EDF proposal to convert Cordemais and Le Havre power stations to waste wood or mixed waste: A Trojan Horse for burning coal and forest wood from 2022?

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The French government is committed to phasing out coal by 2022. For EDF, this would mean having to close its coal power stations in France, one in Cordemais in the Loire-Atlantique Department (1200 MW capacity), the other in Le Havre in Normandy (600 MW capacity).

To avoid having to close these plants – which would mean having to write off two lucrative financial assets – EDF is proposing to convert them to biomass and/or mixed waste. Since the Provence 4 power plant in Gardanne was converted to burning woodchips made from forest wood, there have been growing concerns about the impacts on forests and other wood industries. The government has said that it prefers the use of biomass in small and efficient combined heat and power plants. In this context, it is speaking about burning pellets made from waste wood, 'green waste', including domestic forest residues, and possibly pellets made from mixed waste.

Even if this was technically possible, it would still be highly problematic. Turning coal power stations into waste incinerators instead of closing them down is neither sustainable nor climate friendly and burning large amounts of forest residues harms forests as well as other industries which depend on such wood.

However, as shown in this briefing, it is not technically possible for power stations of the type in Cordemais and Le Havre to be converted to burning mixed waste, nor any type of biomass other than wood pellets from high-quality virgin wood. EDF has spoken of burning black or torrefied pellets made from waste feedstocks. Yet, despite decades of efforts by industry and researchers, nobody has succeeded in producing commercial-scale quantities of torrefied pellets and nobody has been able to operate such pellets plants on a continuous basis. EDF must know this.

Could the EDF's talk about waste and residues be a means to win permission and subsidies to extend the lifespan of France's largest two coal power stations in order to burn coal and/or large quantities of wood pellets sourced from forests around the world?

What types of fuel can be burned in Cordemais and Le Havre?

EDF's two coal power stations in France were built with the same technology as most coal power stations around the world. The technology is different from what is used in the Provence 4 power station in Gardanne, which is far more flexible about the type of fuel that can be burned.[1] In power stations such as those in Cordemais and Le Havre, burning the wrong type of fuel results in corrosion, fouling and slagging (i.e. vital parts of the power station equipment are either slowly worn away or become clogged up).[i]

There is one minor caveat: pulverised fuel power plants can co-fire small amounts of biomass from a variety of feedstocks (including agricultural residues) with a high percentage of coal. However, when biomass is the sole or main feedstock, only pulverised high-quality virgin wood pellets can be burned.

Drax power station in England burns more biomass than any other plant in the world, with three out of six units having been converted to biomass. The power station relies on the same technology as the power plants in Cordemais and Le Havre (i.e. it is also a pulverised fuel subcritical power station). Before carrying out the first unit conversion, the operators, Drax Plc, trialled co-firing first 50% and then over 75% biomass with coal. They found that fast-growing biomass, including annual agricultural crops, had a high content of alkali salts and could not be burned without causing fouling, slagging and corrosion, i.e. damaging the equipment. The only suitable feedstock was "high quality or 'clean' biomass" which was "the product of very slow growing trees, typically from sustainable Northern Hemisphere pine forests with a low bark content".[2] Sawmill residues includes a very high proportion of bark, so they could therefore not be burned either. Drax has been burning pellets from a mix of virgin hardwood (much of it sourced from biodiverse coastal forests in the southern US) and virgin softwood from pine plantations.

What exactly is the technology used in Cordemais and Le Havre?

The technology is called 'subcritical pulverised fuel combustion'. 'Pulverised fuel' refers to the fact that they can only burn fuel – normally coal, but also pellets - that has been pulverised, i.e. ground up beforehand. The term 'subcritical' refers to the steam pressure and temperature inside the boiler. There are some more modern technologies which involve higher pressure and often also higher temperatures, making them more efficient, but most coal plants worldwide – especially older ones - are 'subcritical'.

Enviva's Ahoskie pellet plant, North Carolina (Dogwood Alliance)

Graanul's Imavere pellet plant in Estonia (Biofulewatch)

Enviva's Sampson County pellet plant, North Carolina (Dogwood Alliance)

What about the 'black pellets' which EDF is proposing to burn?

Black pellets have properties that makes them more similar to coal than ordinary (or 'white') pellets. They are also denser and drier, which makes them cheaper to transport and more efficient to burn. This makes them highly attractive to energy companies looking to co-fire biomass with coal or to convert entire coal units to biomass pellets.

However, nobody has ever successfully produced torrefied pellets on a commercial scale, even though researchers and companies have been trying to do

i. This is due to the fact that in a Circulating Fluidised Bed Power Station such as the Provence 4 unit in Gardanne, the same temperature is maintained in all parts of the boiler. In a pulverised fuel plant, that is not possible, resulting in temperatures which do not prevent harmful deposits and corrosive materials from forming/persisting. See for example: citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.429.1039&rep=rep1&type=pdf

so for a long time. Making black pellets from low-quality or mixed feedstock (e.g. waste wood or mixed green waste) rather than high-quality clean virgin wood is even more difficult.

The most widely researched technologies for making black pellets are:

1 Torrefaction (sometimes called 'roasting'): This involves heating biomass to around 250-320°C with little or no oxygen[3] in order to reduce the moisture content and change the chemical structure of the biomass;

2 Hydrothermal carbonisation: This involves heating biomass and water under pressure in a closed vessel at around 180-250°C;

3 Steam explosion: This involves placing biomass into a high-pressure vessel with steam and then rapidly reducing the pressure to change the chemical structure of the wood or other biomass.

Each of those technologies is beset with serious problems and challenges which have not so far been overcome.

Torrefaction:

Most companies trying to make black pellets have used torrefaction. However, major hurdles to producing large quantities of torrefied pellets have been confirmed by IEA Bioenergy, an organisation set up by the International Energy Agency to support bioenergy research, development and deployment worldwide. According to a 2015 IEA Bioenergy report[4]:

> The maturation and market introduction of torrefaction technologies has gone slower than anticipated in 2012, when it was expected that a significant fraction of the biomass pellets supplied today could have been replaced by torrefied pellets. It has been hard to fully prove the claims made earlier on product characteristics, and several companies have gone bankrupt due to inability to produce good quality product or due to a lack of buyers… Although demonstration and (semi)commercial facilities are running now, finding the optimal process conditions for producing a stable and high quality end-product are ongoing.

The authors of the IEA Bioenergy report point out that torrefied pellet developers were by 2015 focusing on domestic and industrial markets instead of larger power stations. Unlike most coal power stations, industrial and domestic pellet users tend to be much more flexible about the quality of the pellets they burn. In other words, as of 2015, efforts to produce torrefied pellets for coal power stations – where they would be most needed – have been all but abandoned worldwide.

Technical challenges, as identified by IEA Bioenergy[5] include:

- Maintaining the same temperatures in the reactor over long periods is difficult, and even harder when waste wood rather than clean virgin wood is used;

- Biomass and/or waste of different size, density and moisture requires differently adjusted pre-treatment. In practice, this means that one torrefied pellet plant could only use one specific type of biomass (e.g. virgin woodchips from conifers rather than a mix of construction waste wood plus forest residues);

- Heavy tar in the gas generated during torrefaction can condense and build up inside the equipment, causing operational problems. Addressing this problem requires additional investment;

- Scaling up the process from a pilot to commercial scale "can be a serious challenge";

- Difficulties in producing torrefied pellets that are easy to grind and durable – essential qualities for pellets used in power stations such as the two run by EDF;

- Higher explosion risks than with conventional white pellets;

- More ash and more alkali salts: Alkali salts are linked to power station equipment corroding or clogging up.

Hydrothermal carbonisation:

This technology is far less mature than torrefaction or steam explosion (even if the latter two do not appear to be commercially viable as yet either). Even the industry magazine, Biofuels Digest, commented in early 2018: "It may take some magic to get Hydrothermal Carbonization to commercialization and profitability."[6]

Steam explosion:

EDF proposes to burn steam exploded black pellets in Cordemais and possibly also in Le Havre. It has installed a small pilot plant for making enough pellets for feasibility trials at Cordemais.

The technology it uses was first developed by a Finnish company called Valmet. It was used by a US firm, Zilkha Biomass Energy, in a pellet plant in Alabama which opened in 2015, one year later than intended. Zilkha announced plans for its second plant in Arkansas. At one point, black pellets from Alabama were shipped to France and burned in the Saint-Ouen biomass boiler in Paris.

However, Zilkha's plant was not as successful as the company had hoped: the company stopped all operations in January 2017 and in November 2017, the State of Alabama voided the air permits because the company had failed to respond to requests for information and had not paid required fees.[7] Zilkha has since announced that it no longer plans to build a pellet plant in Arkansas.[8] Valmet has now agreed to sell the same technology that appears to have failed in Alabama to a French company, FICAP, which wants to build a pellet plant in the Champagne-Ardenne region, to make 120,000 tonnes of pellets a year, including both white and black pellets.[9] By comparison, running one Cordemais unit on biomass at full capacity would require 1.5 million tonnes of wood.[10]

Another developer of steam exploded black pellets is the Norwegian company Arbaflame. In Ontario, Canada, a unit of the Thunder Bay coal power station was converted to burn black pellets produced through steam explosion rather than torrefaction by Arbaflame.[11] However, this plant is reported to be idle 98% of the time,[12] i.e. the conversion has not been a success.

Where might black pellets for Cordemais and Le Havre be produced?

Initially, EDF stated that it would source black pellets to burn at Cordemais from Zilkha Biomass Energy in Alabama (see box above).[13] This would clearly not be an option now. Even if the new pellet plant in the Champagne-Ardenne region was to be successful, it would only produce a small fraction of what would be needed even to operate just one of the coal power plants at a very low capacity. And that would depend on FICAP being able to operate the technology successfully, something Zilkha Biomass Energy seems to have failed to achieve.

EDF has not announced any detailed plans to build its own commercial-scale black pellet plants. There are no existing black pellet plants anywhere in the world which sell sizeable quantities. If all of the torrefied pellet plants identified by IEA Bioenergy in 2016 were operating at full capacity, they would produce a total of 215,000 tonnes a year.[14] However, even this figure is highly over-optimistic. In the UK, for example, a 30,000 tonnes per year plant built by CEG currently produces a mere 200 tonnes annually.[15] An 80,000 tonnes per year plant also included in the figure was in fact shut down in 2016.[16] As for steam exploded black pellets, the only company producing those appears to be Arbaflame and whatever they can produce is being shipped to the Thunder Bay power station in Ontario.

In short, the black pellets required by EDF are not currently being produced anywhere in the world, the technology proposed was tried commercially in Alabama and appears to have failed, and EDF has not proposed how it could scale up black pellet production when all other companies that have attempted to do so have been unsuccessful.

How much wood could be burned at Le Havre and Cordemais?

Drax burned 6.8 million tonnes of (white) pellets made from 13.2 million tonnes of green wood in 2017 across its three converted 660 MWe units.[17] If EDF was to succeed in burning biomass at Le Havre and Cordemais as efficiently as Drax does, it would require pellets made from 4.12 million tonnes of wood[18] a year in order to run just one of the Cordemais units – or the single one in Le Havre – near full capacity.

Prolonging local air pollution

Both coal and biomass power stations are major sources of different air emissions, including sulphur dioxide, nitrogen oxides, and small particulates. Such air pollutants are linked to higher levels of ill health and mortality from respiratory problems, heart disease and strokes.[19]

Overall, burning biomass results in similar levels of air pollution as burning coal in power stations, although less of some and more of other pollutants. Emission figures from Drax reveal that sulphur dioxide emissions have substantially reduced in line with the gradual (albeit still only partial) conversion from coal to biomass. This was expected because biomass contains far less sulphur than coal. Nitrogen oxide emissions have reduced, albeit to a lower extent, yet this coincides with new mitigation technology having been installed, so it is not clear how far it relates to the shift from coal to biomass. Small particulate (PM_{10}, including $PM_{2.5}$) emissions, on the other hand, more than doubled between 2008 and 2016.[20]

Prolonging coal burning:

EDF has made it clear that neither the Le Havre nor the Cordemais power stations would be fully converted to biomass by 2022. Instead, it wants to be allowed to co-fire 50% biomass with 50% coal[21] and to then gradually ramp up the biomass burning until coal is phased out at an unspecified date. ***Permitting these conversions would therefore mean indefinitely delaying the coal phaseout in France.***

References

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18. This figure refers to green tonnes of wood (i.e. freshly cut wood), because black and white pellets differ in moisture content and thus weight per green tonne.

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