Training Seminar

Evaluation of energy efficiency trends and potentials

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Simple macro-economic indicators : energy intensities

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Energy intensities: definition

- Ratios of energy consumption to GDP or value added
- Measured in energy units per monetary unit at constant prices: toe / 95 (95: at 1995 constant national prices converted in)
- Provide an assessment of how much energy intensive is an economy
- Variation over time indicate trends in "overall economic efficiency"or "energy productivity"
- Same way electricity intensities (kWh/)or carbon intensities (CO2/)

Macro-economic data used for energy intensities

(national currency at constant market prices)

GDP = sum of VA of :
- **agriculture and fishing activities**
- **industry (Section C + D + E + F)**
- **service sector**
- **indirect taxe (about 10%)**

GDP expenditure = private consumption of households (about 60-70% of GDP) + gross investment + government consumption + import - export

Energy intensities: general trends

-Usually increase over time in countries in development

Ł The economy is more and more “energy intensive” (industrialisation, diffusion of household appliance and cars, increase welfare…): the energy consumption increases more rapidly than the GDP

-Decreasing trends in most developed OECD countries

Ł The economies are less and less “energy intensive” (“tertiarisation”, saturation in the diffusion of household appliance and cars, …)

Primary versus final energy intensity: correspond to two different level of measurement of the energy consumption

-Primary energy consumption: total consumption of coal, oil, gas , primary electricity, electricity trade balance and renewable

- Final energy consumption: total consumption of final consumers: industry (excluding energy industries) ,transport, households, services & agriculture

Ł for energy efficiency indicators, non energy uses are excluded from final energy consumption

-Difference primary / final: consumption and losses in energy transformations (especially electricity sector) and non energy uses

Primary versus final energy intensity: correspond to two different level of measurement of the energy consumption

-Primary energy intensity : measure trend in the overall productivity of energy in a counrty

- Final energy intensity: : measure trend in the energy productivity of final consumers only, ie excluding energy industries (power sector) and non energy uses

Primary versus final energy intensities

-As a long term trend ,primary intensity increase faster or decrease slower than final intensity due to increase losses in energy transformations , …. as economies are more and more electricity intensive, which increase transformations losses each time electricity is not produced from hydro

Final / primary consumption

Energy balance - Sweden (1999)

	Coal	Crude Oil	Oil Products	Gas	Nuclear	Hydro	Wood waste	Elec.	Heat	Total
PRIMARY PRODUCTION	0,2				19,1	6,2	8,6		0,4	34,5
Imports	2,2	21	5,9	0,7				0,7		30,5
Exports		-0,5	-9,5					-1,4		-11,4
Marine bunkers			-1,5							-1,5
Stock variations	0,1		0,9							1
PRIMARY CONSUMPTION	**2,5**	**20,5**	**-4,2**	**0,7**	**19,1**	**6,2**	**8,6**	**-0,7**	**0,4**	**53,1**
Refineries		-20,5	21,6							1,1
Power plants	-0,7				-19,1	-6,2		12,5		-13,5
CHP plants	-0,1		-0,6	-0,2			-2,5	0,9	2,1	-0,4
Heat plants			-0,3	-0,1			-0,8		1,5	0,3
Own use	-1,1	0	-2					-1	0	-4,1
Distribution losses								-0,9	-0,2	-1,1
FINAL CONSUMPTION	**0,6**		**14,5**	**0,4**			**5,3**	**10,8**	**3,8**	**35,4**
industry	0,6		2,6	0,3			4,4	4,6	0,3	12,8
transport			7,9					0,2		8,1
households, services			2,9	0,1			0,9	6	3,5	13,4
households			*1,1*	*0,1*				*3,6*	*1,2*	*6*
non energy uses			1,1							1,1

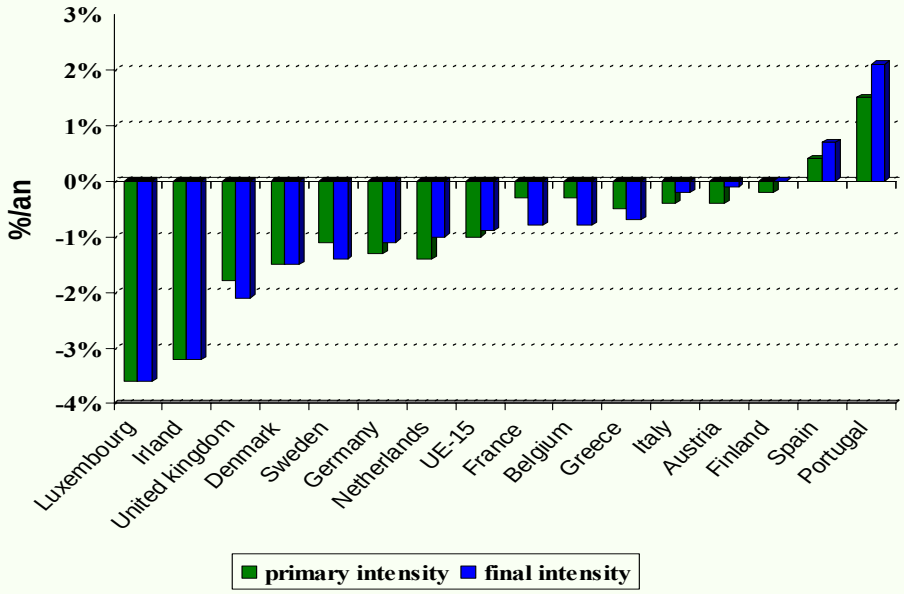
Primary and final energy intensities

-However on recent years and some EU countries reverse trends are observed due to improved efficiency of power plants (gas combined cycle,cogeneration)

-Year to year variation depend on the share of hydro in power generation as there is no loss for hydro compared to 60-70% losses for thermal plant and 67% for nuclear

Since 1990, the energy demand has increased twice less rapidly than the economic activity on average in the EU-15

Variation of energy intensities in the UE-15 between 1990 et 2002



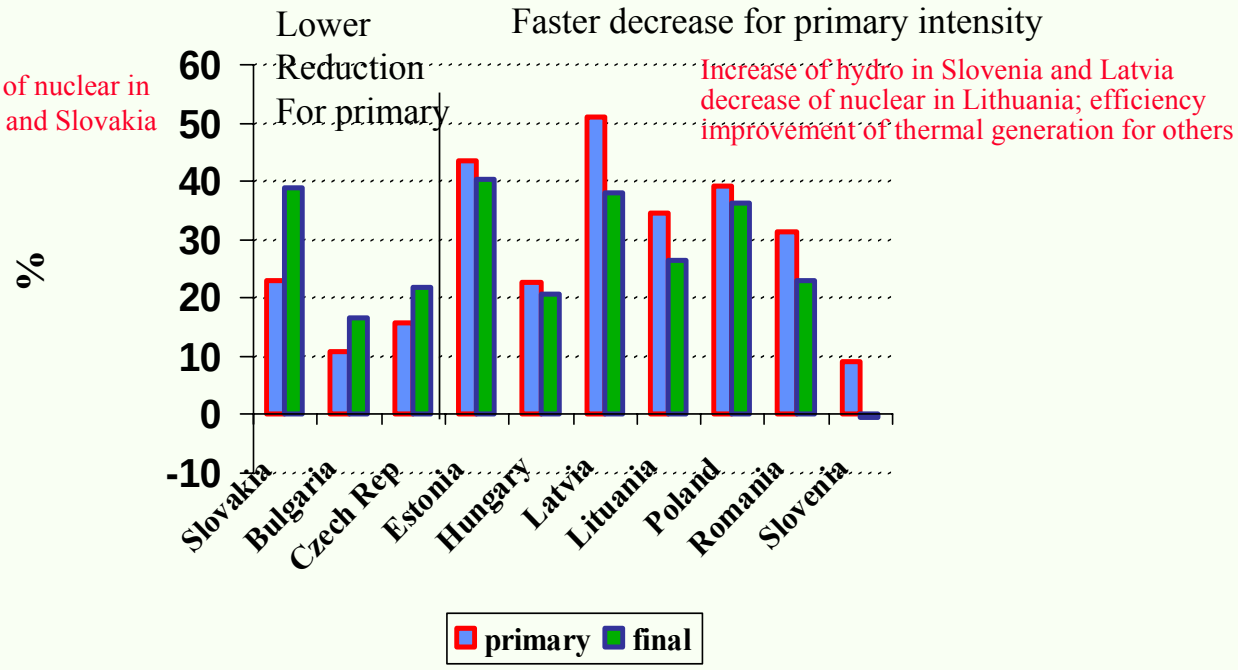
Drop around 1%/an of primary and final energy intensities in the UE-15; Variable decrease among countries except Spain and Portugal

Primary energy intensity decreases generally more rapidly than the final energy intensity due to efficiency gains in the electricity generation.

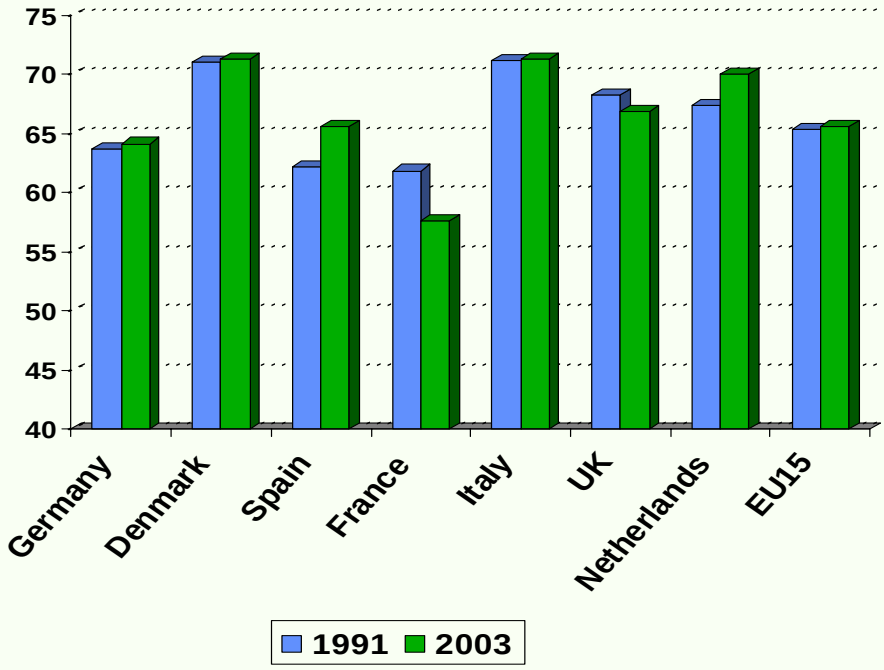
… except in some countries such as France, where the decrease is larger at final level (nuclear effect)

Decrease of primary and final energy intensities in CEEC's: 1992/2000

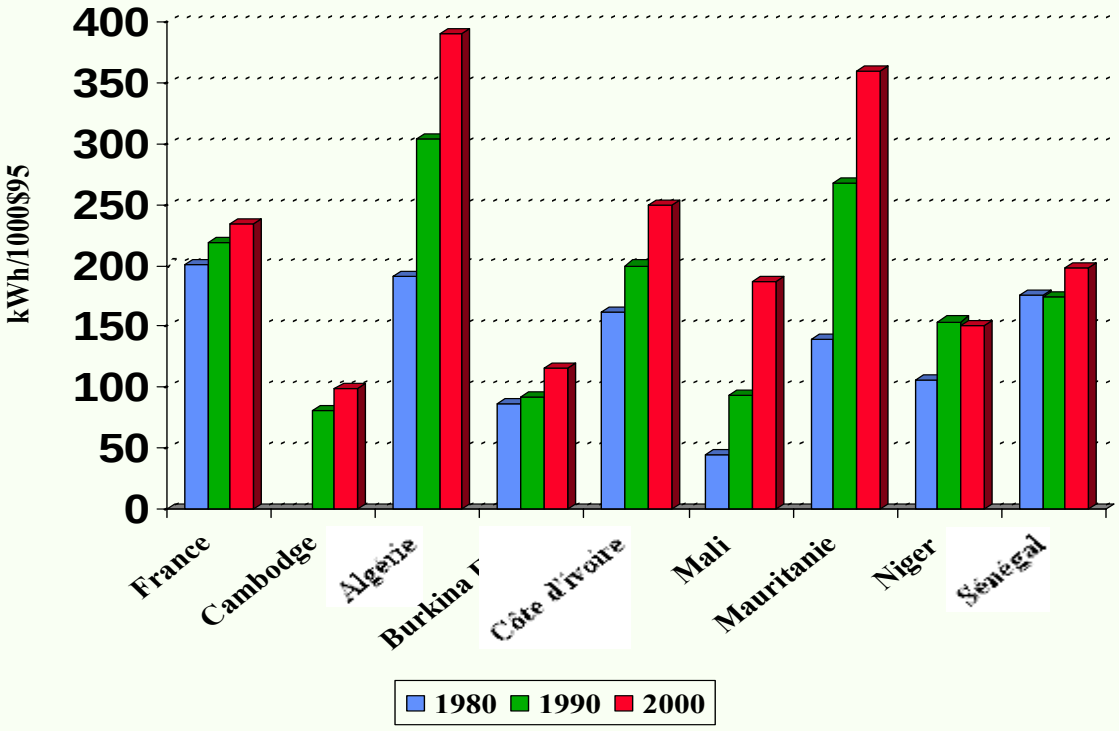
Increase of nuclear in Bulgaria and Slovakia



Ratio final/ primary energy intensities (%)



Electricity intensities (electricity consumption /GDP) : increase rapidly in all countries



Elasticity of energy consumption to GDP

- Elasticity measures the relative variation of the consumption in relation to the GDP
- Over a period, can be approximated by the ratio of annual growth rate of the consumption over average GDP annual growth rate

-If consumption grows by 2%/ year and GDP by 5% /year between 1990 and 2000 elasticity= 2/5= 0.4 over period 1990-2000

Elasticity of energy consumption to GDP and intensity to GDP

- Elasticity measures relation consumption GDP over a period
- Intensity calculated for specific years
- Intensity in monetary units ; elasticity without unit:
- Elasticity more useful for comparison of trends over time and by country
- Intensity useful for measuring levels

Intensity increase élasticity > 1
Intensity decrease élasticity < 1
Intensity stable élasticity= 1

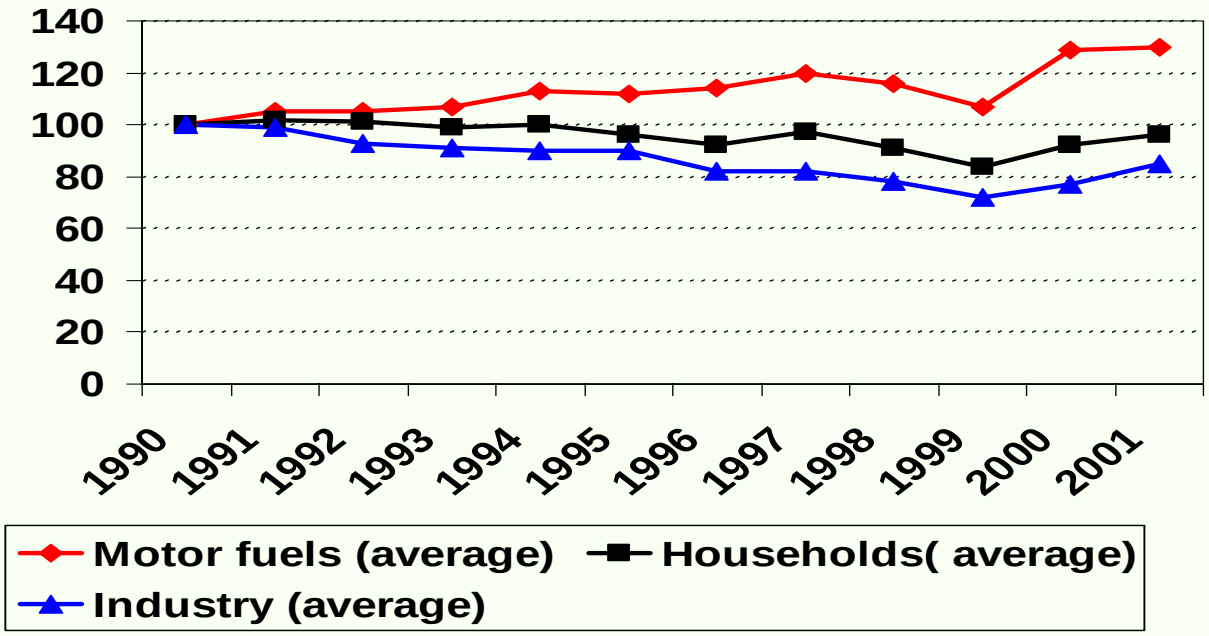
Interpretation of indicators trends : role of prices

- Need to calculate average price by sector in real terms

- Average : weighted average of the price of each type of energy (weighted by the share of each energy in the consumption of the sector)

- Real Ł at constant prices (= current prices divided by the GDP deflator
- or consumer price index)

Average real price per sector



Elasticity of demand to price

- Elasticity: measure the relative variation of demand to price variation

- Equal the relative demand variation to the relative price variation

- I the price increases by 10% and the demand is rdeuced by 3% over one year elasticity = - 3/10= - 0.3

Enerdata

Cross country- comparisons of energy intensities adjustments to purchasing power parities ?

Enerdata

Adjustment to price differences with Purchasing Power Parities (PPP)

•Conversion of national currencies in € with exchange rates does not reflect the fact that in accession countries consumer prices are on average much lower than in the EU

- by a factor **2 on average**
- **in a range of 1.5** for Slovenia to about **3** for Bulgaria or Romania

•Purchasing Power Parities (PPP) account for price differences they improve the comparison of economic indicators, such as energy intensities

•When converting national currencies in € at **PPP**

- the GDP increases by a factor 1.5 for Slovenia or 3 for Bulgaria or Romania
- and the energy intensity decreases by the same factor

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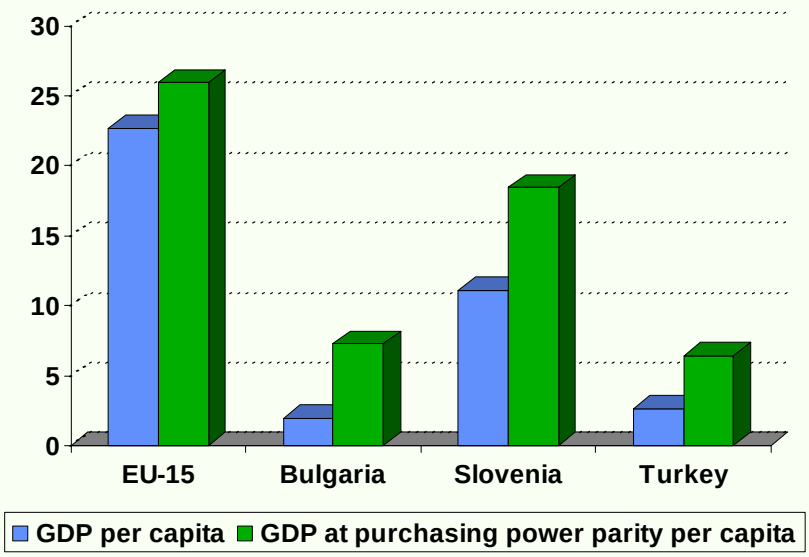
GDP per capita: actual and at purchasing Power Parities (1000 $/capita) (2002)



Why using Purchasing Power Parities for cross country comparisons of energy performance

•Let us take 3 factories producing cars : one in the EU , one in Slovenia and one in Romania or Bulgaria, with the same technical performance, ie the same energy input by car produced (in toe or GJ per car)

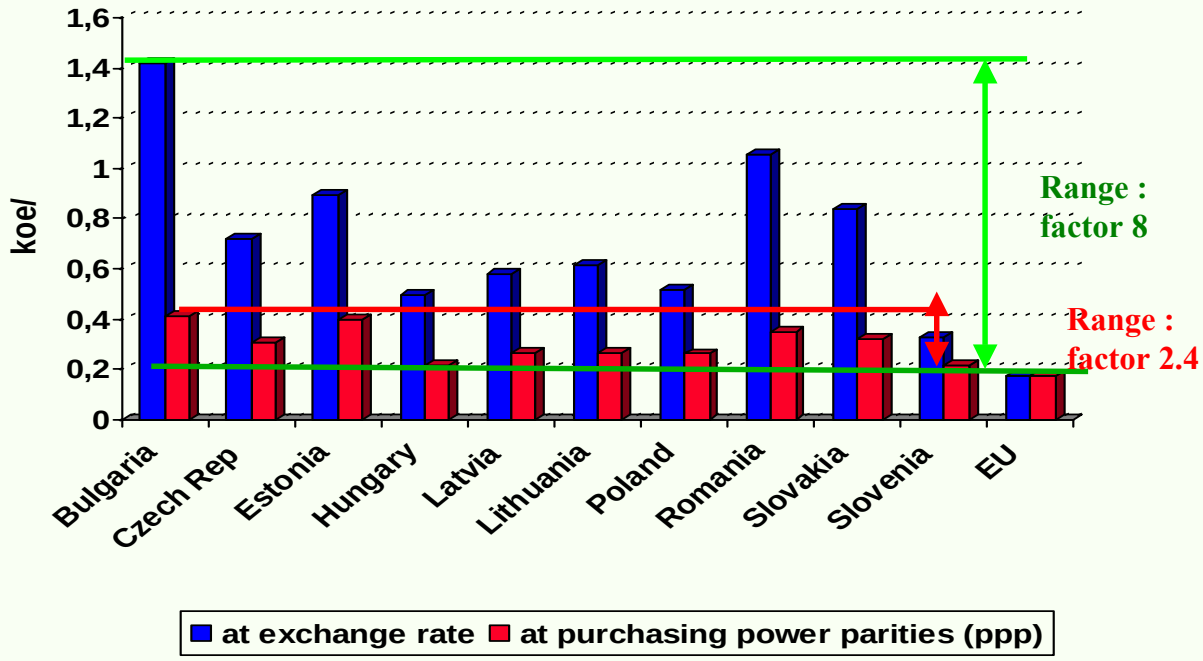
•The value added of each car is mainly made from salaries (capital costs and profits also included) , whose relative level across countries are mainly influenced by the average difference in the cost of living (**1.5** times lower for Slovenia and and **3** times lower for Bulgaria and Romania)

Ł With the same technical performance, the energy used per unit of value added (« energy intensity » for the car industry will be 1.5 and 3 times higher than in the EU in Slovenia and Romania/ Bulgaria respectively with exchange rates but the same at PPP

Enerdata

Primary energy intensities (2001)

Purchasing power parities narrow the differences across countries



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Purchasing Power Parities

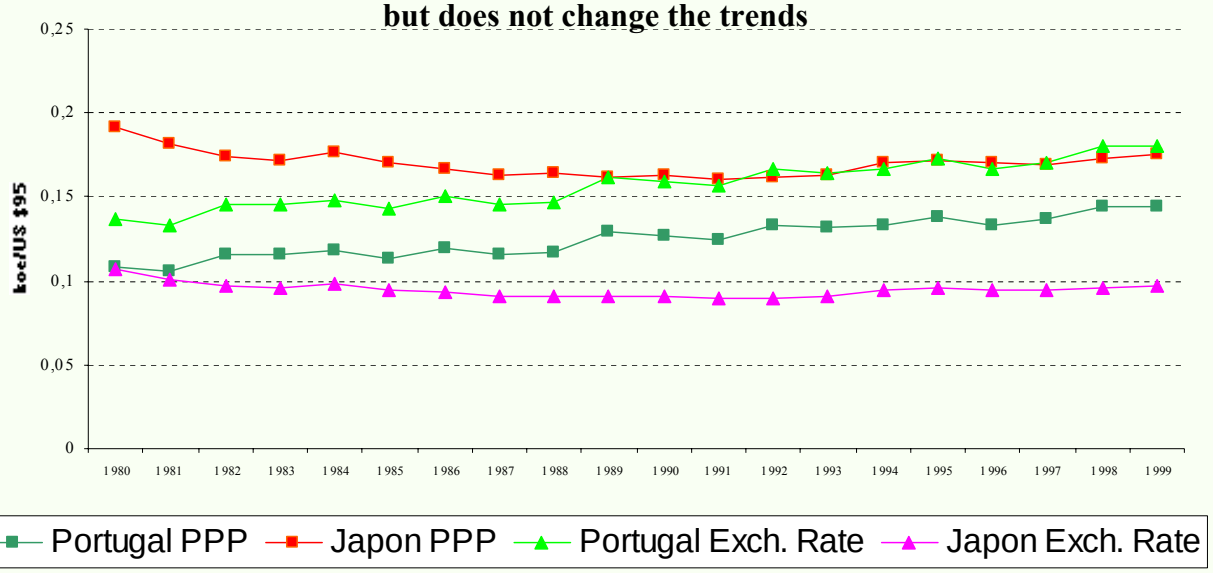
Use of PPP increases GDP and, thus, decreases energy intensity of countries with low cost of living (usually countries with low incomes); conversely intensity of rich countries increases

Ł PPP narrows differences between countries.

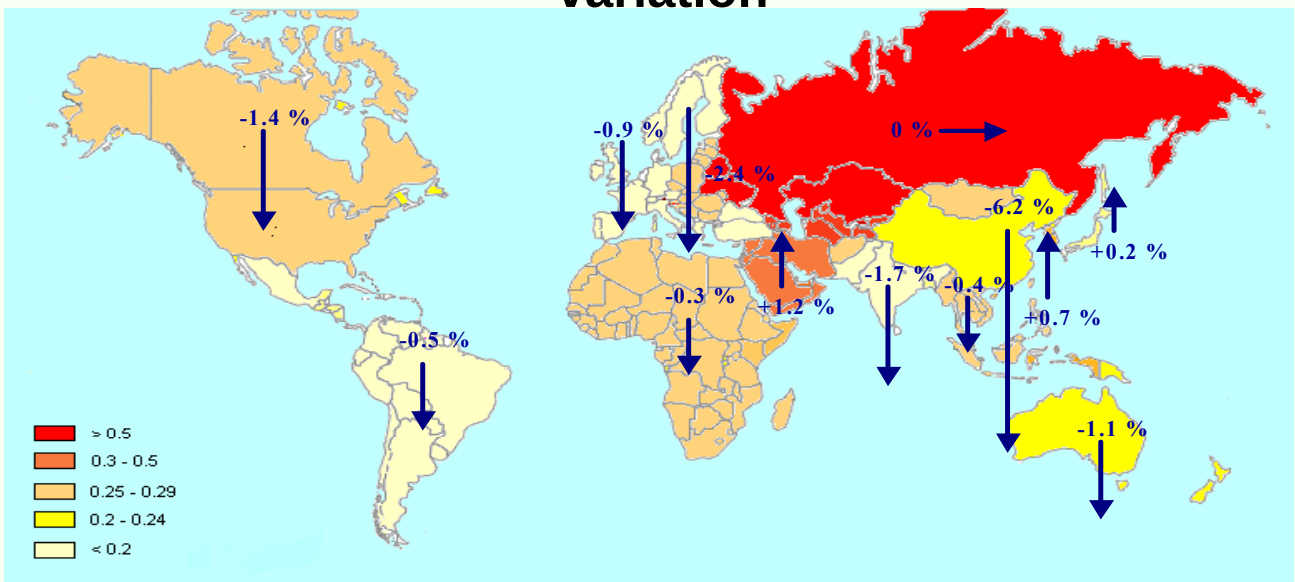
PPP affects the ranking of intensities among countries,…
but does not change the trends

Energy intensities trends: exchange rate versus at purchasing power parities

PPP affects the ranking of intensities among countries,… but does not change the trends



Ranking of primary intensities at world level and variation

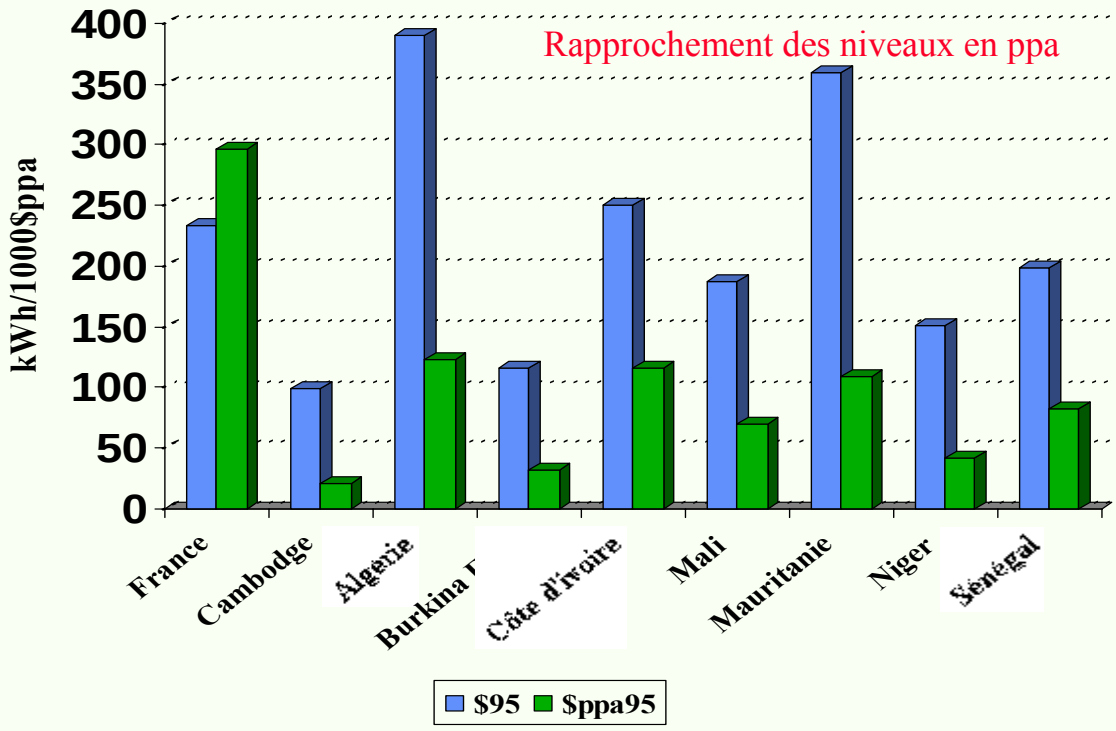


Intenisté primaire en in kep/$95ppa

Source: Enerdata

Grandes disparités des niveaux d'intensités et des tendances au niveau mondial. La Chine explique 1/4 de la réduction mondiale

Electricity intensities : at exchange rates versus ppp *(2000)*



Comparisons of primary and final energy intensities : other adjustements

Enerdata

Cross country- comparisons of energy efficiency performance : what other adjustments ?

Adjustments for differences in :

- Transformation losses (primary fuel/technology mix)
- Climate
- Economic and industrial activities

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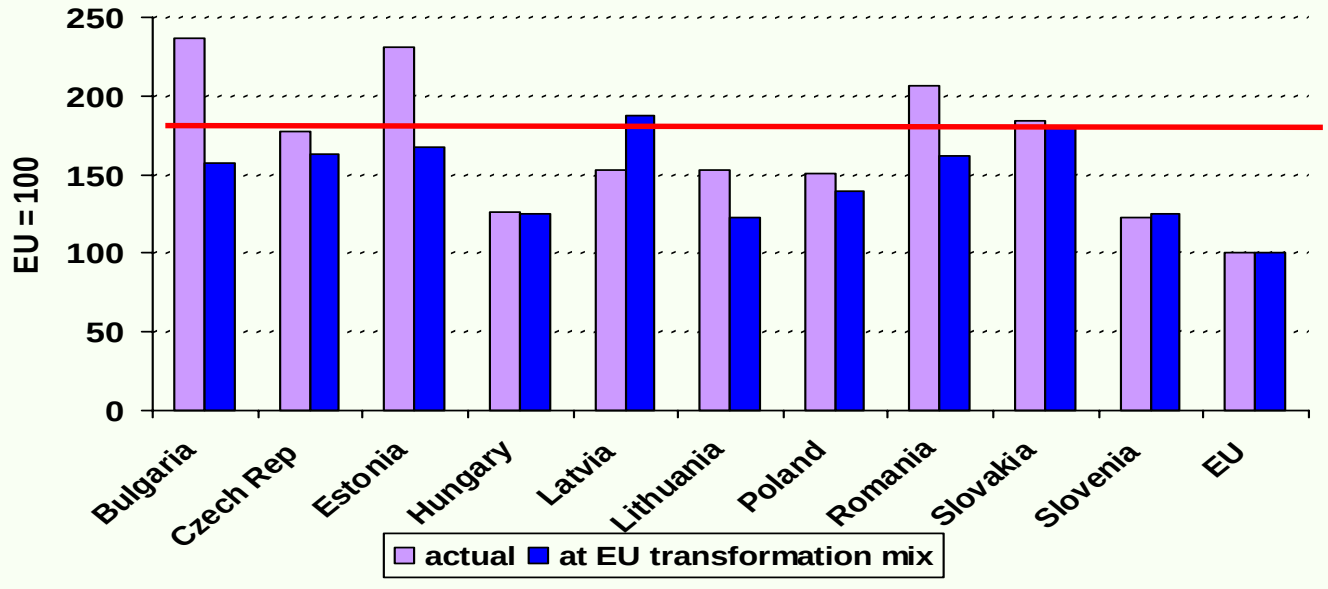
Second adjustment: to average EU primary fuel mix

For some countries (Bulgaria, Estonia, Lithuania, Romania), consumption for transformation very high Ł after adjustment to same primary fuel mix, range down to 1. 9 for primary intensities : to be adjusted now for climatic differences and economic structures



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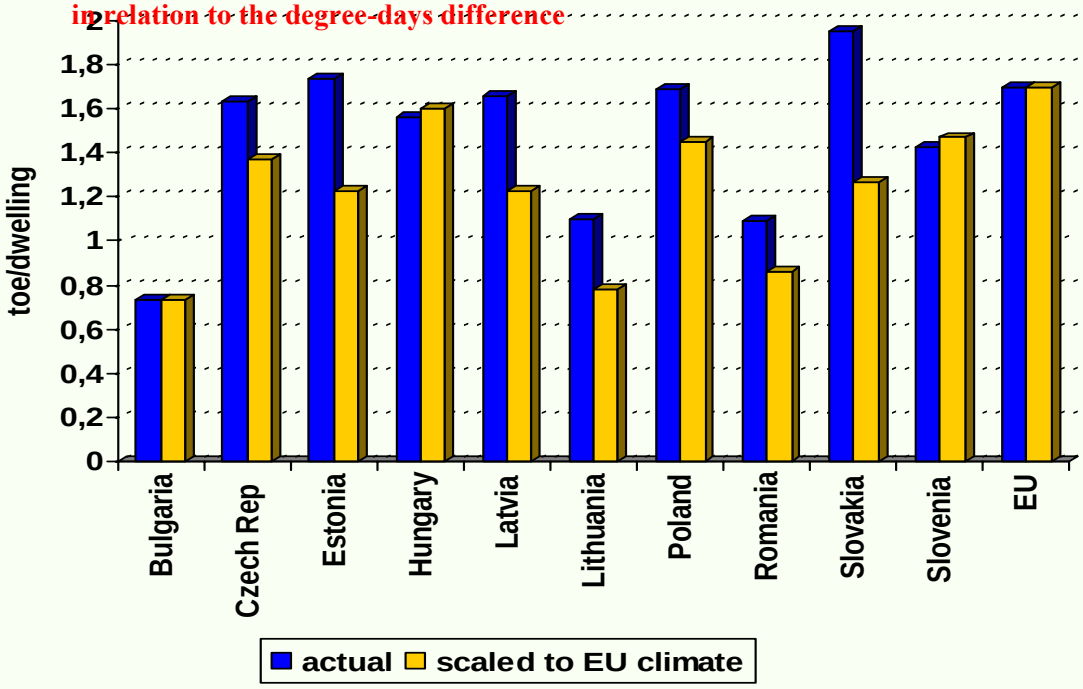
Third adjustment : space heating use to same climate (EU 15 average) : case of households

Adjustment reduces the unit consumption in countries colder than the EU average, in relation to the degree-days difference



Same for services

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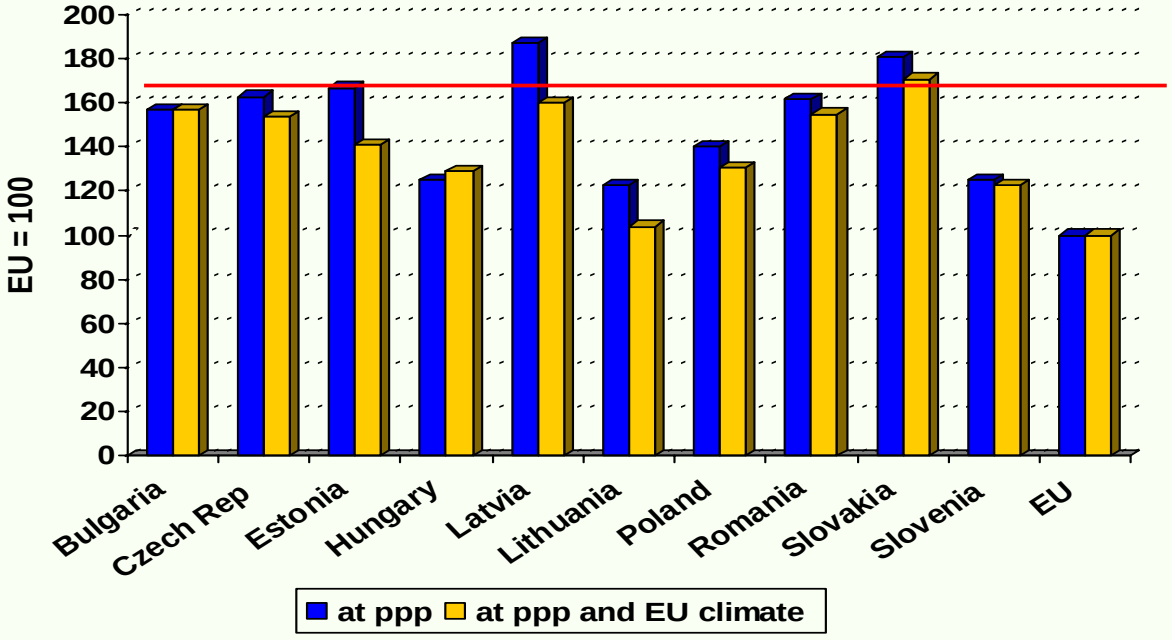
Final energy intensities adjusted to same climate (EU15 average) (at purchasing power parities)



Adjustment important for Baltic countries: their cold climate explain an intensity of about 15% higher: maximum range down to 1.8

Fourth and last adjustment to same economic and industrial structures

Differences in final energy intensity level for come from:
•different industry and economic structures (% of GDP by branch)
•different level of intensities of branches

To leave out difference in economic structures calculation of a fictive intensity with the actual sectoral intensities of each country and the same industry and economic structures as the EU average (GDP structure adjustment made for services, agriculture, mining, construction ,and main manufacturing branches)

Primary energy intensities : all adjustments

After all adjustments, primary intensities are for most countries about 50% higher than the EU average and the maximum range decreases from 2.4 to 1.8