RES4LIVE

ENERGY SMART LIVESTOCK FARMING
TOWARDS ZERO FOSSIL FUEL CONSUMPTION

Report on Policy Recommendations

Deliverable 6.2

WP6. Clustering through Stakeholders' Engagement

Project title

RES4LIVE - Energy Smart Livestock Farming towards Zero Fossil Fuel Consumption

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UNIBO – UNIVERSITY OF BOLOGNA

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PUBLISHABLE SUMMARY

Each policy brief (PB) is a short summary of key findings and recommendations arising from a specific segment of the RES4LIVE project. They will detail, for example, some of the barriers and challenges to the uptake of renewable energy technologies or include regulatory hurdles which affect the livestock farming industry's use of renewables. This compilation of policy briefs aims to highlight the needs of the livestock farming industry, including on an industry level, a governmental level, and a socio-economic level. If implemented, these recommendations would not only make the livestock farming industry more sustainable, energy-efficient, and cost-effective, but they would also improve the welfare of livestock.

These recommendations have not only stemmed from the experiences of project partners in the design and installation process but also incorporated the suggestions and observations from national stakeholders during the project's national workshops. Three national workshops were held by each of the pilot farms, located in Belgium, Germany, Greece, and Italy. The participants mainly included farmers and technology developers who discussed the advantages and challenges of renewable energy source (RES) installation in their respective countries.

The policy briefs were published on the RES4LIVE website under "Outputs" as well as disseminated on RES4LIVE's relevant social media platforms (Twitter/X, Facebook, and LinkedIn). They were also presented in an online policy session on the 19th of September 2024 which featured speakers from the project as well as external speakers to comment on the future of EU agriculture and the recommendations and outcomes of the Strategic Dialogue on the Future of EU Agriculture.[1]

The following policy briefs were completed:

Policy Brief	Title
PB01	Policy Recommendations for the Common Agricultural Policy (CAP)
PB02	Technology-Specific Policy Recommendations (Heat pumps, PVT, BioCNG)
PB03	Country-Specific Policy Recommendations: Belgium
PB04	Country-Specific Policy Recommendations: Germany
PB05	Country-Specific Policy Recommendations: Greece
PB06	Country-Specific Policy Recommendations: Italy
PB07	Policy Recommendations for Livestock Buildings
PB08	Policy Recommendations for Diversifying Farmers' Income

[1] The Strategic Dialogue on the Future of EU Agricultural was a 7-month initiative to bring together experts from across the European agri-food sectors to determine policy recommendations and align political discourse more fully in the agri-food industry.

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1 INTRODUCTION

The livestock farming industry plays a crucial role in global food security, rural development, and economic sustainability. However, it also faces significant challenges, including environmental concerns, market volatility, and evolving consumer preferences. As the sector adapts to these dynamics and as environmental concerns intensify due to the energy intensiveness of the sector, targeted policy interventions are essential to defossilise, innovative, and ensure energy resilience. This report presents a series of eight policy briefs designed to address these challenges through strategic policy recommendations.

The first brief focuses on enhancing the Common Agricultural Policy (CAP), emphasising the need for reforms that support sustainable practices and funding programmes to support investments and installation costs of renewable systems. Subsequent briefs delve into technology-specific recommendations, exploring the potential of heat pumps, photovoltaic thermal (PVT) systems, and BioCNG to enhance efficiency and reduce carbon footprints in livestock operations. These innovations not only offer pathways to enhance energy efficiency but also present opportunities for farmers to generate clean energy on-site.

Country-specific analyses for Belgium, Germany, Greece, and Italy provide tailored recommendations that consider the unique renewable energy landscapes and agricultural practices of each nation. Additionally, we address essential considerations for livestock buildings, focusing on infrastructure design. We also explore strategies for diversifying farmers' income and encouraging the development of renewable energy projects that can serve as supplemental revenue streams.

Together, these policy briefs form a comprehensive roadmap for defossilising the livestock industry. By fostering a culture of innovation and sustainability, we can ensure that the sector not only meets the demands of today but also thrives in a cleaner, greener future.

2 POLICY RECOMMENDATIONS

2.1 PB01: Policy Recommendations for the Common Agricultural Policy (CAP)

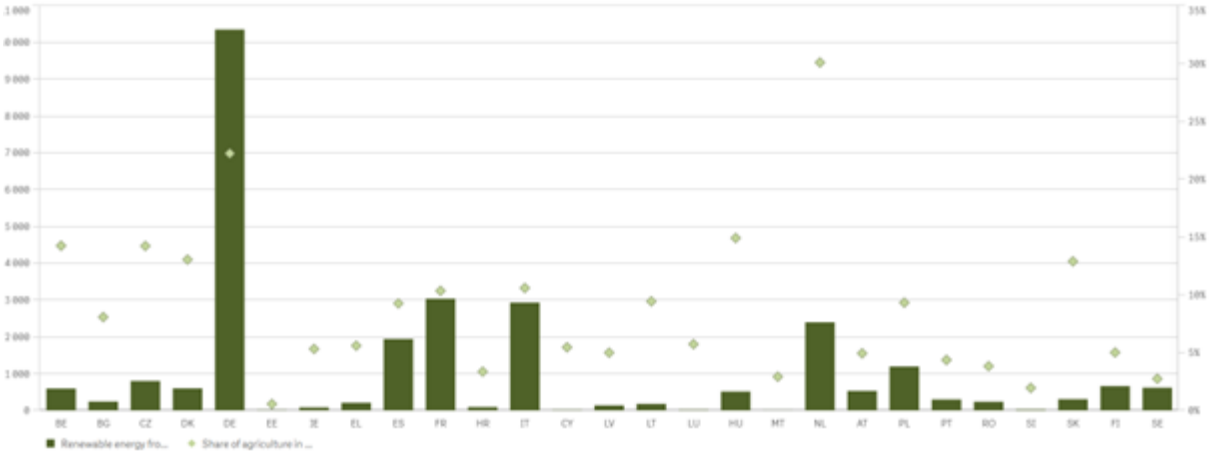
The Challenge

Integrating renewable energy in farming

Farming and connected industries employ 44 million people in the EU, generating 6% of the EU's GDP and 7% of its total exports.[2] However, according to official UNFCCC reporting, farming is responsible for 11% of total EU greenhouse gas emissions, with 43% of these emissions coming from enteric fermentation in livestock and 38% from fertilizer use.[3] If imported feed and other agricultural products were to also be added to the EU's farming footprint, then the sector's emissions would be significantly higher.

Integrating renewable energy in-farm solutions can significantly reduce carbon emissions from energy use by substituting fossil fuels, for example, to heat barns for livestock and power machinery. The sustainable use of biomass residues and by-products can produce energy while avoiding methane release into the atmosphere. Moreover, with around half of the EU's territory being used for agriculture, farmers have a unique opportunity to become net producers of renewable energy and contribute towards Europe's energy transition and energy security. In 2021, renewable energy from agriculture accounted for 11.5% of the EU's renewable energy production (see Graph 1 below). Under the right circumstances, further deployment of renewable energy in agriculture is possible, thereby complementing farmers' revenues and supporting the EU to meet its climate targets and energy sovereignty objectives.

Graph 1: Production of renewable energy from agriculture at Member State level, 2021



Source: Eurostat 2024 C43 Production of renewable energy from agriculture and forestry

[2] Mapping and analysis of CAP strategic plans. European Commission (2023), page 226.

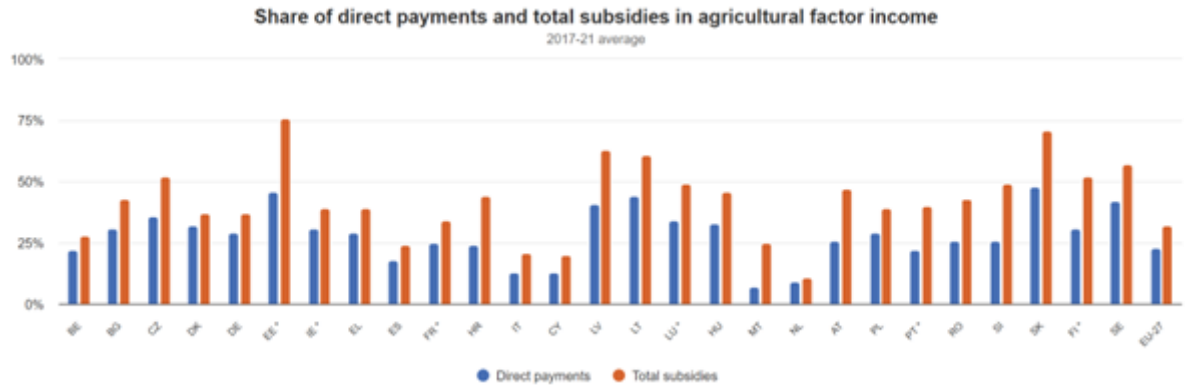
[3] Progress and prospects for decarbonisation in the agriculture sector and beyond. European Environment Agency (2023)

The Opportunity

Introducing the EU's Common Agricultural Policy

The EU's Common Agricultural Policy (CAP) provides income support to farmers - often referred to as "direct payments" - on the condition that a farmer respects a series of minimum environmental and land quality requirements. Additionally, farmers may get investment support to set up or upgrade their farms. Top-up CAP payments – mainly as "eco-schemes" and "rural development" funding – are available to those participating in higher voluntary schemes such as organic farming, carbon sequestration schemes, and additional biodiversity measures.

The CAP has a budget of €378.5 billion, corresponding to 31% of the EU's total budget for 2021-2027.[4] EU farm subsidies from the EU budget together with public co-financing from countries and regions accounted for 32% of EU farmers' revenues in 2021.[5]



Source: Eurostat 2024

Based on CAP objectives and rules, each EU country prepares a CAP Strategic Plan with its own priorities and focus. To track success and implement common objectives the CAP has a monitoring and evaluation framework based on a list of indicators covering environmental and socioeconomic factors. The European Commission checks that countries correctly implement their stated plans. There are two CAP result indicators relevant to renewables that countries must report: "R.15 Renewable energy from agriculture and forestry and from other renewable energy sources"; "R.16 Investment related to climate".

[4] Factsheet on The EU's 2021-2027 long-term budget & NextGenerationEU: Facts and Figures. European Commission, 2024

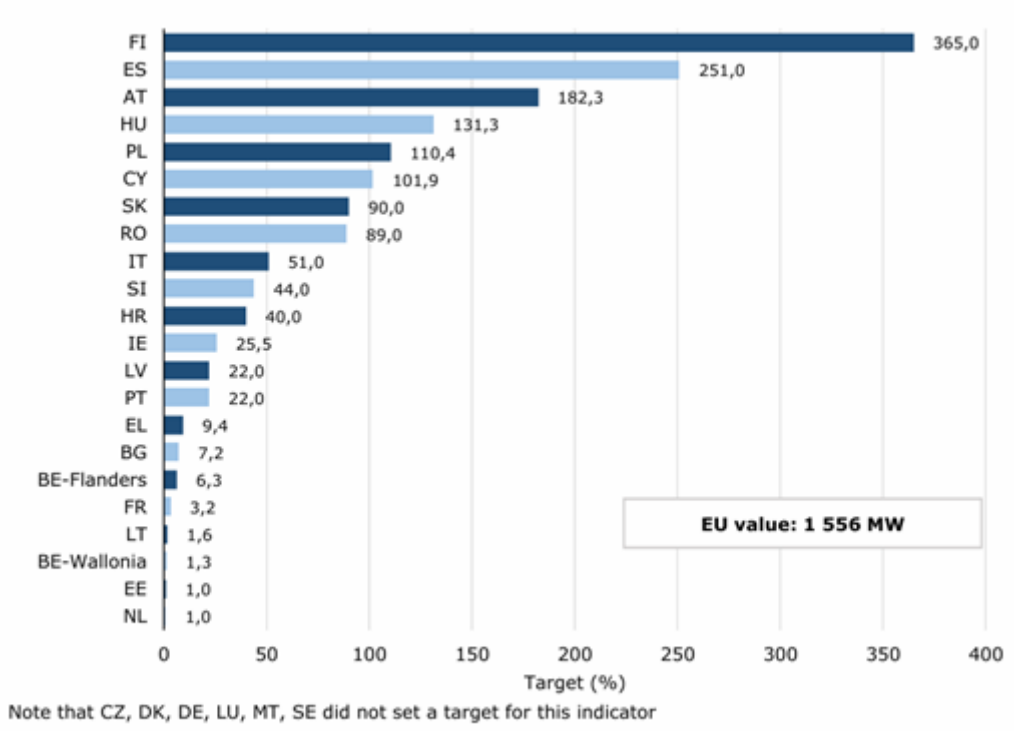
[5] Share of direct payments and total subsidies in agricultural. Eurostat, 2024

Opportunities and barriers for renewables in the current CAP

Overall support for renewable energy in CAP

Under indicator R.15, the European Commission has found that Member States in their CAP national plans intend to install 1556.4 MW of new renewable energy capacity in EU farms by 2029[6] (See graph below), which is a tiny share of the several hundred GW of new capacity needed to reach the EU renewable energy target of 42.5% of final energy consumption from renewables by 2030.

Figure 283 Targets for R.15 Renewable energy from agriculture, forestry and from other renewable sources



Note that CZ, DK, DE, LU, MT, SE did not set a target for this indicator

Indicator: Supported investments in renewable energy production capacity, including bio-based (in MW) EU target: 1 556 MW

Source: European Commission, 2023

EU countries could aim higher by assigning more money for in-farm renewable energy deployment out of their leftover CAP 2023-27 budgets. More importantly, renewable energy deployment should be prioritised in the post-2027 CAP revision discussions, which are expected to start in 2025. CAP plans can financially support renewable energy deployment.

Policy recommendations:

- *Funding investments in generation capacity on farms*.
- *Funding investment in grid connections, smart meters, and other digital infrastructure in farms.*

[6] European Commission, 2023. Page 474

- *Setting clear objectives and defining technologies to decarbonise the farming sector, consistent with the 2024 updates to the National Energy and Climate Plans (NECPs).*

Bioenergy development

Bioenergy is an abundant in-farm renewable energy source. Bioenergy resources include forestry residues (i.e., solid biomass), humid organic material suitable for anaerobic digestion, and other fermentation processes to produce biofuels. Any support from CAP to biomass in the future will have to respect the biomass sustainability criteria laid down in the renewable energy directive. There are usually additional national criteria for biomass, so in-farm biomass installations will vary from one country to another.

In this context, we recommend that public authorities align new biomass projects with the EU biomass criteria from 2023. This will give confidence to farmers that the latest biomass rules are here to stay. Moreover, the new EU criteria can bring a degree of harmonization of national sustainability requirements, which can help bioenergy technology and service providers to work more effectively cross-border. Therefore, the revision of the post-2027 CAP should directly mention the new sustainability criteria and that future national plans step up the support for the next generation of biomass projects.

CAP-supported projects should prioritise biomass to balance intermittent renewables in the electric grid and to decarbonise hard-to-abate sectors (e.g. biofuels for aviation). One of the most effective ways to do the latter is by upgrading biogas plants that currently produce electricity into biomethane plants that can supply renewable gas to industry.

Policy recommendations:

- *EU Countries should align their national policies and bioenergy projects with the 2023 European biomass criteria as soon as possible.*
- *The post-2027 CAP revision and future CAP Strategic Plans should fully integrate the European biomass criteria.*
- *Where possible, prioritise the use of biomass to balance the electric grid and to decarbonise hard-to-abate sectors.*

Deploying solar technologies

Farm structures like barns and houses offer significant rooftop surfaces to install photovoltaic panels, and solar thermal and combined photovoltaic-thermal (PVT) systems. The CAP should prioritise giving support to photovoltaic-thermal systems to maximise the use of rooftop space on European farms, encouraging farmers to cover their average energy needs and where possible become net producers of energy. National support schemes should make it a priority to deploy rooftop solar in farms and permitting rules should be reviewed when needed to simplify procedures.

Agrivoltaics is a promising photovoltaic application with huge potential. According to the Joint Research Centre, if 1 % of the EU's Utilised Agricultural Area (UAA) is covered with Agri-PV system, this

translates into over 900 GW (assuming 0.6 MW is installed per hectare). This is more than the total PV installed capacity that is projected in the EU by 2030.[7]

CAP area payments are possible for land used for agrivoltaics, provided there is a "predominance of agricultural activity". Usually, this is a combination of raised PV panels combined with livestock grazing, although it is also possible to plant and harvest crops. Unfortunately, there is no standardised EU definition of when agrivoltaics qualify for CAP payments. As a result, some countries have moved ahead to set rules for agrivoltaics, while others don't allow for CAP support on this land. Four EU countries have measures supporting agrivoltaics in their CAP strategic plans (Germany, Italy, the Netherlands, and Slovenia) and Czechia just passed a law with new rules on this emerging sector. Meanwhile, the deployment of agrivoltaics in Central European countries is lagging behind due to a lack of support according to Members. We recommend that the European Commission provides detailed guidance on agrivoltaics before member states start preparing their post-2027 CAP Strategic Plans, ideally during 2025 or 2026.

Further guidance should be provided for farmers and public authorities on available funding for agrivoltaics, as well as deploying PV, PVT, and solar thermal on degraded land. With the Recovery and Resilience Facility soon to expire, the EU needs a new tool that can fund the deployment of renewable technologies. While the CAP can do more to support renewables in farms, new large-scale investment tools should be put in place post-2027.

Policy recommendations:

- *The post-2027 CAP should encourage countries to support the deployment of PVT systems in farms*.
- *European Commission to prepare detailed guidance on agrivoltaics – including compatibility with CAP direct payments - by the latest 2026*.
- *New clean investment tools should support agrivoltaics, as well as in-farm PV, PVT, and solar thermal*.

[7] Overview of the Potential and Challenges for Agri-Photovoltaics in the European Union. JRC 2023

2.2 PB02: Technology-specific Policy Recommendations

The Challenge

The agricultural industry, particularly livestock farming, has high energy demands for heat and electricity. In fact, a farm's thermal needs (space heating and domestic hot water needs) are half of the total energy consumption (See **PB07 Policy Recommendations for Livestock Buildings**). According to the European Commission, the agricultural sector accounts for about 10% of total Greenhouse Gas (GHG) emissions in the European Union.[8] There is little renewable energy penetration in agriculture, as farms do not have the investment capability of modernising their energy systems. Therefore, many still use oil, gas, and biomass as the main fuel sources and the majority of agricultural machinery is powered by fossil fuels – primarily diesel engines. Fossil fuel costs are likely to rise in the future, and electrification cannot be the only alternative to heating as this would overwhelm the grid, especially with the inclusion of electric vehicles in the future and particularly in the winter months when electricity demand is high.[9] A mixed solution is the necessary solution and will not overwhelm the electric grid. Modern Heating, Ventilation, and Air-Conditioning (HVAC) applications play a crucial role in agriculture where maintaining optimal temperature and humidity levels is essential for animal welfare (livestock facilities) and crop productivity (greenhouses).

The various clean energy technologies incorporated into RESLIVE's pilot farms were innovative and chosen to explore the technical limit of what may be achieved when they are used in combination, as well as cost-effectiveness. The interventions were selected to replace fossil fuel consumption of certain needs in the pilot farms and prove that fossil-free and sustainable farming is achievable. The trials have been successful – the lessons learned have been summarised below.

Technologies

Heat pumps

The main barriers to adopting sustainable HVAC systems in agriculture include high initial investment costs and limited technical knowledge. However, opportunities exist to overcome these barriers through technological advances and supportive policies. RES4LIVE installed heat pumps, configured differently for each of the four pilot farms, each with different climates and varying heating and cooling needs. Heat pumps have been proven to be an efficient solution for meeting HVAC requirements while reducing carbon emissions. However, there are several ways that heat pumps could be better promoted.

[8] https://climate.ec.europa.eu/news-your-voice/news/looking-how-mitigate-emissions-agriculture-2023-11-13_en

[9] A smart grid with flexible management of electricity (ex. use EVs to store electricity and large-scale storage) is also a useful way of handling grid capacity limitations.

Policy recommendations:

- *Assess the potential of heat pumps in different types of facilities, including additional agricultural facilities, through feasibility studies to determine optimal systems for each location. Additional pilot projects for other climates or different needs should also be supported. Energy audits can pinpoint where heat pumps can provide the greatest energy savings and emission reductions.*
- *Implement monitoring and evaluation systems to track performance and energy efficiency, providing feedback to farmers and technicians on optimising their systems. The RES4LIVE project utilised smart monitoring technologies to monitor heat pump performance, total energy consumption, and environmental conditions in real-time.*
- *Ensure the provisions of Art 16 (Data Exchange) of the Energy Performance of Buildings Directive which guarantees access to building systems' data, are utilised by public or private initiatives to pool data and analyse the performance of HPs installed in farm buildings. This will help build confidence in the technology's effectiveness.*
- *Encourage the integration of heat pumps with other RES, such as solar or geothermal power, to elevate their COP (coefficient of performance), further reducing GHG emissions and energy costs. Modular systems will maximise energy efficiency and minimise fossil fuel usage.*
- *Support research and development in heat pumps. Heat pumps in the agricultural sector, for example, should consider the challenges of high humidity in greenhouses and livestock buildings, where animal wastes may additionally expose equipment to corrosion. The focus should be on materials, coatings, and components that improve the durability and longevity of heat pumps in agricultural settings.*
- *Facilitate dialogue and collaboration among and between heat pump manufacturers, farmers, researchers, and agricultural associations to boost uptake in the farming sector, including through joint projects and knowledge-sharing initiatives aimed at advancing heat pump technology and promoting innovation in the agricultural sector.*
    - *Develop training programs and educational materials for farmers and technicians on the installation, operation, and maintenance of heat pump systems to further skills in the sector.*
- *Establish guidelines and standards for the design, installation, and operation of heat pumps to ensure safety, reliability, and efficiency in the livestock sector.[10] There should be "best practices" regarding issues such*

Box 1: Innovative Financing Models

Some European countries have already explored financial incentives specifically for the heat pump industry. For example, the Danish Energy Agency has a subsidy for electrically powered heat pumps at basic amount plants outside the quota sector.

In the Netherlands, there are subsidies for stimulation sustainable/renewable energy production that include heating with heat pumps.

[10] Heat pump standards are typically designed for general residential, commercial, or industrial applications. The existing guidelines and standards are not sufficiently tailored to the unique needs of the livestock sector. Livestock farming takes place in large spaces, with irregular heat loads, influenced by animal body heat, ventilation requirements, and environmental factors like humidity. There are no known guidelines providing

as system sizing, integration with existing infrastructure, noise levels, seasonal variation in heat demand, and environmental impact to ensure optimal performance and compliance.

- *Provide financial incentives and explore innovative financing models to offset initial investment costs (see Box 1).*[11]

PVT (Photovoltaic Thermal) Systems

The advantage of PVT technology lies in its capability to capture a maximum of solar energy, heat, and electricity from one device at a rate that is up to four times more efficient than PV panels. PVT collectors may be on rooftops, ground-mounted, or even mounted similarly to agri-PV (with enough clearance between the modules and the ground to cultivate a crop). The RES4LIVE project installed PVT systems in three different pilot farms with various energy demands and different climates. In all cases, PVT technology has had a significant contribution to renewable heating and electricity when using the correct type of technology and integration with other renewable energy technologies such as heat pumps. Although PV incentives are still abundant (though becoming fewer) within EU countries, there are very few incentives available to farms in the EU to install solar thermal technology and none for PVT specifically, which is sometimes disqualified from separate support schemes for PV or solar thermal equipment. Policymakers must fill this gap in support for solar technologies (see Box 2). RES4LIVE showed that livestock farms have a high demand for heat which can be most effectively sourced by solar thermal or PVT technologies. When combined with heat pumps, the overall system efficiency was greatly improved and can deliver clean energy all year round. Without subsidies, the payback period of a PVT system depending on location and size is between 3-7 years.

Box 2: Ireland supports farms' investments in PV. Why shouldn't it, and other countries, appropriately support PVT or solar thermal, too?

Ireland's Solar Capital Investment Scheme (including Targeted Agriculture Modernisation Schemes (TAMS)) provides an investment grant to farmers to improve the energy efficiency of farm buildings or their equipment. The investment grant can cover up to 60% of total upgrade cost for a PV system of up to 62kW$_p$.

Policy recommendations:

- *Establish a short- and long-term EU-wide strategy for the adoption of renewable and low-carbon energy sources in agriculture, including feasible targets and specific taxation and incentives based on life cycle assessment processes.*
- *Promote research to develop comprehensive reviews and studies on optimised PVT systems depending on various applications such as agriculture, residential, industrial, etc., along with supporting the correct solutions to market scale.*
- *Raise awareness of state-of-the-art PVT technologies among farmers, contractors, and advisers through demo farms (such as RES4LIVE) and flagship eco-schemes.*

enough detail on how to size heat pumps for agricultural operations, and seasonal variations in heat demand or the specific temperature requirements for different livestock are not considered.

[11] Average manufacturing costs can vary quite broadly because of several factors, including the type of heat pump (such as air-source, ground-source, or water-source), its efficiency, capacity, and installation requirements. Additionally, prices may vary across different EU countries. For example, the cost of an air-source heat pump in Greece could range from ~300 to 700 €/kWth depending on the size and special characteristics of the facility (operation mode, installation location, etc.)

- *Develop capacity building and awareness raising of PVT and solar thermal technologies to installers, plumbers, and electricians for correct installation and maintenance practices to avoid system failures and lower installation costs.*
- *Develop capacity building and offerings from plumbers and installers on integrated systems with higher system efficiency such as solar thermal and heat pumps or in combination with geothermal energy storage.*
- *Incentivise trades such as plumbing and electricians to avoid low-capacity supply and high installation costs.*
- *Develop support and subsidies for PVT and solar thermal to match those previously existing for PV, including favourable investment plans.*
- *Disincentivise fossil fuel use through higher ETS pricing on carbon emissions.*

This would not only support local businesses developing and manufacturing solar thermal and PVT products to ensure the supply chain is kept within the EU at a maximum but would also create new jobs in high-demand trades such as plumbing and electricity, localise and boost the diversity of the EU renewable energy system, and lower energy costs. This is especially beneficial for the agricultural industry, whose high energy needs are generally supplied by fossil fuels. Solar thermal can also lower and relieve the growing grid congestion problem in the EU, where growing electrification will demand huge investments in the grid.

Biogas

Biomethane is made from biogas, which when it is made on farms, comes from anaerobic digesters fed with livestock waste, straw, grass, scraps, etc. On farms, biogas is mainly installed to run Combined Heat and Power (CHP) systems which feed the electricity to the power grid. Germany is one of the leaders in biogas development, with nearly 10,000 biogas plants (in 2022),[12] showing the feasibility and added value of the technology. However, there is very little regulation surrounding biogas, which has slowed down its development. Denmark has attempted some strides on this front; the Danish Energy Agency which is responsible for the rules and regulations regarding the support schemes and the criteria of sustainable biogas production is set on facilitating the advancement to more sustainable energy sources. Therefore, the challenge is to create a unified methodology/legislation on how this framework support can be implemented. This requires investment, research, and clear rules on technology approval from regulatory authorities. The European Commission has already summarised EU countries' ambitions for biomethane, including details regarding biogas production. This entails accelerated investments and reducing bottlenecks in deployment caused by infrastructure or regulatory elements. These are essential first steps to advancing biogas production.

Policies should:

- *Promote R&D policies to research and develop biogas production, including the adaptation of new feedstocks for biogas.*

[12] https://www.biogas.org/edcom/webfvb.nsf/id/DE_Branchenzahlen/$file/22-10-06_Biogas_Branchenzahlen-2021_Prognose-2022.pdf

- *Provide funding for the installation of new biogas plants and offer a coherent package of financial aid.*
    - *EU Member States should prioritise the development of a biomethane industry, such as in Ireland's Climate Action Plan, by supporting the construction of modern anaerobic digestion plants and offering state aid with community ownership options.*
- *During the project, official approval for the RES4LIVE pilot plant took a long time. Ensure the simplified permitting promised under the Renewable Energy Directive streamlines the process for granting approvals to installations.*
- *Facilitate shared ownership of larger, community-scale biogas plants using the residues of several farms and taking investment from and generating a return for people living nearby.*
- *Promote training activities for farmers and advisors at national and regional levels, demonstrating the benefits of biogas and innovation in the sector. Farmers/energy providers should also be trained in correctly choosing feedstocks for their anaerobic digesters.*

Some public support for the high upfront costs of a biogas plant would allow farmers to benefit from the greater energy independence and energy efficiency afforded by the technologies above. The savings and benefits could be ever greater if several farmers, people living close by and/or energy providers share the use of installations and gain confidence in the technology.

Bio-Compressed Natural Gas (compressed biomethane)

Compressed biomethane offers the perspective of fossil-free mobility on farms. However, numerous livestock farms have not yet integrated such systems for technical, economic, and social reasons such as conservative attitudes. RES4LIVE demonstrated the upgrading of biogas to biomethane to cover the fuel demand of tractors and farm machinery. Until this project, there have been no economically viable decentralised BioCNG plants at farm scale (10-35 Nm^3 of raw biogas per hour). RES4LIVE, therefore, has contributed to the calls of the Biomethane Action Plan of the European Commission, which was a part of REPower EU. The Biomethane Action Plan sets out "tools including a new biomethane industrial partnership and financial incentives to increase production to 35bcm by 2030, including through the Common Agricultural Policy".[13] This of course means a need to integrate biomethane into the agricultural industry. Italy has begun a specific biomethane funding programme to promote investments in new plants or reconverted plants (from biogas to biomethane) (see Box 3).

Box 3: Biomethane Funding Projects

Italy's New Biomethane Decree funds some biomethane projects, including both new plants and existing converted agricultural power plants. The funding consists of a **capital grant** on the eligible expenses of the investment incurred and a **feed-in tariff** applied to the net production of biomethane for a duration of 15 years.

[13] https://ec.europa.eu/commission/presscorner/detail/en/ip_22_3131

Policy recommendations:

- *Measures to stimulate interest in developing and commercialising technology to upgrade biogas to biomethane, and to ensure it is available in "farm-scale" versions so that farms are part of this emerging sector.*[14]
- *Operators of small-sized BioCNG plants must be able to offset the GHG quotas for placing the fuels on the market. To this end, offices responsible for calibration must approve simpler, more cost-effective measuring instruments for the quantity and quality measurements of the BioCNG fuel produced for plants.*

Expected Impact

By implementing the recommended policies and supporting the widespread adoption of these technologies in the EU agricultural sector, we can accelerate the transition towards sustainable farming practices, reduce GHG emissions, and promote energy-efficient operations while ensuring the well-being of animals and crop productivity and avoiding environmental degradation. Individual farmers can benefit from reduced energy costs, improved energy efficiency, and lower carbon emissions, resulting in long-term financial savings and energy security/resilience.

[14] Biomethane production technology arguably meets the definition of "innovative technology" under the Renewable Energy Directive. Deploying it would allow Member States to meet their indicative target of 5% of new installed capacity to 2030 being of "innovative" technology. See EUREC and 1-Tech's report Deployment of innovative renewable energy technologies to 2030 to see more technologies such as biomethane production which would fulfil the Renewable Energy Directive's 5% indicative target of innovative technologies.

2.3 PB03: Country-specific Policy Recommendations: Belgium

The Challenge

"Belgium's energy policy is focused on transitioning to a low-carbon economy while ensuring energy security, low consumer costs, and market competition," according to the IEA.[15] Historically, Belgium's energy needs have been significantly covered by nuclear reactors, but a phase-out is underway, with the last reactor scheduled to close in 2025. During the RES4LIVE project, the ILVO pilot farm (a swine farm) in Merelbeke, Belgium implemented an array of renewable energy technologies, including heat pumps, photovoltaic thermal (PVT) panels, and smart energy control systems. The foundation of these recommendations are suggestions and observations from Belgian stakeholders during national workshops held on January 2023, February 2023, and June 2024, in which the participants – who included farmers and technology developers – discussed the advantages, challenges, and experiences of ILVO's investments.

Industry/Technological Level

Ease of Installation

Ensuring that the installation of renewable systems is performed in a timely, quality, and cost-effective manner is a major hurdle for the Belgian renewables sector, particularly in the agricultural sector. This will be key for an increased uptake of renewable energy solutions in agricultural facilities. In Belgium, installation prices are high largely due to manpower (including installers, plumbers, and electricians). During the RES4LIVE project, for example, the initial quoted installation price for PVT panels in Belgium was more than double the quoted prices in Germany or Italy. This is mainly due to the high demand for plumbers and electricians; the cost of materials was significantly lower than the cost of labour. Plumbers in Belgium are generally expensive, especially if new pipelines and systems have to be installed, meaning greater working hours and additional transportation costs. The high upfront costs of installation are a significant barrier to uptake in Belgium.

Technical

While heating from renewables remains relatively uncommon in Belgium, there is an emerging trend of integrating PV and heat pump technologies to heat homes or offices. This duo of technologies can meet the heating needs of farms, too, and was effective at ILVO. The Belgian national workshops also indicated that Belgian stakeholders believe that energy efficiency is key – total energy use per unit of farm output should be reduced as much as possible. Therefore, adapting buildings, combining renewable energy technologies, and implementing proper building standards (see PB07 **Policy Recommendations for Livestock Buildings**) will be key to increasing efficiency and reducing energy costs.

[15] https://www.iea.org/countries/belgium

Policy recommendations:

- *Increase ease of energy installation by reducing upfront costs of installation – mainly by increasing skilled technicians.*
- *Support the combination of RES technologies in an energy system – i.e. PV, PVT, and heat recovery systems.*
- *Reduce total energy use by making agricultural facilities more energy efficient – often through insulated buildings.*

Governmental level

Legislative

In Belgium, most energy legislation is devolved to the country's three administrative regions (Flanders, Wallonia and Brussels Capital) including grid codes as well as focus areas and targets (which complicates the process of designing, installing, and certifying renewable energy systems) and subsidy levels, which means that income earned from a system in Brussels-Capital or Wallonia (which both use green certificates) may differ from the income from one installed in Flanders (which uses a quota system, ecological premium and a net-metering scheme[16]). This system of green certificates is reserved for the production of electricity from renewable sources, but not all types of renewables qualify. The generation of heat through renewable energy sources is promoted through a system of energy subsidies or investment assistance via a tax deduction for the company installing them. Flanders also works with limits on the kWh/m² and also integrates renewable energy in the calculations.[17] Funding is therefore based on these limits (or potential limits for installing a new system). As of 2024, Belgium works with a "capacity tariff" on the grid costs, meaning that peak demand over 15 minutes will influence final bills. This could result in needing to spread out electricity demand to avoid these peaks, in livestock farms this could mean planning feeding times at different times instead of all at once.

Funding

Most national investment in RES technologies in Belgium is delivered via the aforementioned subsidies, but taxation is also used to influence private spending decisions. Recent changes to VAT (a Federal competence) have worked both to boost the uptake of renewables (in 2023, the government permanently reduced the value-added tax from 21% to 6% for newly installed photovoltaic modules, thermal panels, solar water heaters, and heat pumps[18]) and to slow down their growth (in 2021, the federal government introduced a "social electricity" measure aimed at subsidizing electricity costs for

[16] http://www.res-legal.eu/search-by-country/belgium/#:~:text=In%20Belgium%20electricity%20from%20renewable,the%20federal%20level%20in%20Belgium.

[17] https://www.vlaanderen.be/epb-pedia/rekenmethode/rekenmethode-e-peil/epn-methode

[18] https://www.brusselstimes.com/427281/belgium-permanently-sets-vat-on-gas-and-electricity-at-6

Belgium's poorest users).[19,20] The tax system should be reformed to better benefit renewable technologies rather than fossil fuels and to favour efficiently used electricity over natural gas. [21,22]

Policy recommendations:

- *Reform the energy tax system to favour renewable technologies.*
- *Introduce tax exemptions/low interest rates for renewable system installations to offset high initial investment costs.*

Socio-Economic Level

A striking challenge in the Belgian landscape for renewables – and therefore their integration into agricultural facilities – is the lack of trained personnel. Skilling (or reskilling) workers will be key to successfully installing and operating RES systems on livestock farms. A characteristic of Belgium's technicians is that they tend to work only with brands they know. This was made clear throughout the installation process at ILVO, where plumbers for heat pumps would only work with certain brands due to their tools. In ILVO, for example, technicians preferred Alpex instead of Geberit tubes as they were unsure if their tools were certified for Geberit. When dealing with refrigerants, technicians must be qualified as "certified tool technicians". This requirement - feels RES4LIVE - is too strict, reduces the pool of installers, and therefore increases the time waiting for installation. Instead, the rules should be relaxed on specific certifications for technicians.

Finally, a remaining hurdle in the agricultural sector is the perceived "reliability" of fossil fuels when compared to renewables. This perception is more prevalent in older farmers. To correct misperceptions, e.g. by pointing out that gas prices surged during the recovery from COVID-19 and from Russia's invasion of Ukraine, public awareness campaigns are needed to draw attention to the resilience of energy derived from on-site or nearby sources. They should focus on the reliability, stability and efficiency of renewables.

Policy recommendations:

- *Support training, re-training, and cross-training skilled workers in disciplines relevant to the renewable energy sectors (plumbers, electricians, certified tool technicians, stability engineers, etc.).*
- *Stress the reliability and long-term efficacy of renewable energy systems.*

[19] https://www.creg.be/sites/default/files/assets/Publications/Studies/F2289EN.pdf
[20] https://www.energytrend.com/news/20240326-46168.html
[21] https://dashboard.vreg.be/report/DMR_Prijzen_elektriciteit.html
[22] https://dashboard.vreg.be/report/DMR_Prijzen_gas.html

2.4 PB04: Country-specific Policy Recommendations: Germany

The Challenge

Germany's transition towards renewable energy has mainly focused on expanding renewable electricity production, in the 2000s with wind energy and in the last 15 years with photovoltaics. To decarbonise heat, it has been promoting heat pumps in the past couple of years,[23] but their penetration in industry and agricultural settings remains limited.

During the RES4LIVE project, the LVAT dairy farm in Groß Kreutz, Germany implemented an array of renewable energy technologies, including heat pumps, photovoltaic thermal (PVT) panels, a bio-CNG plant, and smart energy control systems.

The recommendations here are suggestions and observations from German stakeholders during the national workshops where the experience of integrating these technologies was discussed. During the German workshops, the participants – who included farmers and technology developers – discussed the advantages and challenges of renewable energy source (RES) installation in Germany, particularly RES technologies showcased in the LVAT dairy farm. The comments, observations, and suggestions made by workshop participants are included and addressed in this policy brief, and policy recommendations are divided into separate levels: industry/technological, governmental and socio-economic.

Industry/Technological Level

Installation held back by lack of skilled workers

Creating an environment where renewable energies are supported and the energy transition is fostered is imperative to increase renewable energy solutions in German agricultural facilities, but installations face obstacles. Many more specialists in PVT systems must be created, although Germany's education system is better equipped than many others to meet this need with its long tradition of workplace apprenticeships.[24]

Policy recommendations:

- *Focus on developing workers skilled in renewable energy technologies and systems. This can include educational programmes to upskill workers or additional courses to re-skill tradespeople. Germany has a good basis on which to build but will need to incorporate renewables more strongly into the curriculum.*

[23] https://www.iea.org/countries/germany/renewables
[24] https://www.bibb.de/en/147679.php

- *Tradespeople should be cross-trained in multiple systems to tackle the skills shortage in the short term.*

Governmental level

Legislative

The LVAT pilot farm in Germany hosted a biomethane micro-fueling station, which would have greatly benefitted from a simpler process to gain certification, for example from standardisation of certification procedures. TÜV, the *Technischer Überwachungsverein* (Technical Inspection Association), which controls the approval process for technical systems, was required to approve the bio-CNG plant and the retrofitted tractor at the LVAT facility. These technologies were reportedly unfamiliar to the local staff assigned to the certification. A national- or EU-level authorisation and certification process would be significantly more efficient, so would eliminating redundancies across the different certificates that may be needed, for example, a TÜV approval and a climate protection certification for renewable systems. Centralising clear descriptions of the process to certify new technology in a database accessible to certifiers would help. An easier, more simplified and centralised certification and approval process (aiming at a "one-stop shop") would make the installation process smoother and more efficient.

Funding

The initial cost of a renewable system like LVAT's bio-CNG plant is significant and takes a long time to be recouped during its operation. This puts such systems out of reach of most farmers, particularly in smaller facilities. Funding programmes to help cover the costs of initial installation will go a long way in the energy transition.

Policy recommendations:

- *Centralise the approval process for renewable energy systems from a local level to a federal level.*
- *Support funding programmes for renewable energies in agricultural facilities –in electrification, renewable heat systems and agricultural machinery (such as the retrofitted bioCNG tractor developed in the RES4LIVE project). Renewable heating is less prevalent in industry and agriculture than in homes or offices and should be strengthened to cover a farm's heating needs and reduce fossil fuel use.*

Socio-Economic Level

RES4LIVE considers in-depth, long-term feasibility studies on animal health and welfare through hybrid ventilation and cooling systems to need more research. Studies are also needed on the economic feasibility of RES4LIVE-type investments, in the lifecycle CO2 savings they generate and in their wider environmental impacts, the results of which may increase the popularity of these technologies.

The desire for defossilised livestock systems is high in Germany, including for farmers; the majority of surveyed farmers in the German national workshops support the move to renewables and furthering the energy transition. Out of all four countries that have pilot farms in the RES4LIVE project, the positive sentiment towards renewables in the agricultural community is highest in Germany.

Policy recommendations:

- *Conduct long-term feasibility studies on animal health and welfare – areas which still need research when it comes to re-engineering a farm's energy system to increase renewables penetration – as well as economic impact and life cycle analyses to better understand the long-term efficiency of certain systems.*
- *Sustain and improve the public perception of renewables in the agricultural industry through public campaigns focusing on the economic and environmental long-term benefits of renewables.*

2.5 PB05: Country-specific Policy Recommendations: Greece

The Challenge

Greece is transforming its energy system towards renewables having determined to stop using coal by 2028. During the RES4LIVE project, the pilot farm at the Agricultural University of Athens in Greece implemented an array of renewable energy technologies, including heat pumps, photovoltaic (PV) panels and smart energy control systems. The recommendations made here come from the comments of stakeholders during RES4LIVE's workshops in Greece. The participants – who included farmers and technology developers – discussed the advantages and challenges of renewable energy source technology (RES) installation in Greece, particularly RES showcased in AUA's pilot poultry farm. The recommendations are separated below into three categories: industry/technological, governmental and socio-economic.

Industry/Technological Level

Ease of Installation

Accessibility is key for the uptake of renewable energy solutions in agricultural facilities and is often a defining factor in choosing which RES technologies to install. The farmers in the Greek RES4LIVE workshops, for example, gravitated towards photovoltaic (PV) panels, much more than heat pumps. PV panels represent the most widely adopted RES technology, largely due to supportive regulatory frameworks. For other technologies to become as popular, they require similarly beneficial regulatory support. As the focus in the Greek market should be on upscaling, accessibility is the first step on that path.

Strengthen Greece's grids to allow farms and other renewable energy production sites to export excess electricity.

Greece's many islands are not all connected to the mainland Greece grid. Therefore, obtaining a grid connection in Greece can also be difficult. Furthermore, they can have weak grids (i.e. liable to mismatches in supply and demand). The Cycladic Islands, for example, have traditionally relied on costly oil and natural gas – an EU-funded project beginning in March 2018 has focused on connecting the Cyclades to the mainland Greece grid over the next 14 years. This will certainly prove to have substantial environmental benefits, including for agricultural facilities on islands. The EU's European Regional Development Fund contributed a significant amount to the project (approximately EUR 138.2 million of the total project budget of approximately EUR 389 million). Improving the capacity and reach of the grid is certainly therefore a priority area – and a challenge – but regardless, the grid space should be more closely regulated and licensed. Grid connections in Greece are quite loosely regulated, and final grid connection offers (GCOs) to licensed producers have largely been granted on a first-come,

first-served basis without specific priority requirements. Priority areas should certainly be a factor in future GCOs.

The PV system in the AUA pilot farm in RES4LIVE, for example, was not connected to a larger grid in Athens; this is mainly due to the fact that the farm does not produce an excess amount of energy to transfer to the grid but is also because that a grid connection would be difficult to obtain, requiring significant resources (including installing a storage system such as batteries) and time to obtain the necessary permitting.[25] The surplus electricity can, however, be donated to other campus buildings. In August 2022, following a longstanding unofficial halt in the approvals of new applications for GCOs, the Ministry of Environment and Energy published a priority framework for granting GCOs to RES stations – to be conducted through a competent independent power transmission operator (IPTO). This could be promising – IPTOs could evolve into a "one-stop shop" (as recommended as part of the "acceleration zones" in the Renewable Energy Directive (RED)) for licensing and connections, reducing administrative barriers and regulatory red-tape to the renewables sector – as well as reducing the licensing queue for renewables which had become very long by 2024. Expansion of the grid will be another necessary step in this process as well.

As well as an expanded grid, there is a need for greater interoperability. While livestock farms have less demand for heating in Greece, there is an emerging trend of integrating PV and heat pump technologies, including geothermal heat pumps, and PVT (combined PV-solar thermal panels). This was successfully demonstrated in the project: the heat pump on the farm at AUA is powered by PV. Heat pumps have proven to replace conventional technologies that provide thermal energy for both heating and cooling.[26] Policies to support the combination of renewable energy technologies in ways relevant to livestock farms are therefore needed.

Policy recommendations:

- *Connect islands to Greece's mainland grid to export surplus electricity and import electricity in times of shortage.*
- *Set up IPTOs as "one-stop shops" for licensing and grid connections*
- *Make it administratively as easy to install heat pumps or PVT modules as it is to install PV modules, with equivalently attractive incentives.*
- *Share best practices across Greece through a variety of means, including conferences, outreach campaigns, and news outlets.*

[25] The AUA pilot farm, like the rest of the AUA campus, is connected to the grid. The PV system installed as part of the project is not connected to the grid. The electricity produced by the PV system is used directly by the farm. When the PV production is not enough (or zero), the facility consumes additional grid electricity. On a yearly basis, approximately 85% of the electricity produced is consumed directly by the farm.

[26] Confined livestock farms in Greece have both heating and cooling needs. While winters in Greece are generally mild, several regions (particularly in the northern part of the country) experience low temperatures. Moreover, heating is required for very young animals, even if only for a few hours per day.

- *Promote the use of different kinds of renewable technologies in farms' energy supply, particularly if they are on weak grids where their choice of technology could have a direct impact on grid stability.*

National level

Escalating energy costs leading to higher costs of food and the need to meet other social aims like the protection of the environment and reduced dependence on energy imports make the case for RES incorporation into the agricultural sector clear. However, legislative barriers – including certification and approvals – can hinder RES installation.

Legislative

Government certification of agricultural facilities as using RES could be an effective incentive or marketing tool. If farmers are to invest in RES systems with high up-front costs, labelling their products as "produced with renewable energy" could be marketed in a way that appeals to consumers - even at a higher price. While standardisation and certification is an important regulatory process, it can also act as a burden to farmers, and therefore a hindrance to compliance. Streamlined, efficient certification and approval processes will be crucial to drive adoption.

Funding

Greece's modified recovery and resilience plan allows it to access Recovery and Resilience Facility (RRF) grants and loans worth €35.95 billion, part of which is going to solar energy projects, but the Greek agricultural industry would also certainly benefit from investment in other RES technologies. In any case, the RES4LIVE project would advise some of the solar energy projects to be focused on the agricultural sector. Subsidies can help offset the initial cost of installation (including equipment financing), but there are other funding aspects which can increase the uptake of renewables in the Greek agricultural sector. This includes tax exemptions or low-interest loans as well as financing secured on future energy savings.

Policy recommendations:

- *Invest in financing opportunities for the agricultural energy transition – including grants, tax exemptions and low-interest loans.*
- *Utilise EU funding programmes for a wider and more innovative variety of RES technologies – or develop systems using a combination of different RES technologies.*
- *Give priority licensing in farms/buildings for self-production (instead of cultivated areas).*

Socio-Economic Level

RES4LIVE's Greek workshops revealed that Greek farmers do not know who to turn to for information on RES technologies, funding, and certification procedures. Numerous consultants from the private sector work in the industry but farmers reportedly generally do not trust them as they feel consultants are more profit oriented than results-driven. For this reason, farmers would prefer public servants with

familiarity with the agricultural sector to explain their options to them. Due to a distrust of private sector consultants, farmers feel "lost" on how to become more resilient and sustainable. This trust – and in parallel, the receptiveness to renewable energy interventions on farms – varies with the age of agricultural producers. While younger individuals tend to be more open to RES installations, older farmers tend to be less interested. Many older farmers reportedly hoped that the younger generation would adopt RES technologies but feel that the younger generation has not yet taken up this challenge because of their cost. The steps illustrated above, particularly with regard to funding mechanisms and a toolkit of incentives and reliable consulting services, would assuage those concerns.

Policy recommendations:

- *The dissemination of information to farmers via trusted bodies like farmers' organisations*
- *Train more operators and installers of RES.*
- *Provide high-quality advisory services from a public body or via a farmers' organisation. The advisory services should include resources on RES technologies, assistance with acquiring funding (e.g., subsidy mechanisms available at both national and European levels), and advice on obtaining certification, licences, and permits. To provide a proper toolkit of incentives and services, the following steps should be taken:*
    - *Identify energy-intensive activities and systems: Assess which processes or systems consume the most energy (such as livestock farms) and understand how different management practices affect energy use. This can be achieved through energy audits as well as smart monitoring and control systems.*
    - *Recommend renewable energy (RES) or energy-efficient systems: Propose commercial or custom renewable energy systems or energy-efficient solutions that can be integrated into the facility or replace existing conventional systems.*
    - *Analyse renewable energy production potential: Evaluate the facility's potential for renewable energy generation and match it with the appropriate renewable energy systems.*
    - *Conduct a techno-economic analysis: Carry out a comprehensive analysis of the technical and economic feasibility of the proposed systems.*
    - *Facilitate technology sourcing and oversee installation: Provide connections to technology providers, manufacturers, and installers. Supervise the installation and commissioning of the systems to ensure proper setup and operation.*

2.6 PB06: Country-specific Policy Recommendations: Italy

The Challenge

Italy has the third biggest EU agricultural sector with an output value of €71.9 billion in 2023.[27] It has over 12 million hectares of Used Agricultural Land, over 900.000 farmers and at least 822 labels for regional products.[28] The livestock sector is a key segment of Italian agriculture, contributing to 28% of total EU farming output and 21.7% of the number of farms.[29]

The country's agricultural sector faces challenges. At least 28% of the Italian territory shows signs of desertification due to rising temperatures and droughts linked to climate change. Most of this land is in the south of the country, where desertification leads to soil erosion and loss of soil fertility that put at risk food production and farmers' livelihoods.[30] Regions in the north of Italy, meanwhile, have experienced irregular rain patterns and floods over the past years.

Another threat is the low and fluctuating prices of key products such as milk, cheese, beef and pork. Reasons for this vary, including the removal of milk production quotas and increased imports of meat products, which have contributed to low profitability across the sector. This in turn has created a lack of generational turnover in Italian farms, with the proportion of young farmers decreasing steadily. Price volatility also discourages farmers from making investments, thereby keeping productivity and incomes low.[31]

Renewable energy and sustainable farming practices can support farmers to tackle these environmental and economic challenges. For this, Italy needs the right policy measures and targeted investment.

Technological Level

Thermal management for livestock farms

Energy costs in Italy and the rest of Europe reached historic highs in late 2021 as the start of Russia's war on Ukraine approached.[32] While they have come down since then, natural gas remains expensive and farmers are likely to struggle to cover their thermal needs over the coming years.[33]

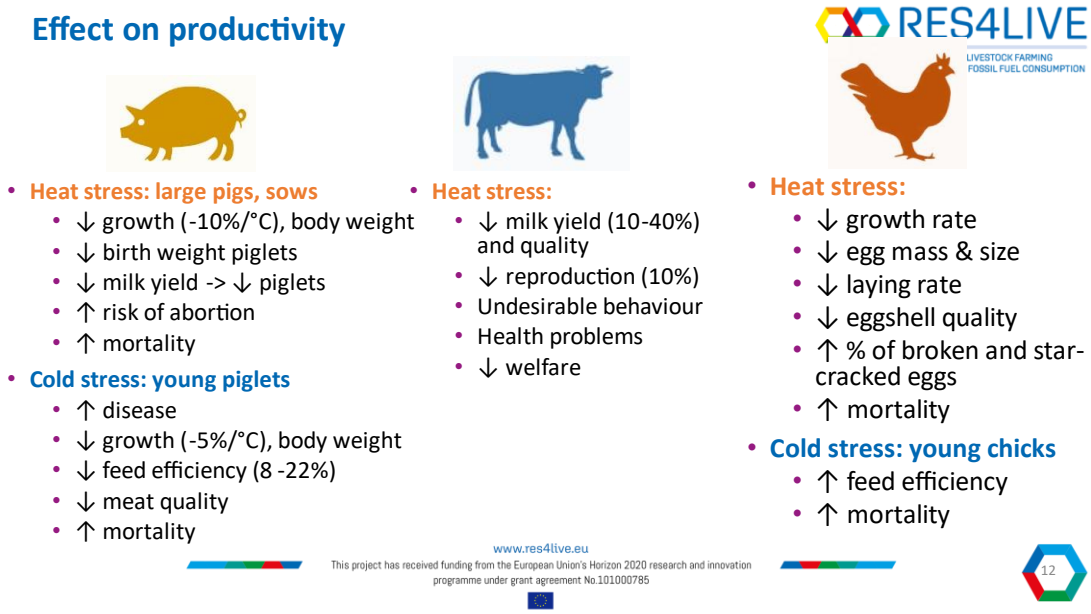
[27] Eurostat, 2024. Performance of the agricultural sector
[28] Terranova Horizon 2020 project. L'agricoltura Italiana in numeri
[29] European Federation of Animal Science, 2024 Agriculture and Animal Farming in Italy
[30] ISPRA, 2022. Press release on ISPRA study
[31] Presentation at RES4LIVE workshop by Marco Alberghini (Bologna, 2024). La Transizione Energetica negli Allevamenti: Problematiche e Prospettive
[32] Trading Economics, 2024. EU Natural Gas TTF
[33] Eurostat 2024. Natural gas price statistics

Inadequate thermal management in livestock farms decreases significantly both farming productivity and animal welfare (see graphic below). For fully grown pigs, cows and chickens, temperatures above 20°C are typically uncomfortable.

Two measures that can significantly reduce energy costs from heating and/or cooling for livestock farms are installing renewable energy in the farm and taking energy efficiency measures to improve the insulation and ventilation of barns. Some of the technologies that can enable farmers to be energy-independent are photovoltaic (PV) installations, photovoltaic-thermal (PVT) systems, biogas plants, heat pumps and wood/pellet boilers. Recovering and co-digesting manure has the added advantage of significantly reducing methane emissions from livestock rearing.

Livestock rearing has considerable thermal requirements that need to be within specific temperature ranges to avoid heat stress and cold stress. It is important to provide targeted support for livestock farmers to invest in insulation and sustainable heating systems to protect farmer's livelihoods and animal welfare. Investment for livestock farms should be earmarked in the post-2027 Italian Common Agricultural Policy (CAP) Strategic Plan, the upcoming Social Climate Fund that will support SMEs from 2027, as well as other relevant national and regional investment funds.

Figure 1: Effect of thermal management on rearing of pigs, cows and chickens



Source: RES4LIVE Workshop in Montichiari, Italy, 2022

Carbon farming

In addition to producing food and renewable energy, farming practices can also store organic carbon: using organic fertilizers, reducing tilling and planting deep-rooted crops can significantly increase the organic-rich topsoil layer. Livestock farming can make a sizeable contribution via carbon-rich manure, preferably after treating it in biogas plants. Adopting practices that improve carbon content in soil (so-

called "carbon farming"[34] – by which the stored quantities may be vast) can increase a field's fertility and its water retention capacity, thereby directly countering the effects of desertification. In this context, agriculture experts at the RES4LIVE project workshop called for policies from the Italian government that reward farmers for storing carbon in their soil.[35] To achieve this, it is necessary to define standardised methods to measure carbon content in soil over time, to fix carbon accumulation objectives and to link the latter to remuneration systems for farmers. The green architecture of the Common Agricultural Policy, in particular, Eco-schemes, can support carbon farming.[36]

Combining remunerated carbon farming with the production of food and renewable energy (biogas) can create more environmentally and economically resilient farms. These holistic land-management systems are likely to attract a new generation of skilled young farmers.

Policy recommendations:

- *Provide targeted financial support for livestock farmers to invest in insulation and sustainable heating systems, including biogas, solid biomass, PVT systems and heat pumps.*
- *Energy investments for livestock can come from the post-2027 CAP, the Social Climate Fund starting in 2027, as well as national and regional investment funds.*
- *Create a legal framework to support "carbon farming" that includes standardised methods to measure carbon content in soil over time, defined carbon accumulation objectives and linked remuneration systems.*
- *Use the CAP to support carbon farming.*

Government level

Renewable energy tenders

In August 2024, the long-awaited decree for the "Incentivisation of renewable source plants that are innovative or have high generation costs and low environmental and territorial impact" (FER II Decree) came into force. The law sets out the rules and annual rates of feed-in tariffs between 2024 and 2028 for innovative renewable energy technologies. The decree gives significant support to biogas (233 €/MWh) and solid biomass plants (246 €/MWh) with small to moderate sizes with electric capacities up to 300 kW that would fit well in many Italian farms. Farms with available water surface could benefit from tenders for floating photovoltaic installations on inland waters with 90 €/MWh for installations up to 1000 kW of electric capacity.

Two innovative technologies important for the farming sector that are missing and should be added to the FER II decree are agrivoltaics and PVT systems (see **PB02 Technologies**). We recommend making a limited review to add both technologies to the decree, ideally in time for the 2025 renewable energy call.

[34] Food and Agriculture Organisation. Global Soil Sequestration Potential (GSOCseq) Map
[35] RES4LIVE project workshop in Montechiari, 2022
[36] EU CAP Network, 2022. Policy Insights - CAP's Green Architecture components

Figure 2: Reference tariffs and conventional useful life of plants in FER II

Fonte rinnovabile	Tipologia	Potenza	Vita utile convenzionale degli impianti	Tariffa
		kW	anni	€/MWh
Geotermica	Tradizionale con innovazioni	Tutte le potenze	25	100
	A emissioni nulle	Tutte le potenze	25	200
Eolica	*Off-shore*	Tutte le potenze	25	185
Fotovoltaica	*Off-shore floating*	Tutte le potenze	20	105
	floating su acque interne	1<P≤1000	20	90
		P>1.000	20	75
Biogas	utilizzanti sottoprodotti e prodotti di cui alla tabella 1	1<P≤300	20	233
Biomasse	utilizzanti sottoprodotti e prodotti di cui alla tabella 2	1<P≤300	20	246
		300 <P≤1.000	20	185
Energia mareomotrice, del moto ondoso e altre forme di energia marina		Tutte le potenze	20	180
Solare Termodinamico		1<P≤300	25	300
		300<P≤5.000	25	240
		P>5000	25	200

Source: Decree FER II, 2024

Legislation on photovoltaics

In May 2024, the Italian government asserted the need to prioritise food production over other land uses, in the context of advancing land desertification by passing a decree introducing a "ban on the installation of new photovoltaic systems with modules placed on the ground and the increase in the extension of existing ones, in areas classified as agricultural". The ban does not include farmland with agrivoltaics, as the land can maintain its agricultural use and because the technology increases shading from the panels that helps to keep humidity in the soil.

To avoid reducing the deployment pace of photovoltaics in Italian farms, we recommend that the government move swiftly in 2025 and provide clear legal guidelines on how to deploy agrivoltaics and incentives to support this technology. We also advise that the government identifies suitable areas of non-agricultural land (i.e. areas not covered by the decree's ban) to build ground-mounted PV installations in line with REPowerEU.

Policy recommendations:

- *Undertake a limited review of decree FER II to extend favourable support terms to agrivoltaics and photovoltaic-thermal systems.*

- *The government should prepare clear guidelines and rules on agrivoltaics in 2026 (see* **Opportunities and barriers for renewables in the current CAP***).*
- *The government should identify and prioritise suitable non-agricultural areas to deploy ground-mounted PV.*

2.7 PB07: Policy Recommendations for Livestock Buildings

Challenge overview:

Livestock housing requires adequate indoor thermal conditions to maximise production and animal welfare, especially to avoid heat stress. However, the importance of building design and standards in creating good conditions has been underappreciated. Few building codes are available and even fewer are specifically developed to guide the livestock production buildings. Maintaining adequate indoor thermal conditions is essential for maximising livestock production and ensuring animal welfare, particularly preventing heat stress. However, the role of livestock buildings in influencing the indoor thermal environment has often been overlooked. In regions with highly variable weather conditions and significant heating and cooling demands, developing building codes to guide farmers make informed decisions is crucial when farmers are upgrading or renovating livestock buildings to improve building efficiency. As reported by Paris et al. (2022), 17% of energy consumption per kg of slaughter weight of pig meat was for heating.[37] Heating accounts for 90% of livestock buildings' energy consumption in Europe, followed by ventilation, lighting, and cooling.[38] Due to climate conditions and additional heating needs, energy use in livestock housing is also considerably higher in northern Europe compared to southern. These energy needs may be addressed with insulation on the walls and/or roof, using windows with a thermal break, more durable and sustainable materials, optimised building shape, and other techniques which do not compromise on animal welfare.[39]

Policy Recommendations:

There are a couple of overarching themes when it comes to improving policies surrounding building standards for livestock facilities. Firstly, funding to deploy good solutions widely is key. To make buildings energy- and cost-efficient through renovation, investment is needed. Public money will likely be needed if livestock sheds [or buildings] are to be upgraded on a large scale. Secondly, additional research is needed into designing livestock buildings for energy efficiency. This includes studying integrated design, ventilation systems, heating systems and lighting systems as well as considering the labour and financial costs of renovation. One of the practical challenges for livestock production houses, even in Southern Europe, is that there is no insulation on the roof. The added insulation on the roof can significantly reduce the impact of solar radiation on the indoor thermal environmental of livestock production houses and thus mitigate the heat stress in animals. However, how thick the

[37] Paris, B.; Vandorou, F.; Tyris, D.; Balafoutis, A.T.; Vaiopoulos, K.; Kyriakarakos, G.; Manolakos, D.; Papadakis, G. (2022) Energy Use in the EU Livestock Sector: A Review Recommending Energy Efficiency Measures and Renewable Energy Sources Adoption. Applied Sciences, 12, 2142.

[38] Costantino, A.; Fabrizio, E.; Biglia, A.; Cornale, P.; Battaglini, L. (2016) Energy Use for Climate Control of Animal Houses: The State of the Art in Europe. Energy Procedia 2016, 101, 184–191.

[39] Masi, Rosa Francesca De; Ruggiero, Silvia; Tariello, Francesco; Vanoli, Giuseppe Peter (2021) Passive envelope solutions to aid design of sustainable livestock buildings in Mediterranean climate. Journal of Cleaner Production, 311, 127444.

insulation should be for the roof or the entire barn for the diverse and dynamic climatic conditions across Europe should be studied individually. In addition, many building materials are available in the market. How to guide farmers to choose the most suitable ones is another consideration that the building code is needed. Finally, standards must be developed to optimise buildings through renovation.

EU level

- Create a publicly accessible database to categorise the options for building designs, building construction materials, ventilation systems, energy supply systems, and insulation materials. A clear database with building codes would aid farms in selecting the most suitable solutions for their location and budget.
- Develop clear standards for livestock buildings on certain aspects of design, e.g. on ventilation, sanitary conditions, and fire protection – particularly for newly built buildings or renovations.
- Establish a short- and long-term funded, multi-year renovation programme for upgrading the energy performance of livestock buildings (such as the renovation of public buildings in the EPBD), according to farms' needs.
- Create and implement an energy audit system to be used by Member States to reward the farmers' investments in energy-efficient livestock buildings either through direct funding or indirectly through tax exemptions.

National level

- Reward farms whose buildings have high energy performance to incentivise sustainable renovations.
- Training programmes for livestock building construction companies in the latest and best practices.
    - Promote training activities for farmers and advisors at national and regional levels, demonstrating the benefits of following the building code for improving energy efficiency, mitigation of heat stress in animals, and improvement of productivity.
- Alongside any EU-level support (see **PB01 Policy Recommendations for the Common Agricultural Policy**), there should be national-level public funding for upgrading/renovating livestock farms, such as grants or low-interest loans.
- Demonstrations of pioneer technologies that advance building insulation technologies to more mainstream accessible technologies for farmers. There is a need for pilot projects to test and demonstrate the economically sound and safe use of building envelope insulation to the agricultural sector and society. This would additionally create awareness among farms and farming organisations on the benefits of improving energy performance.
- Support research in sustainable construction materials, building structure, building design optimisation, and demonstration.

> Some regional governments in Italy have extensively funded the installation of heat pumps in livestock sheds, while others have not. A national-level programme would reduce regional disparities.

Expected impact:

- Overall primary energy consumption could be reduced by at least 40% across the EU by replacing old envelope designs with modern ones.[40]
- Improving the energy performance for climate control through the decrease of the overall consumption of thermal and electrical energy.
- Increased farm profitability as energy costs are significantly reduced while maintaining the same income per production and favouring the sustaining of the rural population.
- The probability of heat stress occurring will be greatly reduced and therefore production can increase while also improving animal welfare.
- Contribute to improving the environmental as well as the overall sustainability of the livestock sector.

[40] Costantino, A.; Fabrizio, E.; Biglia, A.; Cornale, P.; Battaglini, L. (2016) Energy Use for Climate Control of Animal Houses: The State of the Art in Europe. Energy Procedia 2016, 101, 184–191.

2.8 PB08: Policy Recommendations for Diversifying Farmers' Income

Challenge overview:

Farming is often idealised as a way of life, linked with notions of cultural heritage, landscapes, and quality food. Finances may not be the first thing that comes to mind when thinking about agriculture, but farmers are entrepreneurs and need to run a business.

Farming is an activity that is linked with significant economic risks, such as the volatility of international food prices and natural disasters. Additionally, the income of EU family farms is on average about 40% lower than the wages of employees in the whole EU economy.[41] Recently, Russia's war on Ukraine sparked a sharp increase in energy prices[42] that put the sector under pressure, with an overall increase in energy prices in agricultural production of 86% in 2022 compared to 2020.[43]

Producing renewable energy in farms can improve the income of European farmers by adding a new source of revenue and/or reducing energy costs. This paper will analyse technical aspects and business models to accelerate the deployment of renewable energy in farms.

Technical infrastructure

Better rural grid infrastructure

Europe is steadily urbanising, with cities concentrating around 75% of its population and 80% of its energy consumption in only 4% of its total surface.[44] Farms cover 46.4 % of EU land area[45] and together have a huge potential to produce energy from several renewable energy sources, such as bioenergy, solar energy, and wind. To harness this potential, it is essential to develop the electricity grid in urban areas, reinforcing it at the distribution level to allow for more deployment of in-farm renewables, and at the transmission level to move electricity from rural areas to urban centres.

ENTSO-e and ENTSO-g, the organisations representing European electric and gas grid operators respectively, regularly update their joint Ten-Year Network Development Plans (TYNDP)[46]. These plans identify grid infrastructure needs, based on their own energy scenarios to meet EU 2030 targets and climate neutrality by 2050. We recommend that the modelling teams of ENTSO-e and ENTSO-g consult relevant rural stakeholders and pay close attention to the deployment of renewable energy in farming areas, both for electricity and renewable gases.

[41] European Commission, 2024. Income support explained
[42] Trading Economics, 2024. EU Natural Gas TTF
[43] European Economic and Social Committee, 2023. Opinion on the impact of high energy prices on the agricultural sector and rural areas
[44] Eurocities, 2019. Part of the problem, part of the solution
[45] Eurostat, 2022. Farms and farmland in the European Union
[46] ENTSO-e, 2024. TYNDP 2024

Dispatchable renewable energy

The EU's renewable energy target of 42.5% in gross final consumption of energy by 2030 is expected to translate into 69% of renewable electricity in the electricity grid. More than 50% of the total electricity in 2030 is expected to come from wind and solar.[47] Since the start of the Russian war in Ukraine, natural gas is no longer generally seen as the safe bet for cheaply adding flexibility to the electricity grid that it once was. In this difficult international context, Europe needs to add a new capacity of domestic and carbon-free dispatchable power (in addition to energy storage capacity) to meet demand peaks and production valleys for electricity.

Farmers can play a role in stabilising the electricity grid by investing in renewables that can be ramped up on demand (either seconds or minutes till full load), such as biogas plants and some solid biomass plants. Public investment should prioritise the construction and repurposing of plants to operate in a setup that maximises flexibility. For example, a biogas plant that was designed to run continuously in a baseload setup (i.e. 24/7), can be retrofitted with an engine of six times the electrical output to operate on average 4 hours a day. While requiring more investment, adding power to the engine would allow its operator to fetch much higher prices in electricity markets, boosting its revenues. With the right remote-control technology, third-party traders can steer hundreds of small flexible units for a fee as a "virtual power plant" to fetch the best electricity market price for farmers.[48]

Policy Recommendations:

- *While preparing their TYNDP plans and scenarios, ENTSO-e and ENTSO-g should consult relevant rural stakeholders and pay close attention to the deployment of renewable electricity and biomethane from farming areas.*
- *More public investment to support the construction and repurposing of renewable plants to operate in a setup that maximises flexibility for biogas, biomass CHPs, and hydroelectric power.*
- *Provide public investment support to install remote-control technology in renewable energy plants to use them as virtual power plants.*

Alternative business models for in-farm renewable energy

Farmers do not need to work on their own. Just as millions of them have created powerful agricultural cooperatives in the past, they can also join forces with others now to deploy renewable energy. The agricultural sector can find synergies with energy consumers, project developers, and industry – among other actors – to bring in funding and expertise on clean technologies.

Renewable energy communities

Local energy communities can bring together citizens, businesses, public authorities, and other willing actors to design, finance, deploy, and/or operate renewable energy facilities for the benefit of the community. There are over 9000 energy communities across the EU, and there is potential to create many more. Energy communities can help to mobilise local resources and be used as legal structures

[47] Ember, 2023. EU member states target 66% renewable electricity by 2030, slightly short of the REPowerEU 69% goal
[48] Entsoe, 2024. Virtual Power Plants

to apply for financial support.[49] A legally-constituted energy community can sign Power Purchase Agreements, which are long-term energy contracts intended to give long-term price certainty to renewable energy producers and buyers.

The Renewable Energy Directive and the Internal Electricity Market Directive set the key principles for the setup and functioning of energy communities, with national legislation also applying to them. RESCoop, the European Federation of Energy Communities, prepared an online tracker assessing how the implementation is progressing for EU provisions on Renewable Energy Communities and Citizen Energy Communities (see Figure 1). We recommend that EU member states review their national policies for Renewable Energy Communities and integrate the changes proposed by RESCoop, including the following: support schemes that are adapted, fair and proportionate licensing procedures, removing unjustified regulatory and administrative barriers, capacity building for public authorities and providing accessible information for interested parties.

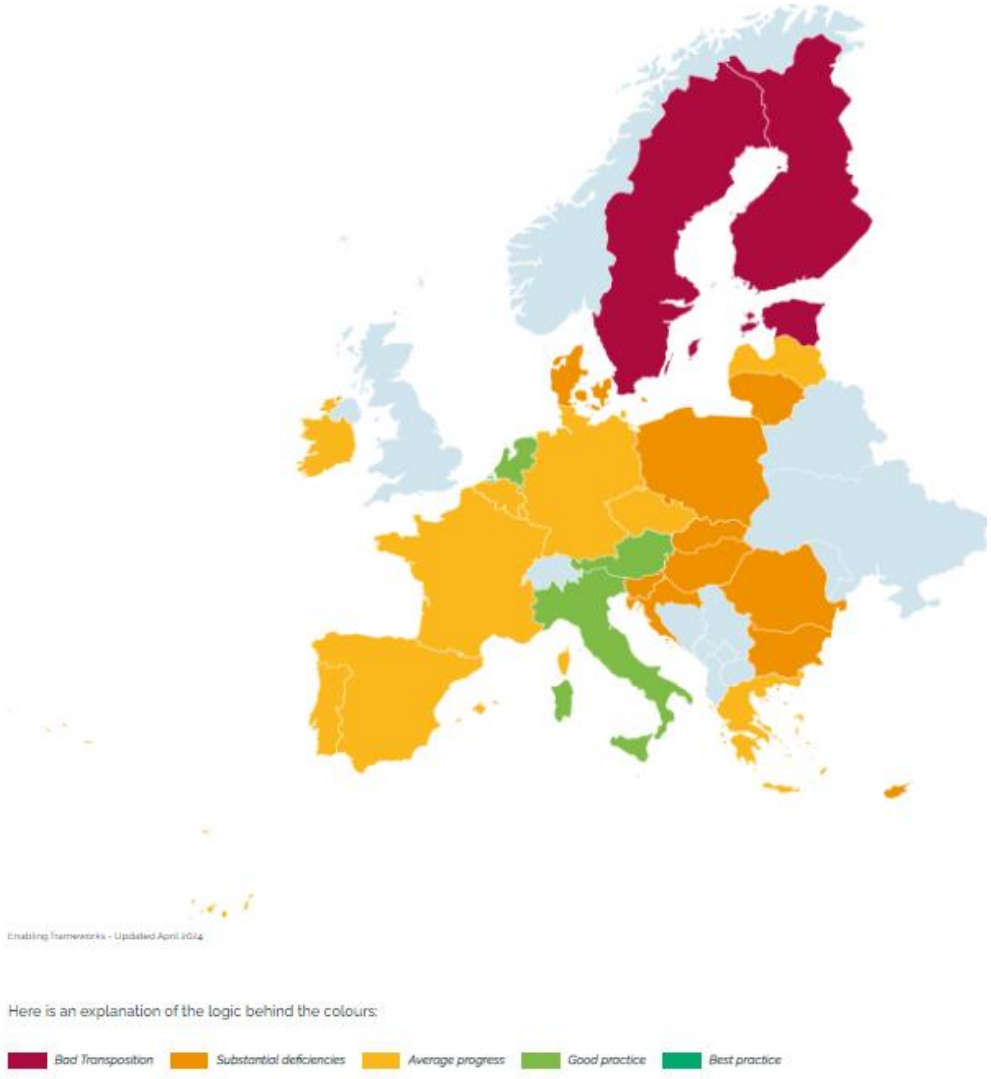
Energy communities can help farmers build renewable energy capacity such as wind and solar installations, hydroelectric power, biomass plants and geothermal facilities. We recommend that public authorities actively provide information to farmers on energy communities via the Farm Advisory System of the Common Agricultural Policy.

Contacts and practical information to create energy communities:

- The Energy Community Platform is a co-financed European project with best practices, technical documents, online tools and a funding guide.
- REScoop is the European Federation of Energy Communities, a network that brings together over 1.500 energy communities.

[49] European Commission, 2022. Energy communities to transform the EU's energy system

Figure 1: Transposition of Enabling Frameworks & Support Schemes for Energy Communities in EU countries.



Source: REScoop, 2022. Transposition tracker of energy community definitions

Third-party ownership

In-farm renewable energy installations may be owned by an entity that is not the farm itself, an arrangement that can suit a farm that lacks the funds to invest by itself. These entities could be developers, investors, or public institutions. As the owners, they would build and operate the plant (or contract these services from another party). Depending on the agreement, the host farmer may get energy at a preferential rate (usually under a PPA) or pay a lease for using the energy with the option to buy the installation at an agreed date. Third-party ownership is a well-known method to deploy

photovoltaic projects in the United States.[50] More recently, this business model has been tested in Europe in combination with circular economy approaches in the CIRCUSOL Horizon 2020 project.

Third-party capital can speed up the deployment of photovoltaic systems in privately owned land, provided that both farmers and investors find mutual gain. Projects should focus on non-productive areas, as well as combining food and energy production in agrivoltaic systems. We recommend that the European Commission provides guidance on how to use third-party ownership schemes to deploy renewable energy on private land.

Policy Recommendations:

- *EU countries should review their national policies on Renewable Energy Communities and integrate the changes proposed by RESCoop in its Transposition tracker.*
- *National and subnational authorities should actively inform farmers about energy communities via the Farm Advisory System of the Common Agricultural Policy and other available channels.*
- *The European Commission should provide guidance on how to use third-party ownership schemes to deploy renewable energy on private land.*

[50] United States Environnemental Projection Agency, 2024. Understanding Third-Party Ownership Financing Structures for Renewable Energy

3 CONCLUSIONS

The path toward defossilising the livestock farming industry is not only a crucial environmental imperative but also a significant opportunity for innovation and economic growth. This report has outlined a set of policy recommendations designed to ease this transition. While each policy brief addressed a different area, either with a regional, technical or legislative focus, there are key themes which emerge: skilling/reskilling workers, funding programs/financial assistance, streamlined certification processes, and expanded research initiatives.

First and foremost, developing a skilled workforce in renewable energy technologies is essential. Training programs must be established to equip current and future workers with the expertise needed to implement and maintain advanced renewable systems, including heat pumps, geothermal units, PVT systems, and other renewable systems. Cross-training tradespeople on several systems ensures a larger and more efficient workforce and will reduce installation costs. By fostering a knowledgeable workforce, the livestock sector will be well-prepared to adopt and integrate these technologies effectively.

Financial assistance is also vital to address the high upfront costs associated with the installation or renovation of energy-efficient systems. Policymakers should consider targeted funding mechanisms, such as grants or low-interest loans, to alleviate the financial burden on farmers. This support will encourage widespread adoption of renewable technologies and facilitate a smoother transition to more sustainable practices.

Additionally, simplifying certification procedures will significantly reduce barriers to entry for farmers looking to implement renewable energy solutions. Streamlined processes will not only save time and resources but also promote greater participation in sustainability initiatives.

Lastly, additional research projects are essential to explore new innovations and optimise existing technologies for the specific needs of the livestock sector. Investing in research will provide valuable insights and data that can drive further advancements – such as in building design – that will aid in the renewable energy transition.

By focusing on these critical areas, we can create a robust framework that supports the defossilisation of the livestock farming industry. Through collaboration between policymakers, industry stakeholders, and researchers, we can foster a sustainable future that not only benefits the environment but also enhances the economic viability of the livestock sector for generations to come.