

# A 2040 vision for the Swedish energy system

By Fredrik Lundberg, July 2024



*The 2040 vision for the Swedish energy system that was set out by the Swedish Society for Nature Conservation (SNF) in 2019 proposed much more wind power, no nuclear power and much less energy use as a route to a 100-percent renewable economy. Five years later, it looks more achievable.*

The report<sup>1</sup> **Fossilfritt, förnybart, flexibelt** (Fossil-free, renewable, flexible), projects a future with less energy use for 2040 with no fossil fuel, no nuclear and no CCS. The report was written by Kristina Östman for SNF.

Energy supply is halved from 2017 (the latest available figures at that time) to 2040. Some of this comes as a result of the postulated nuclear phaseout, as nuclear power is about 66 percent efficient in converting uranium fuel energy content into electricity. Electricity use for buildings will be cut by 25 percent and heating for buildings by 30 percent. Electric vehicles are also much more efficient than fossil cars, and hydrogen steel has less energy input than steel from coal and coke. Increased use of heat pumps and better insulation cuts the use of direct electricity or oil for heating. (Gas is not widely used in Sweden).

Large growth in wind power is also projected, from 18 TWh in 2017 to 90 TWh in 2040. This would mean 7,000 wind turbines at what was then the standard output of 4 MW, but no more than 4,000 using “future tech” 6 MW turbines, or 2000 even larger 12 MW turbines. That future is already here. Onshore turbines are now often 6–7 MW, and offshore turbines 15 MW and more. 90 TWh for wind power is in no way extreme. The Swedish Grid Operator Svenska Kraftnät expects 82–120 TWh by 2035 in its 2024 long-term market analysis.

<sup>1</sup> <https://www.naturskyddsforeningen.se/artiklar/fossilfritt-fornybart-flexibelt-framtidens-hallbara-energisystem/>

The projection for solar power is 15 TWh (from 0.2 TWh in 2017), about the same as Kraftnät's scenarios. Also projected is 8 TWh of solar heat, which is much more than other scenarios. So far no such solar heat for district heating has materialised, but if so it might either replace waste combustion or reduce the use of biomass.

The report relies heavily on biomass at 132 TWh input, compared to 142 TWh in 2017. It notes, however that many biofuels are not sustainable, and that the IPCC does not automatically classify them as carbon neutral. Since the report was written, the conflict has become even more acute between bioenergy output on the one hand and biodiversity and climate on the other. Partly because of limitations in biomass resources, the report sees some lifestyle changes as necessary, for example some decrease in air transport, about 3.5 percent per year, and 40 percent less road traffic as well as around 40 percent fewer cars by 2040. The remaining cars are overwhelmingly electric by that time, but biofuels will play an important role up to 2040, and biofuels of imported origin will be replaced with indigenous biofuels.

This looks both more and less difficult to achieve from a 2024 perspective than it was in 2019.

There is now consensus that battery electric cars (and to an increasing extent other vehicles) represent the future. But with recent Swedish and EU policy backslides a lot of new fossil vehicles will hit the roads over the next several years, many of which will still be there by 2040. It will be more of a challenge to find biofuels for them.

The phasing out of nuclear power was largely accepted and in fact not really in focus when the report was written. This soon changed. Nuclear power became a major campaign argument of the four right-wing parties that won the general election in 2022. Their climate policy as a government consists almost exclusively of high hopes for nuclear power. They say they can build new nuclear power and do it fast, with massive political intervention. They also claim (in line with an international trend, led by the US nuclear industry) that the existing six reactors can undergo life extension to more than 60 years, though they were designed to last 40 years, and there is no experience of very long operational lives anywhere in the world.

So now the ambition to phase out nuclear is by far the most controversial element in the report, in the Swedish political context. That does not necessarily mean that the projected phaseout cannot go ahead. Four reactors were shut down for good between 2013 and 2020. Those reactors would have needed major reinvestments to comply with post-Fukushima requirements, and the operators did not see how such investments would be profitable. None of the shutdowns were foreseen more than a few years ahead, and they were not the result of any political decisions.

Another point where the report completely diverges from the Swedish political discourse five years later is on electricity use, which is projected to be 176 TWh (which is not so far below Svenska Kraftnät's lowest scenario, but is far below the two higher scenarios at 320 TWh).

One reason for the increased use of electricity in the SNF report and even higher figures in later government scenarios is the de-fossilisation of steelmaking, as coal and coke are replaced with hydrogen as a reducing agent.

Currently, less than 20 percent of iron ore is used for steel production in Sweden. The remainder is exported as ore pellets. If all the iron ore were reduced to iron in Sweden, it would require a very large amount of electricity for hydrogen electrolysis compared to maintaining the present level of steel production. It makes a huge difference. The SNF report expects some 15 TWh of additional electricity for making green hydrogen steel, whereas other scenarios require more than 100 TWh for that purpose. It is uncertain if this really can be known or planned decades ahead. So far, electricity consumption has not only grown less than expected. It actually decreased considerably from 2017 to 2023.

Sweden exported lots of electricity (+19 TWh net in 2017) and the SNF report wants to keep it that way, at +22 TWh in 2040. So far, between 2018 and 2023, this figure has been surpassed. Balancing the electricity system with larger shares of wind and solar looks easier in 2024 than it did in 2019, thanks to cheaper batteries and more electric cars which can act as batteries, as well as some hydrogen storage on top of the huge existing hydroelectric dams.

CCS is not even mentioned, a caution well motivated by the absence, so far, of real large-scale projects in Sweden or the EU.

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