Környezetvédelmi
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Minisztérium

CO_2 mitigation potential in the Hungarian public buildings

CENTER FOR CLIMATE CHANGE
AND SUSTAINABLE ENERGY POLICY

CENTRAL EUROPEAN UNIVERSITY

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Szeged, 16-17 April 2009

Overview

- Background: importance of public sector in CO_2 emissions
- Aims of the study
- Methodology
- Details of findings related to electricity consumption in public buildings
- Aggregate results
- Conclusions and recommendations

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Introduction

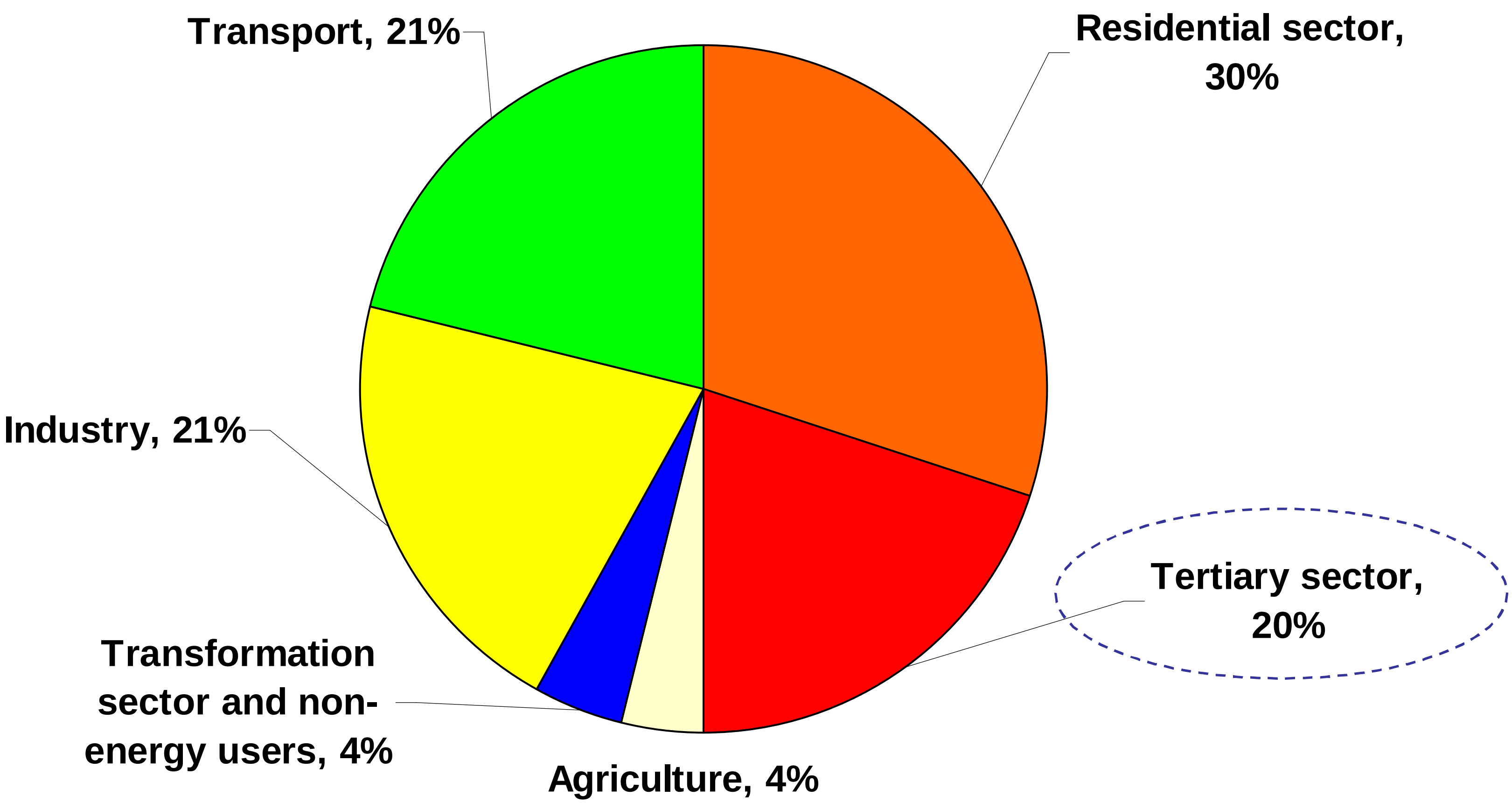
- Project conducted on behalf of the Hungarian Ministry of Environment and Water (KVVM)
- Aim: to estimate CO_2 mitigation potential in the Hungarian public buildings for space and water heating and electricity

Acknowledgements

The study is based on results of projects:

- **Intelligent Energy – Europe Programme**
  - Monitoring Electricity Consumption in the Tertiary Sector (El-Tertiary 2006-2008, co-funded by CEU)
- **UNDP and Energia Központ in Budapest**
  - UNDP/GEF Hungary Public Sector Energy Efficiency Project (processing of energy audits took place in 2008-2009)
- **Hungarian Ministry of Water and the Environment**
  - Carbon Dioxide Mitigation Potential in the Hungarian Public Sector (2008-2009);
  - Greenhouse Gas Emission Scenarios and Emission Reduction Potentials in Hungary for 2007-2025 (2008-2009).
- The following experts contributed to the work with their invaluable advise:
  - Tamas Csoknyai, Istvan Kovacsics and others.

Half of CO_2 in Hungary comes from buildings



Source: constructed based on ODYSSEE 2007

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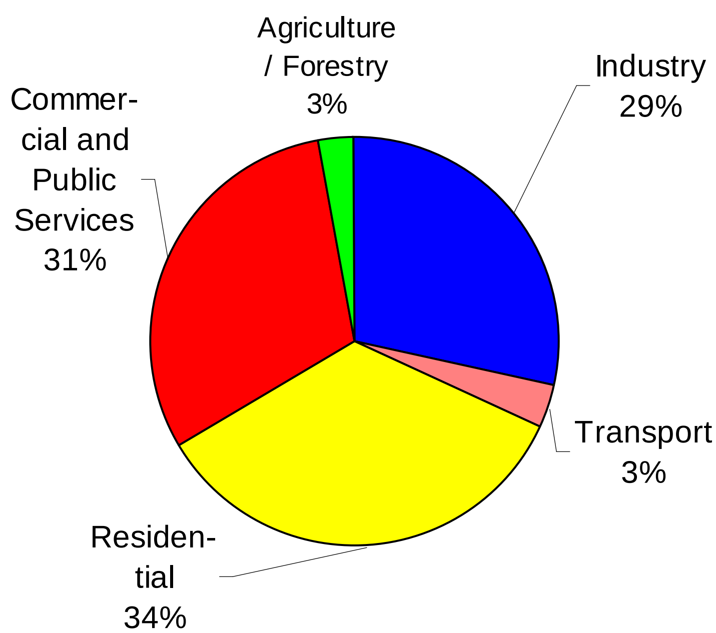
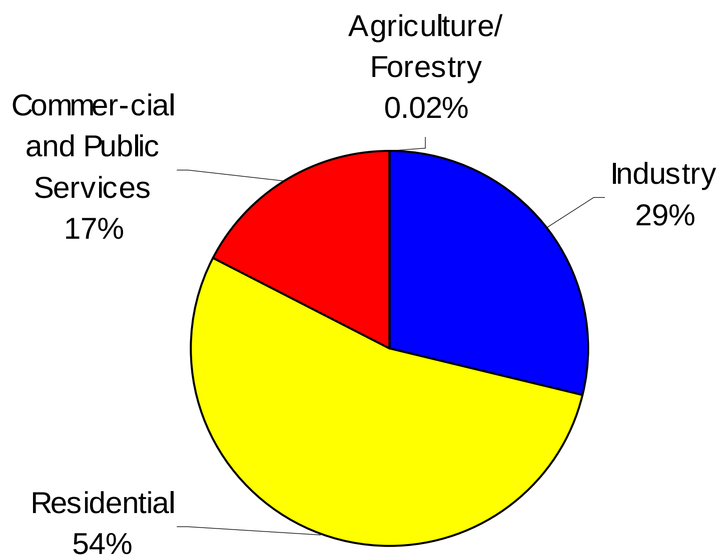
Trends in energy consumption in Hungarian tertiary sector

Electricity consumption by sector in Hungary in 2005

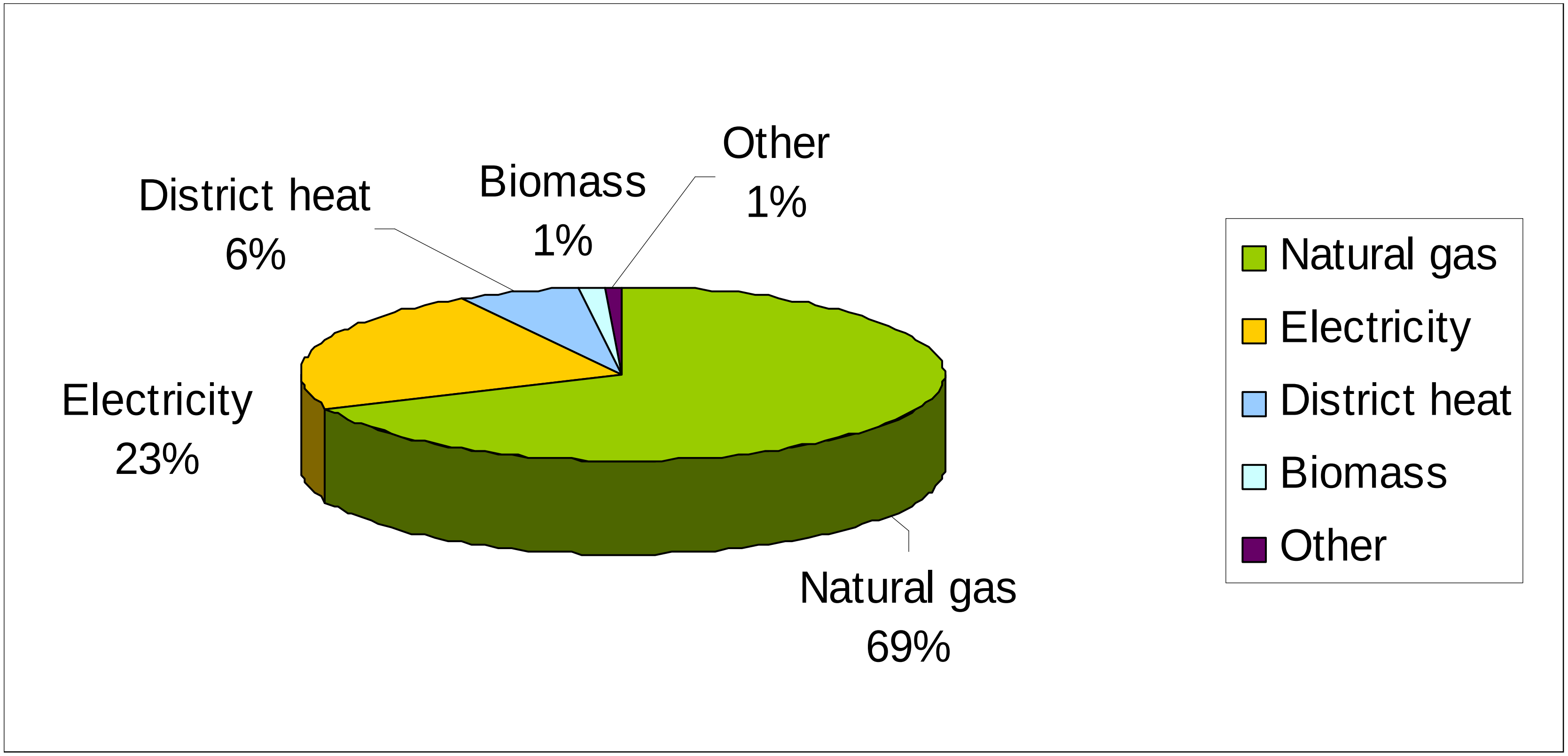


Heat consumption by sector in Hungary in 2005



Source: IEA 2008.

Final energy use by energy carrier in Hungarian tertiary sector (2005)



Source: IEA, 2008. Energy Statistics of the OECD countries

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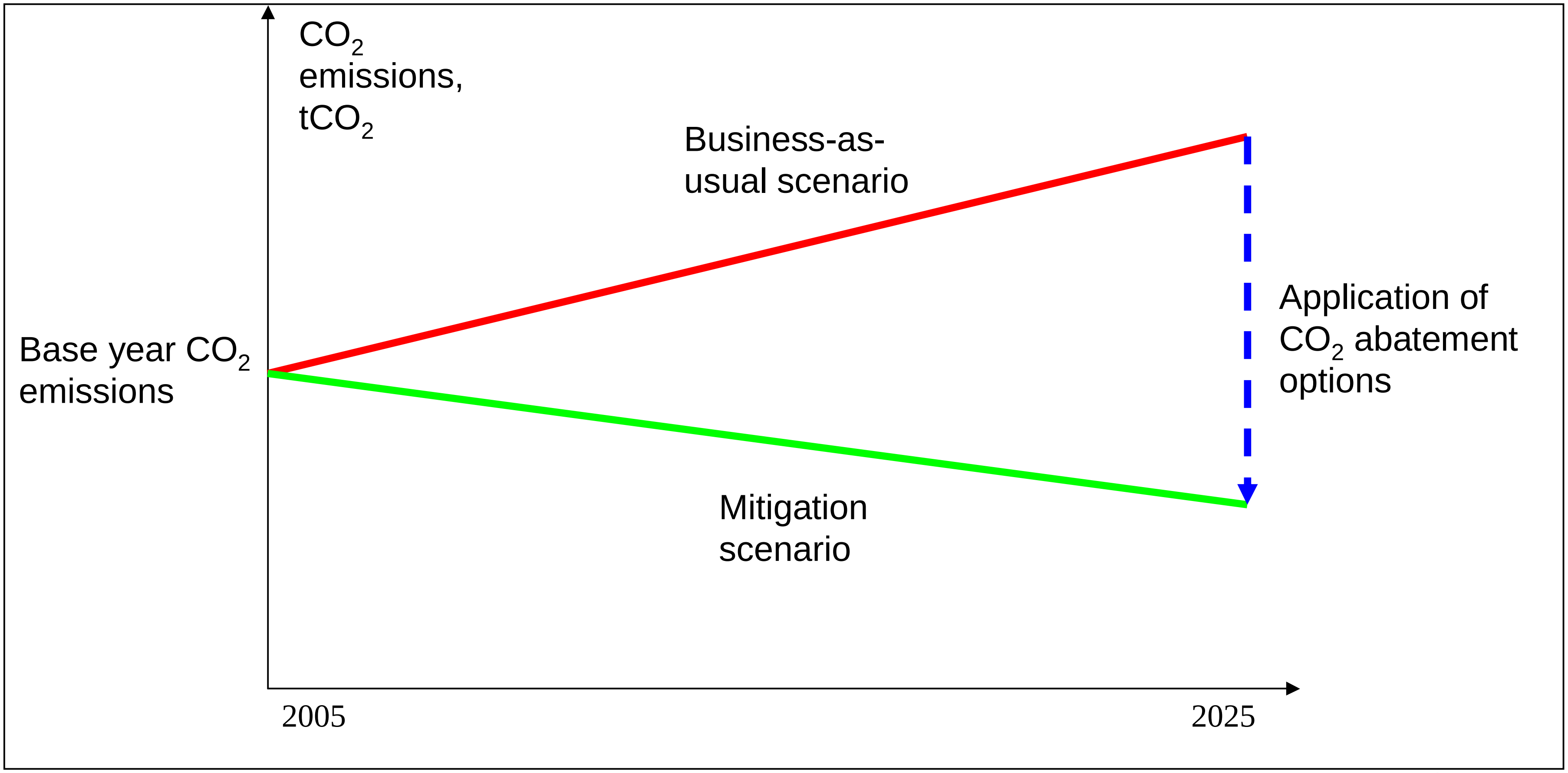
Methodology

- Bottom-up technology-based modelling
- Cost curve method used for estimation of cost-effectiveness of the abatement options
- Mitigation scenario is compared to baseline scenario
- A BAU baseline scenario is used
- Modelling framework is partly based on model of the residential sector developed by Novikova (2008)

Steps of estimation of the mitigation potential



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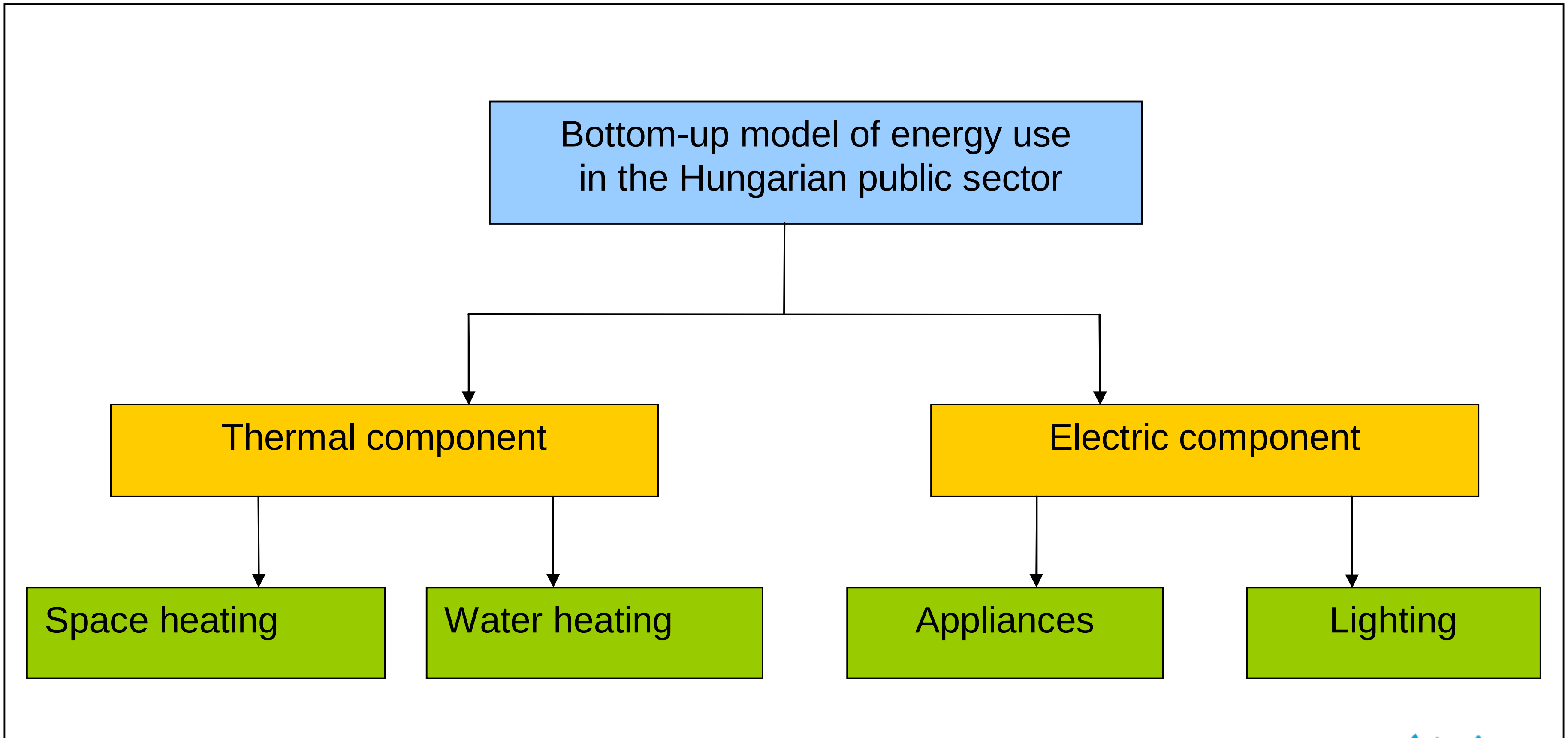
Modelling framework of end-uses in Hungarian public sector



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Technology options in mitigation scenario

- Space and water heating:
  - Existing buildings: high-performance building envelope, temperature management, water demand reduction options, improved efficiency of heating system
  - New buildings: passive house standard
- Electricity
  - Vendimisers, efficient lighting, reduction of LOPOMO consumption of office equipment, efficient fans for ventilation and air-conditioning

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Results 1: electricity

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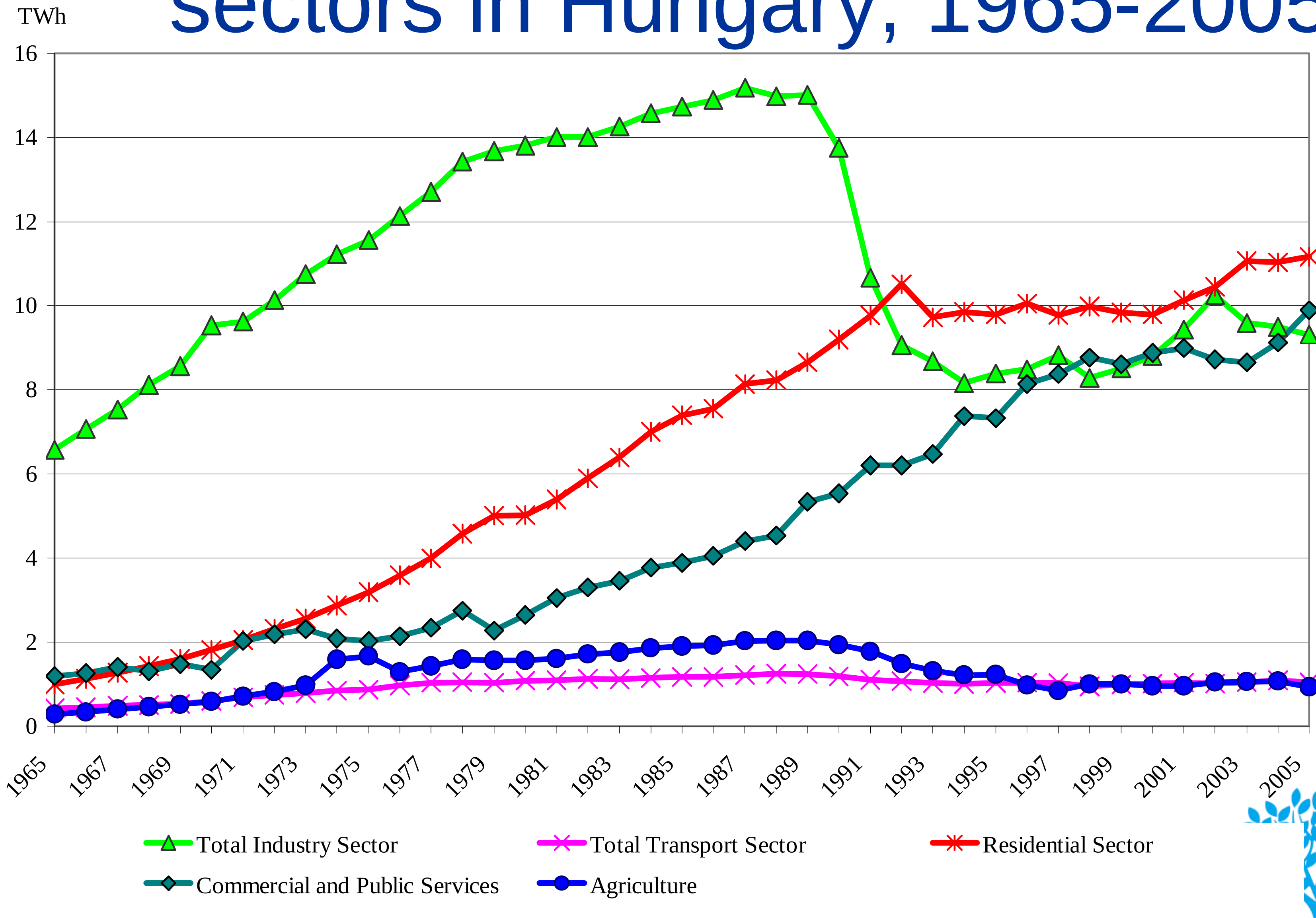
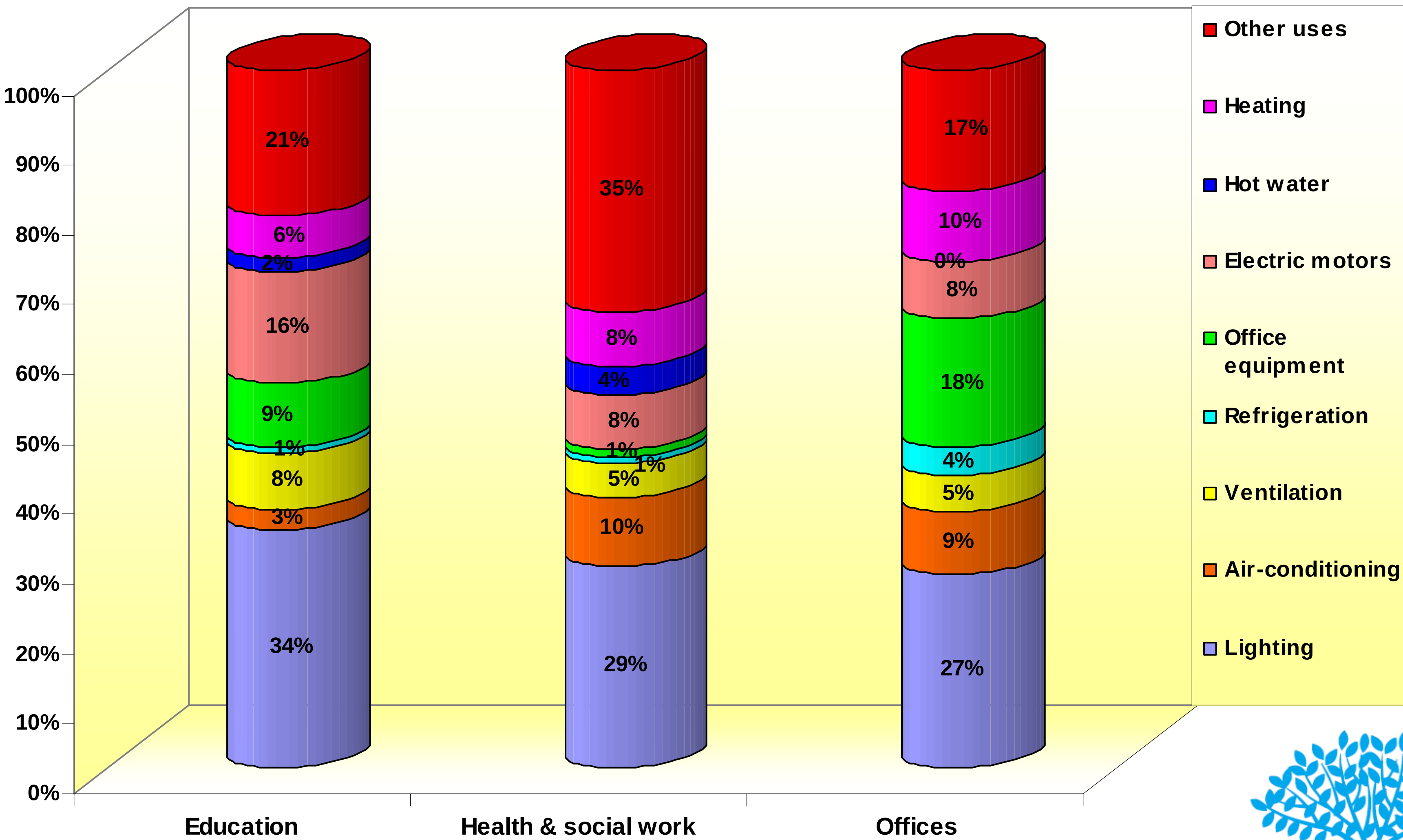
Electricity consumption by end-use sectors in Hungary, 1965-2005



Sources: constructed based on IEA 2004, 2006, 2007

Simulation of electricity consumption in the Hungarian public sector



Source: adopted from Gruber *et al.* 2008.

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End-uses in scope

- Lighting
- Computers & monitors
- Office imaging equipment
- Fans for air-conditioning & ventilation
- Vending machines

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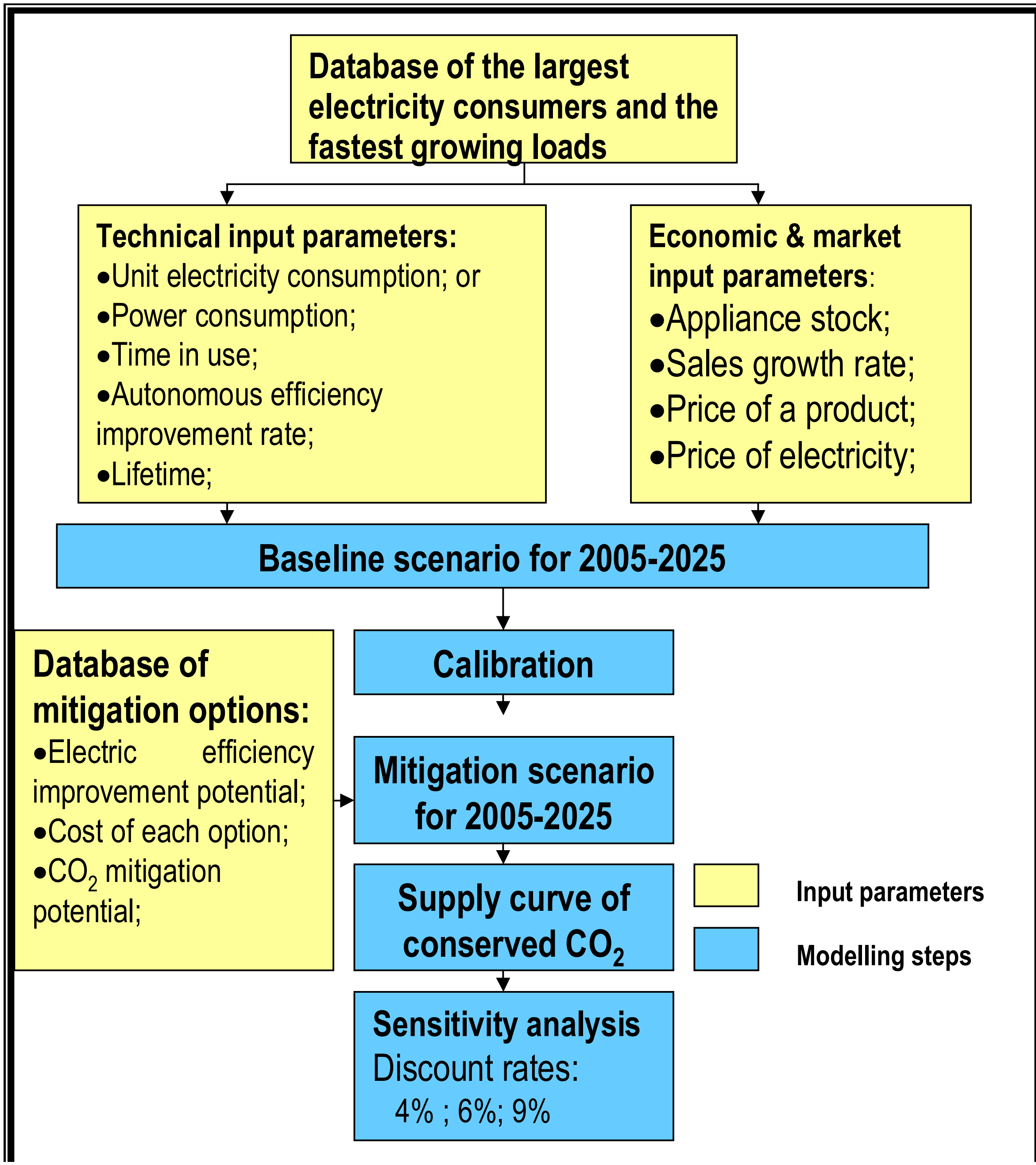
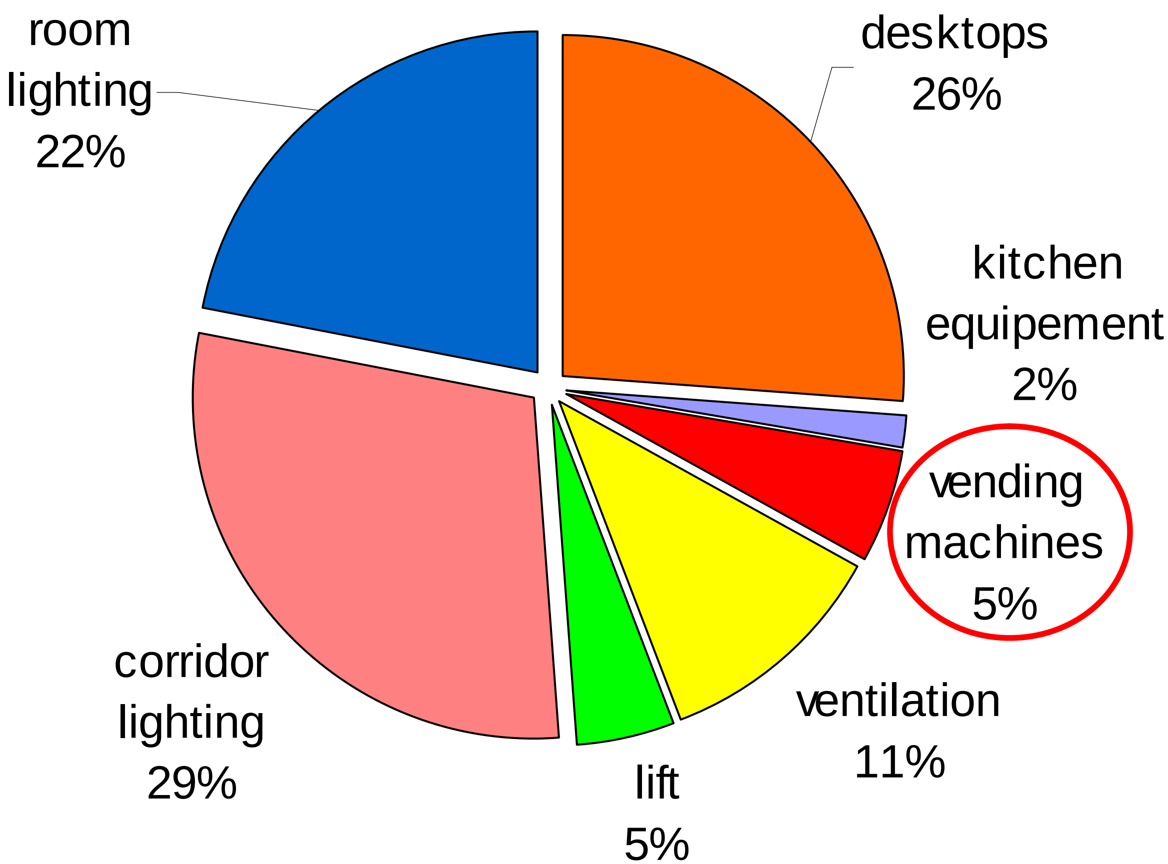
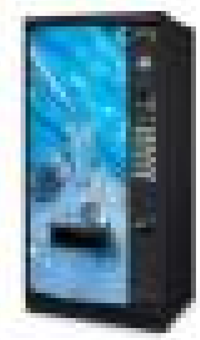
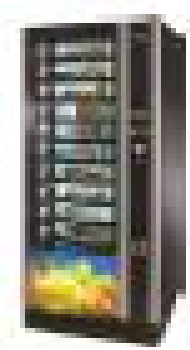
Modelling framework



Breakdown of electricity consumption in Hungarian schools







Source: EL-TERTIARY 2008

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Vending miser

- If no one is near the vending machine for 15 minutes and the compressor is not running, the vending miser will shut off the machine.
- If someone walks by the machine, the motion sensor will sense the movement and send power back to the machine (lights turn on).
- the Vending Miser does not influence the internal thermostat or the compressor.

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Mitigation options

- Vending miser for vending machines
- Lighting
  - Replacement incandescent lamps with CFLs
  - Replacement of T12 magnetic ballast with T8 electronic ballast
  - Replacement of magnetic ballast with electronic ballast, T8 lamps
- Reducing LOPOMO of office equipment
- Efficient ventilation fans

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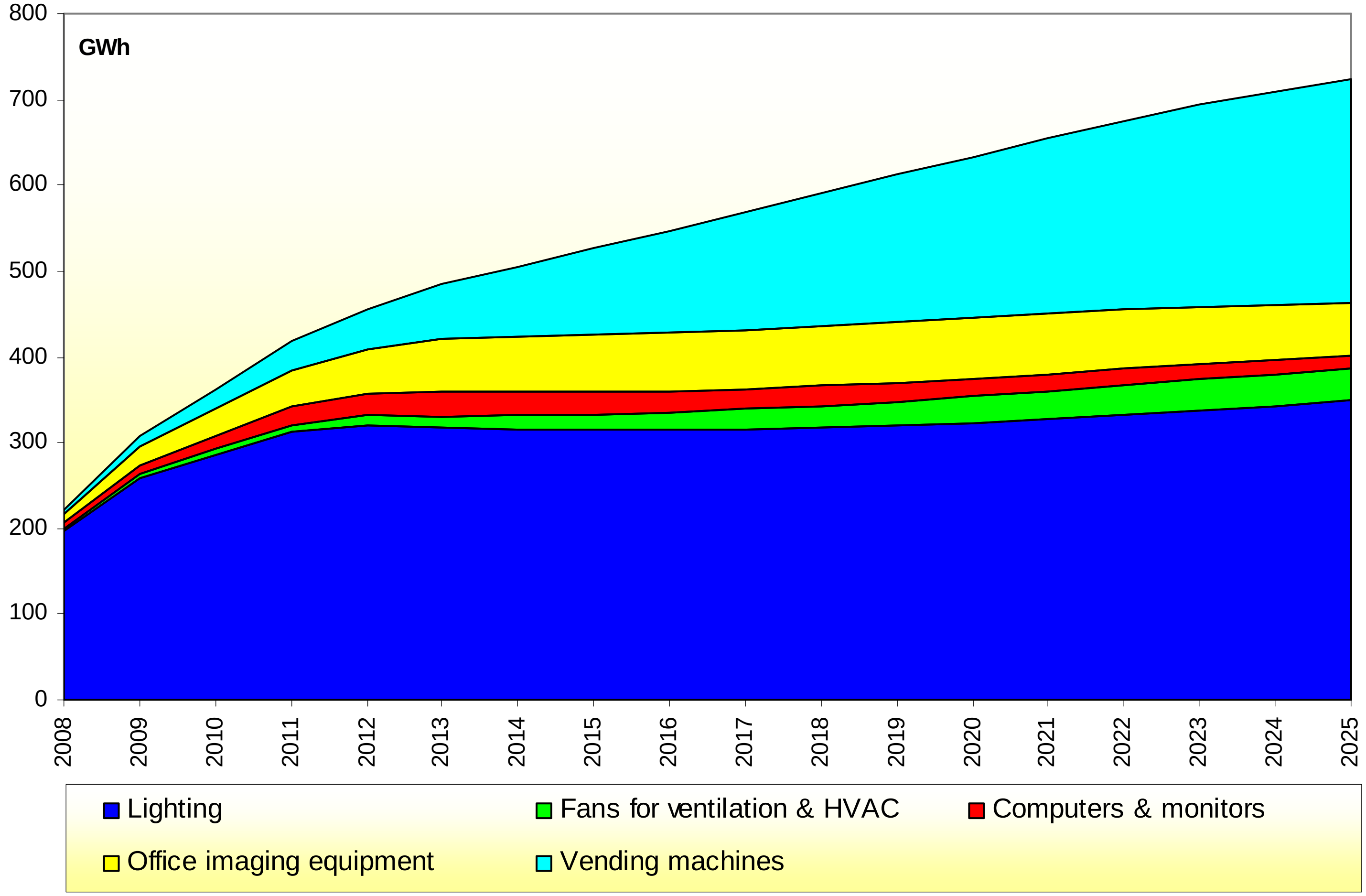
Cumulative potential electricity savings, 2008-2025



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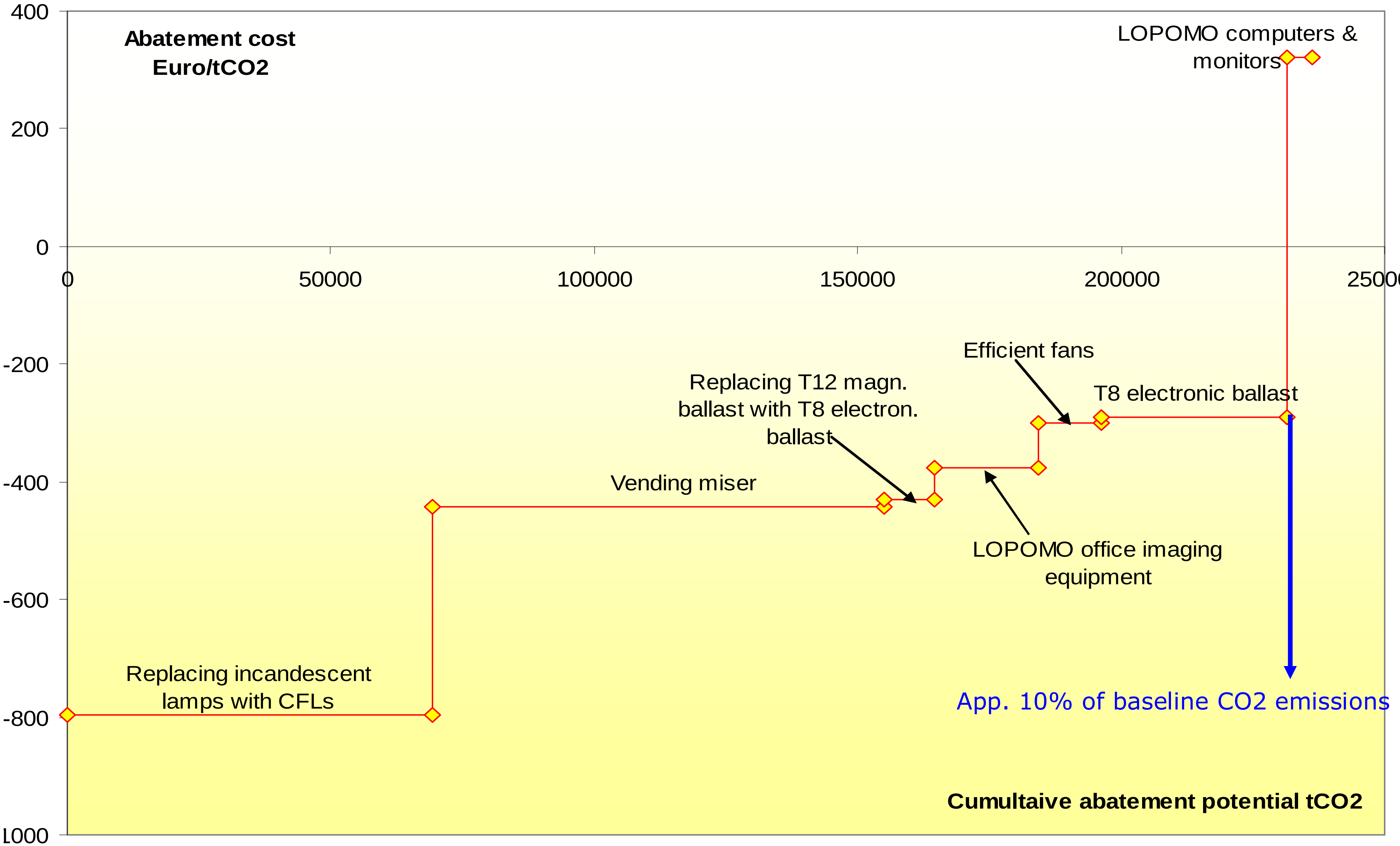
Supply curve of CO_2 abatement



Results 2:
Composite findings on heat and electricity

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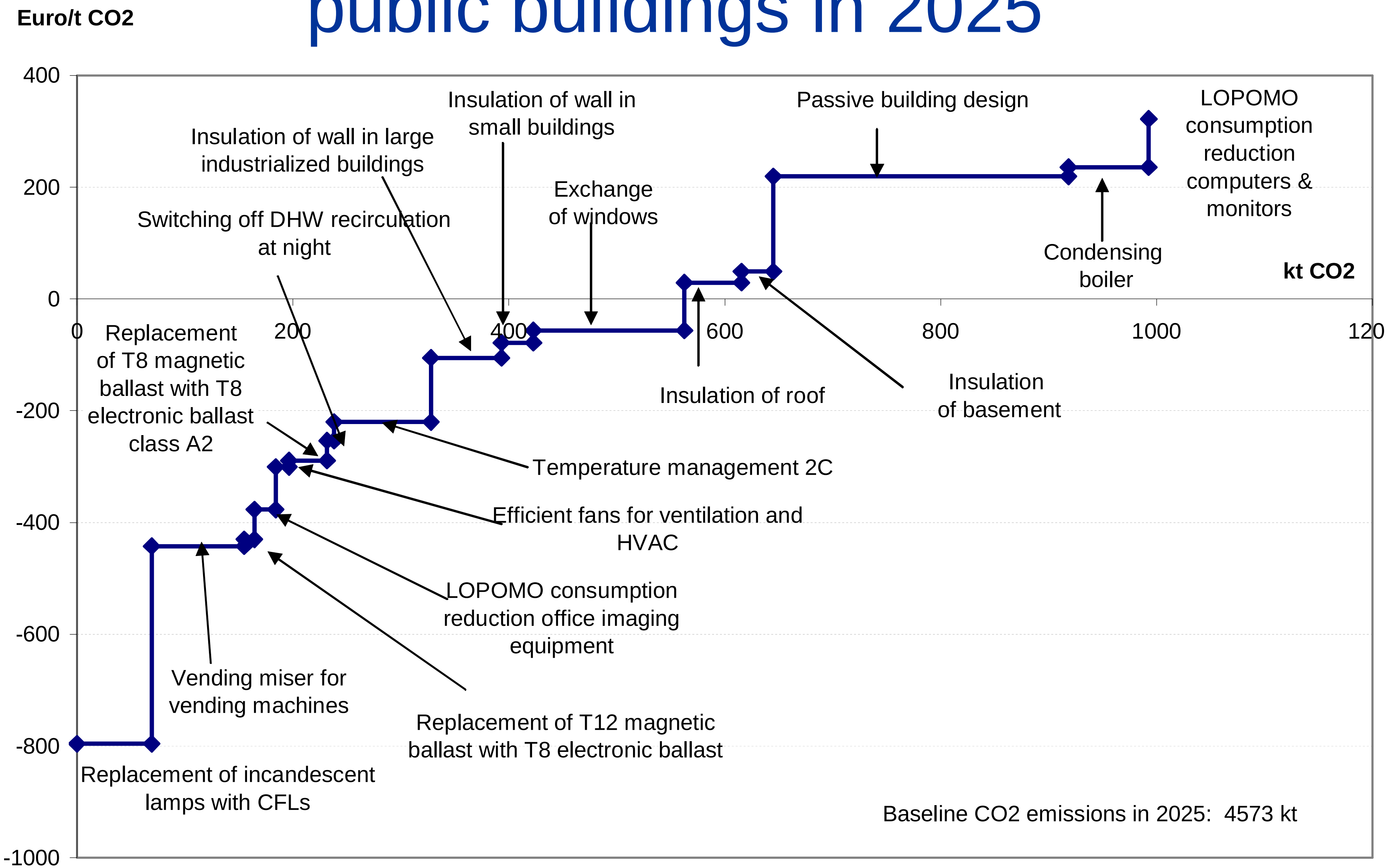
CO_2 mitigation potential in Hungarian public buildings in 2025



CO_2 mitigation potential in cost groups

CO_2 mitigation potential in cost categories	**CO_2 abatement potential in 2025**				Total cumulative investments 2008-2025	Cumulative energy cost savings 2008-2025
	Cumulative		By cost category			
	% baseline of modeled end-uses	1000 tCO_2/yr.	% baseline of modeled end-uses	1000 tCO_2/yr.	million Euro	million Euro
< 0 EURO	12%	563	12%	544	513	2,117
0 - 20 EURO*	12.9%	589	1%	45	513	2,117
20-100 EURO*	13.4%	615	1%	26	838	2,306
100 - 300 EURO*	20.9%	958	7%	343	3,416	3,208
>300 EURO*	21.0%	962	0.1%	5	3,468	3,259

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Conclusions and recommendations

- The most cost-effective options are:
  - efficient lighting,
  - vending misers for vending machines,
  - reduced LOPOMO in office imaging equipment,
  - efficient fans for HVAC and ventilation,
  - switching off the hot water recirculation during nights,
  - and temperature management.
- The largest potential is offered by passive house standard for new construction, exchange of windows, temperature management, vending misers and replacement of incandescent lamps with CFLs.
- The challenge is to adopt the methodology to reflect the recent developments in know-how focusing on integrated and performance-based approaches

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Thank you for your attention!

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Supplementary slides

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References

- Csoknyai, T. (2008) Energy audits 1998-1999. Courtesy of Csoknyai, Tamas, provided in August 2008.
- Display campaign (2008) Energy audits conducted in Nyiregyhaza within the Display campaign project in 2004-2006. Courtesy of Nagy, Peter, provided in September 2008.
- UNDP/Energy Centre (2008). Energy audits collected under the UNDP/GEF Hungary Public Sector Energy Efficiency Project in 2002-2008. Utilization of data approved by UNDP in 2008. Energy audits were accessed in Energy centre, Budapest.
- IEA (International Energy Agency). 2008. Energy Statistics of the OECD coutnries. IEA/OECD, Paris, 2008.
- Kistelegdi, István. 2009. Energiadizájn - A pécsi Modern Magyar Képtár terve [Energy-design - the Modern Hungarian Gallery project at Pécs] Conference presentation. February 5, 2009, Passzivház konferencia, Budapest.
- KSH (Központi Statistikai Hivatal) [Hungarian Statistical Central Office] 2000. The real property of the municipalities 2000.
- KSH (Központi Statistikai Hivatal) [Hungarian Statistical Central Office] 2005. The real property of the municipalities. Budapest, 31 December 2005.
- NIR (National Inventory Report) 2007. NIR 2007 submission, vs. 2.1. Available at: http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/4303.php [Last visited on 20 May 2008]
- Novikova, A. 2008. Carbon dioxide mitigation potential in the Hungarian residential sector. PhD dissertation. Central European University, Budapest, 2008. URL: http://web.ceu.hu/envsci/projects/Potentials/Publications.html
- ODYSSEE. 2009. Enerdata online. URL: http://odyssee.enerdata.eu [Accessed April 2, 2009]
- Ürge-Vorsatz, D. 2000. Lighting municipally financed buildings in Hungary. Market assessment. With special focus on energy efficiency potentials and barriers. Research Report. August, 2000.
- Workshop “Mitigation potential in the Hungarian buildings”, Budapest, October, 6, 2008.
- Zöld, A. and Csoknyai, T. 2007. Technical improvement of housing envelopes in Hungary. In: COST C16 Improving the Quality of Existing Urban Building Envelopes – Facades and Roofs. L. Braganca, C. Wetzel, V. Buhagiar, L.G.W.Verhoef (eds.) IOS Press, 2007.

Modelling steps

- Developing baseline scenario
- Calibration of the baseline electricity consumption and related CO_2 emissions
- Forecasting the mitigation potential for each mitigation option
- Analyzing cost-effectiveness of an individual mitigation option
- Constructing the supply curve of CO_2 mitigation potential as a function of the cost of CO_2
- Conducting sensitivity analysis of mitigation costs

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Conclusions & recommendations

- Study shows that public buildings offer mitigation potential at negative costs, esp. by installation of efficient lighting, vendimisers and reducing the LOPOMO of office equipment
- Reduction of hot water, heat controls and building envelope improvements offer large potential at negative costs.
- The largest mitigation potential stems from application of passive house standard to new construction.
- Despite the fact that some components are less cost-effective, the retrofit of the buildings must be performed to the best possible level and in holistic way and checked by commissioning for proper functioning.

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Measure	CO_2 savings in 2025	Cost of mitiga-ted CO_2 in 2025	Cost of mitiga-ted CO_2 in 2025	Energy savings in 2025	Cost of energy savings in 2025	Cost of energy savings in 2025	Total invest-ments 2008-2025	Energy cost savings 2008 2025
	kt CO_2/yr.	EUR/tCO_2	1000 HUF/tCO_2	GWh/yr.	EUR/kWh	HUF/kWh	mil. EUR	mil. EUR
Replacement of incandescent lamps with CFLs	69	-796	-239	213	-0,26	-78	-299	452
Vending miser for vending machines	86	-442	-133	262	-0,14	-43	35,2	345
Replacement of T12 magnetic ballast with T8 electronic ballast	10	-430	-129	29	-0,14	-42	24	167
LOPOMO consumption reduction in office imaging equipment	20	-377	-113	61	-0,12	-37	20,5	147
Efficient fans for ventilation and HVAC	12	-301	-90	37	-0,1	-29	23,3	57,7
Replacement of T8 magnetic ballast with T8 electronic ballast class A2	35	-289	-87	108	-0,09	-28	81.4	180
Switching off hot water recirculation at night	7	-253	-76	35	0,0003	0,1	0,12	16
Temperature management 2°C	89	-220	-66	446	0,01	2	37,5	207
Insulation of walls in large industrialized buildings	65	-106	-32	325	0,03	9	134	146
Insulation of walls in small buildings	30	-79	-24	147	0,03	10	77,9	63,7
Exchange of windows	140	-56	-17	695	0,04	12	378	336
Insulation of roof	53	29	9	264	0,06	17	205	122
Insulation of basement	29	49	15	146	0,06	18	121	67
Passive building standard	273	219	66	1374	0,09	28	2 161	670
Condensing boilers	75	236	71	369	0,1	29	417	230
LOPOMO consumption reduction in computers & monitors	5	322	97	15	0,105	32	51,8	51,1
TOTAL	**998**			**4526**			**3 468**	**3 259**

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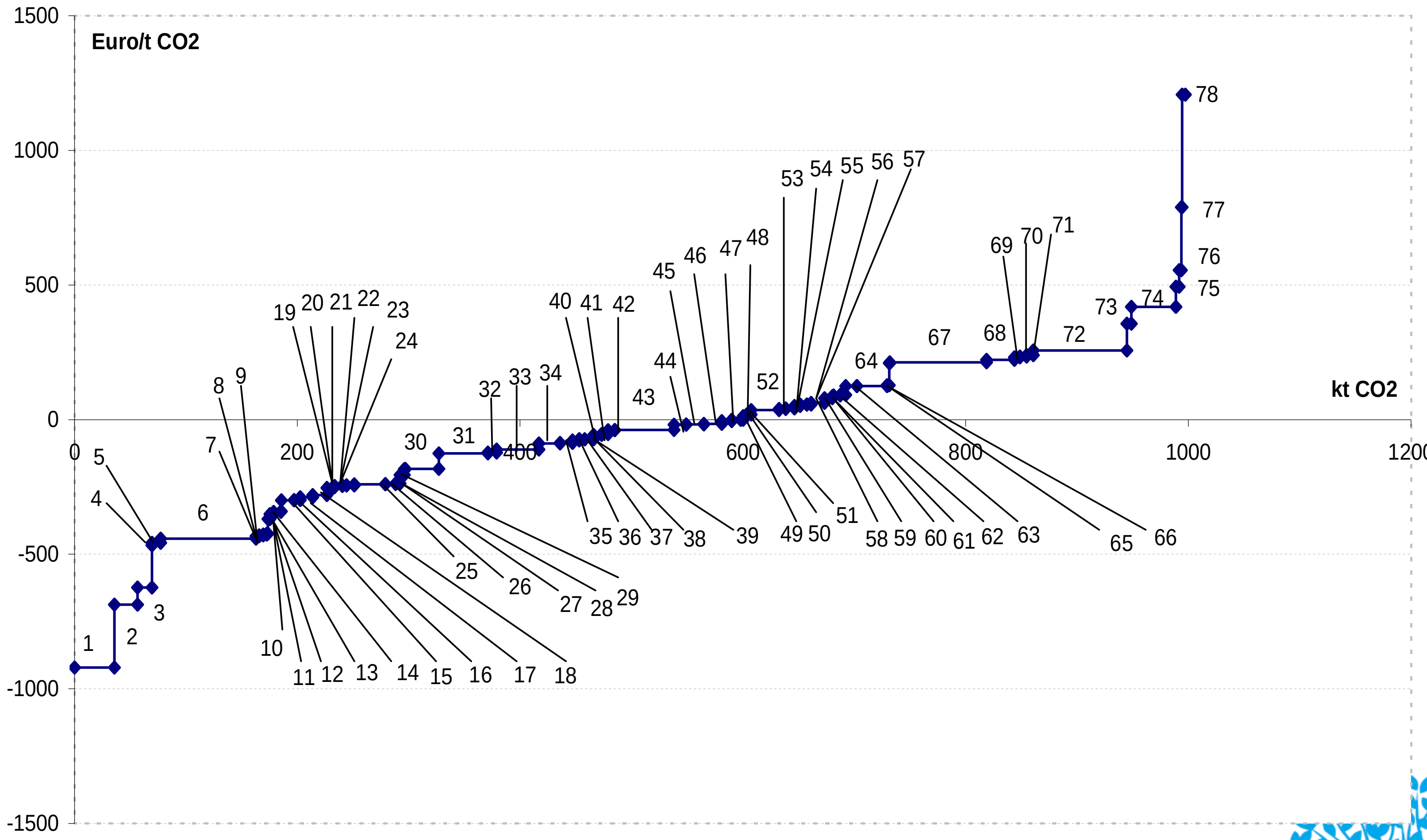
Detailed cost curve for Hungarian public buildings



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Types of electrical end-uses

- Always On products (active and disconnect)
- On/Off products (active, soft-off and disconnect (hard off))
- On/Standby products (active, standby, soft off and hard off (disconnect))
- Job-based products (perform a defined “function cycle” or “job” in active mode)

Source: Fraunhofer IZM 2007

CO_2 mitigation potential in cost groups

CO_2 mitigation potential in cost categories	CO_2 mitigation potential in 2025			
	Cumulative		By cost category	
	% baseline of modeled end-uses	1000 tCO_2/yr.	% baseline of modeled end-uses	1000 tCO_2/yr.
< 0 EURO	13.1%	598	13%	598
0 - 20 EURO*	13.3%	607	0.2%	9
20-100 EURO*	15.1%	692	2%	85
100 - 300 EURO*	20.7%	945	6%	252
>300 EURO*	21.8%	997	1%	53

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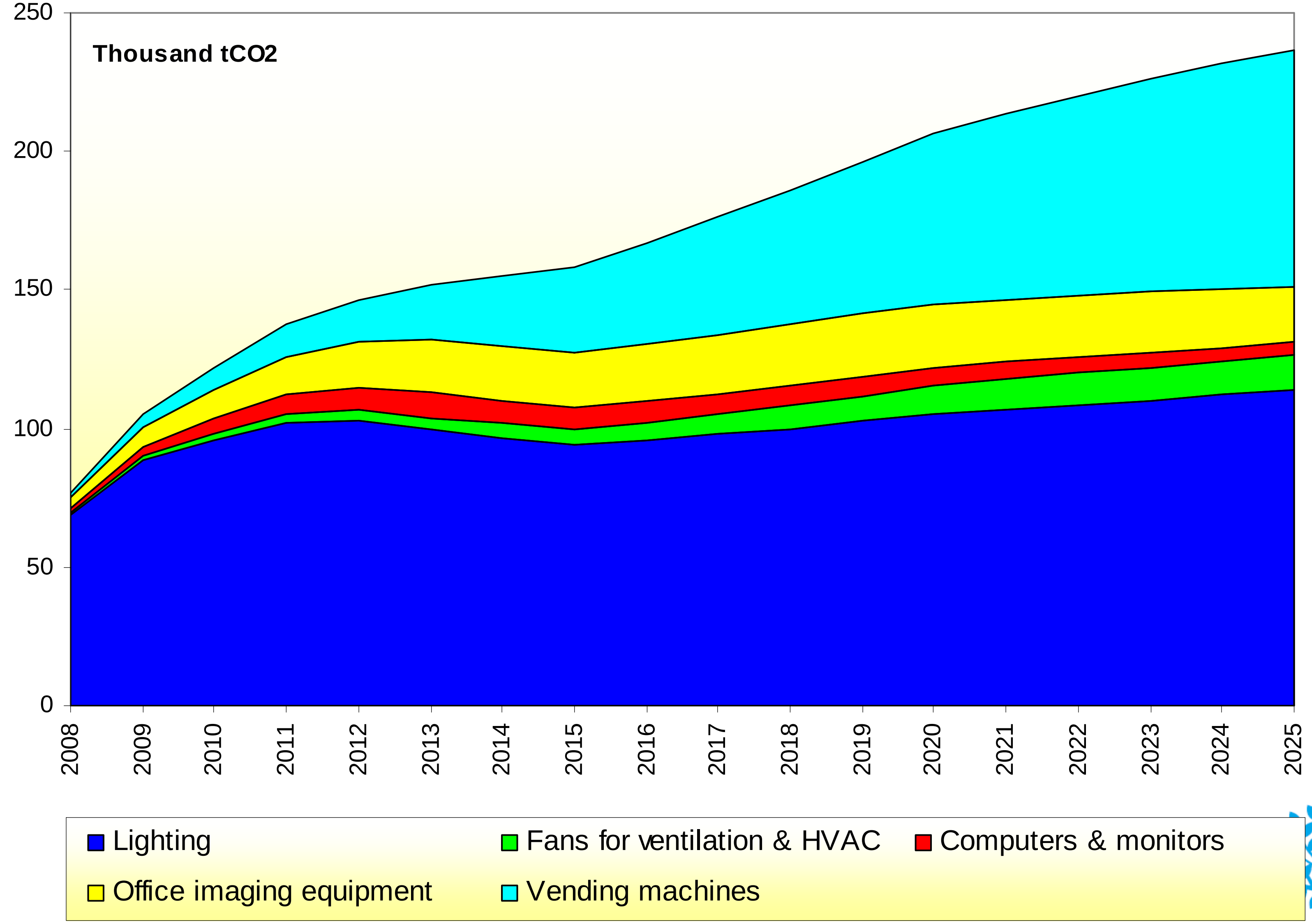
Cumulative potential CO_2 savings, 2008-2025



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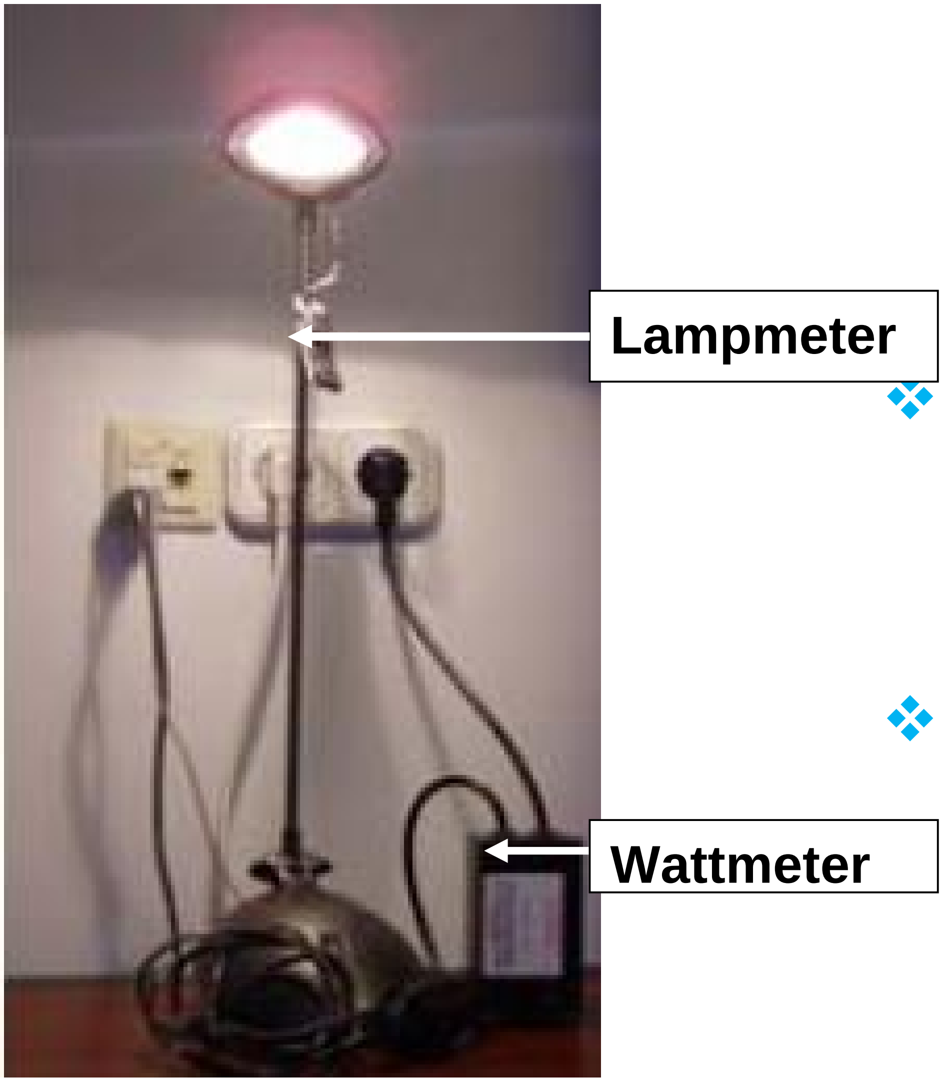
El-Tertiary methodology



- 2-3 week on-site metering
  - lighting by lampmeters,
  - major appliances by wattmeters, and pulsemeters
- document analysis
  - energy bills,
  - building plans,
  - energy supply contracts
- Survey among building managers

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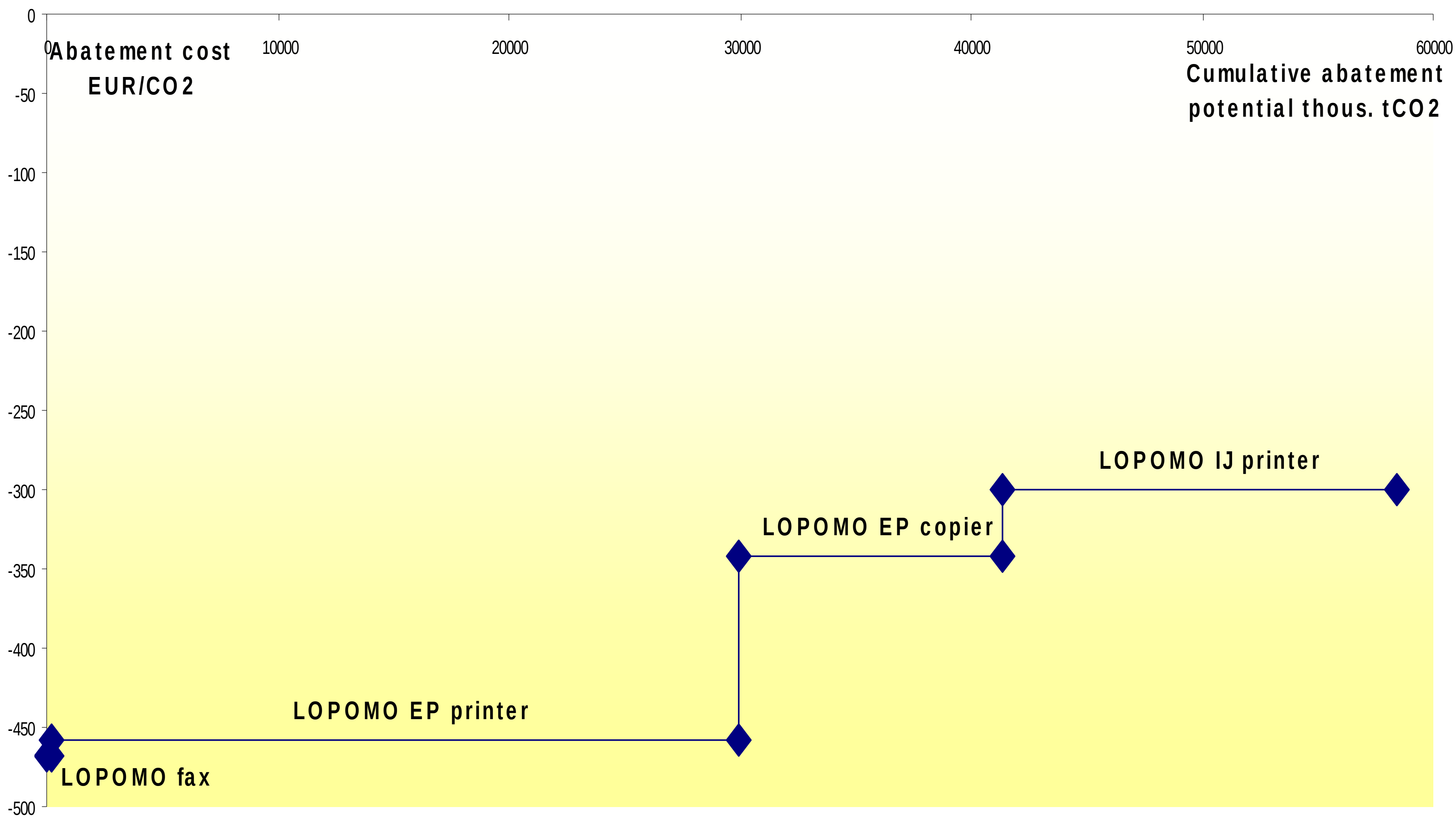
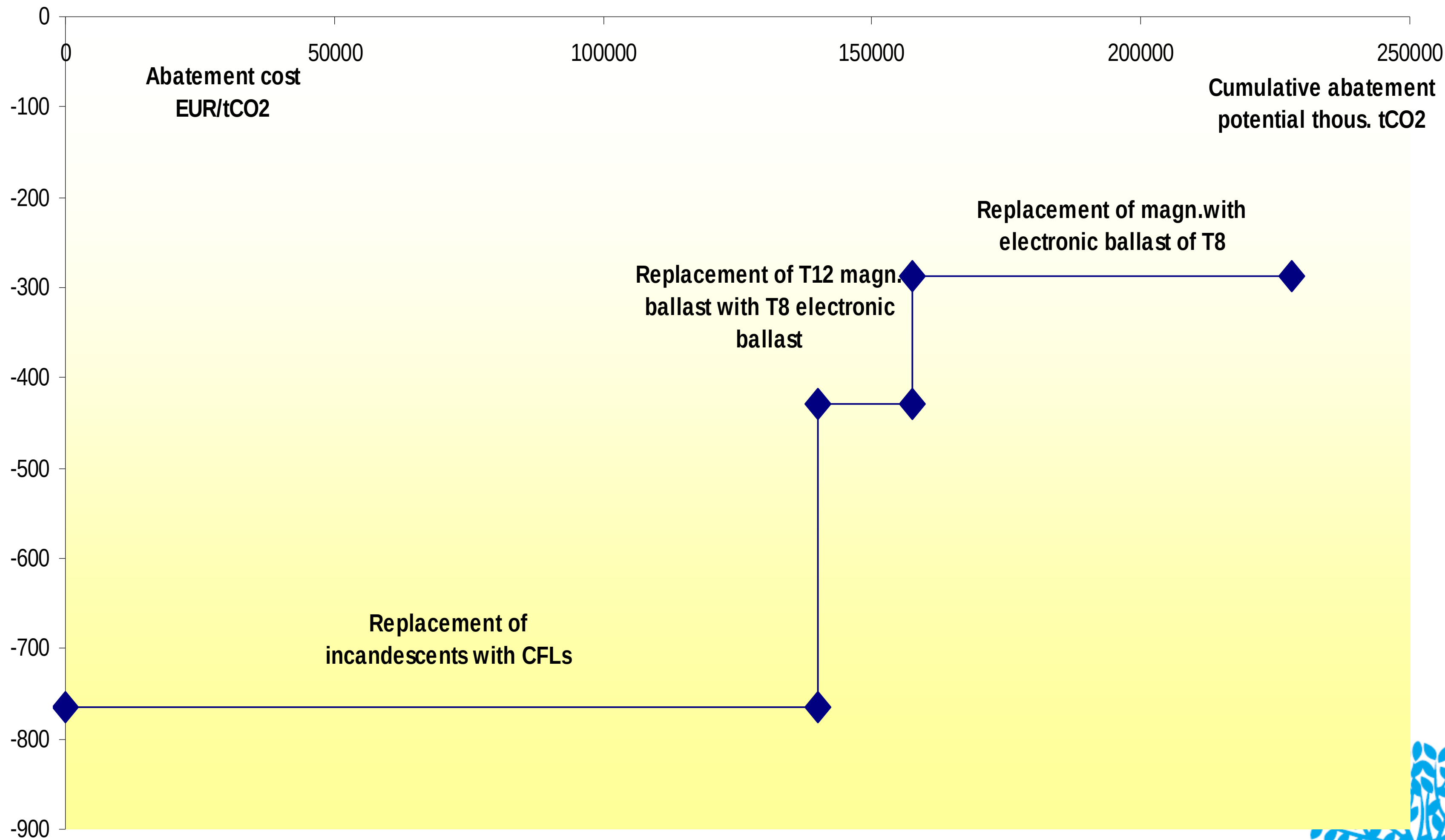
Supply curve for reducing LOPOMO of office imaging equipment



Supply curve for lighting



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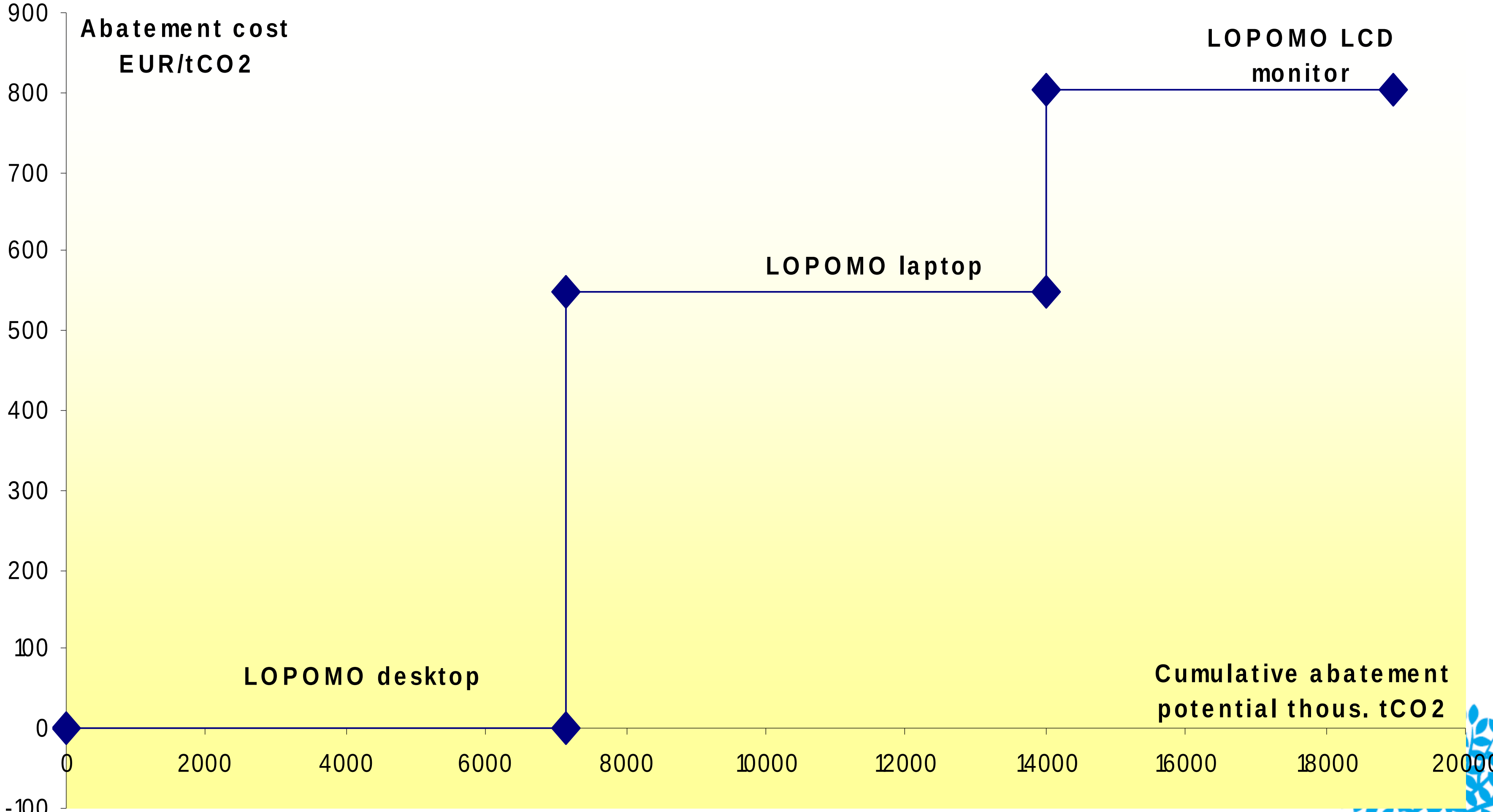
Supply curve for reducing LOPOMO of PCs & monitors



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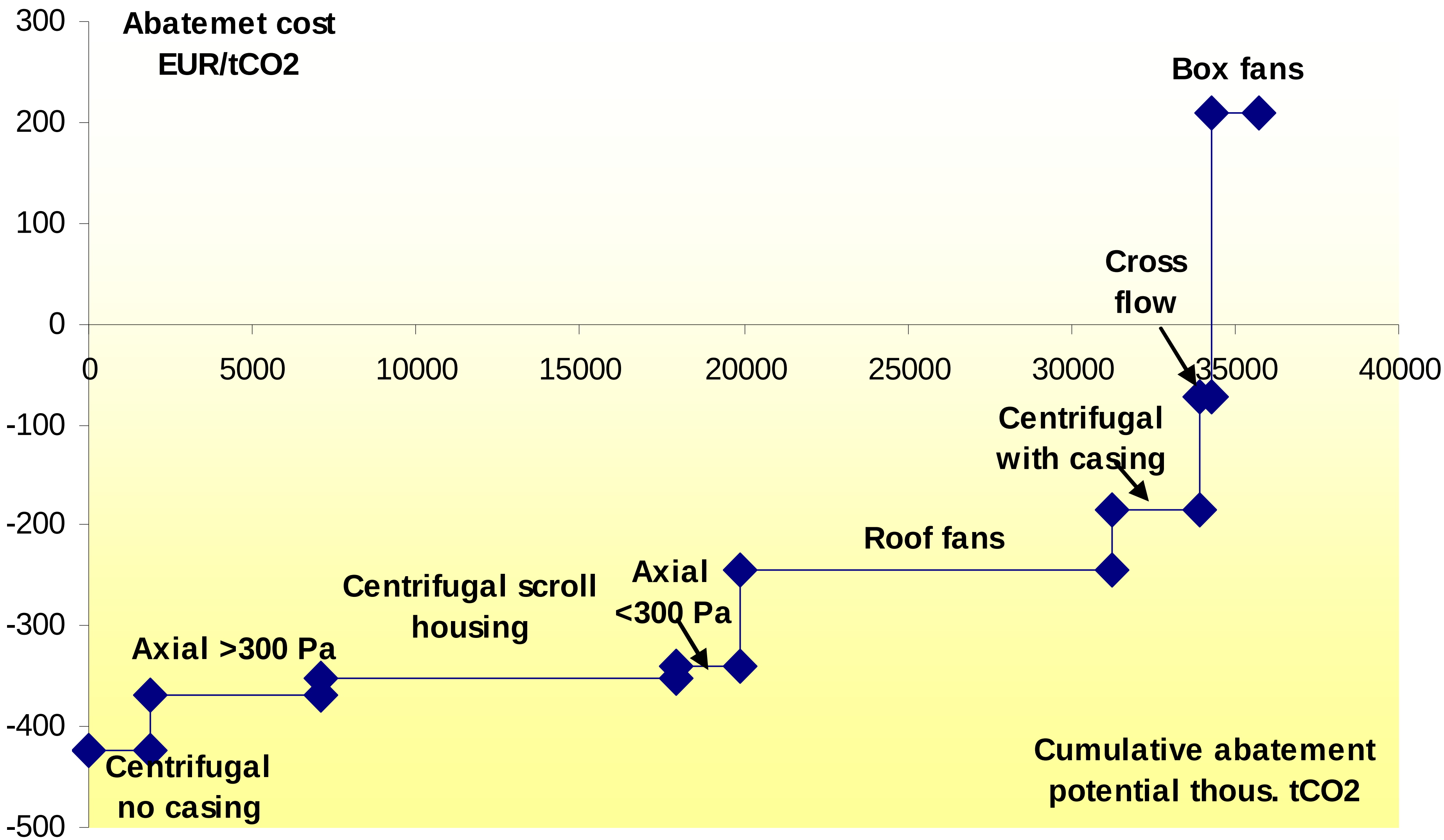
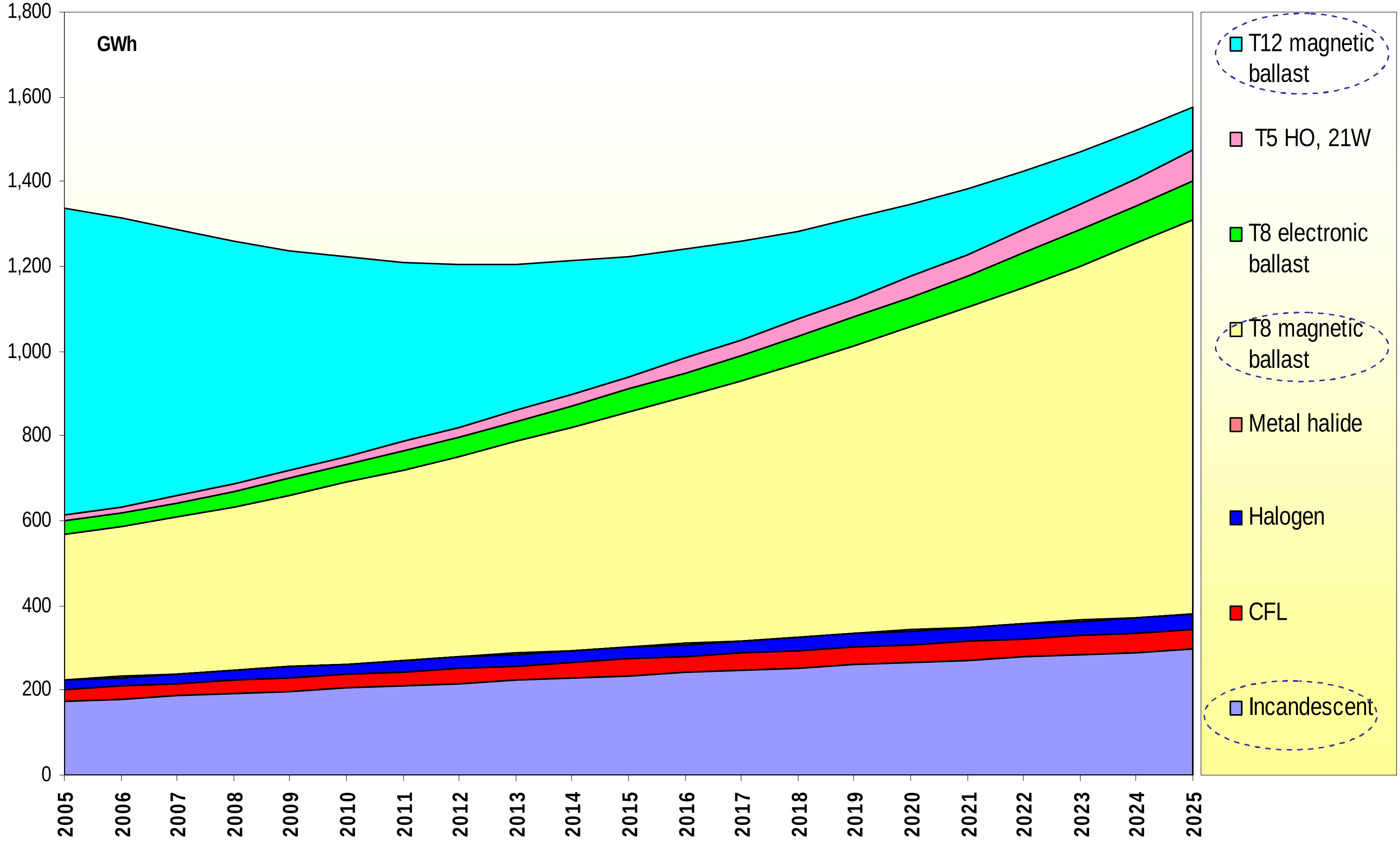
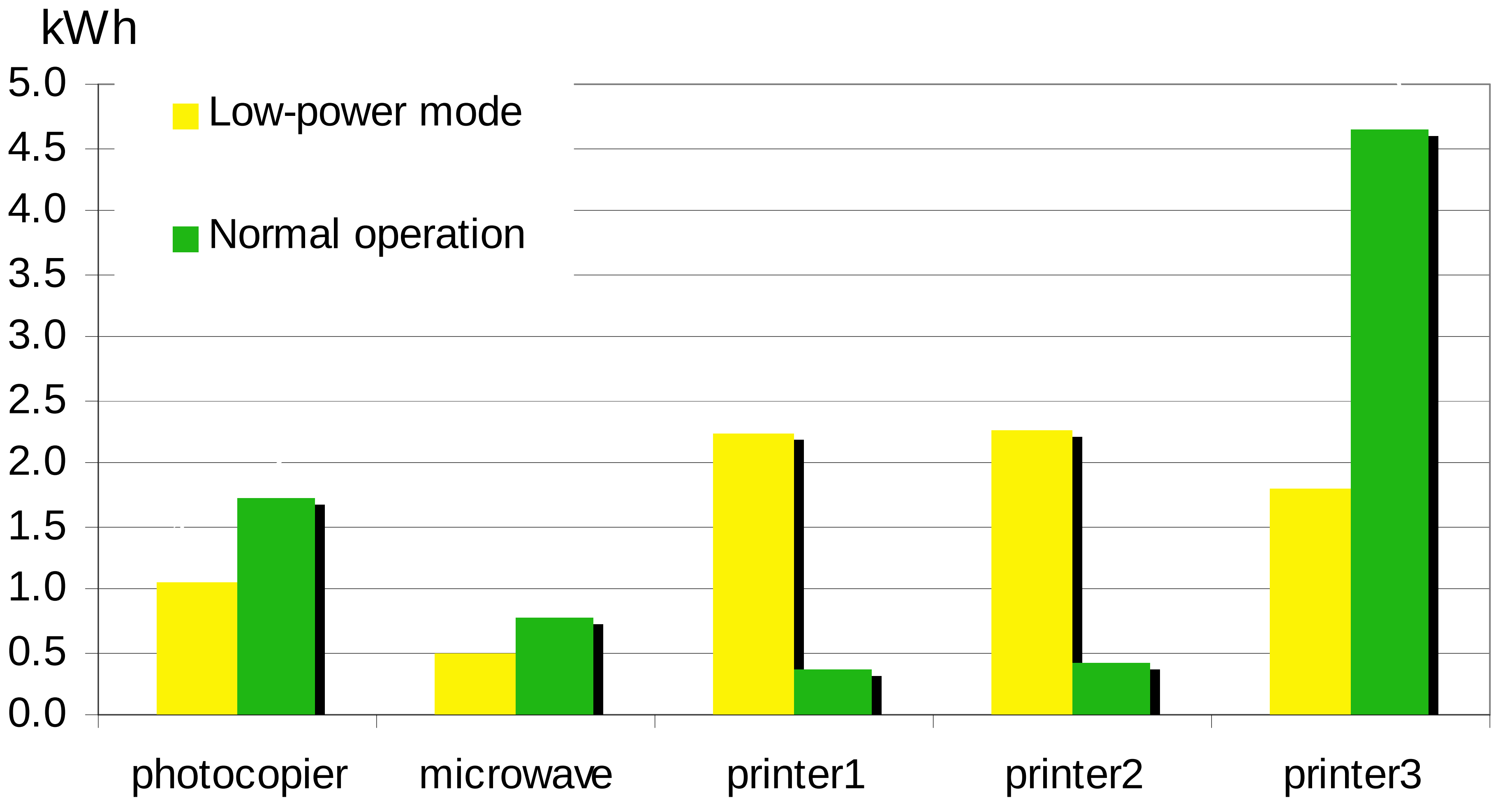
Supply curve for ventilation fans



Electricity consumption by lighting

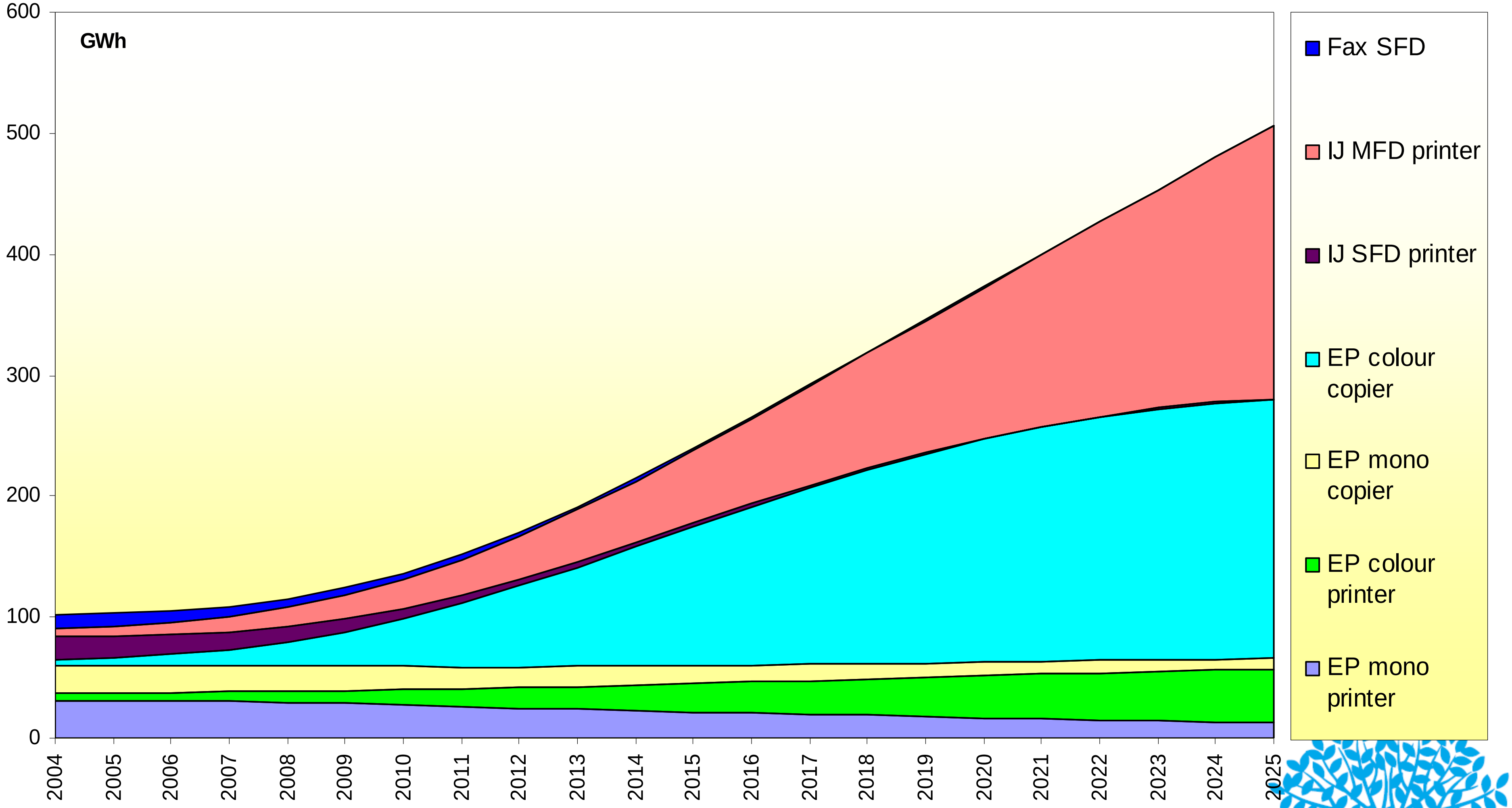


Office equipment



Source: Building #5, EL-TERTIARY 2008

Electricity consumption by office imaging equipment



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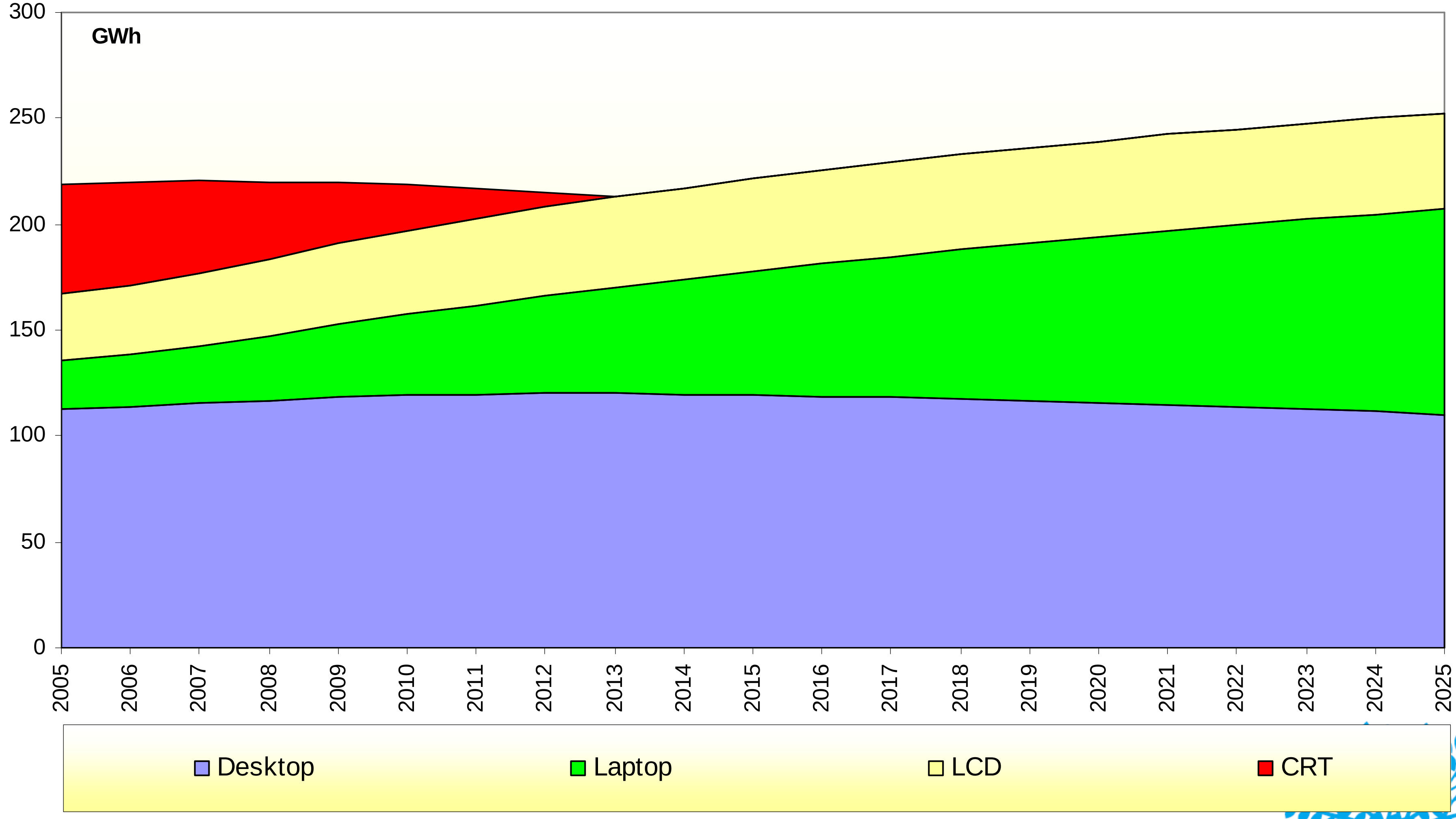
Electricity consumption by computers & monitors



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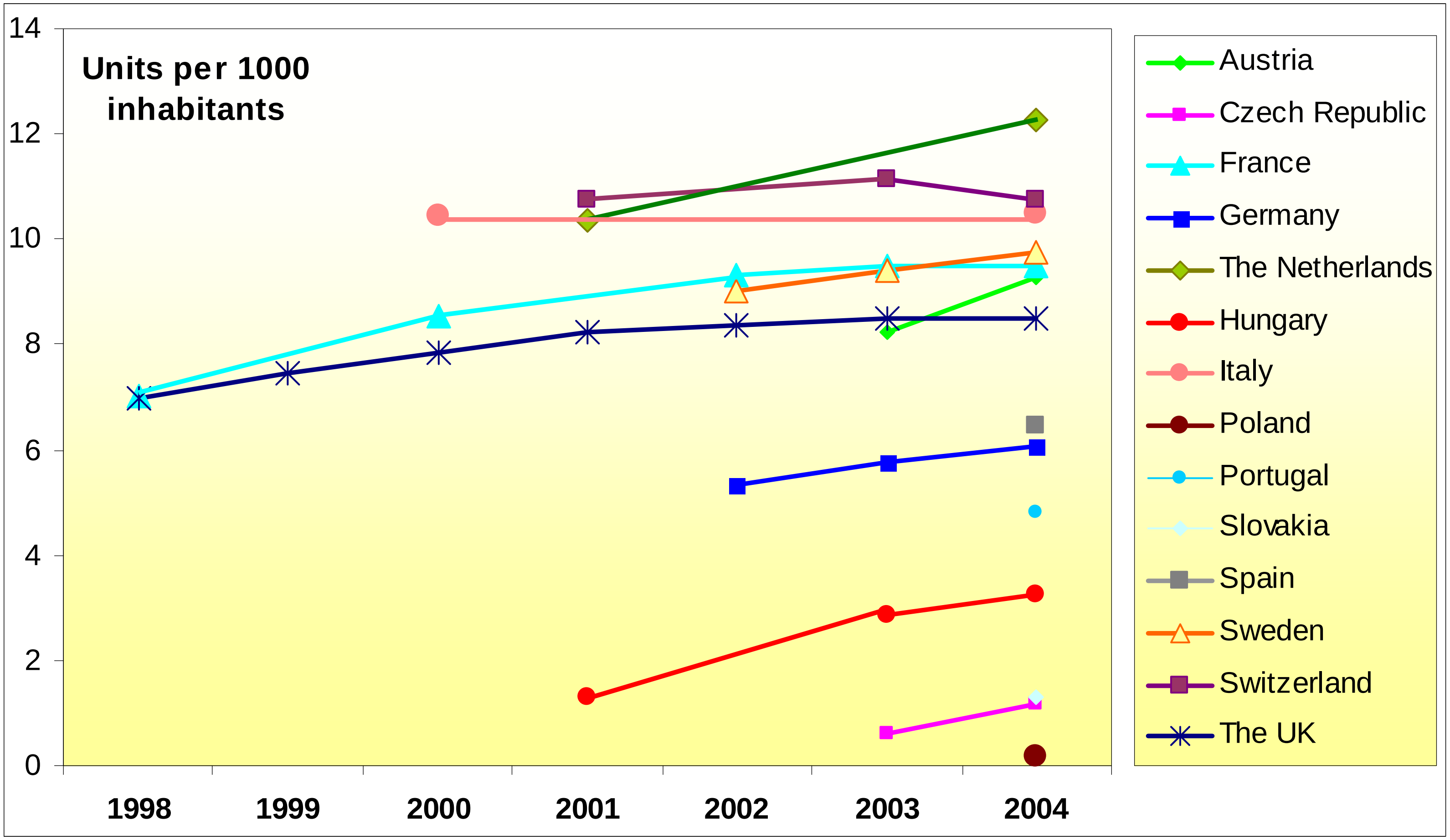
Vending machines, 1998-2004



Source: Constructed based on EVA 2008, BIS 2007

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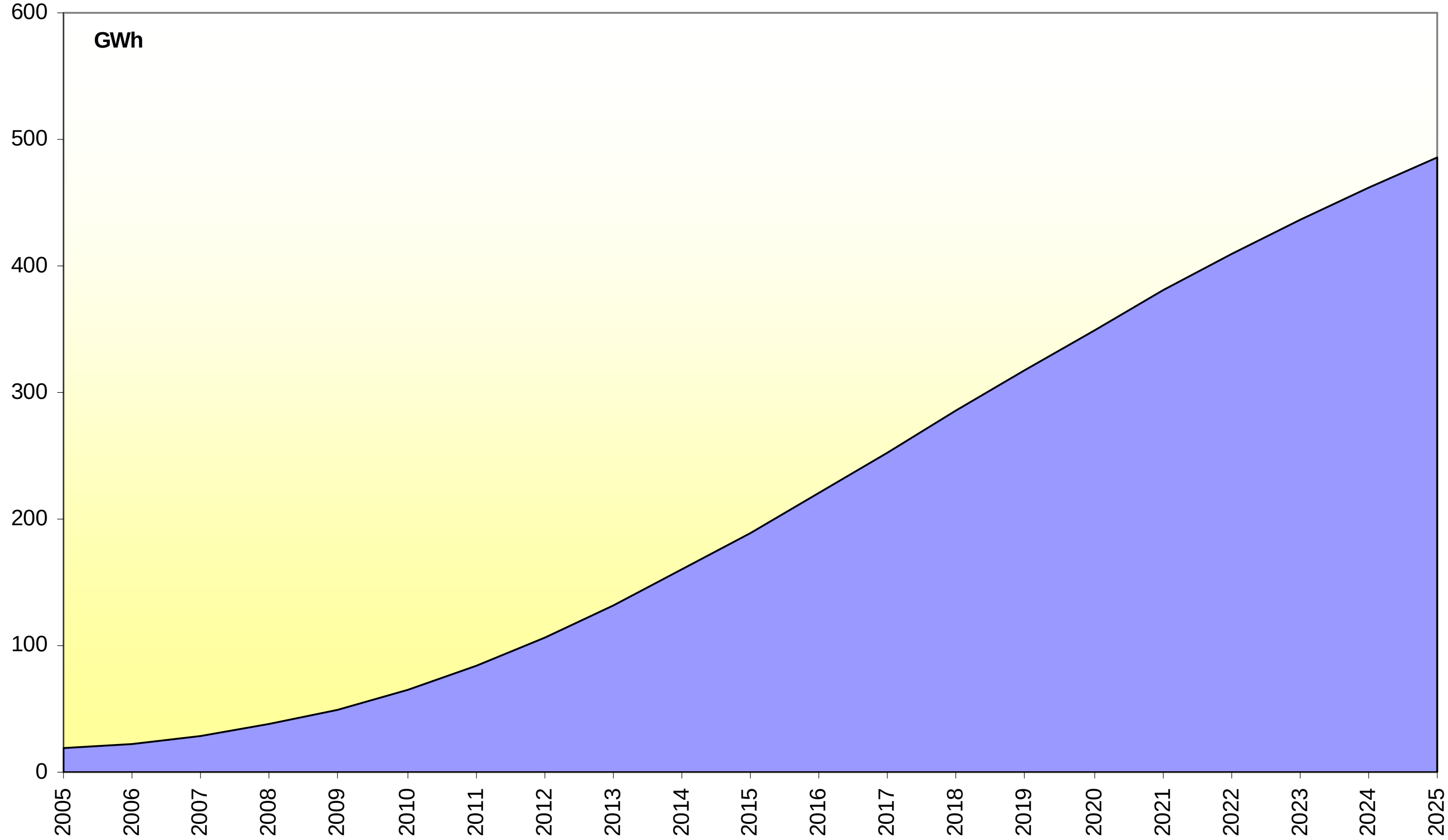
Annual sales of vending machines per country

Year / Country	1998	1999	2000	2001	2002	2003	2004	Annual growth rate, % 2001 -2004
Austria	7,306	7,557	6,987	8,406	7,157	6,256	9,225	3.1
Czech Republic				1,399	2,396	2,149	2,425	20.1
France	37,719	38,974	42,676	43,491	37,737	32,696	34,776	-7.2
Germany	28,730	33,447	33,491	39,276	32,143	30,633	35,956	-2.9
Netherlands	20,296	23,750	25,508	24,062	22,853	25,151	25,273	1.7
Hungary	2,534	5,449	2,445	588	807	984	2,211	55.5
Italy	39,971	48,385	51,893	47,132	48,225	66,855	78,599	1 8.6
Poland				1,280	2,815	2,778	2,328	22.1
Portugal				3,585	5,918	5,656	8,623	34.0
Slovakia				890	901	723	1,273	12.7
Spain				29,049	28,996	29,470	34,148	5.5
Sweden	5,843	6,596	8,945	7,757	8,568	9,674	11,130	12.8
UK + Ireland	46,964	43,623	40,725	4 7,511	45,523	44,213	42,718	-3.5
Total estimated				267,620	253,484	266,494	299,865	3.9

Source:EVA 2008, BIS 2007

Electricity consumption by vending machines



In the period Source: Constructed based on EVA 2008, BIS 2007

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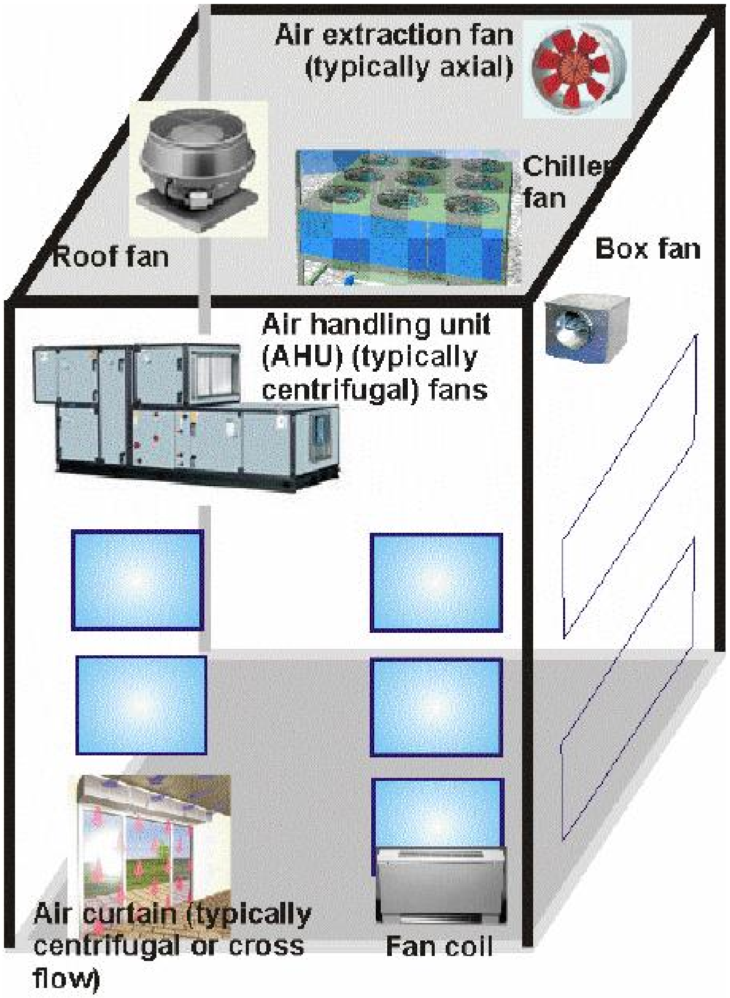
Fans for HVAC & ventilation



Source: Radgen *et al.* 2007.

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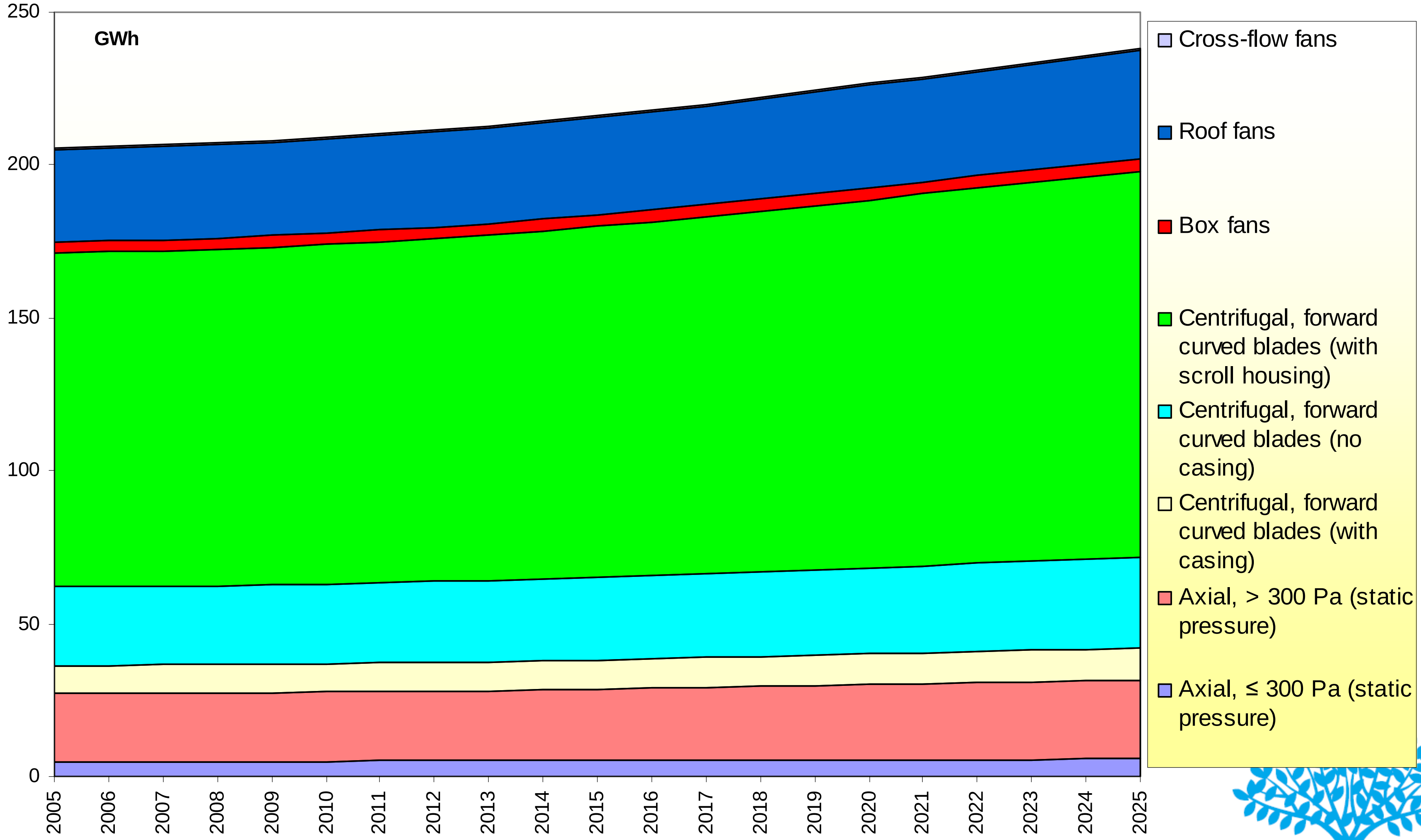
Electricity consumption by fans for ventilation & HVAC



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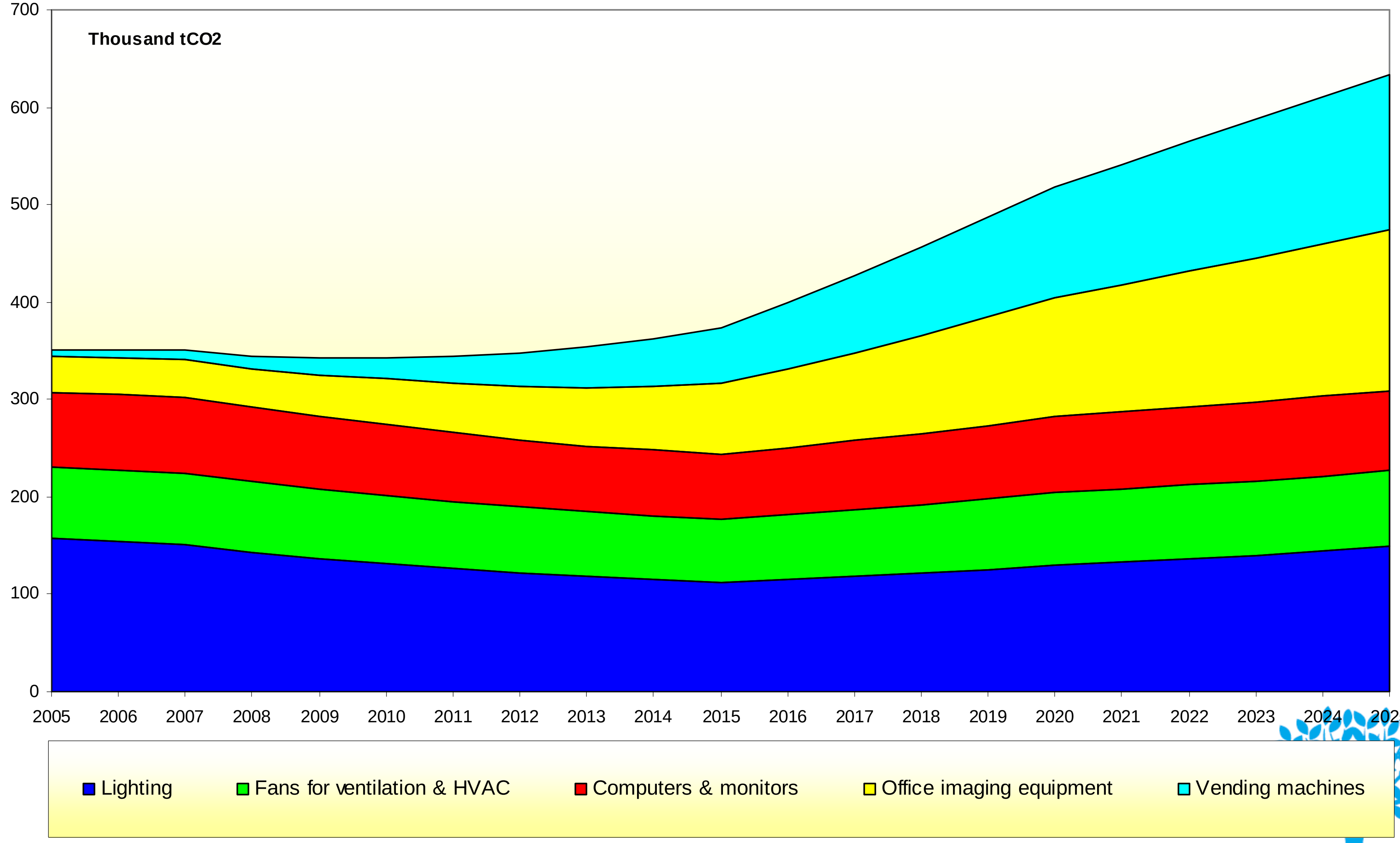
Cumulative baseline CO_2 emissions from the in-scope end-uses



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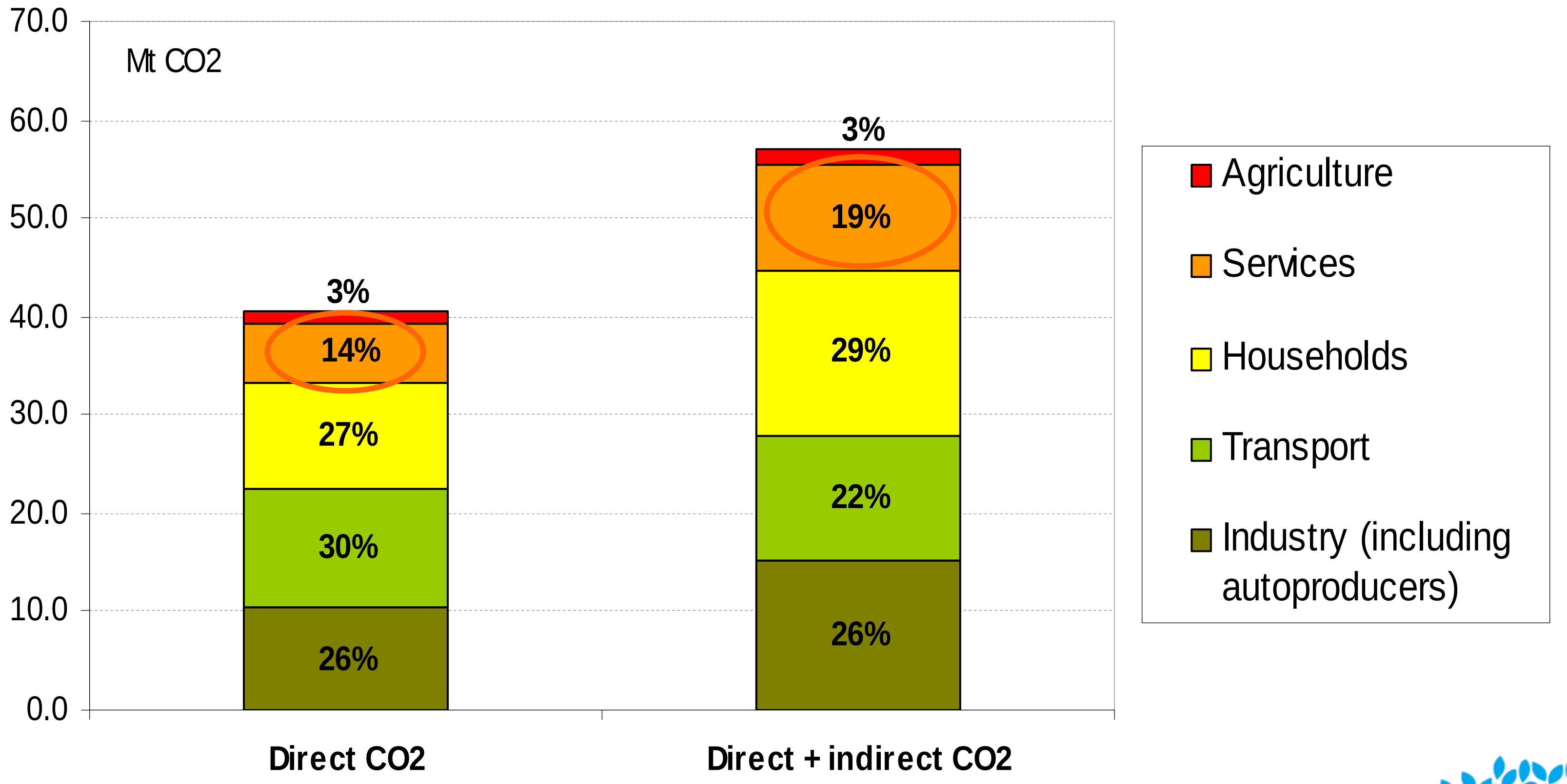
CO_2 emissions in Hungarian tertiary sector



Source: ODYSSEE 2009. URL: http://odyssee.enerdata.eu

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