

Elyse Energy's E-CHO project in Lacq: Green innovation or a costly white elephant?

Introduction

The E-CHO project[1] is an ambitious proposal involving three different but interconnected projects in and around Lacq, in the Pyrénées-Atlantiques Department in France. The proposal is being led by Elyse Energy,[2] a startup company founded in 2020, which holds two-thirds of the shares in E-CHO. The other project partners and shareholders are Avril, Axens and IFP Investissements. The three projects proposed are to:

- Produce 72,000 tonnes of hydrogen per year from renewable and other "zero carbon" electricity (likely nuclear power);
- Produce 75,000 tonnes of aviation fuels and 35,000 tonnes of naphtha[1] from wood, via gasification and Fischer-Tropsch reforming, with carbon capture. Hydrogen is used during the last stage of the process.
- Produce 200,000 tonnes of methanol from hydrogen and captured carbon dioxide ("e-methanol").

Each of these projects would be a 'first of its kind' development worldwide. As discussed below:

- Hydrogen electrolysis (i.e. using electricity to split water molecules) is an energy intensive technology which has been successfully demonstrated, albeit not so far at the scale proposed here.
- All past attempts to produce liquid transport fuels, including aviation fuels, from wood have failed;
- Although the technology for making e-methanol has been demonstrated, e-methanol has not so far been produced at scale anywhere in the world, with the cost of hydrogen and carbon dioxide being the main barriers.

Below we will discuss both the risk of costly project failure, and the environmental risks should the project(s) succeed.

Hydrogen from electricity

Hydrogen electrolysis, i.e. using electricity to split water into hydrogen gas and oxygen, is a proven technology, however, no projects producing even 15,000 tonnes, let alone 72,000 tonnes per year exist worldwide as yet.[3] Only 0.1% of hydrogen production uses electrolysis – the rest is made from fossil fuels, mostly fossil gas.[4] Using fossil fuels to make hydrogen emits significantly more greenhouse gases than burning fossil fuels directly for energy.

1 Naphtha is used as a solvent in oil refineries, soaps, cleaning fluids, for varnishes and in paints, and sometimes as a camping stove fuel.

France and the EU aim to significantly expand hydrogen electrolysis. However, there are three serious problems with this: First, the high demand for electricity, and second, the high demand for water. Third, hydrogen itself is an indirect greenhouse gas, i.e. worsens climate change if it leaks into the atmosphere.

Electricity requirements

The E-CHO hydrolysis project would require 520 MW of electricity – i.e. 4.16 TWh assuming the plant was to run 8,000 hours a year. This is equivalent to nearly one-fifth of all solar power currently produced in France.[5] No new wind or solar power generation would be installed as part of the project, which means that electricity will be diverted from other users, such as space heating and cooling, which accounts for the greatest share of energy use in France.

This is likely to further delay the necessary rapid shift away from fossil fuels and from high-carbon biomass energy: non-emissive renewable electricity will replace significantly more fossil fuels if it is used to electrify heating and cooling, transport, and those industrial processes that can be electrified. This has been confirmed in a report by the International Renewable Energy Association (IRENA) in relation to space heating and cooling (where heat pumps are more efficient than hydrogen) and cars and trucks (where electric vehicles are more efficient).[6] According to a peer-reviewed study, the same is true in most cases for hydrogen vs electric buses.[7] A study by Agora Energiewende concludes that in most industrial processes, electrification is also preferable to hydrogen use, although there are some processes where electrification is not a viable option.[8]

Water requirements

According to the developers, the proposed hydrogen plant would consume 625 m^3 of water per hour, which comes to 5 million m^3 a year (again, assuming 8,000 hours of annual operations), and the whole project (including methanol and aviation fuel production) will require 8 million m^3.[9] This water will be taken from Gave de Pau. Such a large demand for water is concerning given that droughts and heatwaves are becoming more frequent and severe, including in the south of France, and will continue to do so given the level of further warming "in the pipeline" due to greenhouse gases already released. According to findings from the PIRAGUA project, funded by the European Regional Development Fund to help the Pyrenees region adapt to climate change impacts, annual river flows in the region will fall as much as 15% by 2040 and 20% by 2100.

Furthermore, large-scale water abstraction and return of discharge water at high temperature can have significant adverse effects on fish and other aquatic life, as is known from the impacts of thermal power plants.[10] During a public consultation hearing, serious concerns were raised after a representative of the project had mentioned discharge water reaching a temperature of up to 30°C. The company has since said that it would be kept below 28°C,[11] however, this is still significantly beyond the tolerance levels of the river trout.[12]

Hydrogen as an indirect greenhouse gas

Hydrogen is not a greenhouse gas in itself, however, hydrogen that leaks into the atmosphere reacts with the most important oxidant, OH (hydroxyl radicals), which is responsible for breaking down the powerful greenhouse gas methane. Hydrogen leakage thus increases the atmospheric lifetime of methane. Exactly how much warming is caused by hydrogen leakage is a matter of discussion and research, but the fact that hydrogen leaks contribute to warming is not disputed.[13]

Aviation biofuels from wood

How realistic is the technology:

As Biofuelwatch showed in a 2018 report,[14] the quest for transport biofuels from wood dates back to the early 20th century, with the first ethanol refinery using wood having opened in South Carolina in 1910. Although it produced some ethanol, yields were so low that it had to shut down. Ever since, attempts to make liquid transport fuels from wood have failed due to low yields and/or technical problems.

The technology chosen by E-CHO involves wood gasification and Fischer-Tropsch reforming, followed by upgrading the fuel to bio-kerosene. Wood is gasified by exposing it to high temperatures with a controlled oxygen stream. This produces a gas, called syngas, which then needs to be cooled down and cleaned. Fischer Tropsch reforming involves chemical reactions of the clean syngas with catalysts in a reactor. The process has been successfully used with coal (notably by the South African apartheid regime to circumvent the oil embargo), and also with fossil gas, though it is expensive. However, it has never been successfully used at scale with biomass.

The key problems with biomass gasification and Fischer-Tropsch reforming are:

1. Tar formation during the gasification process: Tar removal or prevention remains a significant challenge for biomass gasification, because tars can clog up and corrode plant equipment.[15] Although there are successful biomass gasifiers, a lot of biomass gasification projects have ended in failure.[16]
2. An extremely high level of syngas cleaning is required to produce useable fuel: according to the final report from a European Commission-funded research and development project in 2016, "purity of the syngas needs to meet ppb [parts per billion] concentrations".[17] To the best of our knowledge, this second problem has never yet been overcome.

The E-CHO project also seeks to add a highly challenging pre-treatment technology: torrefaction. This involves heating biomass to 200-400°C in the absence of oxygen to produce 'black pellets'. In 2021, Biofuelwatch looked at the commercial successes and failures of black pellet production, including torrefaction. We found 20 companies that had invested in different biomass torrefaction projects, none of them with any success.[18] Tar formation during torrefaction and failure to achieve the desired quality of wood pellets appear to be the two fundamental problems.

Finally, E-CHO wants to capture CO_2 from the process.

A peer-reviewed article from 2021 looked at woody biomass projects involving gasification and Fischer Tropsch reforming worldwide.[19] It identified 12 such projects. Four of them were marked as 'cancelled', one as 'idle' and another as 'on hold'. One was 'under construction' and five 'operational'.

The plant described as 'idle' was a pilot plant operated by a company, CHOREN, that went insolvent in 2011. CHOREN went bankrupt because its investors lost patience with its failure to commercialise biomass gasification and Fischer Tropsch gasification.[20]

The project described as 'on hold' was a very small Fischer Tropsch pilot plant in Austria which does not appear to have been recommissioned.

The project 'under construction' was a commercial-scale aviation biofuel refinery in Oregon, called Red Rock Biofuels (RRB). That refinery was never commissioned, and, after several years' delay, the company went into foreclosure, i.e. bankruptcy. RRB had received $77 million (70.4 million Euros) in public subsidies, as well as $300 million (274.6 m Euro) in tax-exempt economic development bonds issued by the state government. The technology was fundamentally very similar to what is proposed by E-CHO, except that it did not involve torrefaction or carbon capture.

Four of the pilot plants described as 'operational' are not in fact biomass, or pure biomass, projects. One, by GTI Des Plaines, last used biomass in 2008 and then switched to coal,[21] and two are - or were - pilot plants with co-gasification of coal and biomass.[22] Another one is a small pilot plant to test a variety of different processes and feedstocks.[23]

The final project classed as 'operational' was the BioTFuel pilot plant which tested the precise technology to be used in the Lacq project. We emailed Elyse Energy on 4th March 2024 to enquire about how much fuel was produced in that pilot plant during 2023. The company replied: "*BioTfueL was a semi-industrial demonstration plant that has produced **negligible quantities** of SAF and naphtha to mostly demonstrate the full value chain. The next step is a commercial plant, called BioTJet, to be built in South West France*" [our highlight].

Clearly, the technology for producing aviation biofuels from wood has never been successfully applied anywhere. We therefore believe that the chances of a repeat of the Red Rock Biofuels experience – a costly failure for both public and private funders – are very high, if construction proceeds.

What would the impacts be, if it was to work?

According to the developers, the project will require 300,000 oven dry tonnes of biomass from 500,000 green tonnes of wood (i.e. freshly cut wood).[24] Moisture content of trees varies by species, with many species having a moisture content of more than 50%,[25] which means that even more freshly cut wood may be required.

A regional association opposed to the E-CHO project, Touche pas à ma forêt: pour le climat, has estimated that obtaining the amount of forest wood that the developers say they will use will result in anything between 300,000 to 1.5 million tonnes of CO_2 emissions per year, depending on the type wood sourced from the forest.

At a public meeting, representatives of Elyse Energy stated that during the early years of the project, only roundwood would be used. We assume that this is due to the fact that low-quality feedstock such as brush left behind after logging, or sawmill residues with a large amount of bark, would only add to the major technical challenges of biomass gasification and Fischer-Tropsch reforming.

Since 2001, much of France has seen significant reductions in tree canopy extent, with the Landes forest region having been worst affected, according to a 2023 study based on analysis of satellite data.[26] According to the European Commission, France is not expected to reach its 2030 target for carbon removals under the Land Use, Land Use Change and Forestry (LULUCF) Regulations.[27] Yet, according to the French government's National Low-Carbon strategy, updated in 2020, a significant increase in logging is foreseen, even though this will further reduce forests' capacity to sequester carbon.[28] The state-owned Institut national de l'information géographique et forestière, the amount of CO2 sequestered by forests per year declined by one third in the decade up to 2021.[29]

An additional demand for 500,000 tonnes of wood a year can only compound those climate impacts, as well as worsening habitat loss and thus harming biodiversity in the region.

E-methanol production

This is the third component of the E-CHO project. E-methanol production involves reacting hydrogen with carbon dioxide in the presence of a catalyst. In November 2023, the world's first pilot plant was opened in Germany, which will test and further develop this technology.[30]

Development of any new technology involves a learning curve, called "technology readiness levels". Using the definitions adopted by the European Commission, the fact that the world's first pilot plant has just been opened places e-methanol between technology readiness levels 4 and 5 out of a total of nine levels. Large-scale commercial application is level 9.

The E-CHO project developers apparently seek to 'jump' several technology readiness levels and build a large facility, producing 200,000 tonnes of e-methanol a year, even though this technology is yet to be validated at the pilot plant level. Biofuelwatch is not aware of any successful technology development in the energy sector that has achieved such a leap.

Another concern is that the project would require 280,000 tonnes of CO2 a year. And yet, according to the developers, only 30% of this could come from capturing carbon at the proposed aviation biofuel plant (which, as we have seen, itself faces formidable technical hurdles). The developers state that the remainder would need to be sourced from other nearby manufacturers. However, currently there are no nearby manufacturers so far capturing CO_2, and there are no CO_2 pipelines either. Transport by truck or train is suggested as an alternative, however, this raises serious safety concerns, given that CO_2, is poisonous and even lethal in high concentrations. Nor is it clear where exactly the CO_2 would be procured.

Conclusion

A successful E-CHO project would have several potentially severe negative impacts on climate, freshwater, forests and biodiversity:

The proposed wood-to-jet fuel plant would require at least 500,000 tonnes of high-quality wood and thereby add to the already excessive and growing pressure on forests in France. Whether directly or indirectly, this large new demand for wood would adversely impact forest habitats and the species that depend on them. It would also reduce carbon stores and sequestration, thus worsening rather than mitigating climate change.

The proposed hydrogen plant would divert significant amounts of clean renewable electricity from other uses, where it would otherwise contribute to far greater replacement of fossil fuels and thus greenhouse gas reductions. It would also require large amounts of river water and likely harm fish and other aquatic life as well as depleting freshwater resources at a time of ever more frequent and severe droughts and heatwaves.

Finally, the e-methanol plant, which depends upon successful operation of the other two project components, raises serious questions about the safety of the proposed transport of large quantities of carbon dioxide.

There are compelling reasons to doubt that the E-CHO project could succeed. The E-CHO project is led by a startup company, Elyse Energy. Overall, 90% of startup companies fail,[31] and the record for so-called "cleantech" startup companies that receive large amounts of finance from venture capitalist funds, has been no better.[32] This suggests that large amounts of public and private finance for the E-CHO project alone, cannot guarantee success. Indeed, many of the failed wood to biofuel and black pellet projects discussed in our reports referenced above had also attracted significant private and public funding. As discussed in a recent article published by MIT Technology Review,[33] "*Investors are risking billions on scaling up nascent technologies.*" This, according to the author, is due to the fact that "*transforming academic advances in physical sciences and engineering into commercial businesses is a project that's fraught with dangers. It typically requires startups to build so-called demonstration plants*."

As shown above, the E-CHO project involves large-scale commercial application of two technologies (aviation fuels from wood and e-methanol production) that have not been proven even at the scale of a demonstration plant. The hydrogen electrolysis component of the project uses a technology that has been successfully demonstrated, but never so far at the scale proposed in this project.

Based on the experience with other failed projects, including in the 'advanced biofuels' sector, the risk of significant loss of public funds as well as private investments is very high.

1 e-cho-concertation.fr/

2 elyse.energy

3 iea.org/energy-system/low-emission-fuels/hydrogen

4 Global Hydrogen Review 2023, IEA, Clean Energy Ministerial, Hydrogen Initiative iea.blob.core.windows.net/assets/ecdfc3bb-d212-4a4c-9ff7-6ce5b1e19cef/GlobalHydrogenReview2023.pdf

5 statista.com/statistics/768066/electricity-production-france-source/

6 Hydrogen: A Renewable Energy Perspective, Report prepared for the 2nd Hydrogen Energy Ministerial Meeting, September 2019, irena.org/-/media/Files/IRENA/Agency/Publication/2019/Sep/IRENA_Hydrogen_2019.pdf

7 Electric and hydrogen buses: Shifting from conventionally fuelled cars in the UK, Kathryn G. Logan et.al., Transportation Research Part D: Transport and Environment, August 2020, sciencedirect.com/science/article/pii/S136192092030537X

8 Breaking free from fossil gas, Agora Energiewende, May 2023, agora-energiewende.org/fileadmin/Projekte/2021/2021_07_EU_GEXIT/A-EW_292_Breaking_free_WEB.pdf

9 e-cho-concertation.fr/media/4819438ed9f5b4273107/elyse-ECHO-Depliant_A5-230925.pdf

10 E.g. nrdc.org/sites/default/files/power-plant-cooling-IB.pdf

11 debatpublic.fr/sites/default/files/2024-02/Elyse%20Energy%20Projet%20E%20CHO%20Bilan%20Concertation%20Pr%C3%A9alable%2016%20f%C3%A9vrier%202024%20compress%C3%A9.pdf

12 Field-Based Estimates of Thermal Tolerance Limits for Trout: Incorporating Exposure Time and Temperature Fluctuation, Kevin E. Wherly and Lizhu Wang, Transactions of the American Fisheries Society, 2007, https://deepblue.lib.umich.edu/bitstream/handle/2027.42/141436/tafs0365.pdf?sequence=1

13 See for example A multi-model assessment of the Global Warming Potential of hydrogen, Maria Sand et.al., Nature Communications Earth and Environment, June 2023, nature.com/articles/s43247-023-00857-8

14 biofuelwatch.org.uk/wp-content/uploads/Cellulosic-biofuels-report-2.pdf

15 A comprehensive review of primary strategies for tar removal in biomass gasification, M. Cortazar et.al., Energy Conversion and Management, January 2023, sciencedirect.com/science/article/pii/S0196890422012742

16 See for example: Bioenergy and waste gasification in the UK, Barriers and research needs, Supergen Bioenergy Hub, 2019, supergen-bioenergy.net/wp-content/uploads/2019/06/Bioenergy-and-waste-gasification-report-2019.pdf

17 cordis.europa.eu/project/id/308733/reporting

18 biofuelwatch.org.uk/wp-content/uploads/Black-Pellets-report.pdf

19 Gasification of lignocellulosic biomasses and Fischer-Tropsch synthesis projects worldwide, Henrique Real Guimarães, Energy Conversion and Management, October 2021, sciencedirect.com/science/article/abs/pii/S0196890421008050

20 energycentral.com/c/ec/what-happened-choren

21 gti.energy/wp-content/uploads/2022/05/06-tcbiomass2022-Presentation-Zach-El-Zahab.pdf

22 tki.gov.tr/en-US/rede and southernresearch.org/southern-research-institute-wins-1-5-million-dept-of-energy-award-to-economically-produce-liquid-fuels-from-coal-and-biomass-mixtures/

23 cutec.de/en/for-partners/plant-engineering/chemical-energy-systems/fischer-tropsch-pilot-plant

24 e-cho-concertation.fr/blog/1923/les-ressources-necessaires-au-projet

25 Moisture Relations and Physical Properties of Wood, Samuel V. Glass and Samuel L. Zelinka, Moisture Relations and Physical Properties of Wood, April 2010, fs.usda.gov/research/treesearch/37428

26 Tree canopy extent and height change in Europe, 2001–2021, quantified using Landsat data archive, Svetlana Turubanova et.al., Remote Sensing of Environment, December 2023, sciencedirect.com/science/article/pii/S0034425723003486?ref=pdf_download&fr=RR-2&rr=86336a384a626403

27 commission.europa.eu/system/files/2023-12/Factsheet_Commissions_assessment_NECP_France_2023.pdf

28 ecologie.gouv.fr/sites/default/files/2020-01-20_MTES_SNBC2.pdf

29 ign.fr/espace-presse/les-donnees-de-linventaire-forestier-national-confirment-limpact-du-changement-climatique-sur-la-sante-des-forets-francaises

30 safety4sea.com/worlds-first-pilot-plant-for-green-methanol-production-inaugurated-in-germany/

31 luisazhou.com/blog/startup-failure-statistics/

32 technologyreview.com/2023/12/02/1084059/climate-tech-startups-are-back-and-this-time-they-might-survive/

33 technologyreview.com/2023/12/02/1084059/climate-tech-startups-are-back-and-this-time-they-might-survive/