RES4LIVE
ENERGY SMART LIVESTOCK FARMING
TOWARDS ZERO FOSSIL FUEL CONSUMPTION

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.[1] 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.[2] 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 with the aim of replacing fossil fuel consumption of certain needs in the pilot farms and proving 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

[1] https://climate.ec.europa.eu/news-your-voice/news/looking-how-mitigate-emissions-agriculture-2023-11-13_en
[2] 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.

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reducing carbon emissions. However, there are several ways that heat pumps could be better promoted.

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.*

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- *Establish guidelines and standards for the design, installation, and operation of heat pumps to ensure safety, reliability, and efficiency in the livestock sector.[3] There should be "best practices" regarding issues such 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).[4]*

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.

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

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$_p$.

[3] 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 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.
[4] 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.)

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for solar technologies (see Box 2). RES4LIVE showed that livestock farms have a high demand in 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.

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.*
- *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 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

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and relieve the growing grid congestion problem in the EU, where growing electrification will demand huge investments into 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),[5] 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.*
- *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 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.*

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

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- *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".[6] 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.

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

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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 be part of this emerging sector.*[7]
- *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.

[7] 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.

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