2022

OUR VISION FOR A MORE SUSTAINABLE FUTURE TOGETHER

EU STARCH INDUSTRY DECARBONISATION ROADMAP

STARCHEUROPE
PLANT-BASED SOLUTIONS

1
INTRODUCTION

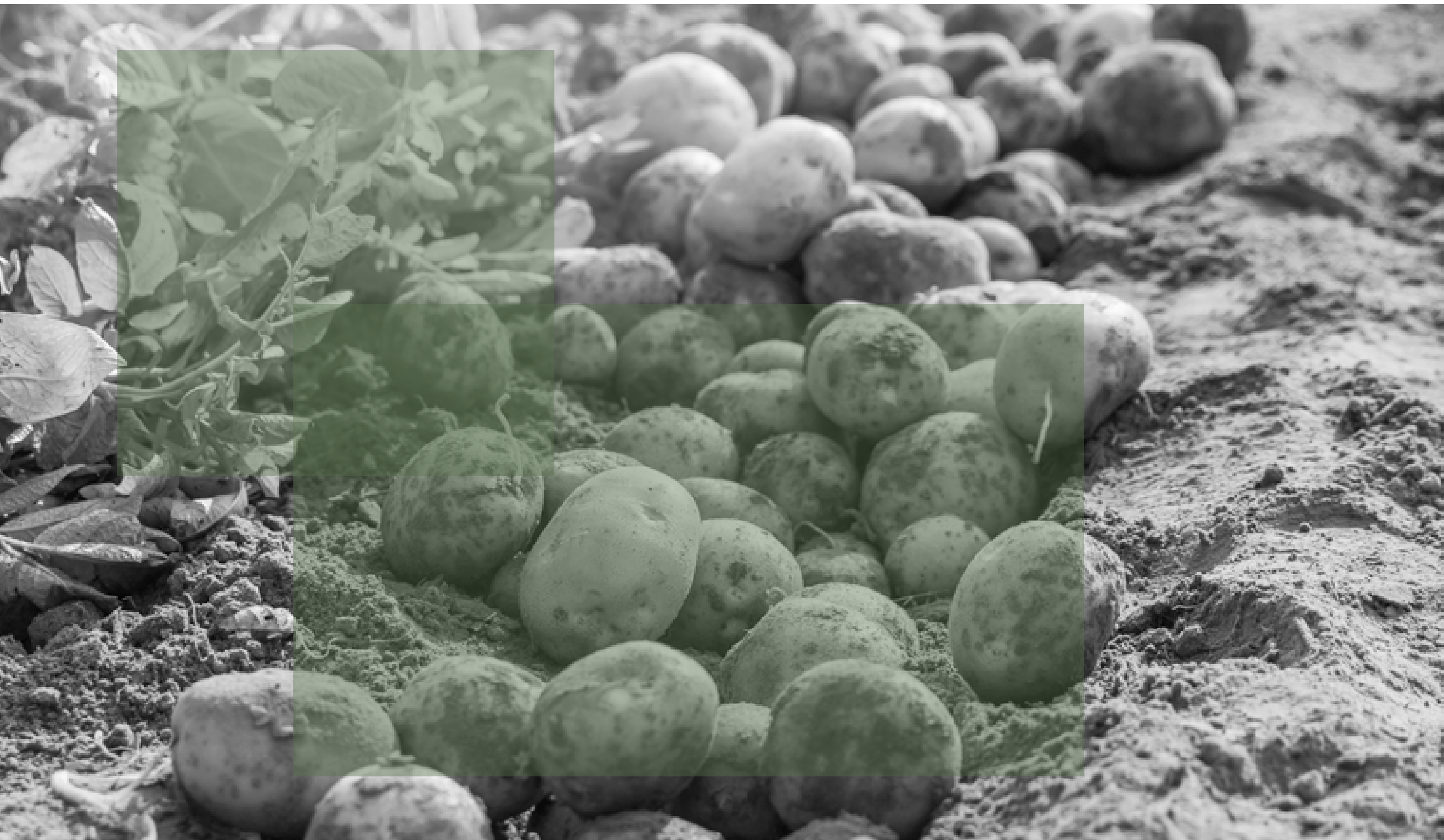
The European Starch Industry Association, **Starch Europe**, is the trade association which represents the interests of the EU starch industry both at European and international level. Its membership comprises 28 EU starch producing companies, together representing more than 95% of the EU starch industry, and, in associate membership, 6 national starch industry associations.

Starch Europe **supports the EU ambition** of achieving climate neutrality by 2050 as outlined in the EU Green Deal and the overall framework of the Fit for 55 Package.

As part of a broader vision of the European starch sector for a more sustainable future, and how our sector can continue to contribute to all pillars of sustainability, we have developed a roadmap for how we could further reduce our GHG emissions in line with EU climate ambitions.

In this context, the European Starch Industry have started by taking full stock of the environmental impact of its activities by conducting a broad and wide-ranging Life Cycle Analysis (LCA) study, the results of which were published on 13 April 2022, and which can be found here: https://starch.eu/2022/04/13/starch-europe-publishes-results-of-2022-life-cycle-analysis-lca/.

These results showed that in spite of an important increase in production, significant improvements were achieved in the period since 2010 when the last sector-wide LCA



study was conducted.
The sector's **total GHG emissions from its own production sites decreased between 2009 and 2019**, in spite of the increased production. An overall GHG emissions reduction of 7% was achieved between 2009 and 2019, translating to a **19% GHG reduction per tonne of dry substance output** in that period.
These reductions were mainly achieved thanks to:

- energy efficiency improvements of the processes of the starch industry,
- the switch of starch plants to less GHG intensive energy sources and the reduced GHG intensity of the electricity grid.

Whilst Starch Europe's most recent LCA study demonstrates that **most of the environmental footprint of the ingredients which we produce occurs at farm level (77% of the total)**, the starch sector is also itself an energy and heat intensive sector and recognises that it needs to continue its own efforts to decarbonise further. The **energy mix** in terms of generated GHG emissions is 17% electricity from the grid, 14% electricity from CHP, 34% steam from CHP, 22% steam from natural gas boilers, 13% natural gas.

While starch ingredients already contribute to the decarbonisation efforts of the starch sector's customers (section 2), there are several technologies and practices which may be deployed and implemented to reduce our sector's own GHG emissions (section 3). To enable the implementation of these technologies, appropriate support measures will be essential (section 4).

2
STARCH INGREDIENTS CONTRIBUTING TO A CLIMATE NEUTRAL EUROPE

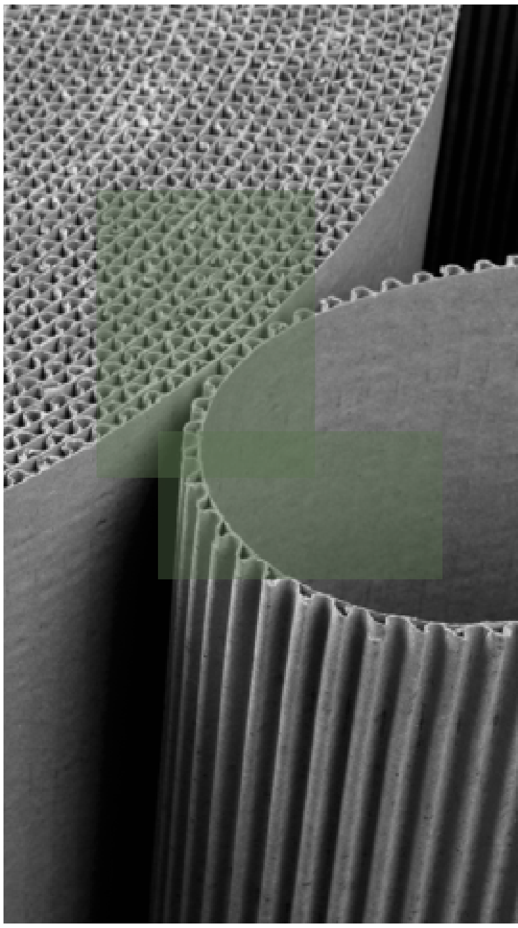
The increased production volumes between 2009 and 2019 are to be welcomed as they make a significant contribution to the decarbonisation efforts of the starch sector's many and varied customers, and to the broader EU Circular Bioeconomy objectives. For example,

- **Recycling of paper and cardboard** is impossible without starch;
- Starch-based ingredients are an important **alternative to fossil-based ingredients** in various industrial applications such as bioplastics, bio-detergents, bio-paints etc.;
- Starch-based ingredients **help improve the shelf-life** of various food products, thus reducing food waste;
- The **plant-based proteins** produced by the starch sector serve as an **important alternative to animal proteins** in many final food products, and help reduce EU reliance on imported proteins;
- Other ingredients of the starch industry, such as fibres and polyols, **contribute to many healthier and more sustainable final food products**.

3
TECHNOLOGIES WHICH CAN BE DEPLOYED TO ACHIEVE FURTHER EMISSION REDUCTIONS

A. Decarbonisation of fuels (scope 1 emissions[1] reductions)

i) Biomass combustion



The sector, which uses steam at high temperatures (> 180°C), relies on the use of gas boilers and of high efficiency cogeneration (CHP) based on natural gas. This guarantees a combined production of heat and electricity.

For a significant decarbonization of the sector, a partial conversion of gas-based boilers, including those in CHP, to carbon-free heat production solutions should be considered. Biomass boilers are currently among the best possible technologies for converting gas-based boilers to carbon-free solutions. While the availability of biomass is limited, projects must have a secure supply. For this, a regulatory framework to prioritize our sector's access to biomass sources is needed.

Two biomass-based technologies might be considered: biomass-based boiler units and biomass-based CHP units.

ii) Hydrogen combustion

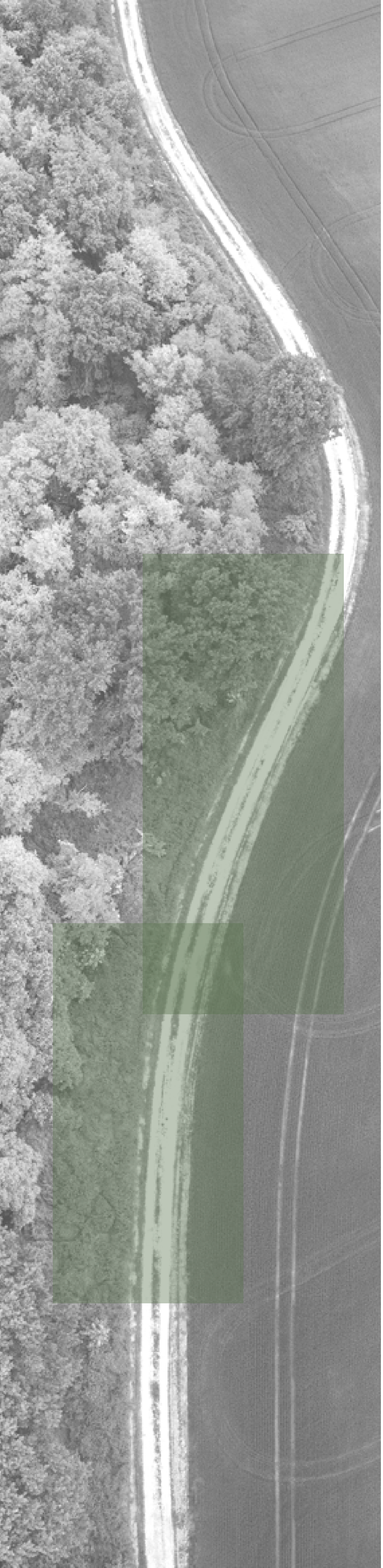
Hydrogen combustion could also be a particularly useful option for applications where high temperatures are needed. Indeed, a number of the other technologies listed in this roadmap (e.g. energy recovery installations or standard heat pumps) are not able to provide such high temperatures. This is to be considered as an option for scope 1 emissions reductions, on condition that low carbon hydrogen is used. Currently the limited availability of low carbon hydrogen restricts the use of this option.

Two hydrogen-based technologies might be considered: hydrogen-based boiler units and hydrogen-based CHP units.

iii) Biogas combustion

Similarly to the case of hydrogen combustion, switching to Biogas is an option for applications where high temperatures are needed.

1. The GHG Protocol Corporate Standard (https://ghgprotocol.org/about-us) classifies a company's GHG emissions into three 'scopes'. Scope 1 emissions are direct emissions from owned or controlled sources. Scope 2 emissions are indirect emissions from the generation of purchased energy. Scope 3 emissions are all indirect emissions (not included in scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions.



iv) Geothermal heat sources

Geothermal water sources may be exploited where geology allows it. This technology will often need to be combined with heat pumps (see chapter 3.b.i).

v) Anaerobic digester units

Anaerobic digester units could be further developed on starch sites to recover industrial effluents into biogas.

vi) Photovoltaic

Photovoltaic installations could also be built or further developed.

B. Switching from high carbon fuels to low carbon electricity (from scope 1 to scope 2)

Our heat requirements are too great for our processes to switch to 100% electric. Some technologies could however be developed, to allow increased electrification, which would allow for a significant reduction in CO_2 emissions. The electricity used to replace high carbon fuels should be low carbon electricity.

i) Heat pumps

New types of heat pump technology that use waste heat to produce high temperatures (> 150° C), suitable for industrial drying processes, represent an interesting new development and could have a significant impact in the decarbonization of our energy mix.

These can provide reductions of heat of 5-10%. It appears strategically sound that these should be the subject of experiments and prototypes with ad hoc financial support. Starch Europe joined the advisory board of a Horizon Europe project which intends to further develop and demonstrate industrial heat pump technology. The project plans to demonstrate three different heat pump technologies in three different industries (Chemical, Paper & Pulp and Food & Drinks).

ii) Electric boilers

Electric boilers can be used to replace gas boilers when the cost of electricity is viable and electrical networks are available.

iii) Mechanical vapor recompression (MVR)

Mechanical vapor recompression (MVR) reduces the consumption of steam at a site. These facilities could provide reductions of heat of 5-10%.

C. Reductions in Scope 2 emissions

i) Renewable electricity suppliers

Power Purchase agreement (PPA) with renewable electricity suppliers (including from other Member States) is expected to be a realistic option for the short & medium term. In May 2022, the Commission published a recommendation on speeding up permit-granting procedures for renewable energy projects and facilitating Power Purchase Agreements[2] .

D. Continuation of energy efficiency actions

The Starch sector is committed to further reducing emissions in the future through additional improvements in energy efficiency performance. The following technologies and processing practices in particular will allow for such improvements.

2. Commission Recommendation (EU) 2022/822 of 18 May 2022.

i) Lower heat demand / lower temperature demand

(1) Separation with membrane (instead of heat)

Polymeric Membranes and Ceramic Membranes used for separation in food and drink processing can contribute to lower operation temperatures. These are most often combined with successive filtrations with different molecular weight cut-off membranes or with other types of separation (pre-treatment by enzymes, concentration by evaporation, ion exchange for demineralization, deacidification, discolouring, etc.). These processing practices could provide reductions of heat of 5-10%.

(2) New drying technologies

New drying technologies using less water in the initial product mixture, superheated steam drying (already available), refractance window drying systems, high electrical field drying or electrohydrodynamic drying, ohmic drying (when such technologies become viable and/or available) could be implemented in our installations. These processing practices could provide reductions of heat of 5-10%.

(3) Lower temperature demand

While current processes require high temperature, this is not always needed. It is possible to lower temperature demand for certain processes (e.g. drying at 130°C). This would lower emissions by allowing the use of novel heat sources (e.g. geothermal heat).

ii) Heat recovery

Use of heat exchangers and heat pumps to recover heat (incl. fatal heat) could provide reductions of heat of 5-10%.

The heat recovery consists of a complete system of heat exchangers, storage tanks and pipes that must also be integrated into the automation, which can result in a substantial capital investment. An 8-year payback time is estimated for certain technologies. As an example, potato juice may be heated up using the heat from the potato water during the protein separation stage.

E. Other technologies and best practices

i) Innovation

Innovation and digitalisation will allow further energy reductions. Innovative chemical, physical and enzymatic treatment techniques and innovative high-performance additives, both environmentally friendly and efficient, will bring new desired functionalities to starches, reducing energy consumption. These new more efficient methods have the advantage of not using chemical reagents, eliminating the need for effluent treatment and reducing energy required for achieving desired functional characteristics.

ii) Design and implementation of innovative strategies

The modelling and optimisation of starch functional compositions, additives used, and treatment technologies will reduce energy consumption and side-streams and effluents generation.

iii) Operational (procedural and behavioural) changes

Operational (procedural and behavioural) changes, including switching off machinery, repair, and maintenance will contribute to reducing energy consumption.

4
REQUIRED POLICY SUPPORT MEASURES

While, as listed above, several technologies and practices can be deployed and implemented to achieve further emission reductions, numerous obstacles need to be overcome, including the cost of switching energy source on the sector's margins, the loss of profits from selling electricity in the event that CHP production is reduced or abandoned, and the lack of forward visibility on energy and GHG related costs. **To overcome these obstacles, appropriate support measures will be essential**.

The demonstration of green technologies to reduce risk will also be an important enabling factor, as will the development and diffusion of innovations and technologies through R&D tax credits, funding of research (e.g. via Horizon Europe[3]) and/or investments and incentives for early market adoption (e.g. via the Innovation fund[4]). Several Aid Schemes supporting research and innovation exist at national level. For instance, in April 2022, the European Commission has approved, under EU State Aid rules, a €700 million French scheme[5] to support research, development and innovation projects by companies of all sizes and active across all sectors. This measure is part of the "France 2030" recovery program that aims to develop industrial competitiveness and future technologies, in order to enhance economic recovery in the aftermath of the coronavirus pandemic. The scheme, which will be in place until 31 December 2023, applies to the following four thematic areas of research, development and innovation ('RDI'):

(i) energy transition and environmental protection,

(ii) digital transition,

(iii) innovations in production processes, and

(iv) research necessary to support the continued functioning of European value chain and the security of supply.

Overall, to increase the implementation of decarbonisation technologies, besides increasing the budget of existing schemes and launching new schemes in Member States where no such schemes exist, attention should be given to supporting all

3. https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe_en
4. https://ec.europa.eu/clima/eu-action/funding-climate-action/innovation-fund_en
5. https://ec.europa.eu/commission/presscorner/detail/en/ip_22_2697

relevant decarbonisation technologies, independently of how innovative they are.

We are committed to work together with policy-makers to address those challenges and unlock the potential to further reduce emissions in the starch sector.

The measures listed below are needed to support the decarbonisation of our sector.

a) Support to allow decarbonisation of fuels (scope 1 emissions reductions)

OPEX-based support systems are needed to reduce the price gap between energy produced by gas and energy produced by low carbon or carbon free fuels, to allow for a switch to biomass, biogas or hydrogen.

While it is difficult to evaluate the OPEX impact of switching from natural gas to biogas or hydrogen under current circumstances, we would estimate that OPEX costs would be of about 55 and 370 €/t CO_2 respectively, considering a natural gas price of 55 €/MWh, a biogas price of 85 €/MWh, a Hydrogen price of 150 €/MWh and a cost for CO_2 emissions of 90 €/t CO_2 (approximate historical prices). This would correspond to more than 9M€/year and more than 60 M€/year respectively in the case of a 40 MW CHP installation (typical of starch plants), with 40% CHP electric efficiency, 50% heat efficiency and 8000h running time.

CAPEX-based support schemes will also be needed in certain cases. It is useful to estimate a CAPEX/t CO_2 over 15 years for implementing a given technology, taking into account the initial investment and GHG emission reduction as well as other technical specifications of the system (MW, Yield, running hours…). For instance, based on currernt technology prices, we estimate a CAPEX/t CO_2 over 15 years of 45 to 80 €/t CO_2 for switching from a gas boiler to a **biomass boiler**. This CAPEX estimation does not take into account OPEX costs (energy prices, costs for management, controls, preparation and transport of fuels…), which in certain cases could be higher than CAPEX costs. Additionally, it does not cover special cases such as campaign plants, for which higher costs are likely.

Furthermore, public **investment in infrastructure** will be essential to allow decarbonisation of fuels. Although some investments are already taking place in the areas of **renewable hydrogen production**[6] and the development of **hydrogen import**[7] **and transport** (grids), important investments are still needed in these areas.

Several support schemes which could facilitate decarbonisation of fuels (scope 1 emissions reductions) are already available: at **EU level**, the use of resources from the **EU Innovation Fund** to support the installation of biomass-based or hydrogen-based units could be considered.

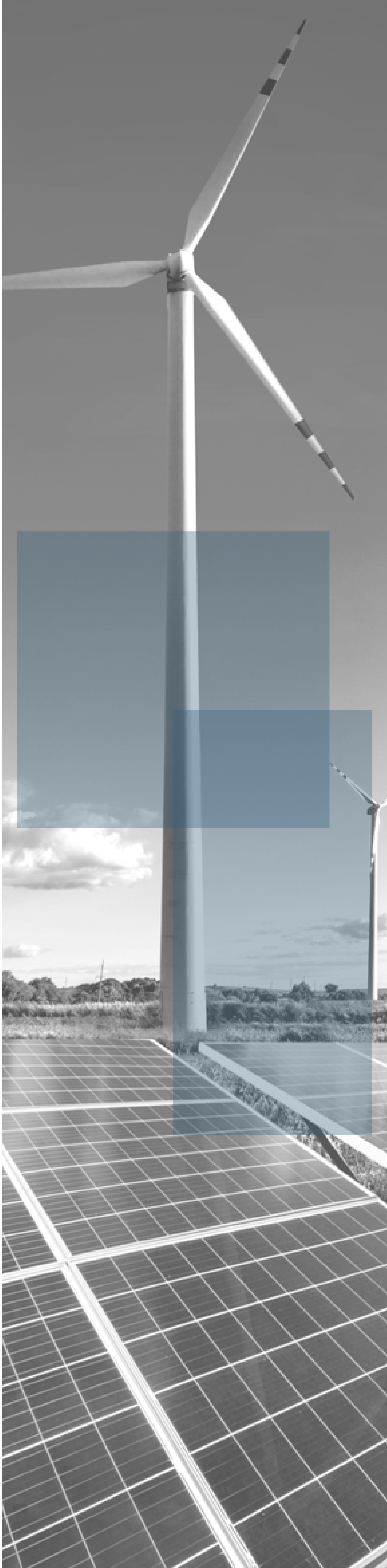
At national level, various schemes are available. For instance, **in France**, a support scheme is available for biomass projects with thermal production above 12000 MWh/year[8] .

In 2021, the European Commission has approved, under EU State aid rules, the following aid schemes:

- a €5.7 billion **French aid scheme**[9] to support renewable electricity production from small solar installations located on buildings. The scheme, which will run until 2026, will be open to operators of small photovoltaic installations located on buildings with a capacity of up to 500 kilowatt. These installations will be eligible to receive support in the form of a feed-in tariff (i.e., a guaranteed price for the electricity produced) over twenty years.

  The level of the feed-in tariffs will vary according to the size of the installation and the business model (i.e., installations injecting all electricity into the grid or installations consuming part of the generated electricity).

- an **Austrian aid scheme**[10] to support electricity production from renewable sources. The scheme aims to support electricity produced from renewable energy sources (namely wind, solar, hydro, biomass



6. https://ec.europa.eu/commission/presscorner/detail/en/ip_21_7022
7. https://economie.fgov.be/en/themes/energy/belgian-federal-hydrogen
8. https://agirpourlatransition.ademe.fr/entreprises/aides-financieres/20220408/appel-a-projets-industrie-zero-fossile-volet-1-bciat
9. https://ec.europa.eu/commission/presscorner/detail/en/ip_21_4424
10. https://ec.europa.eu/commission/presscorner/detail/en/ip_21_7023

and biogas). Payments under the scheme have been estimated to amount to around €4.4 billion until end 2032.

Although these aid schemes target mostly the sale of electricity, they might be relevant for certain installations.

b) Support to allow switching from high carbon fuels to low carbon electricity (from scope 1 to scope 2)

To allow decarbonisation by switching from high carbon fuels to low carbon electricity (from scope 1 to scope 2), the decarbonisation of the electricity grid (especially for EU countries with coal-heavy grids) will be necessary, as will an expansion of existing electricity grids.

Furthermore, **CAPEX-based support schemes** will also be needed in certain cases. As for technologies listed in the previous chapter, it is useful to estimate a CAPEX/t CO_2 over 15 years for implementing a given technology, taking into account the initial investment and GHG emission reduction as well as other technical specifications of the system (MW, Yield, running hours...).

As an example, at current technology prices, we estimate a CAPEX/t CO_2 over 15 years of 8 to 14 Eur/t CO_2 for switching from a gas boiler to an e-boiler, with higher values possible for low running times (e.g. 500-1000 h)[11]. This does not take into account OPEX costs, which in certain cases could be higher than CAPEX costs (energy prices, costs for management, controls, preparation and transport of fuels...).

Depending on the electricity price, the operation of heat pumps, electric boilers or MVR units may not be viable without subsidies. At **EU level**, resources from the **EU Innovation Fund** should be dedicated to supporting the installation of these technologies. Relevant subsidies schemes also exist at national level. As an example, in **the Netherlands**, the **SDE++ subsidies scheme**[12] can provide subsidies to support the installation of **heat pumps** or **electric boilers**.

As an example, **in France** the extension of the **IndusEE**[13] call for projects would be an enabling factor for the application of technologies such as **Mechanical Vapor Recompression (MVR)**.

c) Support to allow reductions in Scope 2 emissions

EU-wide measures to encourage the development of Power Purchase agreement (PPA)

11. Low running times might occur in campaign plants, but it is also usual in non-campaign plants to only run e-boilers when electricity costs are low and uncoupled from gas prices e.g. in summer, with low demand and high production from nuclear and/or renewable sources. Running e-boilers continuously is also possible and would allow to lower CAPEX costs by increasing running time, but this would result in higher OPEX costs. Another option which would allow a higher running time are PPAs for the purchase of year round renewable electricity.
12. https://english.rvo.nl/subsidies-programmes/sde
13. https://les-aides.fr/aide/WGR_3w/ademe/appel-a-projets-indusee-efficacite-energetique-des-procedes-et-des-utilites-dans-l-industrie.html

with renewable electricity suppliers in or across Member States are necessary to allow a more widespread use of these agreements.

d) Support for energy efficiency measures

To facilitate the energy savings improvements described above, appropriate support measures are needed.

For example, **in France**, we propose that the Service and Payment Agency (ASP) counter (guichet Agence de Services et de Paiement) is extended to energy efficiency projects of less than €3M, the Energy Savings Certificates (Certificats d'Economies d'Energie (CEE)) system is adapted to starch factories, and the IndusEE Call for Projects is extended.

e) Specific issue: industries operating CHP units

Finally, there is an important obstacle to decarbonisation for industries operating CHP units and wanting to decrease emissions linked to these CHP units: a financial benefit may exist linked to the operation of CHP units. When CHP is used, electricity is sold (or self-used).

i) Policy support to compensate loss of CHP related revenues

If an industry equipped with CHP consumes less heat or electrifies part of its heat production, depending on the heat reduction and the % of that heat coming from CHP, as a side effect, CHP production will be reduced, and less electricity will be available for selling (or self-use). This removes an incentive for industries using CHP units to decarbonise.

Similarly when non-CHP biomass-based boilers are used to replace CHP units, the entirety of the benefits coming from the sale of CHP electricity will be lost.
Policy support measures are needed to compensate the loss of profitability from not selling or auto-consuming electricity in case CHP production is reduced or stopped. This would be the case for a number of the technologies and practices listed in this roadmap, if implemented in a CHP-equipped industry.

ii) Policy support to avoid loss of CHP related revenues

As an alternative to the policy support measures to compensate the loss of CHP related revenues (described above), policy support could instead be provided to avoid the loss of CHP related revenues, in the form of subsidies or support schemes at EU level to adapt and/or replace CHP installations with low carbon CHP units (see section 4. a).

5
CONCLUSIONS

The Starch Sector remains fully committed to further reducing its emissions, and to playing its part in delivering on the EU Green Deal objectives.
Moreover, as we further reduce emissions from our operations, we are working alongside farmers to support the adoption of more sustainable agricultural practises and address emissions from agriculture.

We will also continue innovation to enhance the contribution of our ingredients to bio-based products across food, feed and industrial outlets in order to drive further downstream reductions.

We expect that the above technologies and best practices will allow the EU Starch Sector to achieve **a reduction in scope 1 and 2 GHG emissions[14] per tonne of starch (starch equivalent – commercial basis) of 25% between 2019 and 2030.** To enable this reduction, however, appropriate support measures detailed above will be essential.

To monitor the sector's progress in line with this roadmap, reductions in terms of scope 1 and 2 GHG emissions per tonne of starch will be monitored every two years based on internal data collection.

Furthermore, **Starch Europe will perform an LCA in 2031** to check that the target(s) are reached, and an interim progress report in 2026.

Beyond the 2030 horizon, and in view of working further towards climate neutrality, the sector will explore further solutions in addition the ones outlined above, such as carbon capture/sink solutions. Starch Europe will consider developing a new roadmap covering the 2030-2050 period.

14. As defined in the GHG Protocol Corporate Accounting and Reporting Standard

EU Starch Sector to achieve a reduction in **scope 1 and 2 GHG emissions per tonne of starch of 25%** between **2019 - 2030**

Starch Europe will perform an **LCA in 2031** to check that the target(s) are reached and an **interim progress report in 2026**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