

# **Economic Evaluation of Carbon Dioxide Emission Reduction in the Household and Services Sectors in the EU**

## **EXECUTIVE SUMMARY**

Within the EU, the household and private and public services sectors are an important source of carbon dioxide, accounting for 39% of total carbon dioxide emissions in 1990 and 30% of total greenhouse gas emissions. Greenhouse gases other than CO<sub>2</sub> contribute for less than 1% to total greenhouse emitted. Indirect emissions related to the use of electricity play an important role in this sector. Emission from the energy supply use that can be allocated to the household and services sector contributes to about 46% of the total emissions of this sector.

There are approximately 140 million dwellings in the EU in 1995. It is expected that the number of dwellings will rise to 156 million in 2010. Almost 20% of the energy is consumed in the household sector. The average energy consumption of a dwelling in a country depends among others on many country specific circumstances. Important are: climate, building construction, building regulation and age distribution profile of dwellings. About one tenth (12%) of the energy in the EU is consumed in the services sector. The energy consumption of a services building depends very much on the standard of insulation, air conditioning, ventilation systems and the appliances used. The five most important energy-functions are heating, cooling, transport of air, heat and cold, lighting and office equipment. Energy demand for these energy-functions can vary considerably depending on the characteristics of the buildings. To examine (specific) CO<sub>2</sub> emission reduction options and their consequences it is often useful to break the services sector down into a number of sectors, e.g. health, education, government (excluding defence), sports and entertainment, services offices, communications and transport, hotels and catering, retail, warehousing etc.

The emission reduction potential for 2010 is calculated using an emission reference level based on frozen technology development. In the frozen technology reference level it is assumed that there is no energy improvement obtained and that no reduction of specific energy consumption occurs. In the frozen technology reference level the emissions of the household sector in 2010 are about 12% higher than the 1990 emissions, 750 Mt compared to 841 Mt of CO<sub>2</sub>-equivalent. The increase is caused by the projected increase of households in the EU15. The frozen technology reference level in the services sector is about 57% higher in 2010 than in 1990, and increases from 438 Mt of CO<sub>2</sub>-equivalents in 1990 to almost 687 Mt in 2010. The large increase is because of the projected larger role of the services sector in the economies of the EU15, increased demand for cooling and increased use of appliances.

There are numerous of options to reduce emissions in the household and services sector. For practical reasons the most important options, in terms of reduction potential, are identified and characterised. Remaining 'small' options are grouped in the options 'miscellaneous' and 'development'. The main household emission reduction option categories are the insulation of existing buildings, energy-efficient new buildings, advanced heating systems and energy efficient electric appliances. The main emission reduction option categories in the services sector are the improvement of the building shell, new efficient buildings, more efficient cooling systems, building

energy management systems, improved lighting systems and improved electric office appliances. Improved refrigeration systems and use of alternative foams are options to reduce emissions of fluorinated gases.

Table 1 and 2 give an overview of the options for the household and services sector respectively, with data on reduction potentials and costs for the EU15. The specific costs are calculated using a real interest rate of 4%, using the lifetime of the option, i.e. installation or equipment.

In 2010 emission reduction potential of 315 Mt of CO<sub>2</sub>-equivalent is identified; about 190 Mt in the household sector and about 126 Mt in the services sector. In both sectors improving energy performance of existing houses has a large reduction potential. In the services sector improved cooling systems also do have a large emission reduction potential. A further 360 Mt of CO<sub>2</sub>-equivalent is avoided because electricity is consumed in 2010 with a lower emission factor than in 1990 (see also the energy supply sector report). Total direct and indirect emission reduction amounts therefore to 677 Mt of CO<sub>2</sub>-equivalent.

Table 1. EU15-average costs and potential (Mt of CO<sub>2</sub>-equivalent) for emission reduction in the household sector.

Pollutant	Measure Name	Emission reduction	Investment	Yearly costs	Lifetime <sup>1/</sup>	Specific abatement costs
		Mt CO <sub>2</sub> eq.	euro/MCO <sub>2</sub> eq.	euro/MCO <sub>2</sub> eq.	year	euro/MCO <sub>2</sub> eq.
CO <sub>2</sub>	Energy efficient TV and video equipment	1	0	-310	15	-194
	Very energy efficient refrigerators and freezers	0.5	0	-317	15	-187
	Efficient lighting: Best Practice (partly implemented)	1	178	-323	8	-181
	Efficient lighting: Best Practice (fully implemented)	2	178	-326	8	-178
	Miscellaneous options (cheap tranche)	11	0	-235	15	-165
	Miscellaneous options (moderate costs tranche)	11	138	-235	15	-156
	Efficient refrigerators and freezers: Best Practice	3	6686	-368	15	-57
	Retrofit houses: wall insulation <sup>2/</sup>	28	2269	-129	50	-42
	Retrofit houses: roof insulation	26	1600	-169	20	-29
	<b>Subtotal: Cost range &lt; 0 euro /t CO<sub>2</sub> eq.</b>	<b>83</b>				
	New energy efficient residential houses: Best Practice	12	1815	-200	20	-11
	<b>Subtotal: Cost range 0 &lt; 20 euro /t CO<sub>2</sub> eq.</b>	<b>12</b>				
	Efficient washing machines, clothes dryers, dishwashers: Best Practice	1	11227	-275	15	7
	Retrofit houses: (highly) insulated windows	49	2344	-177	20	10
	Advanced heating systems: condensing boilers	15	2038	-140	15	50
	<b>Subtotal: Cost range 20 &lt; 50 euro /t CO<sub>2</sub> eq.</b>	<b>66</b>				
	Geothermal heat production	0.2	406	-28	25	58
	New very energy efficient residential houses: Zero Energy	3	3056	-200	20	71
	Solar thermal	8	4879	-52	15	272
	Advanced heating systems: heat pumps <sup>3/</sup>	16	3884	73	15	432
<b>Subtotal: Cost range &gt; 50 euro /t CO<sub>2</sub> eq.</b>	<b>28</b>					
HFC	Domestic refrigeration: hydrocarbons	1	32.5	0	15	3
	<b>Subtotal: Cost range: 0 &lt; 20 euro /t CO<sub>2</sub> eq.</b>	<b>1</b>				
<b>Total potential emission reduction</b>		<b>190</b>				

<sup>1/</sup> The lifetime of some options (e.g. retrofitted (uninsulated) walls and efficient appliances) are chosen at the upper part of the range [De Beer et al, 1994]

<sup>2/</sup> An equally divided mix of the options insulating cavity (cheap) and external solid wall insulation (expensive) was chosen.

<sup>3/</sup> Based on average fuel/electricity use. Replacing electric heating systems may reduce specific costs down to zero for the 4% discount rate case.

Table 2. EU15-average costs and potential (Mt of CO<sub>2</sub>-equivalent) for emission reduction in the services sector.

Pollutant	Measure Name	Emission reduction	Investment	Yearly costs	Lifetime <sup>1/</sup>	Specific abatement costs
		Mt CO <sub>2</sub> eq.	euro/tCO <sub>2</sub> eq.	euro/tCO <sub>2</sub> eq.	year	euro/tCO <sub>2</sub> eq.
CO <sub>2</sub>	Efficient office equipment: Best Practice	3	0	-278	5	-178
	Building Energy Management Systems (BEMS): electricity	3	0	-278	10	-178
	Efficient space cooling equipment	1	377	-277	15	-172
	Efficient lighting: Best Practice level 1	2	651	-278	8	-159
	Very efficient lighting: Best Practice level 2	1	1200	-277	8	-144
	Building Energy Management Systems (BEMS): space heating and cooling	42	0	-153	10	-129
	Retrofit services buildings: wall insulation	14	2269	-157	50	-26
	Retrofit services buildings: roof insulation	13	1600	-162	20	-8
	<b>Subtotal: Cost range &lt; 0 euro /t CO<sub>2</sub> eq.</b>	<b>80</b>				
	Retrofit services buildings: (highly) insulated windows	31	2344	-168	20	35
	New energy efficient services buildings: Energy efficiency level 1	9	4059	-159	20	146
	New very energy efficient services buildings: Energy efficiency level 2	3	6495	-159	20	312
<b>Subtotal: Cost range 20 &lt; 50 euro /t CO<sub>2</sub> eq.</b>	<b>43</b>					
HFC	Stationary air conditioning DX (distributed technology): leak reduction <sup>2/</sup>	1	52.1	32.7	15	37
	Stationary air conditioning chiller: HC and NH <sub>3</sub> <sup>2/</sup>	1	221.9	21.7	15	42
	Commercial refrigeration: leakage reduction	2	82.5	41.5	15	49
	<b>Subtotal: Cost range 20 &lt; 50 euro /t CO<sub>2</sub> eq.</b>	<b>3</b>				
<b>Total potential emission reduction</b>		<b>126</b>				

<sup>1/</sup> The lifetime of some options (e.g. retrofitted (uninsulated) walls and efficient appliances) are chosen at the upper part of the range [De Beer et al, 1994]

<sup>2/</sup> This reduction option covers both the household and the services sector. However, no sectoral breakdown is available.

Table 3 summarises the frozen technology reference level in the household and services sector and shows the position if all the options in Table 3 and all options in the energy supply sector were adopted.

Table 3. Summary of direct and indirect emission levels with and without implementation of the complete reduction potential of household and services sector (Mt CO<sub>2</sub>-equivalent)

	1990		2010 reference		2010 with measures	
	households	services	households	services	households	services
Carbon dioxide	749	413	841	647	448	367
Methane	0	10	0	10	0	10
Nitrous oxide	0	11	0	8	0	8
Fluorinated gases	-	-	2	6	0	3
<b>Total</b>	<b>750</b>	<b>435</b>	<b>843</b>	<b>671</b>	<b>449</b>	<b>388</b>
	<b>1184</b>		<b>1514</b>		<b>837</b>	

Figure 1 and Figure 2 show the share in emission reduction in the household and services sector categorised in four costs brackets.

Figure 1. Households: 1990/1995 base year direct and indirect emissions per greenhouse gas (left), 2010 frozen technology reference level and reduction potentials per cost bracket (right)

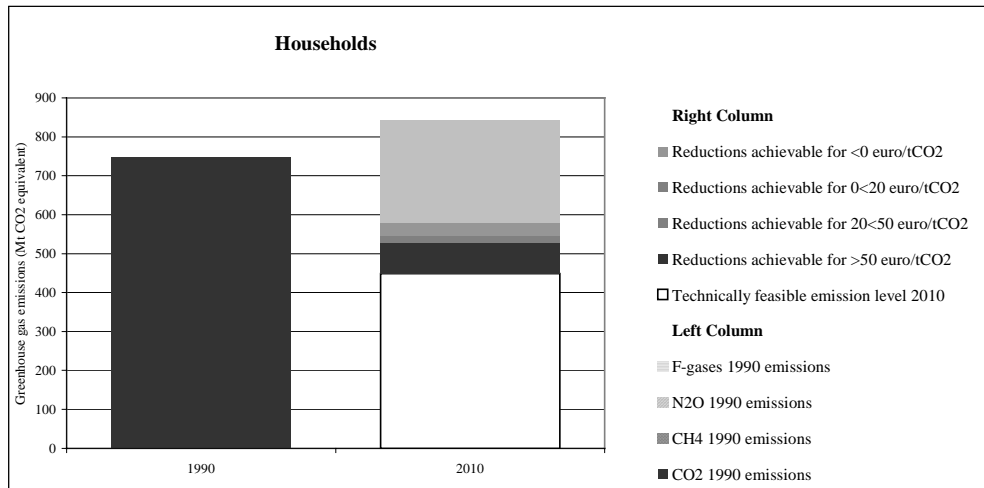


Figure 2. Services: 1990/1995 base year direct and indirect emissions per greenhouse gas (left), 2010 frozen technology reference level and reduction potentials per cost bracket (right)

