

Les Entretiens Européens

Specificity of Nuclear Investments

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3 questions

- **LCOE, an incomplete criterion**
- **The need to introduce 'system' services**
- **The specific constraints of financing**

I. Need for a broader view of LCOE (Levelized Cost of Energy) (1/2)

- **1. Both nuclear and renewables (PV, wind and hydro) are investments with a high proportion of fixed costs (60% for nuclear, 75%-80% for wind and 90% for PV), unlike gas or coal-fired power plants for which variable costs represent a high percentage of the average (and total) cost. As a result, the LCOE is very sensitive to the discount rate and to the construction time of the power plant (see simulation below)**
- **2. This has an impact on the functioning of the wholesale electricity market since the call of the power plants according to the *merit order* is based on the marginal costs (variable cost i.e. fuel cost for the main part); this very strong short-term volatility is accompanied today by a tendency increase of the wholesale price**
- **3. As a result, at certain times prices are zero or even negative and very high at peak times (cf. 8 August 2021: -63 euros per MWh at 2pm and +68 euros at 8pm) (cf 8 October 2021: 291 euros/MWh)**

I. Need for a broader view of LCOE (Levelized Cost of Energy)(2/2)

4. It is necessary to take into account

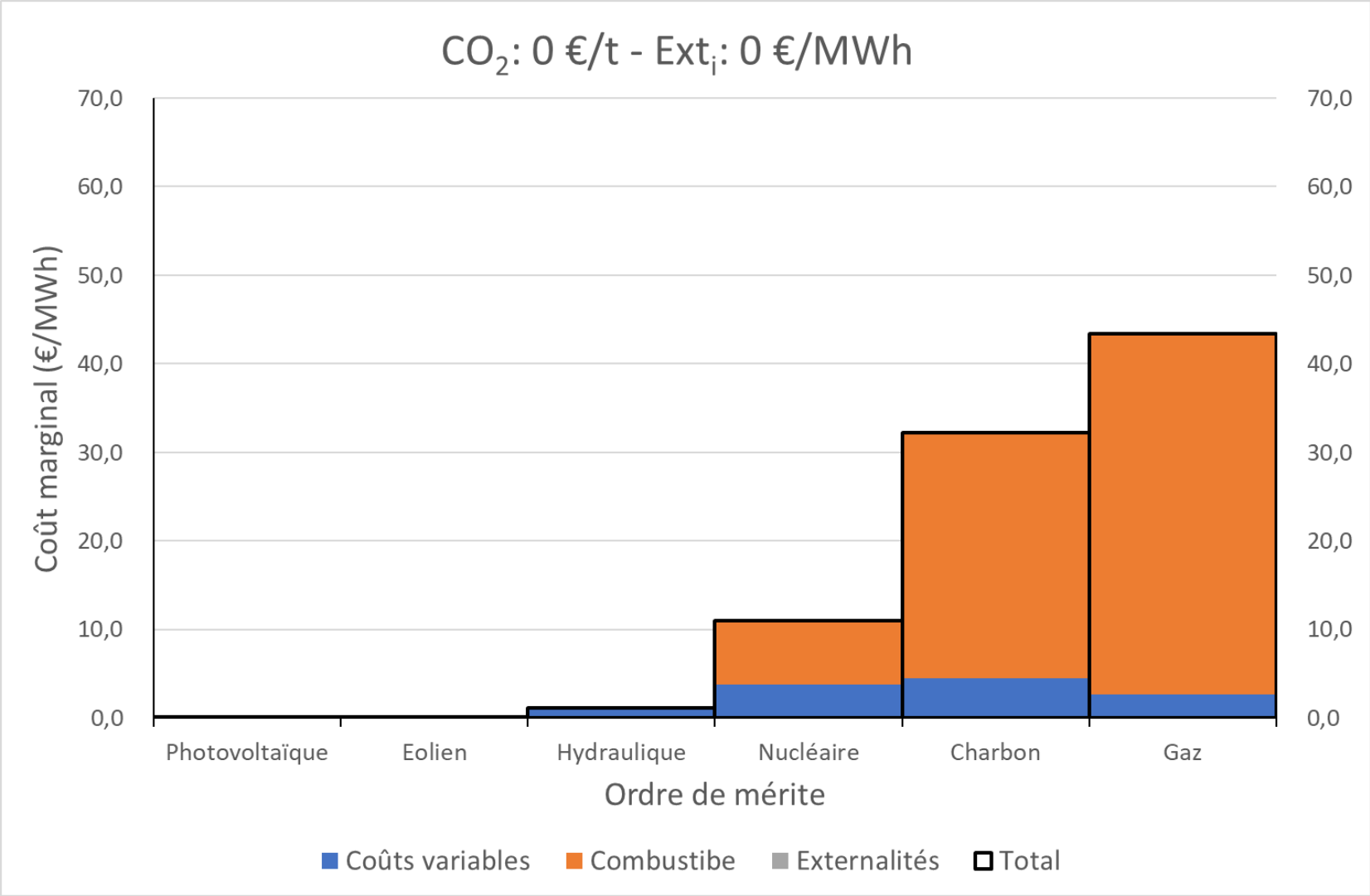
- 1. negative externalities (this is done for oil, gas or coal-fired power by taking into account the price of carbon; the tonne of CO₂ reached 61 euros in September 2021)
- 2. this should be done for intermittent renewables by taking into account the cost of storage (batteries or power-to-gas); the order in which power plants are called can then be modified according to the relative values of the price of carbon and the cost of storage (*see article by Jacques Percebois and Stanislas Pommeret to be published in the journal Reflets de la Physique*)

5. **More generally the liberalisation has favoured investments with low payback period and not investments that provide the lowest cost per kWh.** Investors need to be assured that the sale price of kWh will cover the full costs over time and the longer the payback period, the greater the risks (financial, economic but above all institutional risks).

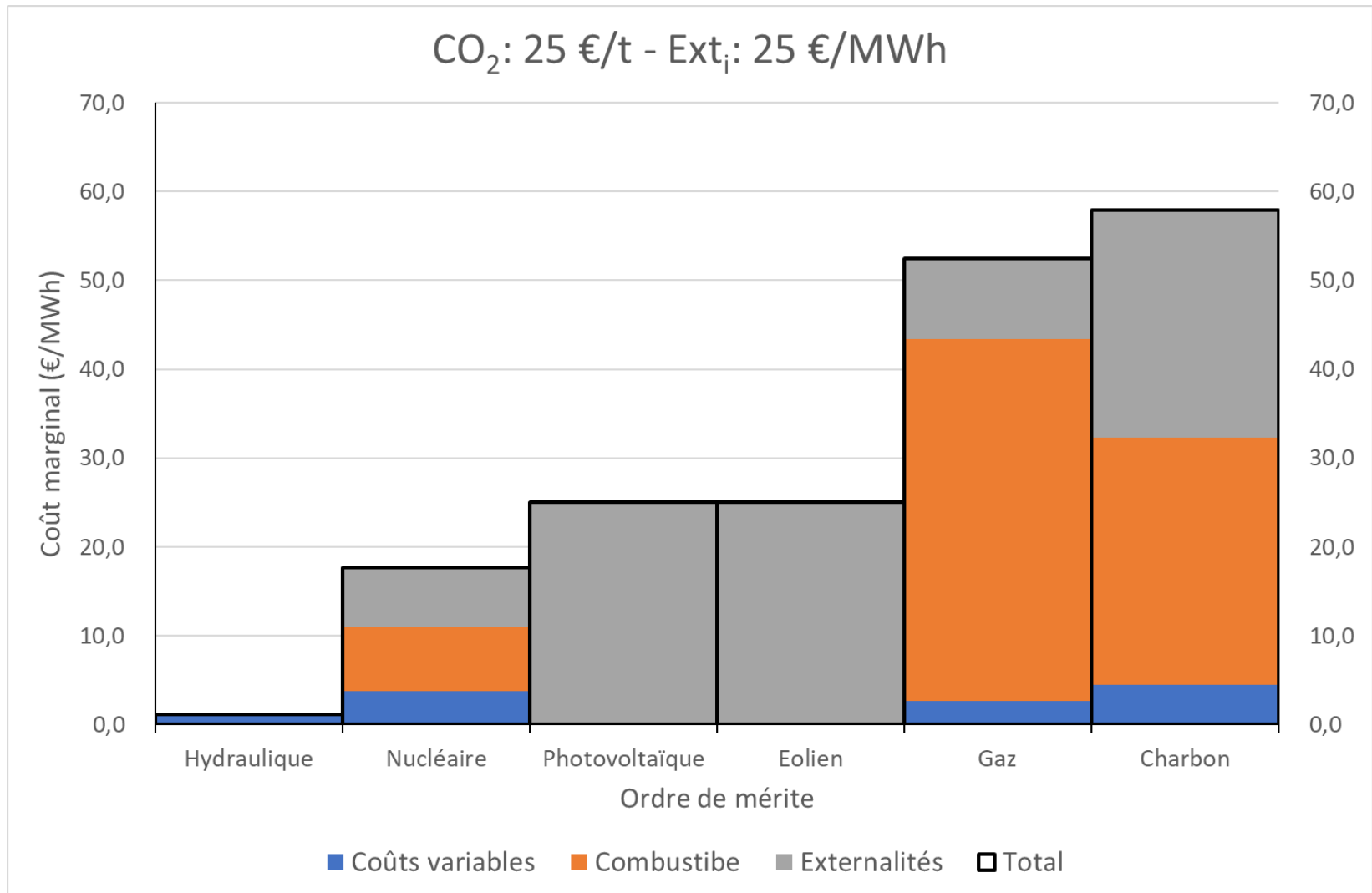
Impact on LCOE: high sensitivity to discount rate, construction cost, construction time and load factor (modest impact of the increase in other costs, especially when they are distant in time, e.g. dismantling)

| | Coût Construction | Durée Construction | Coût Combustible | Coût O&M | Coût démantèlement | Facteur de charge |
|----------------------|--------------------------|---------------------------|-------------------------|---------------------|---------------------------|--------------------------|
| Variation | +10% | +10% | +10% | +10% | +50% | -10 |
| LCOE (r = 4%) | +5.6% | +6.9% | +1.5% | +2.5% | +0.4% | +6.9% |
| LCOE (r = 7%) | +6.7% | +8.7% | +1.1% | +1.8% | ~0% | +8.5% |

Merit order without externalities (Percebois/Pommeret, Reflets de la Physique)



Merit order with externalities (Percebois/Pommeret Reflets de la Physique)



II. Need to take into account the services rendered to the electricity system

- 1. Nuclear power plants (like hydroelectric dams) are both decarbonised and controllable, unlike wind or solar power plants which, although decarbonised, are not controllable (gas or coal-fired power plants are controllable but carbonised)
- 2. Pilotable power plants (rotating machines) contribute to the balance of the grid (maintaining the frequency at 50 Hz) and this service is not remunerated; it should be: in what form? The OECD/IEA has introduced the concept of VALCOE (VA for Value Added)... a shadow price could be introduced which would reduce the LCOE of controllable power plants (i.e. nuclear)
- 3. The presence of a growing share of unavoidable (fatal) electricity (solar and wind) which has priority on the grid (both for legal reasons and because its marginal cost is zero) induces a *crowding-out effect* on nuclear, which reduces the competitiveness of nuclear, whose load factor decreases. By 2030, there is a risk that we will be faced with two problems simultaneously: **too much fatal electricity at off-peak times and not enough controllable electricity at peak times.**

III. Financing mechanisms for new nuclear power

- 1. Contract for Difference (CfD) mechanism (Hinkley Point). The operator borrows on the financial markets or from banks. **But the operator must still advance the funds. The operator only recovers the investment and is remunerated once the reactor has been commissioned**
- 2. Regulated Asset Base (RAB) mechanism (BAR for Base d'Actifs Régulés). **An important advantage is that investors are remunerated from the start of construction and do not have to wait for commissioning. This system reduces the capital cost.**
- 3. Partial public funding mechanism. The State subsidises (at least in part) the operator or uses the mechanism of public grants (State shareholder); the operator borrows the balance on the financial market or from banks. This implies a "renationalisation" of EDF. (cf ARENH reform)
- 4. Other solutions? PPA or "Mankala" model (TVO in Finland)

Reform of the ARENH (subject to the reform of EDF's status)

- **1. Abolition of ARENH?**
- **2. Increase of the ARENH volume beyond 100 TWh but increase of the ARENH price beyond 42 euros per MWh in return (48-50?)**
- **3. Extension of ARENH to all suppliers (100%); nuclear becomes an *essential facility* (SIEG), like the electricity networks. Its price is fixed by the CRE.**