Green-X
Deriving optimal promotion strategies for increasing the share of RES-E in a dynamic European electricity market

Costs and potentials of CHP and DSM

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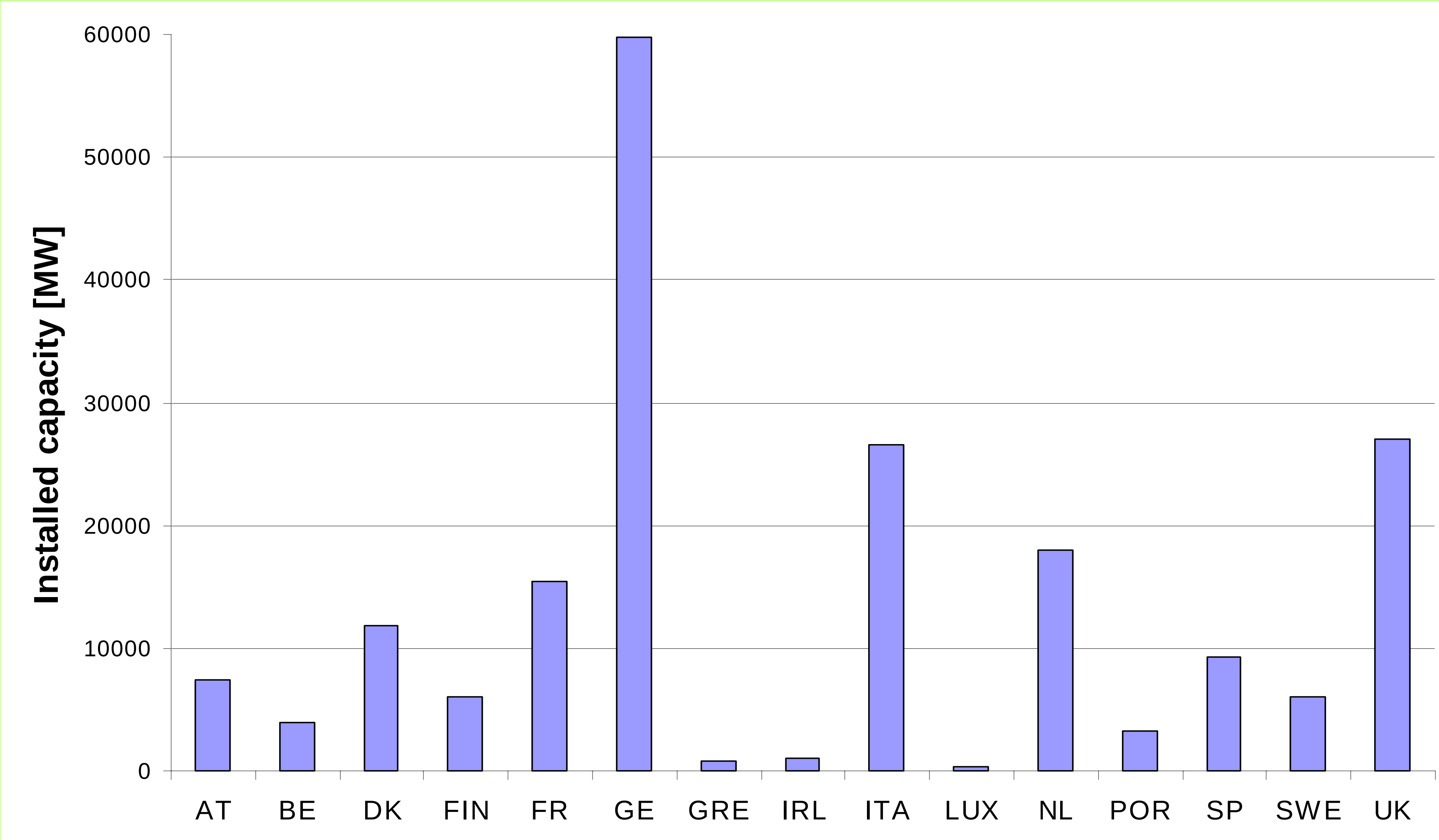
Potentials and costs of CHP and DSM for GHG reduction

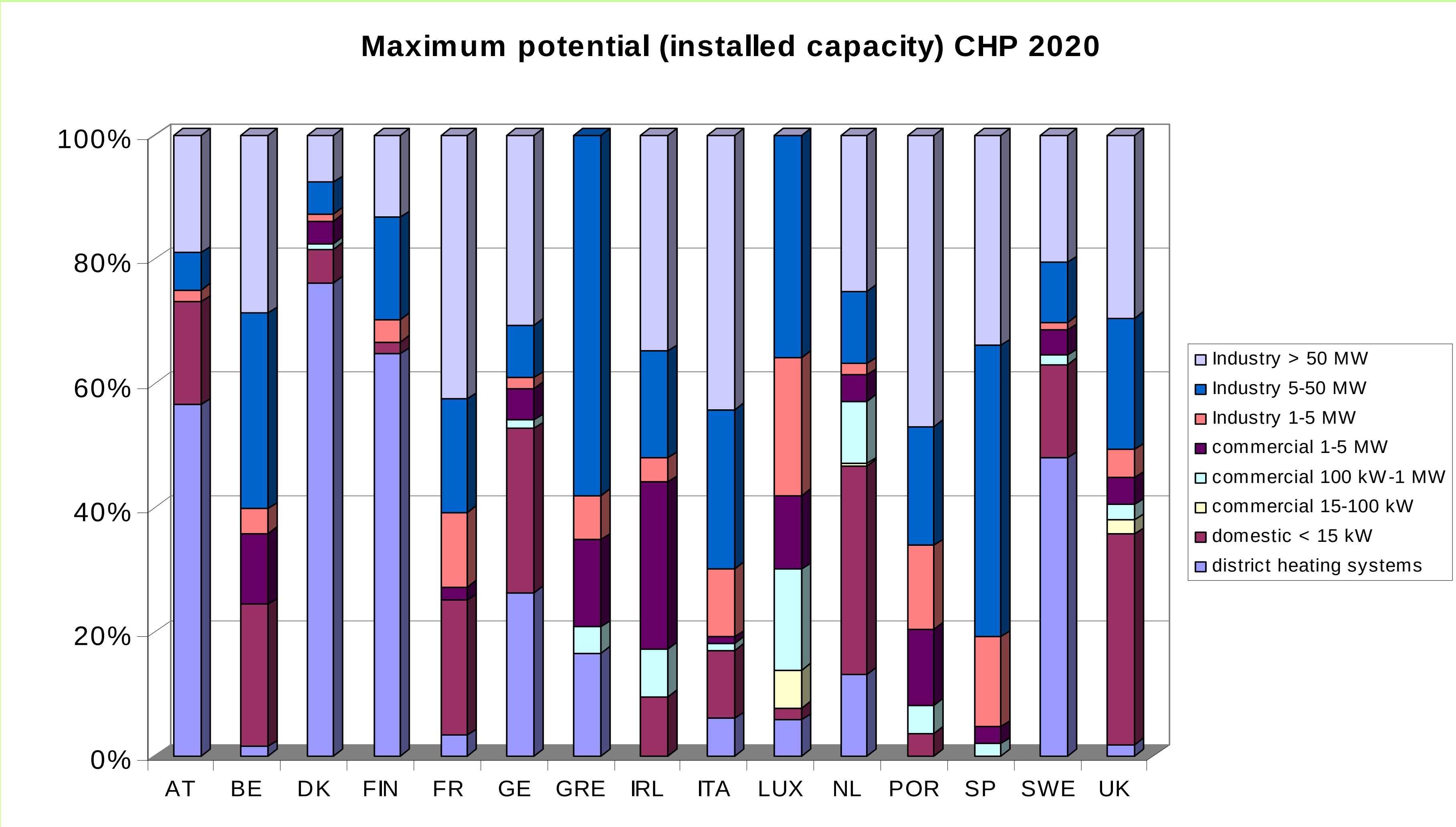
- CHP and DSM offer large, cost efficient potentials for GHG reduction in the EU-15
- CHP and DSM belong to the most complex input variables of the model ***Green-X*** because a large number of sectors, sub-sectors and technologies have to be considered
- A number of new technologies might become cost effective by 2020, e.g. fuel cells
- Especially potentials in different sectors are highly country specific

CHP Potential by country for 2020



Source: Future Cogen

CHP potential by sector for 2020



Source: Future Cogen

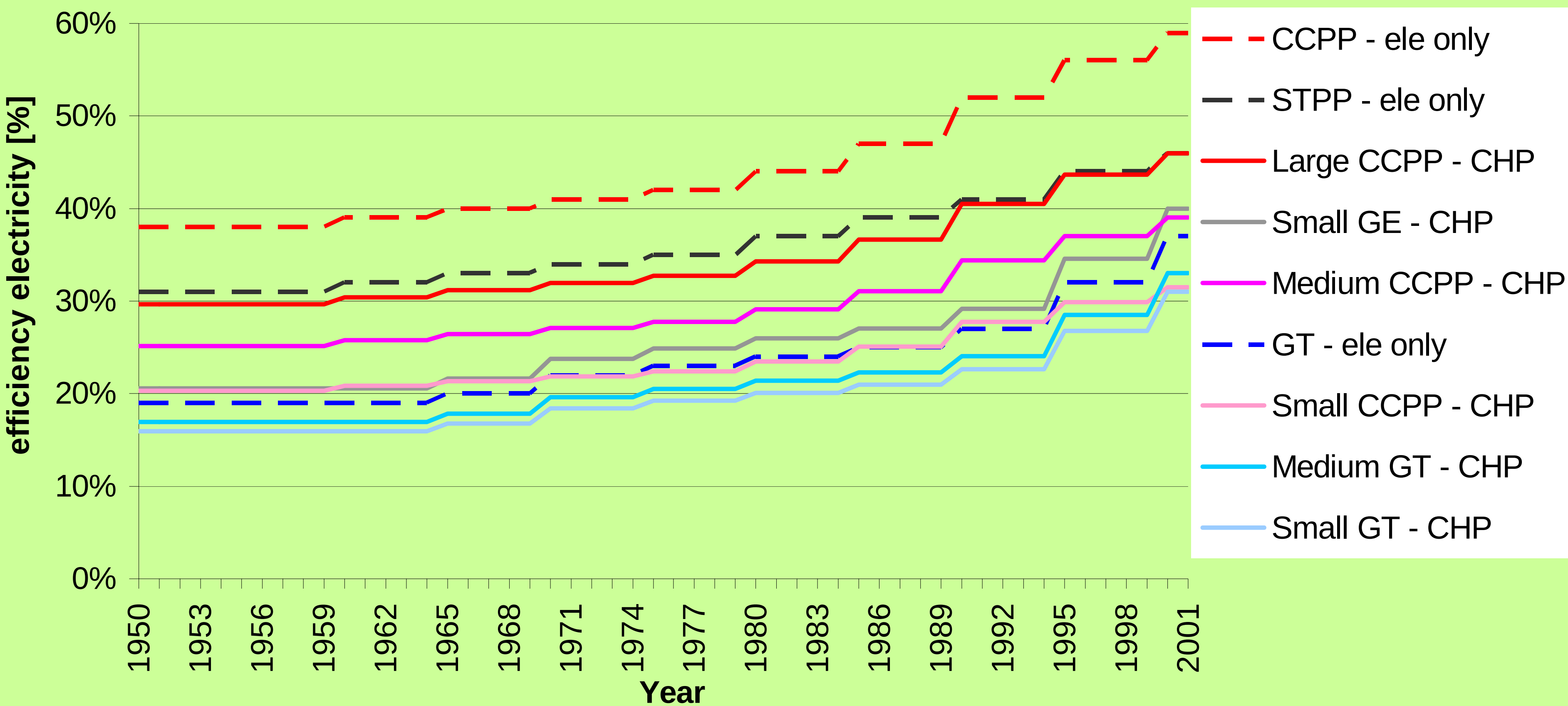
CHP Technologies

- CC: Combined cycle (gas and steam turbine)
- CC-B Combined Cycle Backpressure
- ST: Steam turbine
- ST-B Steam turbine with backpressure
- GE: Gas engine
- GT: Gas turbine
- DE Diesel engine
- PEFC: Polymer electrolyte fuel cells
- PAFC: Phosphoric acid fuel cells
- MCFC: Molten carbonate fuel cells
- SOFC: Solid oxide fuel cells

In the industry, commercial and domestic sector

CHP - efficiencies

Electric efficiencies of CHP plants are usually lower than those of conventional power plants



Techno-Economic data for CHP plants

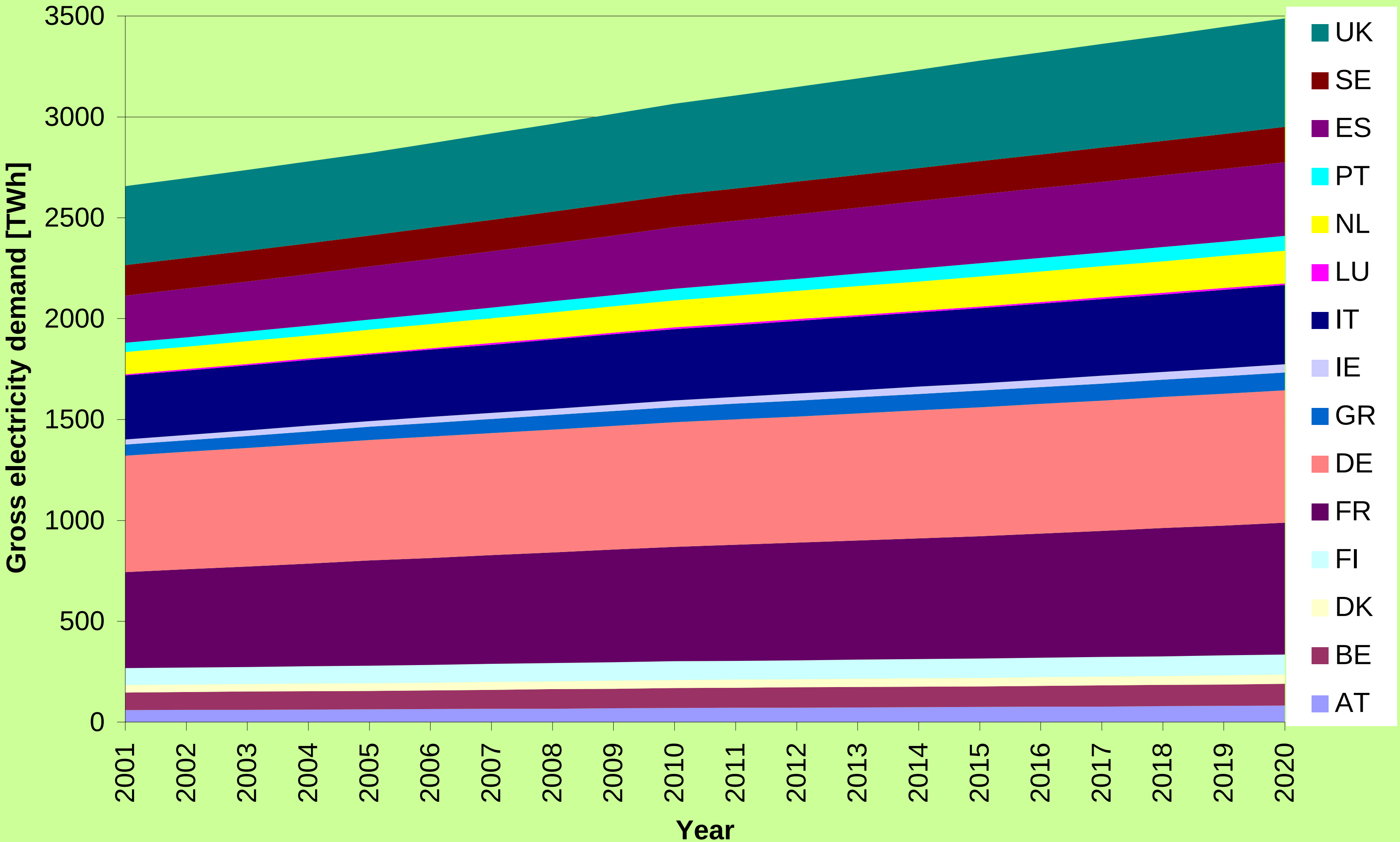
Actual costs of electricity from CHP depend on:

- **fuel price**
- **heat price**
- **techno-economic plant data as shown below**

$$C = C_{VARIABLE} + \frac{C_{FIX}}{q_{el}} = \left(C_{FUEL} + \frac{C_{O\&M}}{H_{EL}} * 1000 - R_{HEAT} \right) + \frac{1000 * I * CRF}{H_{EL}}$$

2020	current technique		GT	CC	CC
	plant-size	[MWe]	5,0	100,0	200,0
	total investment costs	[€/kWe]	591,0	674,9	582,9
	O&M-costs	[€/(kW*a)]	73,9	39,7	29,6
	full load hours	[h/a]	2.300,0	2.650,0	2.900,0
	efficiency electricity	[%]	31,2	42 (52)	45 (56)
	efficiency heat	[%]	54,3	46,0	44,0
	total efficiency	[%]	85,5	88,0	89,0
	heat to power ratio	[GWhth/GWhe]	1,7	1,1	1,0
	life time	[a]	30,0	30,0	30,0

Electricity demand - baseline scenario



Source: Shared Analysis (2003)

DSM Activities

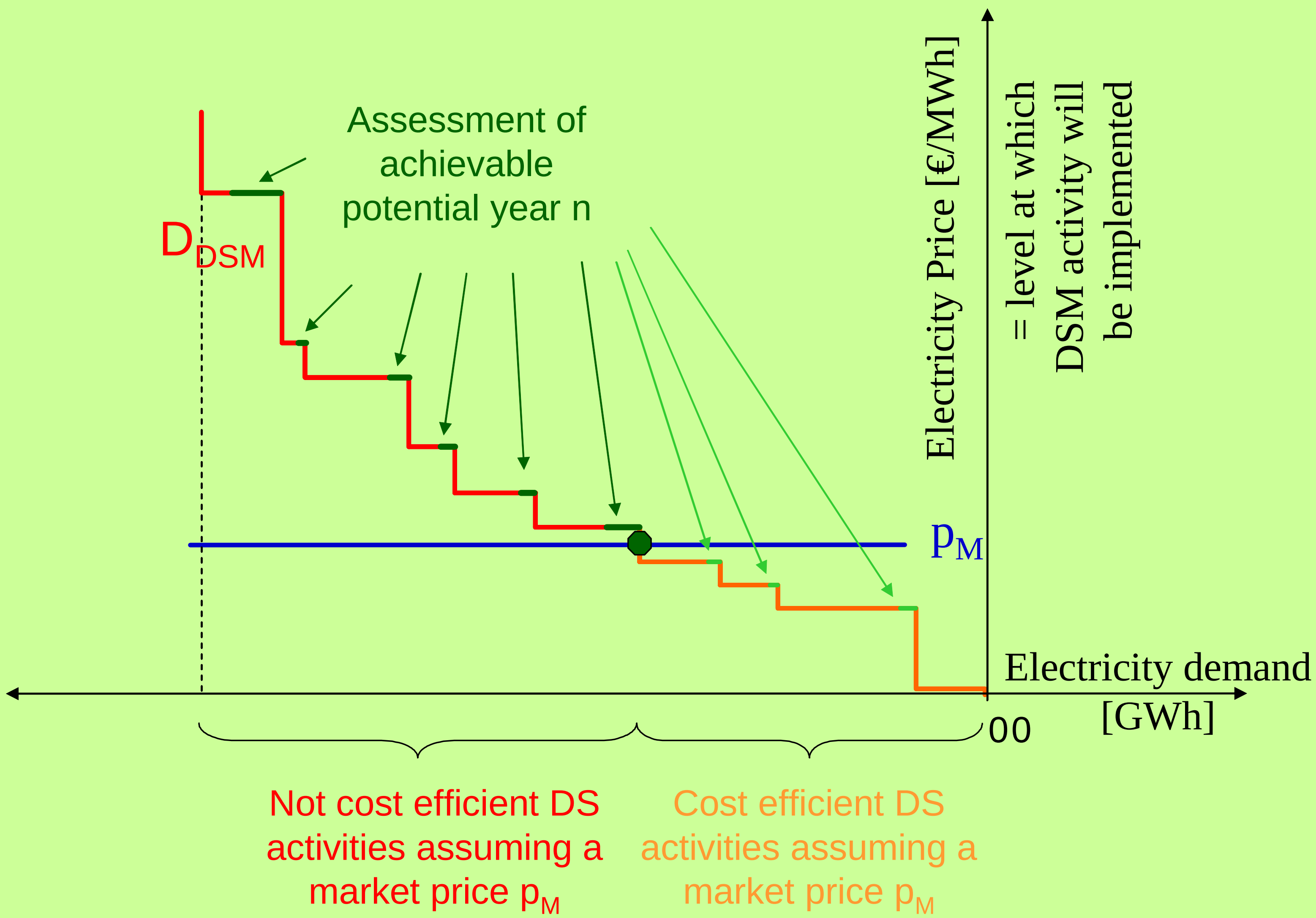
Main Sectors for DSM activities in the electricity sector are:

- Industry
- Households
- Service sector

each containing various sub-sectors, for example the industry sector includes:

- Iron & Steel
- Non-ferrous metals
- Engineering
- Foundries (including iron/steel and non-ferrous metals foundries)
- Food
- Chemicals
- Glass and Glass Products
- Ceramics
- Cement
- Cross sector technologies - including compressed air, lighting, refrigeration

Cost curve for DSM Measures



Data-Base DSM

Example of most important technology specific information

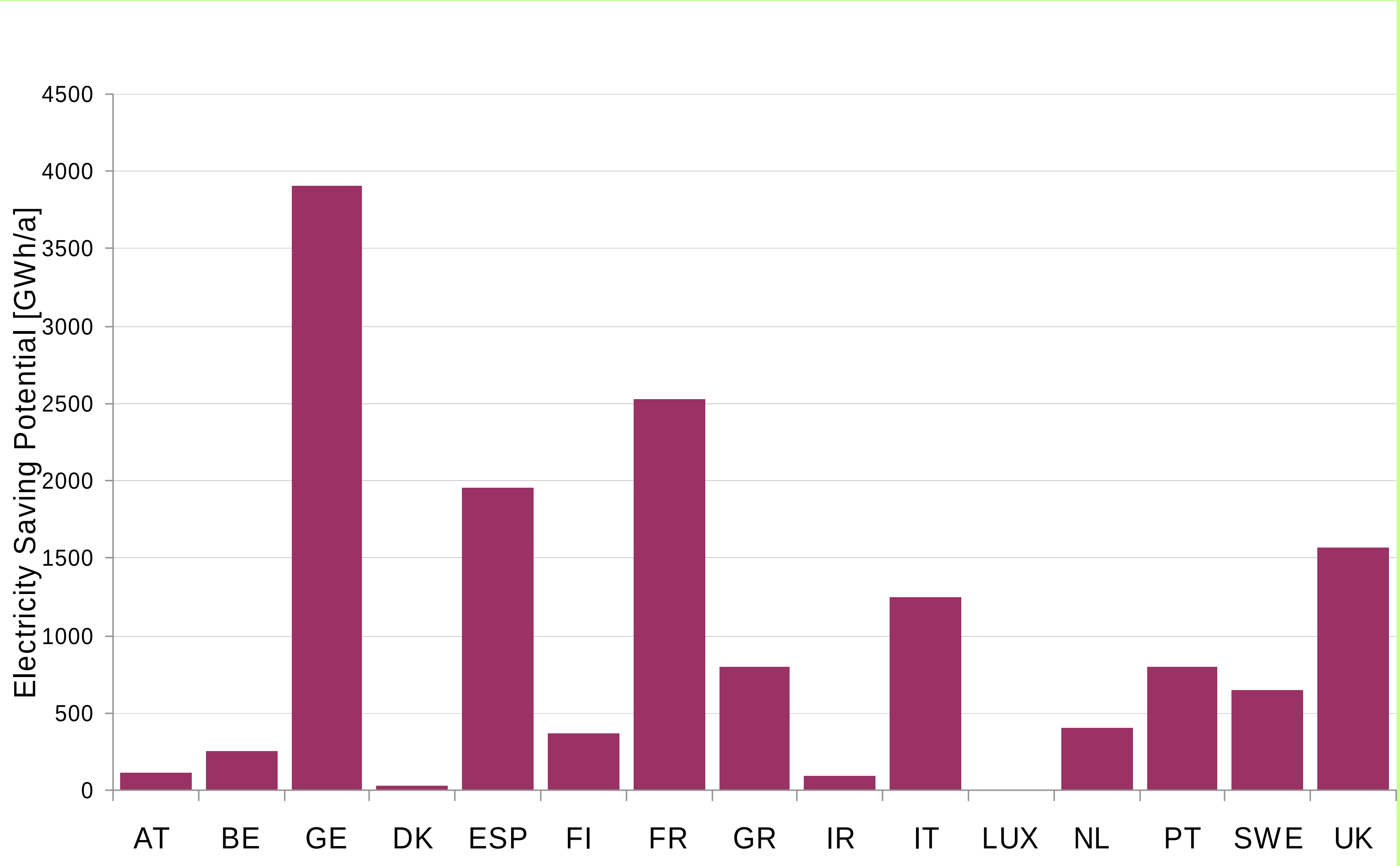
Band Name	Long term potential energy saving compared to BAU 2020 [GWh/year]	Share of realisable energy saving potental compared to long-term potential [% of long-term energy saving]	**Maximum yearly realisable penetration of energy saving compared to BAU [GWh/year]**	**Level of electricity costs where DSM measure is economical efficienct [€/MWh]**	Additional Investment costs year n [€/ unit output]	Energy saving per unit service output [MWh / unit output]	Additional O&M costs independend from electricity consumption [€/ unit output]	Life time of implemented technology [years]	Life time alternative option [years]	Sector/Subsector	Comment alter technology / en
GER-E-DSM-N-I-NFM2	1533,3	1%	**15,33**	**24,17**	548,83	2,667	0,00	20	20	***Primary Smelting (Hall-Heroult)***	stable cathode
GER-E-DSM-N-I-NFM3	520,7	5%	**26,03**	**15,24**	105	0,906	0,00	15	15	***Primary Smelting (Hall-Heroult)***	good houseke
GER-E-DSM-N-I-NFM4	773,1	1%	**7,73**	**6,97**	85	1,344	0,00	25	25	***Primary Smelting (Hall-Heroult)***	improved proc
GER-E-DSM-N-I-NFM5	442,4	3%	**14,75**	**17,07**	99,89	0,769	0,00	15	15	***Primary Smelting (Hall-Heroult)***	best practise
GER-E-DSM-N-I-NFM6	72,5	4%	**2,72**	**0,00**	4,2	0,045	-1,40	15	15	***Al: Further Treatment Furnace***	control system
GER-E-DSM-N-I-NFM7	72,5	3%	**2,42**	**17,51**	0,7	0,045	0,70	15	15	***Al: Further Treatment Furnace***	monitoring & t
GER-E-DSM-N-I-NFM8	143,3	4%	**5,37**	**1,25**	0,85	0,089	0,00	15	15	***Al: Further Treatment Furnace***	improved mar
GER-E-DSM-N-I-NFM9	13,2	2%	**0,20**	**24,39**	6,7	0,036	0,00	15	15	***Sec. Smelting (Shaft furnace)***	impr. refinery
GER-E-DSM-N-I-NFM10	21,9	2%	**0,53**	**55,32**	25,2	0,060	0,00	15	15	***Sec. Smelting (Shaft furnace)***	scrap preheati

Example: Non-Ferrous-Metals

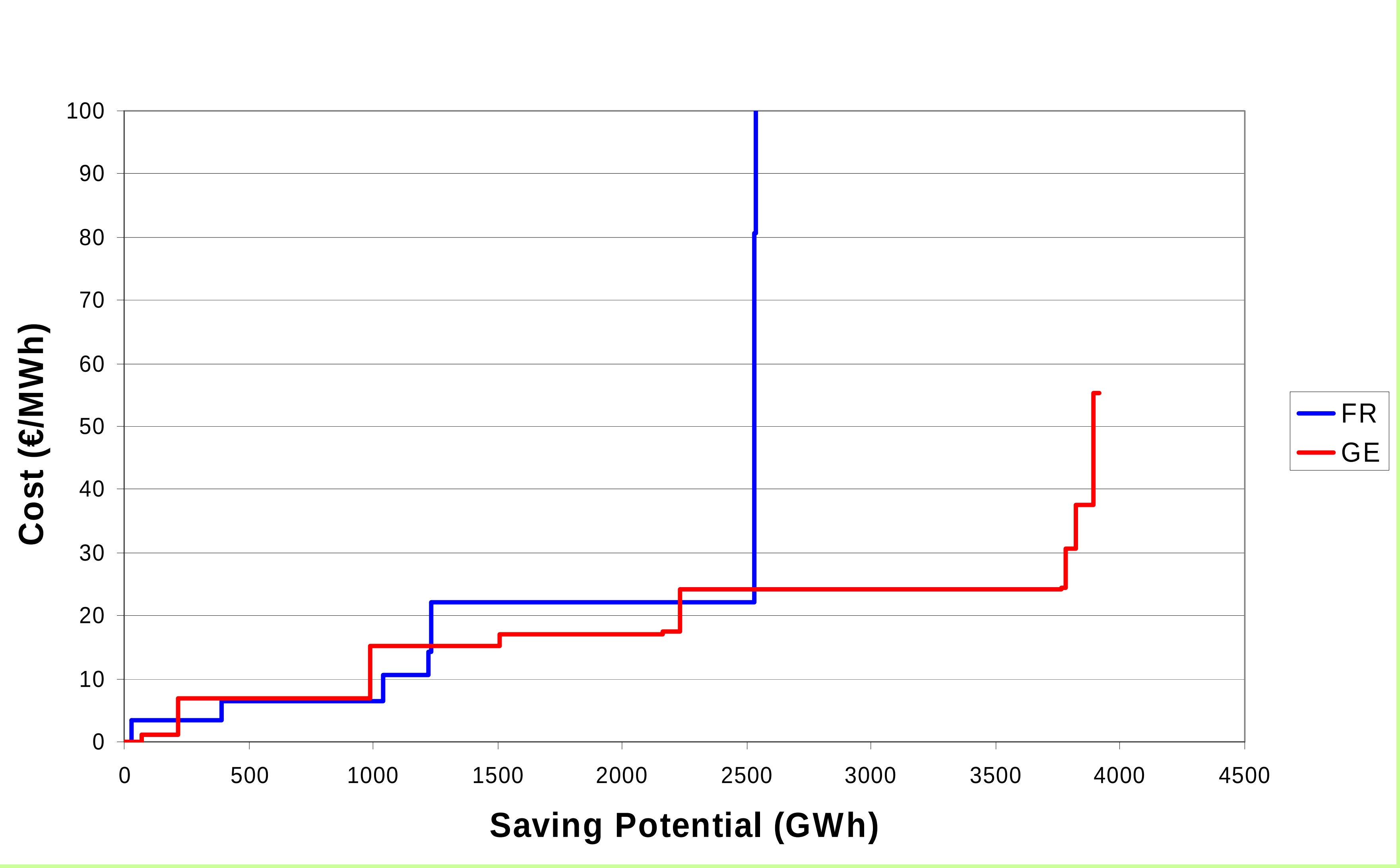
Technologies considered:

Device	Name of Energy Efficiency Technology
Al: Primary Smelting (Hall-Heroult)	Reduced demand of anodes
Al: Primary Smelting (Hall-Heroult)	Stable cathodes
Al: Primary Smelting (Hall-Heroult)	Good housekeeping
Al: Primary Smelting (Hall-Heroult)	Improved process
Al: Primary Smelting (Hall-Heroult)	Best practise
Al: Further Treatment Furnace	Control systems
Al: Further Treatment Furnace	Monitoring & targeting
Al: Further Treatment Furnace	Improved management
Al: Sec. Smelting (Shaft furnace)	Improved refinery
Al: Sec. Smelting (Shaft furnace)	Scrap preheating
Cu: Further Treatment Furnace	Rapid heating
Zinc: Hydrometallic Zinc Process	H2 diffusion anodes
Zinc: Hydrometallic Zinc Process	Improved electrolysis material

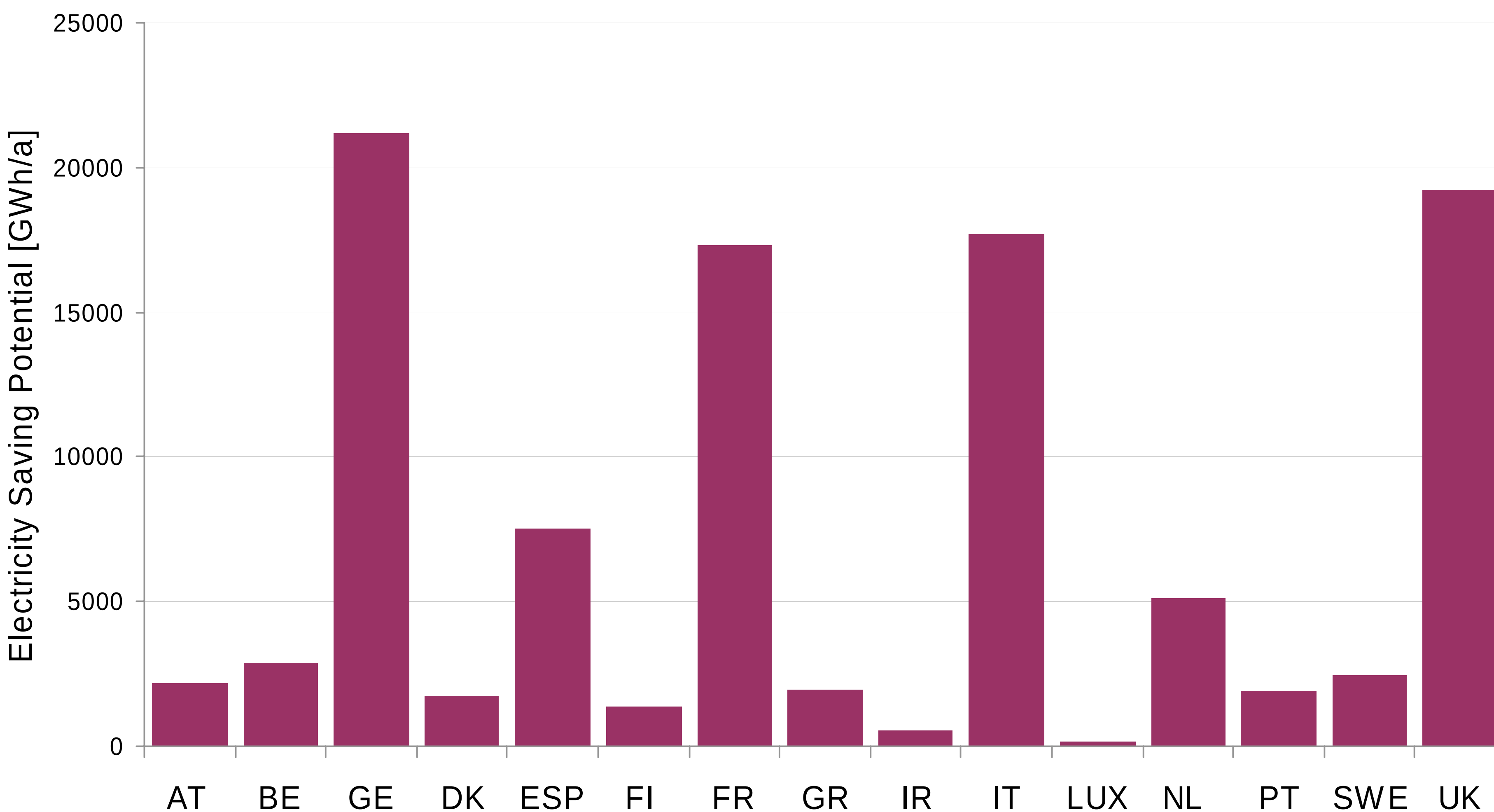
Example: Potential - Non-Ferrous-Metals



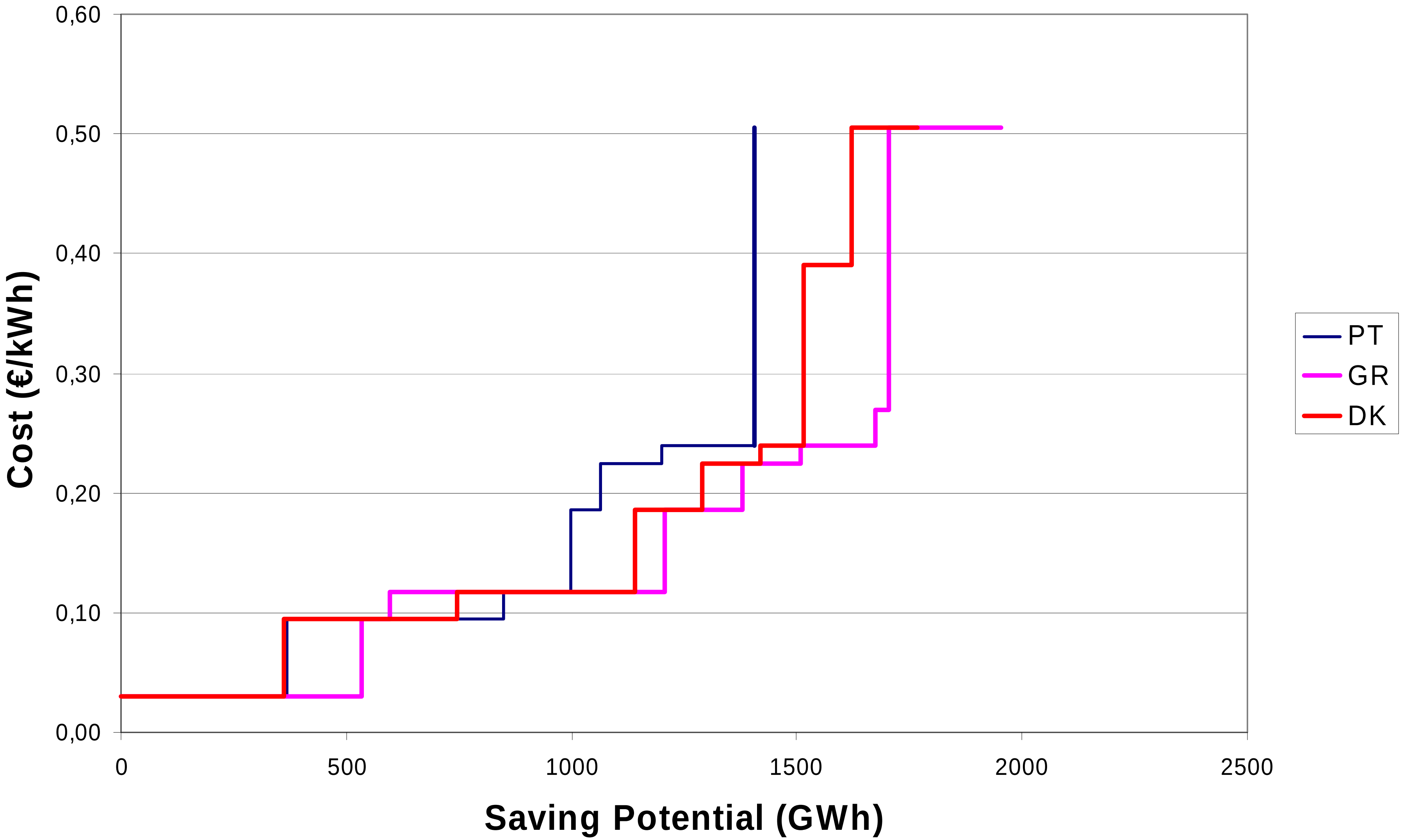
Example: Cost Curve - Non-Ferrous-Metals



Example: Potential - Household Appliances



Example: Cost Curve - Household Appliances



Conclusions

- Only about one third of the overall European CHP potential is exploited, large potentials in small scale domestic and large scale industrial CHP
- Costs of electricity from CHP plants normally higher than from conventional power due to lower full load hours, lower electric efficiency, higher investment costs
- Large DSM potential with partially negative costs can be identified in the industry (especially Engineering, NFM, Iron&Steel and Chemicals) and in the household sector