Training Seminar

Evaluation of energy efficiency trends and potentials

Grenoble, 30 January – 10 February 2006

Assessing trends and potential deviations of energy efficiency indicators

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Agenda

Bridging model’s variables to historical trends of energy efficiency indicators

Using benchmarking and technical studies to evaluate potential future deviations of energy efficiency indicators

Enerdata

Bridging ex-ante and ex-post evaluations for energy efficiency policy evaluation purposes

- > Comparing ex-ante and ex-post evaluations : a condition to actually measure the results of energy efficiency policies (ex-post evaluation)
  - Being sucessful with energy efficiency policies does not mean necessarily that energy consumption decrease
  - Comparing ex-ante and ex-post energy efficiency macro indicators is the only way to evaluate the degree of success of an energy efficiency policy
  - Comparing ex-ante and ex-post energy efficiency technical indicators is the only way to evaluate the degree of success of energy efficiency measures**.**

- > Assessing ex-ante objectives from ex-post achievements : a condition to properly design energy efficiency policies (ex-ante evaluation)
  - Historical trends of energy efficiency indicators show how past policy and measures would actually impact future energy demand evolution
  - The comparison of the actual level of achievement of energy efficiency and the future levels expected from trend continuation with what is already achieved elsewhere (benchlark) or withwhat can be expected from technical studies, show the further potential for improvement
  - Practical objectives for future energy efficiency policies can be derived from this comparison, and further measures can be calibrated accordingly

Enerdata

Bridging macro energy efficiency indicators to model's input

- > What macro indicators?
  - Energy intensity of the GDP
  - Energy intensity of the GDP at constant structure
  - ODEX

- > How are they linked to model's inputs
  - These macro indicators do not correspond to any input of the model
  - But they can be calculated by the model for future years on the basis of the detailed input assumptions, in particular related to energy efficiency in sectors and end-uses
  - Comparing historical trends with future trends should be made carefully because of structural changes in the economy not accounted in the indicators

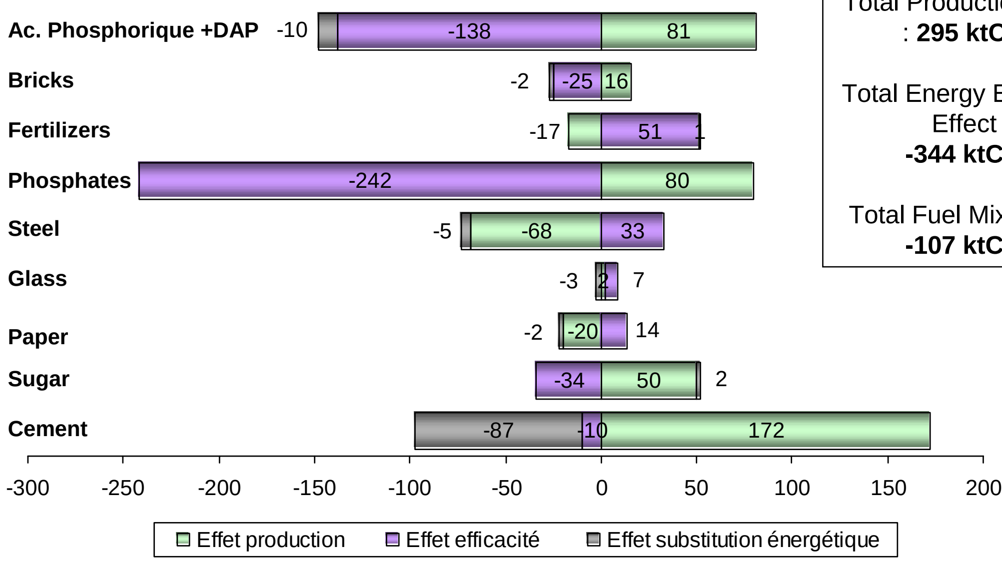
Bridging sectoral energy efficiency indicators to model's input: industry

> **What sectoral indicators?**
- Energy intensity of the industrial GDP
- Energy intensity of the industrial GDP at constant structure
- Energy intensity per industrial branch
- Specific energy consumption per ton in energy intensive industries (EIP's)

> **How are they linked to model's inputs**
- All the indicators directly correspond to models inputs, except overall energy intensities of industry;
- For energy intensities by industrial branch, two difficulties:
  - Accounting separately for EIP's
  - Accounting for structural effects within the branch outside EIP's
- For EIP's, one difficulty if several alternative processes are considered in the model (indicators usually do not make difference among processes)

Bridging sectoral energy efficiency indicators to model's input in industry: what energy efficiency progress has already been achieved?

Explaining CO2 changes in EIP's in Tunisia from 1990 to 2002 (ktCO2)



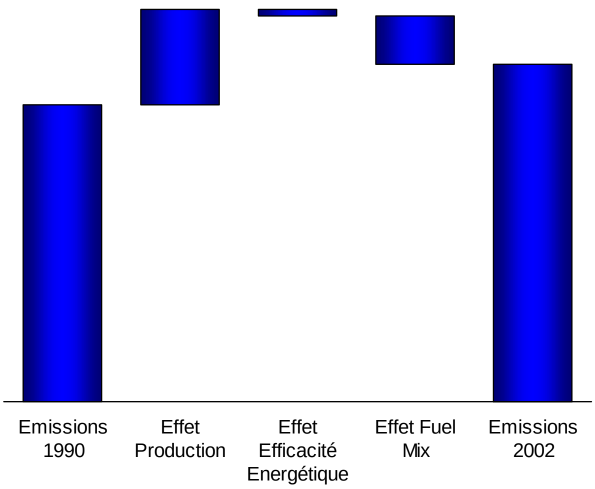
Total Production Effect : **295 ktCO2**

Total Energy Efficiency Effect : **-344 ktCO2**

Total Fuel Mix Effect : **-107 ktCO2**

Bridging sectoral energy efficiency indicators to model's input for cement: what energy efficiency progress has already been achieved?

Explaining CO2 changes in cement industry in Tunisia from 1990 to 2002 (ktCO2)



Indicators analysis

> **production effect** : clinker production increase by 4% between 1990 and 2002

> **Energy efficiency effect** : no process change, very few efficeincy gain; ratio cement/clinker much better

> **fuel mix effect** : a fuel mix evolution good for CO2:
- Increase of natural gas (+19%) and electricity (+6%) between 1990 and 2002
- Decrease of fuel oil fuel oil (-10% between 1990 and 2002)

Bridging sectoral energy efficiency indicators to model's input: households

> What sectoral indicators?
- Energy intensity of the household consumption
- Energy per household for hot water, cooking, total uses
- Energy per dwelling, m², for space heating at constant climate, final, useful
- Specific energy consumption per equipment (electrical appliances)

> How are they linked to model's inputs
- All the indicators directly correspond to models inputs, except overall energy intensity and total consumption per household;
- For space heating a difficulty may come from the disagregation of the stock of dwellings in the model (house versus flat, vintage,…)
- For useful energy, two difficulties:
  - Market shares of energies (different from the share of energies in total toe's)
  - End-use efficiencies of energy products
- For electrical appliance, difficulty because indicators show the specific consumption per appliance, although the model's input is the specific consumption per household equipped

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Bridging sectoral energy efficiency indicators to model's input: transport

> What sectoral indicators?
- Energy intensity of the transport sector
- Energy per pkm, tkm
- Modal split of pkm and tkm
- Annual distance travelled by cars
- Specific energy consumption per vehicle (cars, buses, trucks)
- Specific energy consumption of new vehicles (cars, buses, trucks)

> How are they linked to model's inputs
- Few indicators directly correspond to models inputs: specific consumption per pkm, tkm in railways, waterways, air transport, specific consumption of new vehicles
- The other are calculated by the model for future years on the basis of the detailed input assumptions related to mobility, traffics and efficiency
- For specific consumption of new vehicles a difficulty may come from the disagregation of the stock of vehicles in the model (per fuel, per size,…)
- For specific consumption per pkm, tkm, in rail, waterways, air, attention should be brought to how energy for premices (stations, airport, etc..) is accounted for in energy efficeincy indicators:

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Agenda

Bridging model's variables to historical trends of energy efficiency indicators

Using benchmarking and technical studies to evaluate potential future deviations of energy efficiency indicators: examples

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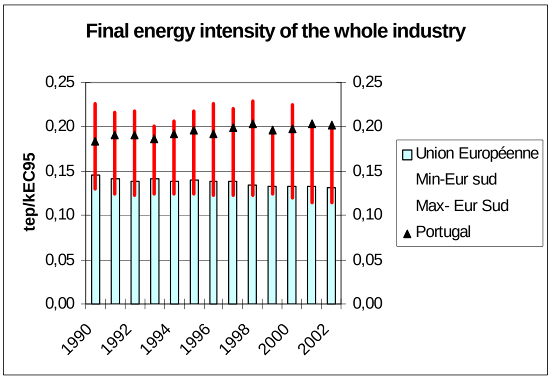
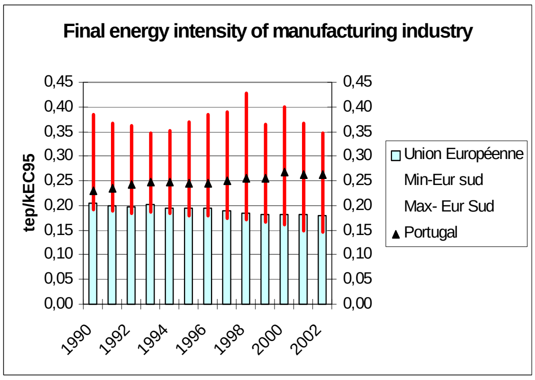
Benchmarking energy intensities in industry





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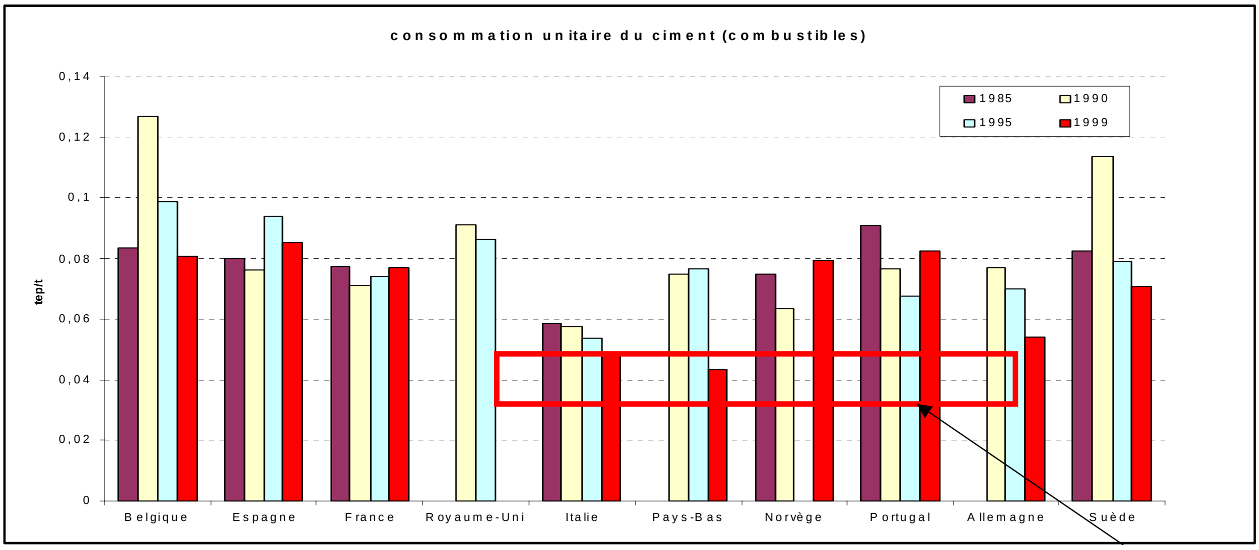
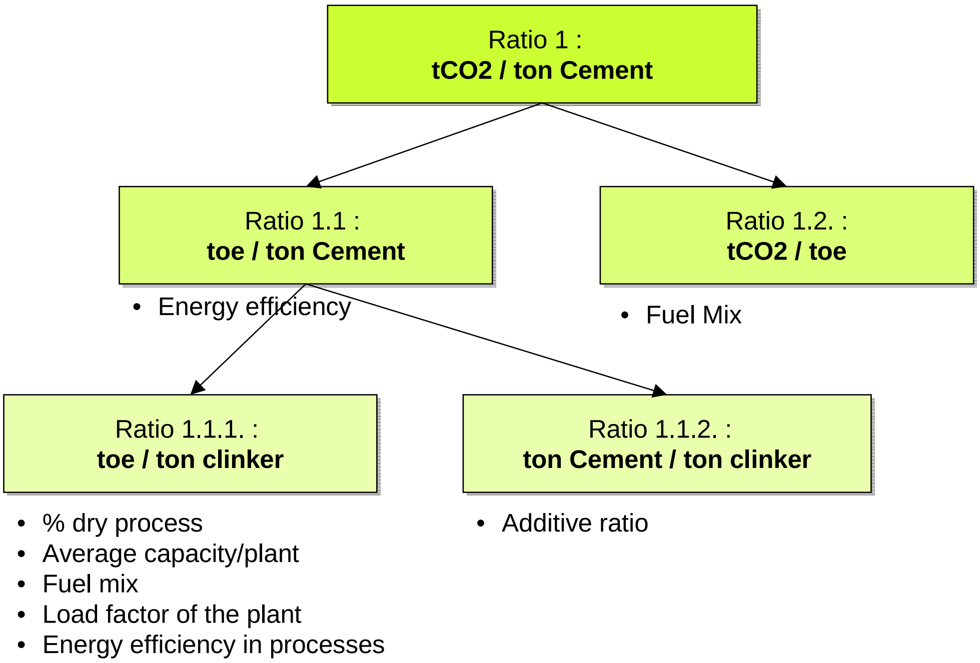
Looking for international best practices: example of cement



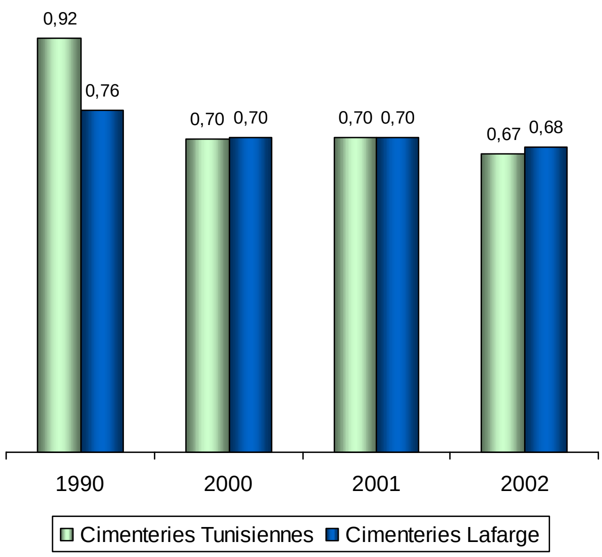
Analysis of « Best Practices »

Methodology for accurate benchmarking of CO_2 emissions of cement factories



A more drastic decrease of the ratio tCO_2 / ton cement in Tunisia as compared to international standards: is there still a possibility for improvement?

Comparing CO2 Emissions per ton of cement (tCO2 / ton)



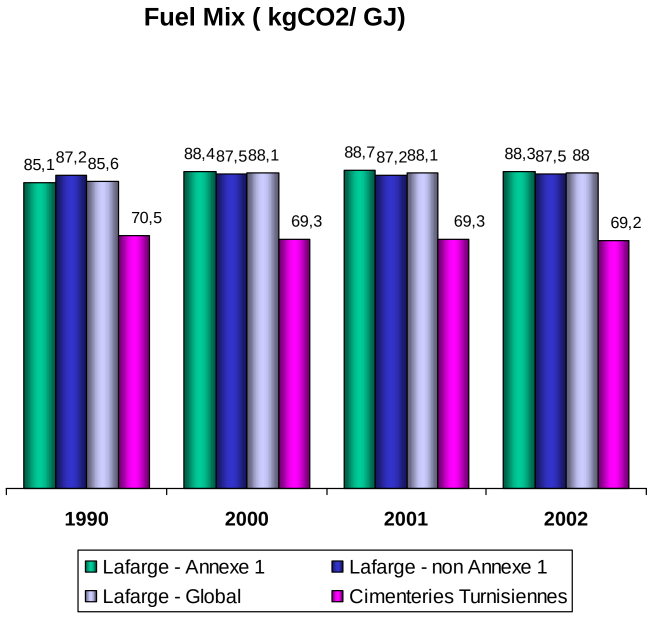
Comments

> Similar evolutions for ratio tCO2 / ton cement

> Strong improvement of the ratio tCO2 / ton cement for tunisia : -27%

Cement factories in Tunisia rely more on energies with low carbon content: this explains why their performance in CO_2 / ton are good, although the energy efficiency performance is not so good

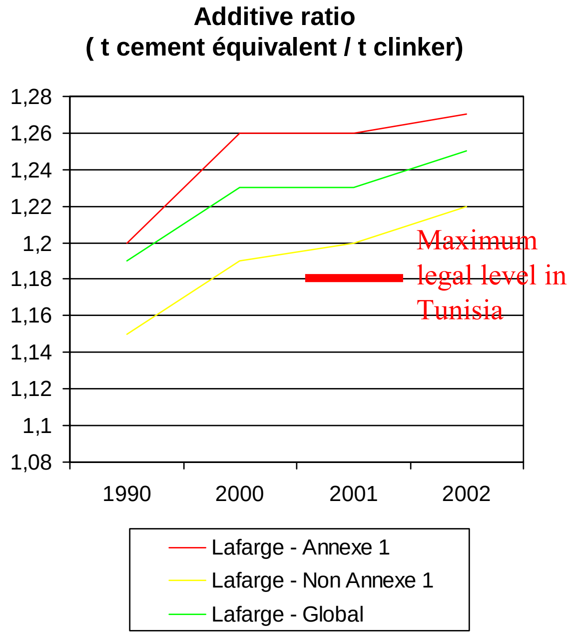
Fuel Mix Ratio



Commentaires

- > Fuel mix ratio is much more favourable for CO_2 in Tunisia : -21% vs. Lafarge in non-annex 1
- > The reason is the high share of gas in the fuel mix
- > Lafarge cement plants consume mostly coal and coke
  - 75% for annex 1 en 2002
  - 68% for non annex 1 en 2002

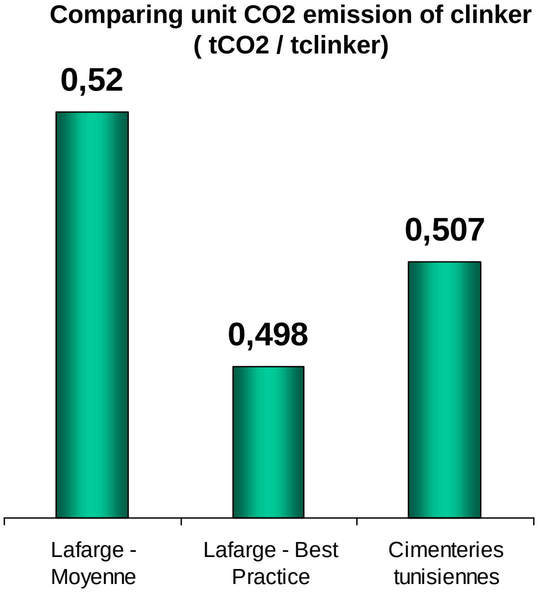
Additive ratio (cement / clinker) is much less favourable in Tunisia, which explains why the energy efficiency performance is not so good



Comments

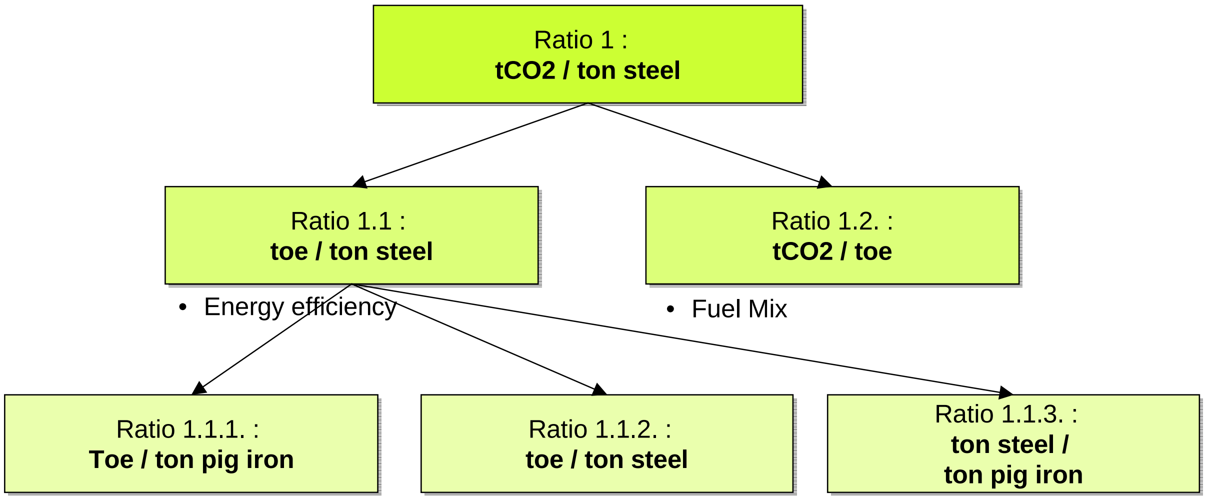
- > The additive ratio is limited today at 18% by the law; it could reach 40%
- > This explain why the ratio toe/ton for cement is high, despite the use of gas, which is more efficient than coal
- > There is a potential for decreasing the specific energy consumption per ton of cement by increasing the additive ratio

Comparing CO2 emissions of clinker production (tCO2 / tonne clinker) shows that despite a good ratio, clinker production in Tunisia may improve its energy efficiency



- > Tunisian plants are below the average international (Lafarge), but with a fuel mix much more favourable (-21%)
- > Best practices (Lafarge) are 2% below tunisian factories, with a fuel mix less favourable

Methodology for accurate benchmarking of CO2 emissions of steel factories



- Ton coke / ton pig iron
  - Blast furnace size and capacity
  - Load factor
  - Energy efficeincy of BF
- Injection ratio
- Fuel mix

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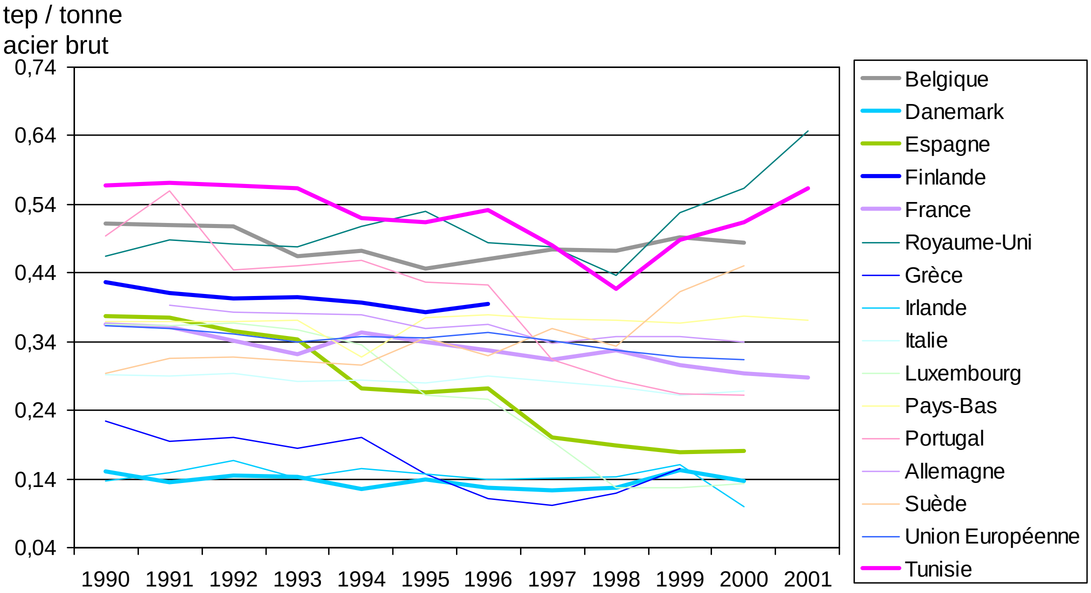
Comparing the ratio toe/ton steel shows that Tunisia could improve the energy performance of the steel industry, but it is not clear how much



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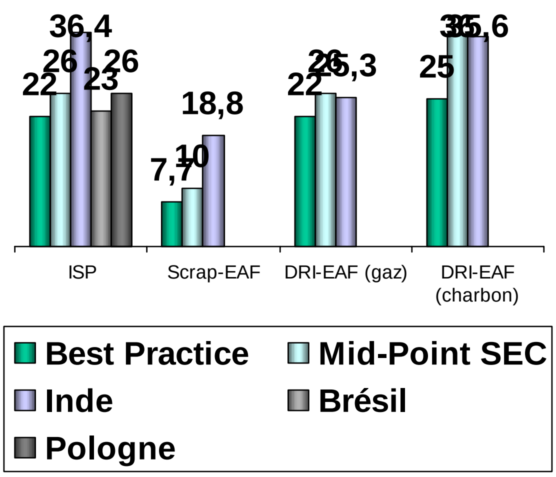
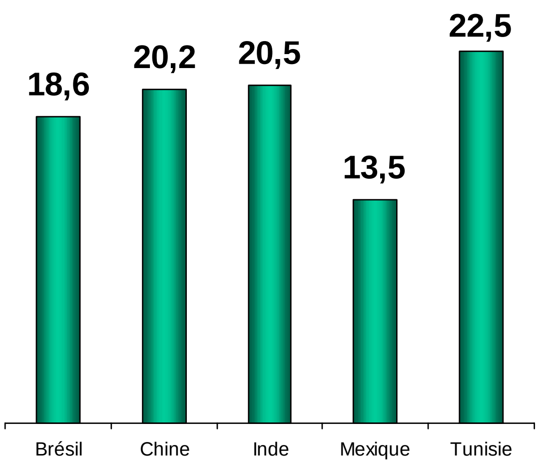
Indeed, there is a wide dispersion of specific consumption per ton of steel accross processes and accross countries, which ask for precaution in benchmarking

Best Practices by process (GJ / tcs)



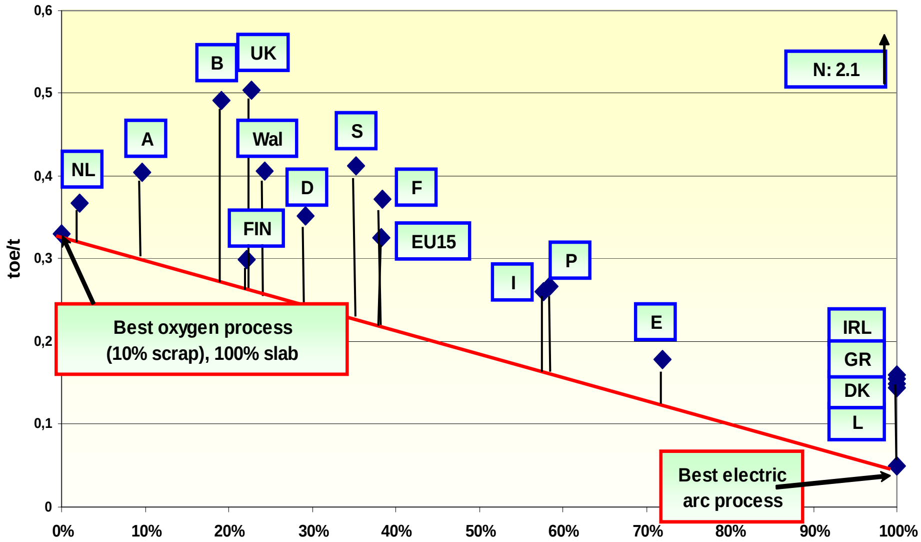
Best practices by country (primary energy) (GJ / tonne acier)



Source : De Beer 99, Pyhlipsen 2000

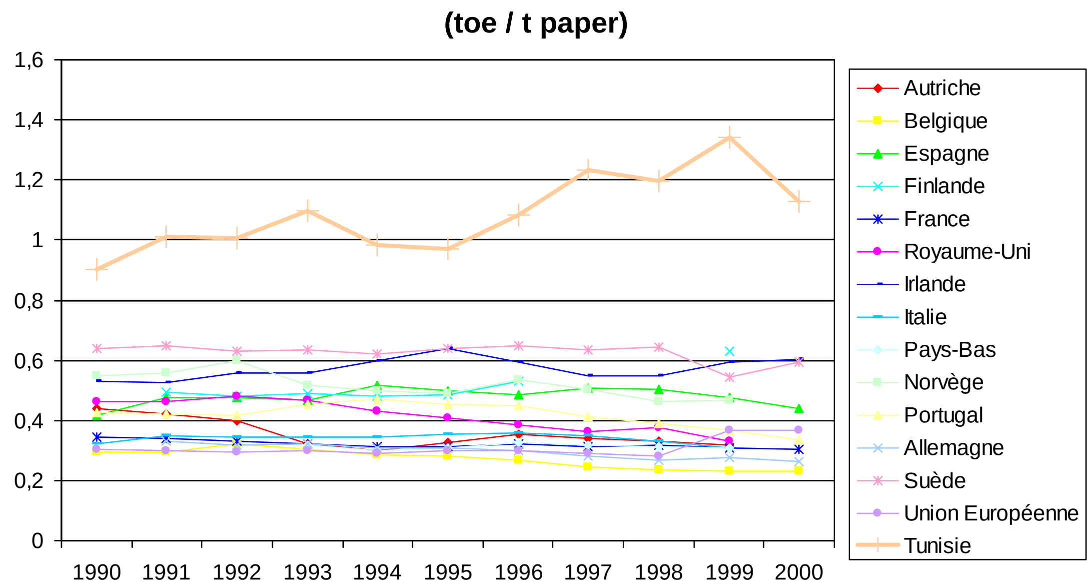
The ratio toe/ton steel must be analysed in relation to the process mix

Specific final energy consumption per ton of crude steel as a function of the ratio electric steel production / total crude steel production (1999)



Note: the product mix (slab, hot or cold rolled products) can shift the red line to higher levels by a maximum of 0.1 toe/t (case of 100% cold rolled steel; see Phylipse

Toe/ton in paper industry indicates a huge potential for energy efficiency improvement in Tunisia. But this may be linked to the primary material for the paper industry (alpha)



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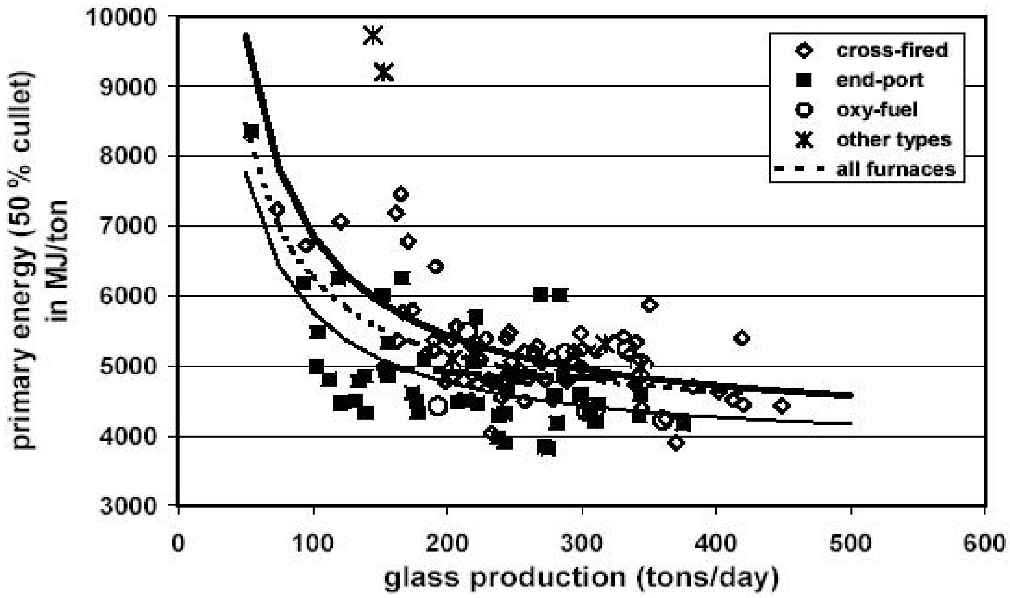
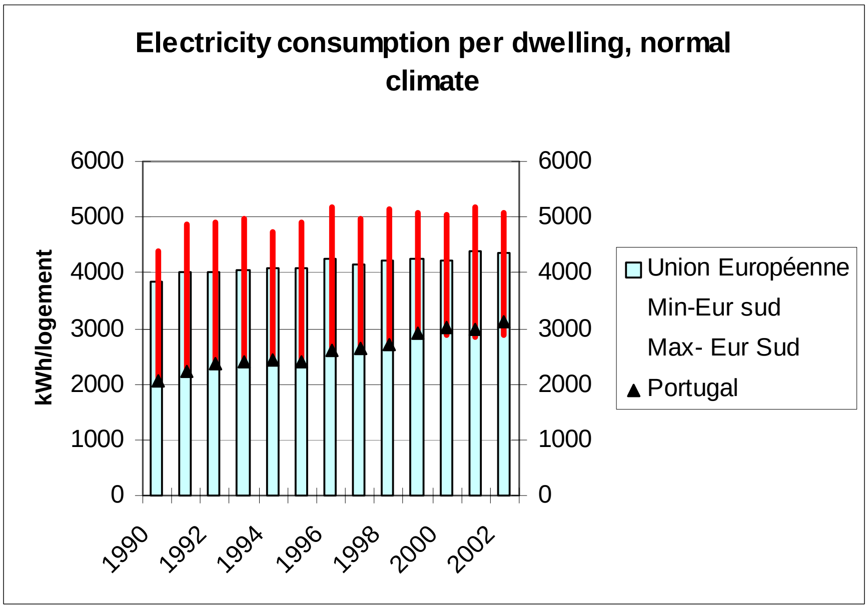
The differences in specific consumption per ton of glass is highly dependant on the size of the glass plant, which is not necessarily an issue for energy efficiency policy



Enerdata

Benchmarking electricity efficiency performances of households



Benchmarking energy efficiency performances for space heating: comparing unit consumption ratios

Unit consumption	**Belgium**	**France**	**Netherlands**	**Germany**	**Denmark**
final energy, per dwelling with climatic corrections	1,95	1,37	1,15	1,52	1,25
final energy, per m² with climatic correction	22,64	15,26		18,02	11,48
useful energy per dwelling with climatic corrections	1,28	1,02	0,92	1,18	1,03
useful energy per m² with climatic correction	14,94	11,35		14,02	9,43
final energy per m², average european climate	13,70	17,23		12,96	9,42
final energy per dwelling average european climate	1,18	1,54	0,99	1,09	1,03
useful energy per dwelling per degree-day, space heating	0,46	0,37	0,33	0,43	0,37
useful energy per m² per degree-day, space heating	5,40	4,10		5,07	3,41

Source: ODYSSEE

Benchmarking energy efficiency performances for space heating: assessing deviations to evaluate potential for improvement in energy efficiency

Deviations

	Fra/Bel	Nld/Bel	Ger/Bel	Den/Bel
final energy, per dwelling with climatic corrections	-30%	-41%	-22%	-36%
final energy, per m² with climatic correction	-33%		-20%	-49%
useful energy per dwelling with climatic corrections	-21%	-28%	-8%	-20%
useful energy per m² with climatic correction	-24%		-6%	-37%
final energy per m², average european climate	26%		-5%	-31%
final energy per dwelling average european climate	31%	-16%	-7%	-13%
useful energy per dwelling per degree-day, space heating	-21%	-28%	-8%	-20%
useful energy per m² per degree-day, space heating	-24%		-6%	-37%

Benchmarking energy efficiency performances for space heating: assessing the reasons for deviations, to design appropriate policy measures

Causes of deviation	Belgium	France	Netherlands	Germany	Denmark
No insulation	21%	21%	14%		1%
loft/roof insulation	43%	71%	53%	42%	76%
cavity wall insulation	42%	68%	47%	24%	65%
Floor insulation	12%	24%	27%	15%	63%
Double glazing	62%	52%	78%	88%	91%
share sfh	73%	56%	69%	79%	60%
share ch	63%	85%	83%	78%	91%
structural	147%	152%	155%	157%	156%

Benchmarking electricity efficiency performances of services