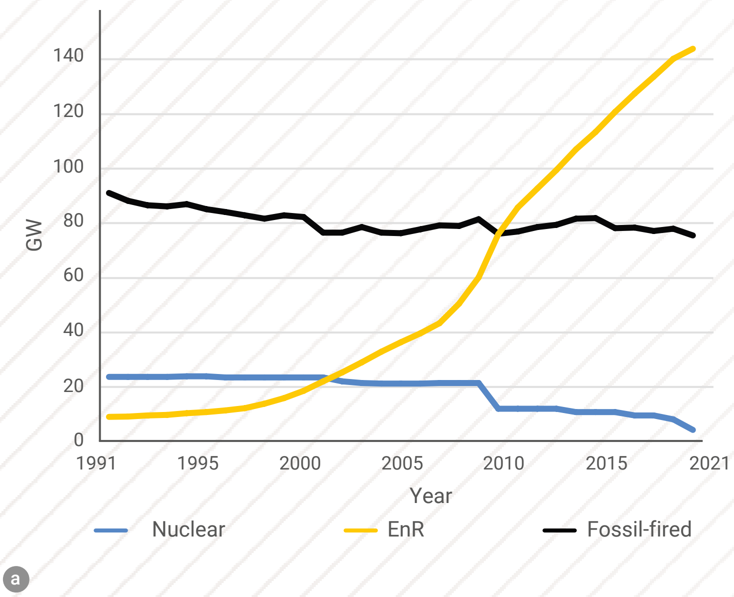
Non-dispatchable sources of electricity: issues and challenges

The growing role that electrical energy is set to play, already discussed in the second part of this issue, now leads us to analyse the consequences and challenges posed by a correlative development of variable or intermittent, non-dispatchable power sources.

There is one essential characteristic of electrical energy as an energy carrier: it is not a stock energy. It must be consumed when it is produced. If it is used later, it must be converted into other forms of energy: mechanical (hydraulic), electrochemical, combustible fluids, etc.

As a prelude to the analysis that follows, let's take a look at the development of the German electricity mix (fig. 1) to get an idea of the challenges posed by the development of non-dispatchable renewable sources.

This example is eloquent, because it clearly shows that the electricity grid must be able to receive the flow of energy required by demand at all times. If non-dispatchable sources are unable to respond (when there is not enough sun or wind), then necessarily dispatchable sources (hydro, fossil-fired, nuclear) must take over. Whatever the cumulative annual production or intermittent power installed, the dispatchable power must always be able to meet the maximum energy flow. In France, the electricity transmission system operator RTE imposes a security



1. German electricity mix: trends in installed capacity (a) and generation (b). Despite a 10-fold increase in the installed capacity of renewable energies (RE), there has been no drop in capacity for fossil-fired power, a dispatchable source whose output is nevertheless falling. In addition, there has been a marked increase in production from coal and lignite (red arrow in figure b), coupled with the phase-out of nuclear power.

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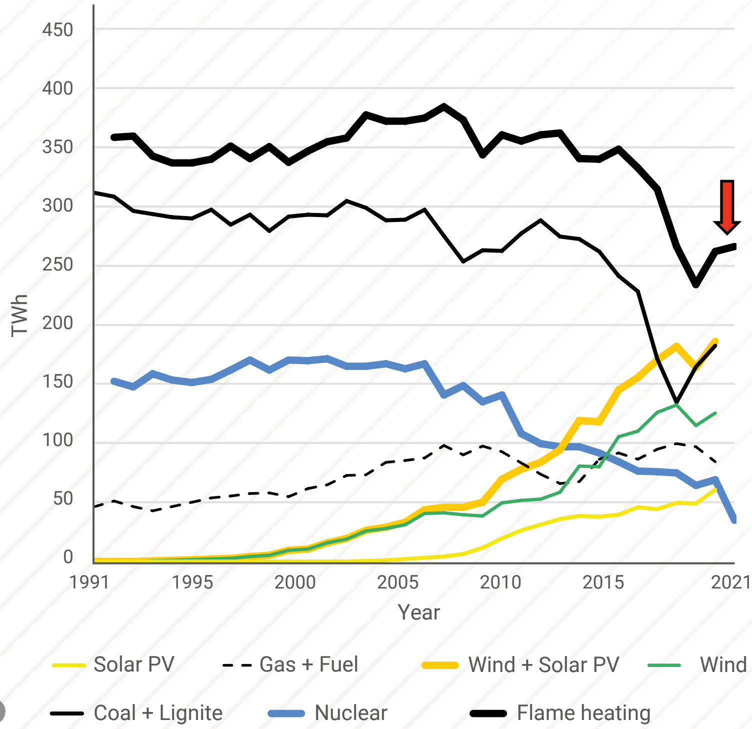
The Andasol solar thermal power plant, located in the province of Granada (Andalusia, Spain). It uses heat storage technology in tanks of molten salt at 400°C, so that it can also produce electricity at night or during the day when the sun is not shining. It generates 175 to 180 GWh of electricity per year.

capacity corresponding to "average peak power", currently worth 94.3 GW. It is therefore necessary to have a dual system, whatever the penetration rate of non-dispatchable renewable sources.

In addition to the shortfall in production that dispatchable sources have to make up for, variable or intermittent renewable electricity sources generate surplus production throughout the year that should be stored. This stock would naturally be extremely useful if it were capable of supplying the dispatchable system at the right moment. To get an idea of the orders of magnitude, let's imagine, for a French electricity grid supplied 100% by intermittent renewable sources, a succession of three days without any production. The backup system should then be able to deliver around 5 TWh, with an average flow rate of around 70 GW. If this production could be provided neither by nuclear power nor by fossil-fired power stations fuelled by natural gas, but by power stations burning hydrogen produced by electrolysis using these surpluses, how much would need to be stored? Taking conversion efficiencies into account, we would need to have a stock of around 0.25 Mt of hydrogen, the production of which would have required the consumption of around 15 TWh of electricity, i.e. three times the volume of the deficit for those three days. We can then think of other means of storage, including hydro and batteries. Before the detailed discussion that follows, we need to be aware of the enormity of the challenge, realising that the energy contained in all the world's batteries, all species combined, is of the order of 1 TWh.... ▮



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