

European Electricity Market between Liberalisation and Climate Protection

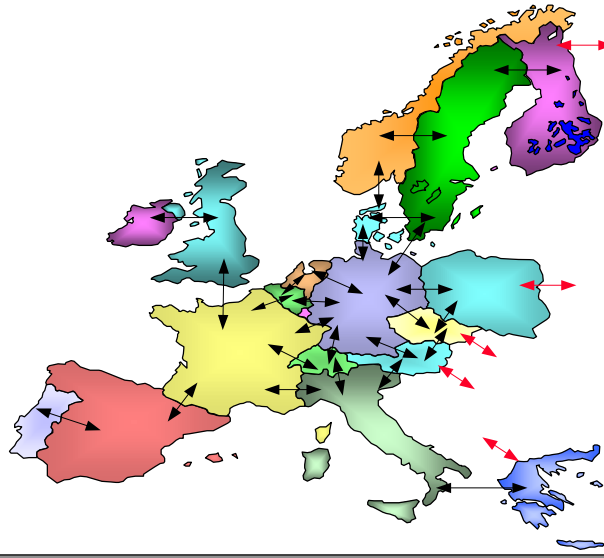
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Paris

Dr. Markus Blesl, Dipl.-Ing. Uwe Remme, Dr. Ulrich Fahl

TIMES – EE (Electricity Generation)

- 19 region model (A, BG, LUX, SE, G, CH, CZ, PL, F, PL, PT, ES, UK, GR, IR, NL, DK, IT, FI, N)
- Detailed power generation sector (CO₂ sequestration and capture options, CHP included) based on a IER power plant database with 25,000 units included
- Detailed electricity exchange balances
- Consideration of CHP expansion options
- Heat and electricity demand reduction options
- GHG: CO₂, CH₄, N₂O included
- Pollutants: NO_x, SO_x, particles
- Time horizon 1990-2030, 5 year periods, 12 time segments per year
- Optional 1FC – learning, clustering approach

Model of the European Electricity market (incl. CHP) – TIMES-EE

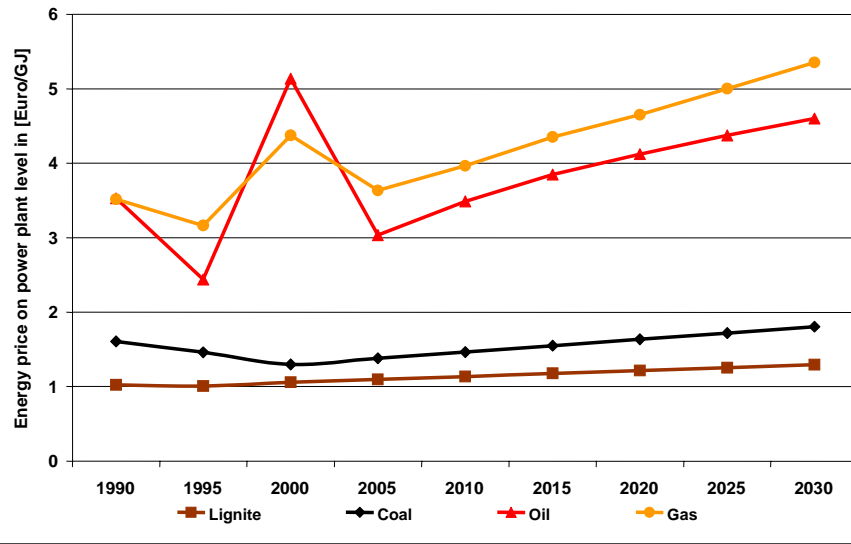


Policy – CO₂ target “Soft landing”

Electricity and heat generation CO ₂ -Emission	Mio. t/a 1990	Kyoto 2010	Reduction targets against 1990 Soft Landing			
			2015	2020	2025	2030
Austria	12,136	-0,13	-14,7%	-16,5%	-18,2%	-20,0%
Belgium	22,477	-0,08	-9,3%	-11,2%	-13,1%	-14,9%
Denmark	23,843	-0,21	-22,6%	-24,2%	-25,7%	-27,3%
Finland	23,761	0,00	-2,0%	-4,0%	-6,0%	-8,0%
France	42,328	0,00	-2,0%	-4,0%	-6,0%	-8,0%
Germany	381,228	-0,21	-22,6%	-24,2%	-25,7%	-27,3%
Greece	35,629	0,25	22,5%	20,0%	17,5%	15,0%
Ireland	10,363	0,13	10,7%	8,5%	6,2%	4,0%
Italy	129,950	-0,07	-8,4%	-10,2%	-12,1%	-14,0%
Luxemburg	0,108	-0,28	-29,4%	-30,9%	-32,3%	-33,8%
Netherland	45,810	-0,06	-7,9%	-9,8%	-11,6%	-13,5%
Portugal	16,448	0,27	24,5%	21,9%	19,4%	16,8%
Spain	66,626	0,15	12,7%	10,4%	8,1%	5,8%
Sweden	9,218	0,04	1,9%	-0,2%	-2,2%	-4,3%
UK	219,282	-0,13	-14,3%	-16,0%	-17,8%	-19,5%
EU-15	1039,208	-0,10	-11,6%	-13,4%	-15,2%	-17,0%
Czech	55,925	-0,08	-10,7%	-11,7%	-13,5%	-15,4%
Poland	187,407	-0,06	-7,9%	-9,8%	-11,6%	-13,5%
Switzerland	0,941	0,01	1,3%	1,5%	1,8%	2,0%
Norway	1,045	-0,08	-10,7%	-11,7%	-13,5%	-15,4%

Policy – CO₂ target “Flexible Mechanism”

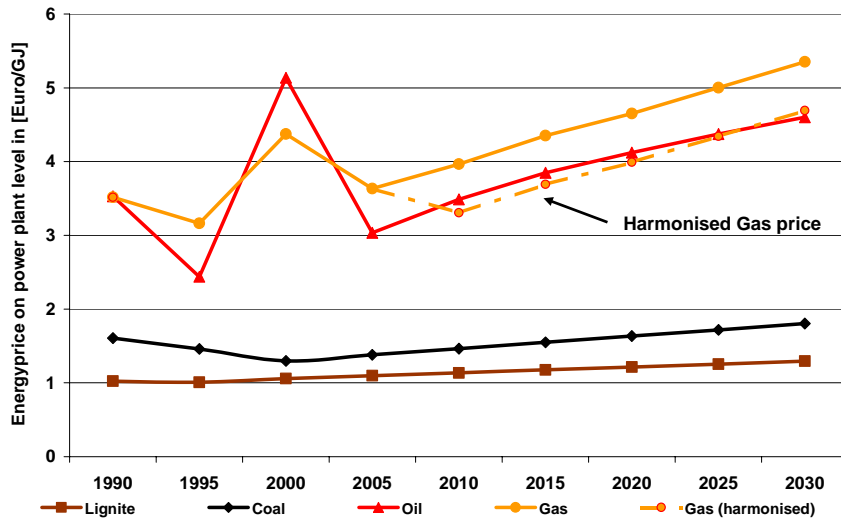
Energy price assumption on power plant level (Euro pro GJ)



Energy price differences on power plant level compared with Germany (tax included) in Euro/GJ

	Light Fuel Oil	Heavy Fuel Oil	Natural Gas	Steam Coal
France	-0,26	0,00	0,00	-0,23
Austria	0,07	-0,19	0,18	0,00
Belgium / Lux	-0,97	0,16	-0,60	0,03
Switzerland	-2,68	0,00	0,00	0,00
Czech Republic	-0,79	-1,43	-0,18	-0,93
Denmark	-1,03	0,00	0,00	0,00
Sweden	-2,55	0,00	0,00	0,00
Poland	-1,16	-1,30	0,00	-0,29
Netherlands	1,40	1,80	-0,74	0,00
Finland	1,56	2,32	-0,16	-0,17
Greece	3,41	1,33		
Ireland	-0,05	1,22	-0,56	-0,45
Italy	3,48	0,19	-0,51	0,11
Luxembourg		0,64		
Portugal		1,39		-0,40
Spain	6,05	3,64	1,34	
UK	0,46	1,54	-0,85	-0,03

Policy – Harmonisation of the European tax system for energy carriers

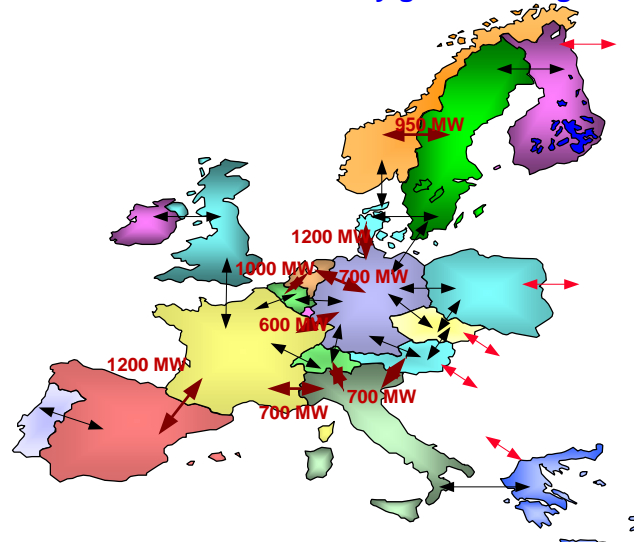


Policy – Higher share of renewable electricity generation

	2010	2020	2025	2030
Austria	78,1	87	91	91
Belgium	6	15	19	23
Denmark	29	32	33,5	35
Finland	35	42	45	52
France	21	30	34	38
Germany	12,5	20	25	32
Greece	20,1	29	33	37
Ireland	13,2	22	26	30
Italy	25	34	38	42
Netherland	12	17	21	25
Portugal	45,6	55	59	63
Spain	29,4	38	42	46
Sweden	60	63	73	77
UK	10	20	24	28

National Targets → Projection

Policy – Extension in the electricity grid exchanges capacities

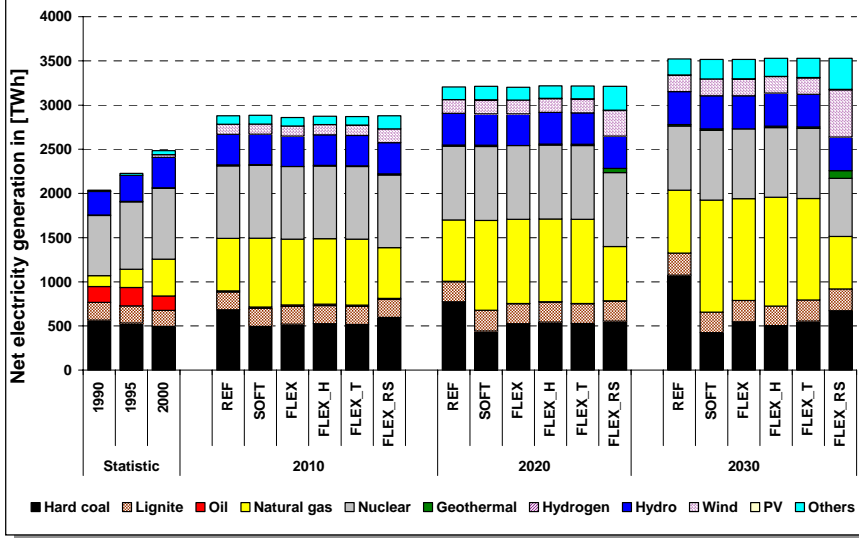


Source: Haubrich, H.J.; Analysis of Electricity Network capacities and Identification of Congestions; 2001

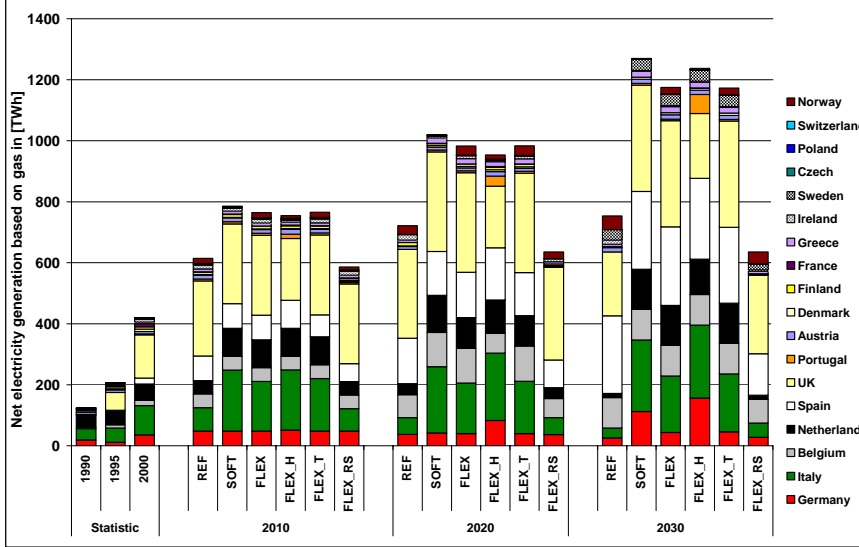
Scenario definition

- Reference case (**REF**)
- CO₂ - Emission target "Soft landing" for EU15 (**SOFT**)
- CO₂ - Emission target "Soft landing" for EU19 (**FLEX**)
- CO₂ - Emission target "Soft landing" for EU19 and additional installation of grid capacities (**FLEX_T**)
- CO₂ - Emission target "Soft landing" for EU19 harmonisation of the European tax System for natural gas (**FLEX_H**)
- CO₂ - Emission target "Soft landing" for EU19 and renewable electricity generation target for EU 15 (**FLEX_RS**)

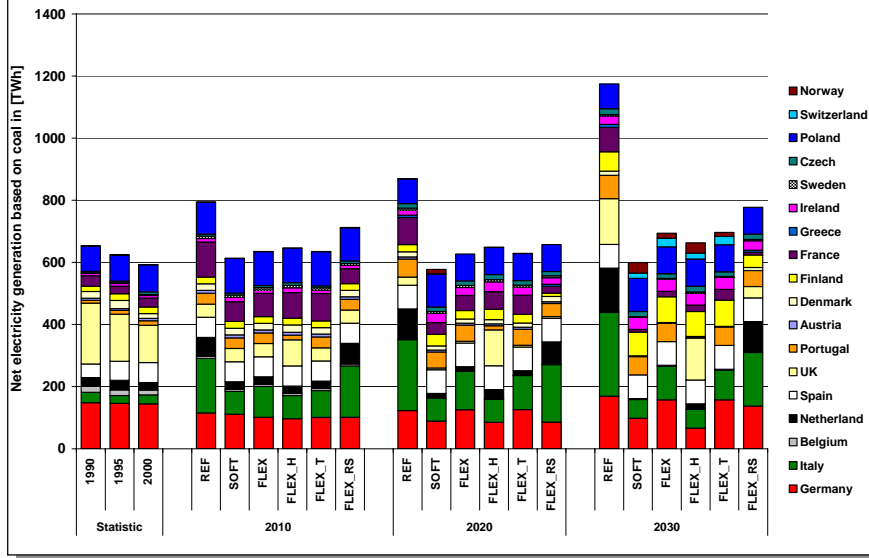
Net electricity generation by energy carriers in Europe 19



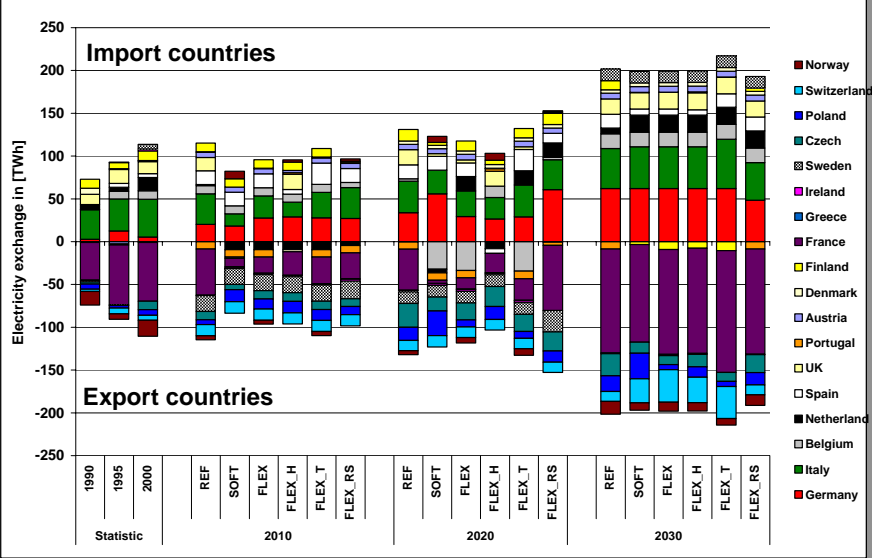
Net electricity generation based on gas in Europe 19



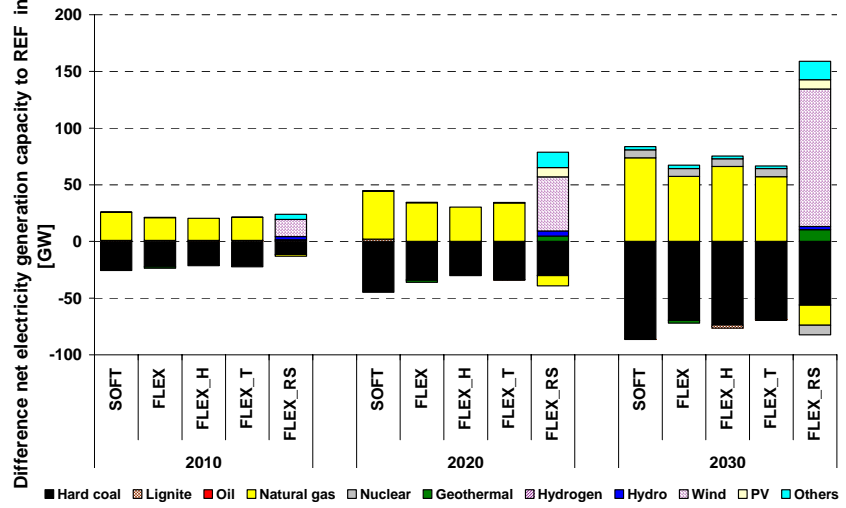
Net electricity generation based on coal in Europe 19



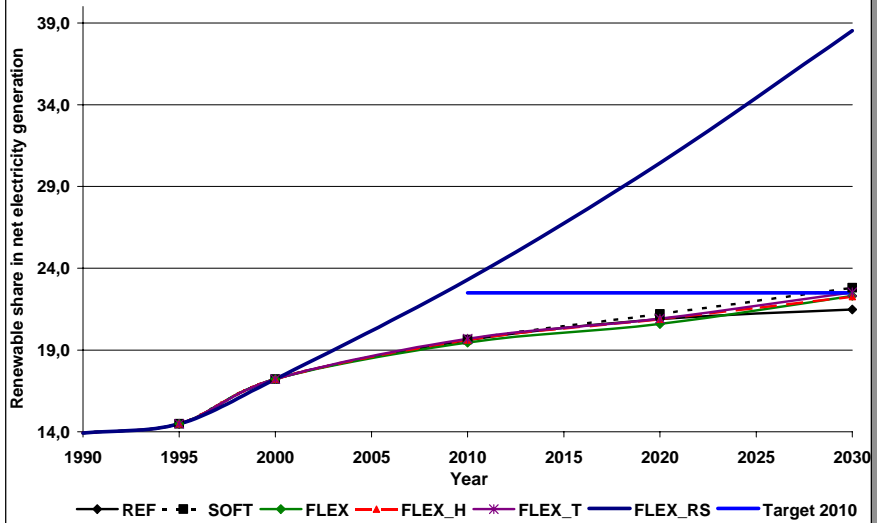
Net – electricity balance for the different countries



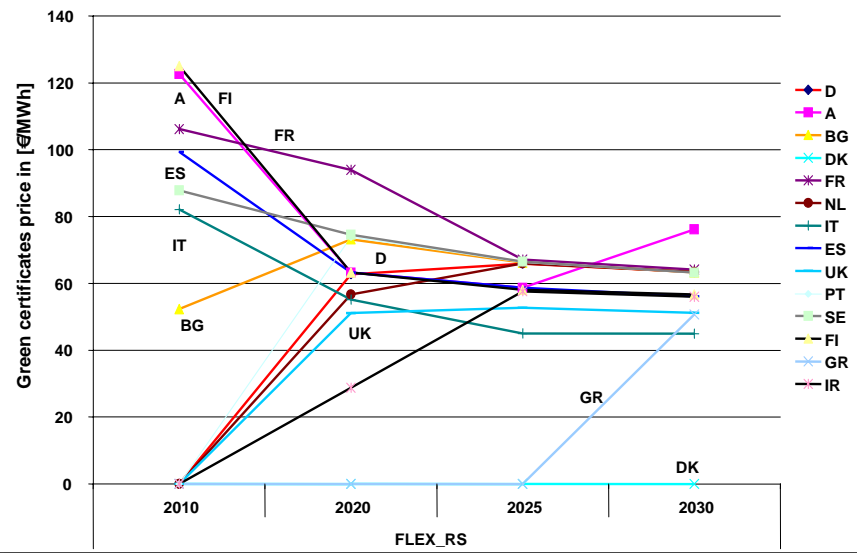
Differences in net electricity generation capacity in Europe-19 relative to REF in [GW]



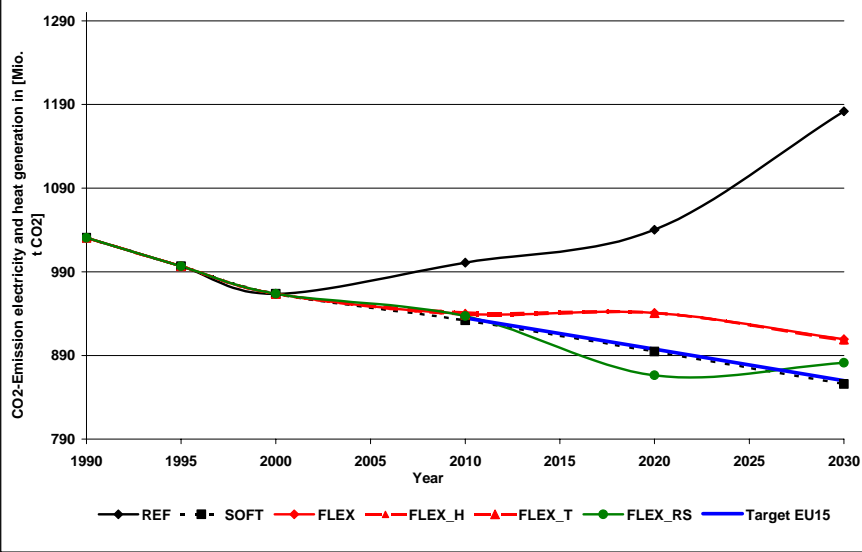
Share of renewable electricity generation



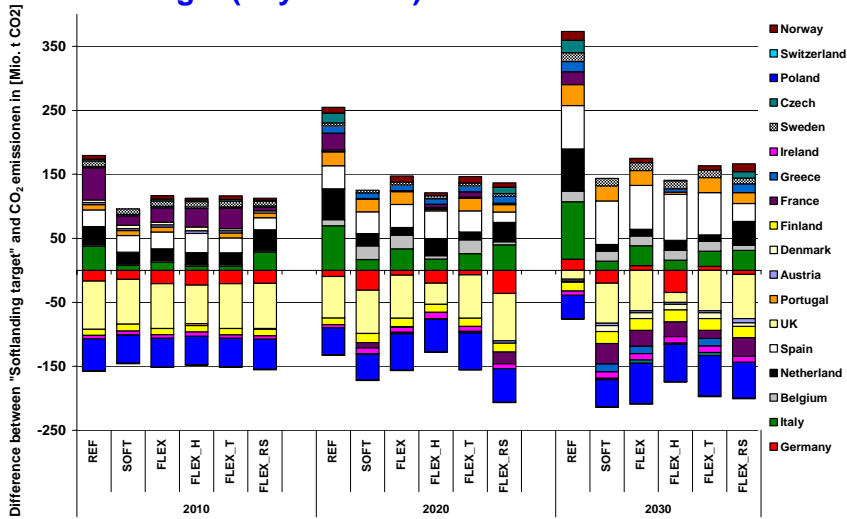
Green certificate prices



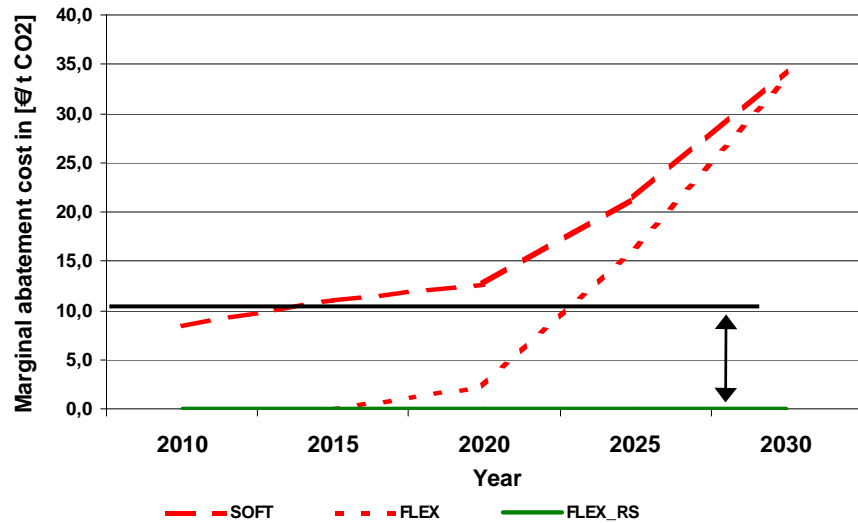
CO₂ Emission in the different scenarios in EU 15



Differences between CO₂ Emission „soft landing“ and national target (buyer/seller)



Marginal cost of CO₂ reduction



Conclusions

- **The differences between Kyoto – target and the emissions of the electricity and heat sector are not so big.**
- **If all European countries will include in the emission trading the certificate prices fall especially because of the hot air from Poland.**
- **Under the energy carrier price assumptions, the harmonisation of the European energy tax system influences the electricity capacities which will be installed in the different countries.**
- **The total amount of electricity exchange will be on the same level if there will be investments in additional net capacities between the countries. But the price for peak-load electricity fall and the national net imports balances will change.**
- **With the national targets for renewable electricity automatically the Kyoto-target will be achieved.**
- **With a common electricity market, a free certificate market, a harmonised tax system the European emission reduction and the national renewable targets can be achieved in the most cost-effective manner leading to the lowest electricity prices.**