

I4F Presents

POLICY BRIEF

***Barriers to overcome
for boosting the market uptake of Social Thermal Energy solutions***

SUMMARY

This study endeavours to set out a framework for seizing the explanatory difficulties in the European-wide roll-out of Social Thermal Energy (STE) systems in the agricultural sector.

To tackle properly the hurdles and other shortcoming hindering the successful impetus of this technology, this document will rely upon concrete and field application observations, displaying the panel of long-standing and circumstantial barriers limiting the market breakthrough.

In order to pave the way toward a remedy for the current situation, in this document a thorough analysis of the cultural and legislative setting will contextualise the available window of opportunity while further reviews will underline the prominence of technology's evolution in the progressive acceptance of a revolutionary means for supplying energy.

PART I : CONTEXT

1. REGULATORY INCENTIVES

1.1. Green Deal (reducing greenhouse gas emissions)

Europe and the world are facing an existential threat from climate change and environmental degradation. The European Green Deal, presented by the Commission on 11 December 2019, aims to tackle these challenges by converting the EU into an efficient, competitive, and resourceful economy, with the following objectives:

1. No net emissions of greenhouse gases by 2050 and becoming the world's first climate-neutral continent by 2050.
2. Dismantling the correlation between resource utilization and economic growth.
3. Ensuring that every individual and place benefits from the transition.

The European Green Deal is also a vital aspect of the EU's recovery from the COVID-19 pandemic. Roughly one-third of the €1.8 trillion investments from the NextGenerationEU Recovery Plan (analysed in more detail in section 1.1.5. below), and the EU's seven-year budget will be used to fund the European Green Deal.

Within this context, the European Commission has adopted a set of proposals to align the EU's climate, energy, transport, and taxation policies with the objective of reducing net greenhouse gas emissions by a minimum of 55% by 2030, in comparison to 1990 levels, emphasizing the necessity of a comprehensive, cross-disciplinary approach, where all relevant policy areas contribute towards the common objective of mitigating climate change. The Commission's proposals include the necessary laws and regulations to achieve the goals set out in the European Climate Law, which entered into force on 29 July 2021. The aim is to significantly change the way our economy and society operate, creating a future that is both environmentally sustainable and socially equitable, while also promoting economic prosperity.

The proposals put forth by the European Commission combine several measures that include expanding the use of emissions trading to additional sectors while also strengthening the existing EU Emissions Trading System (“ETS”). The proposals also aim to increase the use of renewable energy sources and promote energy efficiency, while also accelerating the deployment of low-emission modes of transportation and the necessary infrastructure and fuels to support them. Additionally, there is a focus on aligning taxation policies with the objectives of the European Green Deal, preventing carbon leakage, and implementing tools to protect and expand natural carbon sinks.

- EU Emissions Trading System. The EU ETS is a policy that sets a price on carbon and reduces the cap on emissions for specific sectors of the economy each year. This policy has been successful in reducing emissions from power generation and energy-intensive industries by 42.8% over the past 16 years. Today, the European Commission is proposing to further lower the overall emission cap and increase the rate of reduction. The Commission is also recommending the phasing out of free emission allowances for aviation, aligning with the global Carbon Offsetting and Reduction Scheme for International Aviation (“**CORSIA**”), and including shipping emissions in the EU ETS for the first time. To address the lack of emissions reductions in road transport and buildings, the Commission is establishing a separate emissions trading system for fuel distribution in these

sectors. Additionally, the Commission proposes to increase the size of the Innovation and Modernisation Funds.

- Social Climate Fund. Although EU climate policies are expected to bring more benefits than costs in the medium to long term, they may still pose additional challenges for vulnerable households, small businesses, and transport users in the short term. To ensure a fair distribution of the costs of addressing and adapting to climate change, the policies in the current package have been designed with this in mind.

Moreover, carbon pricing measures generate income that can be used to encourage innovation, economic expansion, and investment in sustainable technologies. The EU has introduced a new fund called the Social Climate Fund, which will supply targeted funds to Member States to help their citizens finance their investments in clean energy, new heating and cooling systems, and more eco-friendly transportation. The Social Climate Fund will be funded by the EU budget and will receive a sum equal to 25% of the estimated revenues of emissions trading for building and road transportation fuels. This fund will provide Member States with €72.2 billion in financing between 2025 and 2032, based on a specialized amendment to the multiannual financial framework. The proposal also recommends using matching funding from Member States, raising the total funding to €144.4 billion for a socially equitable transformation.

- Efforts Sharing Regulation. The Effort Sharing Regulation is a policy that assigns stronger emissions reduction targets to each Member State in several sectors, such as buildings, road and domestic maritime transport, agriculture, waste, and small industries. These targets are based on GDP per capita, with adjustments made for cost efficiency, to account for the different starting points and capacities of each Member State.
- Land use and forestry (LULUCF). Member States also share the responsibility for removing carbon from the atmosphere, which is addressed by the Regulation on Land Use, Forestry, and Agriculture. This policy sets a target for carbon removals by natural sinks in the EU, equivalent to 310 million tonnes of CO₂ emissions by 2030. Each Member State has national targets to expand their carbon sinks to meet this goal. By 2035, the EU aims to achieve climate neutrality in the land use, forestry, and agriculture sectors, which includes agricultural non-CO₂ emissions from sources such as fertiliser use and livestock. To improve the quality, quantity, and resilience of EU forests, the EU Forest Strategy is designed to support foresters and the forest-based bioeconomy while ensuring that harvesting and biomass use are sustainable. It also preserves biodiversity and establishes a plan to plant three billion trees across Europe by 2030.
- Renewable energy. Because energy production and use is responsible for 75% of EU emissions, it's important to hasten the shift to a greener energy system. To achieve this, the Renewable Energy Directive has set a higher target of producing 40% of our energy from renewable sources by 2030, with all Member States contributing to this goal. There are specific targets for the use of renewable energy in transport, heating and cooling, buildings and industry. To ensure that our bioenergy use is sustainable and aligned with our climate and environmental objectives, the sustainability criteria for bioenergy use have been strengthened. Additionally, Member States must design any support schemes for bioenergy in a way that prioritizes woody biomass uses in the cascade principle.
- Energy efficiency. In order to reduce energy use overall, cut emissions, and address energy poverty, the Energy Efficiency Directive has set an even more ambitious annual target for reducing energy use at the EU level. It will provide guidance for establishing national contributions and almost double the annual energy-saving obligations for Member States. The public sector will

be required to renovate 3% of its buildings annually, creating jobs and lowering energy use and expenses for taxpayers.

- CO₂ emission of cars and vans. To combat the growing emissions in road transport, a range of measures are necessary alongside emissions trading. The Commission proposes more stringent CO₂ emissions standards for cars and vans, which will speed up the transition to zero-emission mobility. The new standards require the average emissions of new cars to decrease by 55% from 2030 and 100% from 2035 compared to 2021 levels. This means that all new cars registered from 2035 onwards will be zero-emission. Additionally, to ensure that drivers have access to a reliable network of charging and fueling points across Europe, the revised Alternative Fuels Infrastructure Regulation will require Member States to expand charging capacity in line with zero-emission car sales and install charging and fueling points at regular intervals on major highways, specifically every 60 kilometers for electric charging and every 150 kilometers for hydrogen refueling.
- ReFuelEU aviation and FuelEU maritime. Aviation and maritime industries contribute significantly to pollution, and they require specific measures to complement emissions trading. The Alternative Fuels Infrastructure Regulation will require major ports and airports to provide clean electricity for planes and ships. To promote the use of sustainable aviation fuels, the ReFuelEU Aviation Initiative will require fuel suppliers to increase the amount of sustainable aviation fuels in jet fuel used in EU airports, including e-fuels. Similarly, the FuelEU Maritime Initiative will encourage the use of sustainable maritime fuels and zero-emission technologies by setting a maximum limit on greenhouse gas content for ships that call at European ports.
- Energy taxation. The way energy products are taxed needs to promote a fair and sustainable economy while encouraging environmentally-friendly behaviour. To achieve this, the Energy Taxation Directive is being updated to make sure the taxation of energy products is in line with the EU's energy and climate policies. This means that outdated exemptions and reduced rates, which incentivize the use of fossil fuels, will be removed. The aim is to reduce the negative effects of energy tax competition, and to help Member States raise revenue from green taxes, which are less likely to harm economic growth than taxes on labour.
- Carbon border adjustment mechanism. In order to prevent the loss of emissions reductions due to carbon-intensive production outside of Europe, a new system will be introduced called the Carbon Border Adjustment Mechanism. This will apply a carbon price to specific products that are imported into Europe, in order to ensure that climate action in Europe results in a global reduction in emissions. The goal is also to encourage industry outside the EU to take similar steps in reducing carbon emissions.

The aforementioned comprehensive and interconnected set of proposals cover climate, environment, energy, transportation, industry, agriculture, and sustainable finance, in order to reach the Green Deal objectives. They are mainly focused on:

- Increasing the use of renewable energy in the EU to at least 32% by 2030 and make the EU carbon neutral by 2050. This will involve the deployment of renewable energy technologies such as wind, solar, and bioenergy.
- Improving energy efficiency in buildings, industry, and transport. This will involve measures such as improving insulation in buildings, using more energy-efficient appliances, and promoting the use of electric vehicles.

- Promoting circular economy, which seeks to reduce waste, reuse materials, and recycle products. This will involve measures such as reducing packaging waste, promoting product repair, and increasing the use of recycled materials.
- Protecting and restoring ecosystems, such as forests, wetlands, and peatlands, which can help to absorb and store carbon dioxide.

The primary objective of the European Green Deal is to improve the well-being and health of citizens and future generations by providing: fresh air, clean water, healthy soil and biodiversity; renovated, energy efficient buildings; healthy and affordable food; more public transport; cleaner energy and cutting-edge clean technological innovation; longer lasting products that can be repaired, recycled and re-used; future-proof jobs and skills training for the transition; and globally competitive and resilient industry.

The primary challenge of the green transition in Europe is to make sure that everyone has access to these benefits and opportunities as soon as possible, and in a fair manner. By utilizing various policy tools available at the EU level, the pace of change can be sufficient while avoiding excessive disruption.

To meet the European Green Deal goals of reducing greenhouse gas emissions and achieving climate neutrality by 2050, North-West European countries provide a number of regulatory incentives, measures and support schemes, including:

- France. For instance, France provides tax incentives for renewable energy installations and supports research and development in the field of renewable energy. The French government has a target of deriving 32% of its total energy consumption from renewable sources by 2030. The Ministry of Ecological and Solidary Transition promotes the use of renewable energy sources through the Tax Credits for Energy Transition (CITE) and the Green Certificates scheme, which provides a financial incentive for the production of renewable energy in France.
- Ireland. The Sustainable Energy Authority of Ireland (SEAI) promotes the use of renewable energy in Ireland through different schemes such as the Better Energy Homes Scheme (BEHS) and the Renewable Energy Feed-in Tariff (REFiT). Ireland also offers grants, tax incentives, and programs like the Better Energy Communities program to increase the use of renewable energy.
- Belgium. Belgium offers tax credits for renewable energy installations and supports various initiatives to increase the use of renewable energy, such as a green certificate system and the Renewable Energy Certificates (RECs) scheme, which provides a financial incentive for the production of renewable energy in Belgium. The Federal Public Service Economy is responsible for energy policy and offers support for renewable energy projects, including the Tax Deduction for Energy Investments (IDE), which encourages investments in energy-efficient technologies and renewable energy sources.
- United Kingdom. The UK has a strong focus on renewable energy as part of its efforts to reduce greenhouse gas emissions and achieve a low-carbon energy system. The Department for Business, Energy and Industrial Strategy (BEIS) offers support for renewable energy projects, including the Renewable Heat Incentive (RHI), a government-backed scheme aimed at encouraging the adoption of renewable heating technologies; the Energy Company Obligation (ECO), a government-backed scheme aimed at improving the energy efficiency of homes in the UK, including the installation of renewable energy technologies; and the Climate Change Levy (CCL), a tax on energy used by businesses and the public sector, designed to encourage the use of energy-efficient technologies and the adoption of renewable energy sources. Additionally, the

UK government has set a target to install more than 600,000 heat pumps by 2030, including solar thermal energy systems, which is expected to further drive growth in the renewable heat sector.

- The Netherlands. The Ministry of Economic Affairs and Climate Policy offers support through the Sustainable Energy Subsidy (SDE+) and Energy Investment Deduction (EIA) for renewable energy projects and investments in energy-efficient technologies. Additionally, the ISDE subsidy is available for sustainable investments. This subsidy is mainly aimed at homeowners who want to make their house more sustainable, but can also be used by companies. The subsidy can be used to subsidize a significant part of the investment cost, but critically must be applied for before the purchase of the installations.

The Dutch government has set a target for the country to derive 16% of its total energy consumption from renewable sources by 2023. Additionally, they also have the goal to be completely free of natural gas in 2050. Since most of their heating (domestic and industrial) happens through natural gas, there is a lot of focus on transitioning to heat pumps. This has a problem, because all those heat pumps are connected to the electricity grid which is already being overloaded. Alternative sources for domestic and industrial heating are therefore pretty important for them. STE is a good alternative for this that can help alleviate some of the stress on the electricity grid.

Moreover, all of these countries have a National Renewable Energy Action Plan (NREAP) that sets out each of the country's plans for the deployment of renewable energy sources.

1.2. Fit for 55

The "Fit for 55" package is designed to transform the Green Deal's aspirations into legal measures. This proposal package contains various revisions to existing climate, energy, and transportation laws, and includes new legislative initiatives to align EU policies with the EU's climate objectives.

The key components of the package are:

- A modification of the EU ETS. The EU Commission has proposed a range of changes to the EU ETS with the goal of reducing emissions by 61% by 2030 compared to 2005 levels. This will be achieved by broadening the scope of the scheme, including maritime transport emissions in the EU ETS, phasing out free allocation of emission allowances to aviation and sectors covered by the Carbon Border Adjustment Mechanism ("**CBAM**"), and implementing the global CORSIA through the EU ETS. The modernisation and innovation funds will also see increased funding, and the market stability reserve will be revised to ensure a well-functioning EU ETS. Additionally, a new emissions trading system will be created for buildings and road transport to support member states in meeting their national targets under the effort sharing regulation in a cost-effective way.

The Environment Council adopted a general approach to the EU ETS revision in June 2022, and a provisional deal with the European Parliament was reached in December 2022, increasing the overall ambition of emissions reductions to 62%. The Council and the European Parliament also reached a provisional political agreement on the EU ETS rules for the aviation sector, ensuring that aviation contributes to the EU's emission reduction goals under the Paris Agreement. Finally, in December 2022, the Council adopted the decision on the notification of CORSIA offsetting requirements to contribute to worldwide climate neutrality goals.

- The establishment of a carbon border adjustment mechanism. The Commission's proposed CBAM aims to prevent the EU's emission reduction efforts from being offset by increased emissions in non-EU countries due to production relocation or carbon-intensive product imports. CBAM will work alongside the EU's ETS and replace existing mechanisms to address carbon leakage. It will mirror and complement the EU ETS by applying to imported goods. The goal is to ensure that all goods sold in the EU will face a carbon price equivalent to the EU ETS, regardless of their origin. The Council agreed on the text on March 15, 2022, and in December 2022, negotiators from the Council and the European Parliament reached a provisional agreement on CBAM. The CBAM will be fully compliant with international trade rules.
- An update to the effort sharing regulation, which sets reduction targets for member states in sectors outside the EU ETS. The effort sharing regulation sets annual greenhouse gas emissions targets for member states in sectors that are not covered by the EU emissions trading scheme or the regulation on land use, land use change and forestry. The proposed change to the existing legislation concerns the targets to be achieved by 2030 in these sectors. The Commission's proposal increases the EU-level greenhouse gas emissions reduction target from 29% to 40%, compared to 2005, and updates the national targets accordingly. The calculation method for determining the national targets is still based on GDP per capita with some adjustments to address cost-efficiency concerns. EU environment ministers agreed on a Council negotiating position in June 2022, and in November 2022, the Council reached a provisional agreement with the European Parliament.
- An amendment of the LULUCF regulation to account for greenhouse gas emissions and removals from land use, land use change, and forestry. The Commission's proposal seeks to increase the role of the Land Use, Land-Use Change and Forestry ("LULUCF") sector in achieving the EU's climate targets. To do so, the proposal aims to reverse the current decline in carbon removals and enhance the natural carbon sink throughout the EU. This will be achieved by setting an EU-wide target for net greenhouse gas removals of at least 310 million tonnes of CO₂ equivalent by 2030, which will be distributed among member states as binding targets. The proposal also simplifies the accounting and compliance rules and enhances monitoring. The Environment Council approved the revised LULUCF regulation on 29 June 2022 and a provisional agreement with the European Parliament was reached in November 2022.
- A modification of the regulation for CO₂ emission standards for cars and vans. As part of the Fit for 55 package, the Commission suggested changes to the regulations regarding CO₂ emissions for cars and vans. The proposal sets more ambitious EU-wide targets for reducing emissions by 2030, with a new target of 100% by 2035. This means that by 2035, no vehicles with internal combustion engines can be sold in the EU. The purpose of these stricter CO₂ standards is to help member states achieve their increased national targets for reducing emissions under the effort sharing regulation, while also promoting innovation in the automotive sector. In June 2022, the Council adopted its general approach to the proposal, and in October 2022, an agreement was reached with the European Parliament. Now, both institutions must formally approve the agreement.
- Reduction of methane emissions in the energy sector. The EU Commission introduced a proposal for new rules on reducing methane emissions in the energy sector as part of the Fit for 55 package in December 2021. The Council has agreed on the proposal in December 2022, which focuses on tracking and reducing methane emissions in the fossil fuels sector. This proposal is a crucial step towards mitigating climate change, as methane is the second most significant greenhouse gas after carbon dioxide. The proposal is in line with the EU Methane Strategy of 2020, and the EU Global Methane Pledge launched at the COP26 UN Climate Conference in 2021, where over 100

countries committed to lowering their methane emissions by 30% by 2030 compared to 2020 levels.

- Implementation of ReFuelEU Aviation for sustainable aviation fuels and FuelEU Maritime for a green European maritime space:
 - Sustainable aviation fuels. Sustainable aviation fuels like advanced biofuels and electrofuels can substantially decrease aircraft emissions, but their usage in the aviation sector is currently very low, only accounting for 0.05% of total fuel consumption. To address this issue, the ReFuelEU Aviation proposal has been introduced to decrease the environmental impact of the aviation industry and support the EU's climate goals. The Council has agreed on a preliminary approach for the proposals in June 2022, and further discussions with the European Parliament, known as “trilogies”, will ultimately result in the final approval of the new EU laws.
 - Greener fuels in shipping. The aim of the FuelEU Maritime proposal is to reduce greenhouse gas emissions in the shipping sector by promoting the use of renewable and low-carbon fuels on board ships. The proposal sets a target of reducing the greenhouse gas intensity of energy used on board ships by up to 75% by 2050. Despite some progress, the maritime sector still heavily relies on fossil fuels, resulting in significant greenhouse gas and pollutant emissions. The Council agreed on a general approach for the proposal in June 2022, and negotiations with the European Parliament are ongoing in order to finalize the new legislation.
- Revision of the directive on the deployment of alternative fuels infrastructure. The Commission proposed a revision to existing legislation that seeks to speed up the installation of infrastructure for charging or refueling vehicles with alternative fuels, and provide clean power supply for ships in ports and stationary airplanes. This proposal covers all modes of transport and sets targets for infrastructure deployment, along with measures to enhance interoperability and user-friendliness. The Council reached a common position (general approach) on the proposal in June 2022. The next phase will be negotiations with the European Parliament in trilogues.
- Social Climate Fund. The Social Climate Fund proposal is designed to address the social and economic impact of a new emissions trading system for buildings and road transport. The fund would provide support measures and investments to vulnerable households, micro-enterprises, and transport users, based on social climate plans developed by each member state. In addition, the fund could also provide temporary direct income support. In June 2022, the EU environment ministers agreed on the Council's negotiating position for the creation of the Social Climate Fund. In December 2022, the Council and European Parliament reached a provisional political agreement on the proposal. The fund would be part of the EU budget and receive external assigned revenues up to a maximum of €65 billion.
- A revision of the following directives:
 - Renewable energy. As part of the Fit for 55 package, the European Commission has proposed to revise the current renewable energy directive. The proposal aims to increase the current EU-wide target of using at least 32% renewable energy sources in the overall energy mix to at least 40% by 2030. The proposal also includes the introduction or improvement of sector-specific sub-targets and measures, with a particular focus on areas where renewable energy integration has been slower, such as transport, buildings, and industry. In June 2022, EU energy ministers agreed on their joint position regarding the

proposal for the revised EU renewable energy directive. This agreement allows the Council to begin negotiations with the European Parliament.

- Energy efficiency. The Commission has proposed changes to the existing energy efficiency directive which includes increasing the current EU-level targets for final energy consumption from 32.5% to 36% and for primary energy consumption from 32.5% to 39% by 2030. The proposal also includes several provisions to accelerate energy efficiency efforts such as increased annual energy savings obligations for member states, new rules to decrease energy consumption in public sector buildings, and targeted measures to protect vulnerable consumers. On 27 June 2022, the Council reached a 'general approach' agreement on the proposal. The next step is to negotiate with the European Parliament in trilogues.
- Energy performance of buildings. The EU is revising the energy performance of buildings directive to improve the energy efficiency of buildings in the EU. Buildings in the EU consume 40% of energy and contribute 36% of energy-related greenhouse gas emissions. The new rules aim to make all new buildings zero-emission by 2030 and transform existing buildings into zero-emission buildings by 2050. In October 2022, EU member states reached a common position on the directive revision proposed by the Commission. Negotiations with the European Parliament (trilogues) will follow.
- Energy taxation. In order to align the taxation of energy products and electricity with the EU's energy, environment, and climate policies, the Council is proposing a revision of the directive on the taxation of energy products and electricity. The proposal also aims to update the scope of energy products, rationalize tax exemptions and reductions, and generate revenues for member state budgets. The proposal is currently being discussed within the Council, and in June 2022, EU finance ministers acknowledged the progress report on the revision of the energy taxation directive. Discussions will continue within the Council under the Czech presidency.

1.3. Farm to Fork Strategy

The food system in the EU guarantees that Europeans have access to fresh and safe food. Not only is food production essential for sustenance, but it also provides a source of income. The EU agri-food chain plays a critical role in ensuring food security for more than 400 million people and is a significant economic sector in the region. However, the agri-food industry has a significant impact on the environment. According to a report by the Intergovernmental Panel on Climate Change (IPCC), about one-third of global greenhouse gas emissions come from food systems. Additionally, the current food model has a negative impact on people's health, with more than half of adults in Europe being overweight.

The Commission's "Farm to Fork" strategy is one of the key actions under the European Green Deal that intends to shift the EU's current food system to a more sustainable model in order to achieve climate neutrality by 2050. The strategy has several objectives, including ensuring that there is enough nutritious and affordable food produced within the limits of the planet, promoting sustainable food production, reducing waste and encouraging healthy and sustainable diets to improve the health of EU citizens. In October 2020, the Council endorsed the strategy's objective of developing a sustainable food system in Europe from production to consumption.

The "Farm to Fork" strategy includes various legislative proposals and initiatives, such as promoting organic farming, implementing front-of-pack nutrition labelling and sustainable food labelling, and reducing food waste. In support of this strategy, the Council has put forward several plans to endorse its objectives.

- Organic action plan. As part of the "Farm to Fork" strategy, the Commission introduced an action plan on organic farming in March 2021. This plan sets out a series of measures aimed at increasing organic farming in the EU, with a target of 25% of the EU's agricultural land being used for organic production by 2030. To achieve this goal, EU member states are encouraged to develop their own plans for organic farming. In July 2021, the Council endorsed the Commission's action plan and agreed on several key points. These include recognizing the importance of organic farming for the sustainability of European agriculture, acknowledging that developing organic production can help create jobs and secure incomes, and emphasizing the need for balanced demand and supply to ensure profitability for the sector. The Council also emphasized the importance of considering the specificities and situations of each member state when defining targets and interventions, and stressed the need for collaboration between public and private stakeholders to achieve the goals of the "Farm to Fork" strategy.
- Food security plan. The COVID-19 pandemic exposed Europe's food supply chain to significant supply challenges, highlighting its vulnerability during crises. In November 2021, the Commission published a communication that presented a contingency plan to ensure food security in Europe during such emergencies. During the December Agriculture and Fisheries Council, EU ministers approved conclusions on the plan and acknowledged the need to future-proof Europe's food system against potential risks and crises. The ministers recognized that lessons learned from the COVID-19 pandemic should inform the EU's approach to future disasters. The proposed measures aim to help the EU cope with challenges such as extreme weather events, plant and animal health issues, and shortages of key inputs like fertilizers, energy, and labor. The plan includes the creation of a European Food Security Crisis Preparedness and Response Mechanism (EFSCM) and the establishment of an expert group to ensure that the EU is fully prepared for potential food supply challenges.
- Global standards on food safety. The Council approved conclusions in February 2022 regarding food safety standards in international trade, urging the inclusion of sustainability considerations in the work of the Codex Alimentarius Commission. The Commission was established by the UN Food and Agriculture Organization and the World Health Organization in 1963 to facilitate discussions on international food standards, guidelines, and codes of practice. The EU and its member states are participants in the Commission's work.
- Carbon farming. Farming and forestry have the potential to help combat climate change by absorbing carbon from the atmosphere. In April 2022, the Council approved conclusions on carbon farming, which were based on the Commission's sustainable carbon cycles communication presented in December 2021. The aim of these conclusions is to promote agricultural practices that help capture carbon from the atmosphere and store it in a sustainable way in soil or biomass. Examples of climate-friendly practices include planting hedges or trees, growing legumes, using catch crops and cover crops, practicing conservation agriculture, and maintaining peatlands, afforestation, and reforestation. In these conclusions, ministers recognized the importance of providing adequate financial support to farmers and foresters to incentivize them to adopt these climate-friendly practices.

- Sustainable aquaculture. Currently, the EU relies heavily on imports of fishery and aquaculture products, but there is an opportunity for growth in this sector within the EU. In July 2022, EU ministers endorsed Council conclusions that aim to establish a sustainable, resilient, and competitive marine and freshwater aquaculture sector in the EU.

1.4. Common Agricultural Policy

The EU's agri-food sector is a significant contributor to the economy, with around 10 million farmers and 40 million jobs in food processing, retail, and services dependent on it. However, farmers face unique challenges, including unpredictable weather and climate pressures, market instability due to fluctuating demand patterns and prices.

To provide a cohesive policy for agriculture across EU countries, the Common Agricultural Policy (“CAP”) was established in 1962 by the six founding countries of the European Communities, making it the oldest policy still in operation in the EU. This policy is strongly intertwined in its objectives with the “Farm to Fork” strategy. It aims to (1) provide affordable, safe and high-quality food for EU citizens; (2) ensure a fair standard of living for farmers; and (3) preserve natural resources and respect the environment.

Currently, around one-third of the EU budget is allocated to supporting farmers and rural areas through the Common Agricultural Policy (CAP). This amounts to about 30 cents a day for each EU citizen.

The CAP is divided into two pillars and has three primary areas of focus:

- 1st pillar. Direct support and market measures.
 - Direct support. Direct support within the CAP policy involves providing payments directly to farmers, giving them a financial safety net that allows them to run their businesses effectively. The direct support scheme has several benefits, including ensuring that farmers receive income support in exchange for taking care of their farmland and adhering to high standards of food safety, environmental protection, and animal welfare. This type of support helps maintain farming activities throughout the EU and encourages producers to respond to market signals, resulting in the production of goods that consumers demand. Moreover, farmers who do not comply with specific requirements in areas such as public, animal and plant health, environment and animal welfare, are subjected to "enhanced conditionality," which means they receive less or no support from the CAP.
 - Market measures. The agri-food sector is faced with several challenges, including global competition, economic and financial crises, climate change, and volatile costs of inputs such as fuel and fertilizers. In response to high price volatility in agricultural markets in the EU, a set of rules has been established within the CAP. The Common Market Organization (“CMO”) regulation was developed to improve the functioning of agricultural markets by building on the rules for the common market in goods and services. It provides specific policy tools to intervene in agricultural markets and offer sector-specific support. The CMO regulation includes rules on the marketing of agricultural products, as well as the functioning of producer and interbranch organizations, international trade, and competition. The CMO regulation ensures the diversity, availability, affordability, and safety of agricultural products by facilitating the smooth functioning of the single market. By establishing these rules, the CAP can help counterbalance the challenges that the agri-food sector faces, ensuring that the agricultural markets in the EU function smoothly and that high-quality products are available to consumers at affordable prices.

- 2nd pillar. Rural development. About half of the European continent is comprised of predominantly rural areas, which are home to about 20% of the EU population. Unfortunately, many of these areas are among the least developed regions in the EU, with a lower GDP per capita than the European average. EU rural development measures within the CAP aim to modernize farms, increase competitiveness of the agricultural sector, protect the environment, and promote rural community development, among other goals. The CAP's second pillar provides support to rural development through co-financing by the member states. Additionally, EU cohesion policy, which includes the European Regional Development Fund (ERDF) and the European Social Fund (ESF), supports balanced territorial development and complements rural development policy. By using these tools, the EU hopes to promote sustainable development in rural areas and agriculture, including organic farming, and encourage diversification of activities in these regions.

The CAP policy is dynamic and has adapted through successive reforms to meet new challenges faced by European agriculture. This includes ensuring food security for all European citizens, addressing global market fluctuations and price volatility, maintaining thriving rural areas across the EU, using natural resources more sustainably, and contributing to climate change mitigation.

The European Commission's approval of all 28 Strategic Plans (one for each EU country, and two for Belgium) marked the beginning of the new CAP 2023-2027, whose regulations entered into force in January 2023.

EU farmers will receive a total of €264 billion in funding to support the transition towards a more sustainable and resilient agricultural sector, with the aim of preserving the vitality and diversity of rural areas. When combined with co-financing and additional national financing, the total public budget dedicated to farmers and rural communities during the 2023-2027 period will reach €307 billion. In addition to this funding, other CAP-related programs such as the POSEI programme (*Programme d'Options Spécifiques à l'Éloignement et l'Insularité*) for outermost regions, the EU school scheme, and promotion programs will receive an extra €6 billion of EU funding.

The reformed CAP introduces a number of improvements, including in particular:

- To improve the environmental and climate impact of agriculture within the EU, ensuring that the agricultural sector contributes positively to the EU's environmental and climate goals.
- To provide more tailored support to smaller farms, recognizing their unique needs and challenges, and ensuring that they receive the necessary assistance to thrive.
- To grant greater flexibility to member states in adapting their policies and measures to suit the specific conditions of their local agricultural sector, taking into account the unique characteristics and challenges of their respective regions.

The key elements of the policy are:

- A new environmentally-focused framework that outlines specific conditions for farmers to meet, as well as additional voluntary measures.
- Direct payments and rural development interventions that are more tailored and geared towards specific objectives determined through strategic planning.
- A performance-based approach that requires member states to report on their progress each year in achieving the desired outcomes.

A fairer CAP:

One of the main objectives of all 28 Strategic Plans for the CAP is to support viable farm incomes and improve the resilience of the agricultural sector. Here are some examples of the support that will be provided under the new CAP:

- CAP direct payments will continue to serve as a safety net for farmers, with close to €20 billion in basic income support distributed to eligible farmers each year. However, this support is now conditional on farmers meeting strengthened basic standards for good agriculture and environmental conditions (GAECs), which are expected to cover nearly 90% of EU agricultural land.
- The new CAP will direct more public support to small and medium-sized farms in 25 EU countries through a redistributive payment that amounts to 10.6% of all direct payments. This will provide €4 billion in annual support, which is 2.5 times more than the redistributive payments under the previous CAP (2014-2020) applied by only ten member states.
- To help farmers manage crises, 15% of EU farms will receive support to participate in risk management tools such as insurance premiums or mutual funds.
- The level of support for protein crops and legumes will increase by 25% compared to 2022, with the aim of reducing EU farmers' reliance on imports and certain fertilizers. In addition, 17 other sectors that are facing difficulties will also receive coupled support, which will benefit 21% of EU farms.

A more social CAP:

The EU's rural areas are facing various challenges such as depopulation, lack of access to basic services, limited employment opportunities, and poor connectivity. To address these issues, the new CAP will invest in the social and economic development of rural areas.

- One of the significant features of the new CAP is its focus on supporting young farmers. The approved Plans have dedicated specific support for young farmers beyond the minimum requirement of 3% of direct payments to generational renewal. The total public spending of €8.5 billion will help new young farmers to establish, invest and maintain their business in their initial years of activity. In the 2023-2027 period, it is expected that 377,000 young farmers will be established as farmers in full capacity. Additionally, some Member States plan to undertake further measures to promote farm succession, enhance gender equality in rural areas, and empower women in agriculture.
- To support the development of rural areas, the CAP provides funding to local community-led strategies through the LEADER (*Liaison Entre Actions de Développement de l'Économie Rurale*) approach, with 7.7% of the European Agricultural Fund for Rural Development (EAFRD) budget, or €5 billion, dedicated to this purpose. These strategies are expected to cover 65% of the rural population in Europe.
- The CAP also includes a new requirement for beneficiaries to respect EU social and labor standards, with payments linked to compliance. This incentivizes the improvement of working conditions on farms.

- To make living and working in rural areas more attractive, the CAP will support investments in areas such as digital technologies and services, aiming to create at least 400,000 jobs.
- Furthermore, the CAP will provide funding for advice, training, and knowledge exchange to over 6 million people, or for innovation projects under the European Innovation Partnership. These efforts focus on environmental and climate performance, as well as social and rural aspects.

A greener CAP:

Three of the ten specific objectives of the CAP are focused on the environment and climate, and the "no backsliding" clause requires Member States to set higher environmental goals in their CAP plans compared to current levels. As a result, this is the most ambitious CAP ever in terms of addressing environmental and climate concerns.

- Approximately €98 billion, or 32% of the total CAP funding, will be dedicated to supporting climate, water, soil, air, biodiversity, and animal welfare, as well as promoting practices beyond mandatory requirements. Of this amount, 24% of direct payments are allocated to eco-schemes, and 48% of rural development spending from all plans will fully support environmental and climate objectives.
- The CAP Strategic Plans will also encourage land managers to implement practices that store carbon in soil and biomass, reduce greenhouse gas emissions, and support adaptation efforts in 35% of the EU's agricultural land, such as through extensive grassland management, the growing of legumes and catch-crops, organic fertilization, and agroforestry.
- Crop rotation is expected to be implemented on around 85% of the EU's arable land supported by the CAP, as part of new obligations for farmers. This practice will help to disrupt pest and disease cycles, which in turn will reduce the use and risks of pesticides. To further promote sustainable farming, more than 26% of EU agricultural land will receive support for adopting integrated pest management, using non-chemical methods for pest control, or implementing precision farming techniques.
- The new CAP will provide almost double the amount of support for organic farming compared to the funding provided in 2018. This will be a significant contribution to achieving the national goals of Member States for increasing their organic farming areas, which range from 5% to 30% by 2030.
- Investments in renewable energy production on farms are planned to add 1.556 MW to the EU's total energy production capacity.

Within this context, NWE countries offer a range of regulatory incentives and measures to promote the use of renewable energies in agriculture. These include:

- Financial support: Farmers may be eligible for financial support to cover the costs of installing renewable energy systems. For instance, to invest in renewable energy systems, France provides financial support through the "Agricultural Investment Program" (PIA); Ireland through the "Rural Development Programme" (RDP); Belgium through the "Rural Development Program" (PDR); the UK through the "Rural Development Program" (RDPE); and the Netherlands through the "Rural Development Program" (POP).

- Tax exemptions: Several EU countries provide tax exemptions to incentivize renewable energy investments. France offers an “Investment Tax Credit” (CITE), Ireland has a “Carbon Tax Credit Scheme”, Belgium provides the “Tax Shelter for Renewable Energy Investments” (AIER), the UK offers the “Renewable Heat Incentive” (RHI), and the Netherlands has the “Environmental Investment Allowance” (MIA) for renewable energy investments.
- Subsidies: Renewable energy subsidies are available in various EU countries for the purchase of equipment. Programs such as France's “Gestion Environnementale et Énergétique”, Ireland's “Agri-Environment Options Scheme”, Belgium's “Mesures Agro-Environnementales”, the UK's “Countryside Stewardship” and the Netherlands' “SDE++” and “ISDE” subsidies, offer financial support for farmers who adopt renewable energy technologies.
- Loan schemes: Farmers may be eligible for low-interest loans to support the installation of renewable energy systems. These loan schemes are available in France through the “Agricultural Credit” program, in Ireland through the “Green Loan Scheme”, in Belgium through the “Agricultural Credit Corporation”, in the UK through the “Agricultural Mortgage Corporation”, and in the Netherlands through the “Rabobank”.
- Technical assistance: The EU provides technical assistance to farmers to adopt renewable energy technologies, including training and advice on solar thermal systems. France, Ireland, Belgium, the UK, and the Netherlands provide technical assistance through various agencies such as ADEME, the Department of Agriculture, Food, and the Marine, AFSCA, DEFRA, and LNV.
- Information campaigns: The EU and NWE countries run information campaigns to raise awareness among farmers about the benefits of renewable energy and to encourage them to adopt these technologies.
- Research and development: The EU and NWE countries also invest in research and development to improve renewable energy technologies and increase their competitiveness. An example is the rather prestigious “Wageningen University and Research” in the Netherlands, which does a lot of research into making the agricultural sector more sustainable. Wageningen is getting a lot of government money for this research.

1.5. European Recovery Plan 2021/2027

Since the early stages of the COVID-19 pandemic, the European Union has taken swift action to address the crisis. They implemented immediate measures to utilize the EU budget and provide flexibility in applying budget and state aid regulations. The EU recognized that a joint effort was necessary for a successful recovery, so EU leaders worked towards establishing a recovery fund, resulting in the presentation of a recovery plan for Europe by the European Commission on May 27, 2020.

On July 21, 2020, EU leaders came to an agreement on a comprehensive package totalling €1,824.3 billion (using 2018 prices), which includes both the (1) Multiannual Financial Framework (“**MFF**”) long-term budget of €1,074.3 billion for 2021-2027, and (2) an additional €750 billion recovery effort known as the European Recovery Plan or Next Generation EU (“**NGEU**”).

Thanks to NGEU, the European Commission has the authority to borrow funds on behalf of the Union from capital markets up to the amount of €750 billion (using 2018 prices) to provide the necessary resources to tackle the issues arising from the COVID-19 pandemic. The repayment of these borrowed funds, which will be exclusively utilized by the EU to address the consequences of the COVID-19 crisis, will be scheduled until December 31, 2058.

The NGEU recovery effort will be distributed through seven programs in the form of loans (€360 billion) and grants (€390 billion):

- 1) Recovery and Resilience Facility (“RRF”): €672.5 billion
- 2) ReactEU: €47.5 billion
- 3) Horizon Europe: €5 billion
- 4) InvestEU: €5.6 billion
- 5) Rural Development: €7.5 billion
- 6) Just Transition Fund: €10 billion
- 7) RescEU: €1.9 billion

The RRF and ReactEU are completely funded by NGEU. The other amounts are top-ups to programmes funded under the MFF.

The RRF makes up the majority of the NGEU effort, accounting for almost 90% of the total budget. The facility, amounting to €672.5 billion (using 2018 prices), will be dispersed as follows:

- Loans: €360 billion (€385.8 billion in current prices)
- Grants: €312.5 billion (€338 billion in current prices), of which **(a)** 70% have been committed in the years 2021 and 2022, based on unemployment figures from 2015-2019, inverse GDP per capita, and population share; and **(b)** the remaining 30% will be fully committed by the end of 2023 based on different criteria, including the drop in real GDP over 2020, the overall drop in real GDP from 2020-2021, inverse GDP per capita, and population share.

These funds will enable member states to tackle the economic and social repercussions of the COVID-19 pandemic while also promoting the transition to more sustainable and resilient economies through the green transition and digital transformation.

During the years 2021 and 2022, member states developed their national recovery and resilience plans, outlining their investment and reform strategies for the period up to 2026. They were requested to prepare comprehensive project portfolios covering six policy domains, including the green transition, digital transformation, inclusive growth and employment, health and resilience, social and territorial cohesion, and next-generation policies such as education and skills.

The Commission evaluated the recovery and resilience plans using specific criteria, which included meeting country-specific recommendations, improving growth potential, creating jobs, and enhancing economic and social resilience. The plans were also evaluated based on their contributions to the green and digital transitions, requiring a minimum allocation of 37% of the budget to climate and biodiversity and at least 20% to digital measures.

In 2021, the Council adopted its implementing decisions on the approval of the recovery and resilience plans for 22 EU countries (Austria, Belgium, Denmark, France, Germany, Greece, Italy, Latvia, Luxembourg, Portugal, Slovakia, Spain, Croatia, Cyprus, Lithuania, Slovenia, Czechia, Ireland, Malta, Estonia, Finland and Romania) and in 2022, the Council welcomed the positive assessment of national recovery and resilience plans for 5 more EU countries (Bulgaria, Sweden, Poland, the Netherlands and Hungary).

1.6. Facing the Energy Crisis, pertaining to the Ukrainian conflict

EU leaders and the Council are deeply concerned about the increases in energy prices and the interruptions in energy supply. In response, EU member states have united and are collaborating closely to address the high prices and disparities in the energy market. EU countries recognize that working together is vital to tackling the energy crisis, mitigating its impact, and reducing risks. For instance, pooling resources and making joint purchases of energy can help decrease the cost of imports. The EU's primary objectives in responding to the energy crisis include ensuring that energy remains affordable and competitive for consumers within the EU. Additionally, they aim to increase the EU's energy security and preparedness to deal with emergencies. The EU also intends to strengthen the energy autonomy and resilience of its member states.

In an effort to address the issue of high gas prices, EU countries are working together on:

- Limiting excessively high gas prices. EU countries have agreed on a market correction mechanism that aims to limit the impact of price hikes on citizens and the economy. The mechanism will establish a price ceiling for gas transactions in the event of exceptionally high gas prices, as defined by two parameters: if the month-ahead price on the TTF exceeds 180€/MWh for three consecutive working days, and if the month-ahead TTF price is 35€ higher than a reference price for LNG on global markets for the same three working days.

This temporary emergency regulation is designed to prevent excessively high gas prices that do not reflect world market prices, while ensuring the security of energy supply and the stability of financial markets. The mechanism will apply to month-ahead, three-months-ahead, and one-year-ahead derivative contracts, and has been in effect since 15 February 2023. The regulation can be suspended or deactivated following pre-defined rules outlined in the regulation.

- Improving solidarity and sharing supply. As energy prices continue to fluctuate on global markets, EU countries have agreed to take measures to enhance solidarity and coordination in joint purchasing of gas. The new measures aim to facilitate joint purchasing of gas by member states and energy companies on global markets, allowing them to leverage their combined demand and avoid competing against one another in the buying process.

The EU also intends to establish new rules to foster solidarity agreements between member states. Countries that do not currently have agreements with other EU member states will be able to request solidarity in the event of a crisis or need. Additionally, the new regulation introduces a new price benchmark that will ensure stable and predictable pricing for transactions involving liquefied natural gas, which complements the Title Transfer Facility (TTF). These measures were adopted during the Energy Council on 19 December 2022, and are intended to help EU member states to work together more effectively and to better manage the volatility in global energy markets.

- Cutting energy costs for households and businesses. High energy prices are causing difficulties for both households and businesses in the EU. In response, EU countries have taken urgent measures to reduce the burden on consumers. In October 2022, EU member states adopted an emergency regulation aimed at alleviating the impact of the energy crisis on citizens and businesses most affected by high prices.

The regulation includes three emergency measures. The first involves reducing electricity use during peak hours, which is expected to have a positive effect on EU electricity prices and consumers' energy bills. The second measure involves capping revenues of electricity producers,

while the third measure secures a solidarity contribution from fossil fuel businesses. The new regulation also allows member states to collect funds from the surplus profits of the energy sector and redistribute them to the most vulnerable people and companies in the EU, providing direct support to those who are struggling to pay their bills. These measures are exceptional and temporary, and are valid from 1 December 2022 to 31 December 2023. Overall, the EU's coordinated response to the energy crisis aims to reduce the cost of energy for households and businesses, while ensuring energy security and preparedness in the event of emergencies.

- Reducing the EU's energy dependencies. In March 2022, the leaders of the 27 EU member states agreed to gradually decrease the EU's dependence on Russian fossil fuels due to Russia's invasion of Ukraine and the EU's 2050 climate goals. The Versailles Declaration was adopted at the meeting, which laid out the steps for reducing imports from Russia by diversifying energy sources and routes, speeding up the development of renewables and hydrogen, improving interconnections between EU energy networks, increasing energy efficiency, and reducing overall reliance on fossil fuels.

More than half of the EU's energy came from imports in 2020, with Russia being the primary supplier of fossil fuels. Reducing the EU's reliance on Russian fuels is critical for strengthening energy resilience and autonomy, and accelerating the shift towards renewable energy sources. The REPowerEU plan (analysed in detail below) was presented by the Commission in May 2022, which established the voluntary EU Energy Platform to support coordinated common purchases of energy for all EU countries and some European partners. The EU has also reached new agreements on energy supply with international partners such as the United States, Canada, Norway, Azerbaijan, Israel, and Egypt.

- Securing gas supplies. Due to the unpredictability of gas supply deliveries, the Council has taken urgent measures to ensure gas supplies for the winter and to reduce gas demand in the EU. To achieve this, the Council adopted a new regulation in June 2022, which requires underground gas storage facilities in member states to be filled to at least 80% of their capacity by 1 November 2022 and 90% by subsequent winters. The new regulation also establishes solidarity arrangements between member states to help those countries without storage facilities on their territory. Additionally, EU countries agreed in August 2022 to reduce overall gas demand in the EU by 15% between August 2022 and March 2023. The reduction is voluntary, but the Council could activate an alert mechanism if necessary, requiring countries to make cuts. To prioritize essential services such as hospitals, the law mandates that countries should implement measures which do not affect households. The Council is working on new rules that will increase the EU's targets for energy efficiency by 2030 in the Fit for 55 package.
- Accelerating the green transition. To meet the European Green Deal goals of reducing greenhouse gas emissions and achieving climate neutrality by 2050, EU countries are transitioning towards cleaner forms of energy and reducing reliance on fossil fuels. Renewable energy sources are the focus of this transition, as they are affordable and environmentally friendly. EU countries have agreed to the Fit for 55 package, which aims to speed up the availability of renewable energy sources and support energy efficiency. Additionally, the REPowerEU directive will amend EU legislation on renewable energy, allowing member states to create dedicated "go-to areas" for renewable energy with simplified permitting processes.

At the national level, EU countries are implementing measures to provide relief to citizens and businesses facing higher energy bills. The EU state aid temporary crisis framework and energy prices toolbox guidelines from the Commission are being followed to address this issue. The EU's

green transition will lead to a cleaner environment, improved health, and reduced energy dependencies on fossil fuels.

REPowerEU: energy policy in EU countries' recovery and resilience plans

The REPowerEU Plan was created in response to the energy market disruptions caused by Russia's invasion of Ukraine, with the goal of helping the EU become less dependent on Russian fossil fuels before 2030. The plan focuses on three main strategies:

- 1) Saving energy. This involves encouraging individuals, businesses, and organizations to reduce their energy consumption through small behavioural changes and energy efficiency measures. By doing so, the EU can reduce its reliance on fossil fuel imports from Russia, which is cheaper, safer, and more environmentally friendly. Contingency measures for supply interruptions will also be implemented to ensure energy security. There are various methods to reduce energy consumption in our daily lives, such as lowering heating temperatures or using less air conditioning, utilizing household appliances more efficiently, driving more economically, switching to more public transport or active mobility, and turning off lights. It's important for all energy users to know the best savings opportunities and most effective actions they can take.

The European Commission plans to support citizens by providing targeted information to help them make informed choices and energy-efficient purchases. In collaboration with organizations like the International Energy Agency, member states, and local authorities, the commission is identifying and promoting effective energy-saving actions, including turning down heating and adjusting boiler settings, working from home, driving more efficiently, reducing speed on highways, walking or cycling for short journeys, using public transport or trains instead of planes, and leaving cars at home on Sundays in large cities.

- 2) Diversifying supplies. The EU is working with global partners to find new energy sources and decrease its reliance on Russian fossil fuels. In the short-term, the EU needs to quickly find alternative sources of gas, oil and coal, and in the long-term, renewable hydrogen will be necessary. By replacing coal, oil and gas with cleaner energy sources, the EU can reduce its dependency on Russian fossil fuels, enhance industrial competitiveness, and support global technology leadership.

The industrial sector is a crucial player in accelerating the green transition by developing the equipment and components required to transform the energy system. The adoption of electrification, energy efficiency, and renewables can help the industry save 35 bcm of natural gas by 2030, beyond the targets of the Fit for 55 package. The biggest reductions in gas, almost 22 bcm, could be achieved by non-metallic minerals, cement, glass and ceramics, chemicals production, and refineries. It is anticipated that about 30% of EU primary steel production will be decarbonized by 2030 through the use of renewable hydrogen.

- 3) Accelerating the clean energy transition. The REPowerEU Plan aims to speed up the transition to clean energy and reduce the EU's dependence on Russian fossil fuels. This can be achieved by diversifying energy supplies and promoting energy efficiency. The plan also focuses on accelerating the transition to renewable energy, which is cheaper, cleaner, and can be produced domestically. The Commission proposes increasing the EU's 2030 target for renewables to 45%, and the plan aims to bring the total renewable energy generation capacities to 1,236 GW by 2030. The EU Solar Energy Strategy will also help by bringing online over 320 GW of solar photovoltaic energy by 2025 and almost 600 GW by 2030. These efforts will reduce energy prices over time and reduce import dependency.

The REPowerEU plan, built upon the Fit for 55 package, is supported by financial and legal measures to create a new energy infrastructure and system for Europe.

The REPowerEU plan includes short-term measures to achieve its goals, such as purchasing gas, Liquefied Natural Gas (LNG), and hydrogen through the EU Energy Platform, developing energy partnerships, deploying wind and solar energy projects, increasing biomethane production, approving EU-wide hydrogen projects, promoting energy savings, and coordinating EU-wide demand reduction plans in case of gas supply disruption. The aim is to reduce gas imports by around 50 bcm and save approximately 17 bcm of gas imports, among other things.

The medium-term measures to be completed before 2027 include boosting industrial decarbonization, new national REPowerEU plans supported by the Recovery and Resilience Fund, new legislation for faster permitting of renewables, investments in an integrated gas and electricity infrastructure network, increased focus on energy savings and renewable energy targets, regulatory measures to increase energy efficiency in the transport sector, new proposals to ensure access to critical raw materials, and a hydrogen accelerator to produce 10 million tonnes of renewable hydrogen.

EU member states are incorporating specific sections into their national recovery and resilience plans (RRPs) under Next Generation EU to finance important investments and reforms that will help achieve the REPowerEU goals. These objectives include saving energy, diversifying energy supplies, and speeding up the implementation of renewable energy sources. The investments and reforms should prioritize improving energy infrastructure to meet the immediate security needs for gas, such as liquefied natural gas (LNG), to diversify supply for the entire EU. Additionally, boosting energy efficiency in buildings, decarbonizing industry, and increasing the production and usage of sustainable biomethane and renewable/fossil-free hydrogen. Other objectives include increasing the deployment of renewable energy, addressing energy poverty, incentivizing a reduction in energy demand, and improving energy transmission and distribution. Finally, supporting zero-emission transport and infrastructure, such as railways, and investing in electricity storage.

It is important for EU member states to make sure that the measures funded by the Recovery and Resilience Facility (RRF) are working well with other initiatives supported by national or EU funds. In December 2022, the Council and Parliament agreed to finance the REPowerEU initiative, allowing countries to add specific chapters to their national recovery and resilience plans.

The Commission estimates that an additional €210 billion of public and private investments are needed by 2027 to phase out Russian fossil fuel supplies, with the RRF being the primary source of funding for REPowerEU. To be more specific, the financing of REPowerEU chapters is mostly covered by remaining loans amounting to €225 billion, while grants worth up to €20 billion are provided by the Innovation Fund (60%) and the sale of Emission Trading System (ETS) allowances (40%). Other funding sources for REPowerEU include the Cohesion Policy funds, European Agricultural Fund for Rural Development, Connecting Europe Facility, National and EU funding, private investment, and the European Investment Bank.

2. STATE OF THE ART IN THE RENEWABLE ENERGY DOMAIN

2.1. Different types of renewable energy

The most widely used types of renewable energy can be classified into five categories based on their source. These categories include solar energy, wind energy, water energy, geothermal energy, and bioenergy.

1) Solar energy

Solar energy is produced by harnessing the energy from the sun's rays. It is a clean and limitless source of energy that can be used to generate electricity, heat water, and provide power to homes, businesses and industries. There are several types of solar energy, including:

- a) Photovoltaic Solar Energy (PV). This type of solar energy involves the conversion of sunlight directly into electricity using photovoltaic cells. One module consists of cells joined together. They absorb energy from photons, which release electrons caught up in an internal magnetic field, creating a continuous electric current. The module is connected to electric elements which transform this continuous current into an alternating current, which can be injected into the distribution system for us to use. One of the main benefits of photovoltaic solar energy is that it involves no moving parts or emissions, making it a very clean and efficient way to generate electricity. It is also modular and scalable, and it can be used in a variety of applications, from powering homes to large-scale power plants. Additionally, it requires minimal maintenance once installed.
- b) Solar Thermal Energy (STE). STE consists in converting solar radiation into thermal energy. Sunlight is highly concentrated in mirrored panels, which reflect it towards receivers, which then heat molten salts or other heat transfer fluids. The captured heat is used to heat or to produce steam to operate a turbine or generator, to produce electricity. One of the main advantages of STE is that it is cheap and predictable, and does not rely on any fuel to operate. Additionally, STE can significantly reduce water heating costs and can be combined with other heating systems for increased efficiency. However, the amount of solar energy that can be used varies depending on factors such as the time of day, the season, the weather conditions such as clouds and shading, and the geographical location.
- c) Concentrated Solar Power (CSP). This type of solar energy involves using mirrors or lenses to focus a large area of sunlight onto a small area, generating heat that is then used to produce electricity. This type of solar technology has the versatility to be used for both power generation and heating purposes. However, it requires a relatively large space for the installation of the mirrors or lenses. It's worth noting that weather conditions like clouds and dust can impact the effectiveness of this method.

2) Wind energy

Wind energy is produced by harnessing the kinetic energy of wind. Wind turbines convert the motion of the wind (=kinetic energy of the wind) into mechanical energy, which can then be transformed into electricity. In this way, the wind turbine uses the wind speed to produce renewable energy with very low greenhouse gas emissions and waste. Lastly, in Europe, wind energy production is greater in winter, when there is a greater demand for electricity. Wind energy can be classified into two types:

- a) On-shore wind energy. Land-based wind turbines, known as onshore wind turbines, are installed on land. In Europe, wind turbines must comply with design and construction standards. They have been subject to technical inspections since 2008.
- b) Offshore wind energy. An ocean wind turbine, usually called an offshore wind turbines, is erected out at sea and uses the power of marine winds to produce renewable, carbon-free energy. With higher masts than those of onshore wind turbines, offshore wind turbines are more powerful, and benefit from greater and more regular wind power. They can therefore produce up to twice as much energy as onshore turbines. It works in the same way as an onshore wind turbine but can be installed in two ways: **(i)** on a foundation fixed to the seabed (a so-called "bottom-fixed" foundation); or **(ii)** on a floating foundation anchored to the seabed. Like a bottom-fixed offshore wind turbine, a floating offshore wind turbine generates power from the mechanical energy of the wind. Thanks to its floating offshore structure, however, it has the characteristic of being installed in areas where the water is much deeper and the sea winds stronger and more stable. Another advantage is its ease of installation, since it does not require foundations to be fixed to the ground or the use of specialized vessels for their installation. It can also be towed ashore for major maintenance operations. Furthermore, its distance makes it less visible from the shore.

3) Water energy

There exist different forms of energy that can be derived from water, including:

- a) Hydro energy. Hydro energy is produced by harnessing the energy of moving water (=using the kinetic and potential energy of water), such as in a dam or waterfall. The water drives turbines that in turn drive generators which convert mechanical energy into electricity. This energy can also be used to pump water and provide power to homes, businesses and industries.
- b) Tidal energy. Tidal energy is produced by harnessing the energy of ocean tides. This form of hydro energy uses twice-daily tidal currents to drive turbine generators. This energy can be used to generate electricity, pump water, and provide power to homes, businesses, and industries.
- c) Wave energy. Wave energy is produced by harnessing the energy of ocean waves. This energy can be used to generate electricity and provide power to homes, businesses, and industries.

4) Geothermal energy

Geothermal energy covers all the applications that use the heat contained underground in the subsoil or in groundwater. By harnessing the natural heat below the earth's surface, geothermal energy can be used to heat homes directly or to generate electricity. This heat can be used to generate/provide electricity, cold and heat, which is then distributed through the networks. Geothermal energy's use still remains limited in comparison with its huge potential. In countries such as Iceland, geothermal heat is much more freely available.

5) **Bioenergy**

Several types of renewable energy can be generated from organic matter, which includes:

- a) **Biomass**. Biomass energy is produced by burning organic material, such as wood, crops, and agricultural waste, to generate heat and electricity. In other words, it is the conversion of solid fuel made from plant materials into electricity. The term 'biomass' covers all organic materials with the potential to be broken down and used in an energy recovery process to generate heat, power, natural gas and biofuel (*e.g.* biomass can be used to fuel urban heating plants, district heating and cooling networks and cogeneration plants). It is considered renewable because the organic material used as fuel can be replenished.
- b) **Biofuels**. Biofuels are fuels produced from organic materials, such as crops and waste products, rather than fossil fuels. They can be used to power vehicles, generate heat and electricity, and provide power to homes, businesses and industries. There are two main types of biofuels: **(i) Biogas**, which is made up of a combination of methane and carbon dioxide, is produced by breaking down organic matter in the absence of oxygen. This process is known as anaerobic digestion or methanisation, and it utilizes inputs such as food crop residues, livestock farming effluent, intermediate crops, and organic waste from local authorities and industries; **(ii) Biomethane**, on the other hand, is created by purifying biogas to give it properties that are similar to those of natural gas. It can be used as a fuel for a variety of applications, including heating, cooking, industry, and transportation, as well as for generating electricity. It is often transported and stored using existing gas infrastructure, but it can also be used for localized needs.

The energy sources mentioned above are considered clean and renewable with the added benefit of having low operating costs. Moreover, there are hybrid forms of renewable energy that combine two or more sources to generate power. Examples of such hybrid energies include:

1) **Solar-wind hybrid energy**

Solar-wind hybrid energy is a system that combines the use of solar panels and wind turbines to generate electricity. This system is often used in remote areas where access to the grid is limited.

2) **Hybrid geothermal-biomass energy**

Hybrid Geothermal-Biomass energy is a technology that harnesses the power of both geothermal and biomass energy to create heat and electricity. It is usually used in areas where both geothermal and biomass resources are readily accessible. However, there are some drawbacks to this approach. It can have environmental impacts such as the release of greenhouse gases and the risk of seismic activity from geothermal energy production. Biomass energy production can also contribute to the emission of air pollutants.

3) **Green hydrogen**

Green hydrogen is a type of hydrogen produced through a process called water electrolysis, which uses renewable energy sources like solar or wind power to split water molecules into hydrogen and oxygen. Unlike traditional hydrogen production, which relies on fossil fuels, green hydrogen production is emissions-free and considered a sustainable form of energy. Green hydrogen can be stored and transported for use in a variety of applications, including transportation and power generation. Although the cost of producing green hydrogen is currently higher than traditional

hydrogen, it is expected to decrease as technology improves and economies of scale are achieved. Green hydrogen has the potential to reduce greenhouse gas emissions and transition to a more sustainable energy system by decarbonizing industrial uses of hydrogen, integrating intermittent renewable energies, and enabling the storage of surplus electricity.

2.2. Use of the different types of renewable energies in North-West Europe

Based on available data¹, here is an estimated list of the most commonly used renewable energies in North-West Europe, from most to least used:

1. Wind energy: Wind energy is the most widely used renewable energy in North-West Europe, with a significant installed capacity in countries such as the Netherlands, Germany, and the United Kingdom.
2. Solar energy: Solar energy is also widely used in North-West Europe, with growing installed capacities in countries such as Germany, France, and the United Kingdom.
3. Bioenergy: Bioenergy, including biomass and biofuels, is widely used in North-West Europe for heating and power generation, particularly in countries such as Sweden, Finland, and Germany.
4. Hydro energy: Hydro energy, although widely used in some countries such as Norway, is generally less widely used in North-West Europe compared to other renewable energy sources.
5. Geothermal energy: Geothermal energy is the least used renewable energy in North-West Europe, with limited installations and use in countries such as Iceland and the United Kingdom.

The use of renewable energies varies greatly between countries and regions. The use of renewable energies in the different countries from NWE is constantly evolving, but based on available data, the table below gives estimated information of the most commonly used renewable energies in France, Ireland, Belgium, UK and the Netherlands:

| | Wind | Solar | Bioenergy | Hydro | Geothermal |
|-------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| France | 2 nd | 3 rd | 4 th | 1 st | 5 th |
| Ireland | 1 st | | 2 nd | 4 th | |
| Netherlands | | 2 nd | | | |
| Belgium | | | 3 rd | | |
| UK | | | | | |

¹ Data available as of March 2023.

3. THE INNOVATIVE APPROACH OF NEXT GENERATION STE SYSTEM

Among all alternatives that emerge on the renewable energy market, a promising device has been developed for years from now on and the ICaRE4Farms project offered a room for studying an all new generation of these STE systems. Stemming from real-life experiments and field testing on the Fengtech model, the enhanced capacities of those panels have been officially assessed and demonstrated by a pool of scientific experts and advisory stakeholders.

What follows is a case study description of this breakthrough technology thanks to which new highs are accessible for lowering the global carbone footprint and alleviating the climate crisis. It will revolves around an exhaustive review of this device's main features and aspects which differentiate it from previous prototypes, as well as an outlook of its ever-growing potential of application.

3.1. Backgrounds of Developments

The Fengtech STE panels have been designed and improved for more than ten years by Liquan Feng (CEO of the company) and its associates in the North-West of France, in Mayenne county (Region Pays de la Loire), nearby the city of Laval.

During this time span, former doctor engineer in fluid mechanics endeavoured to develop a solution for supplying a whole holding with hot water, without relying too much on fossil fuel.

In the course of its career, the Fengtech company was accompanied by the local business support organisation, Laval Mayenne Technopole (LMT), whose goal is to dynamise and foster the local economy through innovation. As such, Fengtech entered the Incubation scheme and made it through until its terms. In the meanwhile, the company started installing several systems, first in Mayenne county itself, then in its surrounding, reaching thus around 30 plants settled.

Few times after, LMT spotted several European calls whose objectives fitted with the requirements for an extensive number of effective Renewable Energy alternatives.

In this framework, different applications were submitted and eventually the ICaRE4farms project came to fruition. Starting from that point, this next generation STE systems began to disclose its technical secrets and assets...

To better grasp the following of this study, a necessary brief on the basic functioning and main components of Fengtech STE system must be carried out. Subsequent analysis will detail more in depth different technical but also cyclical and organisational aspects.

This device is composed of 2 essential parts, namely the vacuum tubes and the water tank, to which much be added a white surface whose goal is to reflect and optimise the captured irradiances. Naturally, pipes and other plumbing junctions are mandatory to ensure the effective supply of energy. Initially, there were 2 models, named respectively ETF 1 and ETF 2, whose main difference from one to another revolved around proposing (or not) pressure functionality. However, no further enquiry will be discussed in this analysis since only ETF 2 (with pressure) will still be commercialised.

In short, to heat the water and make it accessible for several uses:

- The water enters the system at one end with a very slow inlet flow, to progressively heat the water while entering the system and keep the stratification in the tanks.
- The water heated in the tubes rises in the upper part of the tank using the thermosiphon principle, flows into the next unit thanks to an elbow pipe that allows the hot water at the upper part of the tank to flow into the colder lower part of the next unit tank.
- The preheated water in a storage tank is pushed naturally from element to element to reach a higher and higher temperature.
- Hot water in the last elements is sent to the hot water buffer tank.

With the described basic functioning, holdings are promised to reduce at least of their energy consumption and to apply these savings in different areas necessitating hot water. Today, thanks to the project and the acknowledged efficiency of its technologies, Fengtech has more than doubled its fleet of installations, implementing them in new territories and activity sectors.

What remain to be explored is how and why characteristics of the Fengtech STE systems (1) diverge from technology counterparts, thus being labelled “next generation” and (2) those advantages are being capitalised upon for widening the market outreach and roll-out of the product.

3.2. Technical advantages over its peers

The Fengtech STE technology is characterised by several prominent aspects due to which it stands out of the crowd. Three sets of specificities enables it to display competitive advantages over competing devices. It relates to capture, storage and “accessibility”.

A. Capture

First thing first, the combination of existing processes, methods and elements has considerably refined the capture functionality of the installation. In short, measurements on Fengtech technology in real conditions stress a range of average performance fluctuating between at least 50% up to 70%, or even more. This score accounts for a full year of functioning; consequently, there are discrepancies depending on climatic aleas, weather conditions and geographical locations.

Indeed, one have to note that this high level of efficiency reflects operations in the North-West Europe area i.e. regions characterised by significant low temperatures and sun irradiances compare to more Southern places, due to typically cloud and overcast weathers.

In this context, such surprising results are explained primarily by the elaboration of an advanced system of capture, established upon several main features:

- **Vacuum Tubes:** Fengtech STE panels are equipped with a specific component that optimise the collect of solar energy. The vacuum tubes contain a special coating that maximise the absorbed irradiance, and thus, the heating factor. Furthermore, not only the absorption factor is reinforced through this specificity but it is also safe: indeed, the tubes are resilient to overheating up to 240°C; henceforth, the potential for grasping surrounding sources of solar irradiances is notably high without too much risk of malfunction.

- Nature of the Absorbed Solar Irradiances:** The system was conceived to capture 3 types of sun rays. First, it assimilates direct irradiance, which are casually the basic source of energy. To that extent, the system exposure has been thoroughly measured so that the chosen angle help to maximise the reception of sun rays: as such, orientating the panels straight to a South-West direction with an exact 45° angle increase the system aperture from 4m² to 8m². Then, the tubes are exposed to diffuse irradiance, corresponding to deviated flow of sun rays available all around. Eventually, the main originality of the Fengtech technology relies on leveraging reflected irradiance thanks to the white surface on which the system is installed. Indeed, if black colour retains heat, blank one is reflective and thus, it reinforces the exposure of the capturing elements while also alleviating the energy loss.

These elements are contributing to the unprecedented results in terms of efficiency where capture plays a major role.

B. Storage

However, the aforementioned components not only boost outputs on this dimension since they also impact other significant capacities of the whole system.

Indeed, two other aspects have to be taken into account, among which storage. This basic feature is key to ensure satisfactory and ground-breaking performances for STE technology in adverse climate conditions.

Storage exerts a keystone influence upon the next generation STE systems, considering the paramount requirement to prevent the discrepancy of temperature between within the tank and the outside. Several “tactics” are tackled to ensure a minimal energy loss.

Getting back to the selected high-performance vacuum tubes, these elements not only and primarily serve the capture function of the system but their composition is pivotal for insulation, in particular within cold and windy conditions. Above all, the 30 tubes composing each panel are filled with water acting as a heat carrying fluid. Nevertheless, these glass materials do not bolster the whole innovative functioning of the system on its own.

On one hand, each panel is equipped with 250L stainless steel water tanks whose design was conceived in order to generate the hot water stratification process, i.e. water is arranged into several layers due to the difference of density between colder and warmer fluids. Based on this inner distribution, the thermosiphon effect is thus naturally prompted: heat exchange occurs thanks to a convection phenomenon stemming from contact between the layered temperatures of the water. This inventive approach is facilitated via the modular layout of a typical STE system. At least two panels are directly connected to one another while their respective tanks assume two roles: 1) in series linkages for water pre-heating; 2) parallel storage for providing water heating and ready-to-use hot water supply.

On the other hand, the system is fashioned to manage excess thermal energy along two axis. The device is built to dissipate exceeding heat into the soil for subsequent uses during next filling since burried water pipes will be warmed-up with their colder fluids by the “stocked solar irradiance”. Another application for evacuating the overheating is depending on safety valves but this solution represents more a last resort since it implies to lose the expelled heat.

C. Accessibility

What is encompassed here under the label of “Accessibility” correspond basically to 2 strands of acknowledgements with the next generation STE solutions.

First, the Fengtech STE systems offer unprecedented performances under climatic adverse conditions. Capture and Storage are the 2 main dimensions accountable for these results since effective operations relies upon these aspects. Consequently, depending on geographic and climatic factors, the system provides a range from 50 to 70% of the required energy needs, in average. It is also conceived to deal with up to 100°C that it will turn into energy supply.

Concretely, these data shed light upon the existing discrepancy between conventional STE systems and the wave of next generation devices, since the formers has been assessed to supply up to 3 times less energy than the latters when it relates to hot water use.

Indeed, this comparison underlines another important point for better seizing the STE potential: concrete applications* (see Market Analysis Document). Consecutive studies in the project framework have displayed a certain versatility of uses for STE devices and amongst those compatible activities, 4 main sectors were initially framed as “priority applications”. Before browsing through them, it is important to keep in mind how those different utilisations are categorised into 2 diverging fundamental groups of usage.

On one hand, hot water is leveraged for direct uses; it comprises feeding or cleaning applications, mainly. Dairy and Calf farms are identified as the 2 priority sectors on this side since the latter applies hot water for preparing the calves’ drinks and feeds while the former ensure the cleansing of milking parlours and tanks via the heated water supply. Yet, in the milking processes, STE systems have proven to be a reliable source of energy for fuelling milk processes like pasteurisation, for instance.

On the other hand, STE operations are also very suitable for building heating applications. The set of relating priority sectors included in this category are the Pig and Poultry farms. More precisely, maintaining an ambient warmth is crucial at the month-long chick growth stage and all along the maternity and post-weaning phases for pigs. In that manner, buildings for these breeding activities must be equipped with hydraulic heaters since conventional electric, gas or wood heaters are not compatible.

It is important to remember that STE applications are water-related activities, offering a wide range of possibilities, but may not be able to supply every possible activity.

Then, next generation Fengtech STE systems have been tested beyond pure technical specifications. Indeed, its accessibility encompasses several aspects related to its modularity, its adaptability and its scalability. STE plants can be dimensioned according to the end-user’s needs and it harnesses specific assets depending on its numbers; hence, the more panels are installed and connected, the more marginal energy is produced compared to conventional systems. Besides, STE systems are quite easy to install: all you need to do first is to pour a concrete slab for levelling the floor and wait for 3 weeks until it dries; thereafter, with the help of installers, piping and junctions between the supplied holding and the plant location needs generally 1 week to be finished.

In terms of affordability, one STE unit can generate between 800 and 1100 kWh/m² of energy savings per year. Knowing that doubling this sum with 2 panels will account for more than the range 1600 – 2200 kWh/m² due to the in-series effects, these results provide guidance about the

real cost of the investment: one unit is sold along with installation 5000€; concretely, in average, simulations in pre-Energy crisis scenario account for 12 years of repayments. However, the current situation is considerably lowering those prognostics. Comparatively, a PV panel, whose efficiency with hot water is 4 times least, costs in general between 9000€ and 23 000€. Eventually, the main asset of the system is its reliability since each panel are guaranteed to operate effectively for 40 years. In case of malfunctions or damages, they are easy to repair – if a vacuum tube breaks, it can be replaced by the end-user itself with one of the few extra tubes provided, for instance. Maintenance is as well simple since it mainly revolves around cleaning the white surface and the tubes to uphold an optimal irradiance capture.

To resume, next generation STE systems are effective, high-performance in averse climatic conditions, affordable and reliable thanks to a long lifespan due to a very low need for maintenance.

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