



Co-funded by the Intelligent Energy Europe
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National ODYSSEE-MURE seminar in Denmark

Copenhagen 17th June 2015

How Denmark ranks in the European scene of energy efficiency?

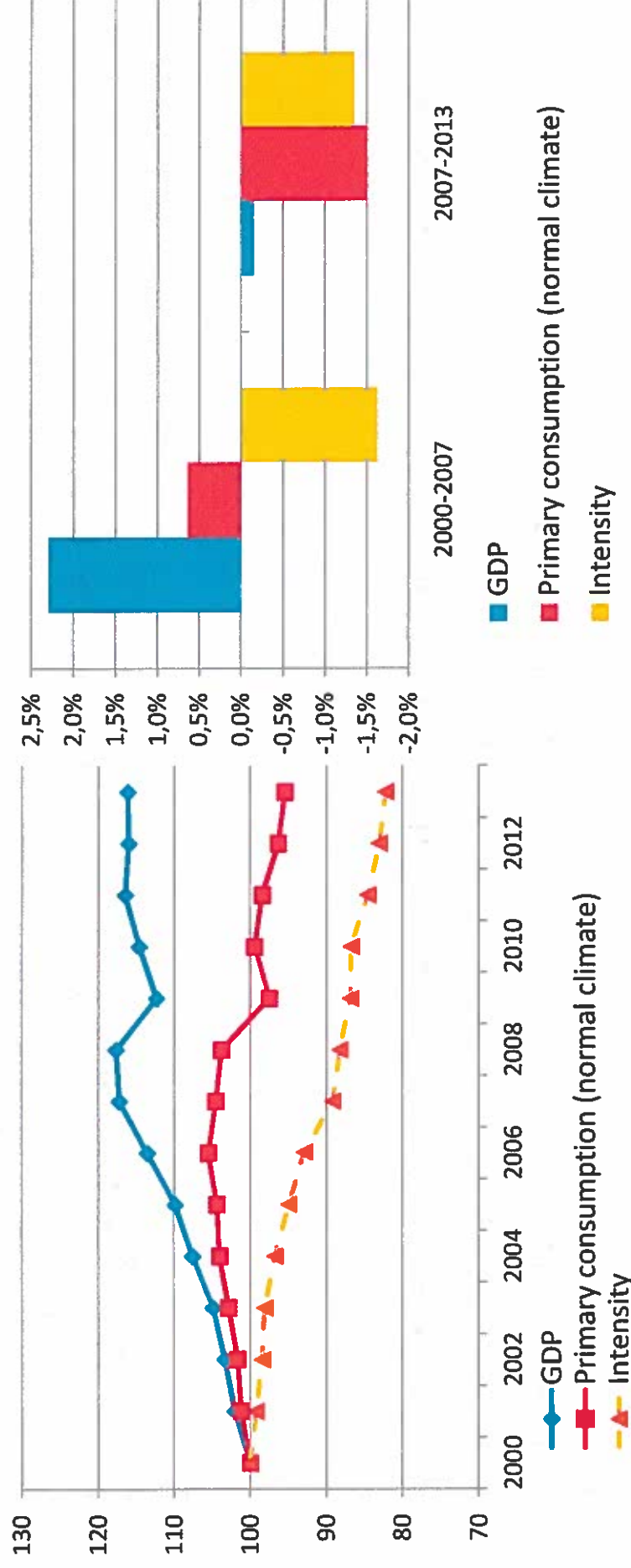
Dr Didier Bosseboeuf, (ADEME), With the participation of Enerdata



- 1. **Macro**
- 2. **Industry**
- 3. **Buildings**
 - 1. **Households**
 - 2. **Services**
- 4. **Transport**

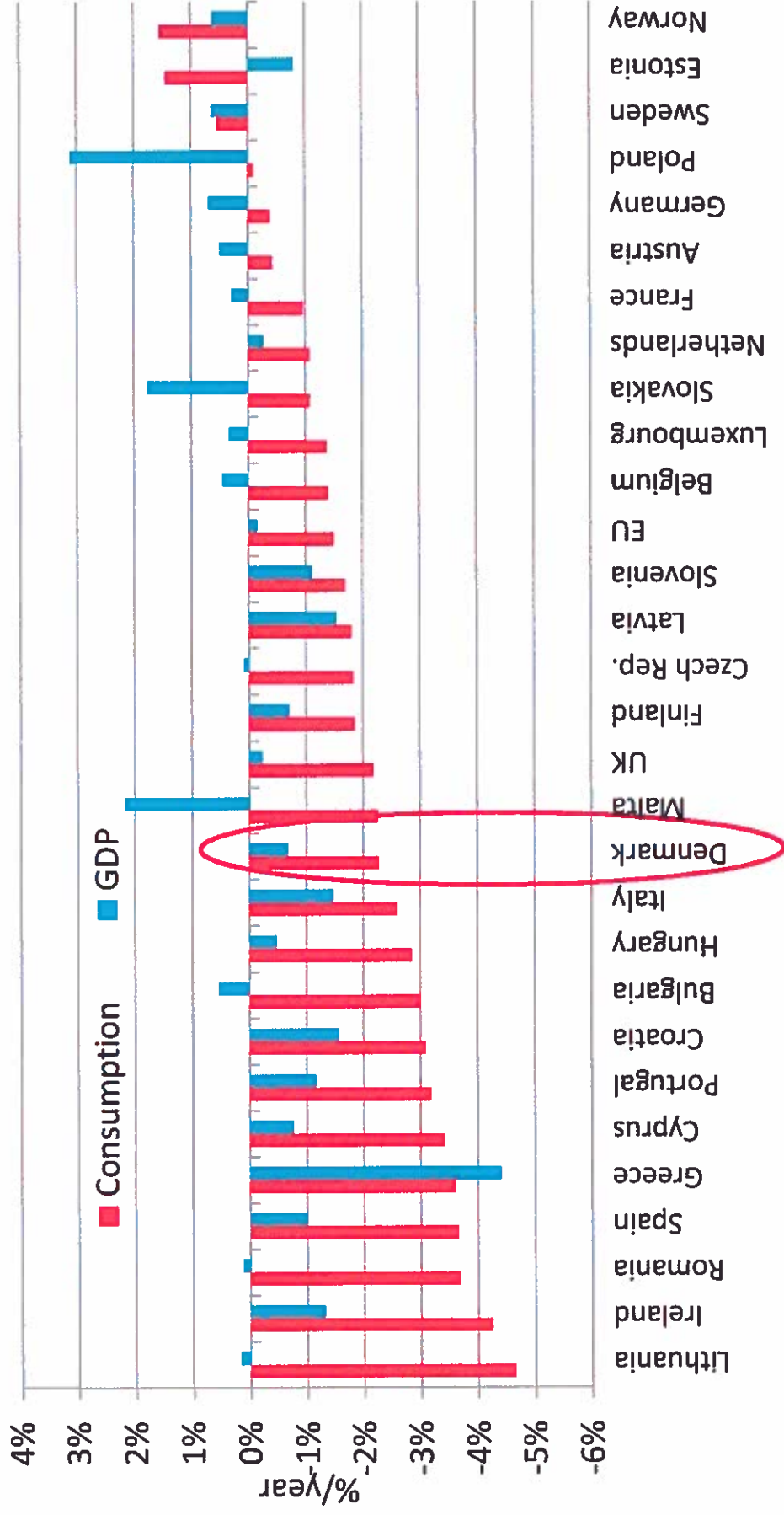
- Strong reduction of the primary consumption since 2007 (-1.5%/year) although the GDP only slightly decreased (-0.2%/yr on average since 2007).
- As a consequence, the primary energy intensity decreased by 1.4%/year, which is only slightly lower than over 2000-2007 (-1.6%/year).
- In 2013, primary consumption and GDP are respectively 7% and 1% below their pre-crisis level (almost zero GDP growth in 2012 and 2013).

Primary energy consumption and GDP trends (EU)



- 26 countries with a decrease of the primary energy consumption since 2007, of which 9 countries with a reduction over 3%/year.
- In most countries such as **Denmark** contraction of consumption much larger than GDP reduction → rapid intensity decrease.

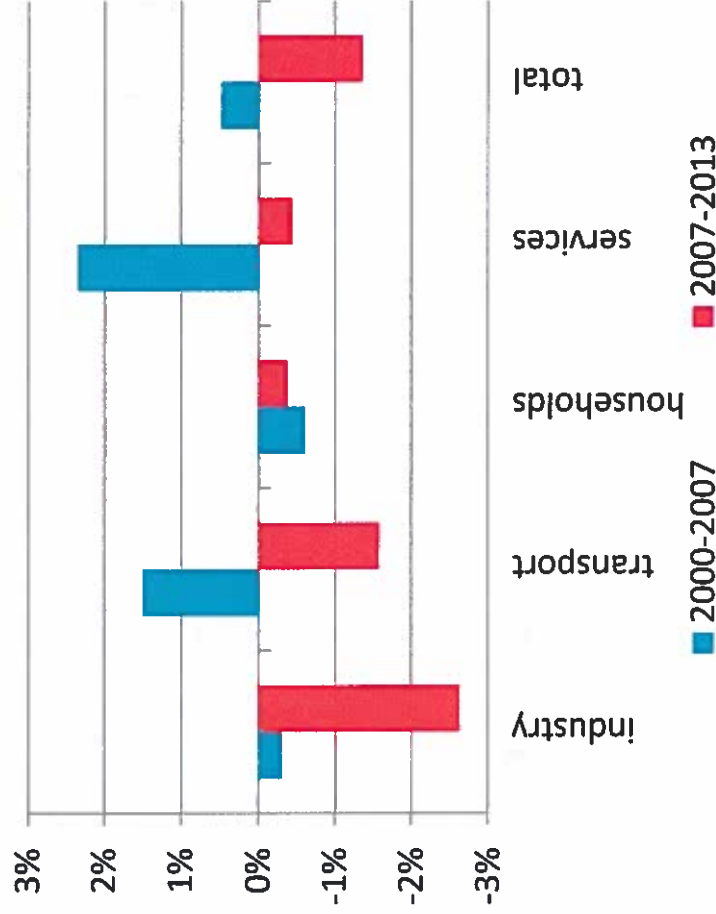
Variation of primary energy consumption and GDP in EU countries (2007-2013)



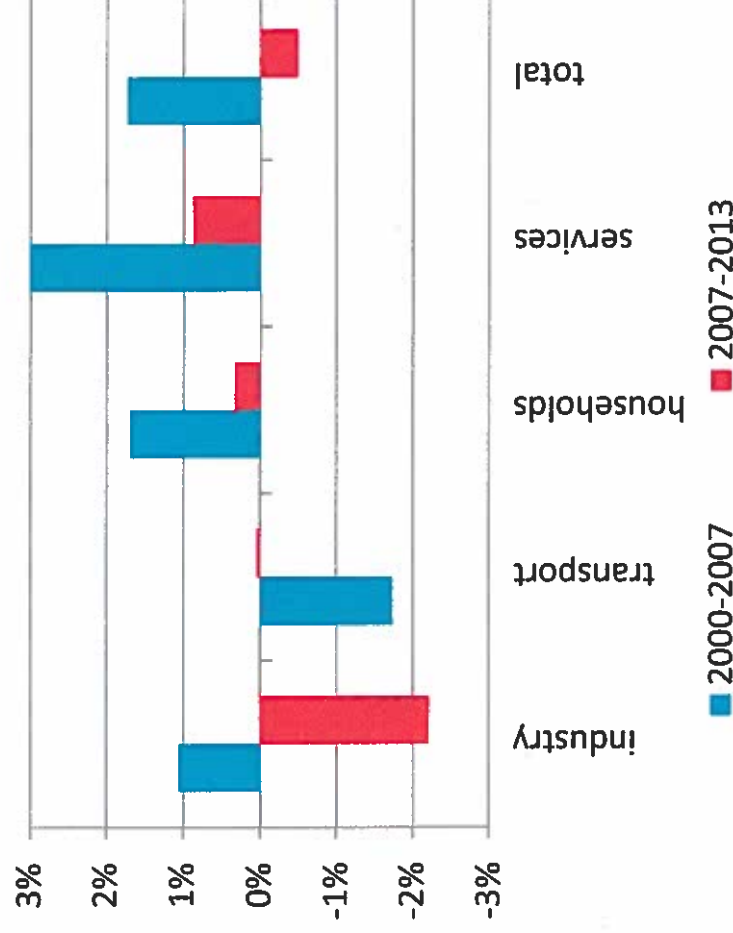
- Rapid decrease of the final energy consumption since 2007 (-1.4%/year), with a stronger effect of the crisis in industry and transport than in buildings.
- Slight decrease in electricity consumption since 2007 (-0,4%/year) after a rapid progression before (4%/year).
- High growth of electricity consumption in services up to 2007; slow down since then.

Final energy consumption trends by sector (EU)

Total final

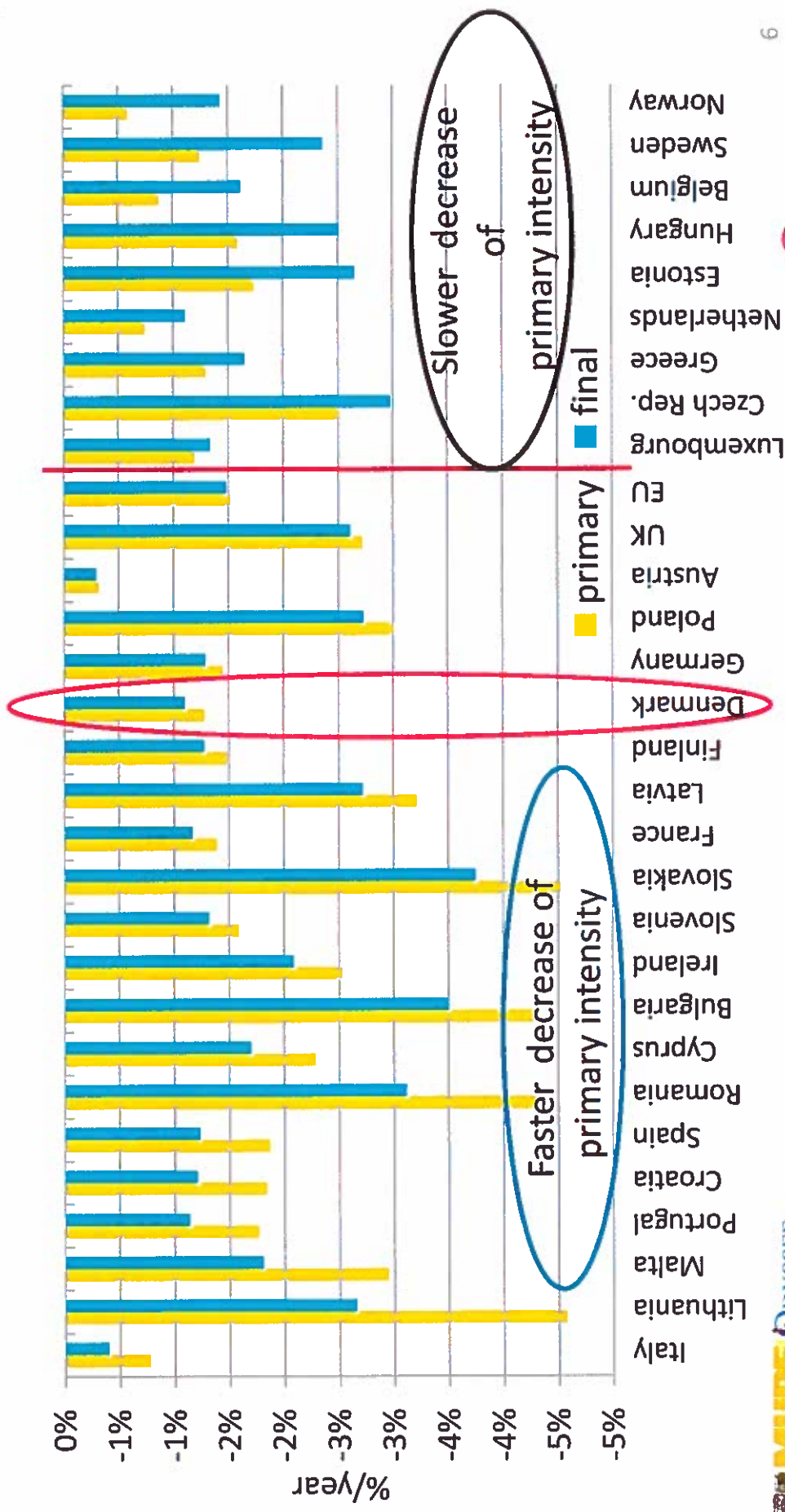


Electricity

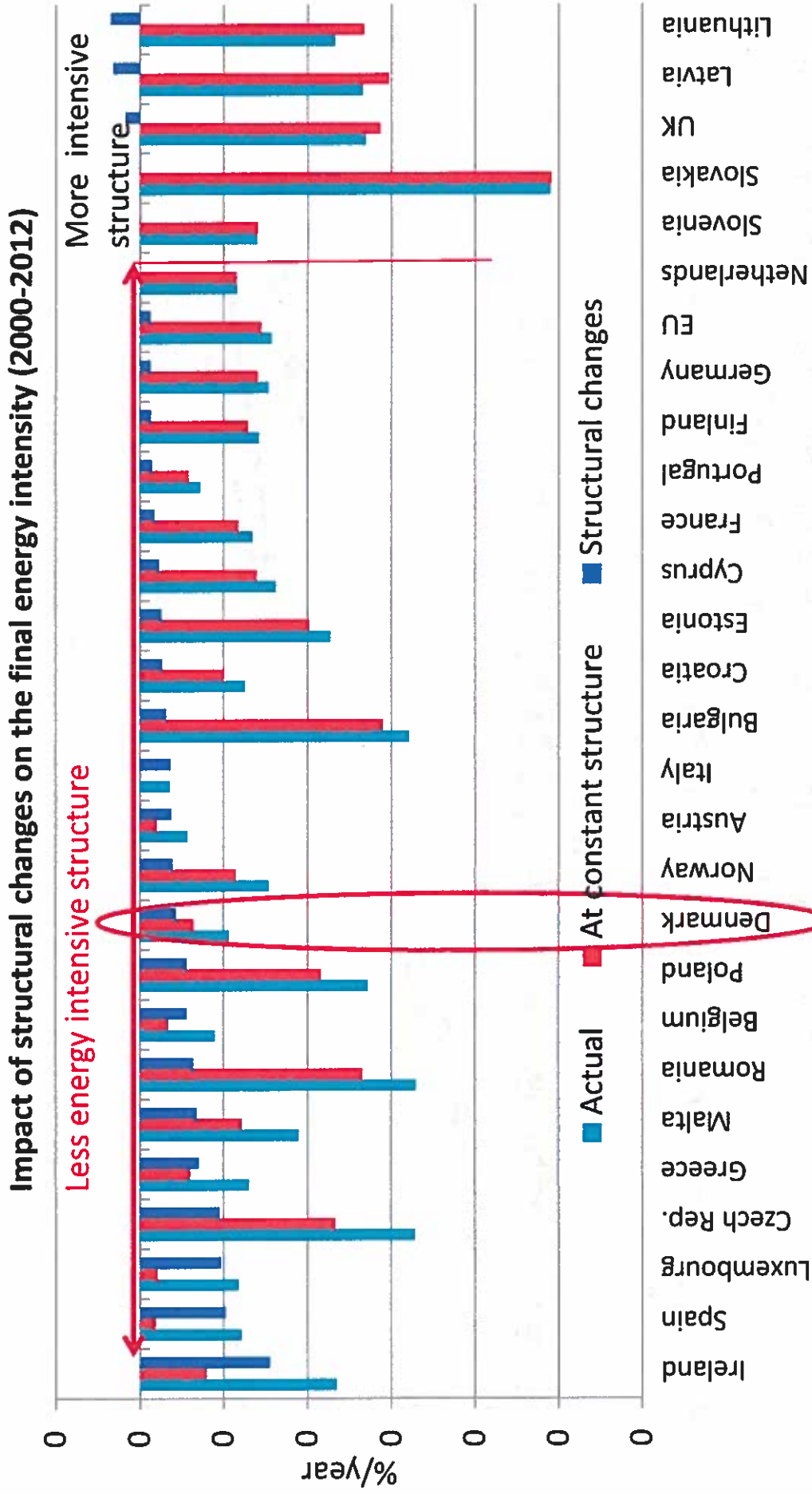


- Since 2000, the primary intensity decreased faster than the final intensity in ¾ of countries due to improvement in power generation efficiency;
- Reverse trend in ¼ of countries, due to specific factors (eg, increasing share of electricity in Belgium, decreasing share of hydro in Sweden and Norway).

Primary and final energy intensities trends in EU countries (2000-2013)

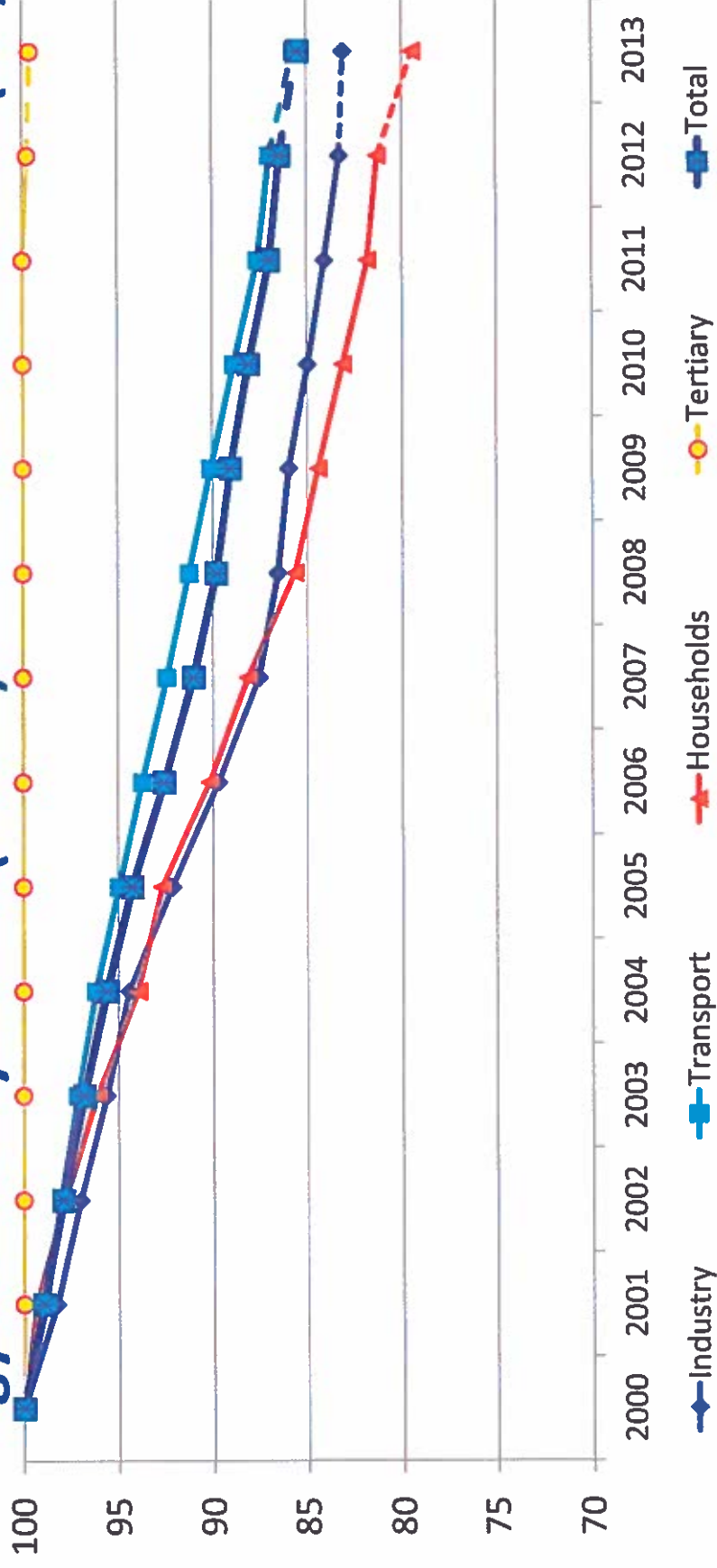


- Most countries have moved to less energy intensive sectors
- In Denmark over 1/3 of the final energy intensity decrease explained by structural



- 15% energy efficiency improvement between 2000 and 2013 (or 1.2%/year)
- Net slow down, mainly in industry, since the economic crisis: -1%/year since 2007, compared to around 2%/year between 2000 and 2007
- Regular and larger gains for households (1.7%/year), followed by transport (1.2%/year)
- No measurable progress in tertiary.

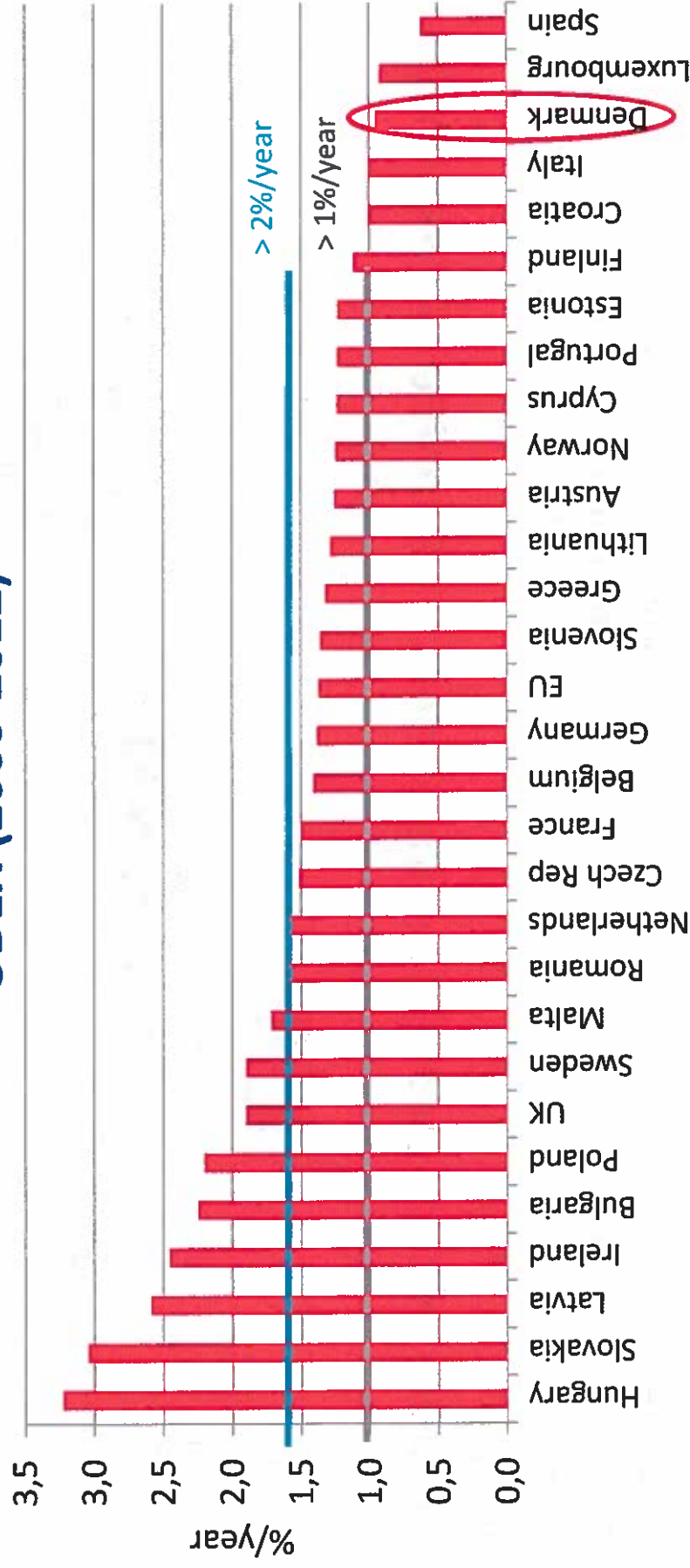
Energy efficiency index (ODEX) for final consumers (EU)



Technical ODEX; calculated as a 3 years moving average to avoid short term fluctuations.
 MURE 2013 based on estimates from short term indicators.

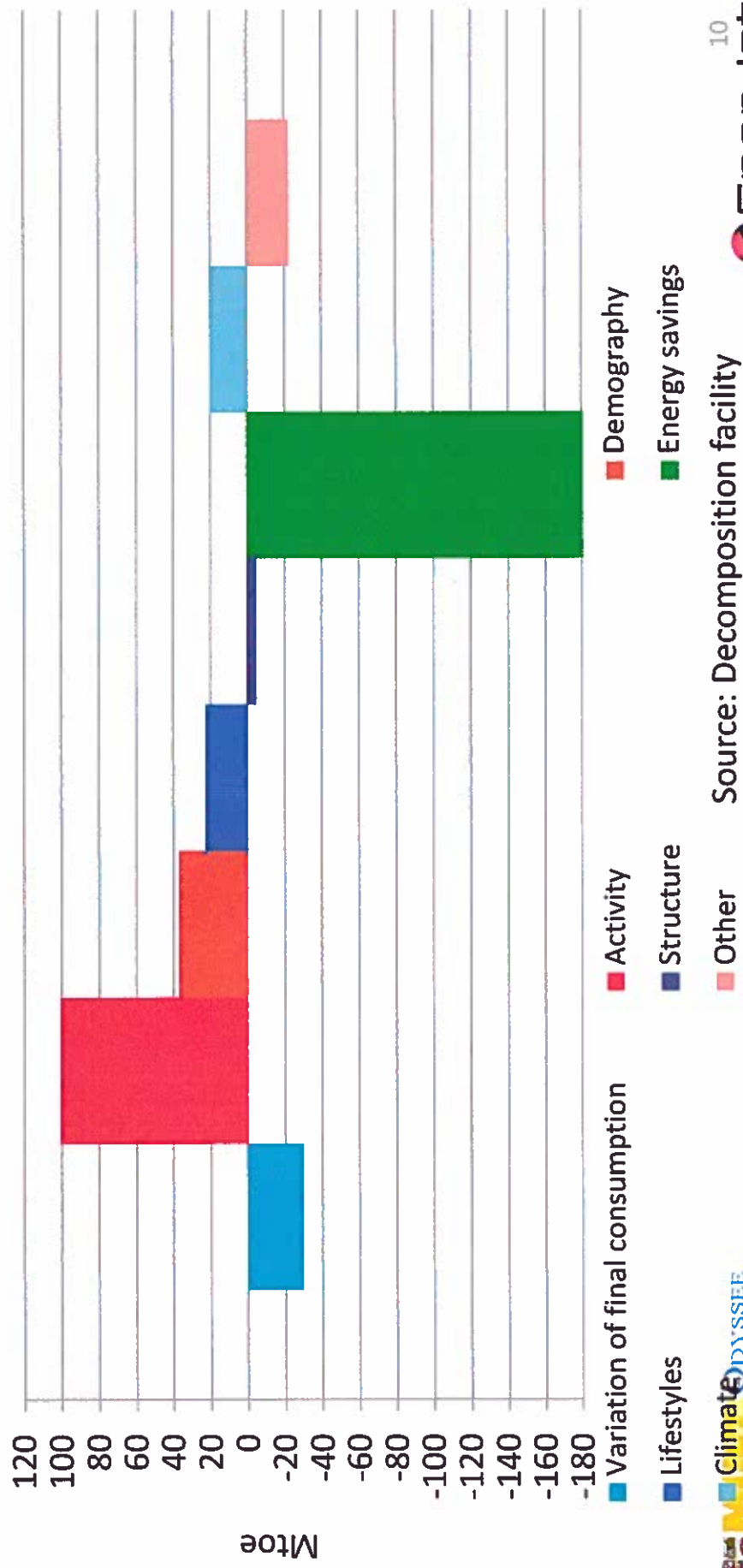
- Energy efficiency improvement above or around 2%/year for 6 countries since 2000 (Hungary, Slovakia, Latvia, Ireland, Bulgaria and Poland)
- 18 countries with energy efficiency between 1 and 2%/year.
- **Denmark seems to perform at slow rate of improvement (less than %/year)**

Energy efficiency improvement for final consumers in EU countries ODEX (2000-2012)



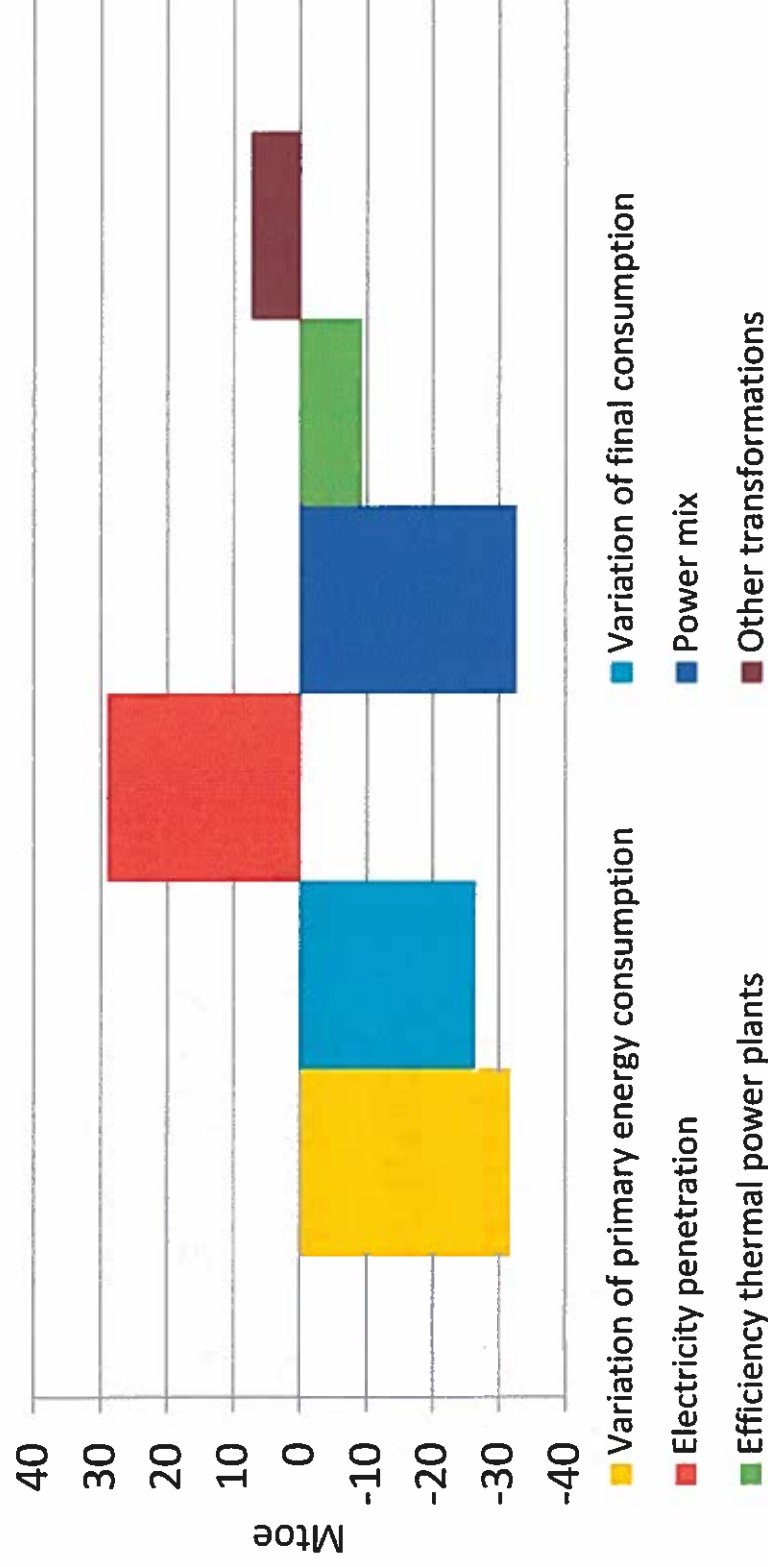
- Economic activity increased consumption by around 100 Mtoe over 2000-2012.
- Demography and lifestyles (increase appliance ownership and larger dwellings) also contributed to increase consumption by around 40 and 20 Mtoe respectively.
- The colder climate in 2012 compared to 2000 also contributed to an increase of 20 Mtoe
- Energy savings of 180 Mtoe offset the effect of these 4 drivers of consumption growth leading to a decrease in final consumption.

Drivers of final energy consumption variation (EU) (2000-2012)



- The primary consumption decreased slightly more than the final consumption.
- This is mainly explained by a change in the power mix (higher share of renewables, lower share of nuclear) and improvements in the efficiency of thermal power generation.
- This trend more than offset the effect of the penetration of electricity, which otherwise would have increased the primary consumption by 30 Mtoe.

Drivers of primary consumption variation (EU) (2000-2012)



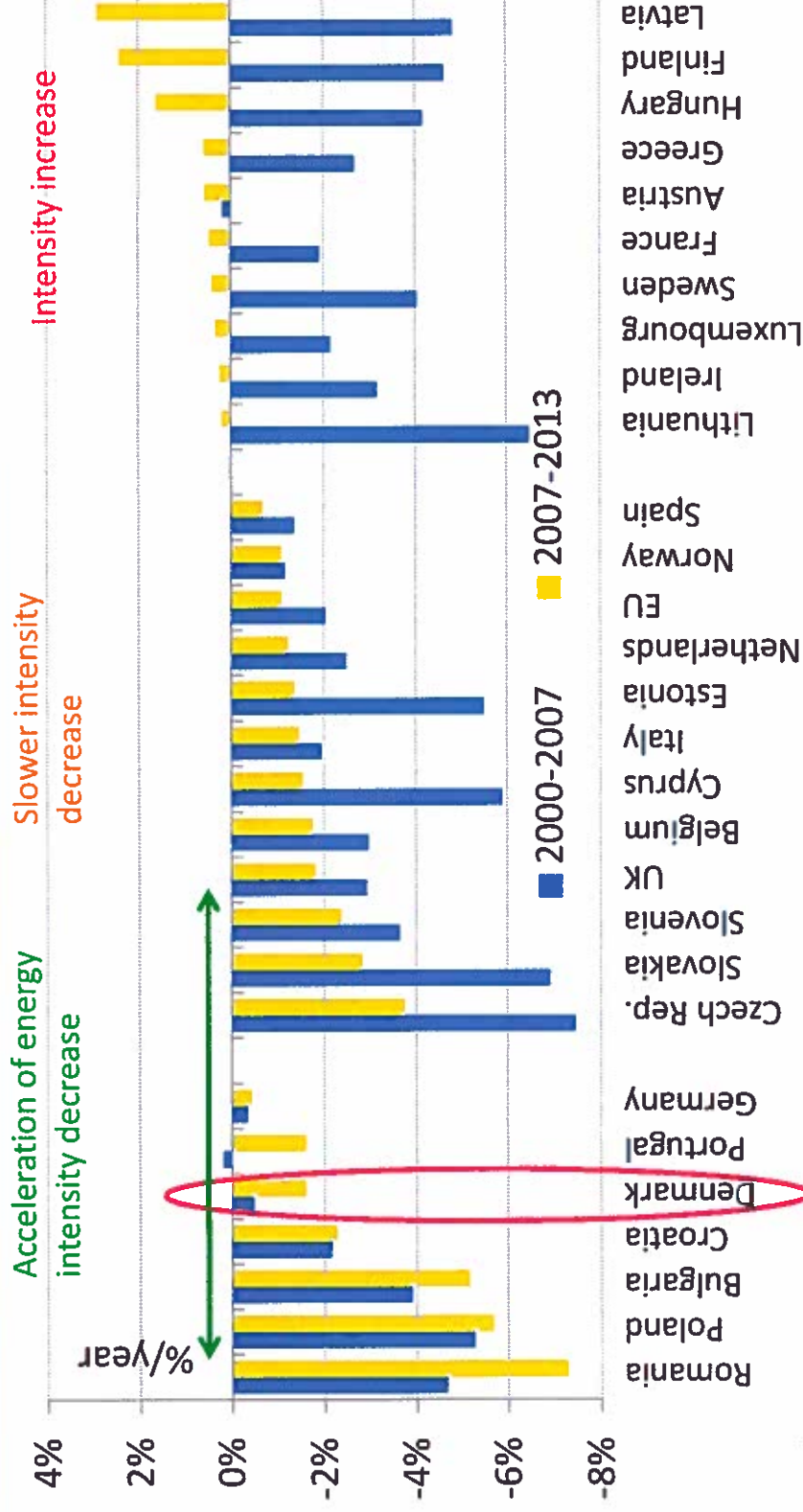
1. Macro
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EU industry: key figures

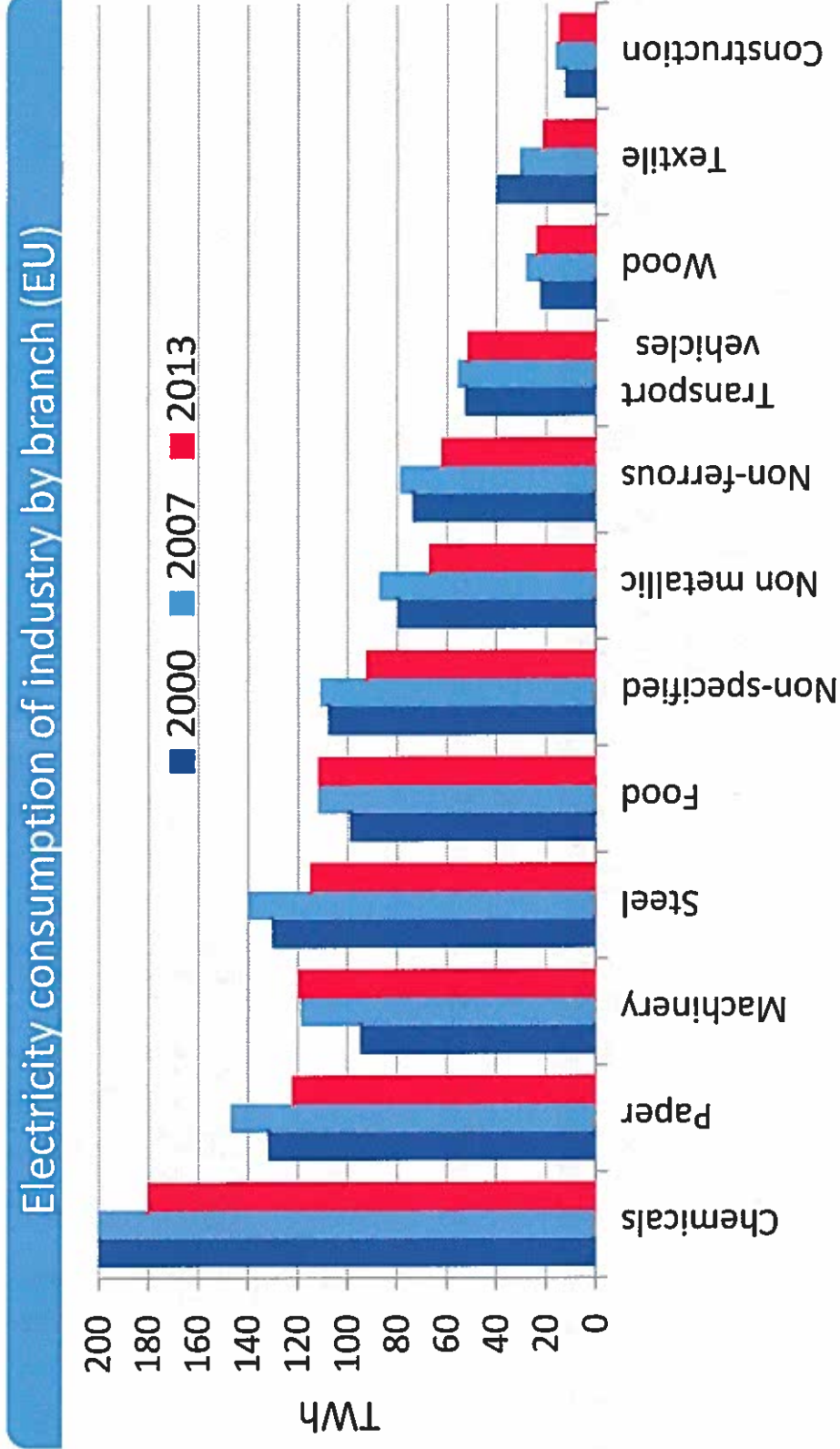
25% of final energy consumption in 2013 against 30% in 2000	-8,5% reduction in industrial activity since 2007;	Energy consumption in 2013 17% below its 2000 level;
	2013 value added only 5% above its 2000 level	Electricity consumption 5% below its 2000 level
		(12% below 2007 level)

- Until 2007, energy consumption grew less rapidly than Value Added in all countries → **intensity decrease.**
- This trend continued after 2007 in **17 countries** with:
 - a faster decrease in 7 countries (generally countries with an industrial growth).
 - a slower trend in 11 countries and at EU average (1.1%/yr compared to 2%/yr before).
- In **11 countries**, the **intensity trend has reversed** since 2007, due to the fact that energy consumption did not follow the reduction in activity.

Industrial intensity trends in EU countries

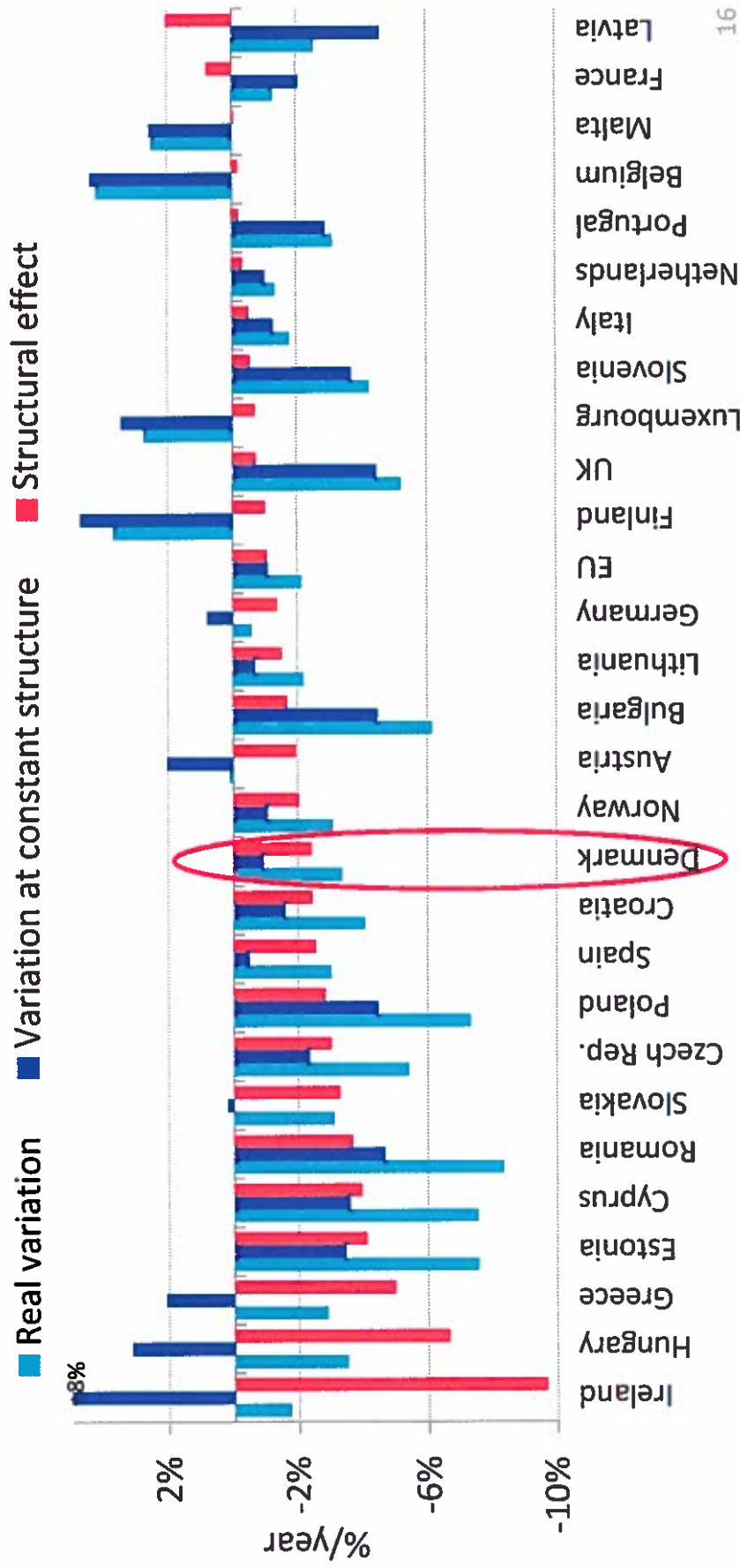


- **Since 2007**, electricity consumption has also **decreased** in all industrial branches.
- **Until 2007**, **increase** for most branches, partly linked to substitution of electricity for fuels (~ 10% of electricity used in 2013 explained by substitution since 2000).
- **Chemical** is the largest electricity intensive branch (**18%**) followed by paper, steel and machinery (12% each)



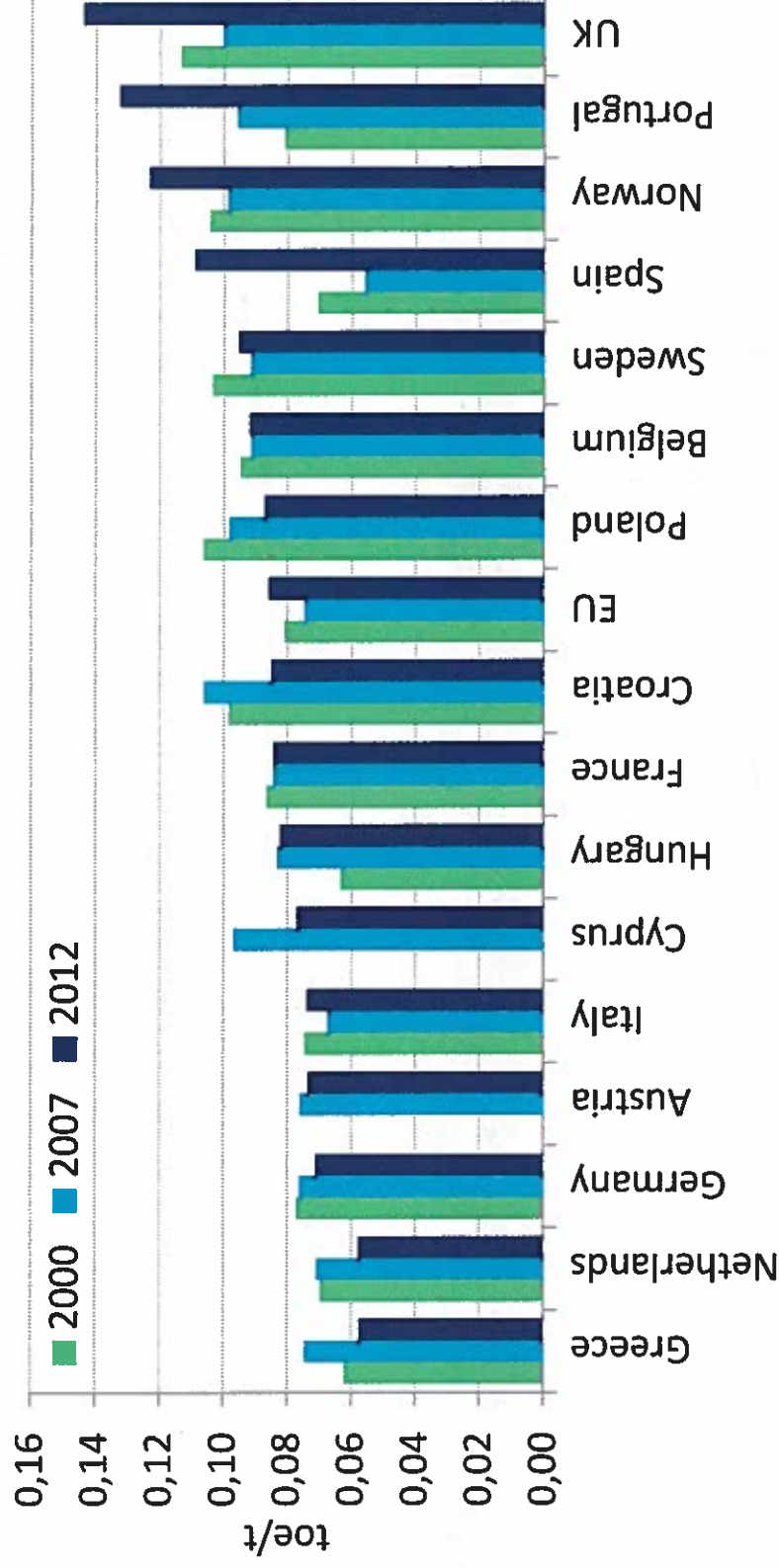
- At EU level, structural changes explain half of the energy intensity decrease in manufacturing industry since 2007. **¾ for Denmark**
- Structural changes were generally quite significant in 10 countries where they explain more than 60% of the intensity decrease (Ireland, Hungary, Greece, Slovakia, Spain, Croatia, Denmark, Norway, Lithuania and Germany)

Impact of structural changes on the energy intensity of manufacturing (2007-2012)



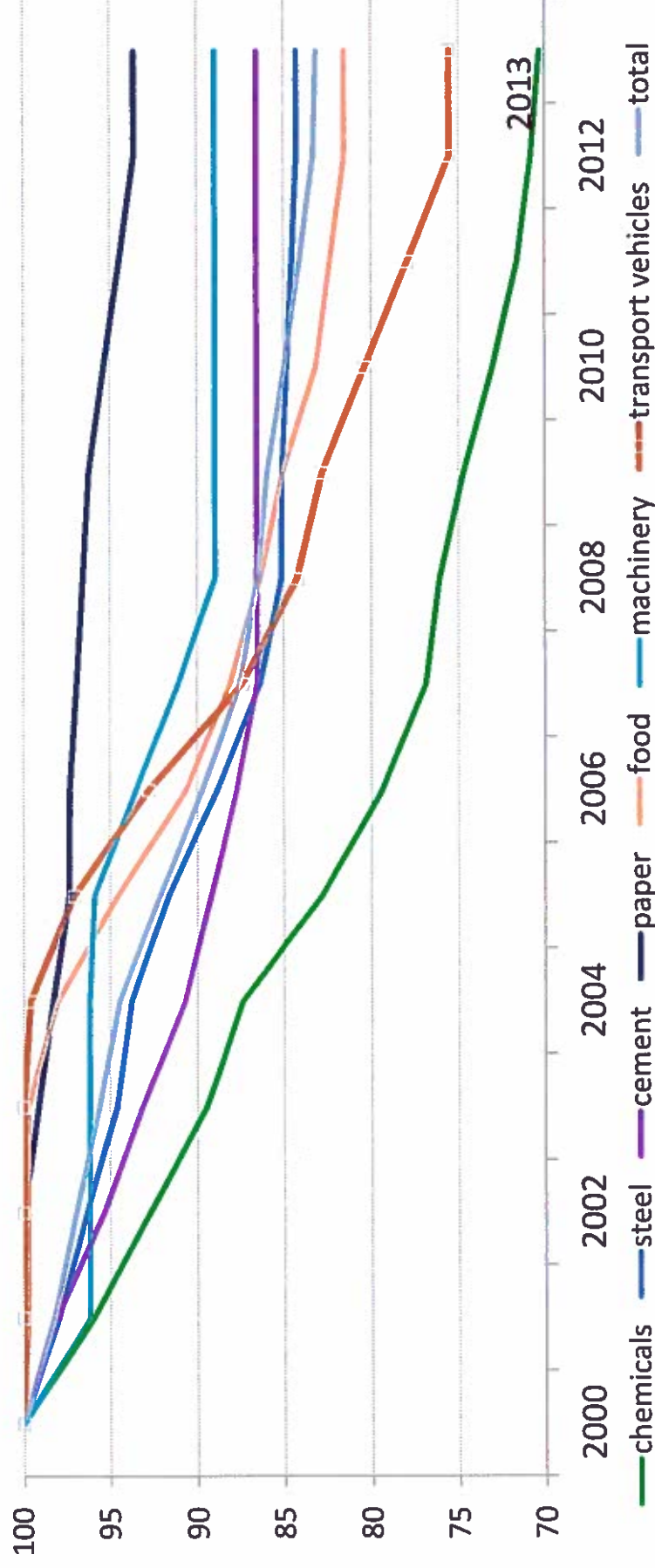
- In 6 countries and at EU level, the specific consumption per ton of cement was **higher in 2012 than in 2007**, especially in countries with a deep recession with plants operating at low capacity (e.g. Spain and Portugal, with a drop in production of 70% and 44% respectively).
- In 7 countries, the specific consumption decreased; it remained stable in 3 countries.
- Differences among countries are partly explained by differences in the ratio clinker to cement production and in the efficiency of cement factories.

Trends in the specific consumption per ton of cement

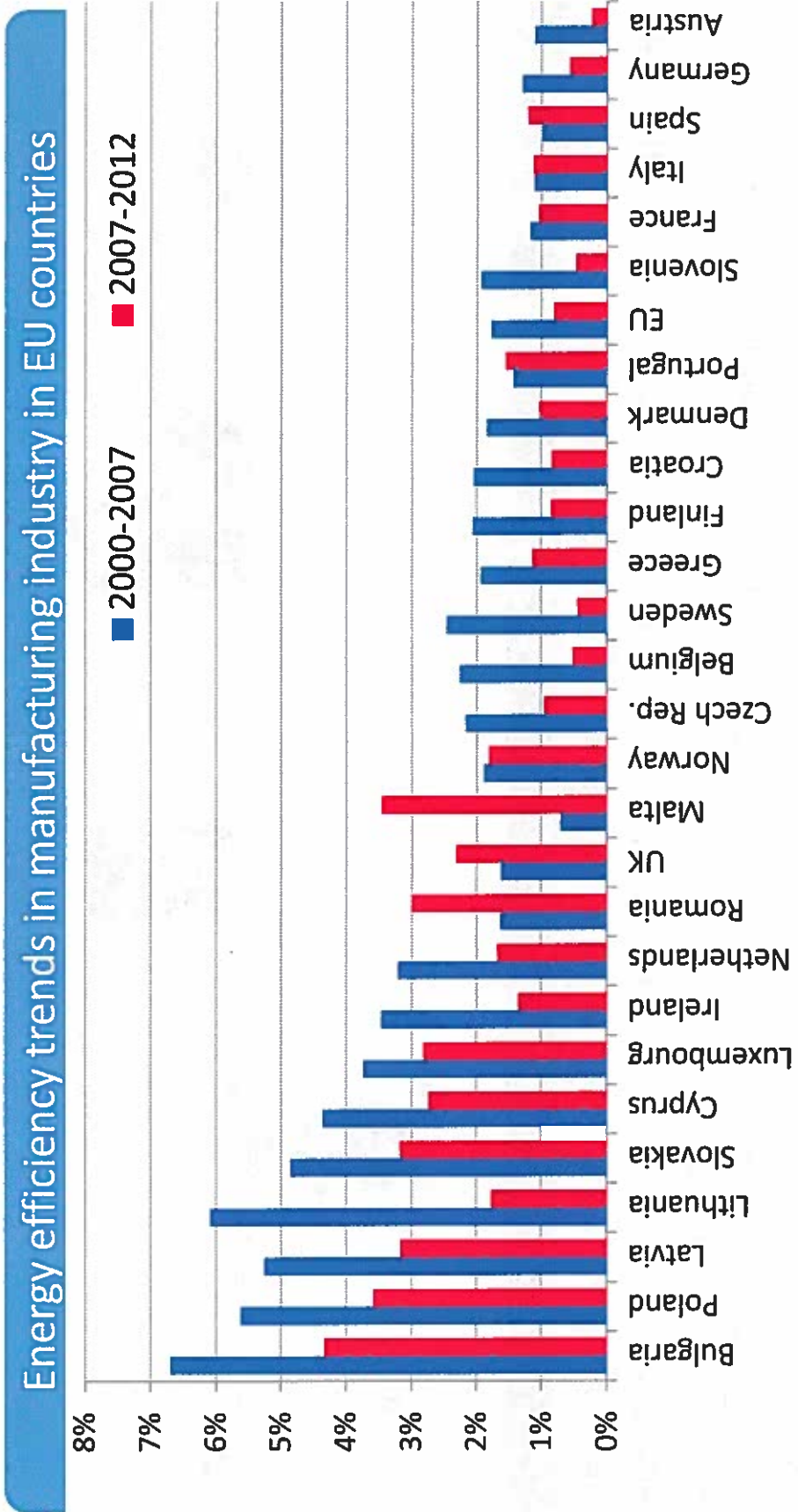


- ODEX decreased by 1.4%/year on average since 2000 (17%).
- Slower energy efficiency progress since 2007 (0.9%/yr from 2007 to 2013 compared to 1.9%/year from 2000 to 2007) because of a slower progress in some branches since 2007 and even no more energy efficiency improvement for others because of the recession (e.g. steel, cement, machinery).

Trends in ODEX in industry (EU)



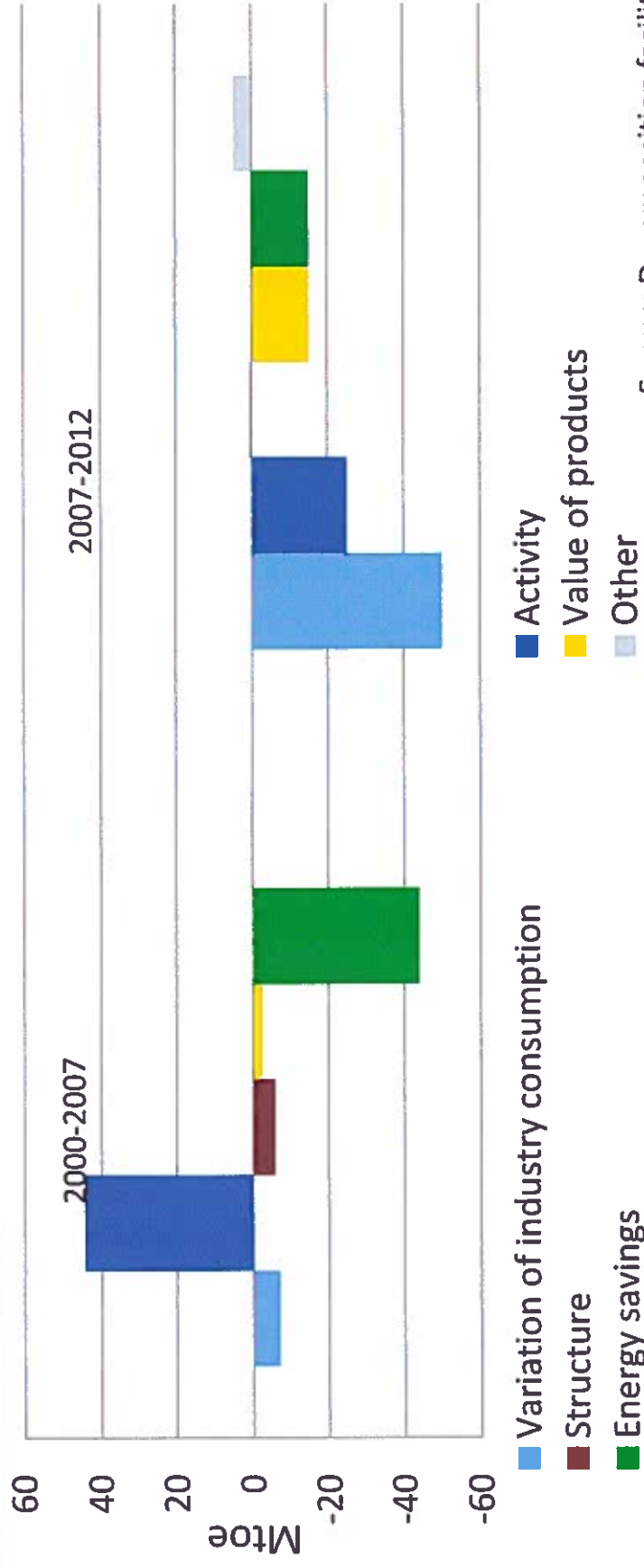
■ Since 2007, a deterioration of energy efficiency is observed in almost all countries due to the recession and the fact that factories do not operate at full capacity and are thus less efficient.



Note: Only “technical savings” are represented, i.e. net of the negative savings due to inefficient operation for industry

- Since 2007 most factors contributed to decrease industrial energy consumption;
- More than half of the 50 Mtoe consumption reduction between 2007 and 2012 is explained by the industrial recession and the rest equally by energy savings and higher production value.
- Energy savings had a much lower impact since 2007 (2,5 Mtoe/yr compared to 6,3 Mtoe/yr over 2000-2007).
- Between 2000 and 2007, the stability of consumption was the result of the balance between the activity effect and energy savings of 44 Mtoe each.

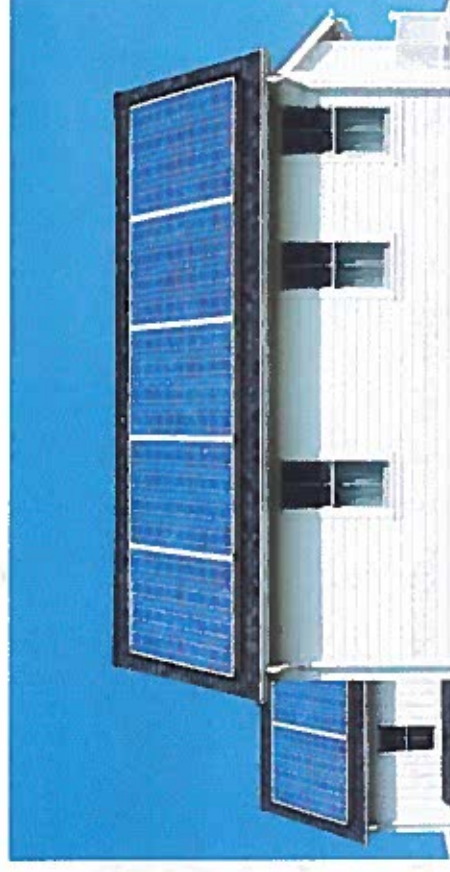
Drivers of the energy consumption of industry after and before the crisis



Source: Decomposition facility 20

Value of product: change in ratio value added over index of production;
Other effects: mainly "negative" savings due to inefficient operations in industry

1. Macro
2. Industry
- ▶ 3. Buildings
 1. Households
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4. Transport

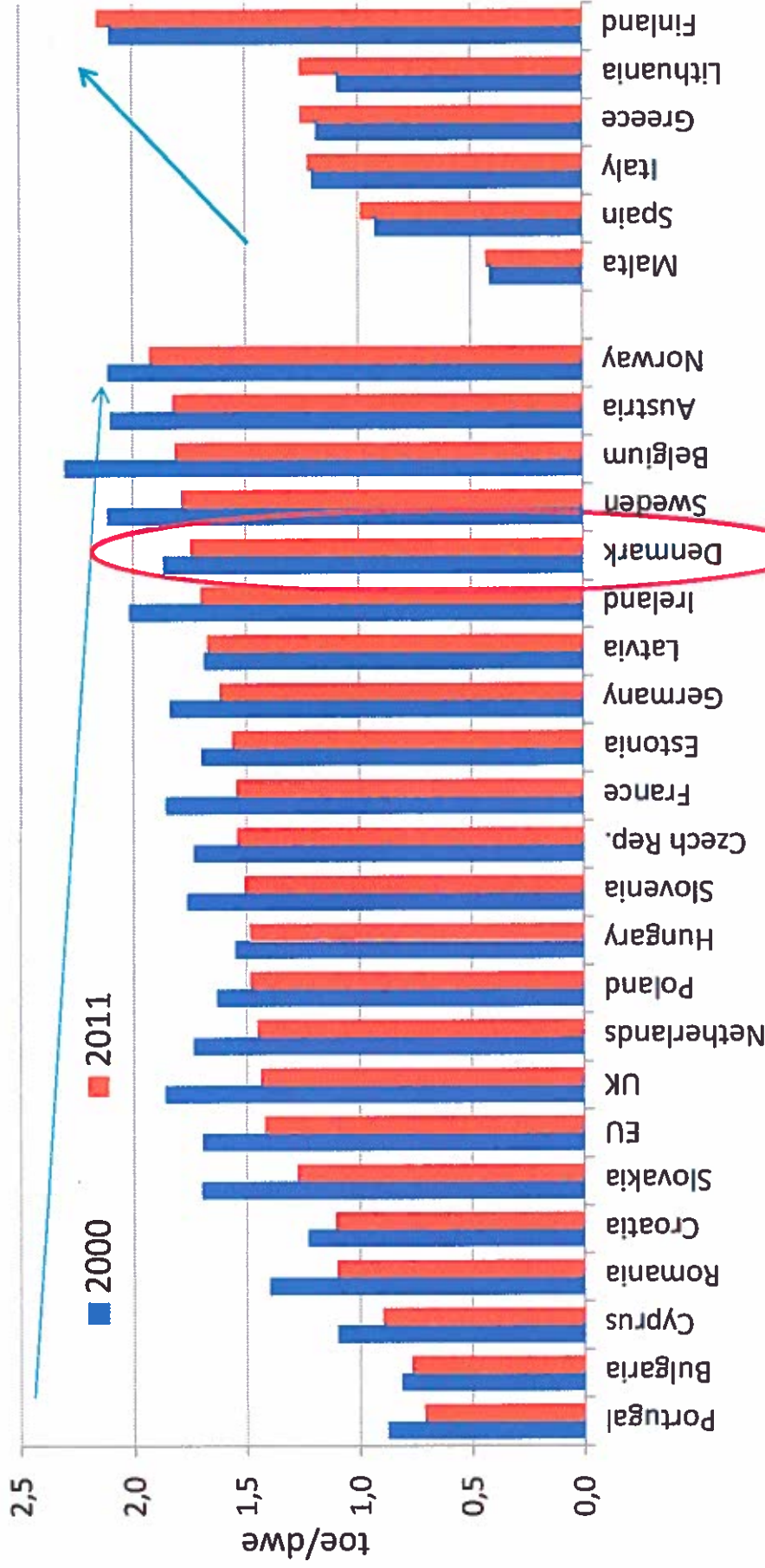


Since 2000 reduction of the average energy consumption per dwelling in 20 countries;

Increase in southern Europe due to heating comfort;

Values in a range of 1 to 2 toe/dwelling (1.4 toe for the EU average)

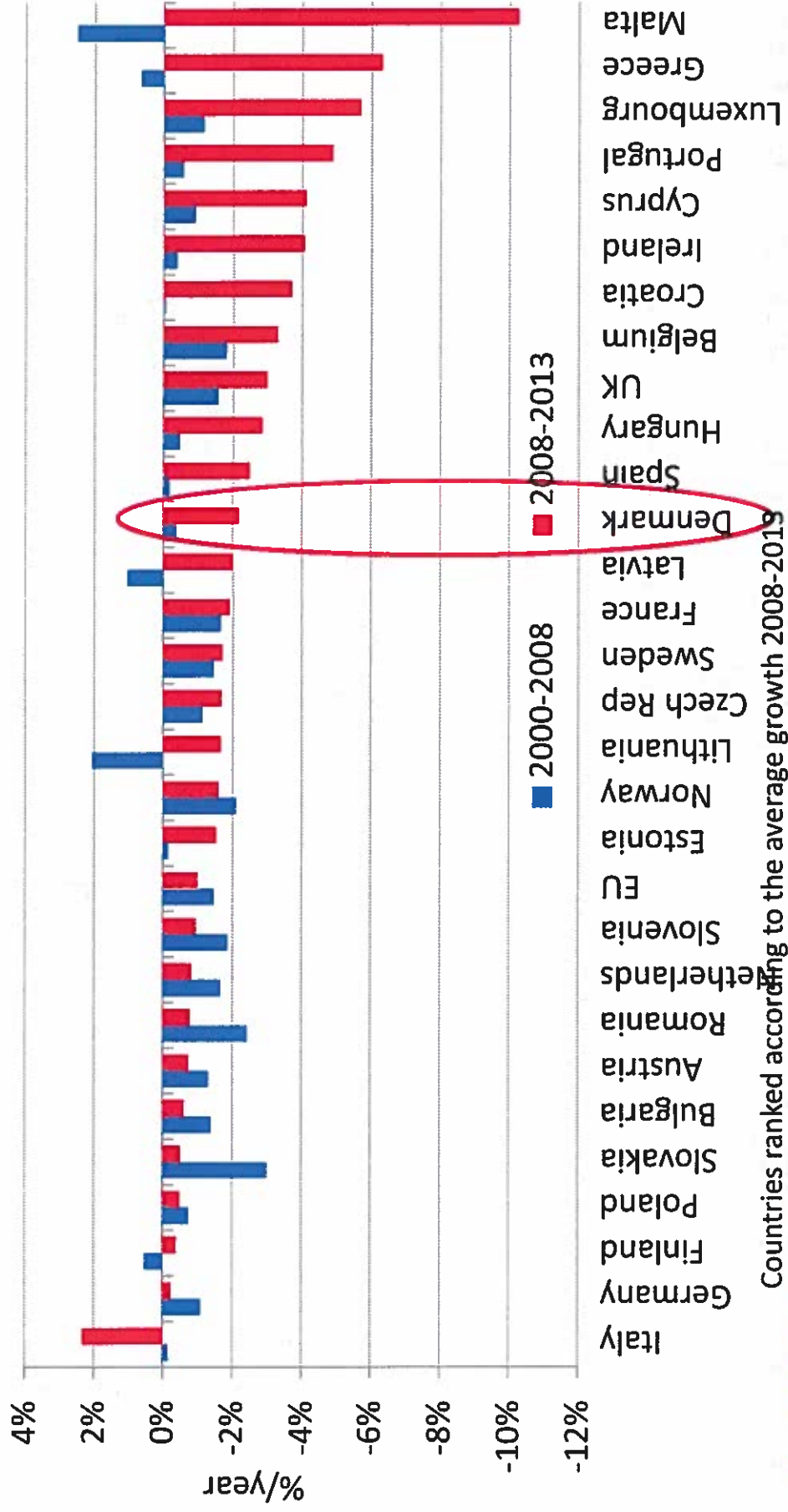
Average consumption per dwelling (at normal climate)*



*2010 for Hungary, Malta and Estonia

- Regular decrease of the average consumption per dwelling above 1.3 %/year at EU level since 2000;
- Strong reduction since 2008 in most countries.

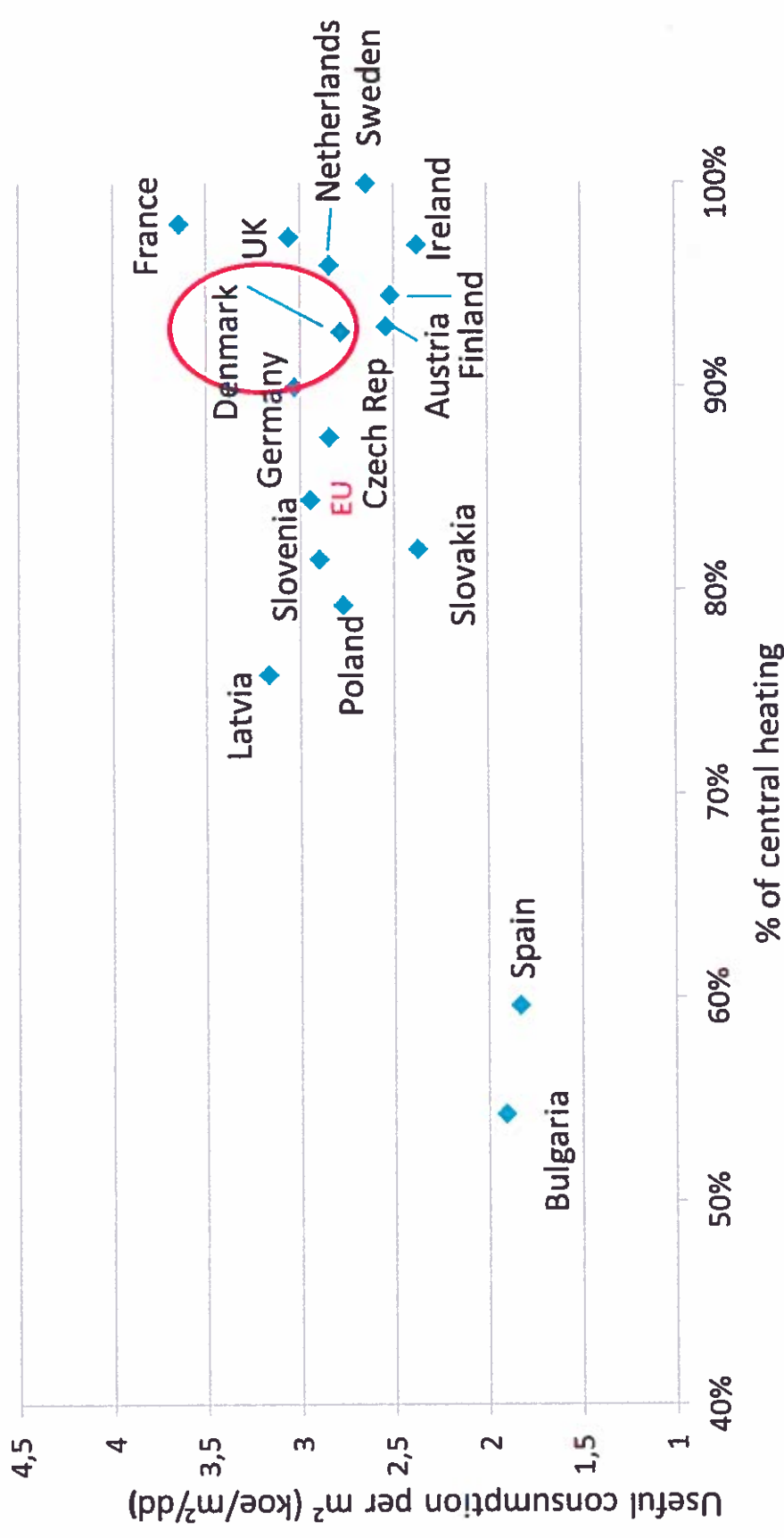
Variation of the average consumption per dwelling*



Countries ranked according to the average growth 2008-2019

Useful Energy use for space heating per m² and degree day (2012)

Danemark not far from the benchmark

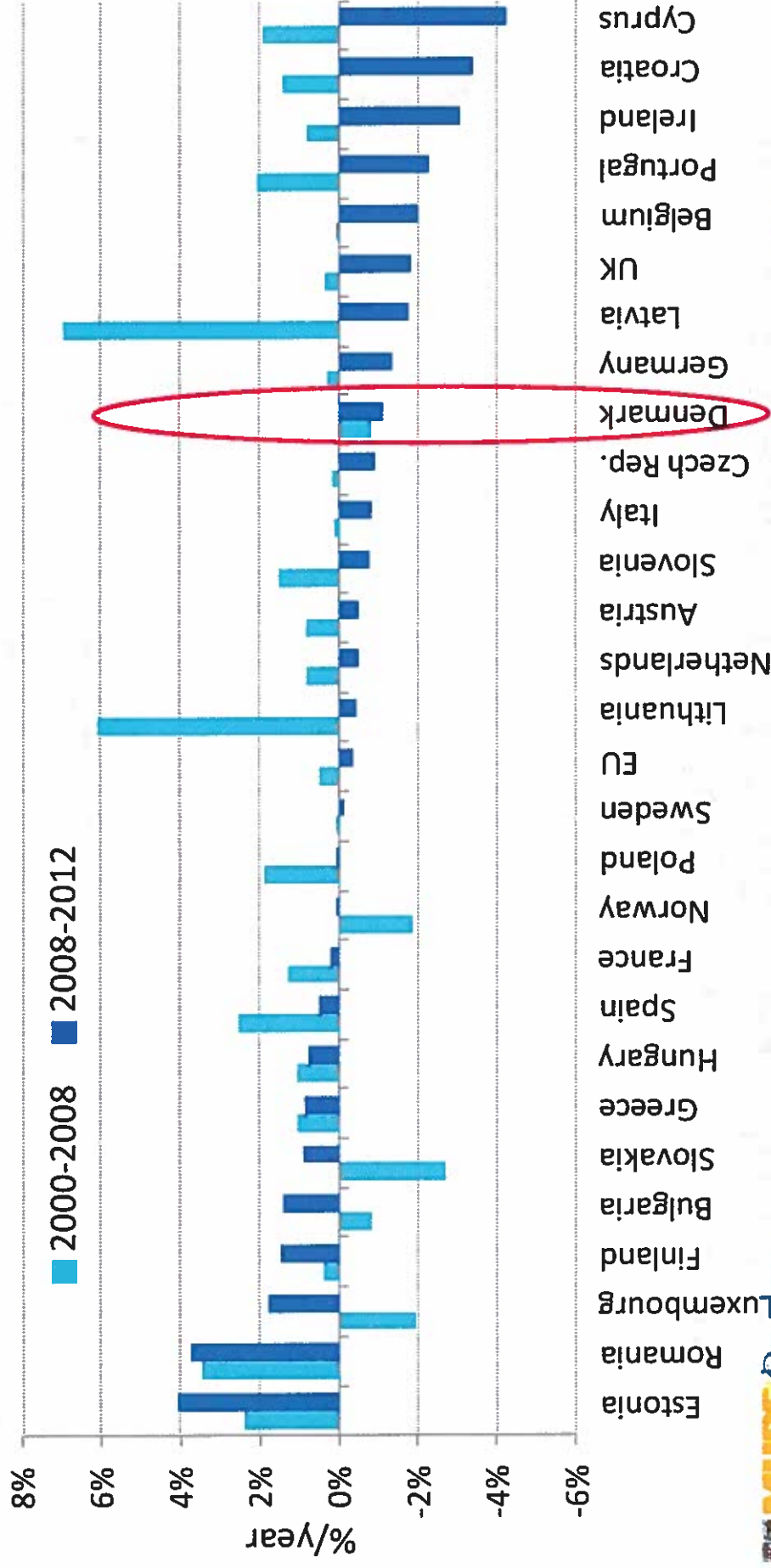


Harmonised degree-days from Eurostat

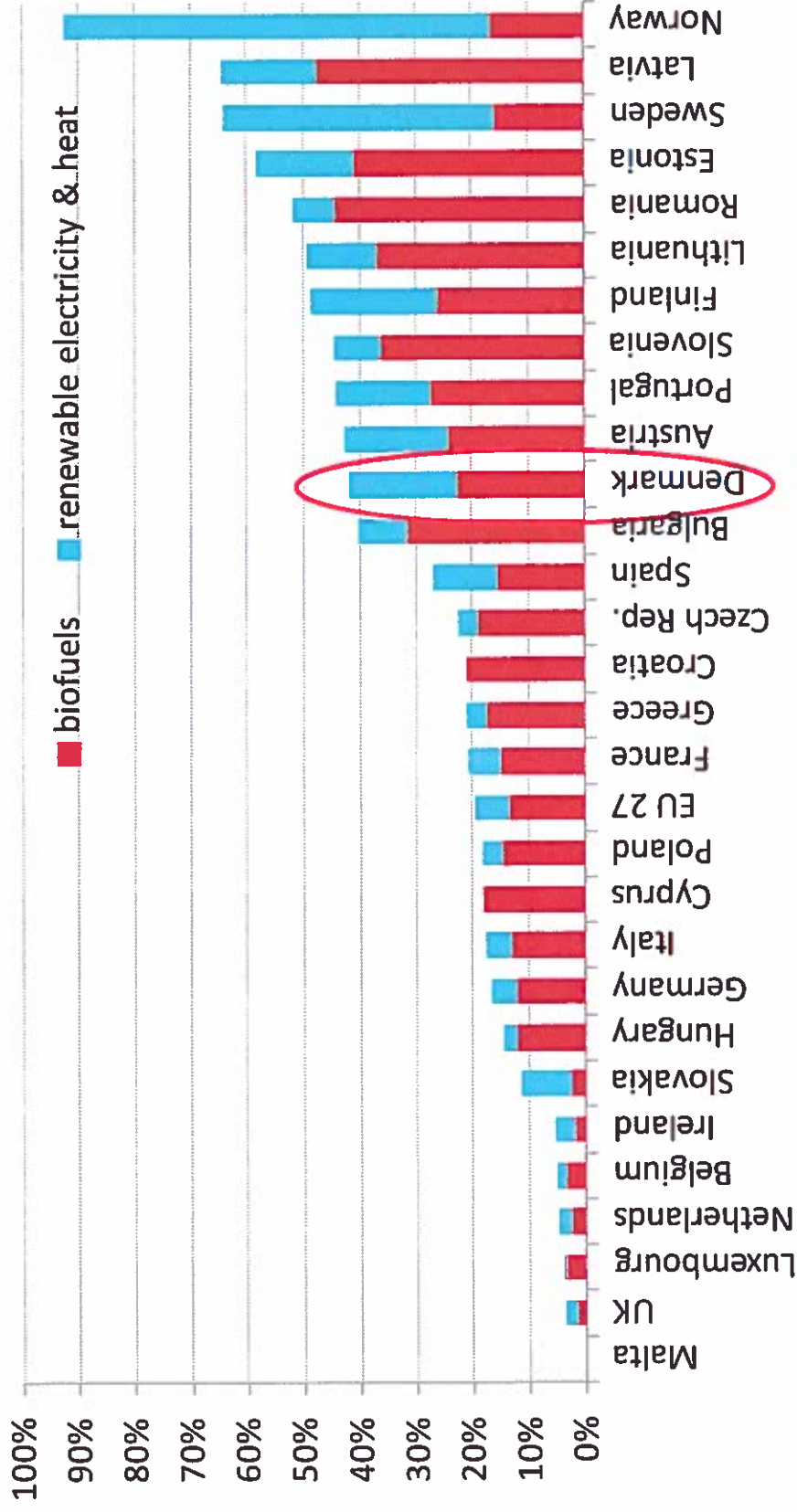
Trends in electricity consumption per dwelling

Since 2008, decrease of the electricity consumption per household in 16 countries and at EU level (-0.4%/year);

In 10 countries, progression despite the recession with most progression for Southern countries (Spain, Greece, Bulgaria) due to air conditioning or Finland, Luxembourg, Romania. **Denmark belongs to the category of countries which accelerates its decrease in electricity specific consumption**



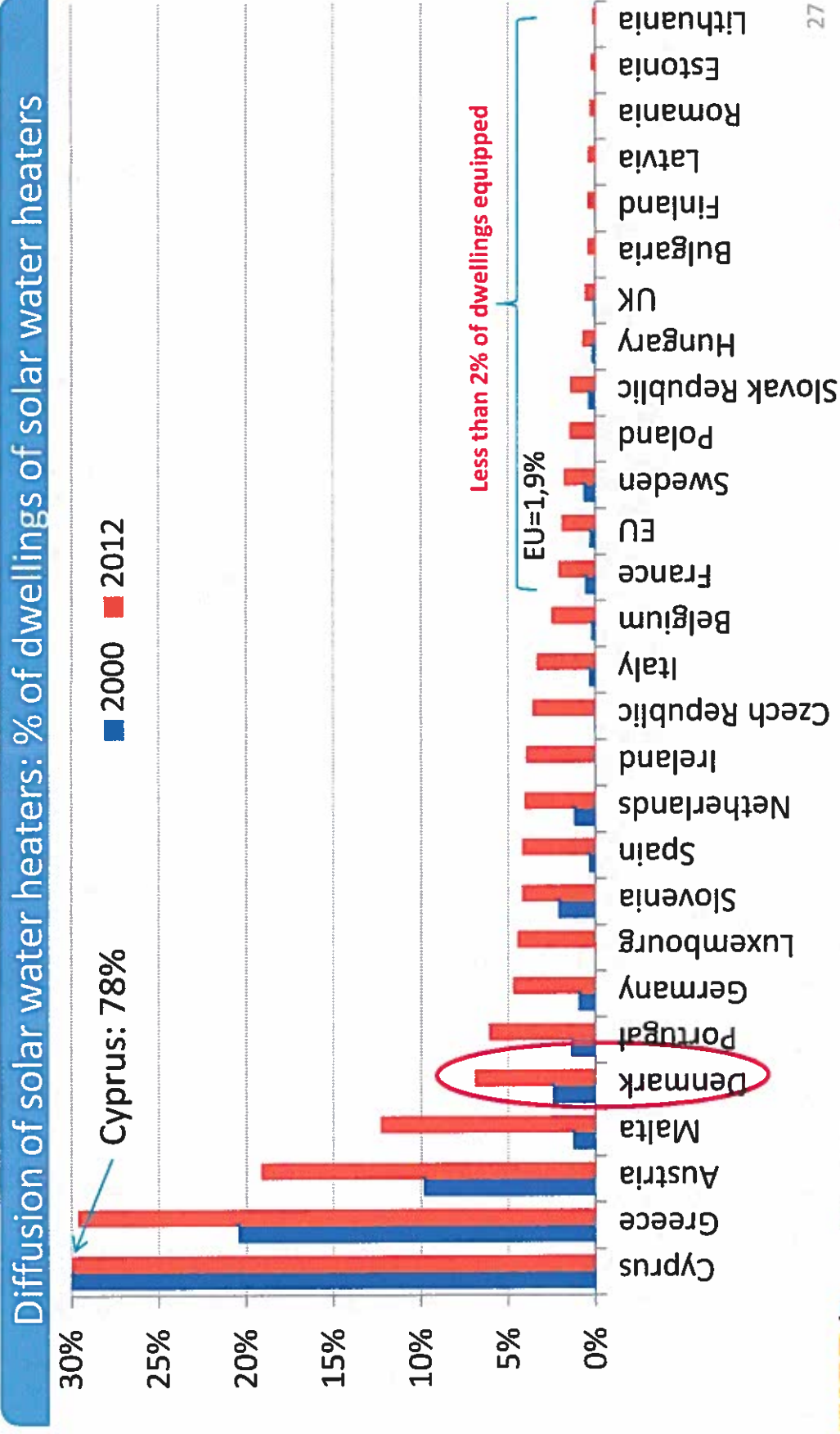
Direct and indirect shares of renewables in household consumption (2012)



At the EU level, the share of renewables in household consumption stands at 19%, of which 13 %-points is biomass and 6 %-points is renewable electricity and heat.

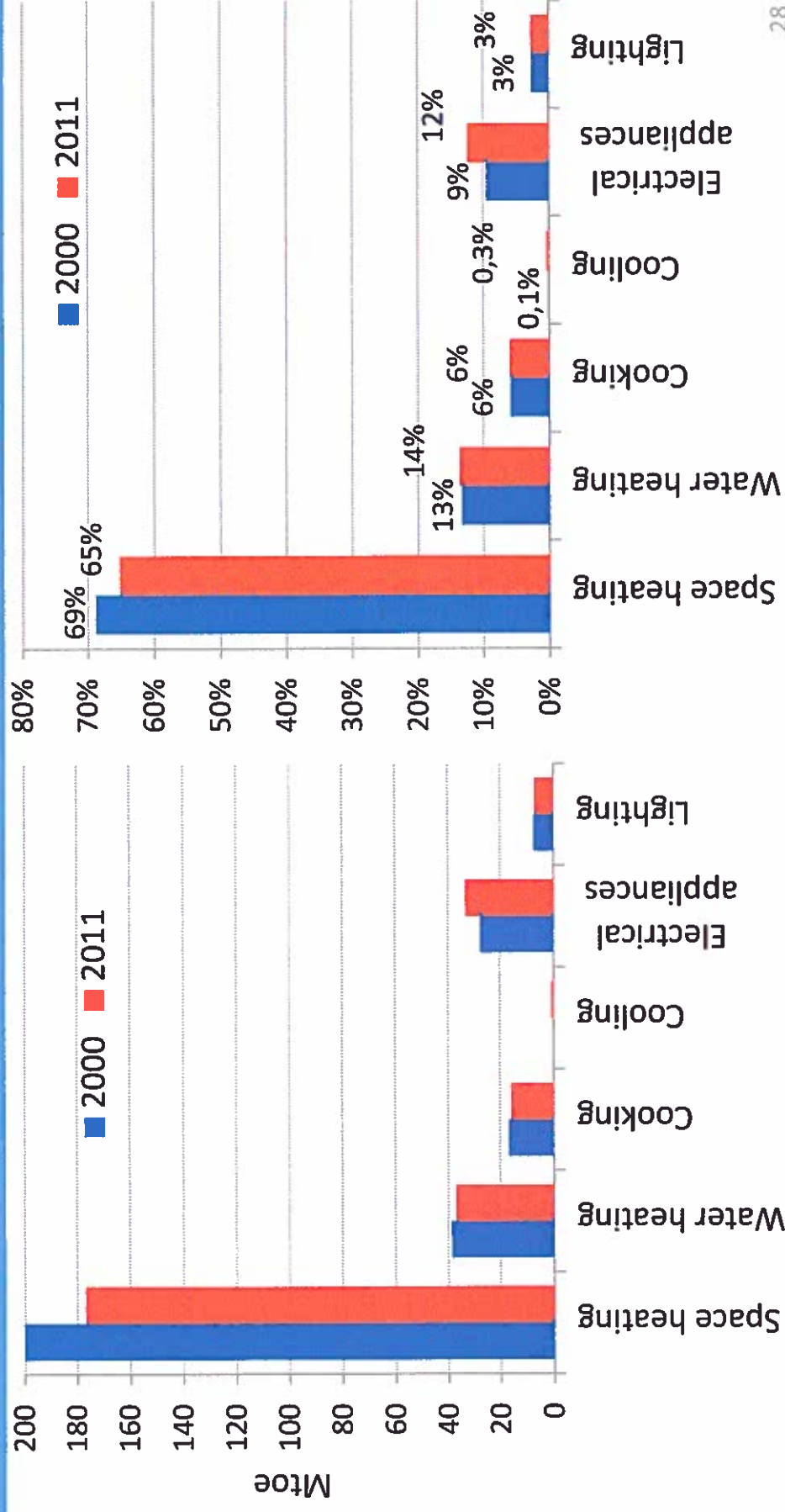
Austria is the benchmark for countries with medium solar radiation (19% in 2012) and Cyprus for countries with good solar radiation (about 80%), followed by Greece (30%);

Denmark leading Scandinavian markets



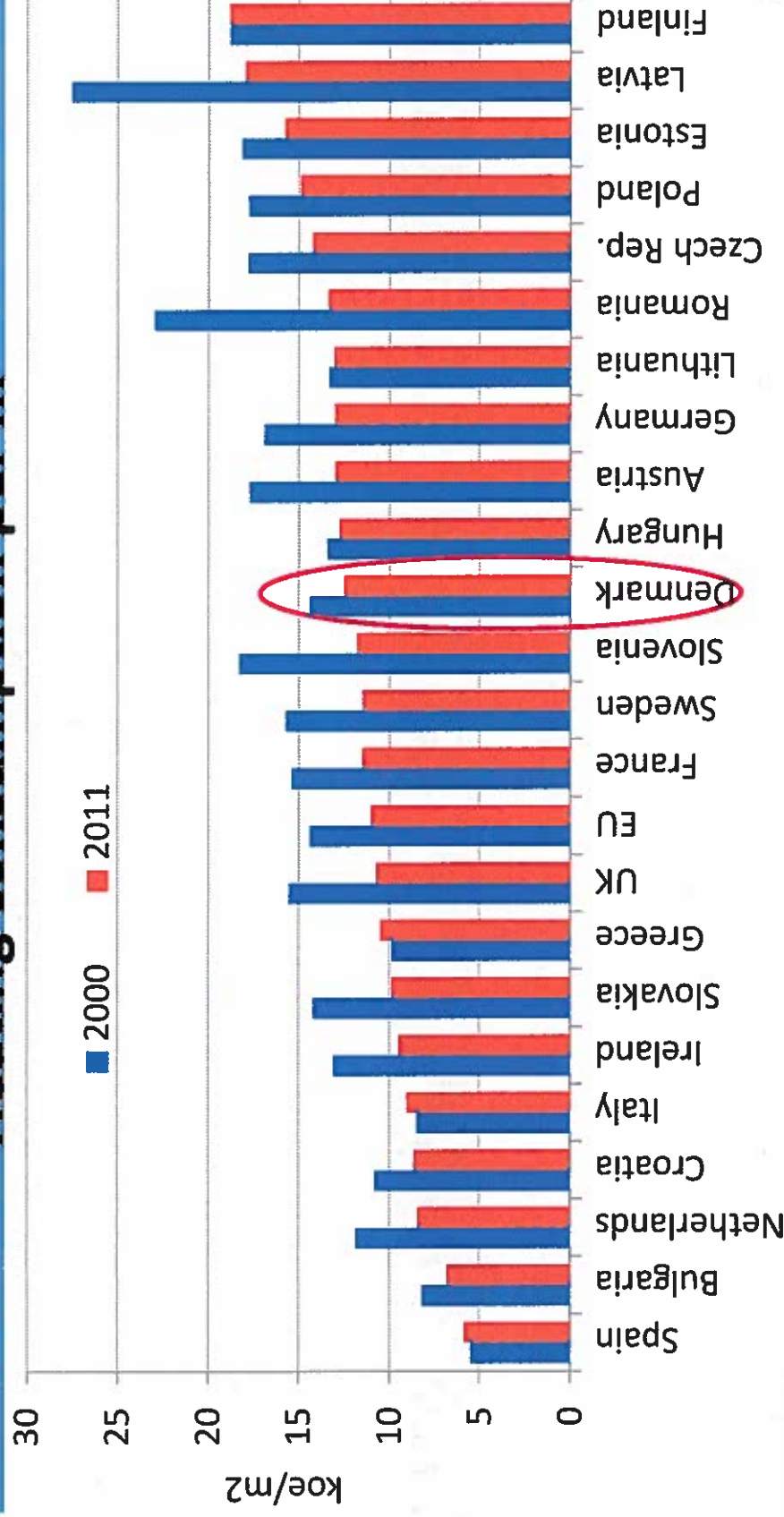
- Declining space heating consumption (-24 Mtoe) and share (-4 points);
- Second end-use: water heating (14%);
- Increasing weight for electrical appliances from 9 to 12%;
- Lighting around 3% and negligible contribution of AC.

Household energy consumption in the EU



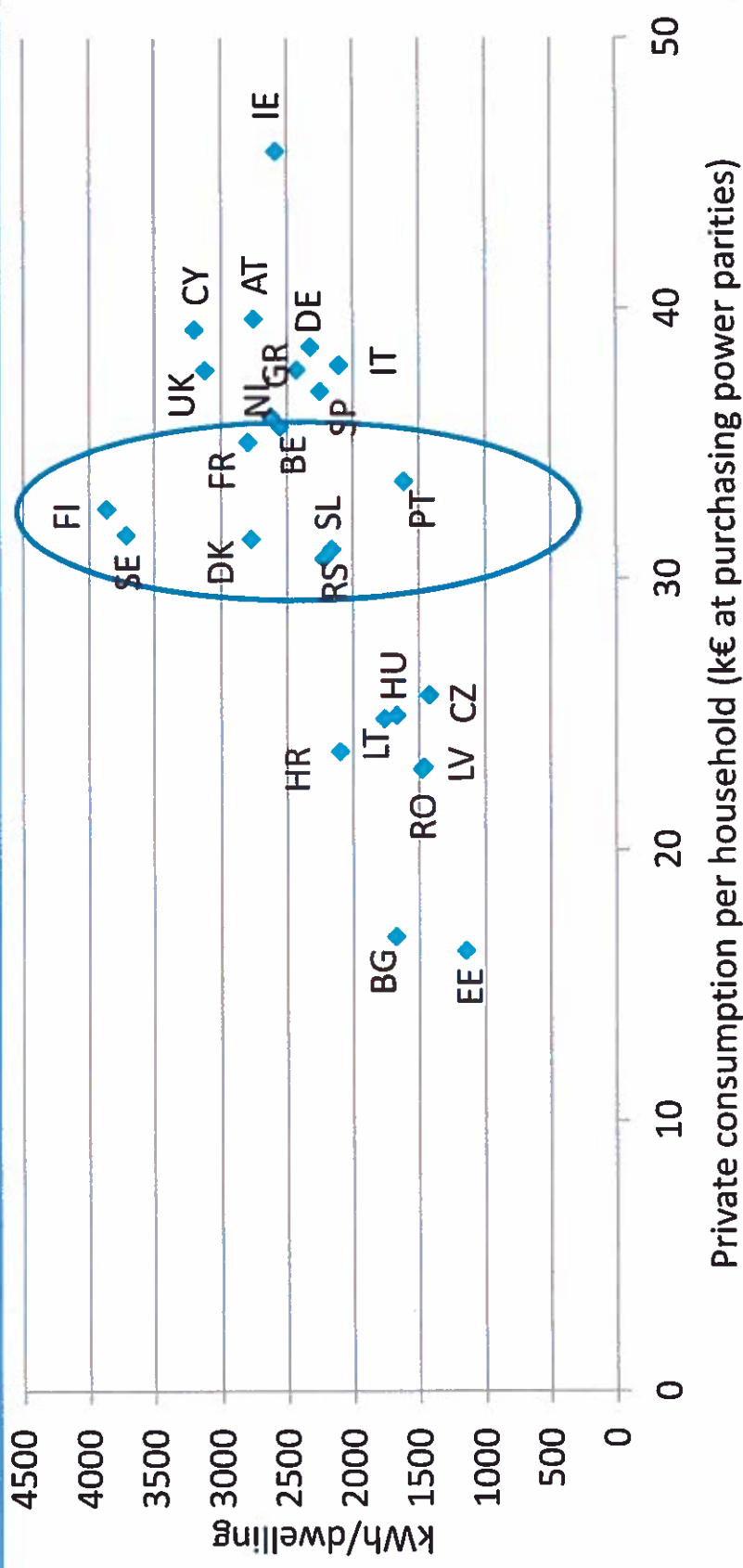
- Decrease of the heating consumption per m² in all countries, except in Southern countries (Italy, Spain, Greece);
- Strong reduction in some EU-15 countries (~25-30% in UK, The Netherlands, Sweden, Ireland, Austria and France)
- And in some new member countries (> 30% in Romania, Slovenia, Latvia and Slovakia), due to higher price and energy efficiency improvements;

Heating consumption per m²

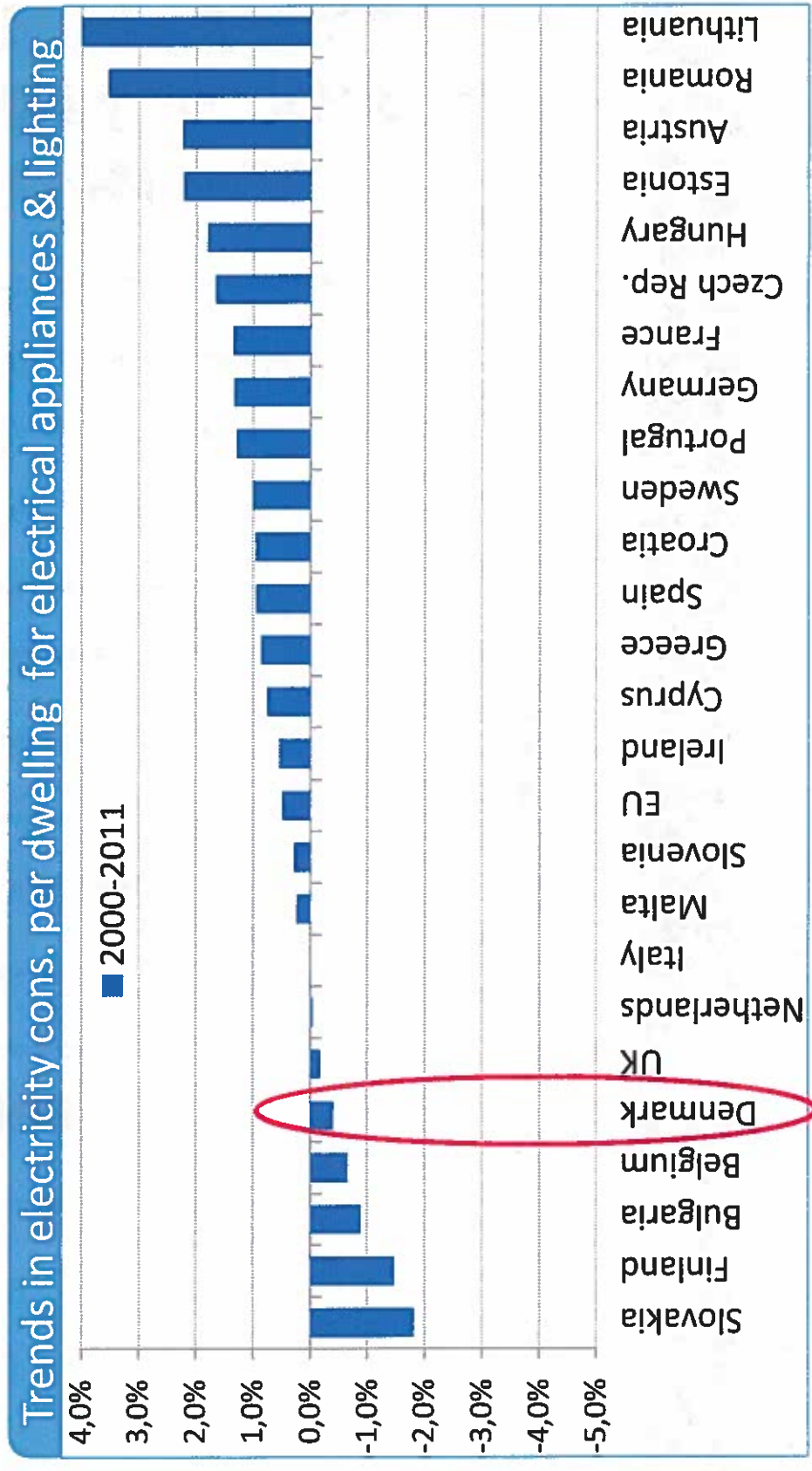


- Significant discrepancies in the electricity consumption for electrical appliances and lighting: in a range from 1000-1500 kWh (Estonia, Czech Republic, Romania, Latvia and Portugal) to around 3000 kWh in UK and Cyprus and almost 4000 kWh in Finland and Sweden
- Partial correlation with average income: there exist huge disparities for a given level of income reflecting differences in lifestyles and equipment efficiency

Consumption for electrical appliances and lighting and private consumption (2012)



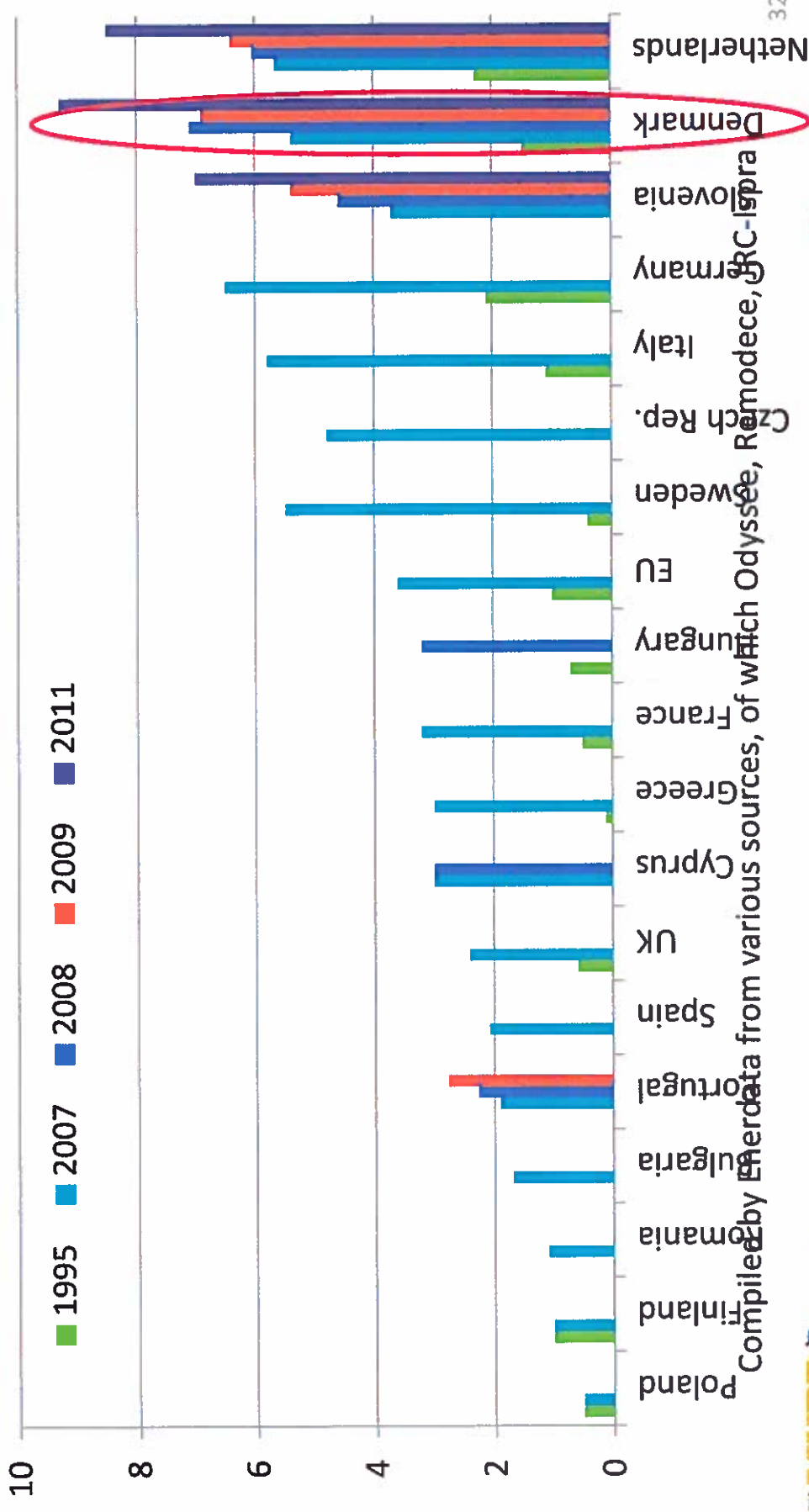
- At EU average, electricity consumption of electrical appliances and lighting increased by 0.5%/year since 2000 with a very unequal progression across countries;
- Increasing trend in almost all countries since 2000 (above 2%/year for 4 countries); on the opposite decreasing trends for 7 countries
- Denmark is able to manage its specific electricity consumption**



About 8 CFL per household in the countries with the largest diffusion of CFL

Denmark is the benchmark in the EU

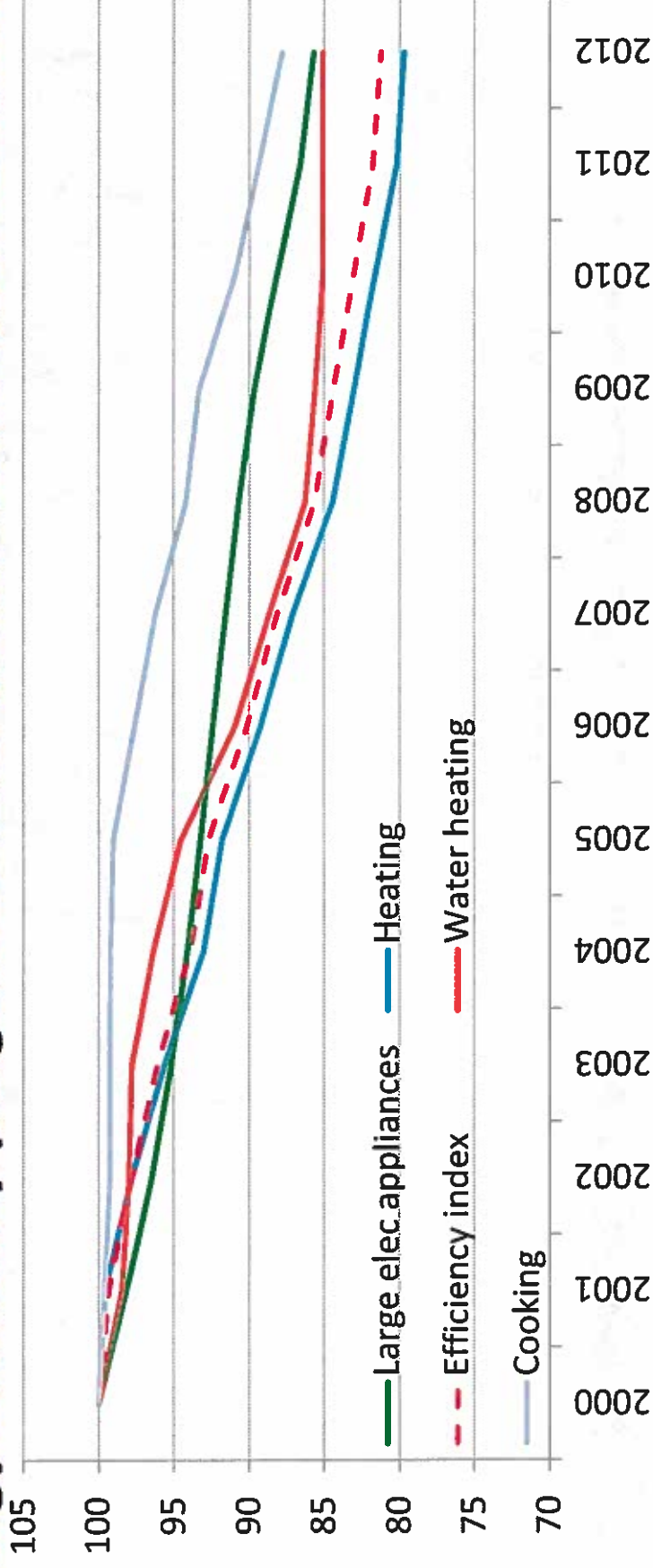
Diffusion of CFL lamps : number of lamps per household



Compiled by Enerdata from various sources, of which Odyssee, Remodece, and C-Ispra

- Energy efficiency improved by 18% over the period 2000-2012, ie by 1.7%/year;
- The efficiency improvement for heating reaches 20% since 2000 ,15% for water heating, and 14% for large electrical appliances.

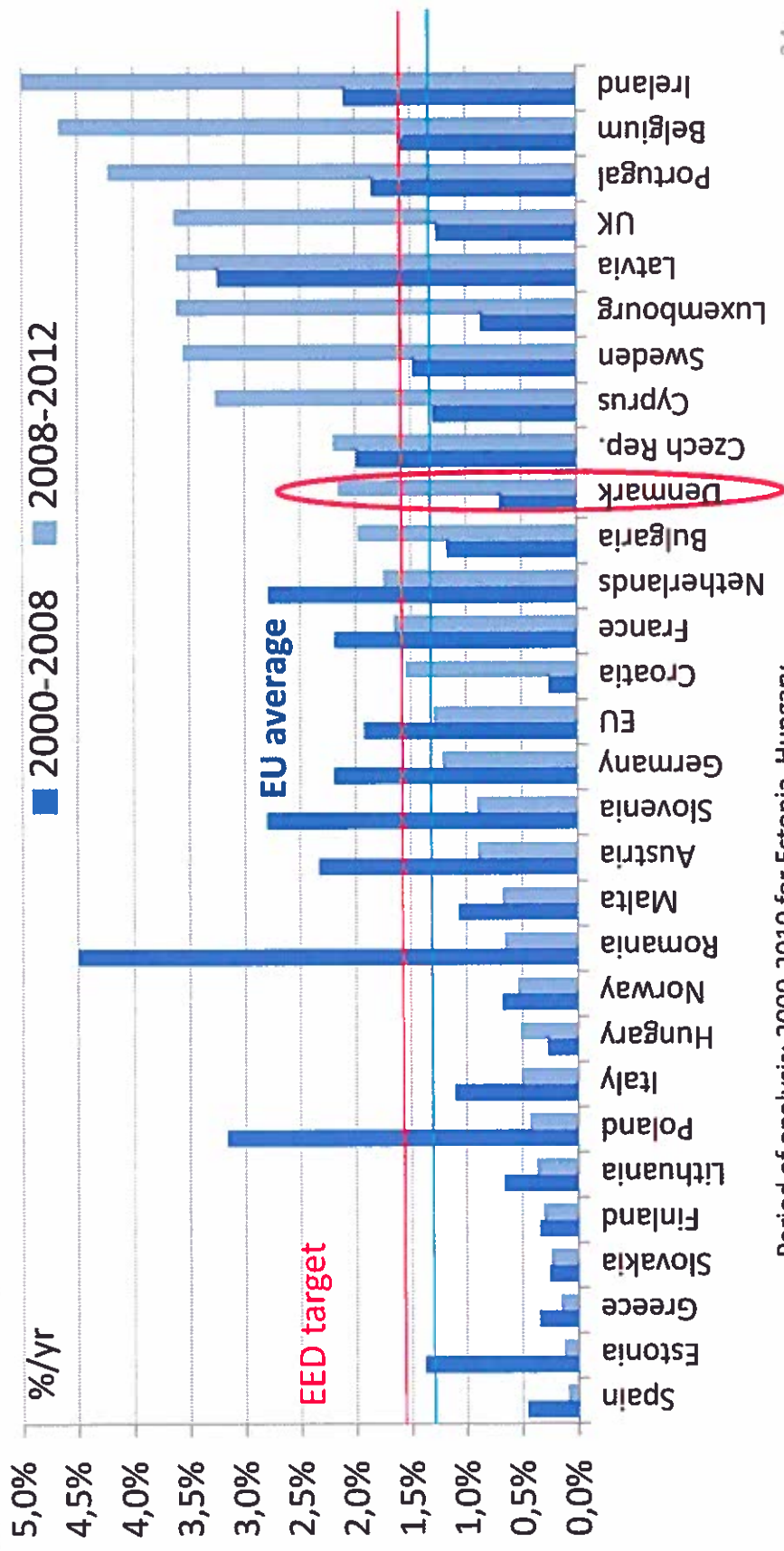
Energy efficiency progress for households in the EU: ODEX



ODEX is an index weighting the energy efficiency progress gains of 8 end-uses/appliances : heating (toe/m2) water heating, cooking (toe/dwelling), refrigerators, freezers, washing machine, dishwashers and TV (kWh/year)

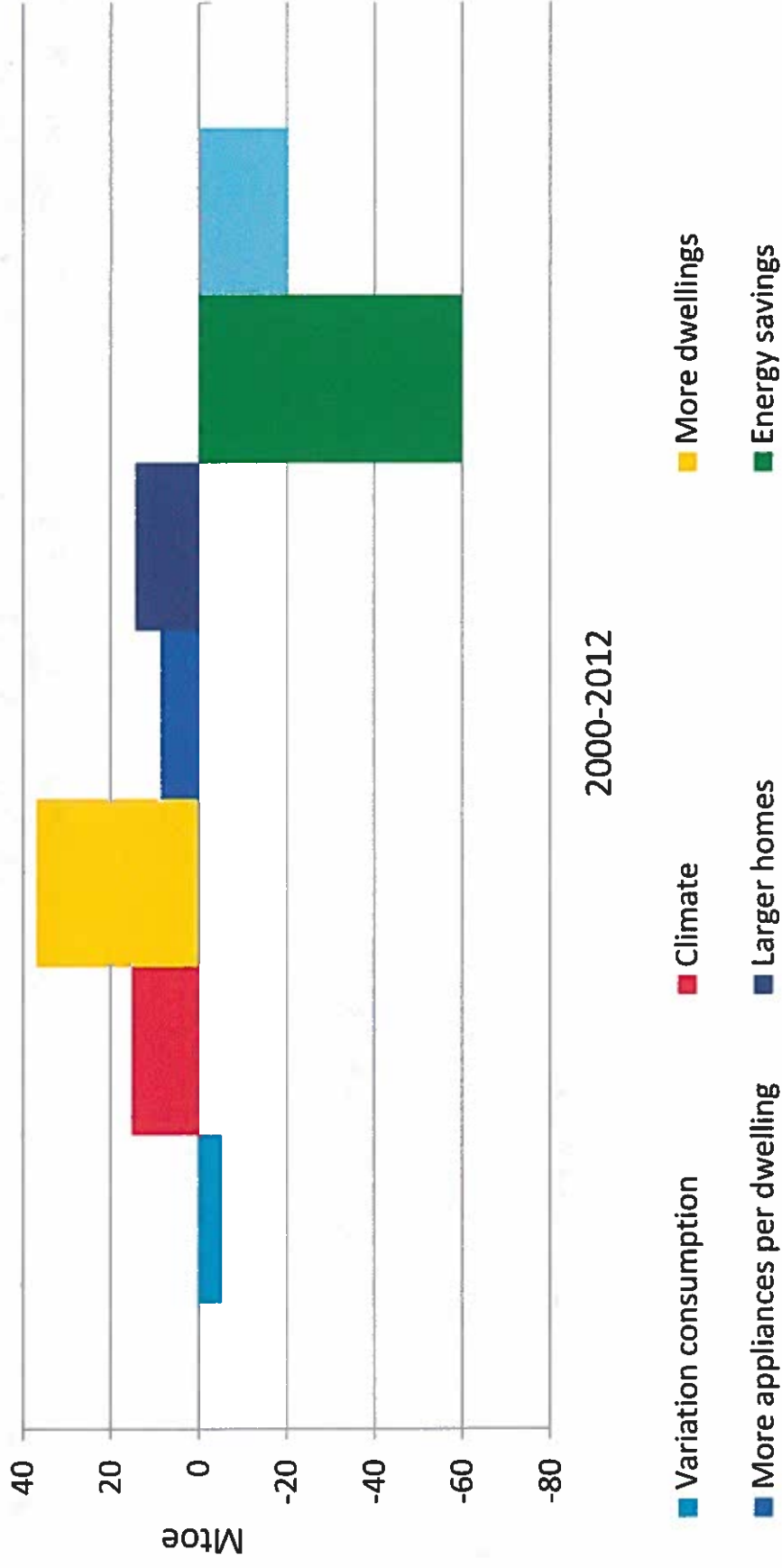
- Slow down in energy efficiency in most countries between 2008 and 2012 (1.3%/year on average in EU, **not in Denmark**)
- On the opposite, large improvements twice higher than the EU average in Cyprus, Sweden, Luxembourg, Latvia, UK, Portugal, Belgium and Ireland .

Energy efficiency improvements by country in the households sector

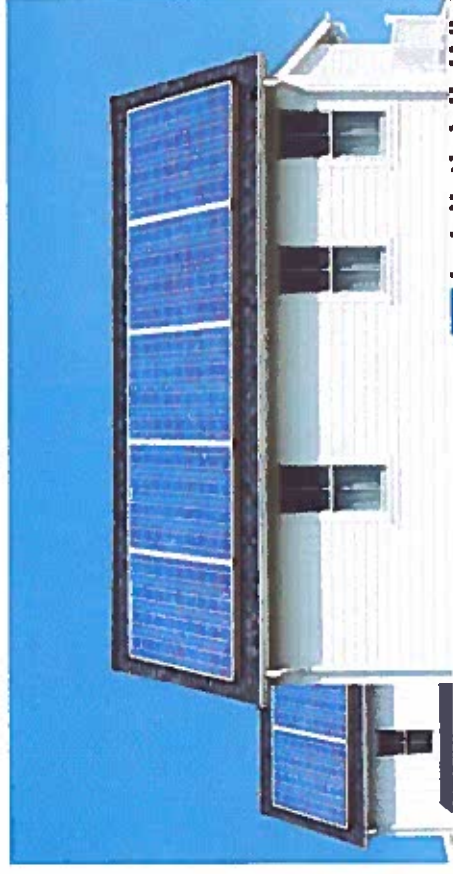


Period of analysis: 2000-2010 for Estonia, Hungary

Decomposition of energy demand changes for households: 2000-2012 (EU)

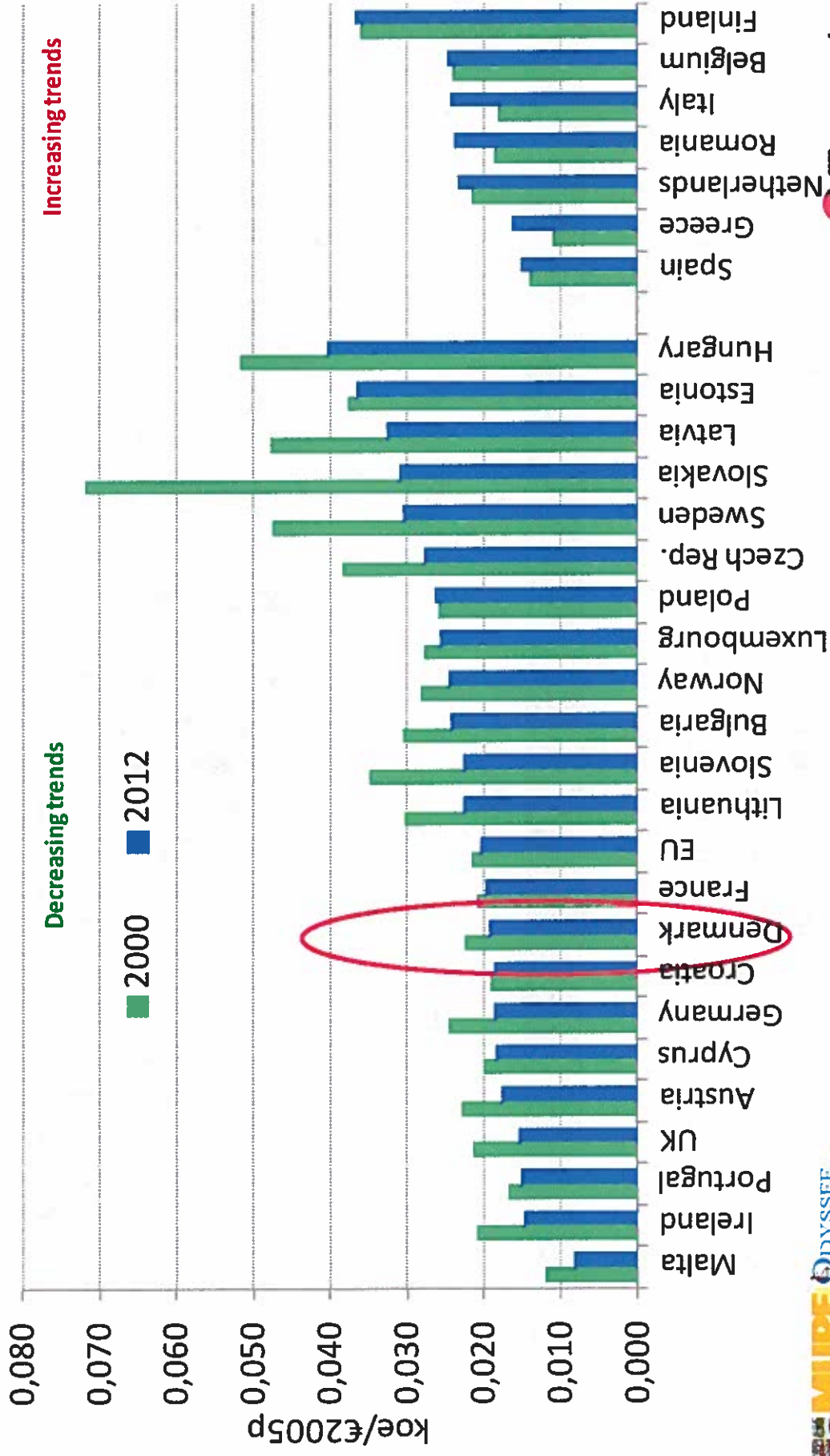


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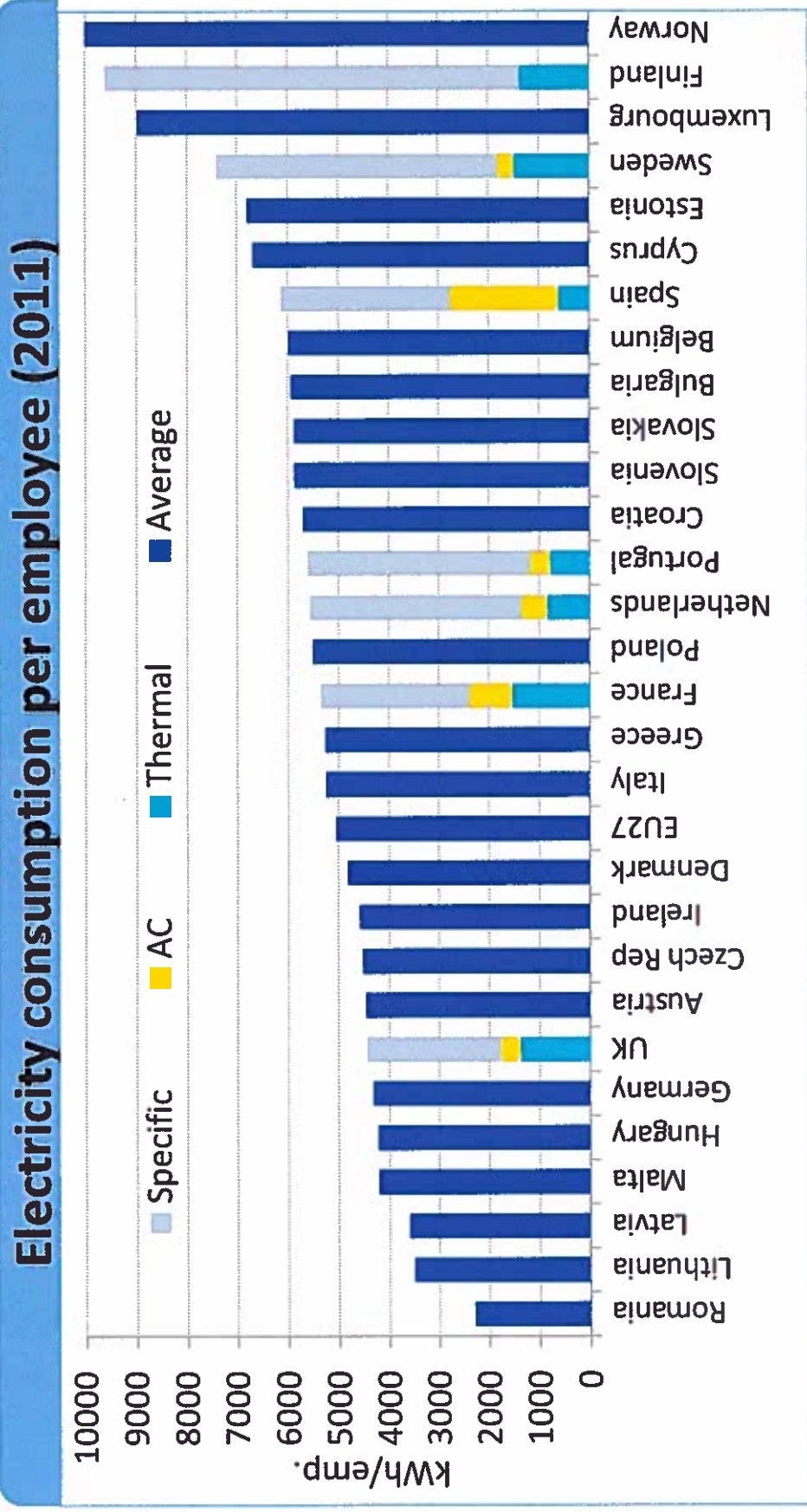


Energy intensity in services

Denmark close to the EU average

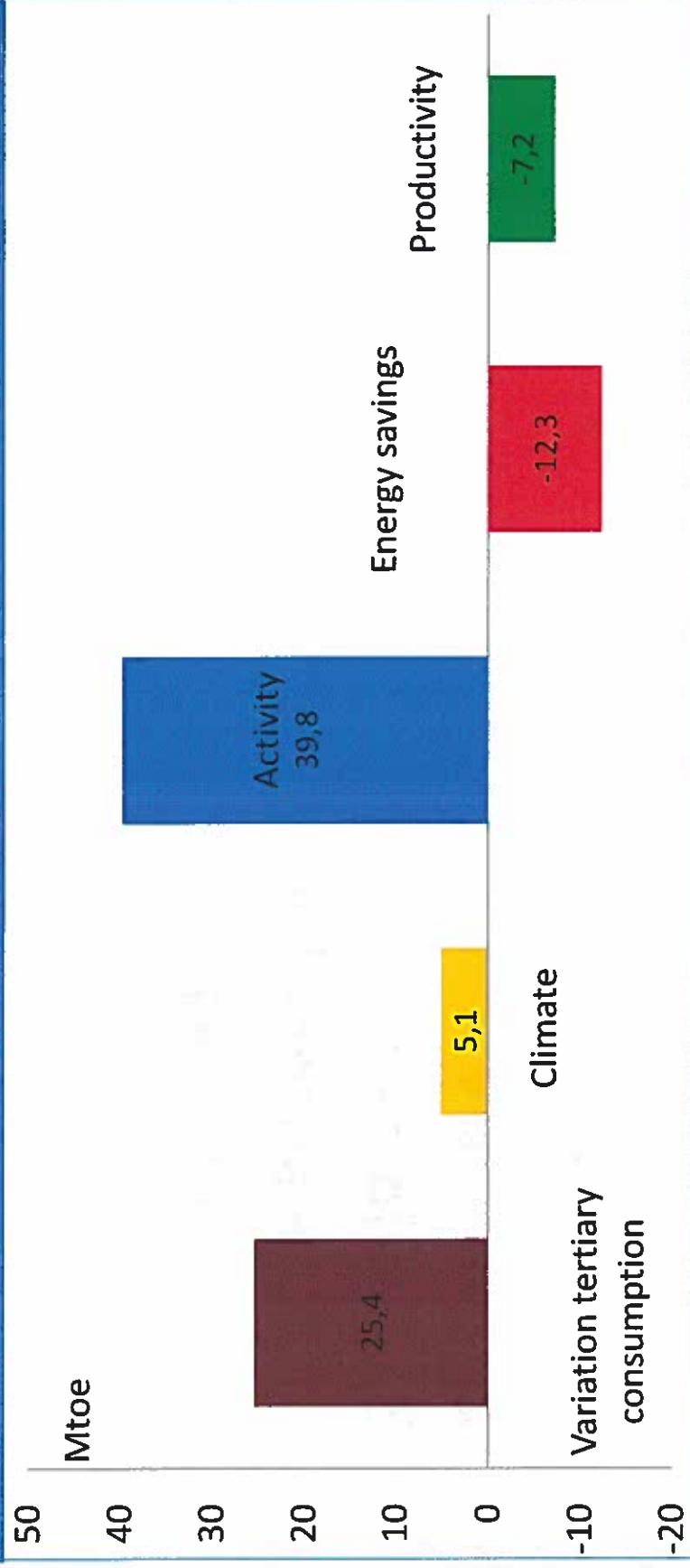


- Large discrepancies among countries: a factor 3 between Latvia, Lithuania and Nordic countries (Norway, Finland)
- High values explained by large diffusion of air conditioning in Southern countries.



- The energy consumption of services increased by 25 Mtoe from 2000 to 2012
- Increase of the value added contributed to raise consumption by almost 40 Mtoe .
- Energy savings and labour productivity gains (VA/employee) decreased the consumption by 12 and 7 Mtoe respectively.

Drivers of the energy consumption in services (2000-2012): EU



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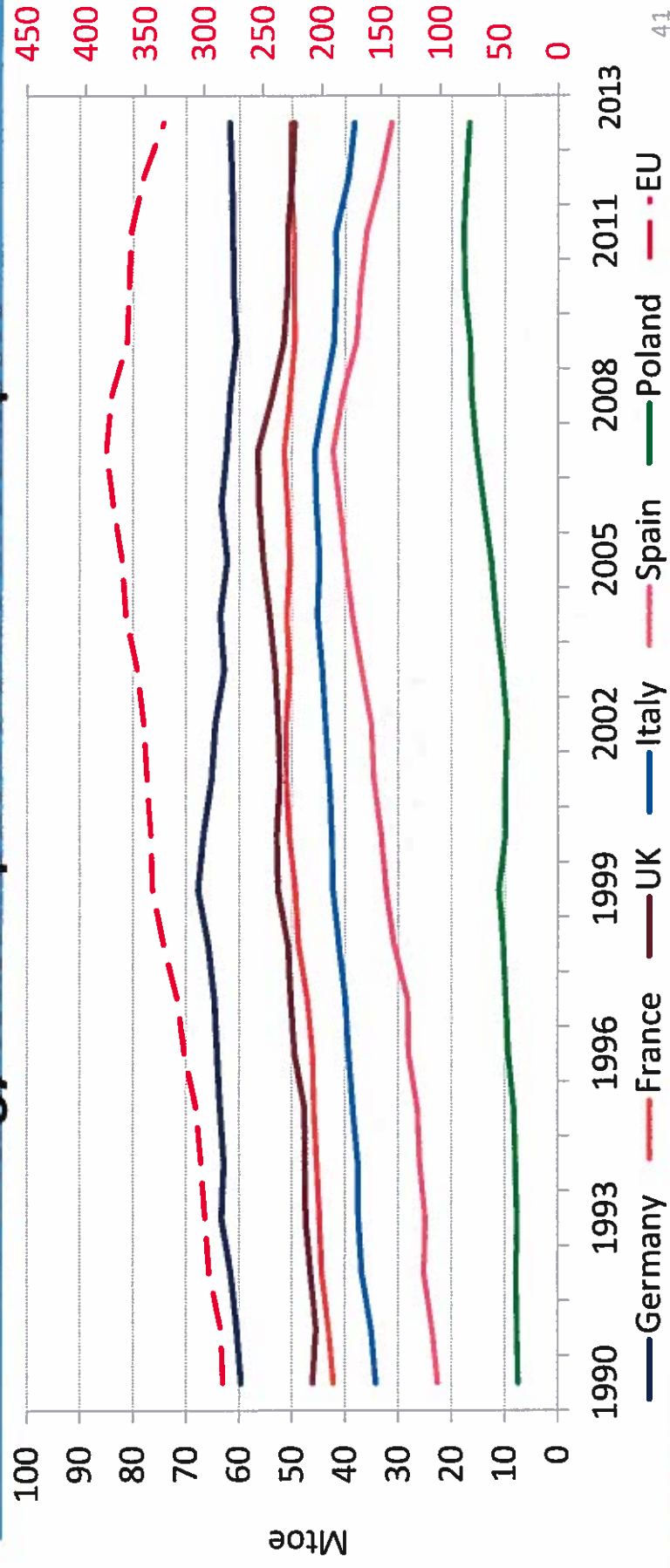
- Decreasing trend since 2007 at EU level (-1,7%/year from 2007 to 2012), due to a stable or decreasing consumption in the largest EU countries:

- Stable in Germany (since 2005) and France (since 2000)

- Decrease in UK and especially in Spain and Italy (by almost 5 and 3%/yr respectively);

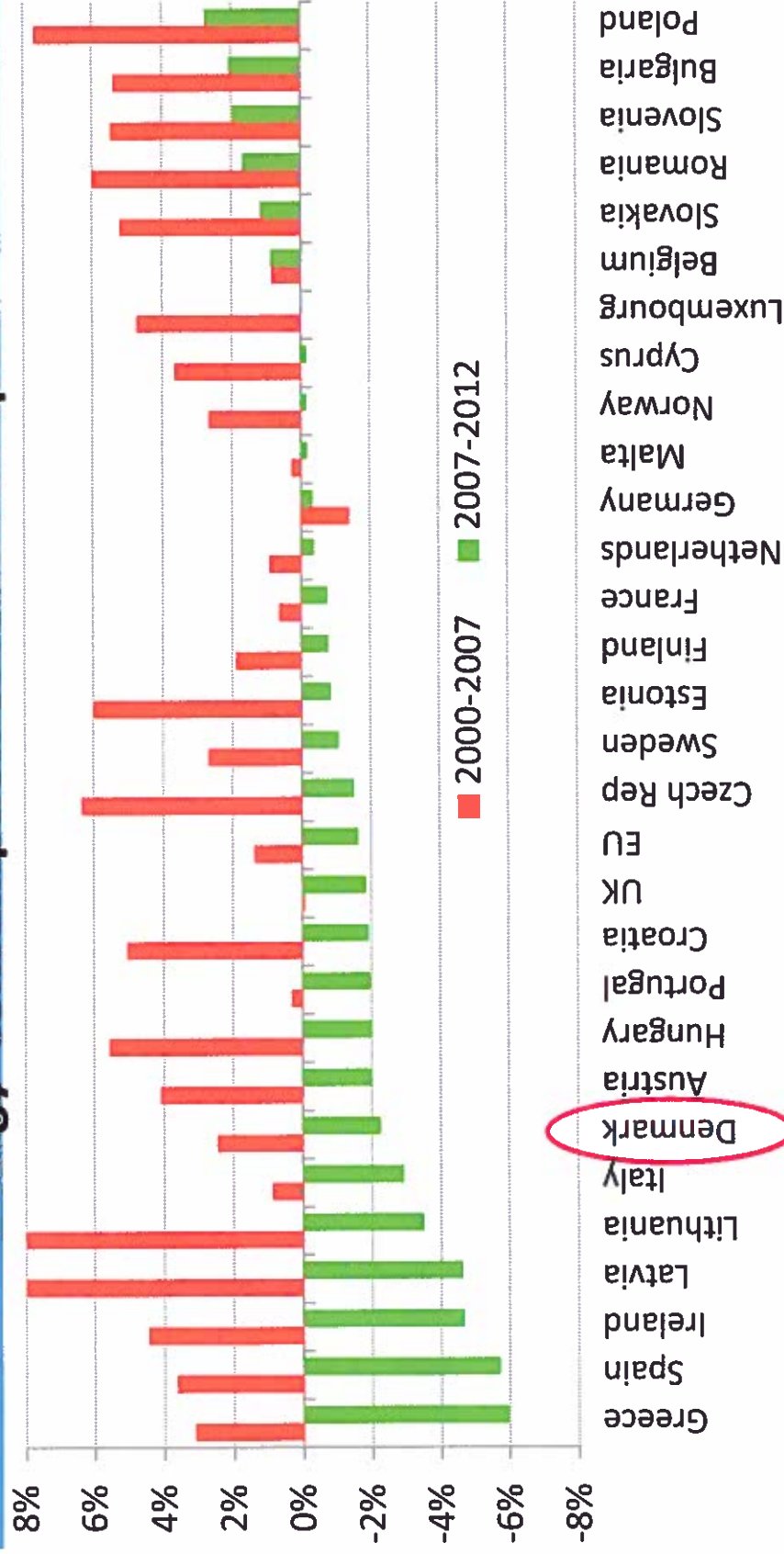
- Contrasted trends for some countries, with a regular progression for some new member countries (Poland, Romania, or Slovenia by around 2%/year) and strong reduction in others (by 5-6%/yr in Greece, and Ireland Latvia).

Energy consumption trends in transport



- Decreasing trends in of road transport consumption in almost all countries since 2007, except in 6 countries (mostly new MCs)
- Strong contrasts compared to the 2000-2007 period in countries hit by the economic crisis (e.g. Greece, Spain, Ireland and Baltic countries).

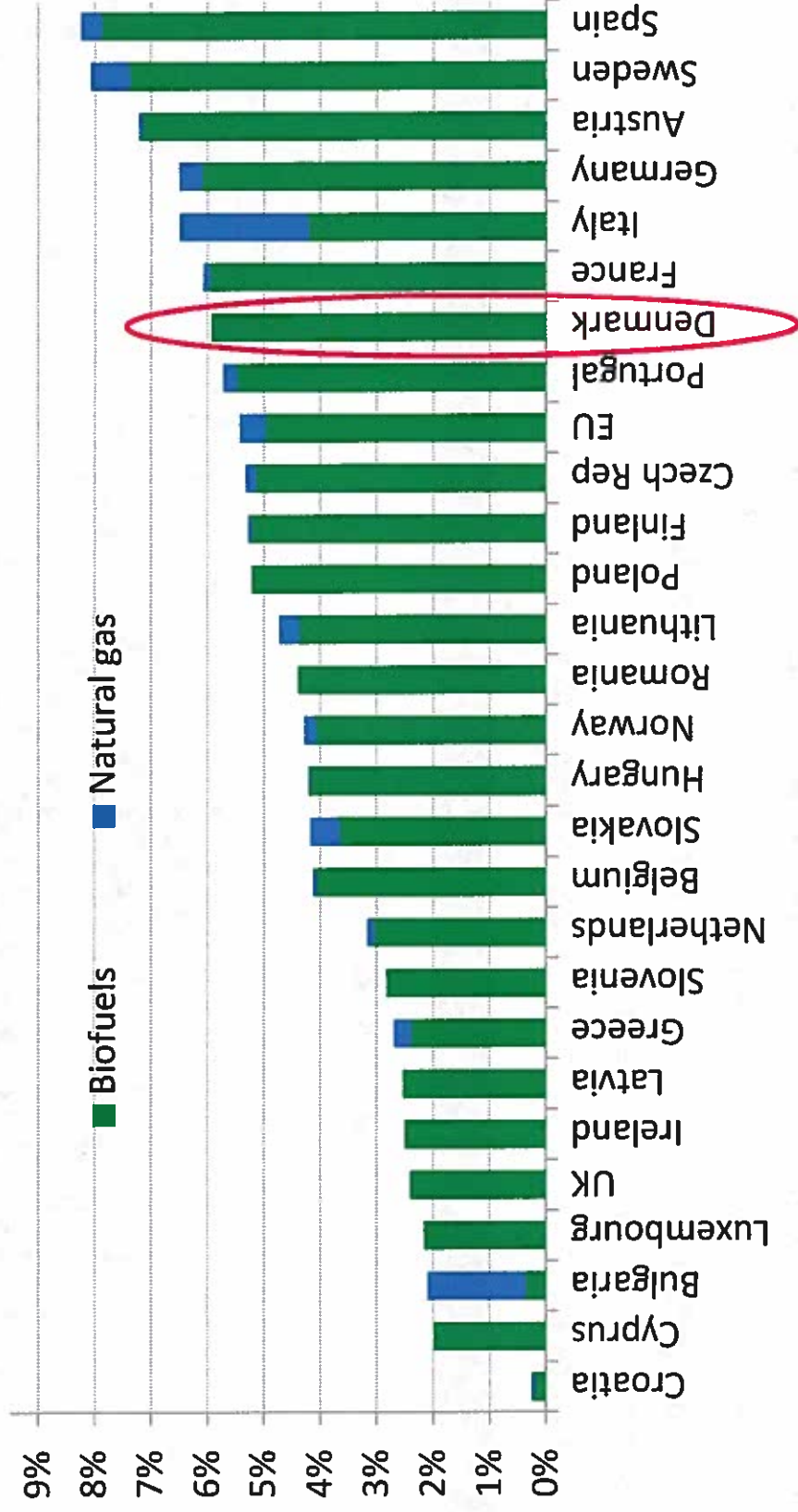
Energy consumption of road transport



Source ODYSSEE

- Alternative fuels (natural gas and biofuels) supplied around 5.5% of the consumption of road transport in the EU, of which 92% of biofuels.
- Spain and Sweden are the leaders (around 8%); **Denmark in top 5 for biofuels**
- Italy and Bulgaria have the highest penetration of CNG (~2%).
- Around 3% of the biofuel is biodiesel

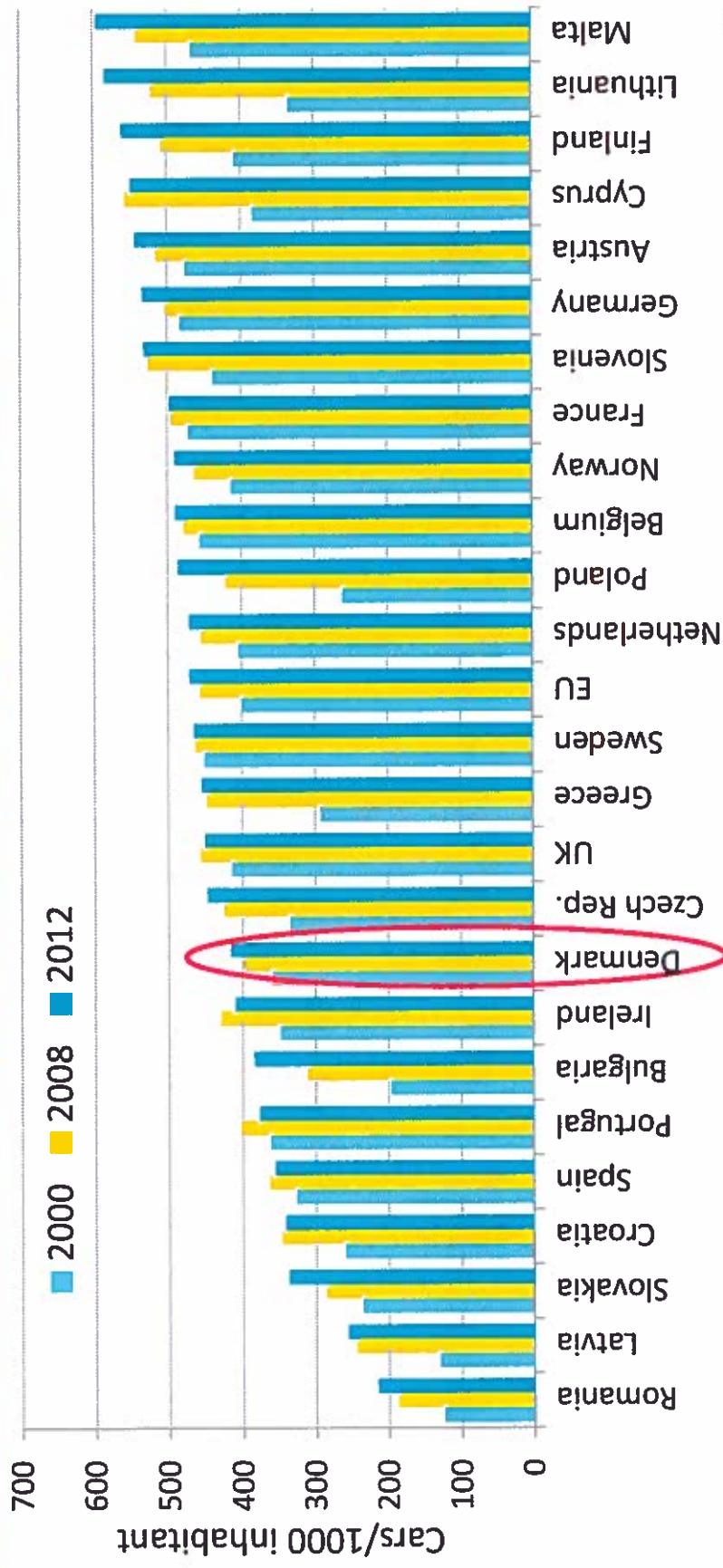
Share of alternative fuels to oil in road transport (2012)



Source Enerdata

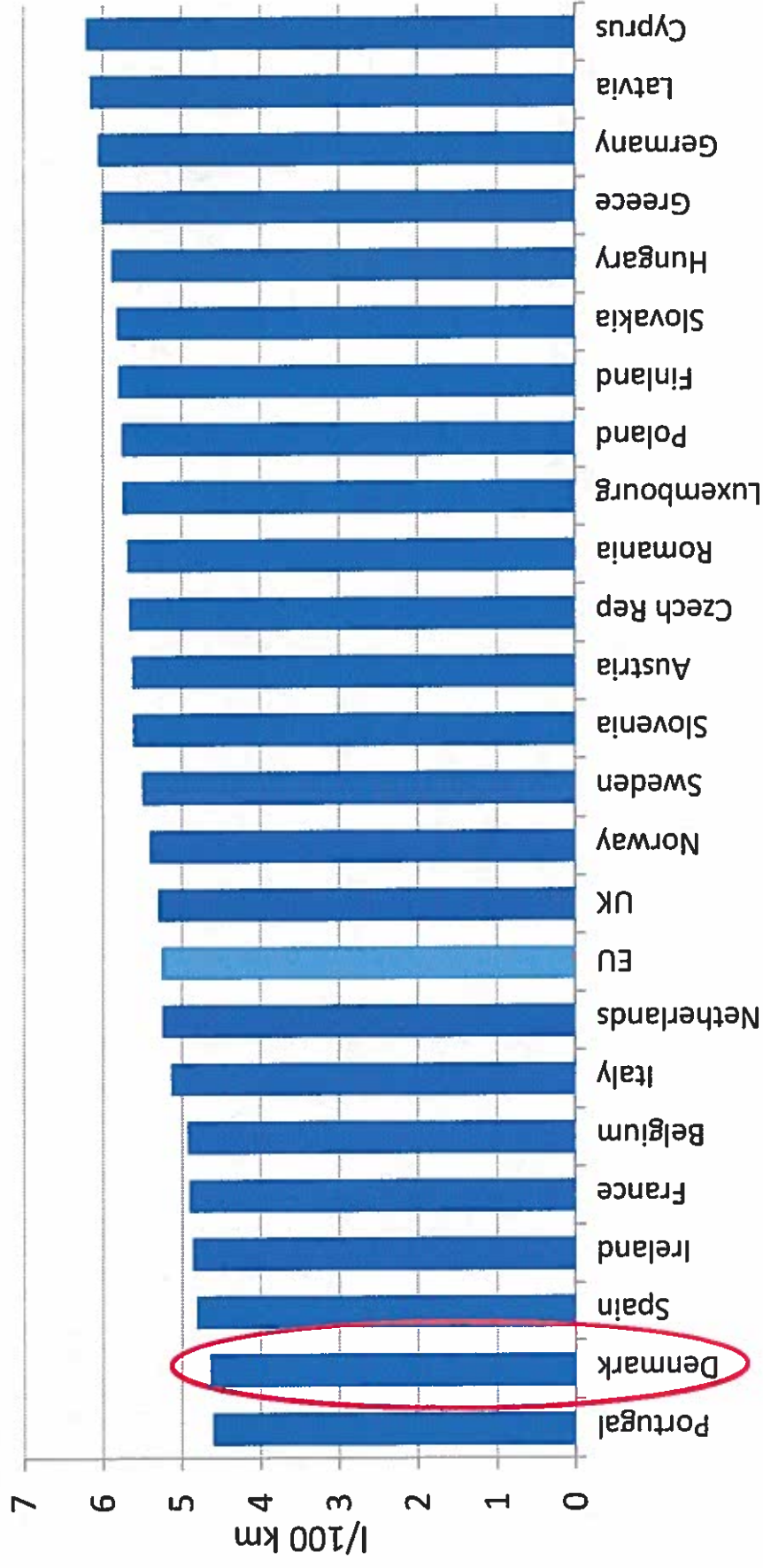
- Low progression in car ownership since 2008 and even decrease in 7 countries
- Very rapid growth in new member countries because of their lower car density with 4 countries with a progression above 5%/year (Bulgaria, Latvia, Lithuania, Poland)
- Low progression since 2000 in some EU-15 countries due to saturation, especially in UK, Sweden, France and Belgium
- **Denmark has a the low ownership compared with is GDP/capita level**

Number of cars per capita



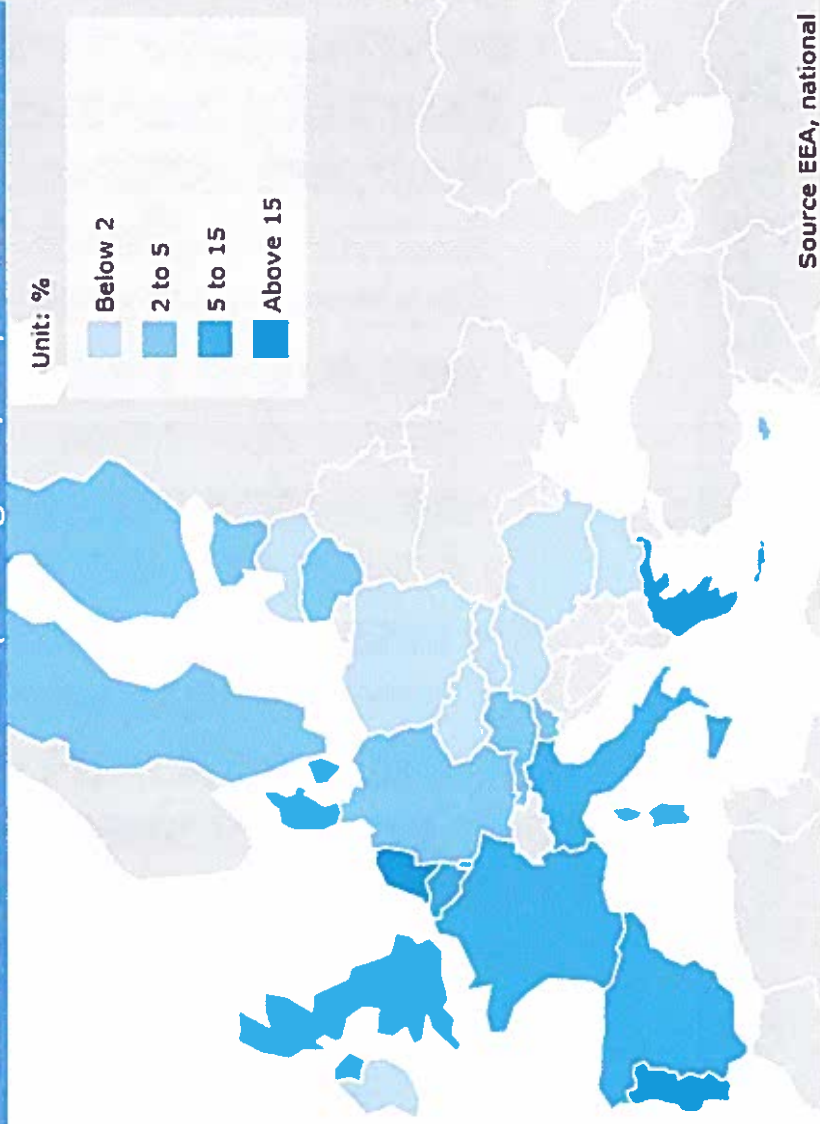
- 6 countries below 5 l/100km with Portugal and **Denmark in the lower range.**
- Convergence in the specific consumption of new cars: 1.6 l/100km difference between extremes values in 2012 compared to 2.4 l in 2000.

Specific consumption of new cars (2012)

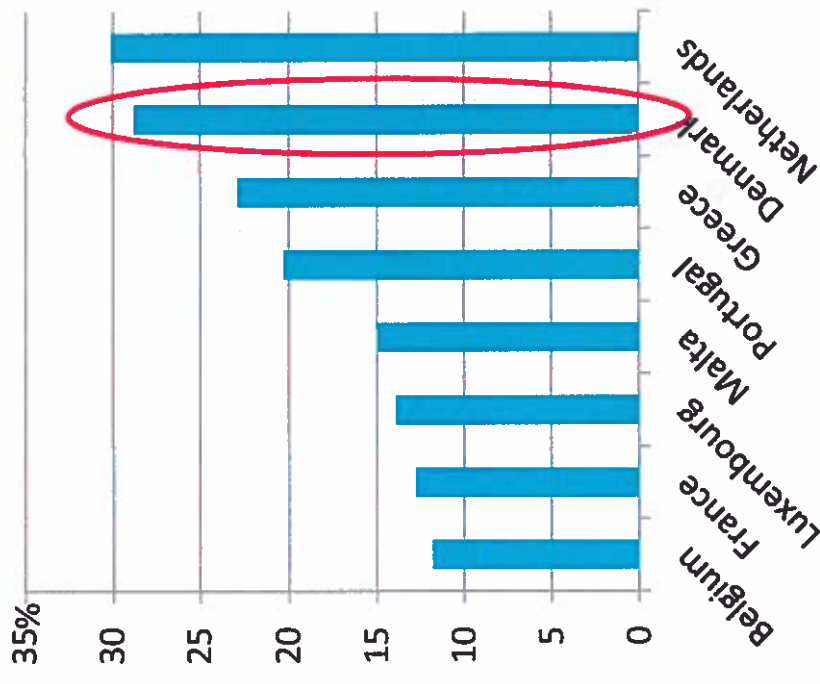


- 8-countries with more than 10% of new vehicles emitting less than 100 gCO₂/km in 2012, and even 4 (Portugal, Greece, Denmark and Netherlands) with more than 20% of new cars <100 gCO₂/km.

Share of efficient cars (<100 gCO₂/km) in total sales

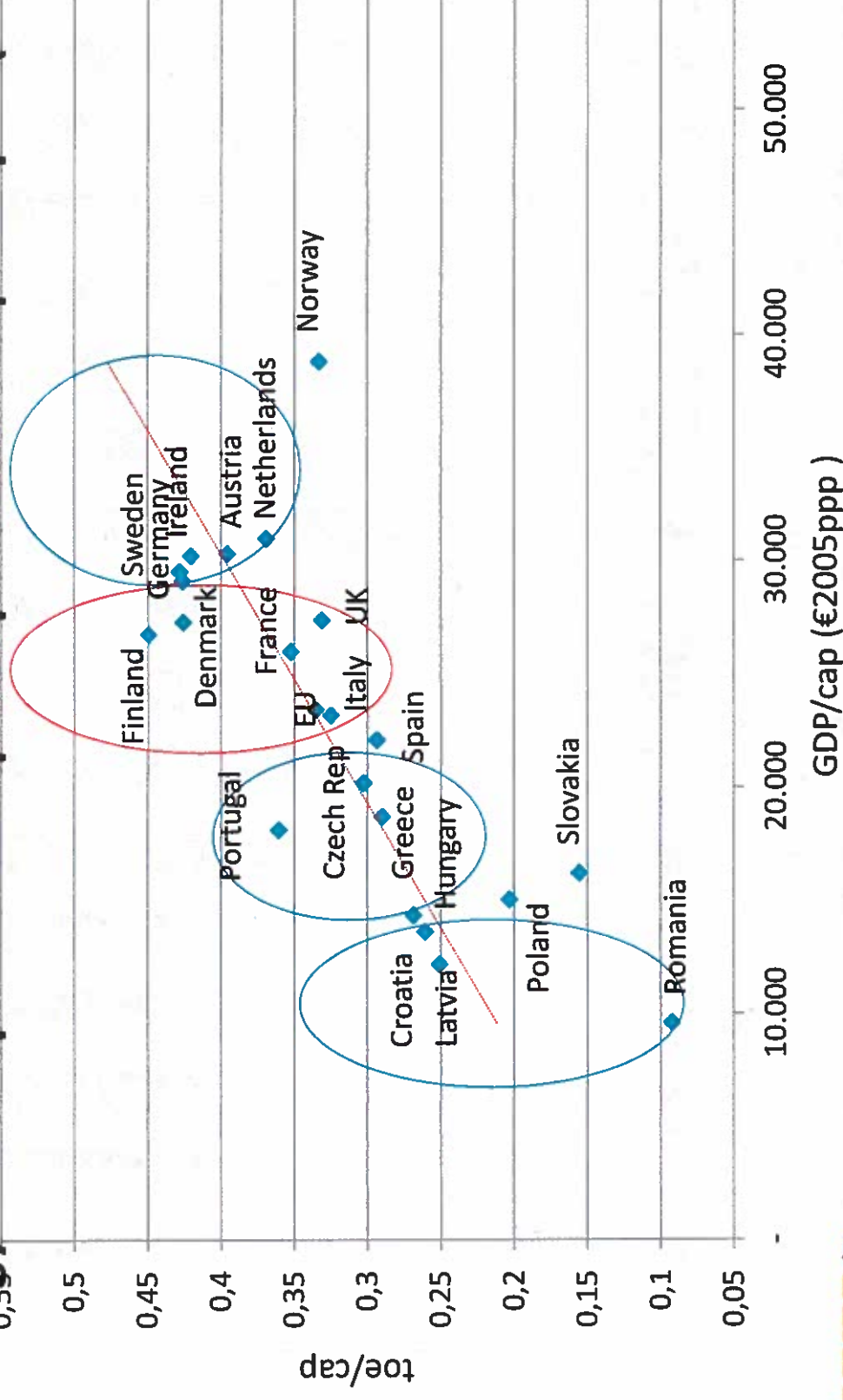


Top countries with highest share of efficient cars (2012)



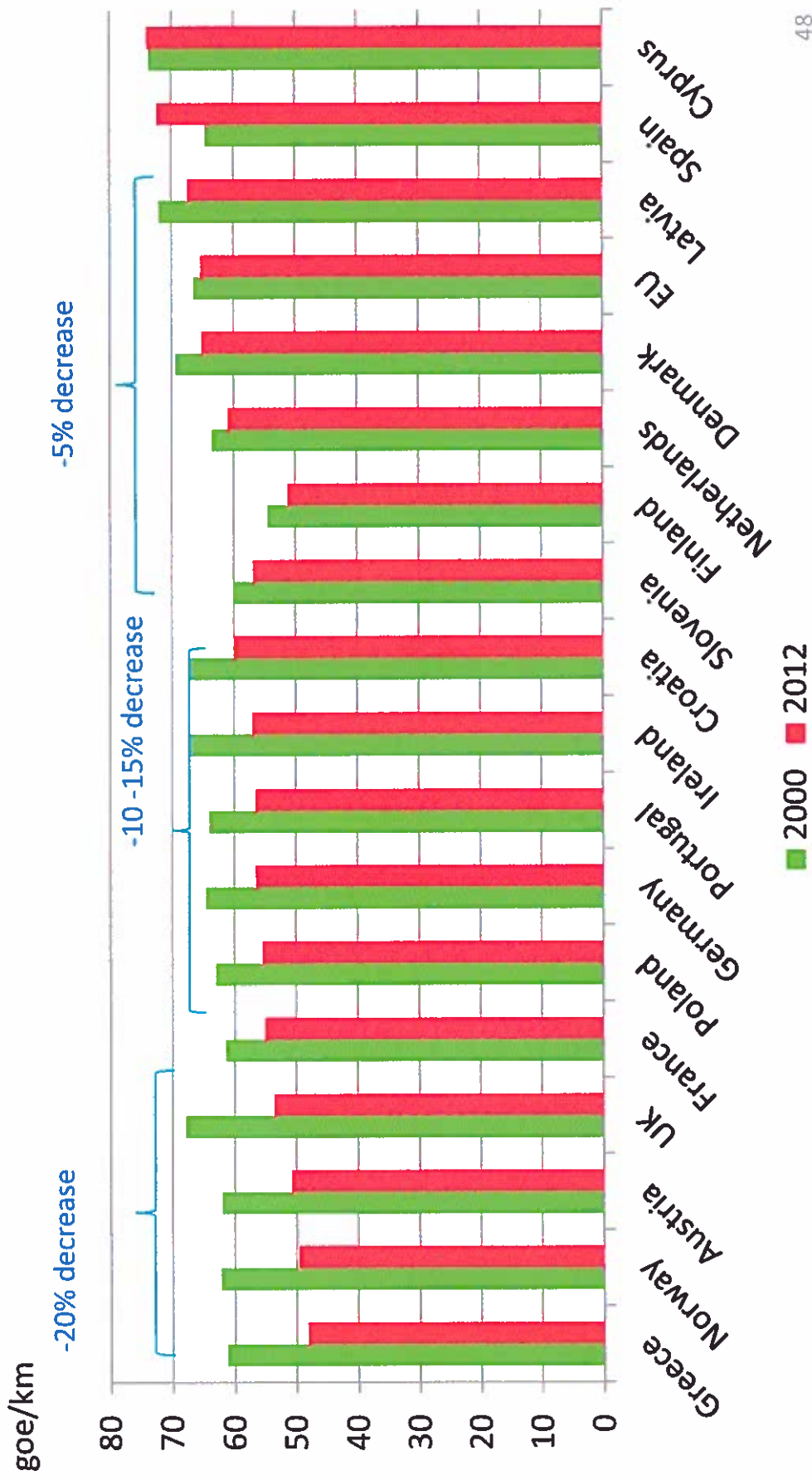
- For a given level of income, range of 20 to 40% in the average consumption of cars, reflecting differences in the fuel efficiency of cars, in the distance travelled and the car ownership. **Denmark is high**

Energy consumption of car per capita and GDP per capita (2012)



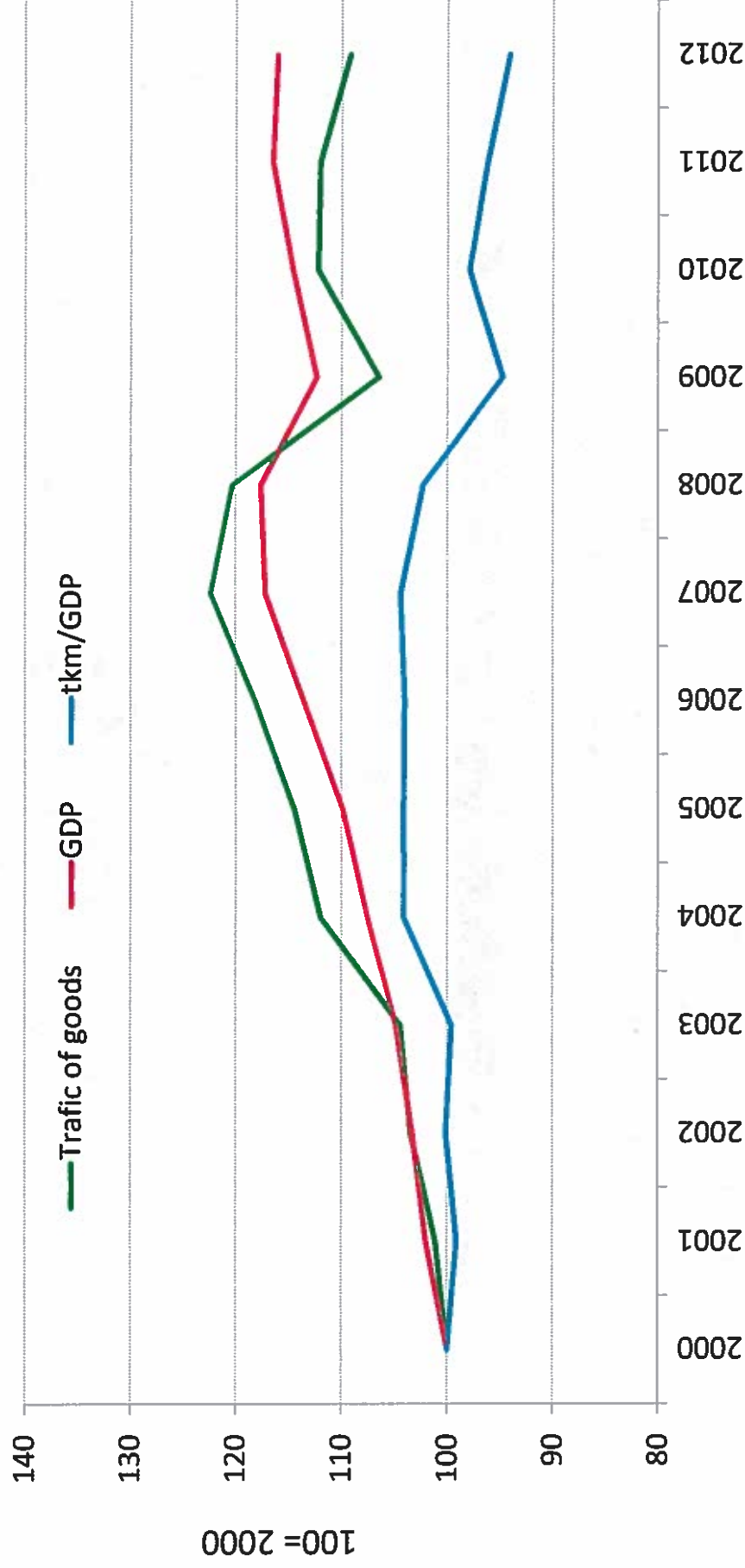
- Decreasing trends in energy consumption of cars per km except for Spain and Cyprus.
- Around 10 to 15% decrease in most of countries between 2000 and 2012
- **Danish are using cars more than the average europeans**

Energy consumption of cars per km (goe/km)



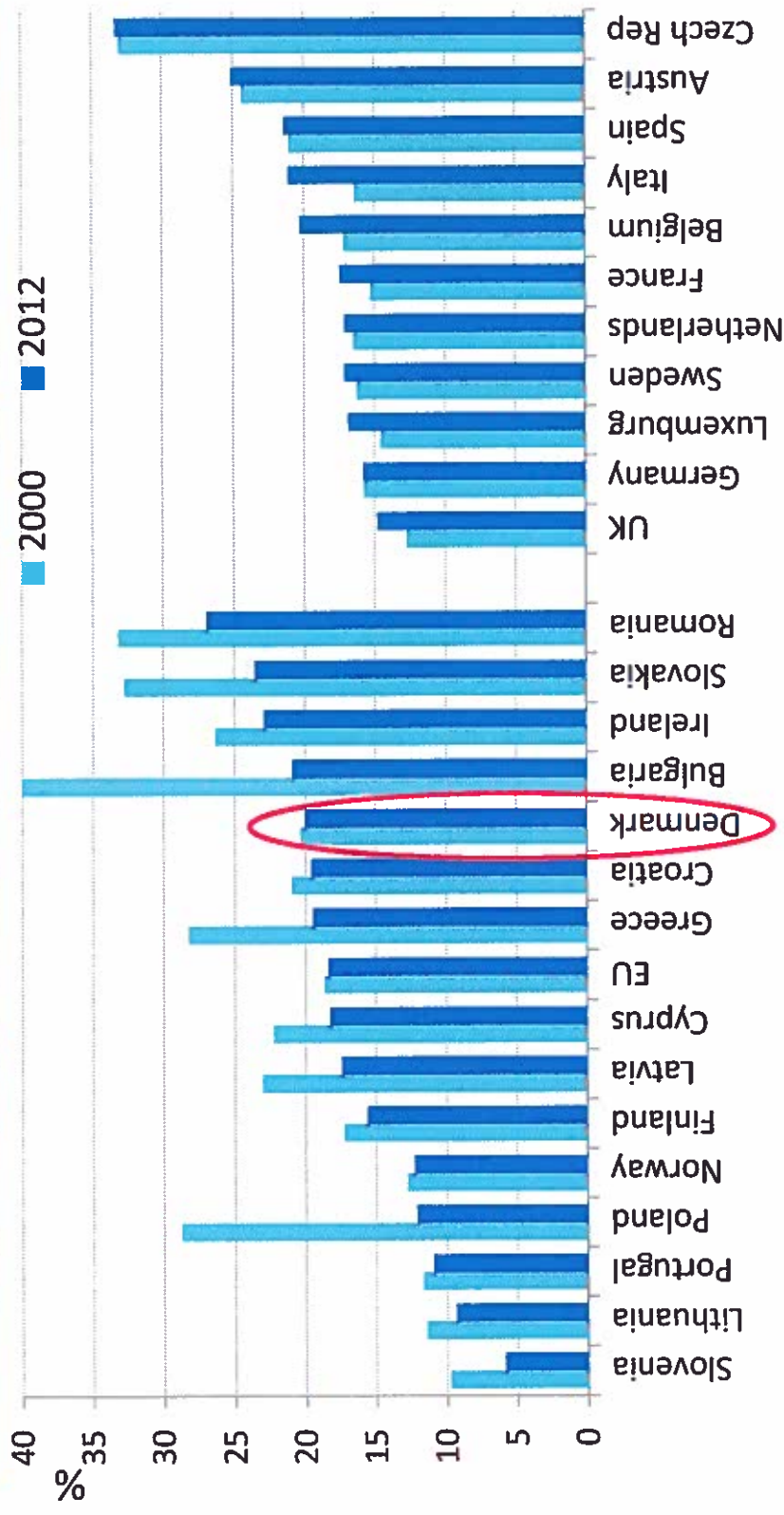
The freight traffic has increased much faster than GDP at EU level until 2007; the intensity of freight traffic per unit of GDP was around 20% higher in 2007 than in 2000. Since the crisis, the traffic has decreased more rapidly than GDP .

Trends in freight traffic and GDP at EU level



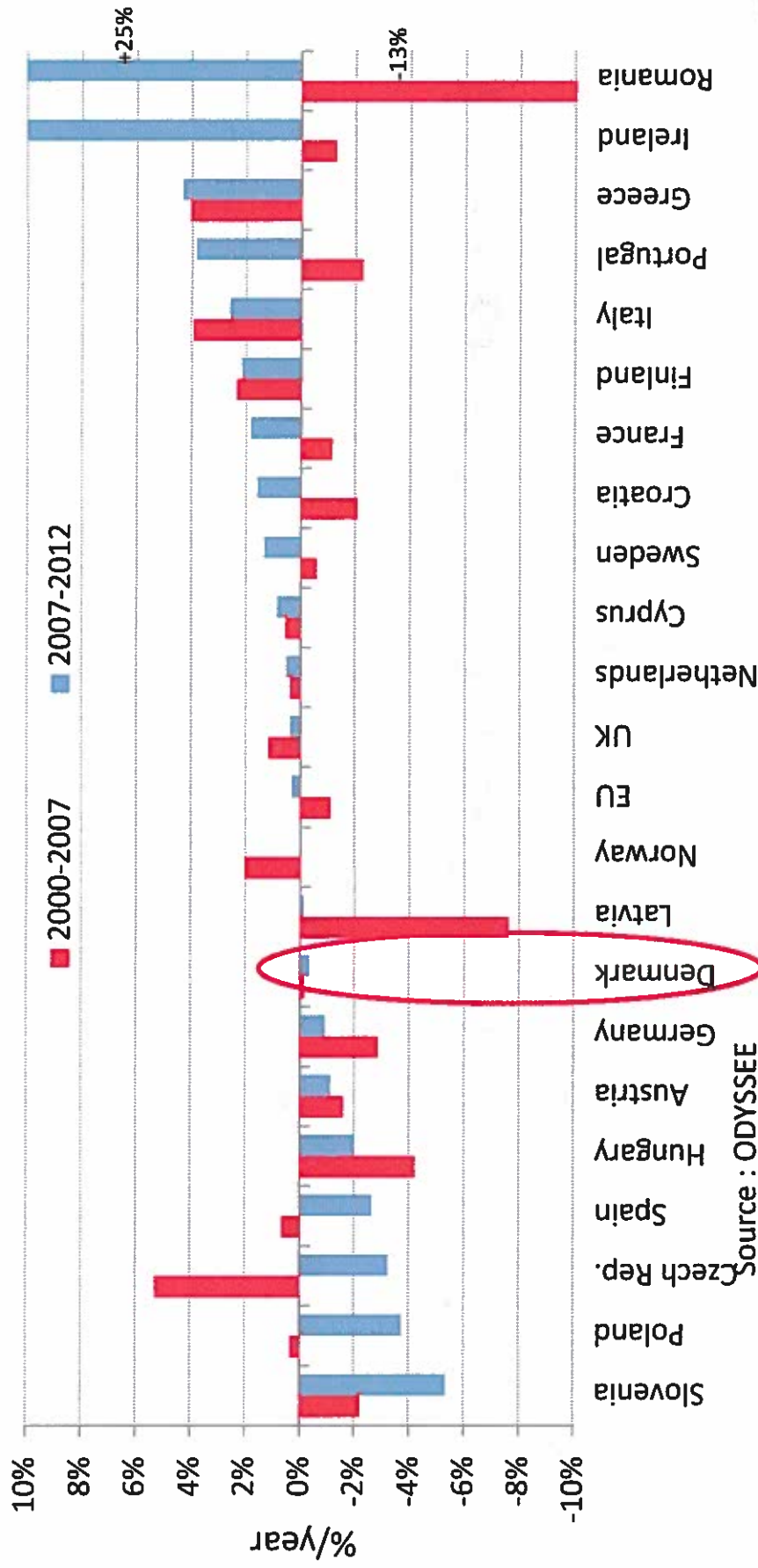
- Decreasing share of public transport in passenger traffic, except in 11 countries
- Stable share at EU level (18.5%)
- Highest progression in Italy (+ 4 points), Belgium (+3) France, UK, Luxembourg (+2).
- Four countries with a share of public transport > 20% (Italy, Spain, Austria and Czech Rep.)
- Rapid reduction in new member countries, where public transport used to be dominant (especially in Poland, Latvia, Slovakia and Bulgaria).

Share of public transport in total passenger traffic



- Reverse trends since 2007 with a deterioration of the energy efficiency trends of road freight transport in around 2/3 of countries.
- Lower efficiency for the other countries except Slovenia, Poland, Czech Rep and Spain.
- No change in Denmark since 15 years**

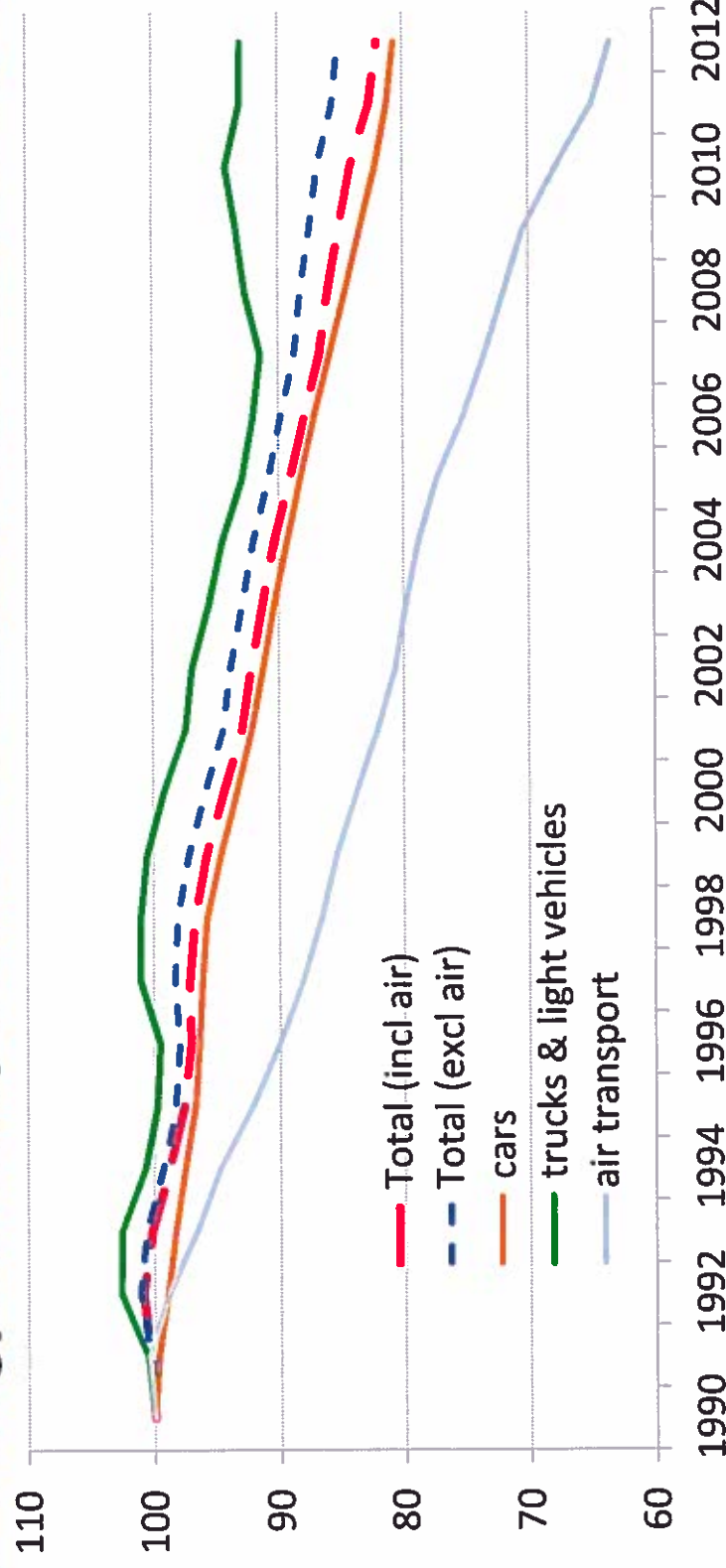
Unit consumption of road transport of goods (goe/tkm)



Source : ODYSSEE
2011 for Germany, Croatia, Poland and Romania

- Regular improvement of the energy efficiency of transport since 2000, by 1.2%/year (1% /year excluding air)
- Acceleration for all modes since 2000
- Regular improvement for cars and larger gains for air transport
- No progress in the efficiency of trucks and light vehicles since 2007; .

Energy efficiency trends for transport in the EU (ODEX)



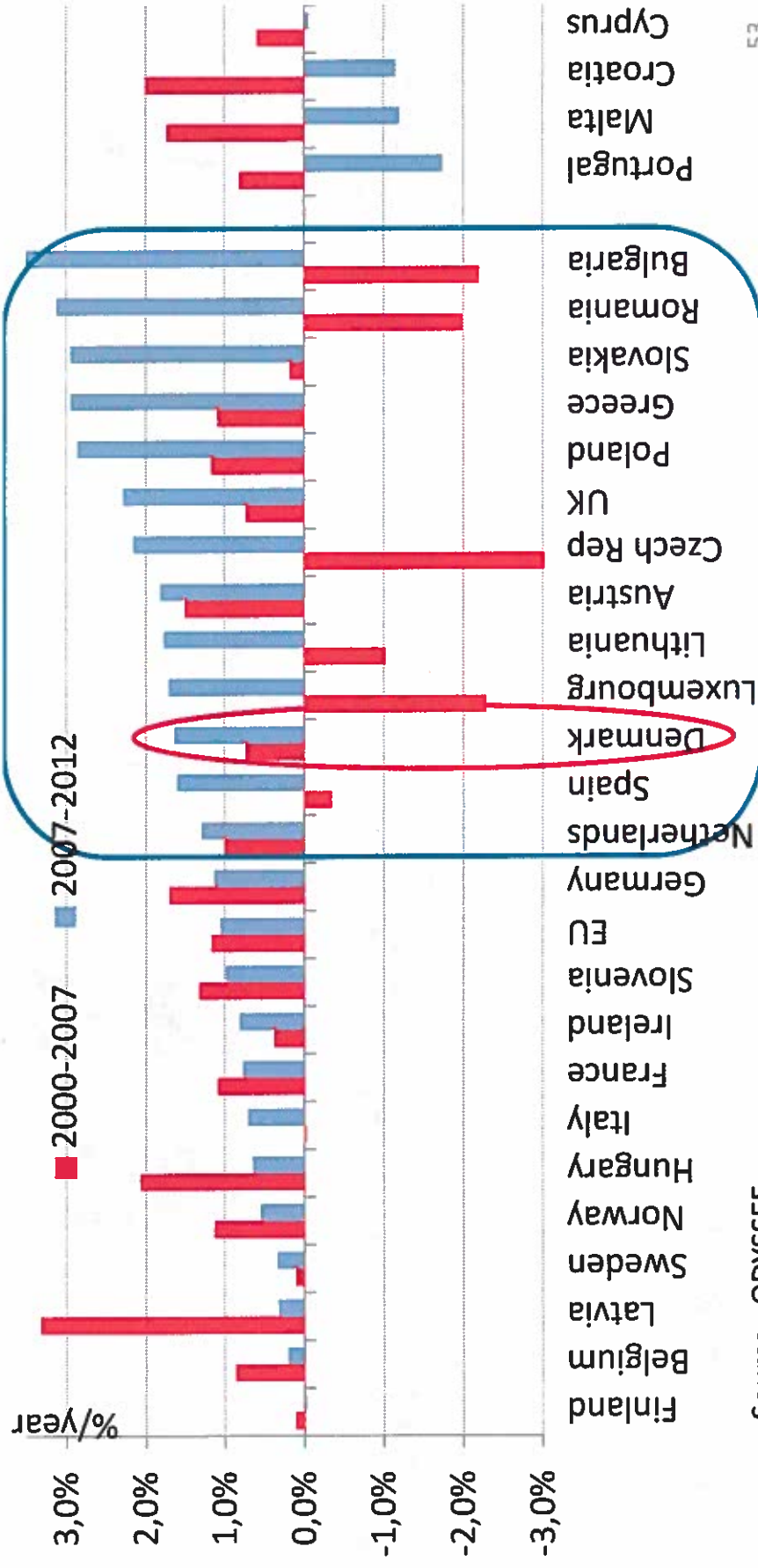
ODEX calculated on 7 modes: cars (litres/km), trucks & light vehicles (toe per tkm), air (toe per passenger); rail, water (toe/ tkm); motorcycles, buses (toe/vehicle)

■ Since 2007, decrease of energy efficiency improvement at EU level and in large western countries (Germany, France, Italy);

On the opposite greater improvement in many eastern and southern countries

In total Denmark is improving quite well having already efficient stocks of vehicles

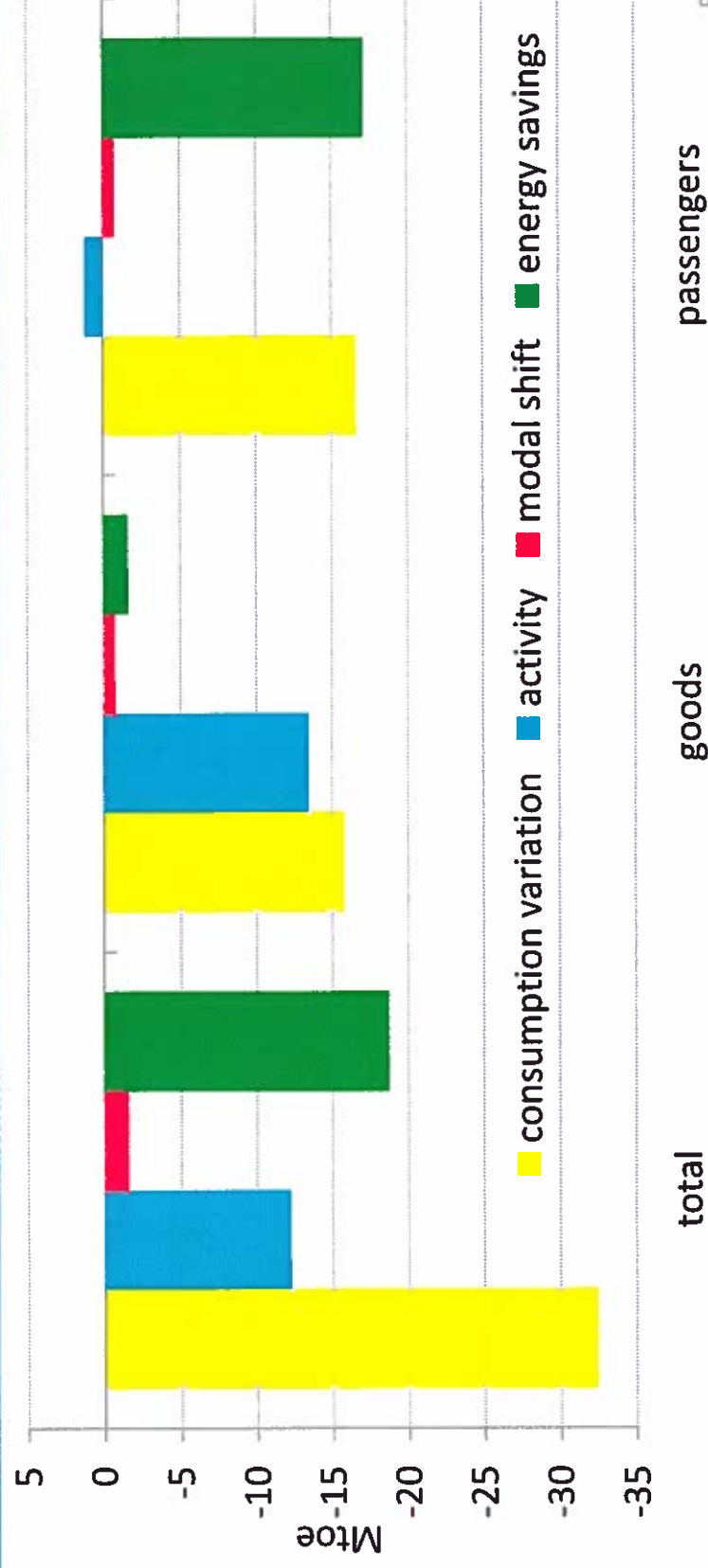
Energy efficiency trends in transport (based on ODEX)



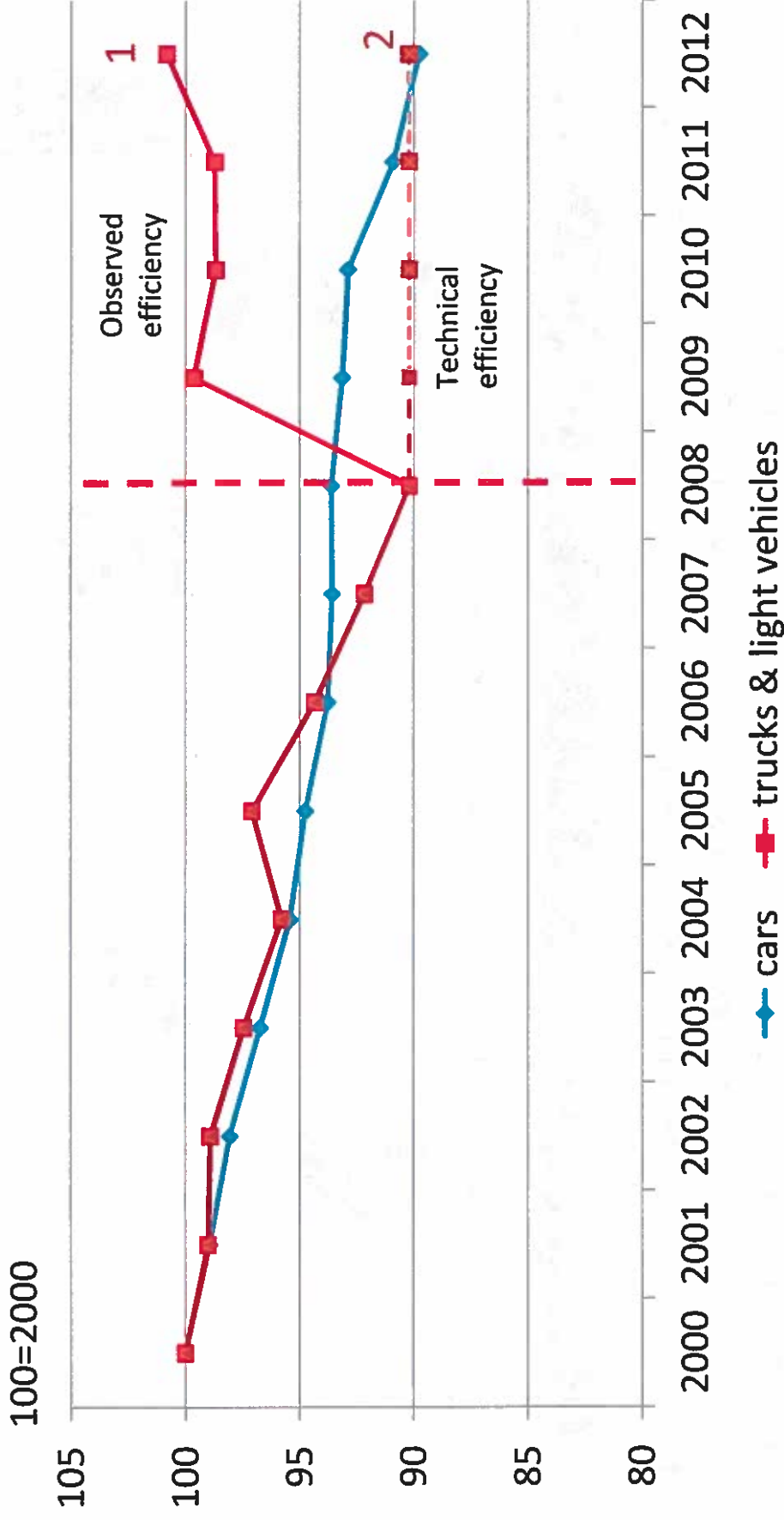
Source : ODYSSEE

- Decreasing consumption of transport since 2007 of 32 Mtoe at EU level
- Around 40% of that reduction is due to the economic recession, with a decrease in freight traffic and the stability of passenger traffic, and almost 60% to energy savings, mostly for passenger cars.
- Almost no efficiency improvements for road freight transport since 2007, because linked to the reduction in traffic .

Decomposition of energy consumption variation of transport: EU (2000-2012)

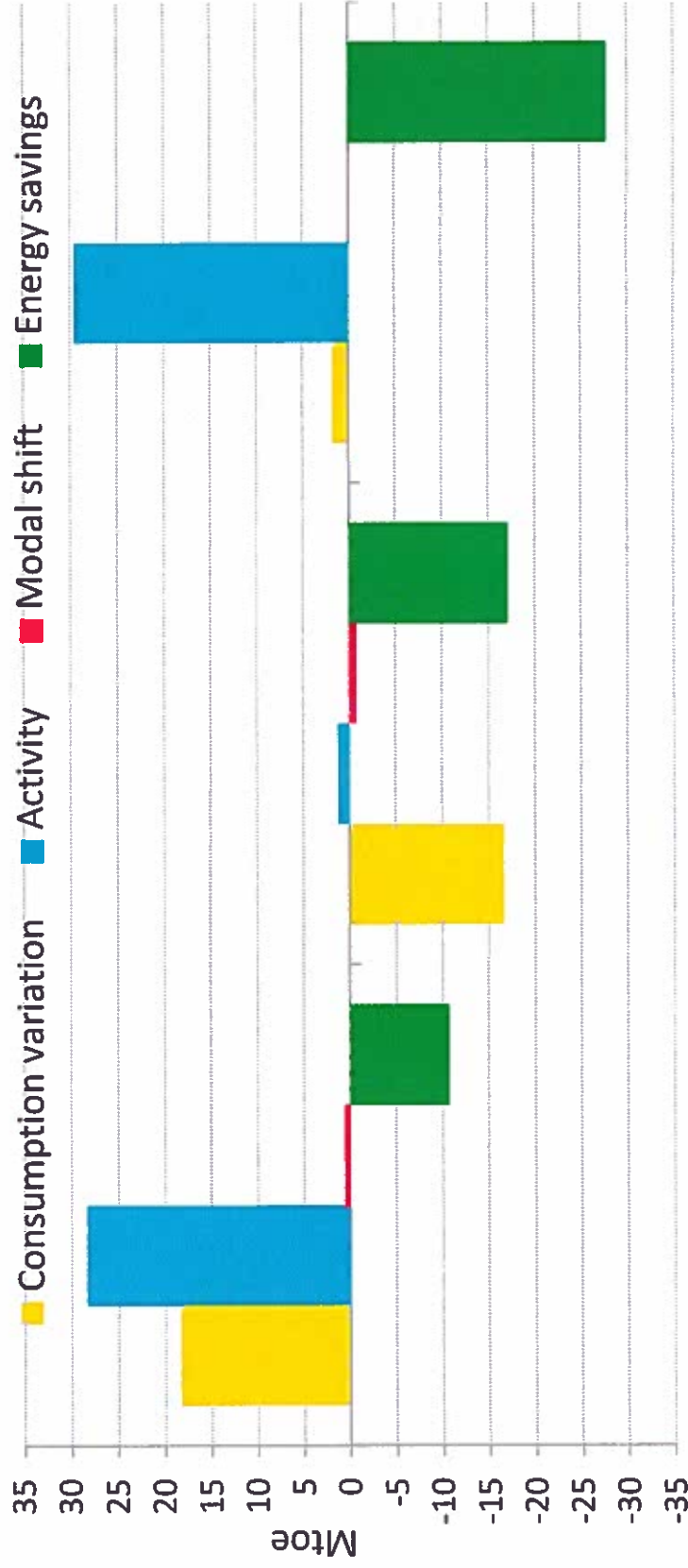


Technical versus observed efficiency/savings: case of transport



Decreasing energy consumption for passenger since 2007 mainly due to energy savings (17 Mtoe) (change in specific consumption per unit of traffic) that more than offset growth in traffic. On average energy consumption of passengers has increased by around 1.7 Mtoe since 2000 due to an increase in traffic (30 Mtoe) and modal shift (0.2 Mtoe) but offset by energy savings (28 Mtoe). Negative but marginal impact of modal split due to a decreasing share of public transport in passenger traffic (or a shift from public transport to car).

Decomposition of energy consumption for passengers: EU-27

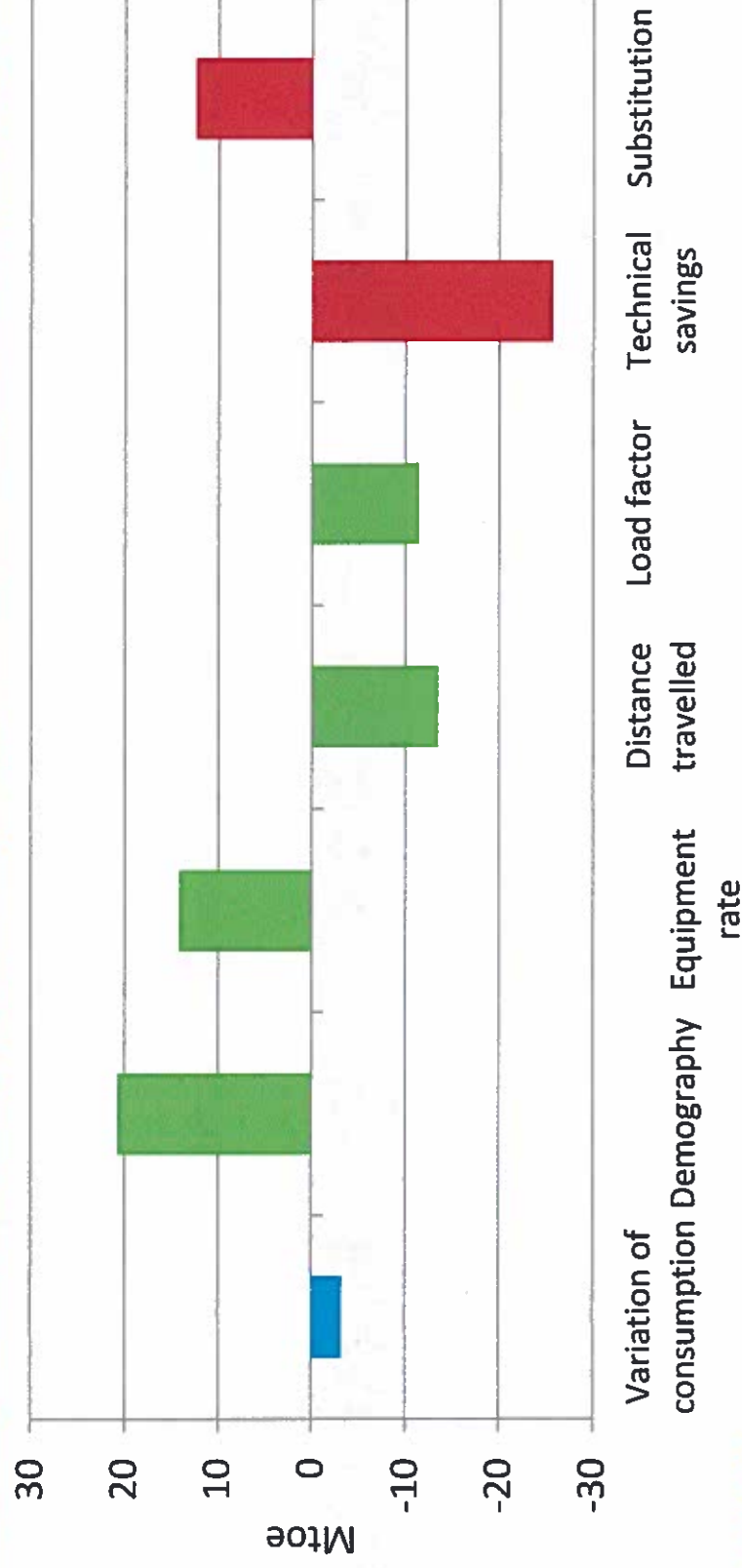


- Between 2000 and 2012, the increase in the stock of cars should have raised the energy consumption of cars by 34 Mtoe, of which 21 Mtoe are due to an increase of population (“demography”) and 14 Mtoe to an increase in car ownership per capita (465 cars per 1000 inhabitants at EU level in 2012, +1.3%/year since 2000).

The penetration of biofuels also increased the consumption (+ 12 Mtoe).

On the opposite several factors contributed to reduce the consumption: energy savings (reduction in the energy consumption per pkm) (- 26 Mtoe) , decrease in distance travelled (-14 Mtoe) and increase rate of occupancy (- 11 Mtoe).

Decomposition of energy consumption variation for cars in EU (2000-2012)



Decreasing energy consumption of freight transport since 2007 mainly due a decrease in the traffic in ton-km and in lesser extend due to modal shift. On the opposite reverse trends in energy savings because of an increase in the energy consumed per tonne –km.

On average energy consumption of road freight only increased by 1.8 Mtoe since 2000 due to an increase in traffic (11.3 Mtoe) and modal shift (1.6 Mtoe) but offset by energy savings (11 Mtoe).

Decomposition of energy consumption variation for freight: EU-27

