

A cost criterion for the mitigation of CO₂ emissions

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Why do we need a cost criterion?

- Fossil energy represents 85 % of commercial primary energy in the world and in Europe (1.5 Gtoe)
- To reduce 20 % the CO₂ emissions by 2020, we must reduce our fossil energy consumption by **300 Mtoe** (or capture and store the CO₂)
- If the average price of fossil energy is 50 €/bl (350 €/toe), the corresponding expense is close to 100 G€/yr
- This means that we have to replace **100 G€/yr** of fossil energies by non-CO₂ emitting energies (or economies). A major question is:
How much will it cost?

A criterion: the equivalent oil price

“The EOP is the price of oil which would be just competitive with an alternate source of energy **without any subsidy or tax”. (*Henri Prévot*)**

By comparing an EOP with the present price of oil, one has a fair approximation of the extra cost (or saving) of the alternate source.

Similarly, one can derive an EGP (natural gas) or an ECP (coal)

The EOP: an estimate

EOP = annual additional expense / annual saving of oil

Annual additional expense (E) = $a \cdot I + M + F$

where I = capital investment

a = annuity

(typically , with a 4 % interest rate:

$a = .12$ (10 yrs), $.1$ (15 yrs), $.06$ (30 yrs))

M = operation & maintenance costs

F = cost of alternate fuel (if any)

Annual fuel saving (O) = annual saving of oil

EOP = E / O

An example of EOP

Ground to water heat pump replacing an oil-fired low temperature central heating (O = 27 MWh/yr – 2.3 toe)

$$I = 10000\text{€}$$

$$a = .1$$

$$M \# 0$$

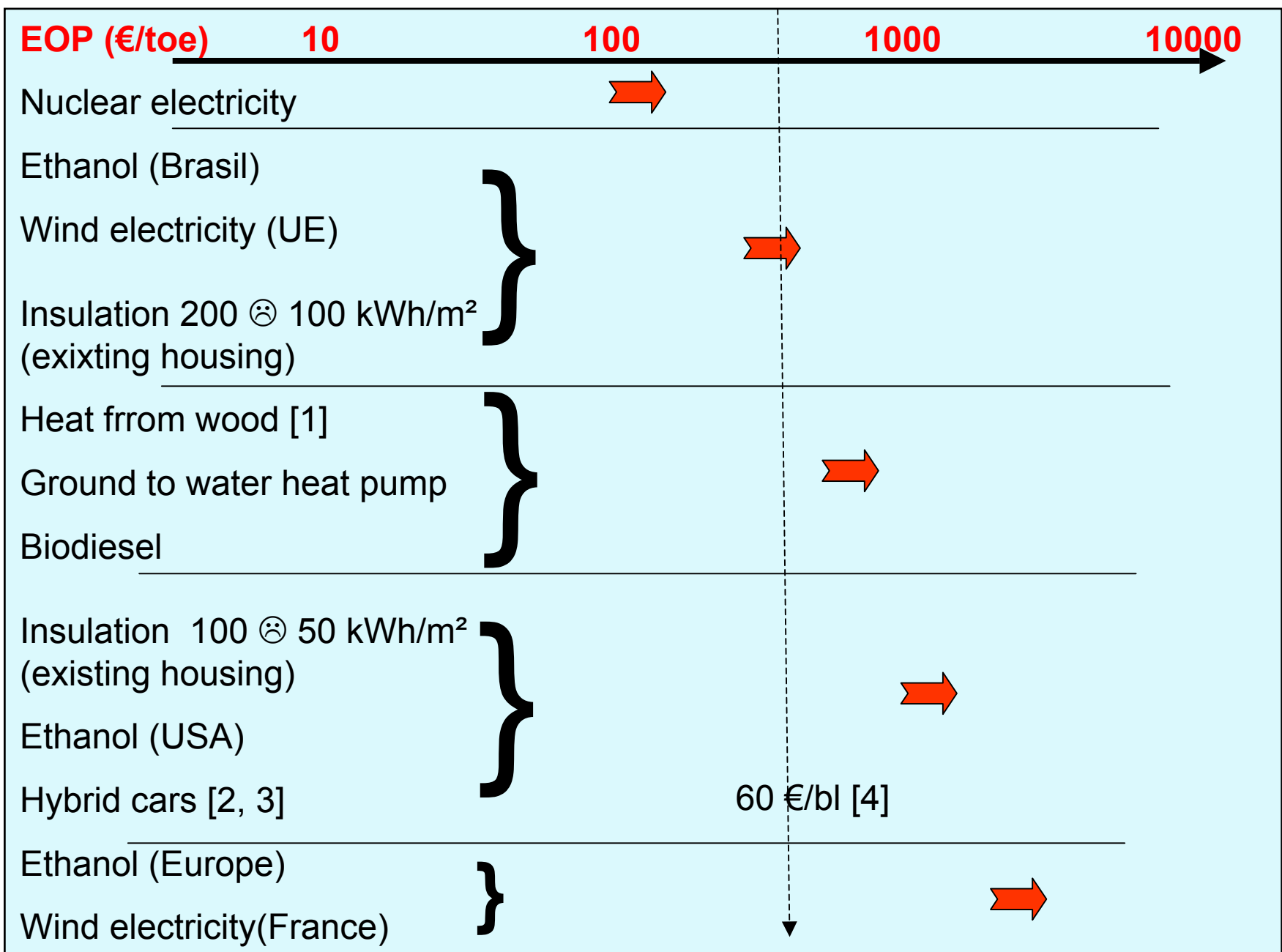
$$F = 7 \text{ MWh (electricity 120 €/MWh)}$$

$$E = 1000 + 840 = 1840 \text{ €}$$

$$\text{EOP} = E / O = 1840 : 2.3 = 780 \text{ € / toe}$$

$$\text{about } 110 \text{ € / bl}$$

Similar calculations can be done for energy saving, renewable energies for stationary and mobile uses, electricity generation with non CO2 emitting technologies.



Some comments

1. The above figures are only orders of magnitude: the actual figures could be 50 % higher or lower (the length of the bars cover a factor 2)
2. The range of EOP's is very large: from 100 to 2000 + €/toe: an illustration that the cost is an issue.
3. If the price of oil (more generally of energy) is low (< 500 €/t), taxes or subsidies will have to be very high: typically, with the present taxes on the fuels for cars and oil at 700 €/t (100 €/bl), biodiesel is competitive.
▶ **high taxes must compensate low prices of oil**
4. EOP (resp EOG or EOC) is not the only criterion, but a helpful indicator:
 - Is the money spent locally or for imports? (consequences on GNP, on the balance of payments)
 - is the technology mature or not? When mature, government help must be limited to the initial phase of industrialization; when not mature, government funding should go to the R&D (i.e. photovoltaic, 2nd generation ethanol...)

Merit orders

The merit orders vary wildly from country to country, depending on many factors: natural resources, geography, current energy mix...

In the 70's, the UK had natural gas, Germany had coal, France « had no oil, coal, no oil, no gas.. no choice but nuclear » (*Lord Marshall*).

Today, Brasil has tremendous capacities for bioenergies at 500 €/t, while in Europe, the cost will be 2000 €/t: if 10 % of oil is replaced by European biofuel (30 Mt), it will cost 45 G€/yr !

Wind electricity is competitive with oil-fired electricity (without any penalty for CO₂) and with coal- fired electricity with a moderate penalty. But it is not competitive in the Swedish or French energy mix.

Conclusions

Considering the enormous sums at stake, it is essential to dispose of a cost criterion: the EOP is a simple criterion which delivers reasonable orders of magnitude.

The orders of merit of the different ways to mitigate the CO2 emissions differ wildly from country to country, both at the world level and within Europe. The objectives should be set at the EU level, but the means left to the individual countries.

Public money is scarce. It should be reserved in priority to:

- a temporary booster for the industrialization of mature technologies**
- the R&D on promising technologies which are not yet mature**