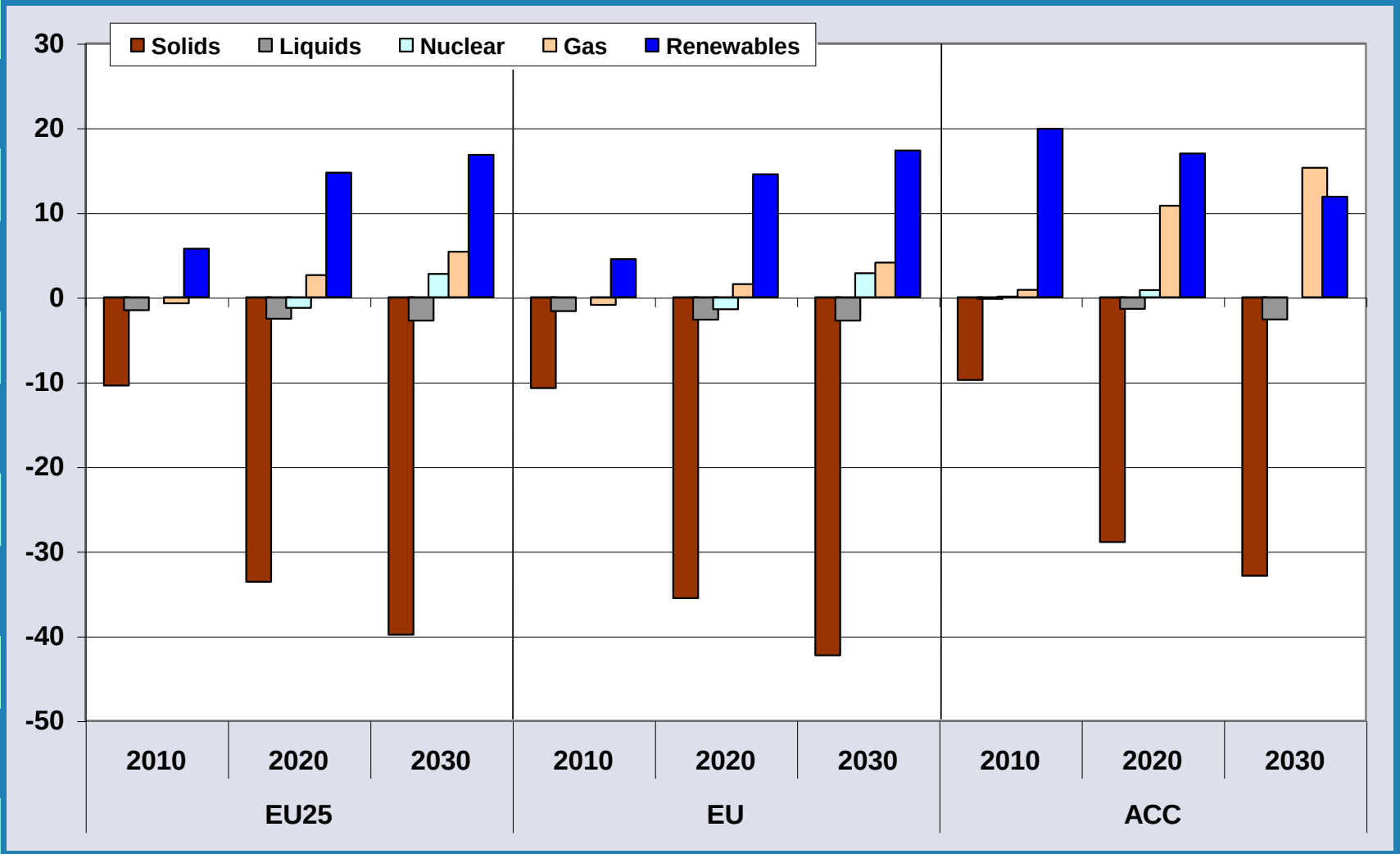
Comparison to the NCLP case

NCLP denotes the "Without climate policy case"
% difference from NCLP case



Comparison to the NCLP case – changes in gross inland consumption

% difference from NCLP case



Comparison to the NCLP case – changes in CO2 emissions by sector

% difference from NCLP case