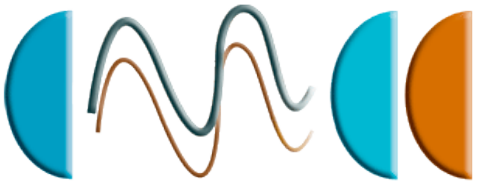


EURO-MEDITERRANEAN CENTER ON CLIMATE CHANGE

2011 INTERNATIONAL ENERGY WORKSHOP

*A more ambitious EU target on GHG emissions: macro-economic impacts through a CGE analysis**

Francesco Bosello, University of Milan – CMCC - FEEM
Lorenza Campagnolo, University of Venice – CMCC – FEEM
Fabio Eboli, University of Venice – CMCC – FEEM
Ramiro Parrado, University of Venice – CMCC - FEEM
Elisa Portale, CMCC - FEEM

Stanford University, July 6-8, 2011

(*) Financial support by ENEL is gratefully acknowledged

Overview

- Background
- The model
- The baseline and policy scenarios
- Results
- Conclusions

Background

Two main pillars

=> Emission Trading Scheme (energy-intensive sectors, CO_2 only, cap-and-trade, grandfathering)

=> EC COM (2007) 1 and 2 set the target of EU climate policy for 2020:

- 20% GHG emission reduction by 2020 compared to 1990
- 20% share of RES consumption over total energy demand
- 20% increase in energy efficiency wrt 2020 BAU trends

However EU emission reduction targets could become even more ambitious (-30%) if other countries implement and participate to the abatement effort => This is the apparent exit of Copenhagen and Cancun (COP 15-16)

Existing assessments

Research analyses:

Boehringer *et al.* (2009), Durand Lasserve *et al.* (2010), Deutsche Bank (Lewis and Curien, 2008,2010), Hohne *et al.* (2011)

Institutional Reports:

- SEC (2008) 85 → -20%, EU country detail, EU "unilateral"
- SEC (2010) 650 → -30%, EU aggregate, Copenhagen framework, revised economic and emission baseline (financial crisis).

Research's aims

Moving from SEC (2010) 650, assessing macroeconomic costs for different policy scenarios

- -20% vs -30% (including RES target)
- BTA and GFDN
- Unilateral vs Multilateral (domestic vs international carbon market)

- Taking into account
  - ✓EU country detail
  - ✓"baseline issue"
  - ✓Alternative policy scenarios

The ICES model

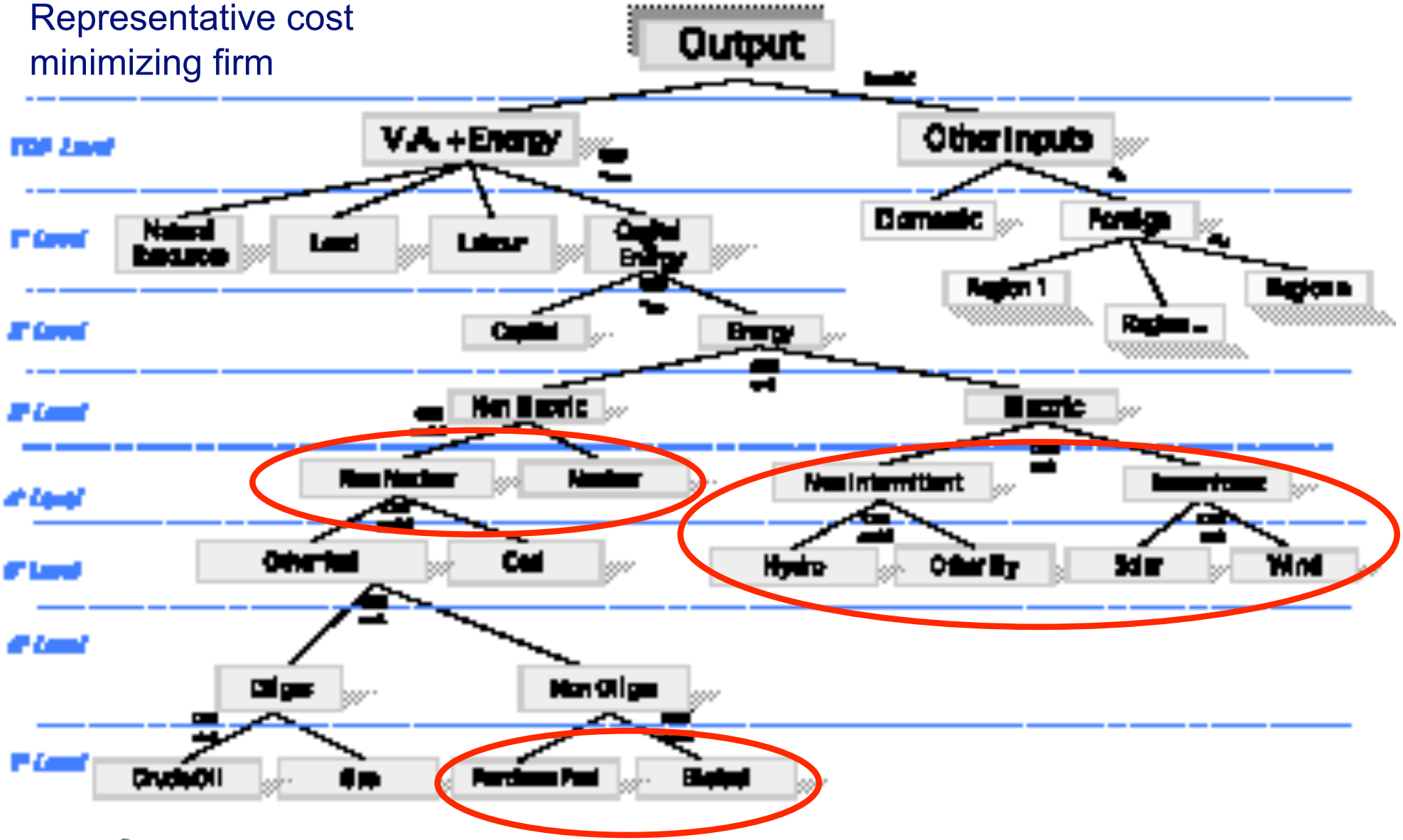
- ✓ Recursive-dynamic, computable general equilbrium model
- ✓ Optimising agents' behaviour
- ✓ Economic interactions among sectors (market-driven adaptation)
- ✓ International trade with capital mobility
- ✓ Growth driven by endogenous investment decisions
- ✓ Calibrated in 2004 (GTAP-7 database) 113 regions, 57 sectors. This version 26 regions, 17 sectors =>
- ✓ Production-side detail improved including nuclear, hydro, wind, solar, biofuels =>

Regional and sectoral detail of the model

Regions		Sectors
Austria Belgium CzechRep Denmark Finland France Germany Greece Hungary Ireland Italy Netherlands Poland Portugal Spain Sweden UnitKingdom RoEU (Rest of EU27)	USA Russia RoA1 (Rest of Annex 1) China India Brazil NonA1_T (Non Annex 1 with pledges) RoW (Rest of the World)	Agriculture Coal Oil Gas Oil_Pcts Nuclear Solar Wind Hydro OthEly (Electricity from fossil source) Paper Minerals Chemicals Iron_Steel Transport Oth_ind (Manufacturing) Services

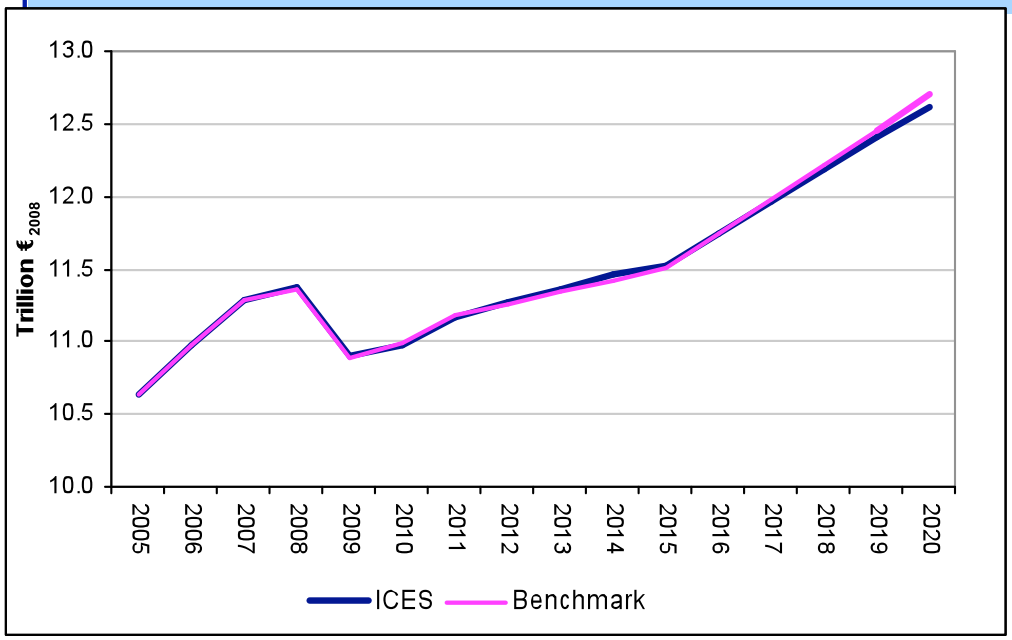
ICES: the supply side

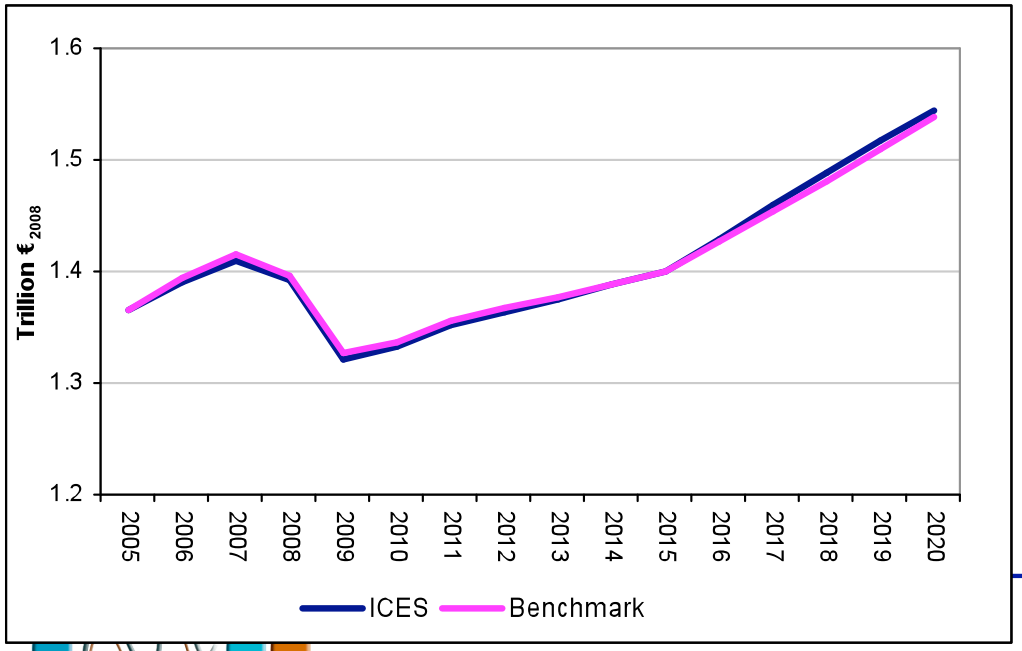
Representative cost minimizing firm



EURO-MEDITERRANEAN CENTER ON CLIMATE CHANGE

The Baseline Assumptions





EU GDP

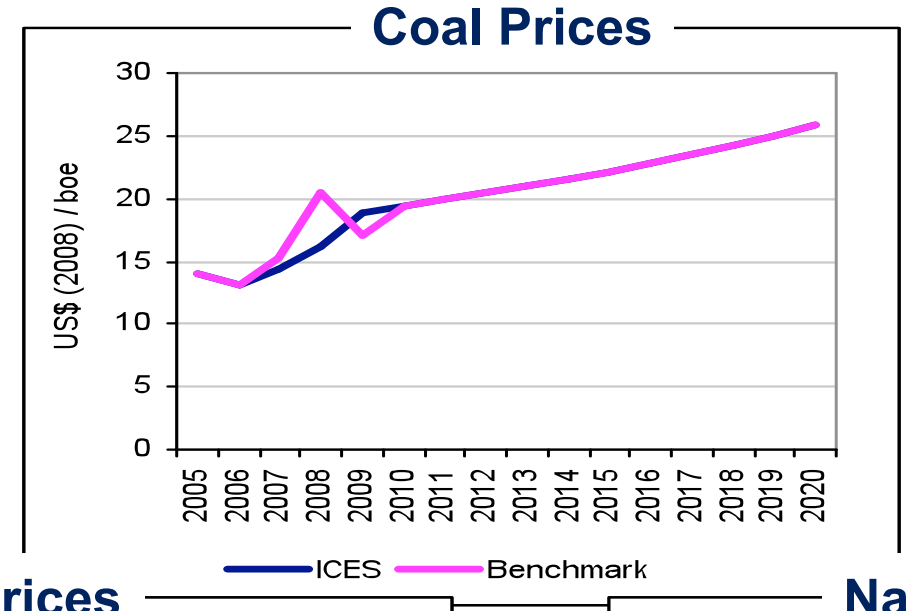
		EU27	Italy
Population in 2020 (Millions)		513.8	61.4
GDP	Trillion €$_{2008}$ 2020	12.1	1.54
	Average yearly growth rate 2005-2010	0.66	-0.45
	Average yearly growth rate 2011-2015	0.98	0.99
	Average yearly growth rate 2016-2020	1.82	1.98

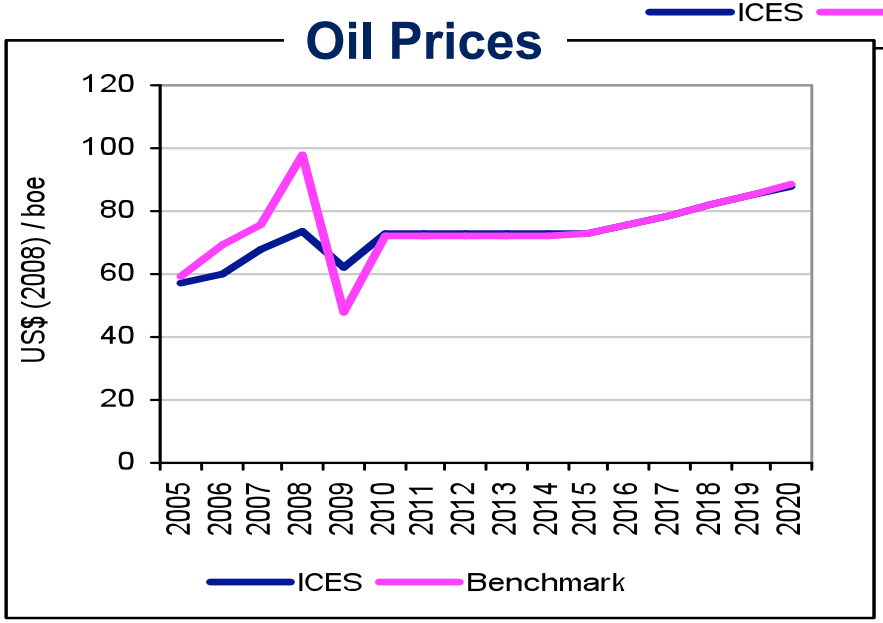
Italy GDP

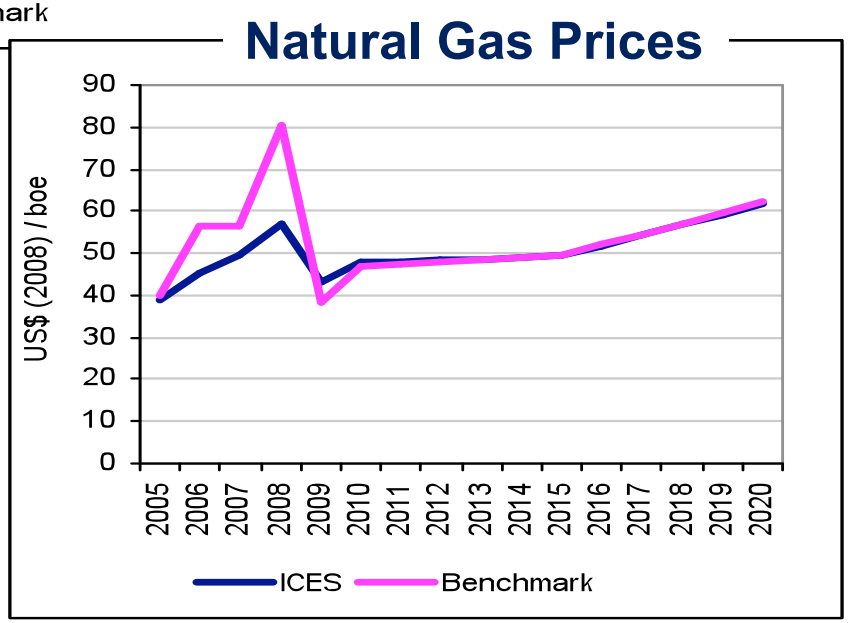
Non EU GDP from WEO (2009) and IMF 2010

Sources:
EC (2010): Economic Forecasts
EC (2010): Ageing Report 2009

The Baseline Assumptions

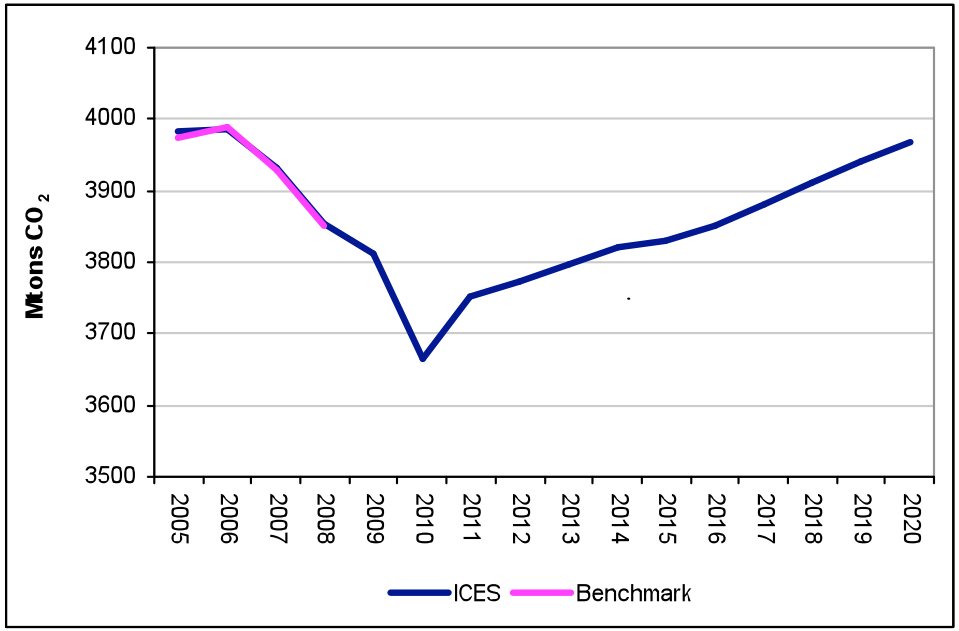






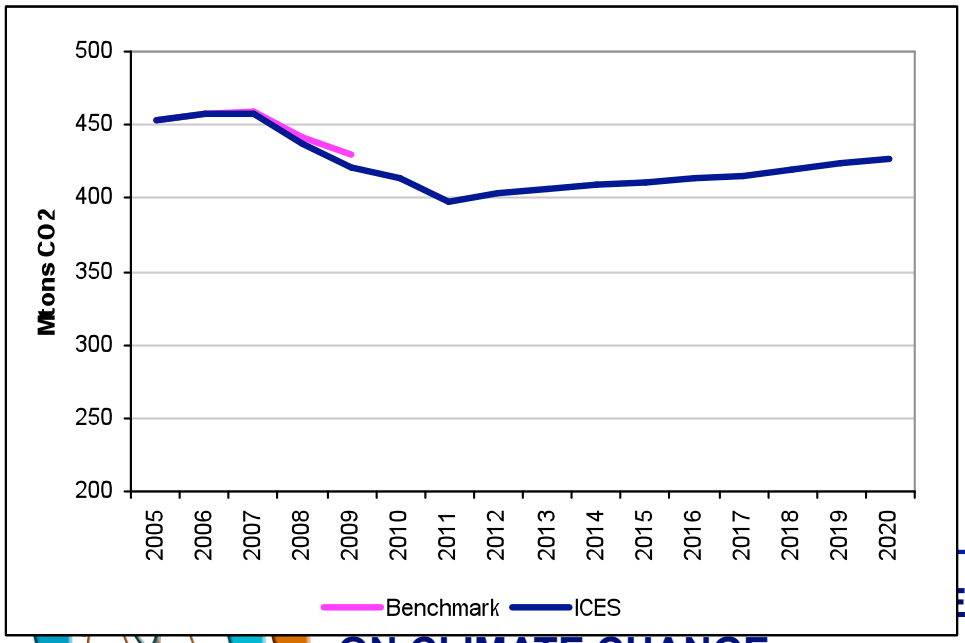
Source: Eurelectric (2010)

The Baseline Assumptions



EU CO2 Emissions

		EU	Italy
EU CO2 Emiss.	Mil Tons CO_2 2020	3967	431
	% ch. wrt 1990	-2,14	8,53
	% ch wrt 2005	-0,40	-5,76
Ren. Share over total en. cons. 2020	% 2005	8,9	6,5
	% 2020	11,6	12,1



	SEC (2008) 85	SEC (2010) 650
Ren. Share over total en. cons. 2020	12,5%	14,8%

Italy CO2 Emissions

Policy Scenarios

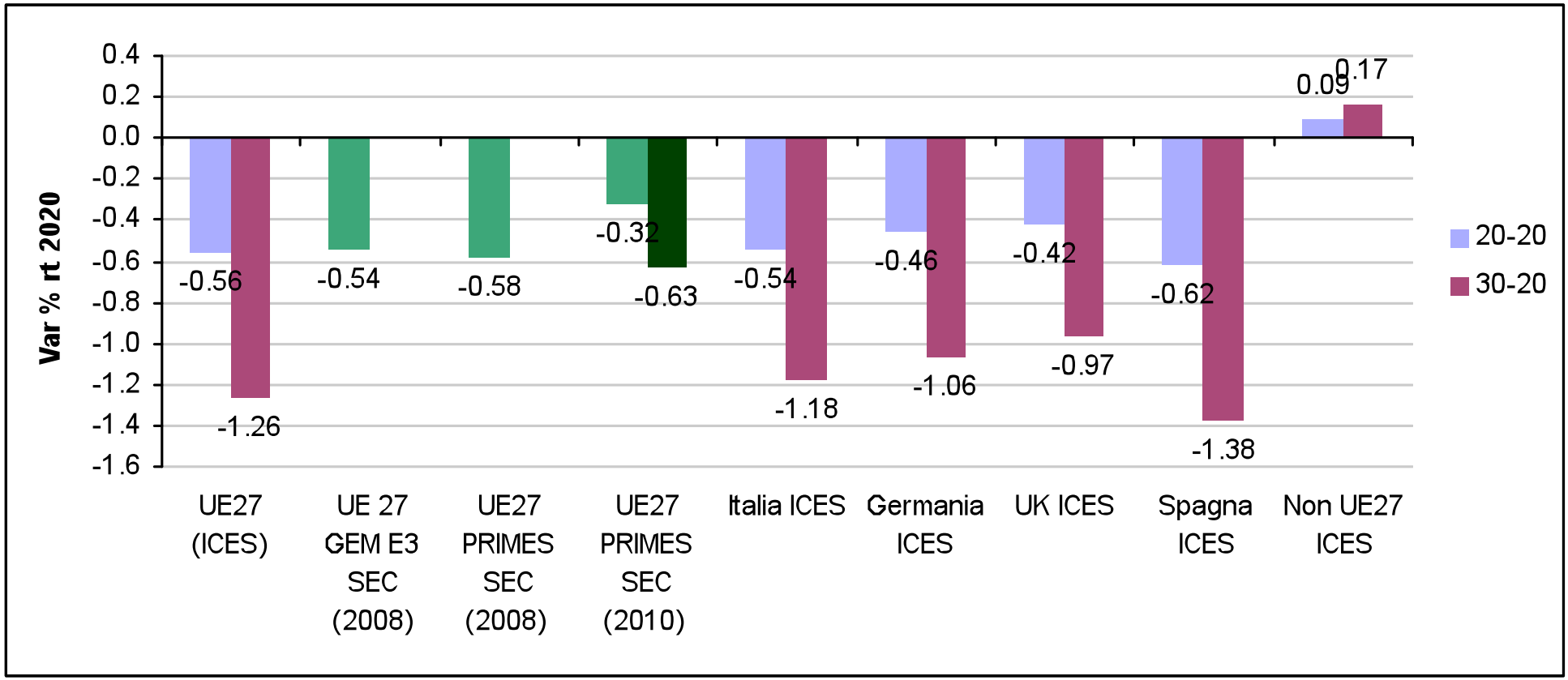
	EU27	NON EU
20-20	20% GHG emission reduction in 2020 w.r.t. 1990 20% RES over total final energy consumption	Business as Usual
30-20	30% GHG emission reduction in 2020 w.r.t. 1990 20% RES over total final energy consumption	Business as Usual
20-20 Low	20% GHG emission reduction in 2020 w.r.t. 1990 20% RES over total final energy consumption	Low pledges
30-20 Low	30% GHG emission reduction in 2020 w.r.t. 1990 20% RES over total final energy consumption	Low pledges
30-20 High	30% GHG emission reduction in 2020 w.r.t. 1990 20% RES over total final energy consumption	High pledges

EU unilateral policy

	EU27	NON EU
20-20	20% GHG emission reduction in 2020 w.r.t. - 12.5% wrt 2005 only CO_2 20% RES over total final energy consumption	Business as Usual
30-20	30% GHG emission reduction in 2020 w.r.t. - 23% wrt 2005 only CO_2 20% RES over total final energy consumption	Business as Usual
20-20 Low	20% GHG emission reduction in 2020 w.r.t. 1990 20% RES over total final energy consumption	Low pledges
30-20 Low	30% GHG emission reduction in 2020 w.r.t. 1990 20% RES over total final energy consumption	Low pledges
30-20 High	30% GHG emission reduction in 2020 w.r.t. 1990 20% RES over total final energy consumption	High pledges

EU 20-20 and 30-20: results

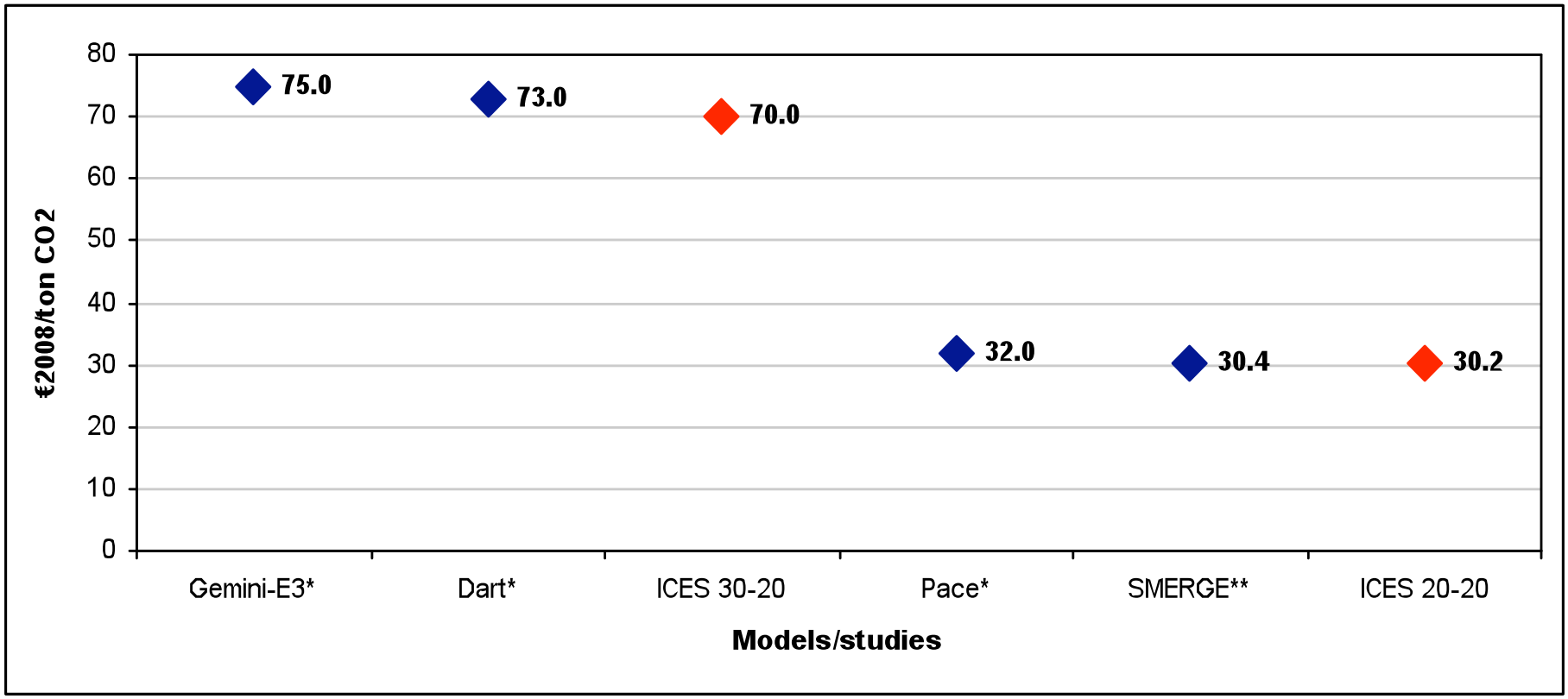
Macroeconomic costs: % GDP changes wrt 2020 baseline



NB: PRIMES is a bottom-up model
Costs are direct costs → investment needed

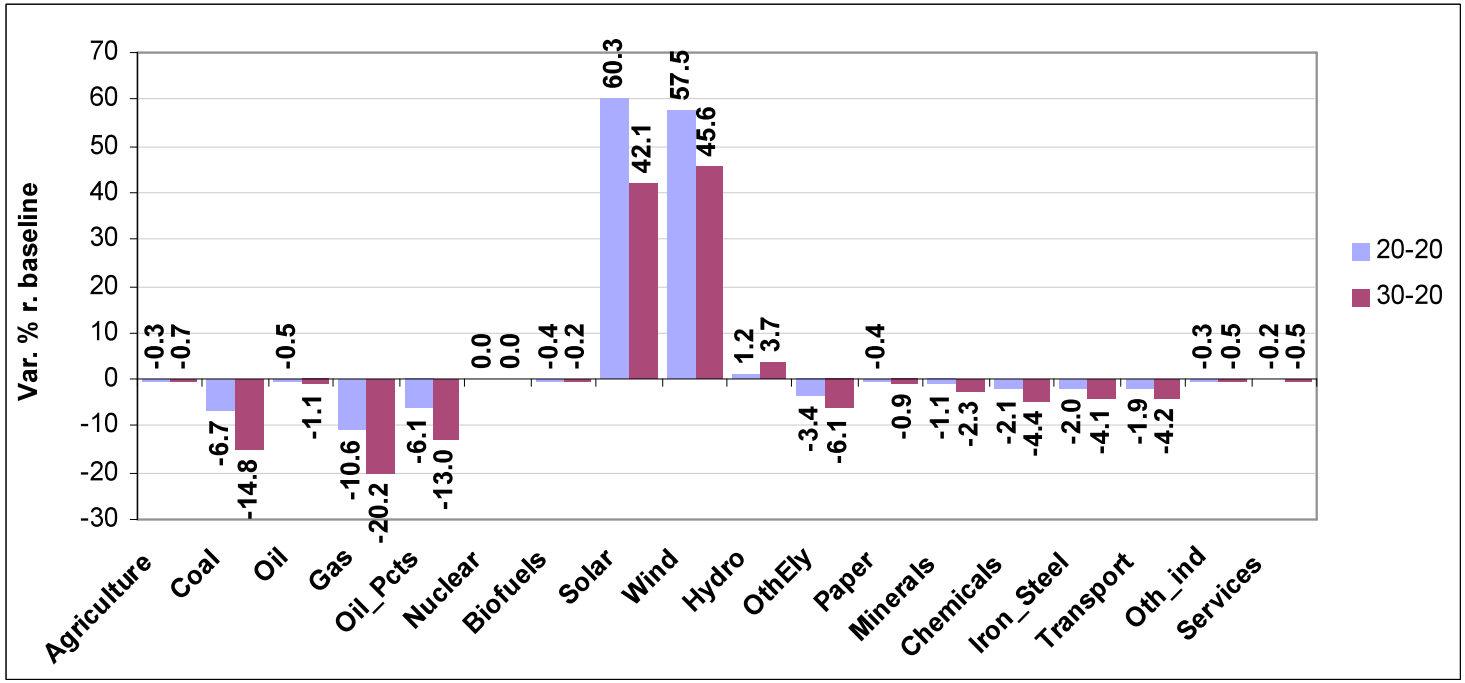
Very strong carbon leakage.
20-20: + 0.97%; 30-20: + 1.69%
=> 70% EU mitigation effort nullified

EU 20-20 and 30-20: results

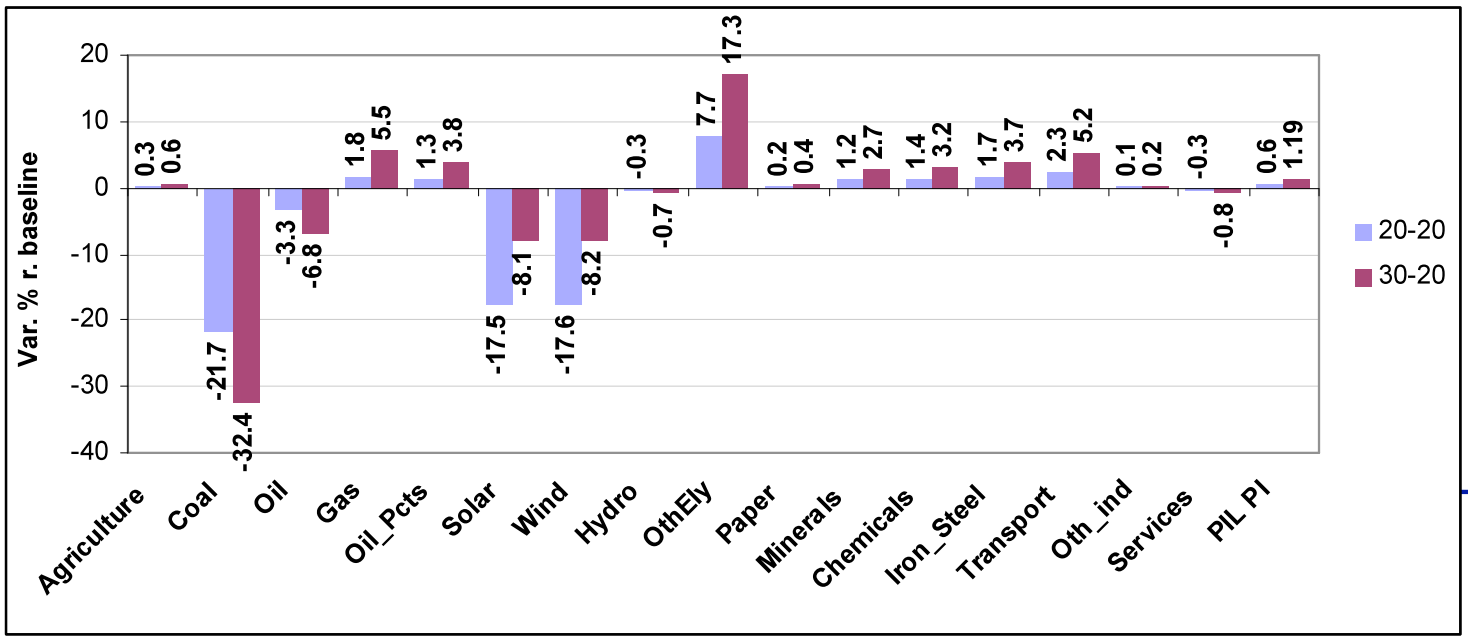


RES subsidy is also needed: 34.7 €/MWh (20-20), 13.7 €/MWh (30-20).
Without subsidy RES share would be 13.8% (20-20) and 17% (30-20).
Reaching 20% RES share increase GDP costs very little.

EU 20-20 and 30-20: results



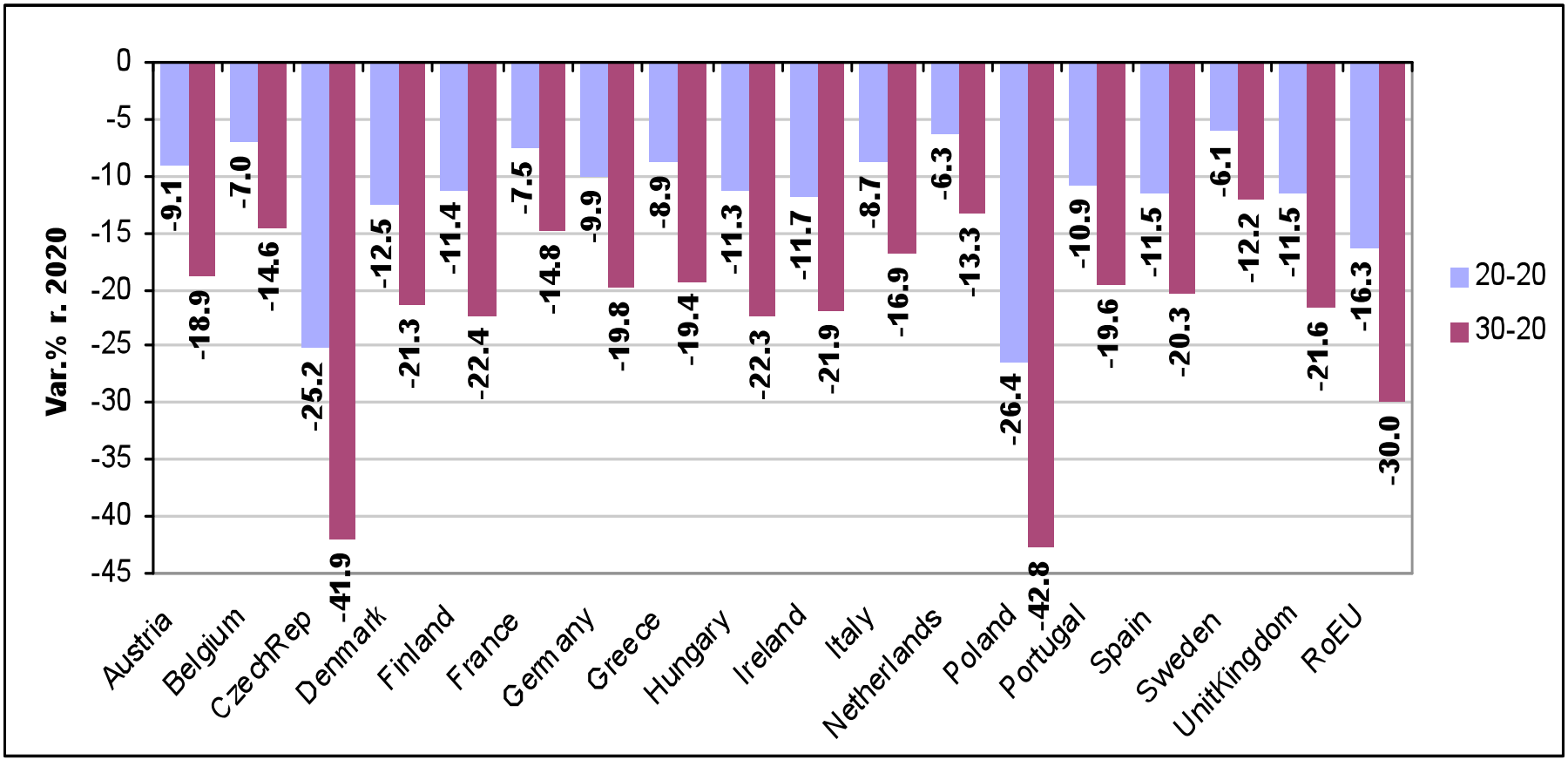
Sectoral output: % ch. wrt 2020 baseline



Sectoral prices: % ch. wrt 2020 baseline

EU 20-20 and 30-20: results

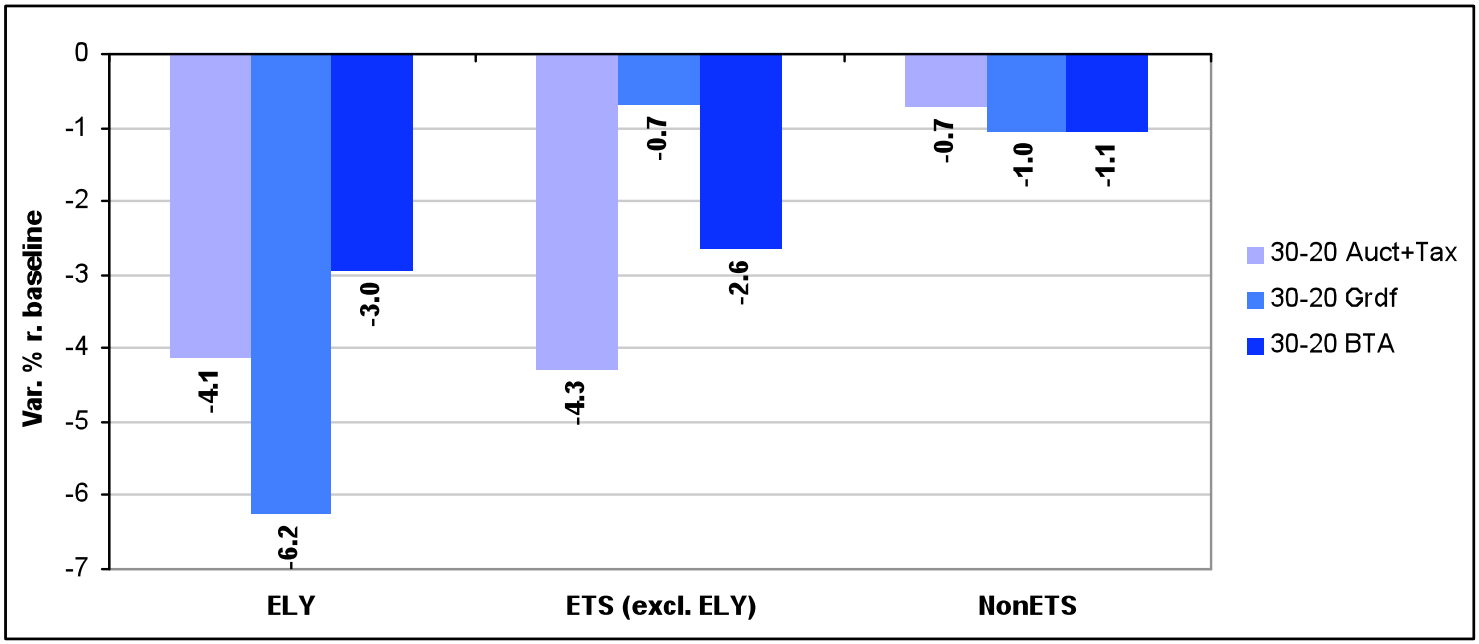
Optimal mitigation burden sharing per country (wrt 2020 baseline)



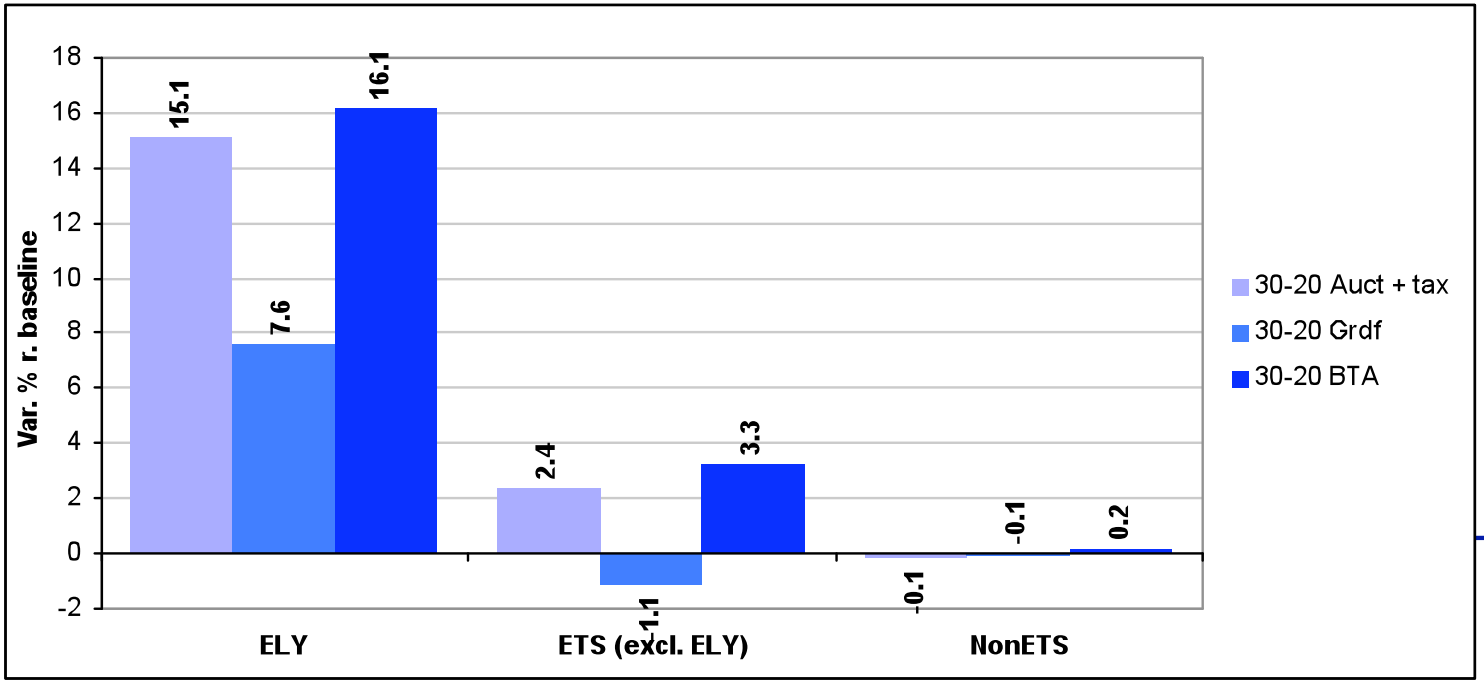
EU 20-20 and 30-20 summary

- The net macroeconomic cost of the EU "20-20" policy is "manageable" (if full efficiency can be exploited).
- Moving to "30-20" doubles the costs.
- The additional goal on RES share does not seem to impose addtional costs to the policy.
- Environmental effectiveness is low (very high carbon leakage).
- The economic burden is non negligible for energy intensive sectors => competitiveness loss?

EU 30-20: grandfathering and BTA



Sectoral output
% ch. wrt 2020
baseline



Sectoral prices
% ch. wrt 2020
baseline

EU 30-20: grandfathering and BTA

Macroeconomic Indicators

	Auctioning ETS Tax Non ETS		Grandfath. ETS Auction. Elect. Tax Non ETS	Auctioning ETS Tax Non ETS & BTA
	20-20	30-20	30-20	30-20
GDP (% ch. wrt baseline 2020)	-0.56	-1.26	-1.38	-1.34
CO2 Price (€/t)	30.2	69.9	114	71
RES Subsidy (€/MgH % 2020)	34.7	13.7	13.7	13.7
RES share over total final energy consumption in 2020	20	20	23	20.5

Carbon Leakage: grandfathering 60%; BTA 65%

Grandfathering and BTA summary

- Grandfathering and BTA do reduce the burden of the mitigation policy on energy intensive sectors
- However the burden of the policy is shifted towards non energy intensive sectors. The net effect is negative (more GDP costs)

By which mechanisms?

- BTA through higher energy (but not only) prices, grandfathering through loss of revenues supporting household demand.

Multilateral Policy

	EU27	NON EU
20-20	20% GHG emission reduction in 2020 w.r.t. 1990 20% RES over total final energy consumption	Business as Usual
30-20	30% GHG emission reduction in 2020 w.r.t. 1990 20% RES over total final energy consumption	Business as Usual
20-20 Low	20% GHG emission reduction in 2020 w.r.t. 1990 20% RES over total final energy consumption	Low pledges
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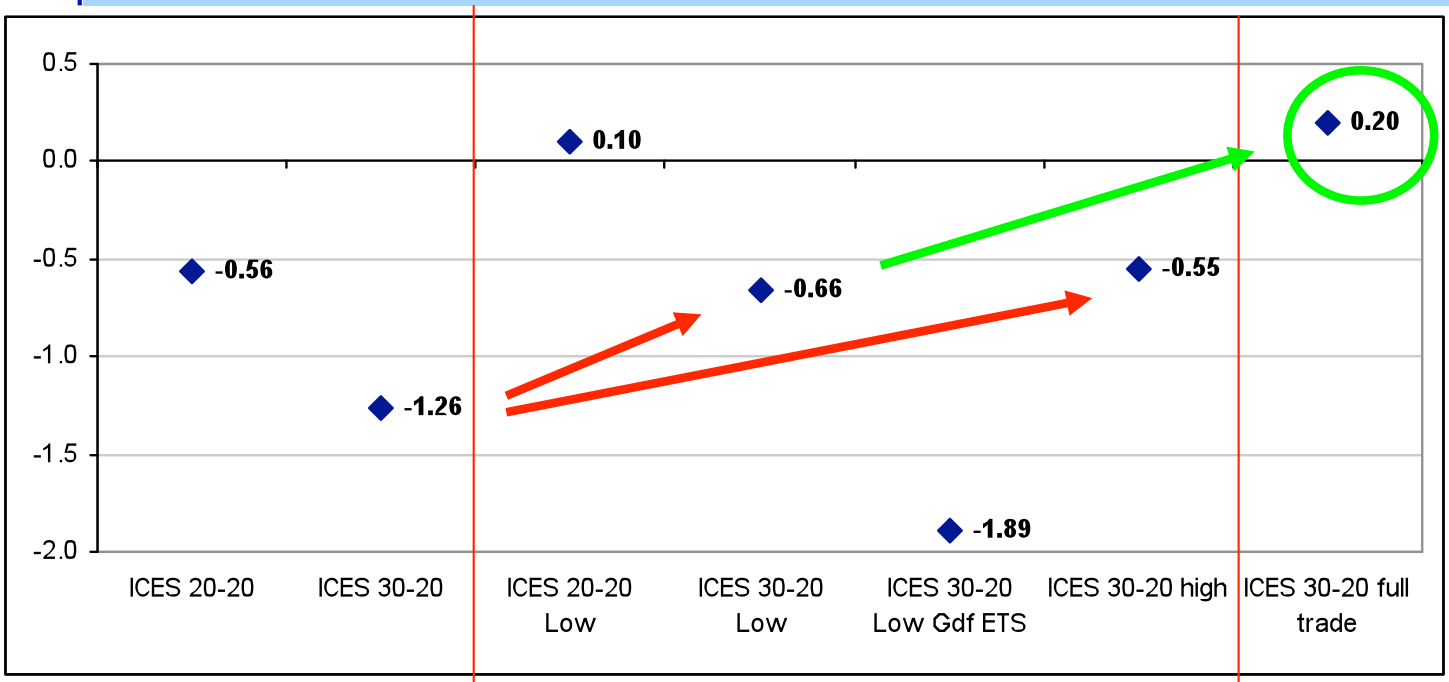
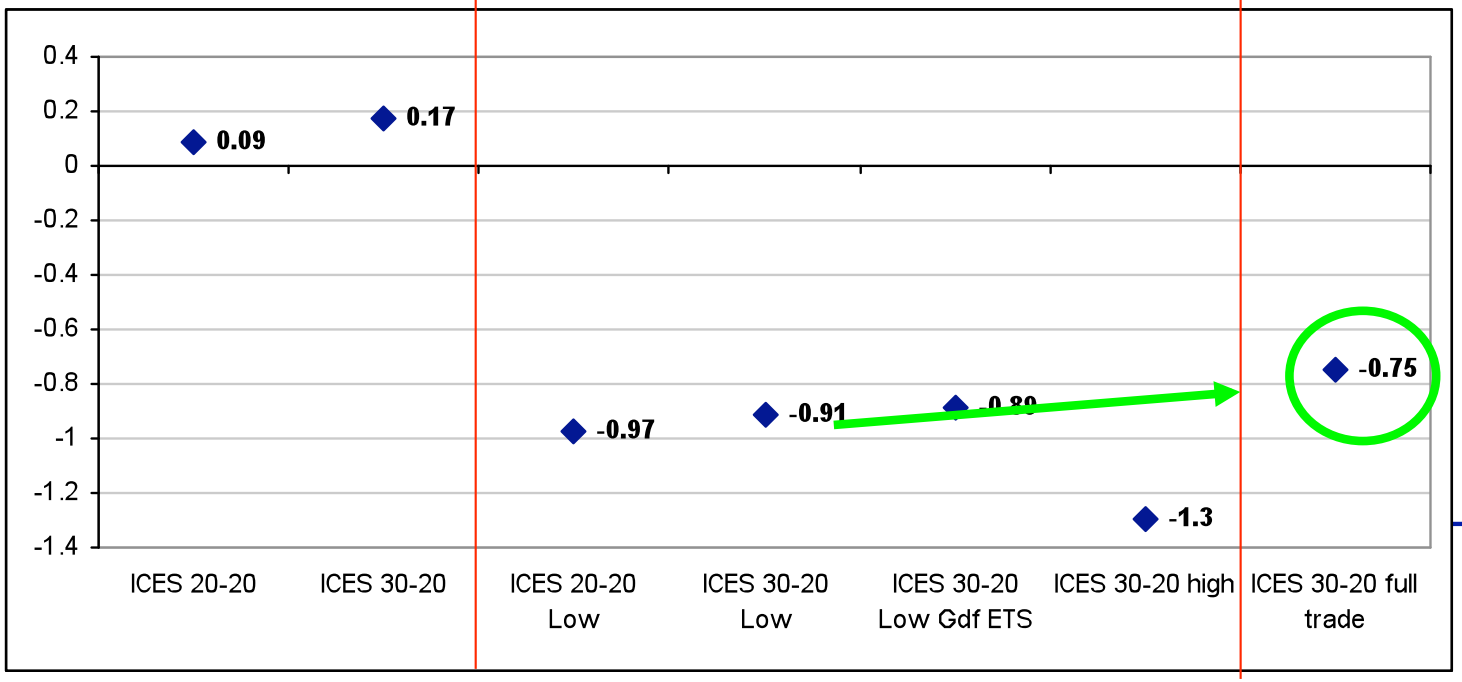
EU policy within the Copenhagen Accord

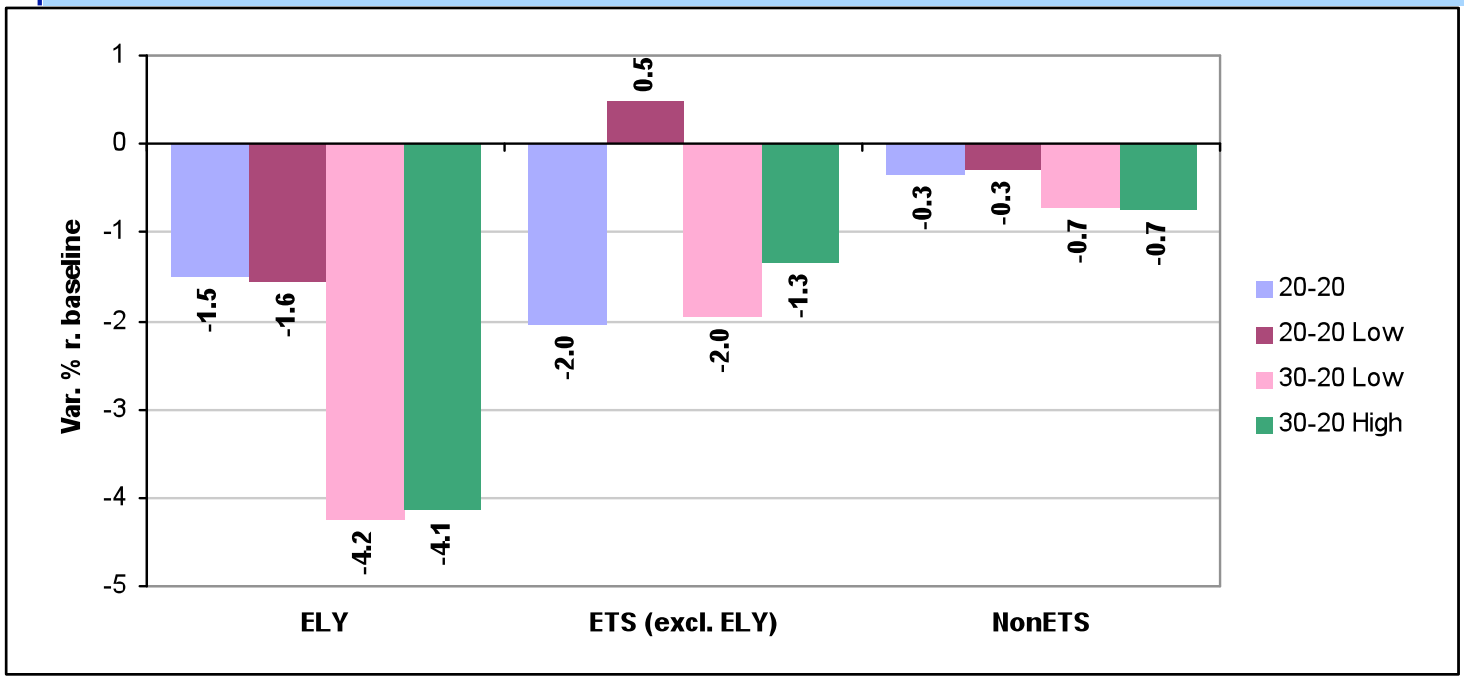


EU GDP: % ch. wrt 2020 baseline

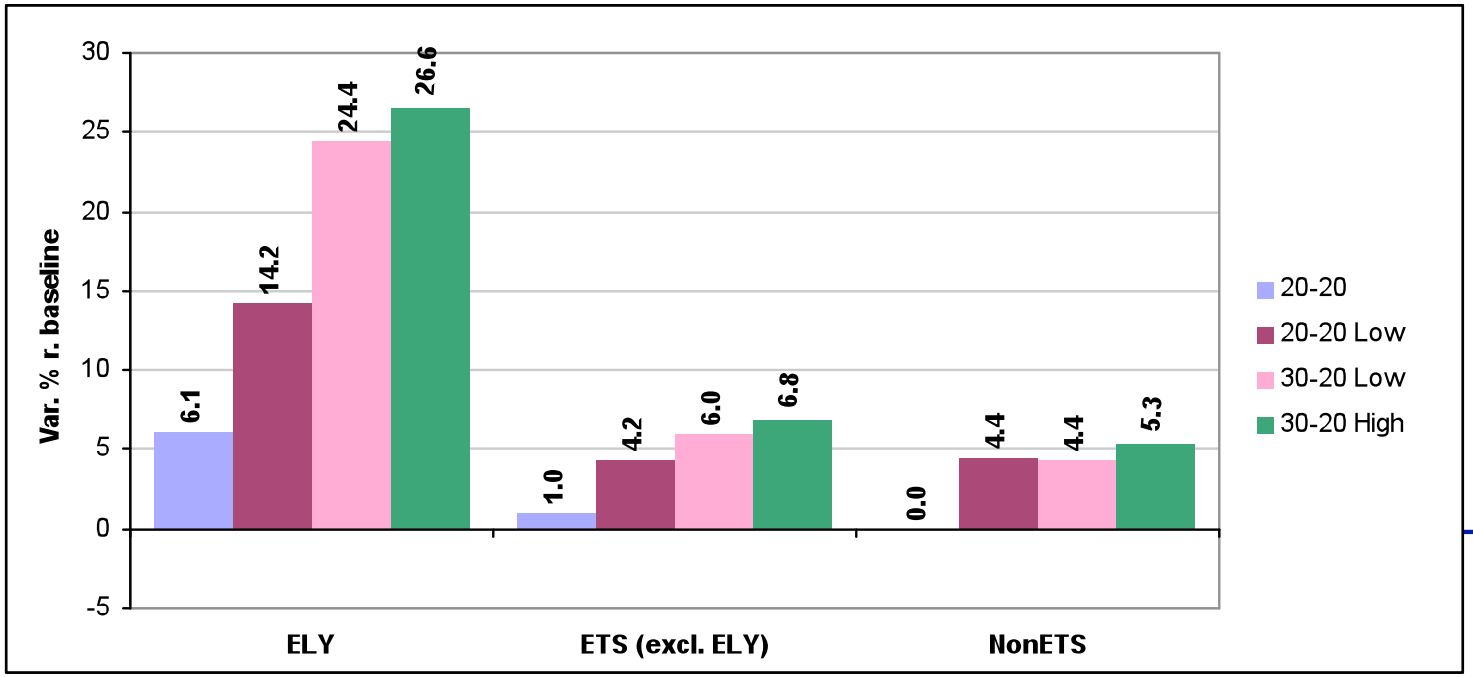


Non EU GDP: % ch. wrt 2020 baseline

EU policy within the Copenhagen Accord



Sectoral output
% ch. wrt 2020
baseline



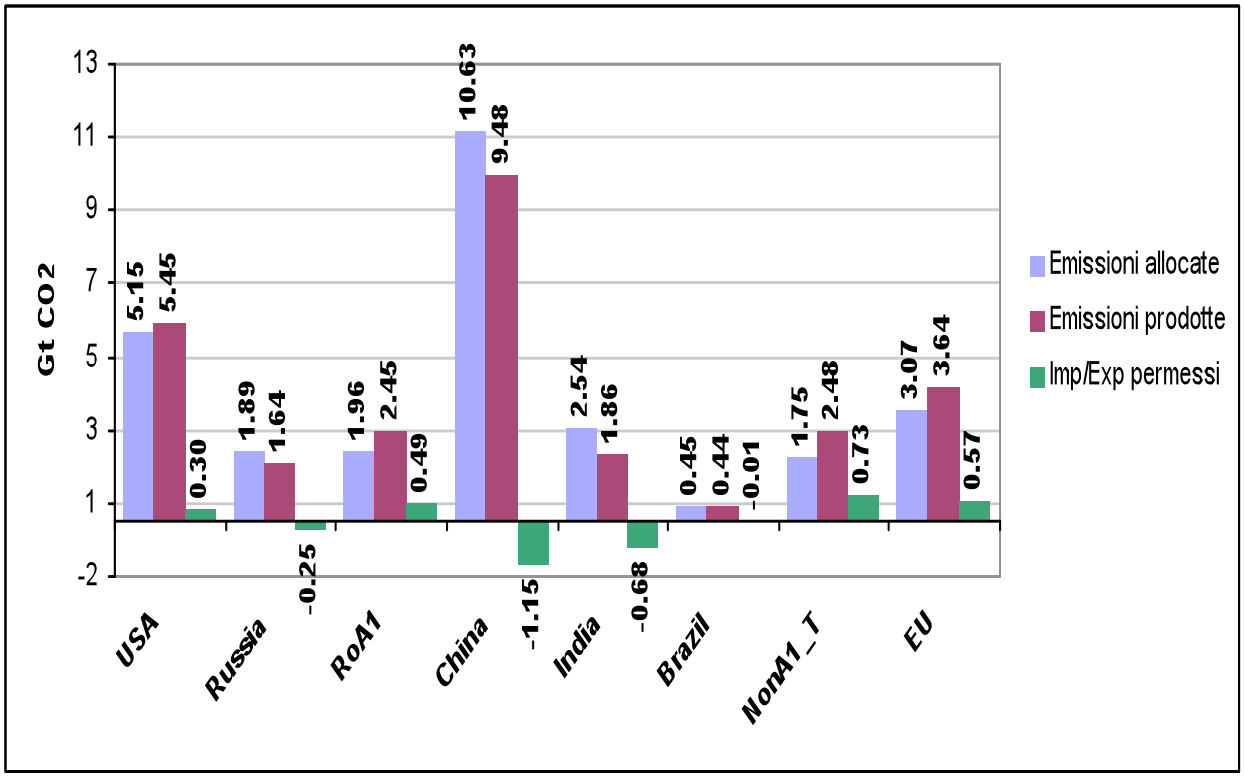
Sectoral prices
% ch. wrt 2020
baseline

30-20 Low and "full" emission trading

GDP impacts
% change wrt
2020 baseline

	Domestic Action	Full Trade
Countries with targets/pledges Total	**-1.25**	**-0.8**
EU Total	***-0.66***	***0.2***
Italy	-0.69	0.1
Germany	-0.46	0.3
UK	-0.17	0.4
Spain	-0.75	0.16
USA	-0.60	-0.37
Russia	-2.37	-4.1
RoA1	-1.18	-0.06
China	-1.62	-3.8
India	1.64	-2.2
Brazil	0.00	-0.18
NonA1_T	-6.79	-1.12
RoW	2.24	1.65

Emission buyers and sellers



Emission trading clearly benefits buyers of permits

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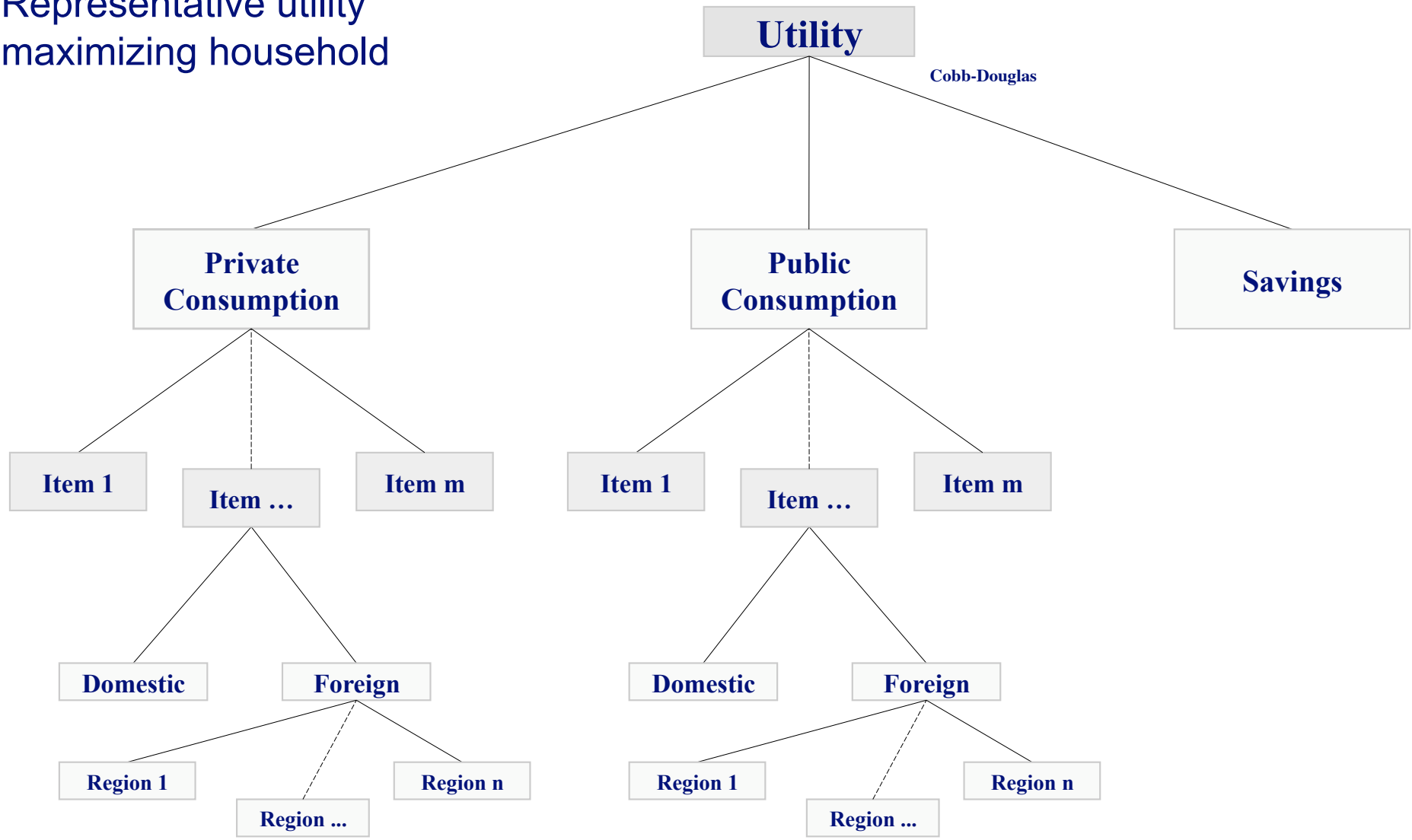
EU mitigation and Copenhagen summary

- Pledges in non EU regions considerably lowers the EU policy costs wrt unilateral policy. Positive competitiveness effect can prevail on the aggregated demand effect (20-20 Low => GDP gains for the EU)
- However, 30-20 Low is costly especially for energy intensive sectors
- Establishing an international carbon market reduce mitigation costs for all signatories (the EU net allowances' buyer can even gain wrt baseline) => relative importance of crucial sectors within EU economy and regional pledges
- Net allowances' sellers would be better off by non participating to the international carbon market => considering long-run technological competitiveness and/or financial transfers

THANK YOU!

ICES: the demand side

Representative utility maximizing household



Indeed, the Copenhagen "Pledges"…

	Low "end" of pledges	High "end" of pledges
EU27	-20% CO_2 w.r.t.1990	-30% CO_2 w.r.t.1990
US	-17% CO_2 w.r.t.. 2005	-17% CO_2 w.r.t. 2005
Russia	-15% CO_2 w.r.t.1990	-25% CO_2 w.r.t.1990
RoA1	-29% CO_2 w.r.t.2005	-32% CO_2 w.r.t.2005
China	-40% CO_2/GDP in 2020	-45% CO_2/GDP in 2020
India	-20% C/GDP	-25% C/GDP
Brazil	-5.3% CO_2 w.r.t. BAU	-9.4% CO_2 w.r.t. BAU

More ambitous mitigation effort could be justifiable