AgEnRes

Deliverable 1.1 Synthesis report on policy goals, measures and targets

Project acronym: AgEnRes

Project title: Analysing of Fossil-Energy Dependence in Agriculture to Increase Resilience against Input Price Fluctuations

Call: HORIZON-CL6-2023-CLIMATE-01-06

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Executive Summary

The Russian invasion of the Ukraine illustrated the susceptibility of the European Agricultural sector to fluctuations in energy prices and how a high dependence on fossil fuels and fossil energy-intensive inputs puts primary producers at risk. Against this background, the AgEnRes project ("AnalysinG of fossil-ENergy dependence in agriculture to increase RESilience against input price fluctuations) has the overall objective ***to design sustainable pathways for policy making to reduce direct and indirect dependence of farmers and the agricultural sector as a whole on fossil fuels and fertilisers and increase the resilience to fluctuating energy prices.***

This report (deliverable 1.1) is the first content-specific output of the AgEnRes project. Its key objective was to *elaborate on key relevant policy goals, measures and targets* relevant for the subsequent work in the project. In this effort, the analysis seeks to provide a thorough understanding of the *existing policy framework*; specifically, whether and how recent policy changes particularly under the EU's New Green Deal framework and related policies that work towards climate resilience and sustainability of the agricultural sector more or less directly address fossil fuel energy independence and resilience to price fluctuations. The policy analysis provides a useful *map of most relevant policies from EU to local levels* with a certain level of precision on the objectives of the policies as well as implementation modes and concrete measures and – where possible – reflections on possible consequences and effectiveness for behavioural change at farm level.

With the goal of providing a framework and high utility for subsequent work packages, the analysis in deliverable 1.1 employed a systems-approach to policy analysis within the shared understanding of system boundaries to 'on-farm' fossil energy use for identifying relevant policy interventions. Against this backdrop, the analysis of relevant policies is limited to interventions and measures concerning only the direct uses of fossil energy (transport, heating/cooling etc) as well as indirect flows of a certain magnitude (e.g. fertilizer, including policies that incentivise maintained use, e.g. price policies).

Moreover, the analysis seeks to reflect the peculiarities of country clusters while paying heed to the authoritative power of the overall EU regulatory framework (Section A), particularly under the EU Green Deal. Shared country clusters with task 1.2 are the basis for the case study approach employed to the analysis and elaborated on in section B, which identifies the different ways of implementation of the shared regulatory framework and implication for reaching energy independence in member states. Six case study country policy profiles are presented for 5 focus regions:

1. Poland
2. Western Europe: Netherlands & Germany
3. Southeast Europe: Hungary
4. Mediterranean: Greece
5. North Europe: Sweden

Figure 1 reflects the conceptual approach to multi-sectoral policy analysis of the multi-level governance system.

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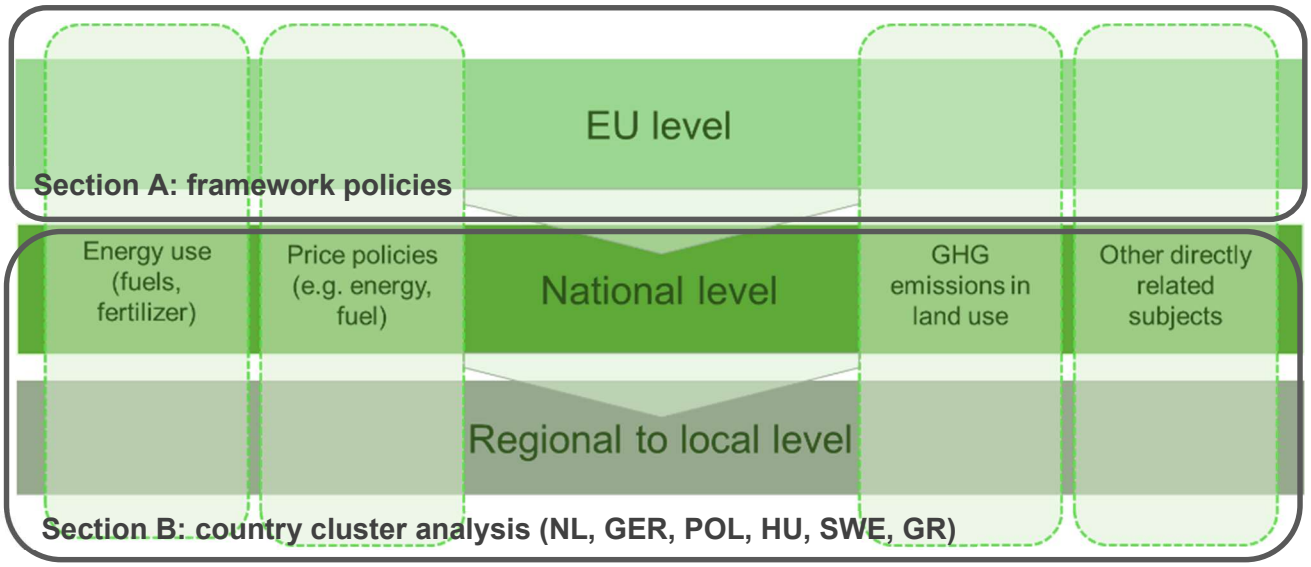

Figure 1. Key subject areas and policy levels for policy analysis in AgEnRes

(own figure, AgEnRes/FiBL CH)

For the mapping of relevant EU policies literature review methods with a content-oriented and qualitative approach was applied. Covering the full range of 'soft' and 'hard' policy measures at 'secondary legal order' from Directives and Regulations to Recommendations or Opinions EU-wide documents and publications were included in the review, from official reports, web pages on legislations, to journal articles of European Union bodies such as the European Commission and the European Parliament and legal text. The content-based scanning was purposefully complemented with expert and stakeholder engagement (with three workshops, two internally with experts and one with external stakeholders working with or on EU policies in the field) for ground-truthing as well as gap analysis in a rather novel policy field of EU policies *in the making*. The workshops served to specify *specific policies* on a broader long-list (policy map) of relevance in line with the research objectives. A short list of policies was carved out that address farming or on-farm energy use or production practices or allow reducing, substituting or avoiding fossil energy-based inputs or practices.

The results explore the short list covering "state-of-the-art policy goals, measures and targets at regional, national and EU level" and how these exert their relevance for energy independence. This short list is presented in two sections: **Part 1** with an analysis and presentation of the key targets of the EU framework policies. In this section, we elaborate on the major EU-level policies and respective policy instruments that in more or less direct ways are relevant for and address on-farm fossil energy use and dependency. Especially key EU framework policies are in focus under the Green Deal and its various packages ("e.g. Fit for 55" and corresponding Effort Sharing Regulation) and related strategies (Farm-to-Fork, Biodiversity) and specific (agricultural) regulations and directives (Climate Law with LULUCF, Renewable Energy, Energy Efficiency, Nitrate and Sustainable Use Directives) and policies (esp. Common Agriculture Policy) that translate these frameworks into actionable legal measures applicable to all member state. Beyond that, action at EU level is of importance (including in soft forms) that sought to respond to the war in Ukraine and energy (price) fluctuations (esp. REPowerEU Plan).

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Most of the EU policies in the policy map (see figure 2) are according to stakeholders and literature prominent, but still rather guiding political frameworks that spell out joint strategies and direction in the broadest sense, partly with more or less explicit or legally binding objectives and concrete targets.

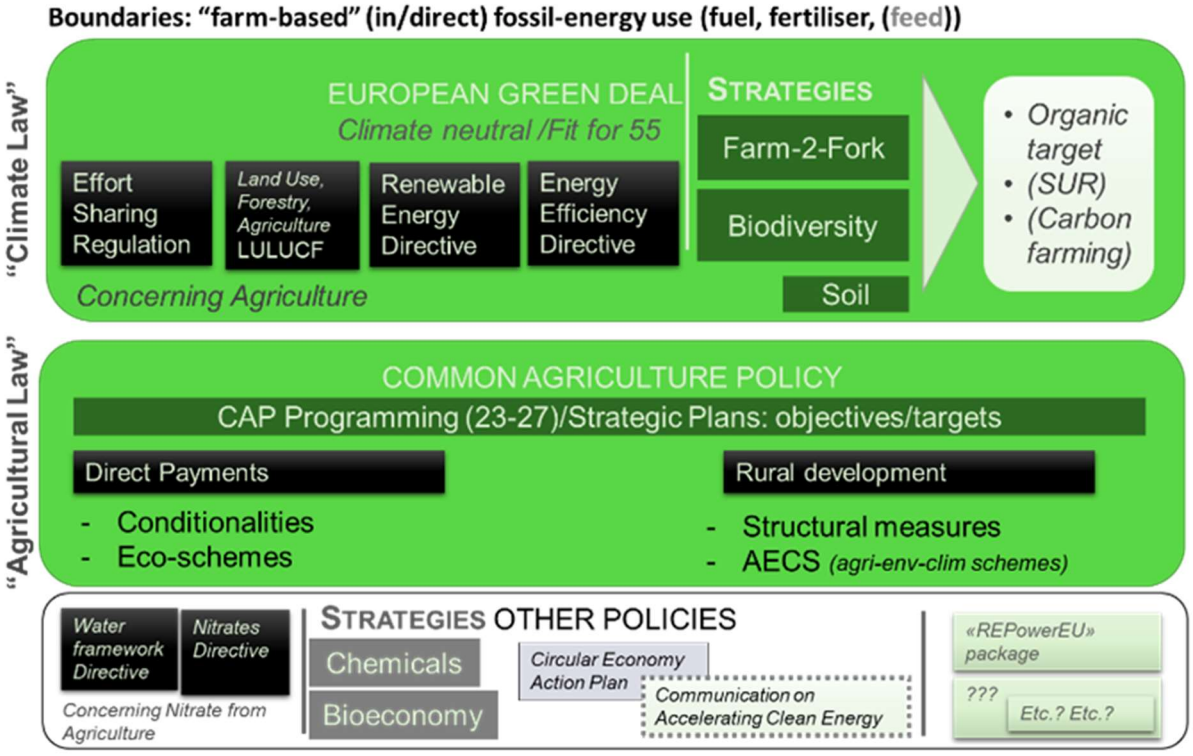

Figure 2. Preliminary EU-Policy Map

(own figure, AgEnRes/FiBL CH)

Expressed in concrete numbers, relevant targets for 2030 (esp. under the Fit-for-55, F-2-F and Biodiversity framework) are:

- **>55% less net GHG emissions by 2030**
- **25% target of organic by 2030**
- **Reducing nutrient loss from fertilisers by at least 50%**
- **Reducing fertilisers by 20%**

Moreover, and in very concrete numerical terms, the **Energy Efficiency Directive** foresees an overall **reduction target of 32.5% in energy use for 2030**, as compared to projections for the EU-wide reference scenario for 2020. There is a certain black box what this target implies for the agricultural sector exactly, though. Regarding the share of renewable energy in the EU, the **Renewable Energy Directive** sets a **binding target of 42.5% for 2030,** and an **ambition to reach 45%.**

The **Common Agriculture Policy** is surely the most significant policy framework in support of agriculture across Europe and at least indirectly a key vehicle also for the implementation of the European Climate Law or the EU Green Deal more generally, including the Farm-to-Fork and Biodiversity Strategies' objectives. Several measures under pillar 1 (eco-schemes) and pillar 2 (Agri-environmental-climate measures and investment programmes), although of a voluntary nature, have a key relevance for supporting farmers in transitioning to more sustainable, fossil energy-free or

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reduced practices. The most prominent set of measures are allowing for achieving the core objectives of CAP along the lines of:

- Farm modernisation incl. resource (energy) efficiency (Indicator R.9)
- Renewable energy production capacity (Indicator R.15)
- Investment in production of renewable energy or biomaterial (Indicator R.16
- Sustainable /improved Nutrient Management (Indicator R.22)

However, member states are free to choose concrete measures for CAP implementation in their countries in line with their policy priorities and they may also choose to not address certain priority areas, leading to certain inconsistencies between countries.

Against this background, **Part 2** analyses the country experiences and explores in more detail how the framework policies are principally implemented in country contexts. It illustrates how specific targets are translated. Where possible the report reflects on the 'forcefulness' of EU frameworks towards the objective of achieving fossil energy independence on farms in practice in specific contexts.

In order to allow for cross-country comparison, the analysis of national (and possibly sub-national) was organised around the EU framework policies elaborated in Part 1 (European Green Deal, particularly Effort Sharing Regulation, LULUCF/AFOLU, Renewable Energy Directive, Energy Efficiency Directive, Farm-to-Fork Strategy, Biodiversity Strategy and particularly agricultural Policy under CAP), as concerns the incentivisation of fossil energy, animal feed or fertiliser use reduction or renewable energy application including through precision farming, support of the transition to organic farming and how they are covered in recent CAP Strategic Plans. A concrete focus was on specific measures under pillar I or pillar II payment schemes, like eco-schemes or agri-environment-climate measures or organic support programmes more generally. National partners that supported data collection and analysis were, as far as possible, elaborating on policies that concern reductions in use of fertiliser or fossil fuel or other fossil energy-based inputs in more indirect ways, e.g. through policies responding to the Nitrogen or Water Directives. A special focus was on national responses to the price fluctuations for fossil energy (based) inputs in the context of the Ukraine war which was hardly spelled out at EU level.

The case studies (Part 2) confirm the impression from section 1 regarding the high relevance of particularly the *climate related measures* (RE and EE Directives) that seek to support and spur the application of renewable energy and energy efficiency in all sectors, though typically not with a *particular* focus on the agricultural sector, which may in some cases deserve more attention. Moreover, there are considerable measures (most importantly the eco-schemes and rural development support schemes with agri-environmental climate measures) in place under CAP that play a principal role for reaching the objective of energy independence.

High variances exist between the countries in terms of uptake rates and implementation design, though (e.g. results based vs activity based). Also, the voluntary nature of most measures limits, to a certain extent, the possible leverage force towards energy independence. In numerous countries the activities are not used (yet) at broad scale because of the complexity or novelty of the measures but also the fact that the financial incentives seem to not outbalance the additional effort or income forgone, amendments of the systems are already seen in the first year of the CAP programming period. Their effectiveness seems undermined by the recent amendments of the conditionalities for basic income support under pillar 1. Eventually, energy independence is no genuine objective present in CAP in its own right, and only indirectly presented and translated fairly indirectly through other

objectives (in relation to climate change, environmental, rural development) adding to the inconsistencies.

Moreover, other national subsidy systems in place counteract efforts in the sector to become fossil-free or at least increase independence and resilience. All countries have some sort of energy subsidy in place with tax exemptions or reimbursement either for the agricultural sector or all energy consumers. These create perverse incentives to continue consuming (or even increasing consumption of) fossil fuels and may therefore cement rather than address fossil energy dependence in the agricultural sector. Often meant as an immediate “relief from price surges” in the context of the energy crisis and farmer protests, only in exceptional cases (like Germany) a will can be seen to remove climate-destructive subsidies. Playing into this incoherence, countries have seen their governments moving further ‘right’ in the political spectrum more recently which spurred according to expert opinion a certain loss in policy commitment. A situation of political volatility creates additional risks to sustainable investment and may impact on farmers’ willingness and interest in changing farming practices.

Overall, numerous policies at EU to national level are highly relevant for further developing and promoting, but may also hamper, the uptake of promising technologies to reach fossil energy independence and GHG emissions targets. For the further work in the project and subsequent work, the analysis has helped identify these key policy interventions of direct or indirect relevance to farm-level practice and behaviour in relation to fossil-fuel uses, including risk considerations. For policy, the analysis helped identify pertaining political blind spots, limitations and inconsistencies in policy frameworks, but also the practical challenges in political realities of implementing member states for achieving energy independence in the sector.

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List of Acronyms

AB	Advisory Board
AECM	Agri-environment-climate measures
AECS	Agri-environmental climate schemes
AFOLU	Agriculture, Forestry, and Other Land Use
AÖP	Agro-Ecology Programme
AUKM	Agri-environment-climate measures
AKG	Agri-environmental Management
BÖL	Organic Farming Research Programme
BMEL	Federal Ministry of Food and Agriculture
BLE	Federal Agency for Agriculture and Food
CAP	Common Agricultural Policy
CO2	Carbon Dioxide
CSP	CAP Strategic Plans
DAPEEP	Renewable Energy Sources Operator and Guarantees of Origin
DEYAs	Municipal Water and Sewerage Utilities
D	Deliverable
DoA	Description of Action
EAFRD	European Agricultural Fund for Rural Development
EAGF	European Agricultural Guarantee Fund
EC	European Commission
EE	Energy Efficiency
EEG	Renewable Energy Sources Act
EED	Energy Efficiency Directive
EKF	Energy and Climate Fund
EIP-AGRI	European Innovation Partnership 'Agricultural Productivity and Sustainability'
ESD	Effort Sharing Decision
ESR	Effort Sharing Regulation
ETS	Emissions Trading Scheme
EU	European Union
EUR	Euro
FAQ	Frequently Asked Questions
F-2-F	Farm to Fork Strategy
FAKT	Support Programme for Agri-environment, Climate Protection, and Animal Welfare
GAEC	Good Agricultural and Environmental Conditions
GAK	Improvement of Agricultural Structures and Coastal Protection
GLÖZ	Standards for Good Agricultural and Environmental Conditions of Land
GHG	Greenhouse Gas
GOEV	General Organization for Land Reclamation
ha	Hectare
HDÚ	National Decarbonisation Roadmap

HUF	Hungarian Forint
IPM	Integrated Pest Management
KPEiK	National Energy and Climate Plan
kW	Kilowatt
LULUCF	Land Use, Land Use Change, and Forestry
MA	Ministry of Agriculture
MFF	Multiannual Financial Framework
Mtoe	Million tonnes of oil equivalent
MW	Megawatt
NAP	National Action Plan
NAS	National Adaptation Strategy
NECP	National Energy and Climate Plan
NGO	Non-Governmental Organization
NOAP	National Organic Action Plans
NVZ	Nitrate Vulnerable Zone
NPK	Nitrogen, Phosphorus, and Potassium
ÖKO	Ecological Management
OTAs	Local Government Authorities
R&D	Research and Development
R&I	Research and Innovation
RED	Renewable Energy Directive
RES	Renewable Energy Sources
RRF	Recovery and Resilience Facility
SCT	Special Consumption Tax
SGD	Sustainable Development Goals
SMEs	Small and Medium-sized Enterprises
SOC	Soil Organic Carbon
SP	Strategic Plan
TAO	Company Tax Allowance
TOEV	Local Organization for Land Reclamation
UAA	Utilised Agricultural Area
WAM	with additional measures
WEM	with existing measures
WP	Work Package

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Introduction

The Russian invasion of Ukraine has dramatically shown the dependence of the EU agricultural sector on imported fuels and mineral fertilisers. For 30% of the nitrogen consumed, as well as 68% of phosphates or 85% of potash nutrients, the EU depends on external imports. Large quantities of natural gas are needed to produce especially nitrogen fertilisers, whereas the generally high energy costs for companies across Europe have led fertiliser companies to significantly reduce their production. In consequence, the prices for fertiliser products for EU farmers have increased on average by 149% in September 2022 compared to September 2021(European Commission, 2022a). Fluctuating and high prices of fossil fuels and mineral fertilisers in combination with a reduced supply of fossil-based inputs are a major threat for income security of primary producers as well as food security and affordability for consumers (European Commission, 2022a). While considerably improving the resilience and income of primary producers, the reduction of greenhouse gas emissions and efficient use or even substitution of (fossil-based) inputs also poses an important contribution to address the climate change issue and for realising the objectives set out in the European Green Deal.

Project objectives of AgEnRes

Transitioning away from the use of fossil fuels and energy-intensive inputs is critical for the economic and environmental sustainability of the European agricultural sector. This transition towards fossil fuel independence and less fossil-fuel-intensive technologies in the EU agricultural sector will need time and investments. In particular, there is an urgent need to design pathways for the energy transition of the European agricultural sector in ways that are feasible in practical and normative terms and sustainable, accordingly. Against this background, the AgEnRes project (“AnalysinG of fossil-ENergy dependence in agriculture to increase RESilience against input price fluctuations) has the overall objective:

“to design sustainable pathways for policy making to reduce direct and indirect dependence of farmers and the agricultural sector as a whole on fossil fuels and fertilisers and increase the resilience to fluctuating energy prices.”

Specifically, this overall objective AgEnRes aims at creating sustainable pathways that decrease the agricultural sector's reliance on hydrocarbons and that increase resilience to fluctuating energy prices In line with core ideas of the European Green Deal the project allows considering economic and environmental goals at both the micro and macro levels. Specifically, it delivers key insights how to enhance the economic, environmental, and climate performance of farming systems.

The project is organized around five sub-objectives that allow achieving the general project objective:

1. To develop analytical tools and capacity to integrate the use of fossil energy and energy-intensive inputs in modelling and in socio-economic analysis at various scales
2. To improve decision-making at farm level in relation to the use of energy and energy-intensive inputs, in particular mineral fertilisers
3. To improve capacity of the farming sector to cope with variations in the price of energy and energy-intensive inputs
4. To develop effective interventions and policy instruments to mitigate variations in the price of energy and energy-intensive inputs in agriculture

5. To ensure the governance and future use of the AgEnRes model toolbox, including an Intellectual Property Rights (IPR) legal framework for the partners and a mechanism aimed at including new partners in the years to come

Organization of work in the AgEnRes project

In line with the objectives, work is organized around three key components (cf. figure 3).

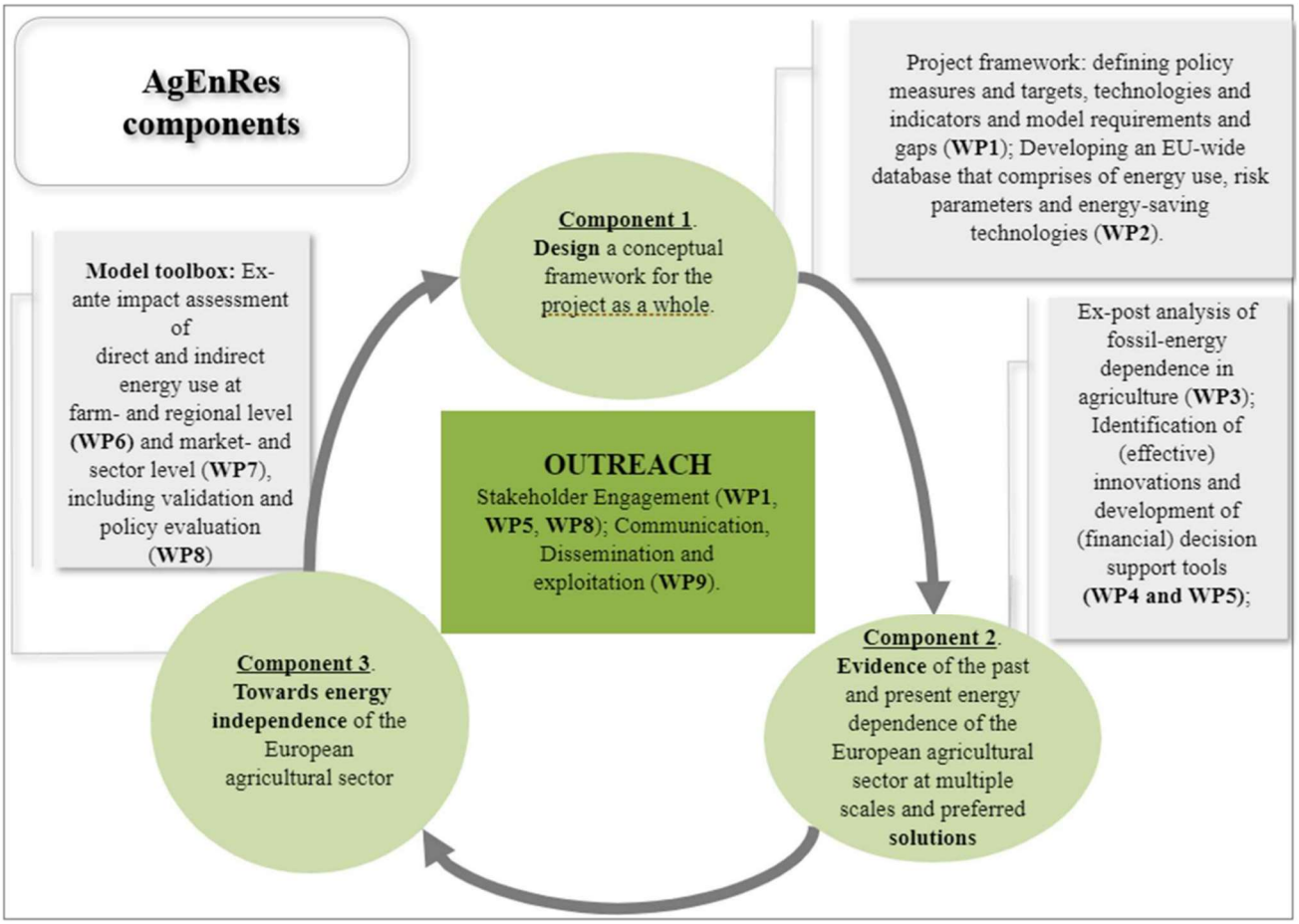

Figure 3. Key components of AgEnRes

(project consortium)

Component 1 designs a conceptual and data framework. The conceptual framework (WP1) identifies policy targets and measures, most promising technologies to reduce energy dependency and indicator, data and model requirements and gaps. The data framework (WP2) consists of an energy use (focusing on fossil fuels and fertilisers) accounting system as well as an EU-wide database on the selected energy-saving technologies.

Component 2 identifies evidence and solutions based on observed data at different scales and behavioural economics experiments at farm level. In this effort component 2 focuses on the evidence of the past and present energy dependence of the European agricultural sector at multiple scales in WP3, and preferred solutions in WPs 4 and 5.

Component 3 develops, integrates and tests data, models and tools at different scales. Component 3 builds on components 1 and 2 and incorporates them into a set of foresight models at farm,

regional and market level to permit ex-ante evaluation of the impacts of innovations and policy measures and targets at different scales.

About this report (Deliverable 1.1: Policy Analysis)

This deliverable is the first content-specific output of the AgEnRes projects and elaborates on key relevant policy goals, measures and targets. It provides the – policy related – framework for the subsequent work from ex-post analysis of fossil independence in the sector to foresight models at farm, regional and market level that would also permit ex-ante evaluation of the impacts of certain policy measures and targets at different scales. For this effort it key to understand the existing policy framework; specifically, whether and how recent policy changes under the EU's New Green Deal framework, and beyond, that seek to foster the climate resilience and sustainability of the agricultural sector do also more or less directly address fossil fuel energy independence and resilience to price fluctuations.

Work package 1

The analysis at hand marks an integral part of an overarching conceptual and data framework for the subsequent work in AgEnRes. The conceptual framework to be provided in work package 1 comprises of three interrelated components that will allow for streamlining the further work in AgEnRes in separate working packages, allowing integrating data and key results:

1) A comprehensive short-list of specific policy objectives, targets and measures that are most relevant for achieving energy independence and resilience to price fluctuations (task 1);

2) A final short list of key innovations and technologies that are most promising as basis for assessing and allowing future deployment of on-farm solutions reducing energy dependency (task 2); and

3) An overview of the key indicators as well as data and model requirements and gaps that allows to monitor and evaluate the identified policy targets and measures (on energy use, energy efficiency and price fluctuations) as well as global drivers at different scales (task 3).

The three components are intricately interlinked and together provide a coherent approach to reaching the project objective. Policies are highly relevant for further developing and promoting, but may also hamper, the uptake of promising technologies to reach fossil energy independence and GHG emissions targets. Likewise, a thorough assessment of the available options for technological innovation for overcoming energy dependency is important as to identify the relevant policy frameworks behind current technological lock-ins or to allow energy transitioning. However, there is a need to specify key indicators to judge current and evolving policies and farm level innovations in terms of their actual contribution to energy independence and resilience. These indicators may build on and further develop the Common Agricultural Policy (CAP) indicator framework (highlighting context, output, result and impact indicators) and therefore allow to consider also general, politically relevant objectives in relation to GHG emission reductions and climate neutrality. In the working package, the team working on the different task 1.1-3 has therefore installed highly collaborative working routines that ensure co-designing in the analysis.

Analytical Framework and Method

The work in AgEnRes is oriented at identifying feasible pathways for achieving a higher independence from fossil-energy inputs and resilience from respective price fluctuations for farmers in Europe. In line with a system-thinking approach to transforming the agricultural system, policies that target decisions at farm level play a critical role as levers. These may, for instance, concern opting for energy-efficient technologies or substituting fossil fuel with renewable energy sources. The analysis of relevant policies is focused at the objective to provide a thorough and useful map of the most relevant policies from EU to local levels in a way that is precise about the objectives of the policies but also about implementation modes and concrete measures. Where possible the analysis should be sufficiently clear enough about possible consequences, e.g. behavioral change at farm level. This way this analysis assures utility for subsequent work packages focused at modelling and impact assessments. Apart from primary sources such as the legal provisions themselves, empirical studies but also anecdotal evidence (e.g. input by stakeholders) that help shed light on policy implementation and behavioral change at individual farmer level play an important role.

The analysis at hand is confronted with a set of analytical challenges that have been discussed within the consortium in a series of online and live workshops between February and March 2024. In the interest of producing practically and politically useful as well as analytically sounds results the following pragmatic approach has been chosen in addressing them:

Boundaries: Agricultural and food systems are highly complex with a multiplicity of 'energy-based' connections between sub-components and -processes, especially along value chains. Considering that even policies with no explicit fossil energy focus may impact on the use of fossil energy or resilience to price fluctuations at farm level – in indirect ways – it is important to draw clear boundaries beyond which policies may be considered principally negligible. Therefore, in the context of this study we will not elaborate on policies that only very indirectly may impact on independence or resilience, like social policies that help ensure social security specific recipients (e.g. families). In line with the research question, and in close collaboration with task 1.2 and the overall consortium, the AgEnRes approach is to focus on policies that concern decisions at farm level that explicitly relate to the direct use of fossil energy or fossil-energy based inputs as well as policies that specifically focus on price fluctuations of fossil energy in the agrarian sector or more generally.

On-farm fossil energy use and dependence

In terms of relevant energy sources as a focus of political interventions, there are a variety of direct or indirect energy inputs to be considered in the energy bill (see overview in figure 4).
From a farm-level perspective, fertiliser use poses the activity in EU agricultural practice with the highest indirect fossil energy use. Despite this indirect relevance, it accounts for around 50% of *all* energy input, followed by on-farm diesel use (31% of total energy input). In comparison, just about 5% of all total energy input concerns the production of pesticides and seeds, and another 8% of the energy is used for processes related to management or processing, such as irrigation, storage or drying. According to this balance around 55% of the total energy-related inputs (production of fertilizers and pesticides) occur outside the individual farm and are only indirectly consumed by farmers (Paris et al., 2022). However, this energy bill does not apply equally to all production types. Most of the "energy load" of nitrogen in fertilizer actually occurs in cereal production (55%) followed by grasslands (18%), oil seeds (10%) and fruits and vegetables (4%). A similar order of the shares is seen in phosphorous (cf. Was et al. 2024, AgEnRes Deliverable 1.2).

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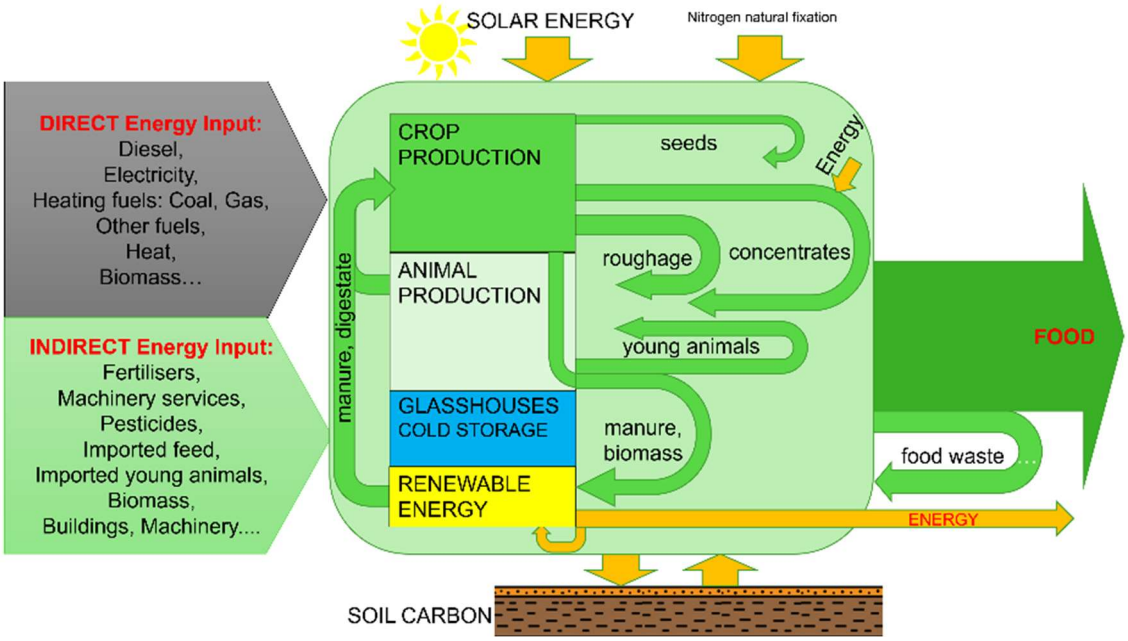

Figure 4. Conceptual framework of energy flow in agriculture at sector scale

(Was et al. 2024, AgEnRes Deliverable 1.2)

Beyond type of farm and corresponding production methods, energy dependence is also a matter of size. As a matter of scale, energy consumed through fuel combustion, for instance, is in absolute terms highest on large farms, however, also more efficient in comparison to medium or small sized farms because of economies of scales and the fact that more efficient and modern machinery is applied on large farms (cf. Was et al., 2024, AgEnRes Deliverable 1.2). On average, a considerable amount of energy (mainly diesel consumption) is used for tillage, harvesting and crop maintenance. However, regional variation exists: While overall a minor source of fossil energy use, irrigation is of critical importance in Mediterranean countries but also in Western European countries, like the Netherlands.

Considering the magnitude of the actual indirect and off-site energy consumption and the high dependence of farmers on fertiliser use, the analysis seeks to explicitly consider policies that concern the respective processes in relation to energy use in fertiliser and pesticide production as much as possible. Beyond that the major focus will evidently be on fossil-energy-free technologies and strategies at farm-level in particular in relation to energy efficient applications or substitution through renewable sources of energy.

Context dependency: There are considerable limitations for simplified cross-country generalizations and extrapolation from one implementation realm to another. Policy effects seen in one context may not necessarily play out in the same way in a context with an entirely different institutional, socio-economic or ecologic context. EU countries differ considerably in terms of how farming is done in line with their ecological conditions, socio-economic capacities and historical trajectories of developing the sectors (e.g. post-socialist societies). This translates into different levels and types of susceptibility to energy price fluctuations.

Various context specific factors determine to what extent and how fossil energy at farm site may be easily substituted or effectively reduced, most notably:

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1. Average size of farms (e.g. with distinct levels of mechanisation and energy use)
2. Climatic conditions (e.g. impacting on the need for cooling, heating or irrigation)
3. Types of farms/farming practice (e.g. high energy crop or horticulture systems vs low energy input vinery)

In AgEnRes we have identified country clusters that reflect a certain production and energy consumption "profile" with specificities that more or less directly determine to what extent and in relation to which practices agriculture is fossil energy dependent in these countries (see Table 1 and Figure 5-6). Western Europe and the Mediterranean, for instance, hold responsible for two thirds of the overall energy costs in agriculture in Europe. Except for Austria, Slovenia and Ireland (highly livestock oriented production), field crops have by far the most important role in the energy bill of farmers in most regions, however, with varying degrees, when seeing it inside the full portfolio of production types. Field crops are most significantly adding to the energy bill in Southeast Europe (SE: 62%), followed by North Europe (NE: 41%) and Poland (39%). Countries with vast grasslands, like Great Britain, Ireland, Austria or Slovenia have a relatively low energy consumption even where agricultural land is still of significance in terms of area. In fact, the combination with livestock creates the possibility of using manure for fertilising crops and makes countries less dependent on mineral fertilisers.

Table 1. Share of total EU energy cost in specified farm type and regions (clusters)

(adapted from: Was et al. 2024, AgEnRes Deliverable 1.2)

% of total EU energy cost in specified farm type and regions (clusters)							
Farm type	WE*	SEE*	CS*	NE*	ME*	ASI*	PL*
	% of total EU energy cost per farm type & clusters						
(1) Field crops	11.2	5.9	1.1	2.4	7.5	0.5	3.6
(2) Horticulture	6.4	0.4	0.0	0.5	1.7	0.0	0.9
(3) Wine	1.4	0.1	0.0		1.8	0.1	
(4) Other permanent crops	0.8	0.2	0.0	0.0	4.4	0.0	0.3
(5) Milk	9.4	0.7	0.4	1.4	2.1	1.2	1.4
(6) Other grazing livestock	5.0	0.5	0.3	0.9	2.7	1.0	0.3
(7) Granivores	4.7	0.4	0.2	0.1	1.9	0.2	1.2
(8) Mixed	5.4	1.1	1.2	0.5	1.2	0.3	1.5
TOTAL (%)	44.3	9.5	3.2	5.8	23.4	3.4	9.3

*WE (Western Europe); SEE (Southeast Europe); CS (Czechia & Slovakia); NE (North Europe); ME (Mediterranean); ASI (Austria, Slovenia, Ireland); PL (Poland)

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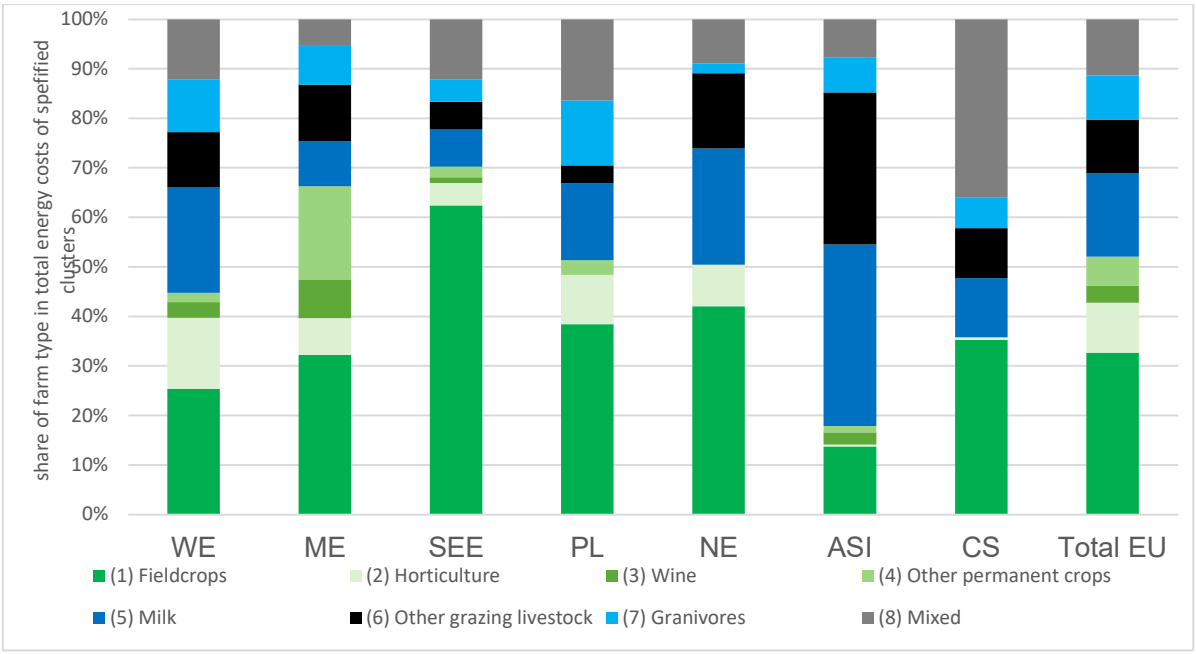

Figure 5. Conceptual Structure of energy costs by production type in specified regions (clusters)

Source: Was et al. 2024/Deliverable 1.2

Figure 6. AgEnRes country clusters

(Source: Was et al. 2024, AgEnRes Deliverable 1.2)

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Zooming further into specific production types, the picture may dissolve even further. For the sub-type of protected crops, for instance, production plays a minor role in Scandinavian/Northern countries (colder temperatures /limited sunlight detrimental to greenhouse cultivation) in comparison to southern countries. These also benefit from favourable climatic conditions in a way that energy for heating can be reduced considerable compared to, for instance, countries like the Netherlands that have extensive Greenhouses but less favourable conditions.

In line with the differences seen across these different regions in reference to the (combinations of) different production types for energy dependence, the policy analysis at hand has a dedicated national case study section (Part II) which will elaborate on the implementation of specific relevant EU policies for five focus regions. The following cluster representatives are chosen:

1. Poland
2. Western Europe: Netherlands & Germany
3. Southeast Europe: Hungary
4. Mediterranean: Greece
5. North Europe: Sweden

European member states share and are in their policy implementation not independent from the supranational EU frameworks why a considerable part of this report is dedicated to clarifying this shared EU-level legal framework first. However, country level analyses will allow getting a more nuanced picture of how the implementation of these policies varies at national and sub-national levels in line with national peculiarities.

Policy maturity: With regard to the shared EU-level legal framework, it is important to note that numerous of the policy packages tied to the rather recent European Green Deal framework, and although partly highly relevant, are still only "*in the making*". It is not perfectly clear how they will be implemented concretely at country or lower policy levels in some cases. With policies being still in their infancy, the analysis at hand is faced with principally considerable limitations to *infer* on the effectiveness – or let alone longevity – of policies. Adding to the situation, limited data is available for reporting or monitoring of specific relevant policy measures, like the new CAP programming that just started in 2023 and will not be ending before 2027. In AgEnRes we apply a pragmatic approach to handle those analytical limitations. This may mean to triangulate EU-wide targets and directives with "bottom up information" concerning specific local to national policies that have already addressed the issues reflected in the new framework regulation – without necessarily being a response to this framework. Moreover, earlier phases of relevant programmes may allow gaining a first idea of key avenues but also major hurdles for implementation of new targets. Past programming periods will be drawn on wherever useful and as to gain an idea of the hurdles and opportunities for effective implementation. With this approach the project may generate insights that may as well be fed back into ongoing policy revision processes, increasing the utility of the project for policy makers.

For identifying *future political interventions* to significantly improve fossil energy use efficiency or even reach energy independence, it is useful to consider possible alternative technologies and tools that may be used by farmers as real alternatives to current practice or as means to reduce the energy intake or through-put, such as precision farming. The idea is that the economic resilience of farmers may be increased by reducing energy consumption, and by that improve economic efficiency. A broad set of agricultural practices, and corresponding policy recommendations to be adopted, e.g. for CAP related measures, has been identified such as: promoting renewable energy sources, implementing

energy-saving technologies, improving fertilizer management, improving crop rotation practices, conservation tillage, and improving water management and adoption of sustainable farming practices (Hasanzadeh Saray & Torabi Haghighi, 2023). In addition, automation and smart technology (artificial intelligence) may be applied in a complementary fashion to optimize energy use in farming (Kabir & Ekici, 2024)

The problem with future innovations is that apart from policies oriented at supporting research and development, they hardly or only very generically may be captured within the existing policy frameworks, e.g. where there is a general support for alternative renewable or biomass-based sources of energy, an extension of policy provisions may be easy to implement. The technologies and respective future political interventions in their support are still not in existence and therefore have to be spared from the analysis. In reflection with insights from the adjacent task in 1.2 (corresponding deliverable with inventory of key promising technologies: see Was et al. 2024), this analysis may only to a very limited extend be able to identify regulatory gaps or mal-adapted incentive structures towards the known alternatives. The project will elaborate further on this policy-innovation nexus in its subsequent work package 8.3.

Co-benefits and trade-offs: When striving for innovation and behavioural change towards more resilient system and considering the variety of country contexts and technical possibilities, system thinking including possible relationships and trade-offs is key. Taking a broader sustainability perspective, the objective of reaching energy independence form one among several environmental policy objectives including also concerns of climate change mitigation and the reduction of GHG emissions, biodiversity conservation, or water pollution. Fossil energy dependence is in fact very closely tied to climate mitigation as well as water pollution objectives in that the latter follow the aim to reduce these harmful. Adding to this is the proper drawing of spatial and temporal boundaries to the considerations of possible benefits or trade-offs. Employing a new technology or practice with a supposedly better energy profile, may in fact unfold as having numerous trade-offs or an own hidden energy bill. For instance, externalising feed because of its “energy footprint” may lead to shifting to imported feed, based on even less energy efficient systems in the global South with long-distance transportation (Bronts et al., 2023). In addition, it may counteract policy objectives of reducing emissions from deforestation or biodiversity conservation targets.

In the mix of practices, a supposed immediate solution may trigger higher energy demands later and actually increase dependence. One concrete example is that energy crops that may help substitute fossil fuel combustion on farm (diesel) do in fact have a considerable energy (esp. fertiliser) footprint themselves as illustrated in sustainability studies (e.g. Mahapatra et al., 2021). In other cases, co-benefits rather than trade-offs may be thinkable, when for instance using waste, or residuals as biofuels on the same or other farms. This upcycling of different agro-industrial wastes may in fact help avoid pollution and improve waste management (Nair et al., 2022). Such changes in practice may also create additional income opportunities and increase the financial resilience of farmers. Although not a core focus of this analysis coherence with additional environmental objectives is an aspect that the project wants to pay attention to on a principle level.

Fuzzy fossil-energy use in organic

Organic farming is one very specific practice that is the focus of numerous different policies and environmental objectives. As a systematic approach it delivers on numerous dimensions rather than being strong on just one dimension why the evaluation of its energy bill needs to be put in thorough perspective of other values generated and possible interlinkages and trade-offs. As a practice it is

broadly portrayed as a knowledge-intensive form of agriculture that through on-farm management processes reduces dependence on (external) inputs based on a certain amount of (fossil-based) energy for production, transportation and use of mineral fertilizers. Synthetic fertilizers and certain pesticides are principally not allowed in organic farming. According to IFOAM, this reduction potential amounts to around 20% of the GHG emissions from agriculture (IFOAM, 2022). In general, nitrogen fixating legumes, such as clover grass, and the use of organic manure to recycle nutrients are used to build up soil fertility. Still, huge variation exists among different ecosystems, regions and management approaches and proposing organic as *the* way to address energy dependence, through avoiding mineral fertiliser, disregards the high variation in production types and contexts. At the same time rejecting the practice because of its inconclusive role for energy dependence risks achieving other policy objectives.

One key aspect in organic management is rotation (e.g. N-fixing legume) for substituting fossil fertiliser which may however increase the demand for production area leading to reduced system area yields (Morais et al., 2021). Without significant changes in human diets area demand may even undermine co-benefits for ecosystem health (Morais et al., 2021) and counteract conservation targets. At the same time, FADN data (European Commission, 2023i) (European Commission, 2023i)also indicates that spending on fertilisers is – generally – lower for organic plant production farms than conventional counterparts. Organic arable crop farms (cereals, oilseeds, protein crops and other arable crops) have 45-90% lower costs per hectare for fertiliser, while generating a higher or similar income per work unit plus positive environmental and climate co-benefits, e.g. through reducing greenhouse gas emissions *and energy use*. The production of organic cereals, oil crops, pulses, eggs and dairy products uses less energy per unit of food compared to conventional production. This is in line with the conclusion of IFOAM, that organic agriculture shows a lower energy use per hectare and per unit product (15% less energy per unit produced). Although organic farming uses often more machinery including for mechanical weeding, the energy demand per hectare was suggested to be still 22% and 35% lower per year (for a Swiss case study) than conventional farming. Per kg harvested dry matter energy demand was 2 % to 17% lower (IFOAM, 2022).

However, this was not the case for fruit and meat production (similar energy use) and vegetables (higher energy use in organic systems; European Commission, 2023d). Evidently, positive effects depend highly on the type of organic production. While, for instance, emission reductions can principally be seen for CH4 and N2O for organic (animal *and* plant) farming, there are hardly any differences in (all) GHG emissions for dairy products and eggs between organic and non-organic producers. Positive effects are reported for organically produced fruits. Eventually, organic systems do not significantly outperform conventional systems in reducing ammonia emissions both per unit of area and per unit of product. (European Commission, 2023d). Another additional factor is the build-up of 10% more soil organic carbon compared to conventional practices. Together with 25% lower emissions of nitrous oxides this is suggested to translate into one tonne of CO2 eq per hectare and year (Sanders et al., 2023). The considerations on policies that promote the conversion to or maintenance of organic farming need to be put in thorough perspective in line with this variability between types of production and contexts as well as the multiplicity of policy objectives beyond fossil energy independence or climate goals.

Multi-level, cross-sectoral policy analysis

European agricultural policy is special because of the supranational nature of organisation across scales and sectors. The EU is often referred to in literature as the prime example of multilevel governance (MLG) referring to the interplay of different policy levels from local to national to

EU/supranational and vice-versa. A core idea is that in a multi-jurisdictional set-up (Hooghe & Marks, 2002) policy making is not just a sender-recipient kind of top-down regulation but dispersed across and shared between different political strata. The set-up of EU polity with the European Parliament and Council, the EC or bodies like the European Committee of the Regions follows both the idea of joint EU-wide policies as well as subsidiarity that lends high levels of autonomy in shaping policies to national and sub-national processes. With governance, beyond but also explicitly including public policies of member states, the concept also captures the empirically valid idea that also non-state actors and non-regulatory ways of governing and policy making matter (Fairbrass & Jordan, 2004). According to this idea the focus of the analysis will be at both international/EU-level policies and on types of policies that go beyond "hard" regulatory acts and may involve "soft" approaches to power, other actors, e.g. through voluntary commitments or self- or co-governance. At the extreme end of the spectrum stand publicly supported research programmes that promote technological innovations in universities and industry that help produce high-value fuels and products from various biomasses that may be used by farmers (Jaiswal et al., 2022).

In WP1, the identification of the policy targets and policy measures is performed in a mapping exercise that allows a *light touch review* of the existing policies at local, regional and national level. In light of the considerations of boundaries and possible indirect relationships, the policy analysis inventory started out based on the logic displayed in Figure 7 as associated with the reduction of energy use, GHG emissions, as well as price fluctuations of energy-intensive inputs.

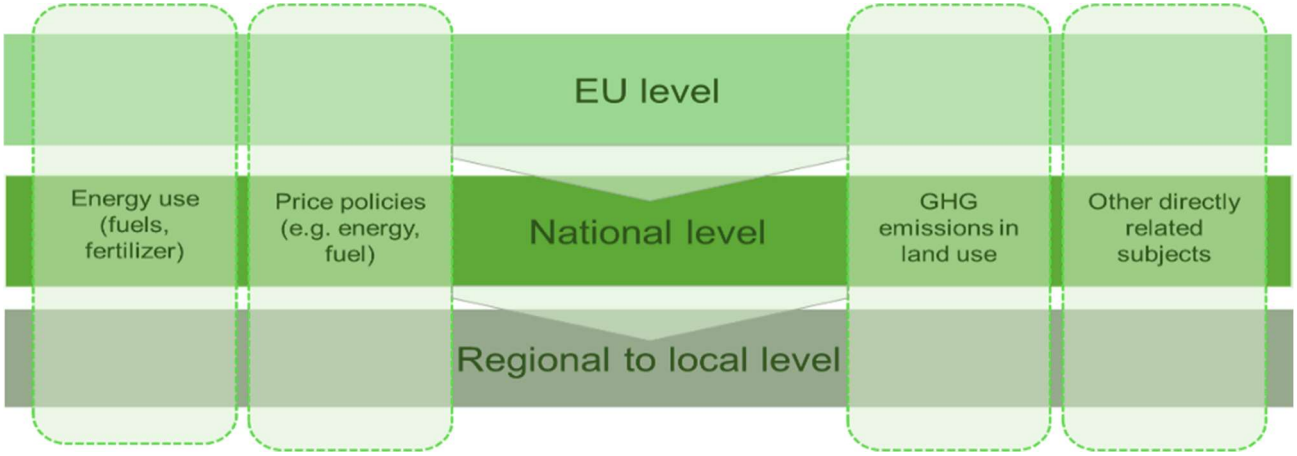

Figure 7. Key subject areas and policy levels for policy analysis in AgEnRes

(own figure, AgEnRes/FiBL CH)

The review includes legal and regulatory frameworks, enabling and constraining policies, programmes at EU level (Part 1) that fund initiatives boosting more sustainable and climate-friendly agriculture, in various way including through information, research and development or on the basis of partnerships with private actors. The same methodology is applied to relevant policies designed and/or implemented at member state (and where applicable sub-national) level.

From strategies to targets – typology of policy

Conceptually one needs to recognise and spell out the differences between different types of policies not least to get an idea of how forceful they are for shaping action in agriculture but also to be able to reflect high contextual variation among member states. The treaties of the EU, for instance, are the legal foundation of the EU. They form the constitution or what is known as "primary law". Treaties

build the basis of the overall political set-up and modes of joint working and carve out roles and responsibilities (competencies) of and between the member states in their relationship with and within the supranational European structure regarding those joint affairs. The treaties, for instance, equip the EU and its institutions with the core competency of policy making in the areas of agriculture and environmental policies. They also spell out the shared principles and key objectives of the EU and this way guide so called "secondary law" (like regulations, decisions or directives). Throughout time, the EU developed several shared frameworks and strategies, like those known as the "Green Deal", "Farm to Fork" or "Biodiversity" Strategies that provide a shared framework for the respective policies of the member states along broader objectives or, possibly with concrete, numerical targets for future policies. Frameworks are the key reference for more concrete and, more or less, binding policy measures at secondary level that countries will put in place as to achieve these objectives. They are typically accompanied with policy guidelines on how to put the policies in place exactly. The EU knows 5 different types of policy measures at "secondary legal order" (European Commission, n.d.-g).

- **Directives**: that are legally binding with an established common goal, but high national discretion in decision making (often reflected in nationally varying targets and measures). Transposition into national law is expected within a certain timeline.
- **Regulations**: directly applicable laws that directly apply to member states without further addition or transposition into national law
- **Decision**: binding legislative or (more common) non-legislative acts (i.e. deviating from legislative procedures involving the Parliament and or *with* the European Council; by contrast adopted by the EC following delegation or to implement a legislative act)
- **Recommendation**: EU institutions can make their views known and suggest certain actions without imposing any legal obligation on its addressees. They have no binding force.
- **Opinions**: The instrument allows EU institutions to make a statement, without imposing legal obligation on the subject. An opinion has no binding force.

Case Study approach

Following the multi-level organisation of policy making in the EU for numerous policies and the high variability in terms of energy-dependence profiles across different country clusters the analysis follows a case-study approach where by diving into a concrete example we can make sense of the "how" of implementation as a basis for insights into EU, national and subnational policy-making and implementation and with that the effectiveness of EU policies.

While the elaboration of national peculiarities is a core objective of case study approaches a shared analytical approach was chosen to ensure to be able to compare implementation experiences and to draw conclusions in terms of policy recommendations for as well as across specific member states. Consortium partners located in the respective countries were asked to help shed light onto national level implementation of the most relevant policies that were iteratively identified in the course of numerous internal workshops and exchanges in the consortium (February/March/April) as well as in the course of a workshop with relevant stakeholders working on or in EU policies in June 2024. Figure 7 maps this preliminary long list of relevant policies. Researchers were given the option to drop or add policies to the list if deemed relevant with respect to the research objective.

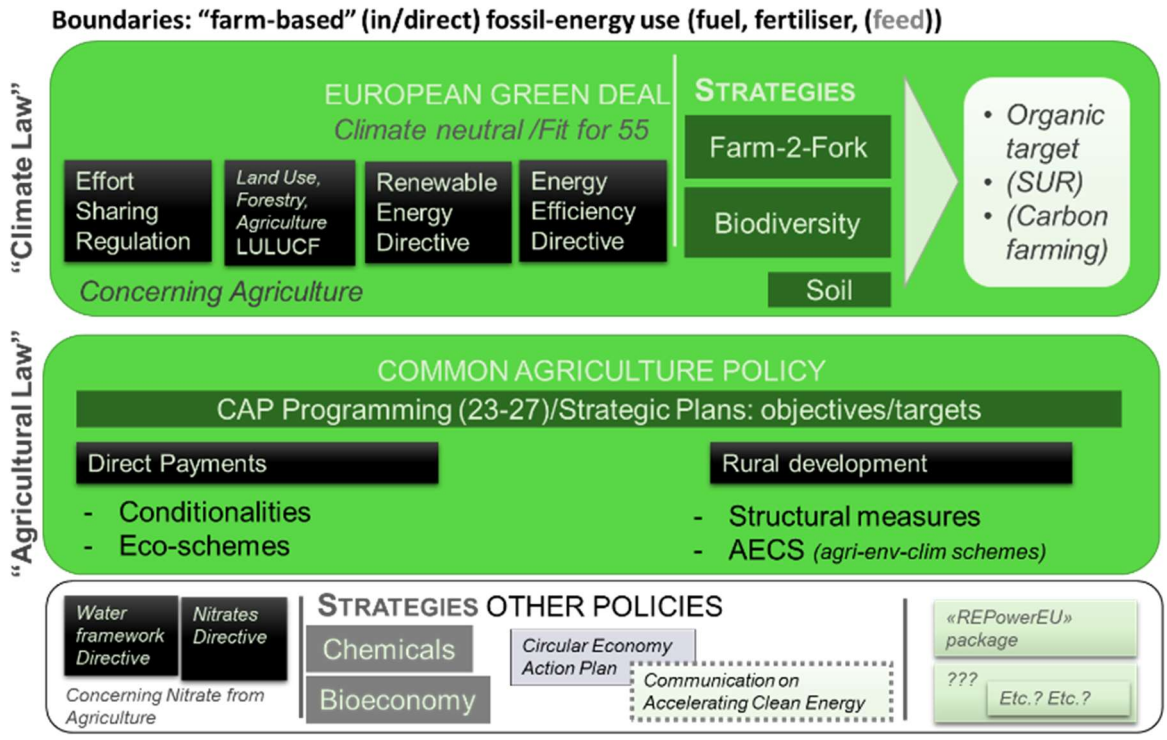

Figure 8. Preliminary EU-Policy Map

(own figure, AgEnRes/FiBL CH)

With the qualitative approach of content analysis (of policies and secondary literature on those policies as to gain an insight into how they are assessed and evaluated) a set analytical dimensions and corresponding research questions was developed to guide the scoping and inventorising work at EU and national level.

Table 2. Dimensions of analysis for EU and national policies

Column	Description
Name	***Name of policy analysed***
Policy type	E.g., regulatory, framework
Level of policy implementation	EU, national, regional, local
Sectors	E.g., energy, agriculture, environment
Legal frameworks associated	Legal frameworks associated
Developments	Historical context of the policy
Funding programs	Funding programs
Agents	Responsible for implementing the policy
Policy goals/objectives/targets	Policy goals, objectives, targets
AgEnRes relevant measures	Measures relevant to the AgEnRes project
Effects/effectiveness	Effects and effectiveness
Challenges	Challenges faced in implementing the policy

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In Appendix 1 the template is displayed that was used to give guidance to partner researchers for doing national policy inventories in all six focus countries and five regions as concerns core aspects to pay attention to when reviewing the policies and literature in their respective countries.

Long-list to short-list

Work was oriented at the idea of gaining an overview of relevant agri-environmental policies ("state of affairs") in the EU and its member states as to understand their relevance for promoting energy independence or resilience at farm level. In this effort, a synthesising and mapping approach was applied to policy analysis rather than a systematic or Meta-level approach to literature review. The latter seems limited in two respects: 1) the novelty of the policies under consideration 2) the impact on fossil energy (in)dependence. In terms of the first most of the policies relevant for consideration are tied to recent policy changes in the aftermath of the European Green Deal or in response to the Ukraine war and energy crisis. Academic literature has only just started to shed an eye onto their working. In terms of the second, we gathered and synthesized relevant information on existing EU policies in more content-oriented way that allowed understanding how exactly the policies may unfold in practice in the focus countries. To this end key policies, such as the European Green Deal, F-2-F or Biodiversity Strategies and policies and directives in relation to CAP, Energy Efficiency or Renewable Energy Directives were studied in detail based on qualitative data and by means of content analysis employing the afore-mentioned dimensions and research questions to the material. As to avoid drowning in all sorts of policies with more or less direct relevance in energy dependence, a limiting approach to sampling was employed within the analytical boundaries of the project and based on input of consortium partners and stakeholders.

In a workshop mid-June 2024, stakeholders discussed a broader map of policies as identified based on the initial policy scoping. The mapping started with a rough orientation of the policy field using chatGPT.

Questions to ChatGPT in pre-scoping:

- *"Which EU policies address fossil fuel use in agriculture?"*
- *"Which EU policies address the reduction of mineral fertilizer in agriculture?"*
- *"Which EU policies address renewable energy in agriculture?"*

Overview of prompts of ChatGPT (ordered by frequency):

- *Common Agricultural Policy (3)*
- *Renewable Energy Directive (2)*
- *Bioeconomy Strategy (2)*
- *Farm to Fork Strategy (2)*
- *National Renewable Energy Action Plans*
- *Circular economy Action Plan*
- *European Green Deal*
- *European Agricultural Fund for Rural Development (EAFRD)*
- *Horizon 2020 and Horizon Europe*
- *Smart Villages Initiative*
- *Water Framework Directive*
- *Nitrates Directive*
- *European Innovation partnership for agricultural Productivity and Sustainability (EIP-AGRI)*

Since this AI based search lacked precision and was considerably mixing up different levels or types of policies, while not providing information on details of implementation or interlinkages, the further mapping was organized mainly based on a more extensive literature review based on targeted keyword search in Web of Science (WoS) and science direct (SD).

Search strings and their combinations yielding 172 (WoS) and 71 (SD) results:

"agriculture" AND energy" AND "fertiliser" OR "fertilizer "energy AND agriculture"; "energy use" AND "agriculture" OR "farming" AND "policy"; fertiliz(s)er AND agriculture; mineral feritliz(s)er AND agriculture; "renewable energy directive" AND "agriculture" AND implementation.

The number of papers was further reduced through refining the results based on date (years 2018-2024, considering that current, not historical, policies are the major focus) and relevant disciplines (like Agricultural Economics). Employing abstract screening for topical relevance, the literature was reduced further to 42 digital documents. Out of these 42 documents on policies in relation to sustainable agriculture, energy use, and fossil fuel, in fact, 39 rather qualify as 'grey literature', i.e. EU-wide documents and publications which include official reports, web pages on legislations, or journal articles of European Union bodies such as the European Commission and the European Parliament. Three sources already focused on specific EU member states and helped with a first understanding of how the EU policies (e.g. CAP, Farm to Fork) are principally implemented at the national level. These national studies also served as a basis for developing the short list with the experts in the consortium and a group of relevant stakeholders in that a template could be developed for relevant research question to be applied to national policies.

After internal workshops with consortium partners were used to consolidate the long list of policies including by defining the boundaries of the shared research, the stakeholder engagement that took place mid-June 2024 was conducted to specify *specific policies* on the long-list (broader map) in terms of their relevance in line with the research objectives. On this basis the short list of policies was carved out that address farming or on-farm energy use or production practices or allow reducing, substituting or avoiding fossil energy based inputs or practices in some way. This short list serves as "a state-of-the-art on current policy goals, measures and targets at regional, national and EU level" and is summarized in the discussion section of Part 1.

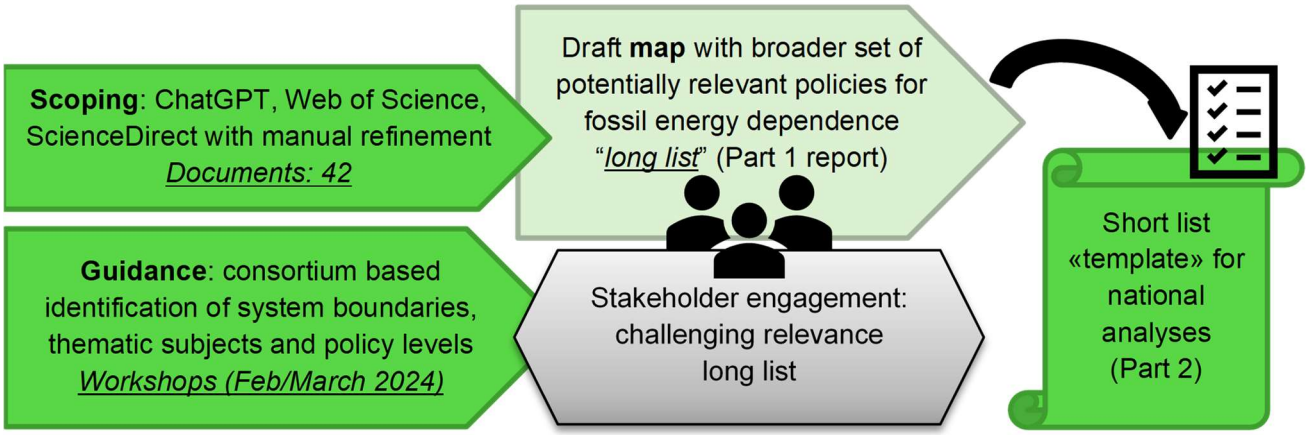

Figure 9. Review and analysis steps towards policy short-list

(*Own figure, AgEnRes*)

Part 1: EU-wide policies

Although national level policies deserve attention in their own right (see part 2), EU level policies provide a shared policy framework for national policies. Generally, EU institutions, such as the European Commission, hold considerable legislative authority for developing strategic policy frameworks, directives or regulations/decisions which codify commonly shared goals. In this section, we elaborate on the major EU-level policies and respective policy instruments that in more or less direct ways are relevant for and address on-farm fossil energy use and dependency.

European Green Deal

First presented in 2019, the Green Deal is a package of policies to transform the EU Economy such that the continent can achieve its target of climate neutrality by mid-century. The EU's Green Deal is the major policy framework of the European Union to address climate change and environmental-related challenges overall (European Commission, 2019). One month after the European Commission published its communication on the European Green Deal on 11 December 2019, the European Parliament adopted a resolution welcoming the new initiative. The EGD spells out three core targets:

1. To be the first climate neutral continent by 2050
2. To have more than 55% less net GHG emissions by 2030
3. To have three billion additional trees planted by 2030

In fulfilment of the second, medium-term target of reducing emissions by at least 55% by 2030 the Commission has put forward a package of different regulations, directives, policy schemes and respective funding schemes, some of which also concern agriculture (see figure 10).

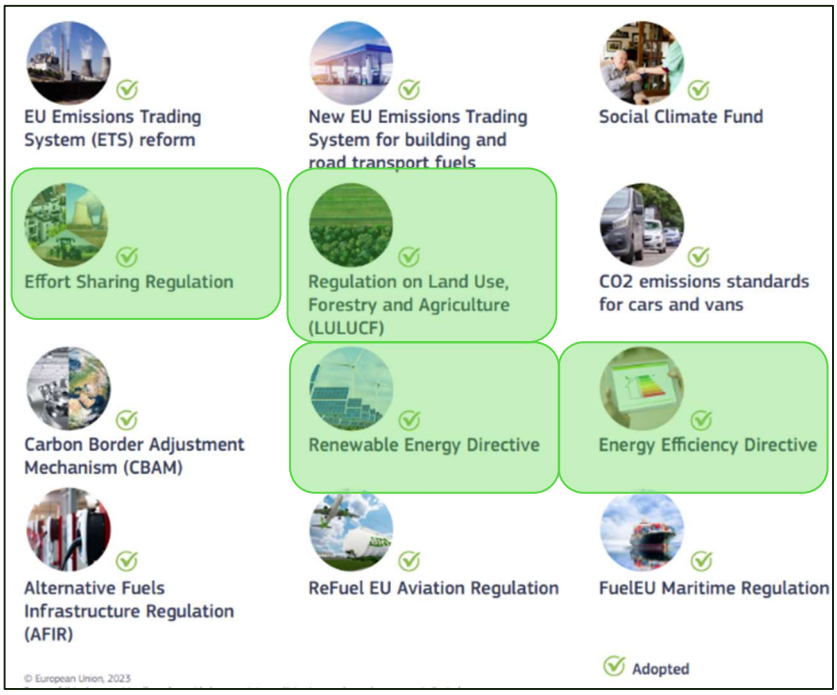

Figure 10. "Fit for 55" Proposals of the EC with relevance for energy use in agriculture

(European Commission, 2021, amended: green highlights of relevant packages to agriculture)

Effort Sharing Regulation (ESR)

The Effort Sharing Regulation (ESR) forms an important part of the package of proposals under the European Green Deal aimed at reducing the EU's emissions by 55% by 2030 (compared to 1990 levels). The ESR amending a prior version of 2018, entered into force on 16 May 2023 and establishes for each EU Member State a national target for the reduction of greenhouse gas emission by 2030 in key sectors: transport (excl. aviation), buildings, agricultural direct non-CO2 emissions, waste and other industries not covered by the EU Emissions Trading Scheme. In total, the emissions covered by the Effort Sharing Regulation account for almost 60% of total domestic EU emissions. Initially adopted in 2018, the amendments from 2023 set new national targets that each Member States will contribute to the collective emission reduction target at EU level of reducing emissions by 40% until 2030 compared to 2005 levels (European Commission, n.d.-b).

Table 3 summarises how in accordance with Article 4(3) of the ESR the new greenhouse gas emission reductions targets for 2030 are shared among EU member states in relation to their 2005 levels determined in comparison to targets from 2018. The data on overall emission reduction targets under the ESR is contrasted with emission reduction trends 'projected' in literature (HET 28) for the agricultural sector as well as with current trends and trends considering 'additional' policy measures.

Table 3. EU Member States GHG emission reduction targets (for 2030 vs. 2005 levels)

	New (2023) GHG targets as of Effort Sharing Regulation and trends of projected emission reductions until in the agricultural sector with current /additional measures								
Member State	ESR 2023	HET28 target	Current trend	Trend + meas.	Member State	ESR 2023	HET28 target	Current trend	Trend + meas.
Austria	-48	-35	-10	-10	**Italy**	-43,7	-32	-8.8	-8.8
Belgium	-47	-34	-8.1	-24.5	**Latvia**	-17	-2	22.5	14.2
Bulgaria	-10	+1	37.8	37.8	**Lithuania**	-21	-4	-6.4	-11.0
Croatia	-16,7	n.a.	-20.8	-26.4	**Luxembourg**	-50	-34	8.4	-16.7
Cyprus	-32	-24	6.6	6.6	**Malta**	-19	-14	-9.5	-9.5
Czechia	-26	-10	-0.8	-0.8	**Netherlands**	-48	-35	-4.4	-4.4
Denmark	-50	-39	-16.4	-16.4	**Poland**	-17.7	-5	11.8	11.8
Estonia	-24	-8	28.7	28.7	**Portugal**	-28.7	-18	-1.0	-3.6
Finland	-50	-35	-12.2	-15.6	**Romania**	-12.7	0	4.2	1.9
France	-47,5	-33	-6	-6	**Slovakia**	-22.7	-6	-0.70%	-10.4
Germany	-50	-33	-12.2	-18.9	**Slovenia**	-27	-15	4.9	-1.1
Greece	-22,7	-23	0	0	**Spain**	-37,7	-29	-11.3	-20.8
Hungary	-18.7	-9	17.2	17.2	**Sweden**	-50	-36	-10.7	-10.7
Ireland	-42	-39	7.7	-11.2	**EU average**	-40	**-28**	-4.1	-7.9

Source: European Commission, n.d.-a; European Environment Agency, 2023; Color codes: countries with orange highlights follow trends with increasing emissions in comparison to the reference year, red letters indicate increases in emissions (compared to 2005-2021)

Generally, sectoral GHG emissions from agriculture have hardly changed at EU level between 2005 and 2021 (average 2.7%) with high variation among members states. Even with additional policy measures, numerous Member States anticipate a reversal of emission reduction trends, e.g. Greece and Romania. By contrast, additional measures are expected to further decrease agricultural emissions in Austria, Croatia, Denmark, Finland, Germany, Spain and Sweden (European Environment Agency, 2023). The more recent stagnation in emission reductions is in harsh contrast to the emission reductions experienced between 1990 and 2012 in the sector −24% (or −19% respectively, for total EU emissions excluding LULUCF). This decrease was linked to a reduced number of livestock, productivity increases and agricultural and environmental policies (Fellmann et al., 2018).

While sector targets for agriculture are not further specified under ESR, agricultural non-CO2 emissions are – principally – included. However, the agricultural sector faces 'material' limitations for reducing emissions that are 'harder to abate' than, for instance, emissions from fossil energy. This is of particular concern for non-CO_2 emissions deriving from enteric fermentation, N2O from soils or manure management (European Commission, 2023b). Moreover, Member States are allowed to make use of removals from the LULUCF sector to fulfil their obligations under the Effort Sharing Regulation. Allowances under ESR are limited to 280 million tonnes of CO_2 eq at EU level for the full 2021-2030 period to not discourage efforts for further emission reductions in the sectors (European Parliament & European Council, 2018). Yet, there exists greater flexibility for Member States with a larger agricultural sector (like Spain or France) and/or higher shares of emissions from agriculture (like Ireland, Denmark, Lithuania or Latvia). Higher allowances for other countries may also reflect incentives to re- or afforest, or recognise the level of development in the sector (European Parliamentary Research Service, 2018; see Table 4). To stimulate additional action in the land use sector, Member States can use up to 131 million credits over each of the 2021-2025 and 2026-2030 periods to comply with their overall national targets. In fact, emission reductions through natural sink of CO2 in the land use, land use change, and forestry (LULUCF) sector have further declined in the last decade rather than serving as a basis for achieving neutrality in the sector (European Commission, 2023).

Table 4. Accountable removals EU-28 (total/%; per ESR 2018) in context of country cluster features (emissions in CO2 eq., %, /ha), UAA

Country cluster	country ID	total GHG emissions Mt CO_2 eq. 2018	UAA 2020 in ha	Agric. CO_2 emissions per ha	GHG emissions (agriculture) Mt CO_2, 2018	share agricultural of total emissions	max LULUCF removals in ESR 2018, Mt CO_2 eq.	share accountable LULUCF of total agr. emissions
Western Europe	DK	48.2	2'629'930	**4**	11.0	**22.9%**	14.6	**13.2%**
	FR	444.8	27'364'630	**3**	74.8	**16.8%**	58.2	**7.8%**
	NL	188.2	1'817'900	**10**	18.2	9.7%	13.4	**7.3%**
	UK	462.1	17'269'000	2	40.8	8.8%	17.8	4.4%
	BE	118.5	1'368'120	**7**	10.0	8.4%	3.8	3.8%
	DE	858.4	16'595'020	**4**	63.6	7.4%	22.3	3.5%
	LU	10.5	132'140	**5**	0.7	6.5%	0.3	3.6%
South-Eastern Europe	RO	116.1	12'762'830	2	19.9	**17.1%**	13.2	**6.6%**
	HR	23.8	1'505'430	2	2.7	**11.4%**	0.9	3.3%
	HU	63.2	4'921'740	1	7.1	**11.3%**	2.1	2.9%
	BG	57.8	4'564'150	1	6.4	**11.1%**	4.1	**6.4%**
Poland	PL	412.9	14'784'120	2	33.1	8.0%	21.7	**6.6%**
Northern Europe	LV	11.7	1'968'960	1	2.6	**22.2%**	3.1	**11.9%**
	LT	20.3	2'914'550	1	4.3	**21.1%**	6.5	**15.2%**
	SE	51.8	3'005'810	2	6.8	**13.1%**	4.9	**7.2%**
	FI	56.4	2'281'710	**3**	6.6	**11.6%**	4.5	**6.9%**
	EE	20.0	975'320	1	1.4	7.2%	0.9	6.3%
Mediterranean	ES	334.3	23'913'680	2	39.6	**11.9%**	29.1	**7.3%**
	PT	67.4	3'963'940	2	6.8	10.1%	5.2	**7.6%**
	GR	92.2	3'916'640	2	7.8	8.4%	6.7	**8.6%**
	IT	427.5	12'535'360	2	30.2	7.1%	11.5	3.8%
	CY	8.8	134'140	**4**	0.5	5.7%	0.6	**12.0%**
	MT	2.2	9'800	**7**	0.1	3.0%	0.0	4.6%
Czechia-Slovakia	CZ	128.1	3'492'570	2	8.6	6.7%	2.6	3.0%
	SK	43.3	1'862'650	1	2.7	6.3%	1.2	4.4%
Austria-Slovenia-Ireland (animals)	IE	60.9	4'920'270	**4**	20.0	**32.7%**	26.8	**13.4%**
	SI	17.5	483'440	**4**	1.7	9.8%	1.3	**7.5%**
	AT	79.0	2'602'670	**3**	7.2	9.2%	2.5	3.5%
EU average/sum	**EU**	**4'226.0**	**174'696'520**	**2**	**435.3**	**10.3%**	**280.0**	**6.4%**

Source: own calculations and/or based on Mielcarek-Bocheńska & Rzeźnik, 2021, Eurostat, 2022, (UK values: Defra 2022), European Parliament & European Council, 2018, values equal or **above EU** average in **bold**

Funded by the European Union

Land use, land use change and forestry (LULUCF)

As part of the 'Fit for 55' package the EU revised its Land Use Land Use Change and Forestry Regulation (European Union, 2018) in 2023 (publication date 21 April 2023, EU/2023/839) as to provide a coherent policy framework for member states that, among other things, accounts for all agricultural emissions (CO2, methane and nitrous oxide) relevant for the ESR. Generally speaking LULUCF specifies how the land use sector contributes to the EU's climate goal to reach climate neutrality by 2050. It principally concerns Greenhouse Gas (GHG) emissions and removals from cropland, grassland and forests. Oriented at the overall objective of the Green Deal to have three billion additional trees by 2030 in contribution to the 55% 'net' target, the revised LULUCF regulation set a separate land-based carbon removal target of 310 million tonnes of CO2 equivalent by 2030. This EU-wide target is to implemented through binding net removal national targets for the LULUCF sector. While the regulation of 2018 required 'emission' neutrality (known as the 'no-debit-rule'), the revised regulation of 2023 demands an additional annual removal of 42 $MtCO_2e$ in relation to the 2016–2028 sector's average (−256MtCO2) at the EU level (European Union, 2023).

In operational terms the 310 MtCO2e target is distributed 'equitably' among the 27 Member States employing an emission allocation method based on both, the average emission/removal for the years 2016–2018 and the area of managed land of each MS. This method is suggested to reflect not only the current mitigation performance of the national LULUCF sector (considering recent impacts of natural disturbances) as well as the capacities of member states to improve their performance with the area available for additional action (positive land use change and potential to improve land management practices) as a proxy for this capacity (Di Lallo et al., 2024).The revised Regulation proposes pre-defined budgets (sum of net emissions and removals) for the period from 2026-2029 based on a linear trajectory starting in 2022 (average inventory data for 2021-2023 as reported in 2025) and ending in 2030. Member state compliance will be assessed in 2032. In fact, the LULUCF removal target of 310MtCO2e further extends the limit for aggregate net carbon removals at 225 million tonnes of CO2e until 2030 as spelled out in the European Climate Law to not counteract mitigation ambition (European Union, 2021a). This extension may essentially reduce pressure on the sector to further mitigation efforts including through improved management practices and may undermine efforts to further reduce fossil-energy based inputs. In practical terms, Member States are requested to reflect the role of the LULUCF sector and specific targets in their National Energy and Climate Plans for the 2021-2030 period and Members States have to assess whether their CAP Strategic Plans are aligned with the new LULUCF targets, accordingly.

Renewable Energy Directive

The Renewable Energy Directive provides the legal framework for developing clean energy across all relevant sectors of the economy in the EU. As part of the Clean energy for all Europeans package the Renewable Energy Directive (2018/2001/EU) entered into force in December 2018. It is aimed at maintaining the EU's status as a global leader in renewables and, more broadly, helping it to meet its emissions reduction commitments under the Paris Agreement. The Renewable Energy Directive established a binding target for the EU to achieve at least a share of 32% renewable energy by 2030 with a possibility to revise this target by 2023. The new target extends the trajectory of ambition from the 20% target for 2020. In support of the Member States, the Directive introduced a range of new measures for sub-sectors of the economy, where progress has been slower in the past – like heating, cooling and transport – which are also highly relevant for agriculture. For transport, e.g. the target is increased to 14% share of renewable fuels by 2030. It also envisions citizens to play a more active

role in the deployment of renewables by enabling renewable energy communities and self-consumption establishing also better criteria to ensure the sustainability of bioenergy (European Commission, n.d.-c).

Under the impression of the invasion of Ukraine and in an effort to further reduce energy dependence from Russia, the Directive was revised in 2023 and entered into force in November 2023 to accelerate the transition to clean energy(European Union, 2023b). In an effort to increase the share of renewable energy in the EU's overall energy consumption, **the binding target for 2030 was risen from 32% to 42.5%, with the ambition to reach even 45%.** This would almost double the existing share of renewable energy in the EU (reference year 2019). As part of its REPowerEU action plan (see next sub chapter on non-climate policies) the EU envisions, among other things 320 GW of newly installed solar photovoltaic capacity by 2025, and almost 600 GW by 2030 (European Commission, n.d.-d).

Concerning bioenergy in transport, agricultural tractors are an explicit focus of the newly amended Directive ('Article 1: Scope, European Union, 2023a). The amended Directive sets "technical specifications on health and environmental grounds for fuels to be used with positive ignition and compression-ignition engines, taking account of the technical requirements of those engines.' The directive also pursues the idea that agriculture may itself serve as a source for biofuels, bioliquids or biomass fuels, which, however and according to Art. 29 (European Union, 2023b), "shall not be made from raw material obtained from land with a high biodiversity value" or with another ecologically sensitive status (like peatland).

EU Energy Efficiency Directive

The Directive on Energy Efficiency 2012/27/EU of November 2012 targets ways of achieving energy efficiency by reducing overall energy consumption. In this effort it is a central component in achieving the EU's climate ambition under the Green Deal (reducing greenhouse gas emissions by at least 55% in 2030, compared to 1990). Moreover, it is a specific contribution to increasing present and future energy security and affordability. For its first phase, the Directive specified the target to reduce energy consumption by 20% by the year 2020 compared to baseline projections (so called 20% energy efficiency target, (Eurostat, 2023a)). This EU commitment implied primary energy consumption in 2020 to not exceed 483 million tonnes of oil equivalent (Mtoe); and final energy consumption not 1,086 Mtoe in 2020 (Eurostat, 2023b).

As part of the European Green Deal package, a revised proposal to the Energy Efficiency Directive was put forward by the Commission in July 2021 and further enhanced as part of the so called REPowerEU plan presented in May 2022 as to decrease the EU's dependency on fossil fuel imports from Russia (see further down). The revised Energy Efficiency Directive (European Union, 2023a) entered into force just before the revised Renewable Energy Directive. It more than doubles the annual energy savings obligation (Article 8) by 2028. While binding for all member states the target ensured that an additional 11.7% reduction in energy consumption is ensured by 2030, as compared to projections for the EU-wide reference scenario for 2020, translating into an overall reduction target of 32.5% for 2030. In concrete, EU countries are to achieve cumulative end-use energy savings for the entire obligation period from 2021 to 2030 which equal new annual savings of at least 0.8% of final energy consumption in 2021-2023, at least 1.3% in 2024-2025, 1.5% in 2026-2027 and 1.9% in 2028-2030, respectively (European Union, 2023a). This energy saving trajectory spelled out in the Energy Efficiency Directive (excluding UK after Brexit), marks a key policy instrument for driving energy savings across all end-use sectors, such as buildings, industry or transport. In effect, EU energy consumption by 2030 should not exceed 992.5 million tonnes of oil equivalent (Mtoe) for

primary energy and 763 Mtoe for final energy. With the Energy Efficiency Directive the EU wants to comply with commitments made under the Global Pledge that aims at doubling the global rate of energy efficiency improvements from about 2% to over 4% by 2030.

Reflecting national circumstances in relation to energy intensity, GDP per capita, energy savings potential or earlier energy efficiency efforts, EU countries set their so called indicative national contributions either using projections of the EU reference scenario 2020 or employing an updated version (communicated in December 2023). If countries fall behind their suggested national contributions, the Directive works with an enhanced 'gap-filling mechanism'. In March 2024, the Commission communicated on corrected indicative national contributions (with an updated reference scenario). In accordance with Article 4(5) of the EED recast, these corrected numbers are to be used as basis for EU countries' updated integrated National Energy and Climate Plans (NECPs). The next NECPs update was due in June 2024.

Table 5. corrected vs. indicative national contributions for FEC for all member states

	Notified indicative national contributions (Mtoe)	Corrected indicative national contributions (Mtoe)		Notified indicative national contributions (Mtoe)	Corrected indicative national contributions (Mtoe)
BE	29,90	29,02	LU	3,05	2,80
BG	8,42	8,42	HU	17,91	16,17
CZ	20,35	20,35	MT	0,80	0,68
DK	13,73	13,73	NL	38,41	38,41
DE	155,53	155,53	AT	21,97	21,61
EE	2,59	2,53	PL	58,50	58,50
IE	10,45	10,45	PT	14,37	14,37
EL	15,40	14,64	RO	23,20	22,47
ES	70,20	66,28	SI	4,43	4,32
FR	106,93	106,93	SK	10,27	8,70
HR	6,55	5,88	FI	20,60	20,60
IT	94,40	93,05	SE	30,11	25,41
CY	1,81	1,81	**EU**	**787,62**	**770,38**
LV	3,54	3,46	**Gap (Mtoe)**	**24,62**	**7,38**
LT	4,20	4,25	**EU target (%)**	**-8,9%**	**-10,9%**

Source: (European Commission, 2023b)

As of Article 31 of the Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action ('Governance Regulation') the Commission will assess the final updated NECP. Should this yield an ambition gap toward the 2030 target for energy efficiency, the Commission will propose measures in exercise of its powers at Union level ('ambition gap filling mechanism') (European Commission, 2023b). Moreover the Directive establishes the fundamental principle of 'energy efficiency first' for EU energy policy with 'legal force'. It implies for member states to consider energy efficiency in *all relevant policy and major investment decisions* taken not only in energy but also non-energy sectors, which principally includes agriculture.

Carbon removals

On 10 April 2024, the European Parliament adopted a provisional agreement on the so called Carbon Removals and Carbon Farming (CRCF) Regulation. The voluntary framework covers the certification of carbon removals of sorts, including through 'carbon farming' and serves as the shared framework for monitoring and reporting on sustainable investments into removals, including carbon farming

solutions. The link to the reduction of fossil energy dependency and increased resilience is principally rather indirect, but may depending on the design of voluntary measures be notable. Existing incentive-based schemes (e.g. Sweden) may include bioenergy and carbon capture and storage (BECCS), which may create an additional need and competition for energy and land. The provisions are currently referring generally to the sustainability criteria of the Renewable Energy Directive (Fallasch et al., 2024). Particularly since the actual details of the EU to national policies are still unclear, we consider the subject, for now, less relevant. Carbon farming may eventually also be directly impacting on specific management practices, like top soil carbon storage (incl. through biochar or crop rotation with legumes) and the scheme may lead farmers to employ more sustainable fertilisation practices. Increasing farm income from carbon farming (through carbon markets or other reimbursement options) may furthermore have a – very indirect – impact on resilience. The role of the measure remains currently ambiguous and inconclusive.

The European Climate Law

With the European Climate Law that entered into force on 29 July 2021, the climate neutrality commitment set out in the European Green Deal for the European economy and society by 2050 gains actual legal weight. With its amendments of prior Regulations (EC) No 401/2009 and (EU) 2018/1999, the 'European Climate Law' raises ambitions in relation to the intermediate target of reducing net GHG emissions by at least 55% by 2030 (compared to 1990 levels) as a responsible pathway to climate-neutrality by 2050. Moreover, it puts in place a process for setting a 2040 climate target based on an indicative greenhouse gas budget for 2030-2050 (published by the Commission). It also establishes an independent European Scientific Advisory Board on Climate Change and seeks stronger adaptation provisions

The climate neutrality target implies achieving net zero greenhouse gas emissions for EU countries as a whole, including through emission reductions or removals. The climate 'law' legally binds EU institutions and Member States to act at EU and national level to meet the climate targets in fair fashion among Member States while ensuring that the transition to climate neutrality is irreversible. The legal status also ensures predictability for investors and other economic actors. All member states and economic sectors are jointly contributing to the objective of achieving net zero GHG emissions by cutting down on emissions, by investing in green technologies or by protecting natural carbon sinks. The first refers for instance to investing in green (energy saving or fossil fuel substituting) technologies the latter to restoring or protecting the natural environment (as basis for further removals). The law explicitly recognised the need to enhance the EU's carbon sink through a more ambitious LULUCF regulation. A corresponding LULUCF proposal by the Commission from July 2021 entered into force in May 2023.The latter actually extends the envisaged net removals from the agricultural sector set in the European Climate Law, which limited the aggregate net carbon sink at 225 million tonnes of CO2e until 2030 as to ensure sufficiently ambitious mitigation efforts (European Union, 2021).

In the effort to strengthen coherence across Union policies with the overall climate neutrality objective, the law demands member states to engage with sectors to prepare sector-specific roadmaps to spell out pathways to net-zero in different areas of the economy. In this respect it serves as the legal basis for all sorts of climate-related policies across sectors and policy fields 'mainstreaming' the net-zero idea as for instance relevant for the implementation of various national policies (e.g. Renewable Energy or Energy Efficiency Directives).

Operationally the Climate Law draws on measures that help to keep track of progress made in member states such as the governance process for Member States' national energy and climate plans, regular reports by the European Environment Agency, or the latest scientific evidence on climate change and its impacts. Member states progress is to be reviewed every five years, in line with the global stocktake exercise under the Paris Agreement and as a basis for possible adjustments to political actions.

Non-Climate policies (EU)

Recent EU Policy Action on fossil fuel price fluctuations

Communications and recommendations

The Russian invasion of Ukraine in 2022 has left a significant impression on the above EU Energy and Climate Policy. In October 2021, the Commission adopted the Communication on 'Tackling rising energy price' to address the immediate impact of price increases and to make the EU energy market resilient against future shocks. It presented a toolbox for the EU and its Member State with short-term measures such as emergency income support for households, state aid for companies, or targeted tax reductions (on fuel). By contrast medium-term measures sought to accelerate the transition toward a decarbonised and hence resilient energy system (European Commission, 2023a).

In March 2022, a second Communication was adopted proposing collective European actions to ensure that issue of energy supply at reasonable prices for the winters to come. The Communication carved out options for Member States for intervening in fossil fuel (gas) and energy market including exceptional measures for addressing full supply disruptions. For strengthening the EU's outreach to suppliers, a Task Force was suggested for common gas purchases at EU level as well as a mandatory minimum level in EU underground gas storage to buffer interruptions of supply.

Amending the existing Regulation on measures to safeguard the security of gas supply (EU/2017/1938) for the period of one year, the Commission has also adopted in June 2022 a proposal for a new Regulation on Coordinated Demand Reduction Measures for Gas (EU/2022/1369) which covers a voluntary reduction target of 15% for natural gas demand for EU countries for the winter 2022-23. Furthermore, the proposal gave the Commission the possibility to declare a 'Union alert' on security of supply where the Council may impose a mandatory gas demand reduction on all Member States, based on a corresponding proposal of the Commission. Along with the proposal, the Commission adopted the Communication 'Save gas for a safe winter' in July 2022, suggesting to reduce gas demand *voluntarily* by 15% from 1 August 2022 to 31 March 2023. Member states may employ various measures that encourage lowering gas demand and consumption in the public and economic sectors, as well as households.

The latest Council activity was the adoption of a recommendation that encourages Member States to continue reducing gas consumption until 31 March 2025 by at least 15% compared with their average consumption from 01 April 2017- 31 March 2022.

REPowerEU Plan – Addressing dependency from Russian fossil fuel

In this context, the Commission presented the so called REPowerEU plan in May 2022 aimed at decreasing the EU's dependency on and phasing out fossil fuel imports from Russia(European Commission, n.d.-d). In an effort to address the surge in energy price and the climate of uncertainty created by Russia's invasion of Ukraine, the REPowerEU plan builds on the three strategic actions

to: a) save energy, b) diversify energy supplies, c) produce clean energy (European Commission, n.d.-c). The EU has accomplished its voluntary target to reduce gas demand by 15% and managed to reduce natural gas demand by 18% between August 2022 and March 2024, saving about 125 billion cubic meters of gas. To avoid blackouts and energy shortages, the EU has furthermore installed a system that ensures filling up gas storage ahead of every winter. Agreeing to 80% of capacity for 1 November 2022, (and having reached 95%), Member States are expected to reach 90% of capacity by 1 November of each year.

In concrete and in an effort to ensure greater energy security the EC's REPowerEU Plan pursues greater diversity in energy supply while banning seaborne imports of Russian crude oil and refined petroleum products and coal based on EU sanctions. With purchases from different, supposedly more reliable, energy partners and in combination with more domestic energy from renewables this was seen to increase the resilience of the energy system. While the share of EU gas imports from Russia was 45% in 2021, it was reduced down to 15% in 2023.

Moreover, instruments for common gas procurement have been put in place with the aim to ensure affordable energy and avoid further supply disruptions. Through the so called EU Energy Platform the EU coordinates on infrastructure investments and negotiations with external gas suppliers since April 2022 as to achieve better conditions for EU consumers and to prevent outbidding among EU countries. AggregateEU is the Commission's instrument for aggregating demand and coordinating the purchasing of natural gas at EU level. Gas demand from EU and Energy Community companies are pooled and matched with supply offers from the global market. Five short-term tendering rounds were organised since April 2023 for companies to voluntarily conclude individual or joint purchasing contracts with gas suppliers (volume of 43bcm).

As part of the Plan the Commission adopted a proposal on 18 May 2022 to amend the Renewable Energy Directive (REDII) on the promotion of the use of energy from renewable sources, the Energy Efficiency Directive (EED), and the Energy Performance of Buildings Directive to further accelerate the transition to clean energy and energy efficiency as to enhance energy resilience. While the European Parliament and the Council are still working towards adoption of the revised REDII, the Commission already highlights the "rapidly increased renewable energy installation" and how "more electricity from wind and solar than from gas [was produced] for the first time ever" (European Commission, n.d.-d). Moreover, the proposal by the Commission from 2021 to amend the Directive on Energy Efficiency by 2023 (as part of the EU Green Deal) was further enhanced in 2022 in light of the energy crisis (see above).

To fund the Plan, the Commission mobilised around €300 billion mostly drawing on the Recovery and Resilience Facility (RRF). Member states were allocated an additional €20 billion through the Innovation Fund and sales of ETS allowances and could request a total of €5.4 billion coming from the Brexit Adjustment Reserve (BAR).

Farm to Fork Strategy (F-2-F)

The Farm to Fork Strategy (European Commission, 2020) marks a core component of the EU Green Deal with which the EU wants to enhance the sustainability of food production, among other things by *reducing pesticide use by 50%,* as well as by *reducing fertiliser use by 20%.* With the *25% target* for share of agricultural land to be managed *organically* the strategy sets a complementary goal for those reduction targets. (*see further details below*). First communicated on 20 May 2020 under the

title ‘A Farm to Fork Strategy – For a fair, healthy and environmentally-friendly food system’, a resolution on the strategy was adopted on 20 October 2021 by the European Parliament (Milicevic & Nègre, 2023).

In the effort to make the EU’s food system more sustainable, the F-2-F strategy sets out six overarching objectives (at least two principally highly relevant to this analysis: No. 2 & 5, European Commission, 2020a):

1. Reducing the environmental footprint of food production
2. **Promoting sustainable farming practices**
3. Ensuring food safety and quality
4. Encouraging healthy eating habits
5. **Supporting local and small-scale producers**
6. Reducing food waste throughout the supply chain

The F-2-F strategy helps addressing key objectives spelled out under the Green Deal and the Biodiversity Strategy for 2030 by (European Commission, 2020a)

- Promoting innovation in small and medium-sized enterprises (SMEs)
- Boosting sustainable practices such as precision agriculture, agro-ecology, carbon farming, and agro-forestry.
- Scaling-up agro-ecological approaches in primary production
- Reducing the use of pesticides and antimicrobials,
- Strengthening the role of the European Innovation Partnership 'Agricultural Productivity and Sustainability' (EIP-AGRI).
- Investing in R&I related to food, bio economy, natural resources, agriculture, fisheries, aquaculture, and the environment. The concrete targets of the F-2-F for the sector foreseen until 2025 /or 2030 are to:
- Reduce carbon emissions from agriculture by 50% compared to 2005 levels by 2030
- Decrease food waste by 50% by 2030
- Increasing the adoption of organic farming practices to 25% by 2030
- Implementing improved food labelling regulations by 2025

Regarding the *reduction of GHG emission, fertiliser and energy use* the F-2-F strategy (European Commission, 2020c) explores ideas on concrete measures. Considering that nearly 70% of the total emissions of GHG from the sector (10.3%) relate to the animal sector, the EC plans to, for instance, to facilitate the market entry of **sustainable** and innovative **feed** additives to support the transition to more sustainable livestock farming but also to reduce carbon leakage through imports (emphasizing carbon sequestration on farms).

Energy use in the Farm-2-Fork Strategy

For reducing energy use on farms, the strategy *encourages* farmers to invest in **renewable energy production**, such as developing biogas from agricultural waste and residues like manure, food and beverage industry waste, sewage, wastewater, and municipal waste. It also highlights the potential for **solar panel installations** on farm houses and barns to promote energy efficiency in agriculture and food sectors. Regarding the **sustainable use of inputs** (pesticides & fertilisers), the F-2-F further identifies an urgent need for farmers to transform their production methods quickly, making the best use of nature-based, technological, digital, and space-based solutions.

In this respect the EC spells out **targets** for agricultural production and farming partly with quantified values: i) Reduction of chemical and hazardous **pesticides by 50%;** ii) Reduction of **fertilizer use by 20%**; iii) Reduction of **nutrient losses** by at least **50%;** iv) Ratio of **25%** of EU arable land dedicated to **organic farming**; v) Reduction of sales of antimicrobials by 50%. (European Commission, 2020c)

Overall responsibility for the Farm to Fork Strategy lies with the European Commission who develops, implements, and oversees the strategy to ensure its alignment with the broader objectives of the European Green Deal. In support of achieving the objectives of the Green Deal, the Commission also proposed to convert the Farm Accountancy Data Network into the Farm Sustainability Data Network to collect data on relevant sustainability indicators (European Commission, 2020a). Financial support for technical and financial assistance stems from existing EU instruments, such as the cohesion funds or the European Agricultural Fund for Rural Development (EAFRD). One of the key R&I related funding lines for the F-2-F strategy is through the Horizon Europe programme, which proposes to spend EUR 10 billion on research and innovation related to food, bio-economy, natural resources, agriculture, fisheries, aquaculture, and the environment. (European Commission, 2020a)

In practice, the F-2-F strategy is implemented by the member states as part of their National Action Plans under CAP, organic action plans as well as climate and other related laws. (Schebesta et al., 2020). That means that the success of the strategy is in fact closely tied to and relies on the Common Agricultural Policy (CAP, see separate section) and in how far this is aligned with and adjusted to the new F-2-F targets. So far, there were only some 'light adjustments' in vis-à-vis pertaining tensions with food sector policies, which are typically dealt with separately from agricultural policies. Generally, the F-2-F strategy is being criticised for being too vague or unclear especially regarding applicable sustainability principles or responsibilities of sectoral actors (European Commission, 2020a). Despite the promises of a fair transition phase, the F-2-F ideas and new CAP implementation coincide with heightened frustration among (conventional) farmers about increased environmental conditions for direct payments vis-à-vis a pertaining cost-price squeeze (European Commission, 2020c).

EU 25% target on organic agriculture

As part of the Farm-to-Fork, the EU has formulated the goal of achieving 25% of Utilised Agricultural Area under Organic Management in 2030. The target was also explicated in its EU Organic Action Plan adopted in March 2021 (European Commission, 2022b). Considering that in 2020 14.8 million ha were under organic farming, representing just about 9.1%, total of EU organic agricultural land needs to multiply by about factor 2.5. The CAP Strategic Plans (CSPs) and respective CAP programming are seen as a core vehicle for reaching the goal of having 25% of EU farmland organic by 2030 (Lampkin & Rees, 2023). Organic farming is seen to contribute to four out of nine of the 2023-2027 CAP objectives (protecting the environment, contributing to the preservation of landscapes and

biodiversity, generating a viable farm income, and responding to societal demands on food health, sustainable food and animal welfare) (European Commission, 2023i):

In the 2023-2027 CAP Programming period, organic farming gains a more prominent role. Complementary, the European Commission is further increasing support to Research and Innovation in organic farming under its Horizon Europe programme (2021-2027). (European Commission, 2023e). Considering different points of departure for different member states, the ambitions for 2030 vary considerably between countries from 5% (Malta, 2022 level: 0.6%) to 35% of farmland (Austria, 2022 level: 25.7%; see table 6 and European Commission, 2022b). Belgium-Wallonia, Germany and Sweden have set ambitious targets above EU-average with 30% of UAA under organic farming by 2030 (Lampkin & Rees, 2023, Reinecke et al., 2024). Member states are encouraged to indicate national target values for organic farming in their national CAP strategic plans and to develop corresponding national organic action plans (so called NOAP), (European Commission, 2023i)

Except for Greece and Lithuania most of the countries have organic targets specified for 2030 or the end of the CAP programming (2027) and organic action plans in place (see table 6; Lampkin & Rees, 2023, Reinecke et al., 2024).

Table 6. EU Member States' organic sector target for 2030 and share of farmland in 2022

Organic area target and current share of farmland under organic agriculture					
Member State	**Target 2030 in %***	**Organic Area share 2022 (%)**	**Member State**	**Target 2030 in %***	**Organic Area share 2022 (%)**
Austria	35%	27.5%	**Italy**	25%/2027	17.9%
Belgium*	5%/30%	7.5%	**Latvia**	25%	15.4%
Bulgaria	7%/2027	2.2%	**Lithuania**	No plan	9.0%
Croatia	12%	8.6%	**Luxembourg**	20%/2025	6.3%
Cyprus	7.5%/2025	5.7%	**Malta**	5%	0.6%
Czech Republic	22%/2027	16.0%	**Netherlands**	15%	4.2%
Denmark	20%	11.5%	**Poland**	19%	3.5%
Estonia	14%	23.4%	**Portugal**	12%/2027	19.2%
Finland	25%	15%	**Romania**	6%	4.3%
France	18%/2027	10%	**Slovakia**	14%/2027	8.5%
Germany	30%	11.2%	**Slovenia**	18%/2027	10.7%
Greece	No plan	17.6%	**Spain**	20%	11%
Hungary	10%/2027	5.9%	**Sweden**	30%	19.9%
Ireland	10%	2.1%	**EU average**	25%	10.4%

*Source: (Reinecke et al., 2024a); *Belgium with 2 separate targets for each administrative region*

Already in the 2014-2022 CAP funding period, nearly all EU Member States (27 out of 28), supported organic farming based on measure 11 of the European Agricultural Fund for Rural Development

(EAFRD) including both conversion to (measure 11.1) and maintenance of (measure 11.2) organic farming practices. (European Commission, 2023i). This support included in principle higher subsidies under Rural Development compared to what is provided to conventional farming. By 2020, approximately 61.6% of EU land dedicated to organic farming received targeted financial aid. On average, this aid amounted to EUR 144/ha from CAP support and EUR 79/ha from national co-financing (National Organic Support). For the 2023-2027 funding period, a significant portion of the funding from both the European Agricultural Guarantee Fund (EAGF) and the EAFRD will be allocated to support organic farming areas. Also, the European Investment and Structural Funds (ESI Funds) offer support to producers, SMEs and organic stakeholders in the EU through operational programmes. As part of the EU's Common Strategic Framework (CSF) the Funds aim at supporting economic development in all Member States, as part of the Europe 2020 strategy. The design of support for organic interventions varies among Member States.(European Commission, 2023i)

Biodiversity Strategy

The EU's Biodiversity Strategy (EC, 2020a) mirrors the organic target for the EU and objectives as spelled out in the Soil Strategy. In this respect, it reinforced the objective of considerably reducing pesticide and fertiliser use. Moreover, the strategy defines the target of *10% of farmland* to be managed primarily for nature rather than food production (European Commission, 2020b). On a principle note, these objectives provide a framework for making more efficient use of the productive land. However, trade-offs may arise from dynamics regarding the F-2-F strategy's objectives of using less fossil energy, fertilisers or pesticides if more units of produce have to be produced per unit of land more efficiently, e.g. based on more (possibly fossil energy based) inputs.
In an effort to help biodiversity recover by 2030 the Biodiversity strategy has the following targets:

- Expanding the Natura 2000 network so that 30% of EUs land is protected
- Restore 20% of the EU's land and sea areas by 2030 and incrementally working towards full health by 2050
- Placing at least 10% of agricultural area under high diversity landscape features
- Placing at least 25% of agricultural land under organic farming by 2030
- Reducing nutrient loss from fertilisers by at least 50% and reducing the risk and use of chemical pesticides by 50%

Nature Restoration Law

In June 2024 the Council formally adopted the agreement reached in the EU Parliament in February on the Nature Restoration Law. The law is in force since 18 August 2024 and is aimed at restoring ecosystems, enhance biodiversity, and improve resilience to climate change the Law sets legally binding targets for the restoration of degraded habitats. In the broader context of the objectives of the Global Biodiversity Framework (Kunming-Montreal Agreement) of the UN Convention on Biological Diversity (CBD) as well as the EU Birds and Habitats Directives as well as Natura 2000, the Nature Restoration Law mandates Member States to restore at least 20% of land or sea in the EU by 2030; and all ecosystems by 2050. To this end Member states will be required to develop so called "National Restoration Plans" that specify national objectives and measures in line with national circumstances. Apart from the recovery of wetlands, forests, or marine environments, the law promotes sustainable agricultural and forestry practices. The Law is expected to spark relevant transformations in

agricultural practices towards more sustainability and the restoration of key functional ecosystem services vital for farming. A focus is on healthier soils, pollinators, and improved water management and changes in practices that could principally lead to more resilient agricultural systems, reducing the dependency on chemical inputs like pesticides and fertilizers while improving crop yields and quality and reduced susceptibility to climate change impacts, such as droughts and floods. Moreover, the law encourages the integration of nature restoration efforts with agricultural activities, potentially offering financial incentives and support for farmers adopting sustainable practices.

Sustainable Use of Pesticides Directive

To reflect the ambitions set in the EU Green Deal, Biodiversity and Farm to Fork strategies in on sustainable agriculture, the European Commission adopted a proposal for a new Regulation on the Sustainable Use of Plant Protection Products transforming the existing rules on the Sustainable Use of Pesticides (see Directive 2009/128/EC) into a regulation that would be directly binding and uniformly applicable to all Member States. The proposal spells out EU-wide targets to **reduce the use and risk of chemical pesticides by 50% by 2030** and forms part of the package of measures under the F-2-F Strategy to make the EU's food system more sustainable and mitigating the economic losses from climate change and biodiversity loss.

While the toxicity of pesticides for human health and ecosystems marks the major concern behind ambition and proposal, chemical pesticides also come with a (indirect) fossil energy consumption from production and transport to on farm application – however one at a rather modest level of only up to 5% (Paris et al., 2022). This energy load, however, does not directly correlate with levels of eco-toxicity and in fact more sustainable practices may encompass higher quantities of substances or frequencies of application.

The Environmental Committee of the Parliament sought to increase ambition further to a 65% risk and use reduction. However, the proposal was eventually withdrawn on 27 March 2024. No agreement could be reached because the European Parliament rejected the proposal and discussions in the Council did not progress. Pending an updated proposal, the Sustainable Use of Pesticides Directive of 2009 (2009/128/EC) remains in force.

Adopted on 21 October 2009 the existing SUR Directive (2009/128/EC) provides for a range of actions toward a sustainable use of pesticides in the EU aimed at reducing the risks and impacts of pesticide use on human and environmental health. Among others, the SUR directive of 2009 promotes Integrated Pest Management (IPM) and (non-chemical, technical) alternatives to pesticides. The SUR required Member States to adopt National Action Plans (NAPs) to implement the Directive for the first time by November 2012. The plans encompassed quantitative objectives, targets, measurements and timetables to reduce the risks and impacts of pesticide use. The Directive is linked to the EU Regulation on the placing of plant protection products on the market (No 1107/2009) with relevant provisions in relation to facilitating the rapid approval of low-risk substances and the use of such products following IPM principles. The Directive established deadlines for implementation of all measures that were phased over the period November 2011 to November 2016. In November 2016 inspection of pesticide application equipment became compulsory and Member States are required to implement all relevant measures of the Directive (European Commission, 2017).

The national action plans build the basis of Member State implementation and controls of the Directive. The Directive demands that these plans include specific measures that ensure that actions are taken on the training of users, advisors and distributors, inspection of pesticide application

equipment, the prohibition of aerial spraying, limitation of pesticide use in sensitive areas, or information and awareness raising about pesticide risks. The promotion of IPM marks a cornerstone of the Directive and general principles are laid down in Annex III to the Directive (European Commission, 2017).

Seven member states had previous plans and with different starting points the completeness and coverage of NAPs varies considerably. In fact, the Commission criticised numerous plans and demanded Member States to improve plans including by spelling out precise and measurable targets. The different NAPs of member states are inconsistent in terms of establishing quantitative objectives, targets, measurements and timetables for various action areas with often little detail on certain aspects. In around 80% of cases, action plans do not specify how the achievement of targets or objectives will be measured. Explicit targets exist only for some areas, like testing pesticide application equipment, but are lacking in others, such as concerning measures to protect the aquatic environment. Only France and Lithuania have produced a revised NAP. The major target of the French NAP is a pesticide use reduction by 50% by 2025, with an initial 25 % milestone in 2020. Notable risk reduction targets are also found in Germany, the Netherlands, Finland and Denmark with risk reduction indicators based on pesticide hazard classification and higher risk pesticides having a higher weighting. All the NAPs include some measures to promote IPM encouraging the availability of IPM guidelines, as well as the provision of training or demonstration farms. The NAP, however, do not specify specific targets for IPM application or how it may be measured and implemented.

Table 7. Reported risk or use reduction targets (bold **measurable**) according to NAPs

Member State	Risk reduction	Use reduction	Member State	Risk reduction	Use reduction
Austria	yes	--	Italy	yes	--
Belgium	**yes**	yes	Latvia	yes	--
Bulgaria	--	--	Lithuania	yes	--
Croatia	yes	--	Luxembourg	--	yes
Cyprus	yes	yes	Malta	--	--
Czechia	yes	--	Netherlands	--	--
Denmark	**yes**	--	Poland	yes	yes
Estonia	yes	--	Portugal	yes	--
Finland	yes	yes	Romania	yes	--
France	yes	**yes**	Slovakia	yes	--
Germany	**yes**	yes	Slovenia	--	yes
Greece	**(-)**	--	Spain	yes	--
Hungary	yes	yes	Sweden	yes	--
Ireland	yes	--	EU sum	21 **(4)**	9 **(1)**

Overview of the member states that have reported either on their risk reduction (n=21) or use reduction targets (n=9) specifying also for which countries actually measurable targets exist for risk (n=4) or use reduction (n=1). Greece, although with measurable risk reduction targets has not reported on it (yet).

Agricultural policies

Common Agricultural Policy

The Common Agricultural Policy (short: CAP) is surely the most significant policy framework in support of agriculture across Europe and as described it is also a key vehicle for the implementation of the European Climate Law or the Green Deal more generally including the Farm-to-Fork and Biodiversity Strategies. The core objective behind its inception in 1962 was to ensure affordable food for EU citizens and a fair standard of living for farmers. With the reforms of 1992 the CAP focus shifted away from primary market to producer support establishing a system of direct payments for farmers while supporting environmentally friendly practices. Since 2003 subsidies are decoupled from production with a focus on land stewardship and compliance. The major reform in 2013 further highlights competitiveness, sustainability, and rural development (2014-2020). With the recent programming period all member states are currently implementing their CAP Strategic Plans. (European Commission, n.d.-f). To help the EU farming sector cope with both local and global challenges, this new Common Agricultural Policy, adopted in December 2021, aims at contributing to the transition towards a smart, sustainable, competitive, resilient and diversified agricultural sector to ensure long-term food security. ((European Commission, 2023c)

Regulatory basis

Serving as a commonly shared policy framework it is composed of a set of regulations and directives established at the EU level and as part of the Treaty on the Functioning of the European Union (European Commission, n.d.-d). The CAP is organised in so called programming cycles of typically four years. The current cycle 2023-27 started on 1st January 2023 and rests in different regulatory components (European Commission, n.d.-d):

- Regulation (EU) 2021/2116, repealing Regulation (EU) 1306/2013 on the *financing, management and monitoring* of the CAP;
- Regulation (EU) 2021/2115, establishing rules on support for *national CAP strategic plans*, and repealing Regulations (EU) 1305/2013 and 1307/2013;
- Regulation (EU) 2021/2117, amending Regulation (EU) 1308/2013 on the common *organisation of the agricultural markets*;
- Regulation (EU) No 1151/2012 on *quality schemes* for agricultural products;
- Regulation (EU) No 251/2014 on *geographical indications* for aromatised wine products;
- and Regulation (EU) No 228/2013 laying down measures for agriculture in the *outermost regions* of the EU.

In the course of its 'greening' the CAP has established a set of policy measures to promote sustainable farming practices including those that help reducing energy use (e.g. through precision farming) or shifting to renewable energy in agriculture.

Current CAP Strategic Plans (CSPs)

With their CAP Strategic Plans (CSPs) Member States develop integrated responses to regional challenges, prioritise objectives and optimise resource utilisation for effectiveness and efficiency under consideration of key EU environmental frameworks (e.g. Farm-to-Fork and Biodiversity Strategies, as part of the European Green Deal; European Commission, 2023d) or the Climate Law. In an effort to reduce the number of regional rural development plans (European Commission, n.d.-e), Member States were required to produce national CAP Strategic Plans for the CAP programming period 2023-2027 and to agree them with the EU Commission (European Commission, 2023d). While the Commission assesses how the CSP contribute to overall nine specific and one cross-cutting objectives of the CAP linked to common EU goals for social, environmental, and economic sustainability in agriculture and rural areas (see figure) (European Commission, 2023j), member states are principally free to define the specific measures to achieve them according to their nationally defined needs and priorities (Lampkin 2024). In reference to the war in Ukraine, the communication of the EC on the CAP strategic plan clearly outlines the idea that CSP serve as a key vehicle to achieving more resilience in the agricultural sector, including through reducing the member states "dependence on synthetic fertilisers; transform their production capacity in line with more sustainable production methods; and promote the production of renewable energy." (European Commission, 2023c: 5)

Figure 11. The 10 key objectives for the CAP programming 2023-2027

(Source: European Commission)

Along with their CSPs, Member States specify programming tools to deliver on these objectives that are approved by the Commission (European Commission, 2023d). In their approved CAP Strategic Plans member states may set and select from 44 targets tailored to national level needs (European Commission, n.d.-f) specifying how, for instance, member states want to reduce their emissions or

organise land-based carbon sequestration, achieve a good status for water bodies, or a favourable conservation status of designated habitats and species. While national targets may well refer to other national or regional plans or legislation, there is no legal requirement for Member States to reach or contribute to these targets.

Regarding greenhouse gas (GHG) emissions CSP prioritise interventions with a focus on storing carbon in agricultural soils, while decreasing nitrous oxide and methane emissions. Although methane and ammonia emissions from livestock are principally addressed in several CSPs, only a few have specific targets. Efforts may be tied to specific (voluntary) eco-schemes (see sub-chapter) like those concerning outdoor grazing or feed management to mitigate emissions. In some countries the support for organic was transferred partly or entirely to the voluntary scheme. Some of the specific guidelines and regulations, e.g. regarding the management of waste from livestock in Nitrate Vulnerable Zones may exert its effect only indirectly by enhancing on farm nutrient management. Some Member States' CSP include explicit measures to promote the use of organic fertilisers as an alternative to synthetic ones. Additionally, CSP foresee investments in support of climate friendly practices like manure management, bio-gas production, or circular nutrient management, along with promoting extensive grassland management and organic farming. CSPs also refer to programs and initiatives aimed at helping farmers to cope with energy price fluctuations and to manage the challenges associated with energy costs. Some Member States have introduced according risk management measures that provide farmers with tools for income stabilisation or subsidise insurance costs against market uncertainties. The use of risk management tools remains limited and is suggested to not translate into the promotion of different farming practices (Beck et al., 2024).

Member states translate overall policy objectives such as under the F-2-F (e.g. 25% organic targets) or Biodiversity strategy (e.g. pesticide use reduction) into own strategic action plans. Member states work toward achieving a set of targets specified at national level by each EU country in their CAP Strategic Plans and report on their effectiveness with a concrete set of performance indicators.

Performance

In line with the CAP targets, there are in total 44 result indicators under CAP legislation. Some are fairly directly relevant for fossil fuel or fossil energy dependence, e.g. those relating to (renewable) energy, fuel and fertilizers use, particularly:

- Indicator R.9 Farm modernisation: Share of farmers receiving investment support to restructure and modernise, including to improve resource efficiency *(incl. energy)*
- Indicator R.15 Renewable energy from agriculture and forestry and from other renewable sources: Supported investments in renewable energy production capacity, including bio based (in MW)
- Indicator R.16 Investment related to climate: Share of farms benefitting from CAP investment support contributing to climate change mitigation and adaptation, and to the production of renewable energy or biomaterial
- Indicator R.22 Sustainable Nutrient Management: Share of utilised agricultural area (UAA) under supported commitments related to improved nutrient management

- Others may be relevant only in more indirect ways as they encourage resource efficiency or innovation in more general terms or support developing practical knowledge and skills to implement such measures, like:

- Indicator R.1 Enhancing performance through knowledge and innovation: Interventions supporting provision of knowledge, innovation and exchange in agriculture and rural areas to enhance sustainability and resource efficiency of performance

- Indicator R.19 Improving and protecting soils: Share of UAA under supported commitments beneficial for soil management to improve soil quality and biota (e.g. reduced tillage, crop rotation) – *(reducing fertiliser needs)*

- Indicator R.21 protecting water quality: Share of UAA under supported commitments for the quality of water bodies - *(may improve nutrient management, reduce pesticide and fertiliser use)*

- Indicator R. 29: Development of organic agriculture: Share of UAA supported by CAP for organic agriculture, with split between maintenance and conversion

For a full overview of all more or less indirectly relevant CAP indicators see Deliverable 1.3. It is beyond the scope of this analysis to further explore the utility of the performance indicators for reflecting the actual effectiveness of existing CAP measures in supporting achieving independence from fossil energy in the EU. Within the project AgEnRes a separate deliverable is planned that will elaborate on this question further and in more detail. Deliverable 1.3 will review and reflect on both the relevance and suitability of the CAP indicators in contrast to alternative indicators as discussed in literature to reflect on the effectiveness of policies in this regard.

Financing

Within the EU budget, CAP draws on two key funds: 1) the European Agricultural Guarantee Fund (EAGF) for market measures and direct support (pillar 1), 2) the European Agricultural Fund for Rural Development (EAFRD) in supports of rural development initiatives (pillar 2). EU member states handle payments individually at a national level in accordance with their priorities (Ref 1) and may complement either funding line with national budget. The CAP budget is considerable and amounts to 35% of the annual EU resources. In concrete numbers, the EU's multiannual financial framework (MFF) for 2021-27 (as adopted on 17 December 2020), amounts to a total of €1.21 trillion (in current prices). An additional €808 billion is available from the next generation EU recovery instrument. The total budget of the CAP for this period of around €386.6 billion is allocated to the two funding lines (EAGF and EAFRD; (European Commission, n.d.-a))."

CAP pillars

The CAP system is structured around two main pillars of support measures.

Pillar 1 concerns direct payments to farmers and income support for farmers to stabilize their income and maintain agricultural operations across the EU. These payments help sustain food production and rural livelihoods, providing a safety net against market fluctuations. The European Agricultural Guarantee Fund (EAGF) finances these direct payments. The pillar also encompasses direct payments that work as market interventions aimed at stabilising agricultural markets.

Pillar 1 measures are seen as a key vehicle for achieving the objectives of several overarching EU frameworks such as the Farm-to-Fork Strategy or the Green Deal (Runge et al., 2022). While the EU serves as an important framework of orientation for CAP, member states have high national discretion over spending under pillar 1 in the new programming period 2023-27. The principle of subsidiarity has been more prominent for pillar 2 already in the past. What was known as "greening" in the previous programming period has now transitioned to a *voluntary* measure known as eco-schemes.

Nonetheless, farmers receiving direct payments have to respect obligatory EU standards on good agricultural and environmental condition of land (GAEC) that may in indirect ways also impact on the use of energy (esp. indirectly as in the case of standards in relation to soil organic matter maintenance, maintenance of permanent grassland, water protection from pollution through buffers, crop rotation or soil erosion protection that matter for fertilizer use, esp. leakage or loss). The standards are to:

- maintain a stable area of permanent grassland;
- protect wetlands and peatlands;
- maintain soil organic matter and soil structure through a ban of burning arable stubble;
- protect water from pollution through the establishment of buffer strips along water courses;
- prevent soil erosion through relevant practices;
- protect soil by defining rules for minimum soil cover;
- preserve the soil potential through crop rotation;
- maintain non-productive areas and landscape features, and ensure the retention of landscape features through, for example, a ban on cutting hedges and trees during the bird breeding and rearing season;
- protect environmentally-sensitive permanent grasslands in Natura 2000 sites.

Eco-schemes

Introduced in the recent CAP reforms, and in contrast to the earlier "greening", eco-schemes are voluntary measures that Member States may choose to draw on under their respective direct payment schemes at their own discretion, as long as they are legally in line with the guidance in Article 31 of the Strategic Plan Regulation (Runge et al., 2022).

Eco-schemes are funded by the European Agricultural Guarantee Fund (EAGF), and they grant recipients annual payments for *voluntarily* adopting specific more sustainable practices, such as precision farming, reduced fertiliser use, and improved soil management. Some eco-schemes have direct repercussions for fossil energy use. Although all member states are expected to earmark 25% of their budget for the voluntary scheme, there is high variance among Member States in terms of how many eco-scheme measures are available to farmers (between 3 and 21) considering the variety of environmental preferences and natural resource settings and policy objectives that EU countries may have in relation to environmental aspects like animal welfare or climate (Runge et al., 2022). Accordingly, the complexity and level of ambition of individual measures of countries vary quite dramatically. Overall a strong emphasis is on the matter of biodiversity enhancement and non-productive land, prominently through support for organic farming (Runge et al., 2022). Another focus is on greenhouse gas emission reduction esp. through interventions on agricultural soils, aimed at storing more carbon and decrease nitrous oxide and methane emissions, or on reducing the quantity

of fertiliser or pesticides used including through precision technology application as to increase the efficiency of agro-chemicals. In the Netherlands and Ireland, for instance, eco-schemes focus on reducing fertiliser use and enhancing soil health through precision farming techniques. Germany implemented eco-schemes that prioritize the reduction of greenhouse gas emissions from agriculture. (Runge et al., 2022; For more detail on specific country implementation: see case study Part II)

In the current CAP programming period (2023-2027), a total of €44.7 billion is available for eco-schemes measures in the members states with potential environmental or climate outcomes.

Implementation and effectiveness

Although way too early to judge the performance of the voluntary measure implementation is being examined through a dedicated EU CAP Network thematic group on eco-schemes with the objective to optimise design and implementation through knowledge sharing success factors in relation to design, good practices in administrative procedures or efficient verification and dealing also with questions of awareness raising and other uptake (or reluctance) factors (EU CAP Network, 2023). As a new tool in a new CAP funding period, a number of issues were raised on eco-schemes already in its early stages of implementation that concern matters of simplicity and ensuring accessibility to farmers of all farm types and sizes or the quality of advisory services or opportunities for knowledge exchange among farmers. It is also still to be seen how eco-schemes will fulfil the principle of increasing environmental ambition over time, importance of involving farmers in the design process, need for high quality advice and opportunities for knowledge exchange (Runge et al., 2022). Also, because the success of the voluntary measure hinges on the will of farmers to participate and not only the financial incentive, the complexity of the measure remains a major hurdle, which is often beyond cognitive capacities

Pillar 2 is broadly speaking focused on supporting rural development projects. The corresponding financial instruments and regulatory measures support environmental sustainability, economic viability, and social well-being in rural communities. Overall the pillar 2 measures allow for investments for achieving three long-term objectives: Fostering the competitiveness of agriculture and forestry; Ensuring the sustainable management of natural resources and climate action; Achieving a balanced territorial development of rural economies and communities (European Commission, n.d.-e). Pillar 2 measures are strongly oriented at national policy priorities in relation to these overarching objectives.

The European Agricultural Fund for Rural Development (EAFRD) finances initiatives under pillar 2, with at least 30% of the funding dedicated to climate action and environmental measures For the European agricultural fund for rural development (EAFRD), the total allocation amounts to €95.5 billion. This includes €8.1 billion from the next generation EU recovery instrument to help address the challenges posed by the COVID-19 pandemic. Around 30% of the recovery funds have become available in 2021, with the remaining 70% released in 2022. The measures under pillar 2 receive considerable co-financing through national budgets (European Commission, n.d.-a; European Commission, n.d.-e)

Since 1992 environmental objectives have gradually become an integral part of pillar 2 funding with the establishment of agri-environmental schemes as general measure for all member states. The target of reducing emissions from agriculture is an explicit focus since 2015 when the schemes was renamed as agri-environmental *and climate* scheme (AECS). The recent measures resemble broadly those from the 2014–2020 CAP Programming period (Barral & Detang-Dessendre, 2023).

Other policy provisions

In principle there is a range of policies especially in the environmental sector that may impact on the use of fossil energy or fertilizers on farms – though in very indirect ways, like that in order to increase the water quality of the country there is a general reduction of nitrogen that may be applied to soil. While not further elaborating on most of this broader set of policies (like Water framework directive, restoration law or Carbon Removal framework), the analysis will very briefly elaborate on the Nitrate Directive tied to the so-called Water Framework Directive.

The Nitrates Directive is aimed at protecting water quality across Europe by preventing nitrates from agricultural sources to pollute ground and surface waters and by promoting the use of corresponding good farming practices. The Directive aims to reduce water pollution caused by nitrates used in agriculture by:

- monitoring nitrate concentrations of water bodies
- designating nitrate vulnerable zones
- establishing codes of good agricultural practices and measures to prevent and reduce water pollution from nitrates

The Nitrates Directive requires EU Member States to monitor the quality of waters and to identify areas that drain into polluted waters or at risk of pollution. These concern waters that due to agricultural activities are eutrophic or could contain a concentration of more than 50 mg/l of nitrates. Those areas are defined as Nitrate Vulnerable Zones (NVZs).

The Nitrates Directive forms an integral part of the overarching Water Framework Directive and is one of the key laws protecting waters against agricultural pressures. The commission launched a public consultation on the evaluation of the Nitrates Directive. Interested parties such as farmers, industries, NGOs, citizens, public administrations, water authorities and others are invited to share their views until **8 March 2024** to evaluate if the Nitrates Directive remains fit for purpose. Another public consultation followed between April and May this year on a Commission Directive amending Annex III of the Nitrates Directive.

Implementation

According to the Nitrated Directive, EU countries must:

- Designate Nitrate Vulnerable Zones (NVZs)
- Establish Codes of Good Agricultural Practice implemented voluntarily by farmers
- E.g. establish action programmes by farmers within NVZs on a compulsory basis, as to i) limit the application of nitrogen from manure; ii) identify polluted water, or waters at risk of pollution; iii)

Synthesis and discussion of shared EU policy framework

Various EU-policies serve as common policy framework for all member states and are highly relevant for further developing and promoting the uptake of promising technologies to reach fossil energy independence and GHG emissions targets. Others may play a hampering or rather ambiguous role. In the case of regulations, EU policies apply quite directly to member states. However, most of the EU policies under consideration and represented in our policy map as a result of consortium member and literature consultation are rather framework decisions that spell out joint "strategies" in the broadest sense, sometimes with more or less explicit and more or less legally binding objectives and concrete targets. Generally, EU institutions, such as the European Commission, hold considerable legislative authority for developing strategic policy frameworks, particularly through their directives and regulations that codify the commonly shared goals of EU member states in more or less direct and explicit ways. Also, there is a certain 'implementation force' behind the EU system of setting 'binding' targets and reporting on their achievements regularly. Eventually the system relies heavily on reporting and monitoring as well as the exchange of best practice for compliance.

The most concrete and immediate targets of relevance for 2030 are indeed those in relation to the Fit for 55 and the F-2-F and Biodiversity strategies, that may be summarised with the below short list of targets:

- **>55% less net GHG emissions by 2030**
- **25% target of organic by 2030**
- **Reducing nutrient loss from fertilisers by at least 50%**
- **Reducing fertilisers by 20%**

With the 55% target being part of the EU climate law, i.e. an EU level regulation, the target has a prominent legal status. Beyond that, the organic target holds a certain legal weight, because it is an integral part of (pretty much all) member state CAP strategies and achievement needs to be reported on to the European Commission. CAP is a major vehicle for addressing the reduction target of fertiliser use in the EU. In addition, fertiliser use reduction is also, though fairly indirectly, addressed in the Sustainable Use Directive of 2009, the Water Framework and Nitrate Directives.

Also, just from EU level analysis of policies in relation to the energy price increases (in context of the Ukraine war) it is not possible to infer straightforwardly that EU level policies would have directly impacted on the price of fossil based inputs such as fertiliser or energy at farm level, not least because national states choose to apply own and more immediate "price mitigation" measures often with even more legal weight than EU level *voluntary* reduction target (15% for natural gas demand for EU countries for the winter 2022-23) or corresponding "soft" recommendations and communications at EU level. Overall, the share of EU gas imports from Russia was reduced from 45% (in 2021) down to 15% in 2023. However, in itself such diversion from one to another source of energy may only very indirectly address the problem or even exacerbate the dependence, because with reduced eligible sources of fossil energy market price has experienced a significant increase. Their role may be seen as rather 'ambiguous', because while the policies have themselves spurred price surges they have at the same time triggered a range of policy interventions as well as higher commitment towards transitioning from fossil to renewable energy or achieving energy efficiency quicker. Policies that hold a particular relevance in this context are the amended Renewable Energy and Energy Efficiency

Directives with their corresponding legally binding targets, some of which have actually risen considerably in ambition more recently and under the impression of the war and energy price volatility.

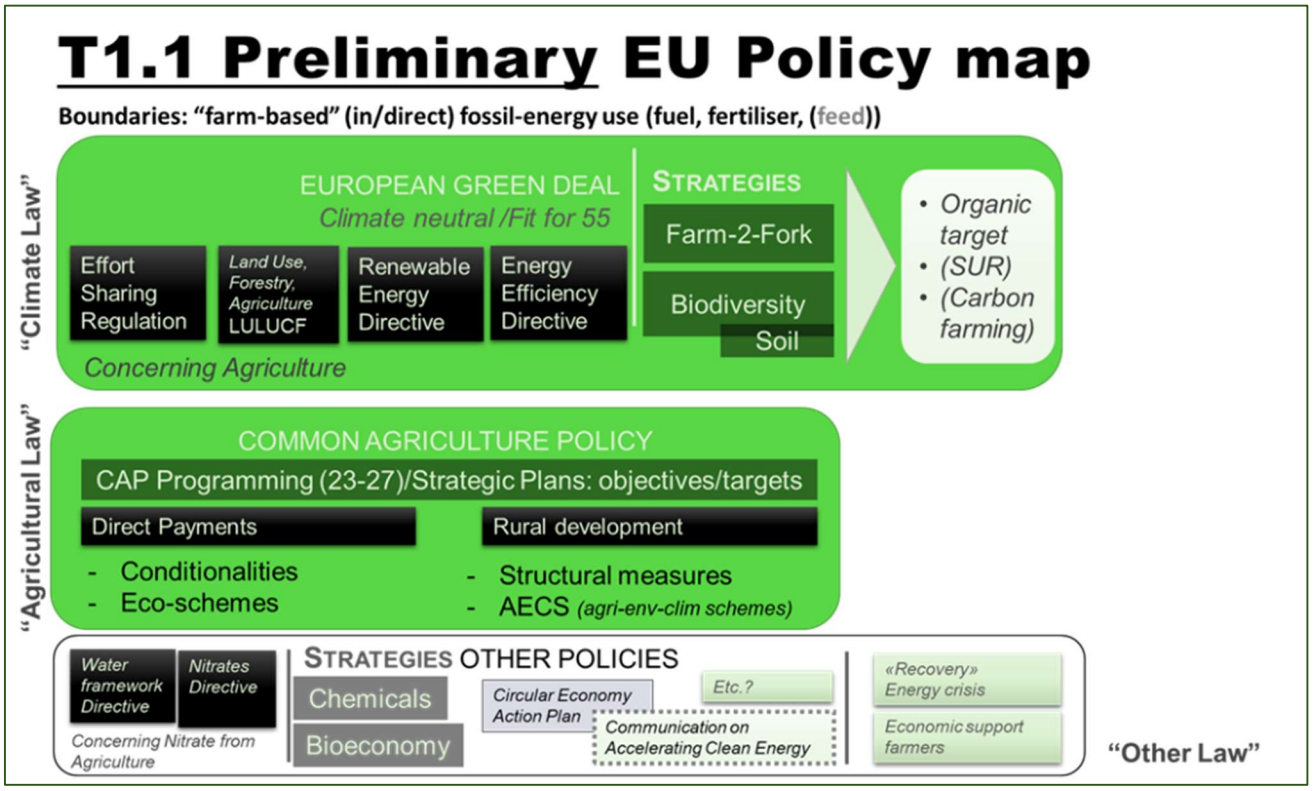

Figure 12. preliminary EU policy map (long list) as discussed with experts & stakeholders

In terms of **energy use** the **EE Directive** foresees an overall **reduction target of 32.5% for 2030**, as compared to projections for the EU-wide reference scenario for 2020, however with a certain black box what this target implies for the agricultural sector. Regarding the share of renewable energy in the EU, the **Renewable Energy Directive** sets a **binding target of 42.5% for 2030,** and an **ambition to reach 45%.**

The **Common Agricultural Policy** (short: CAP) is the most significant policy framework in support of agriculture across Europe and as described it is also a key vehicle for the implementation of the European Climate Law or the Green Deal more generally including the Farm-to-Fork and Biodiversity Strategies but also of the EE and RE Directives for the sector. In principle, it has a key role for achieving energy, or climate related objectives of the sector. Among others (there are in total 44 indicators), members states are also obliged to report on the achievement of their performance in relation to policies that target fossil energy independence in the sector concretely, namely:

- on farm modernisation incl. resource (energy) efficiency (Indicator R.9
- renewable energy production capacity (Indicator R.15)
- investment in production of renewable energy or biomaterial (Indicator R.16
- sustainable /improved Nutrient Management (Indicator R.22)

Recently the principle of subsidiarity has regained traction in the design and application of EU policies, including and particularly on agriculture (CAP). This limits to a certain extend the possibility to suggest that EU policies were the key lever for an actual or even direct impact on fossil energy independence

in practice and at farm level. In practice, member states are free to choose the concrete measures for CAP implementation in their countries and they may also choose to not address the priority areas in their concrete CAP strategy and to not report on their performance, accordingly. However, on a principle note, numerous countries offer financial support to farmers for investments or maintenance of specific technologies, innovations or farming practices from either pillar 1 or pillar 2 of CAP.

Still many EU level targets may vary partly considerably among EU member states (see data on Effort Sharing, Table 4, Organic targets, Table 6). Another pertaining issue is the actual difficulty to anticipate relevance and impact of very recent policy programmes in the context of Green Deal and new CAP programming. The programming is only 1.5 years young and in parts there is an expectation that adjustments may be made along the way.

It is against this background that this analysis has a dedicated section on country case studies to explore in further depth how the framework policies are principally implemented in country contexts, how specific targets have been translated, and how we may anticipate (where possible already, and partly drawing on empirical experience with predecessor policies) and assess their ‘forcefulness’ toward the objective of achieving fossil energy independence on farms.

Part 2: case studies of relevant national policies

Within the commonly shared policy framework of the EU, member states hold considerable discretion for implementing EU law. There are significant nuances between how nation states chose to implement EU law in line with their political culture, institutions or policy agendas. distinct member states. Further policy variation may arise within member countries that are further sub-organized into federal states or regions. In order to allow for cross-country comparison and data coherence the national sections follow, whenever possible, a similar approach to and structure of presenting the policy analysis by carving out all relevant national targets and policies or measures linked to their implementation of:

- the European Green Deal, particularly in relation to
    - Effort Sharing Regulation
    - LULUCF/AFOLU
    - Renewable Energy Directive
    - Energy Efficiency Directive
    - Farm-to-Fork Strategy and,
    - Biodiversity Strategy.
- Agrarian Policy under the CAP, particularly as concerns the incentivisation of energy or fertiliser use reduction or renewable energy application such as precision farming or the transition to organic farming and how they are covered in
    - recent CAP Strategic Plans including specific measures under
    - pillar I or pillar II payment schemes
    - or corresponding eco-schemes or climate measures
    - or organic action plans
- Other policies, only indirectly linked to the above, that more or less directly concern
    - reductions in use of fertiliser or fossil fuel or related fossil energy-based inputs, e.g. Nitrogen pollution or Water Quality related policies
    - price fluctuations for fossil energy (based) inputs, esp. in the context of the Ukraine war
    - financial support measures for primary producers with a focus on price fluctuations for fossil energy or other fossil energy-based inputs, e.g. diesel tax or insurances against price fluctuations

The analysis is provided as country profiles for specific focus countries that are representative of the afore-mentioned clusters: the case study sample reflects different regions with different (combinations of) production types of high relevance to the subject of energy dependence. The analysis in Part II

will elaborate on the implementation of specific relevant EU policies in six member states from those five focus regions.

1. Poland
2. Western Europe: Netherlands & Germany
3. Southeast Europe: Hungary
4. Mediterranean: Greece
5. North Europe: Sweden

Western Europe: Germany

Summary

Germany is driving decarbonization in its agricultural sector through diverse policies. Central is the 2019 Climate Protection Act mandating 65% emissions cut by 2030 (BMUV (German Federal Ministry for the Environment, 2021) compared to the 1990 emission level and thus achieving the European climate protection target for 2030. To meet this target, Germany employs a multi-pronged approach involving agricultural incentives under laws like the Renewable Energy Sources Act ("Erneuerbare Energiengesetz", EEG) promoting, among others, farm-based renewables, environmental regulations limiting pollution, and energy policies boosting renewable integration and efficiency. In Germany, there are various tax incentives for investments in sustainable technologies in agriculture (especially under the Climate Protection Act & EEG). Specific measures focus on improving nitrogen use, expanding biogas, preserving carbon sinks, optimizing livestock, and organic practices. While voluntary now, binding policies like green gas blending obligations are planned. Complemented by the EEG's feed-in tariffs and research funding, this regulatory approach aims at transitioning agriculture away from fossil fuels while maintaining productivity and meeting sustainability and climate goals (BMWK (Federal Ministry for Economic Affairs and Climate Protection), 2022).

Federal Climate Protection Act

With the Federal Climate Protection Act (Bundes-Klimaschutzgesetz) Germany has establishes legally binding greenhouse gas emissions reduction targets for different sectors of the German economy, including specific goals for agriculture. It serves as the overarching legal framework driving decarbonization efforts across sectors.

As key **policy target**, the Act mandates a 65% reduction in agricultural emissions by 2030 compared to 1990 levels (BMUV (German Federal Ministry for the Environment, 2021). Introduced in 2019, there are numerous specific measures to meet emissions targets in the agricultural sector:

- *Improving nitrogen use efficiency and limiting surpluses*
- *Boosting biogas/bioenergy production from agricultural residues like manure*
- *Preserving carbon sinks like forests and permanent grasslands*
- *Optimizing livestock management to reduce emissions*
- *Encouraging organic farming practices*
- *Funding research into emissions reduction techniques*

One of the Act's core objectives is fulfilling climate targets through the expansion of renewable energies. Biogas and other bioenergy from agricultural residues play a key role, directly relevant to the agricultural bioeconomy. The Climate Protection Act supports the reduction of greenhouse gases and offers tax incentives for investments in climate-friendly technologies, including in agriculture (BMWK (Federal Ministry for Economic Affairs and Climate Protection), 2022). Monitoring and data collection efforts are required to track progress on the emissions reduction targets in line with the EU frameworks. The overarching targets and policy signal established by the Act provide direction for complementary measures, regulations and research priorities that fall under AgEnRes' scope.

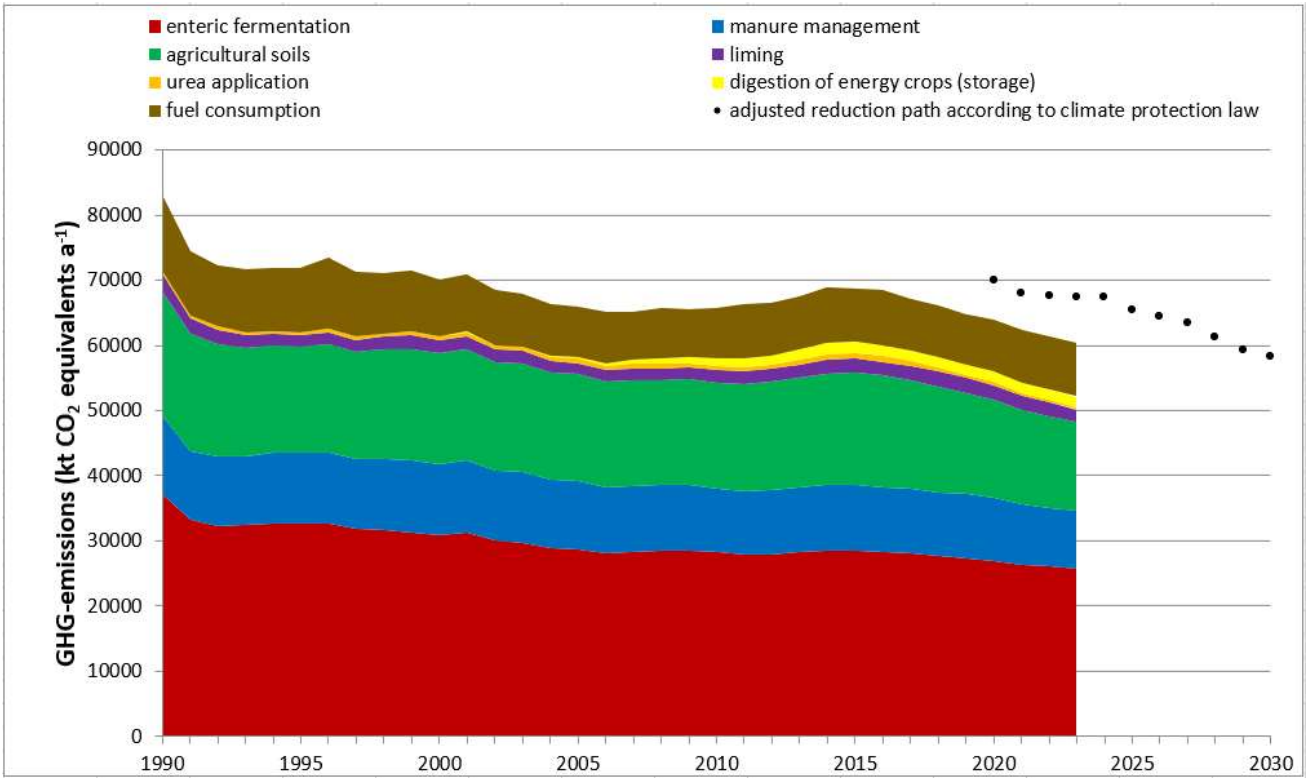

Figure 13. Annual GHG emission from German agriculture (submission 2024) and prior years (estimate)

(GWP CH4 = 28; GWP N2O = 265)

Source: Calculations of gaseous / particulate emissions from German agriculture 1990-2022 (Vos et al., 2024).

The Renewable Energy Sources Act

The Renewable Energy Sources Act (Erneuerbare Energien Gesetz, EEG) is Germany's main policy mechanism to promote the expansion of renewable energy sources in the electricity sector. It provides financial incentives through 'feed-in tariffs' and priority grid access for renewable electricity. The overarching **policy target** is to increase the **share** of renewable energy sources in Germany's **electricity** consumption to **at least 80% by 2030**. The EEG aims at facilitating the transition towards a sustainable, climate-friendly electricity supply.

Originally the EEG was introduced in 2000, with major revisions taking place in 2014 and 2023 (Umweltbundesamt (German Environment Agency), 2023). In the agricultural sector, the EEG incentivizes the production of biogas and other bioenergy from agricultural residues by providing feed-in tariffs. It also promotes the installation of photovoltaic systems on agricultural buildings like barns and stables more recently (BMWK et al., 2023). The 2023 revision includes further provisions for 'innovation tenders' to support new technologies like green hydrogen production, which could utilize agricultural feedstocks.

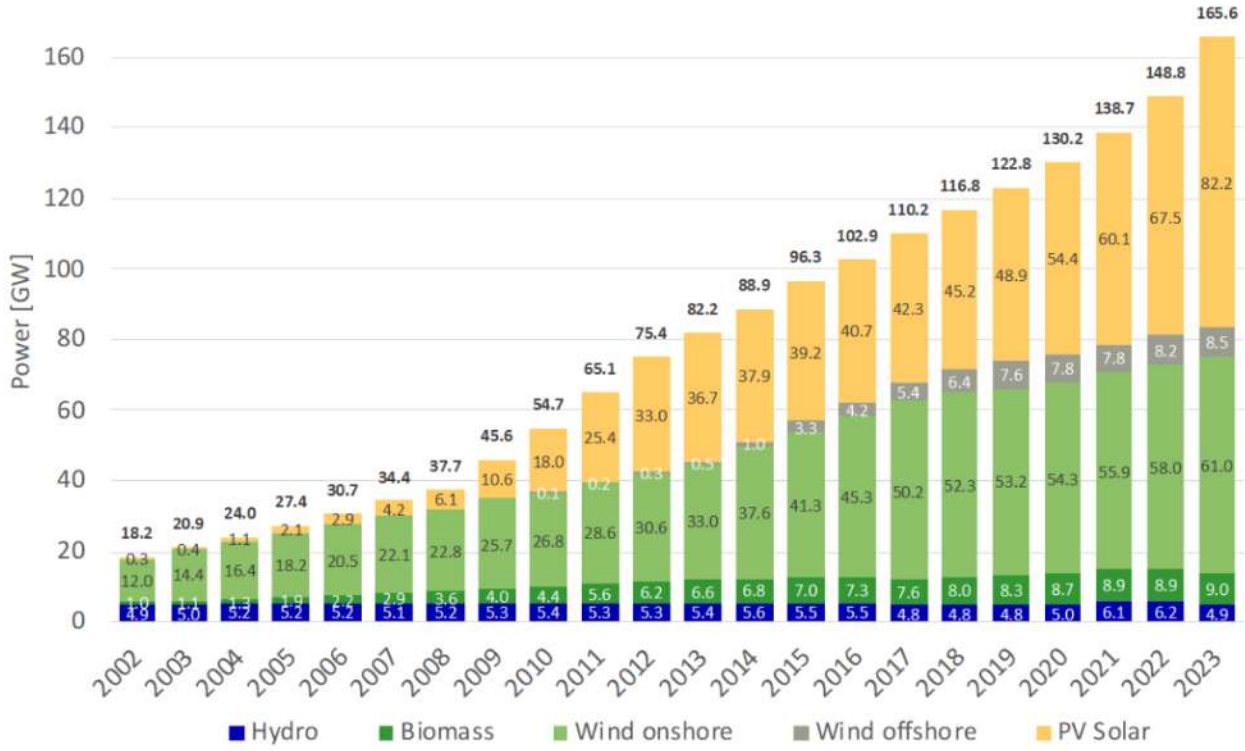

Figure 14. Renewable energy contribution and their development in Germany 2002-23 (in GW)

Source: (Philipps & Warmuth, 2024) *p.23*

Regarding the promotion of agri-PV installation the revised EEG encourages multiple use approaches in agriculture. However, in an effort to reduce detrimental effects for other objectives like biodiversity additional PVs in agricultural areas are limited to a maximum of 80 Gigawatt by 2030 and 177.5 GW by 2040. In the call for new installation supported by the federal ministry agri-PV and other “special” PV are also eligible for a higher reimbursement of energy (9ct/kW). A special “biodiversity PV” is in the making with special conditions. (BMWK et al., 2023)

BLE Funding Program for Energy Efficiency

This two-stage program first supports the creation of a CO2 savings concept and then the implementation of individual measures to increase energy efficiency on agricultural farms. Funded are energy consulting, CO2 savings investments, knowledge transfer, research and development, as well as the expansion of renewable energies and efficient heat and cold supply.

This federal programme aims at achieving the goals of the Climate Action Plan 2030 in agriculture and horticulture. This includes reducing CO2 equivalent by 16 million tonnes compared to 2014 (BLE (German Federal Office for Agriculture and Food), 2023). In order to achieve this goal, companies in primary agricultural production that switch to climate-friendly technologies will receive financial support.

Introduced in 2019 the funding programme is financed by the federal government's Energy and Climate Fund (EKF). A total of 156 million euros is available for the period until the end of 2023 (BMEL (Federal Ministry of Food and Agriculture), 2020). It provides funding for consulting, technology

investments, research and development related to energy efficiency and renewable energy, including on farms.

Energy price policies

Energy price freeze – war Ukraine

The sanctions imposed on Russia in the context of the Ukraine war, particularly targeting Russian gas imports, led to a significant rise in energy prices, which in turn resulted in considerably higher costs for end consumers (Destatis (German Federal Statistical Office), 2023). To mitigate the sharp increase in energy costs, the German government implemented several measures. One key initiative was the introduction of energy price caps for gas and electricity in autumn of 2022. This regulation allowed private households, small and medium-sized businesses, and associations to pay a capped price for 80% of their projected annual consumption (based on estimates from September 2022). The capped price was set at 12 cents per kilowatt-hour for gas and 9.5 cents per kilowatt-hour for district heating, with any consumption exceeding this limit subject to the regular market price. This price cap expired in December 2023 (Bundesregierung (German Federal Government), 2024c).

Another measure to reduce consumer costs is the early abolition of the EEG levy in July 2022. The levy, which had been 3.72 cents per kilowatt-hour, was reduced to zero by transmission system operators, leading to a direct reduction in electricity costs (Bundesregierung (German Federal Government), 2022). In addition, the German government has retroactively reduced VAT on gas from 19% to 7% from October 2022, which applied until March 2024. This reduction also applies to district heating, which provides further relief for consumers. Therefore, gas from biogas plants, distributed through the natural gas grid, was also included (Bundesministerium der Finanzen (German Ministry of Finance), 2024).

To relieve the national CO2 pricing, which was introduced with the Fuel Emissions Trading Act (BEHG) in 2021, the increase in the CO2 price for heating oil, natural gas, and fuels by five euros per tonne (from 30 to 35 euros) planned for the beginning of 2023 has been postponed by one year (Bundesregierung (German Federal Government), 2024a).

Another planned relief package targeted the energy-intensive companies, as well as agriculture and forestry. This included a reduction in the electricity tax, with an annual funding volume of 3.25 billion euros. In addition, the electricity price compensation scheme was maintained, and the so-called "Super Cap" for energy-intensive companies, worth 1.18 billion euros, was extended (Bundesregierung (German Federal Government), 2023).

Agrarian diesel tax reduction

To address the budget shortfall in the 2024 federal budget, both spending cuts and additional revenue measures were adopted, including the elimination of subsidies for agricultural diesel. Currently, diesel used in agricultural and forestry vehicles in Germany benefits from a tax reduction of €0.2148 per liter, while the standard tax rate is €0.47 per liter. According to the government's initial plans, this tax refund was to be completely abolished. However, following protests by farmers in early 2024, a gradual reduction of the agricultural diesel refund was instead adopted. To provide affected businesses with an adjustment period, the reduction of tax benefits will be phased in over several years. In 2024, the refund rate will be reduced by 40%, followed by additional reductions of 30% in both 2025 and 2026 (Bundesregierung (German Federal Government), 2024b).

Agricultural policies – Common Agricultural Policy (CAP)

Like other member states, Germany's Agrarian Policy is subject to the legal framework provided by EU laws, particularly the Act on the Implementation of Direct Payments Financed under the Common Agricultural Policy which requires the country to also develop a strategic action plan, among other things. The funding foreseen under the German Strategic Plan amounts to around 30.5 billion EUR for the full period until 2027 (BMEL (German Federal Ministry of Food and Agriculture), 2023). As a federal country, agricultural policies is considerably shaped by the German "Länder" policies in pillar 2 and there are corresponding federal strategies developed which may imply that some federal states follow different political targets in agriculture (e.g. Baden Württemberg with an organic target of 40% until 2030 (Umweltministerium Baden-Württemberg, 2023) beyond the national 30%) or focal areas of support under pillar 2. According to political priorities, federal states may work with a diverse set of investment and support programmes. Baden Württemberg, for instance, uses a combination of regional rural investment and support programmes like the Förderprogramm für Agrarumwelt, Klimaschutz und Tierwohl (FAKT II support programme for climate mitigation and animal welfare), the established Agrarinvestitionsförderprogramm (agrarian investment support programme), regional development Programme LEADER and a women focused measure called "Innovative Massnahmen für Frauen im ländlichen Raum" (IMF, innovative measures for women in rural areas) (StM Baden-Württemberg, 2023).

With regard to the specific objective of energy independence in agriculture, there are indeed no specific *national agricultural-energy* laws, regulations or other legal acts that *specifically* target the subject of energy efficiency or the introduction of renewable energy in the agricultural sector specifically or as part of the implementation of the CAP 2023-2027 in Germany. This is indeed mostly handled under the renewable energy sources Act (Umweltbundesamt (German Environment Agency), 2023). Still the German CAP implementation draws on several measures in both pillars with a certain more or less direct relevance to the subject of fossil energy use as they relate to improving farm management or fostering innovation investments that exert an influence especially on (mineral) fertilizer use.

Pillar 1 Direct payments

Like in other countries, a considerable amount of the direct payments to farmers concerns the provision of basic income (total of 12.78 billion out of around 21 billion in total under pillar 1 for 2023-27 with around 300,000 applicants) (BMEL (German Federal Ministry of Food and Agriculture), 2024b). There is also a "top-up" for particularly small farms (12% of funds) and young farmers (3% of funds) (Infodienst Landwirtschaft (Agriculture Information Service), 2023). Coupled income support is earmarked only for mother cow /sheep/goat keeping for meat production (77Eur/cow; 34/sheep/goat) (Landwirtschaftskammer, 2024). While basic funding is received irrespective of sustainability of practices, EU-wide good agricultural and environmental conditions apply as "conditionality" for all basic income funding also in Germany. However, in the context of farmer protests and demands for less bureaucracy, as of Jan 2025 (applying back to 2024), certain conditions (abbreviated as "GLÖZ" in Germany) will no longer apply (e.g. GLÖZ 8 concerning the non-use of 4% of crop land) or are amended (like GLÖZ2 limiting the conversion of land us in peatland areas) (BMEL (German Federal Ministry of Food and Agriculture), 2024a). Over the funding period there is a certain decline in basic

income in favor of pillar 2 payments from around 158EUR/ha in 2023 to around 149EUR/ha in 2026 (Infodienst Landwirtschaft (Agriculture Information Service), 2023).

Eco-schemes (Öko-Regelungen)

Germany has earmarked 1 billion EUR *annually* for eco-schemes under pillar1, called "Öko-Regelungen" (BMEL (German Federal Ministry of Food and Agriculture), 2019) (Umweltbundesamt (German Federal Environmental Agency), 2024). They serve as a key and voluntary measure to incentivise sustainable agricultural practices beyond mere conditionality for CAP direct payments. The eco-scheme payments may also be applied for by farmers not subject to direct payments. If combined with pillar 2 payments for activities, like AECM or BÖL, the same activity/service may not be subsidised twice and pillar 2 premiums must be reduced accordingly.

The country offers seven eco-schemes (European Union, 2024a) and a number of them are explicitly assumed to have an indirect impact on the use of nitrogen/fertilizer including through:

- *non-production (eco-scheme 1),*
- *crop diversification (increasing soil fertility; obligation to at least 10% legumes, eco-scheme 2)*
- *avoidance of leakage /nutrient loss or build-up of SOC (e.g. agroforestry; eco-scheme 3).*

Regarding extensification of grazing, eco-schemes 4 and 5 work through limiting the eligible heads of animals on grassland (ÖR 4) and/or further reducing the use of fertilizer (ÖR4: allowing plowing). The suggested link to nitrogen reduction is very indirect in eco-scheme 5, which also works as the only results-based payment among the 7 eco-schemes – tied to the presence of specific grassland species (defined at "Länder" level) (BMEL (German Federal Ministry of Food and Agriculture), 2019). Payments vary depending on ecoscheme type and sub-type (e.g. defined by agricultural practice (cropland, permanent crop, grassland)), year of implementation, or implementation levels (e.g. higher payments for first ha) and range between 45EUR and 1300 EUR (non-production only) per ha/farm.

With the exception of eco-scheme 5 (grassland species), uptake was lower than planned in 2023 which is suspected to be grounded in the complexity of (some) schemes, their novelty, as well as market dynamics vis-à-vis rather modest premiums. Also, the newly established exemptions for GAEC standards (Good Agricultural and Environmental Conditions) of CAP direct payments in 2023 are seen to have de-incentivised action. Based on the mixed experience, there have been adaptations in the eco-schemes (simplifications & payment increases) and further amendments are planned for 2025 which are expected to lead to higher "claiming" in 2024. In a current discussion with stakeholders, changes and additional schemes from 2025 are explored including how to make them more attractive, simple, but still ambitious (European Union, 2024a).

Pillar 2

Federal Organic Farming Programme (CAP pillar 2 component)

Under pillar 2, the Federal Organic Farming Programme provides financial support and incentives to promote the growth and development of organic farming in Germany. Key elements of the program include:

- direct payments to organic farmers to compensate for yield gaps and higher production costs compared to conventional farming
- funding for research projects to develop innovative organic farming techniques and improve productivity
- support for advisory services, training programs, and knowledge transfer to help farmers transition to and improve organic practices
- promotion of organic products through marketing campaigns and support for organic producer associations
- subsidies for investments in organic processing facilities and infrastructure

The program is jointly implemented by the Federal Ministry of Food and Agriculture (BMEL) and the Federal Agency for Agriculture and Food (BLE). The overarching goal is to increase the share of organic farmland in Germany to 30% of total agricultural area by 2030, up from around 10% currently.

The BÖL was first launched in 2002 as the Federal Organic Farming Scheme. It has since been expanded and extended multiple times, with the most recent extension in 2010 to include other forms of sustainable agriculture (Bundesprogramm, n.d.).

The program is financed through the federal budget, with an annual budget of around €30-40 million in recent years and it covers around 20% of the full budget under pillar 2 (BMEL (German Federal Ministry of Food and Agriculture), 2023). Additional funding comes from the EU's Common Agricultural Policy (CAP) and state-level programmes. As a full programme, BÖL offers diverse levers and works based on a set of different tax incentives and funding lines for farmers who (wish to) opt for organic farming and implement sustainable agricultural practices. BÖL directly supports the development of sustainable agriculture practices, including organic farming. The program's focus is on research, knowledge transfer, and investment support

Agri-environment-climate measures (AECM / AUKM “Agrarumwelt- und Klima-Maßnahmen)

Agri-environment-climate measures are *voluntary* sustainable practices that farmers may implement for a period of five years (BMEL (German Federal Ministry of Food and Agriculture), 2019). With the financial support incentives for behavioural change are provided by remunerating additional costs or forgone income tied to the application of new sustainable practices.

In Germany the implementation of AUKM measures is through the federal states which develop own programmes of the federal states for rural development reflecting state specific priorities and contexts. Since the 2014 progamming period support for Agri-environment-climate measures in Germany is handled as a separate chapter under the European Agricultural Fund for Rural Development with around 24% of the pillar 2 budget earmarked for this line (BMEL (German Federal Ministry of Food and Agriculture), 2023). Until then around one fourth of all EAFRD funding in Germany was for federal programmes on Organic farming, animal welfare and AUKM together supporting more sustainable practices. Through the federal funding line “Verbesserung der Agrarstruktur und des Küstenschutes» (GAK), federal co-financing may be claimed by states in implementing AUKM (BMEL/ German Federal Ministry of Food and Agriculture, 2019).

AUKM as a framework is implemented at federal state level according to funding priorities of the sixteen states (some small states cooperate, like Berlin with Brandenburg). Various measures, among many others oriented at animal welfare, climate and environmental protection, also focus on sustainable farm practices (soil health, mixed crops/legumes, reduced plant protection or fertilizer use, animal feeding) that have an impact on the use of fossil energy in more or less direct ways. Baden-Württemberg in its FAKT II programme, for instance, supports milk producers that use hay instead of silage and has established conditions to the related to maximum 1.7 livestock units per ha (forage consuming) (BMEL (German Federal Ministry of Food and Agriculture), 2017). The state also supports the conversion to organic agriculture with 430-1450 EUR /ha (crop/grassland vs. permanent crops) during the first 2 years and an additional 240-1000EUR (crops/grassland vs. permanent crops) for maintenance thereafter. In one of its grassland related measures (B7) farmers are incentivised to avoid mineral fertilisers over 5-year periods. Table 8 displays the range of maintenance payments offered for organic agriculture under pillar 2 among different federal states. Overall payments have increased by up to 25% compared to the 2019 funding period.

Table 8. Maintenance payments under federal AUKM

Land use	Arable	Vegetables	Orchards/hop	Grapes	Protected cropping	Grasslands
€/ha/a	220-314	375-680	850-1060	850	375-4210	190-284

Source: Reinecke et al., 2024b

Other Environmental Policies

Fertilizer Act

The **Fertilizer Act** (Düngegesetz) is national legislation aimed at regulating fertilizer use in agriculture. While principally harmonised with EU SUR and Nitrate Directives, it is not a direct one-to-one implementation of EU Directives. The Fertilizer Act has been in place since 2009, but is currently being amended, with the latest amendment draft from 2023.

The Fertilizer Act provides the legal basis for key provisions, like the Fertilizer Ordinance (Düngeverordnung), the upcoming Nutrient Flow Ordinance (Stoffstrombilanzverordnung), and a new Monitoring Ordinance. In essence it regulates fertilizer application and is aimed at avoiding nutrient surpluses and reduce ammonia emissions. In practice it obliges farmers to document on-farm fertilization measures and quantities to keep track of the corresponding fluxes.

With this the Act follows three major Policy Targets:

- *Protection of water bodies from nutrient input and pollution*
- *Preservation of soil fertility*
- *Promotion of sustainable agricultural practices*

The Fertilizer Act and related ordinances seek to reduce nutrient pollution from agriculture by regulating fertilizer use and promoting sustainable practices. This aligns with EU directives like the Nitrates Directive and is relevant for AgEnRes' work on sustainable agriculture.

Mediterranean: Greece

Summary

As in other countries, the National Energy and Climate Plan (NECP) forms the backbone of the climate policy in Greece. The related Renewable Energy Directive (RED) and other EU climate and energy frameworks have driven the initial adoption of renewable energy and sustainable practices in agriculture in Greece. Evaluations of past programmes have shown that financial support and technical assistance are critical for the adoption of new technologies at the farm level. These insights have shaped the design of current and future support mechanisms. Greece has made significant strides in promoting solar and wind energy, particularly within the agricultural sector. The government offers various incentives, including subsidies for installation costs and favourable feed-in tariffs for the energy produced. These measures have encouraged farmers to integrate solar panels and wind turbines into their operations, enhancing sustainability and energy independence. Although Greece is making significant efforts in promoting renewable energy and sustainable agricultural practices, its current measures are not as comprehensive and detailed as compared to other countries in relation to improving soil fertility or regarding fertiliser use efficiency.

National Energy and Climate Plan

Greece has committed to the European Union's climate targets and has developed its own National Energy and Climate Plan (NECP). This plan outlines specific measures for reducing greenhouse gas emissions and increasing the use of renewable energy. The NECP serves as a comprehensive framework guiding Greece's efforts towards a sustainable and low-carbon future. The NECP presents and analyses policy priorities and measures across a wide range of developmental and economic activities for the benefit of Greek society. The **National Climate Law**, adopted in 2022 (Law 4936/2022/17.5.2022), stipulates, *inter alia*, a reduction in greenhouse gas emissions **by 55% by 2030 and by 80% by 2040,** compared to 1990, with the ultimate goal of **climate neutrality by 2050** (MFA (Ministry of Foreign Affairs), 2023)**.**

The key policy priorities of the NECP for the **agricultural sector** (including shipping and tourism) are the following:

1. PPN.1: Promotion of Infrastructure for Natural Gas Use
2. PPN.2: Management and Utilization of Agricultural and Livestock Residues
3. PPN.3: Promotion of the Use of RES and Energy Efficiency Improvement Actions in Ports
4. PPN.4: Development of Domestic Production of Advanced Biofuels and Supply Chains for Their Use
5. PPN.5: Promotion of RES Use and Energy Efficiency Improvement Actions in the Agricultural Sector
6. PPN.6: Sustainable Tourism Development and Destination Management Plans
7. PPN.7: Promotion of RES Use and Energy Efficiency Improvement Actions in Tourist Units

Reduction of Greenhouse Gas Emissions and Environmental Targets

The major climate objective for Greece in the original NECP was to reduce total GHG emissions by at least 40% compared to 1990 (achieving a reduction rate of >42%). Equivalent reduction targets are to be achieved in relevant sectors both within and outside the emissions trading system (ETS), and

in line with corresponding Central European targets. Greece is expected to develop detailed measures and sector-specific targets under the Effort Sharing Regulation (ESR) framework to contribute to the overall emissions reduction goal.

The plan further specified quantitative targets for the reduction of national emissions of specific atmospheric pollutants and envisions corresponding roll out measures to support both the LULUCF and agricultural sectors, such as through organic farming, supply chain organisation, waste usage, or increased use of domestic biofuels. The rural development programme is sought to intensify afforestation efforts, to increase carbon removal from the LULUCF sector. Correspondingly, carbon removal from sinks is expected to continue to grow at least until 2040.

In the agricultural sector specific attention is given to methane (CH4) and nitrous oxide (NOx) emissions as significant GHGs. The plan suggests monitoring and mitigating these emissions through best practices and technological advancements. In the energy sector, the decommissioning of lignite-fired power plants by 2028 marks a major measure.

Carbon Farming

Greece is exploring various carbon farming initiatives to contribute to climate mitigation efforts. These initiatives include soil carbon sequestration and afforestation projects. By enhancing soil health and increasing forest cover, Greece aims to capture more carbon dioxide from the atmosphere, thus playing a critical role in combating climate change and promoting sustainable land use practices

Increase in the Share of Renewable Energy Sources (RES) in Energy Consumption

In the original NECP the following sector specific shares of renewable energy sources (RES) were envisioned:

- at least 35% in gross final energy consumption of
- at least 60% in gross final electricity consumption
- exceeding 40% in heating and cooling
- 14% in the transport sector (achieving 19% according to the relevant EU calculation methodology)

While the Renewable Energy Directive is a key framework for further specification CAP serves a central role in investment support.

Revised NECP of 2023

In alignment with the new national and European (Green Deal – ‘Fit for 55’) climate targets, the NECP has undergone significant changes building on the feedback from the European Commission. The new plan was presented in January 2023 and finalized and submitted to the EU by October 2023. Relevant updated targets of the NECP are:

- reduction in greenhouse gas emissions by 55% by 2030, compared to 1990 levels, and achieving climate neutrality by 2050.
- 80% share of renewables in electricity production by 2030.

- Energy Storage and Hydrogen: Increased targets for energy storage (batteries and pumped hydro) and the introduction of hydrogen technology.

With Greece's latest National Energy and Climate Plan the country has risen its targets for renewable energy to 28 GW by 2030, compared to 19 GW under the previous plan as to achieve 80% renewables in the country's energy mix by 2030. The European Commission has assessed Greece's draft updated NECP, submitted on 3 November 2023 (European Commission, 2023f) (see figure 15).

Greece's key objectives, targets and contributions

	2030 value submitted in the draft updated NECP	2030 target indicated by EU legislation	Assessment of 2030 ambition level
Greenhouse gas (GHG) emissions in ESR sectors (compared with 2005)	N/A	-22.7%*	No projections provided in the plan, but Greece would overachieve based on its nationally net -46% target for ESR sectors
GHG emissions in LULUCF (Mt CO_2 eq. net GHG removals)	-4.8	-1.154 (additional removals target) -4.373 (total net removals)**	Greece is projecting to meet the target
Energy Efficiency (final energy consumption)	15.4 Mtoe	14.6 Mtoe***	Greece's final energy consumption is above the indicated target resulting from EU legislation
Renewable Energy (share of renewable energy in gross final consumption)	44%	39%****	Greece's submitted contribution to the EU target is significantly above the one resulting from EU legislation

* under the Effort Sharing Regulation (ESR).
** under the Regulation on Land Use, Land Use Change and Forestry (LULUCF).
*** according to the formula set out in Annex I of the Directive (EU) 2023/1791 on energy efficiency and amending Regulation (EU) 2023/955 ('EED recast').
**** according to the formula set out in Annex II of the Regulation (EU) 2018/1999 on the Governance Regulation of the Energy Union and Climate Action.

Figure 15. Greece' key objectives and tragets on GHG, energy efficiency and renewables

(Source: European Commission (2023b).

Regarding Prosumers and Citizens the plan mentions a reserved capacity of 10 MW per sub-station to accommodate the needs of households, farmers and SMEs. It also mentions the programme 'Photovoltaic at STEGI' with 238 million EUR from the Recovery and Resilience Fund to support PV and battery systems for exclusive self-consumption. Regarding energy communities and consumers, a dedicated envelope of 100 million EUR under the Recovery and Resilience Facility will be mobilized. Additionally, specific technical assistance and an advisory mechanism will be established in support of energy communities.

Regarding Grids Greece plans to substantially reinforce its interconnection capacities with neighbouring countries, to reach the 15% interconnection target already by 2025, with an objective to reach an interconnectivity rate of 23.1% by 2030. The plan provides a clear and detailed investment plan in cross-border interconnection capacities up to 2035. Considerate of the numerous autonomous islands in Greece that also require internal connection capacities, the plan provides an overview of internal connections. However, the plan does not provide sufficient details on the necessary upgrade of the distribution grid (Solar Power Europe, 2023).

In addition to solar and wind energy, certain regions in Greece are exploring the potential of geothermal energy. This renewable resource is particularly beneficial for heating agricultural facilities, such as greenhouses. The regulatory framework for its use has recently been completed and the call for interest for the lease of geothermal exploration rights in four areas of Central Ki– Eastern Macedonia and Thrace is under way. In this context, it is evident that the introduction of specific incentives for the development of projects for the exploration and exploitation of high-temperature geothermal fields and the implementation of an effective licensing system are a priority for the development of the national policy in the field of geothermal energy (NECP) (MFA (Ministry of Foreign Affairs), 2023). Accordingly, it is of utmost importance to design and adopt specific measures to inform local communities in areas with important geothermal fields.

Renewable Energy Directive

Under the Renewable Energy Directive (RED), Greece aims at significantly increasing the share of renewable energy in total energy consumption. The country has made substantial investments in wind and solar energy projects to meet its targets. A $33 billion investment in power generation is foreseen to facilitate changes in Greece's energy mix, particularly for the period 2021-25 (see figure 16), meant to propel the country beyond its 2030 renewable energy targets (BloombergNEF, 2020).

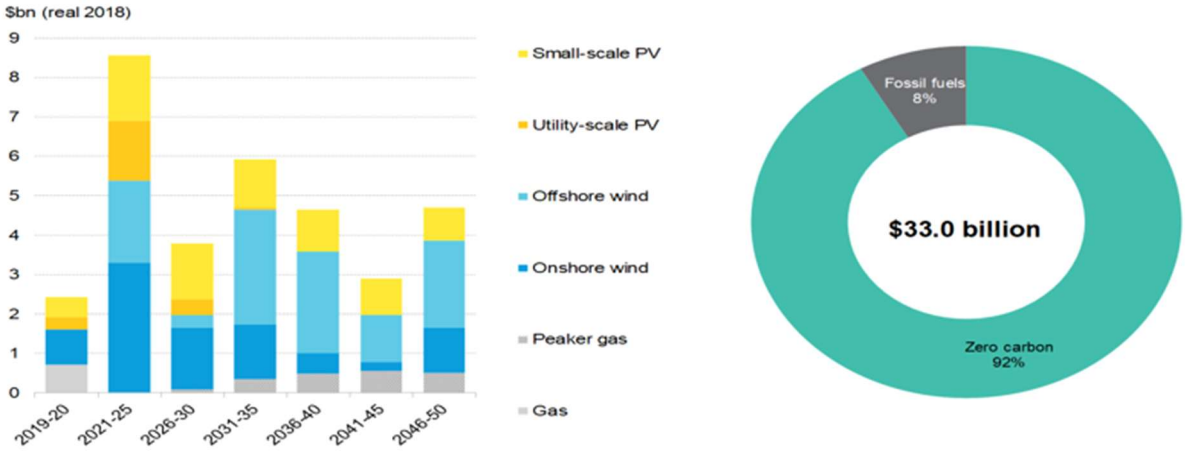

Figure 16. investment in new generating capacity (real vs. planned)

Source: (BloombergNEF, 2020)

National Renewable Energy Action Plan (NREAP): By 2025, renewable sources, primarily wind, are projected to constitute over half of the electricity generation, reaching around 68% by 2030. While this would be in line with Greece's earlier targets of achieving at least 60% renewable energy in total electricity consumption by 2030 there remains a gap to the revised targets. Looking ahead to 2050, renewable energy, including hydro, is foreseen to dominate the power sector, generating 96% of Greece's electricity. With this envisaged expansion of the renewable energy capacity, Greece is working towards significantly reducing its dependence on fossil fuels and enhance energy security.

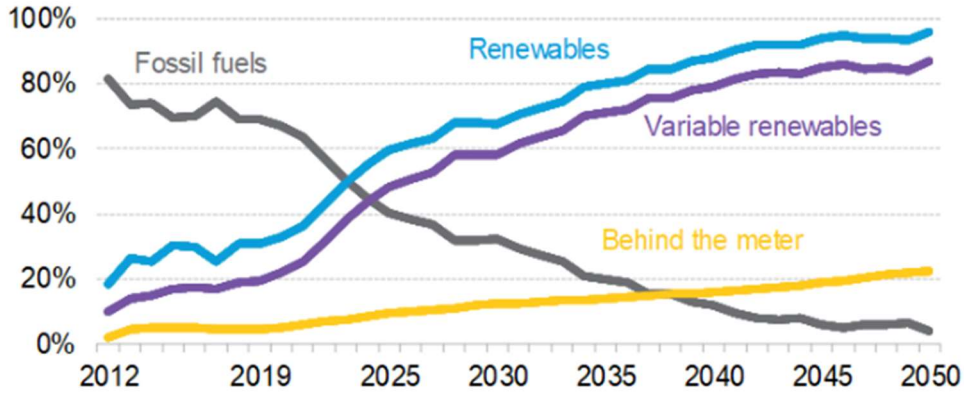

Figure 17. Relative share of electricity generation in Greece until 2050

Source: (BloombergNEF, 2020)

Greece made several significant changes to its support scheme for renewable electricity generation to increase the rate of deployment and ensure low electricity prices. Among other things, Greece is taking steps to reduce the time needed for licensing and permitting projects for renewable energy, electricity infrastructure and energy storage. In August 2022, Greece approved its first Offshore Wind Law, which aims for 2 gigawatts (GW) of offshore wind capacity by 2030.

In the last ten years, Greece has significantly reduced the share of fossil fuel in the energy mix. Once with one of the 'dirtiest' power producing sectors, Greece has managed to reduce emissions from electricity production by 64% since 2005, when the European Union first set up its emissions trading scheme. Greece's renewables are increasingly gaining market share and help replacing fossil fuels, particularly lignite. In May 2024, renewables accounted for more than half of the country's energy mix – a new record − with 54% of total electricity demand being met by solar, wind and hydro sources.

Energy Efficiency Directive

Greece implements various programs in line with the EU Energy Efficiency Directive, targeting improvements in buildings, industries, and transportation. These programs are designed to enhance energy efficiency across different sectors, including agriculture, as to reduce energy consumption, and lower overall emissions. Through these initiatives, Greece is promoting sustainable practices and contributing to the broader EU goals of energy efficiency and environmental sustainability. The targets to be achieved per NECP encompass:

- improvement in energy efficiency by 38% according to the European methodology
- Final energy consumption not to exceed 16.5 Mtoe by 2030
- Primary energy consumption not to exceed 21 Mtoe by 2030
- Cumulative energy savings of 7.3 Mtoe during the period 2021-2030
- annual energy renovations of 3% of the total floor area of heated and/or cooled buildings owned and occupied by central government by 2030

Price stability and relief policies

In response to the energy price spikes resulting from the Russian-Ukrainian war, Greece has implemented subsidies to assist farmers in managing increased energy costs. Greek farmers benefit from tax reductions on fuel used for agricultural purposes. This includes rebates on excise duties for diesel used in farming machinery. The Greek government provides direct subsidies to reduce the cost of fuel as to stabilize production costs and ensure that Greek farmers remain competitive in the market. These subsidies are designed to stabilize energy prices, ensuring that energy remains affordable for agricultural production and mitigating the impact of volatile energy markets on the farming sector.
To address the increased energy costs faced by farmers, the government will ensure that farmers participating in cooperative schemes (cooperatives, organizations, producer groups, etc.) and those practising contract farming will receive a medium-term cost reduction of at least 30% compared to current prices, for a decade (Υ.Π.ΕΝ (Greek Ministry of Environment and Energy), 2024b).

To achieve this, the government will prioritize and subsidize the construction of photovoltaic parks with batteries, which will be made available exclusively to these categories of farmers through long-term bilateral electricity supply contracts. These bilateral contracts, similar to those used in the industry, will be implemented within two years from the measure's application. An additional 10% discount on agricultural electricity (Υ.Π.ΕΝ (Greek Ministry of Environment and Energy), 2024b), following a decision by the Public Power Corporation (DEI). The discount will be effective from May through September (months of high agricultural consumption). Granting the Advance Payment and Refund of the Special Consumption Tax (SCT) on Internal Combustion Engine (DIESEL) Fuel Used Exclusively in Agriculture for the Year 2024 following paragraph 1 of article 73 of law 2960/2001 (A'265).

To address the rising costs of fertilizers exacerbated by the war, the Greek government has provided financial aid to farmers. This assistance includes subsidies and grants designed to help farmers purchase fertilizers at more stable prices.

Support of renewables to support energy independence

Greece is one of the countries that has also accelerated its support for renewable energy projects to reduce dependence on imported fossil fuels. This initiative includes fast-tracking permits for renewable energy installations and increasing financial incentives for the adoption of renewable energy in agriculture.
To further reduce reliance on fossil fuels, Greece has, for instance, initiated programmes supporting the use of biomass and biofuels in agriculture. These programs provide financial incentives to farmers for the production and utilization of biofuels. By leveraging agricultural by-products and other organic materials, farmers can generate renewable energy, contributing to environmental sustainability and economic resilience.

One way of Greece supporting bioenergy is through public-private co-financing of projects with private companies to share the financial risk of setting up advanced biofuel production facilities. Along similar lines, Greece supports feedstock development: Subsidies or tax breaks could be offered for cultivating or processing specific feedstocks suitable for advanced biofuels, promoting a sustainable supply chain.

Various National Research and Innovation Funds benefit universities and research institutions working on advanced biofuel technologies. Also, in the Horizon 2020 context Greece participates in EU research programs on advanced biofuels, like in the MUSIC project (MUSIC, n.d.).

Under the National Recovery and Resilience Plan the Ministry of Environment and Energy's has set up a programme for "Photovoltaics on the Field," with a Budget of 30 Million Euros. Beneficiaries will receive a 30% subsidy, up to 350 euros per kW, with the subsidy amount not accumulating with the de minimis aid received by farmers. It is clarified that for applications with a capacity of up to 30kW, net metering is applied. For applications from 31kW to 50kW, consumption coinciding with the photovoltaic station's production at the same time is offset, and any excess production is compensated at a fixed price by the Renewable Energy Sources Operator and Guarantees of Origin (DAPEEP - as a simple self-producer) (Υ.Π.ΕΝ (Greek Ministry of Environment and Energy), 2024a).

The "Produc-e Green" initiative aims to support investment projects in the production of goods within the green industry sector, with a focus on the manufacturing sector and the electromobility supply chain, renewable energy sources, as well as products and goods intended for energy savings. The objective of this initiative is to achieve technological, productive, administrative, and organizational upgrades, as well as innovative and outward-looking development and growth. The ultimate goal is to enhance the competitive position of manufacturing enterprises in both the domestic and international markets. According to Article 11 of the Joint Ministerial Decision of the Action. As amended and currently in effect, the aid intensity rates are determined according to the regional aid map in force on the application submission start date and are reflected in Tables 2 and 3 of the FAQ document (Hellenic Republic, 2024).

A significant milestone is the "Apollo" program (N.5106/2024, ΦΕΚ 63A/1.5.2024 reg.3468/2006 A'129 article 14Δ), the largest energy net metering program with green energy in the country. Through competitive processes, mature RES projects will be selected, which will begin electrification within two years. The energy supplied from these projects will be used to cover part of the energy needs of vulnerable citizens, local government authorities (OTAs) of the first and second degree, municipal water and sewerage utilities (DEYAs), as well as Local and General Organizations for Land Reclamation (TOEVs and GOEVs). Through the "Apollo" program, TOEVs and GOEVs will experience significant and permanent relief from the energy costs that hinder their critical mission and stifle their developmental potential (Hellenic Republic, 2024).

Agricultural/ Environmental Strategies

Biodiversity Strategy and Sustainable Use Regulation

Greece has developed a national biodiversity strategy in line with the European Union's targets aimed at reducing the overall use and risk of chemical pesticides by 50% by 2030 as to enhance biodiversity and promoting sustainable agriculture. By implementing sustainable agricultural practices, Greece wants to further preserve its rich natural heritage and ensure the health of its agricultural landscapes. In this effort,

With consideration of specific national or local challenges and tailored to specific environmental and agricultural conditions in Greece, it has further specified country specific reduction targets, such as to

additionally reduce the use of certain high-risk pesticides by 55% - a target even more ambitious than the general EU target.

Currently the EU Directive on the Sustainable Use of Pesticides (2009/128/EC) of 2009 and the corresponding National Action Plan (NAP) for the Sustainable Use of Pesticides form the legal framework for implementation of this strategy. They establish specific measures for training, inspection, and enforcement to ensure the safe use of pesticides.

In this context, Greece has implemented stricter national laws concerning the controls , registration and use of certain chemical substances. New policy strategies furthermore expand the monitoring and reporting requirements, but also increase the support for organic farming, and enhanced incentives for farmers to adopt sustainable practices. Greece explicitly promotes the use of biological (rather than chemical) control methods and integrated pest management (IPM) practices.

Organic targets / Farm to Fork (F2F) Strategy

In support of the EU's Farm to Fork Strategy, and to promote organic farming, while pending a specified national action plan, Greece has in fact national actions and policies in place to increase the share of area of organic farmland from around 17.6 in 2022 to more than 25% by 2027, three years before the corresponding target will apply for EU (EEA (European Environment Agency), 2023). The country plans for a considerable extension of the area under CAP as to encourage the adoption and maintenance of organic practices in the country. Land under support for organic is planned to increase from around 248,000 ha in 2018 to around 846,000 by the end of the current funding period (2027). To that end the country has increased the overall annual support for organic from 97 M€ to 259 M€ in the corresponding time frame – half channeled through ‘eco-schemes’ as major vehicle for maintenance under pillar 1. Overall and considering the considerable expansion foreseen, support slightly decreases from 390 € to around 306 € per hectare. In total, the budget for organic is planned to be around 1.5 billion € (11.2% of the overall available 13.3 billion CAP budget available to Greece) over the full programming period 2023-7 (Lampkin & Rees, 2023). Regional development support under pillar 2 provides incentives for farmers to convert to organic. In fact, for some crops payments have increased considerably in comparison to the prior programming period (Lampkin & Rees, 2023).

Common Agricultural policy (CAP)

Pillar 1: Eco-Schemes

With the aim to enhance the environmental performance of its agricultural sector and ensure long-term sustainability objectives, Greece, like other countries, has implemented eco-schemes under the CAP that directly support sustainable farming practices on a voluntary basis. A considerable amount (ca. 50%) benefits organic farming (Lampkin & Rees, 2023). Notably, the schemes are oriented at a reduced set of practices concerning encouraging crop diversification, the maintenance of permanent grasslands, or sustainable water management.

Pillar 2: Rural Development Program

Under Pillar 2 of the CAP, Greece's rural development programme focuses on several key areas to enhance agricultural sustainability and productivity. In fact, this explicitly includes investments into renewable energy installations on farms, such as solar panels and wind turbines. Additionally, the programme supports energy efficiency measures to reduce overall energy consumption and

promote the adoption of precision farming technologies, which optimize resource use and improve agricultural outputs. Regarding fertilizer use, for instance, Greece supports farmers by assisting them in purchasing digital application licenses that provide information on farms, soil sampling, management practices, crop history, and yield targets. This support allows farmers to manage cultivation, irrigation methods, plant protection, and nutrient balance more (energy) effectively.

Other interventions aim at reducing GHG emissions, by improving grazing land environmental conditions in areas prone to desertification, addressing erosion and pastureland degradation. Or through implementing a livestock programme that helps optimise diets and GHG emissions accordingly (European Commission, 2023f).

Renewable Energy Sources (RES)

Regarding the promotion of renewable energy sources in agriculture, Greece effectively utilizes European Union funds, particularly from the CAP (*pillar 2*), to support renewable energy projects on farms. These funds are instrumental in financing the installation of solar panels, wind turbines, and biogas production facilities.

The CAP funds under Pillar 2 typically cover up to 60% of the investment costs for renewable energy projects. The exact percentage can vary based on specific measures and regional priorities. For example, investments in biogas production facilities can receive up to 60% funding, with maximum support for installations up to 500 kW capacity. Solar panels and wind turbines are similarly supported, with specific caps on installed capacity to ensure broad participation and impact.

Eligibility Criteria for the funding schemes are farm size, project type and environmental compliance: Both small and medium-sized farms are eligible, with specific incentives for smaller farms to ensure equitable access. The funding is available for projects that contribute to the reduction of greenhouse gas emissions, enhance energy efficiency, and promote sustainable agricultural practices. Projects must comply with EU environmental standards and demonstrate clear benefits in terms of sustainability and resource efficiency.

Between 2014 and 2020, more than 300 biogas plants in Greece received support from the Common Agricultural Policy (CAP) funding for renewable energy projects. Additionally, there were significant increases in solar and wind energy installations on farms during this period
Under the current CAP framework (2021-2027), Greece aims to increase the number of beneficiaries of renewable energy projects by 20% annually. The focus is on reaching more remote and less developed agricultural areas. This is expected to include an additional 150-200 farms each year, thereby enhancing the overall impact of these incentives (Wikipedia, 2024).

Also for maintenance CAP offers subsidies for renewable energy installations that are in place to ensure the longevity and efficiency of these systems. With its National Support Programmes Greece offers subsidies for maintaining biogas plants and other renewable energy installations.

South-Eastern Europe: Hungary

Summary

Hungary has a set of policies in place aimed more or less directly at reducing the use of fossil fuels and fertilizers within the agricultural sector. Hungary's National Energy and Climate Plan takes a central role in addressing the matter of GHG emissions in all, including the agricultural, sectors and this way contributing to the European Green Deal, Renewable Energy Directive or Farm-to-Fork Strategy. The updated CAP Strategic Plan of 2022 marks a second important cornerstone for governing energy, fertiliser and renewable energy use in agriculture, with the most relevant funding instruments being the Agro-Ecology Program (AÖP); the Agricultural and Environmental Management Payment Scheme (AKG) and the Organic Farming Payment Scheme. It also relates to addressing energy price fluctuations and indirectly climate mitigation in agricultural production and land use. Beyond that, relevant policies are aimed at mitigating the price fluctuations that agricultural producers have to deal with in the current global political and economic context.

EU Green Deal implementation in Hungary

National Climate Change Strategy (NCCS)

In 2018 Hungary has accepted its second National Climate Change Strategy for the period 2018-2030 with visions for 2050. It was developed by the State Secretariat (in charge of climate policies) in cooperation with the National Adaptation Centre (ITM (Ministry of Innovation and Technology), 2018). In its National Decarbonisation Roadmap and the National Adaptation Strategy relevant guiding principles for the agricultural sector are spelled out. The Strategy highlights the particular relevance of the agricultural sector for "*the increase of energy efficiency and mobilizing energy savings*" (p.15) and for decarbonization of the sector. For the sector, the National Decarbonisation Roadmap (HDÚ) foresees a more efficient use of resources and the production of biomass and use of residues for energy use and for more efficient crop production. Along the same line, the National Adaptation Strategy (NAS) outlines similar aspects (biomass, precision, organic farming) with a primary focus on water-related (retention, flood prevention, improving soil saturation, etc.) adaptation challenges. Relevant short and mid-term action plans under HDU and NAS are summarized in figure 18.

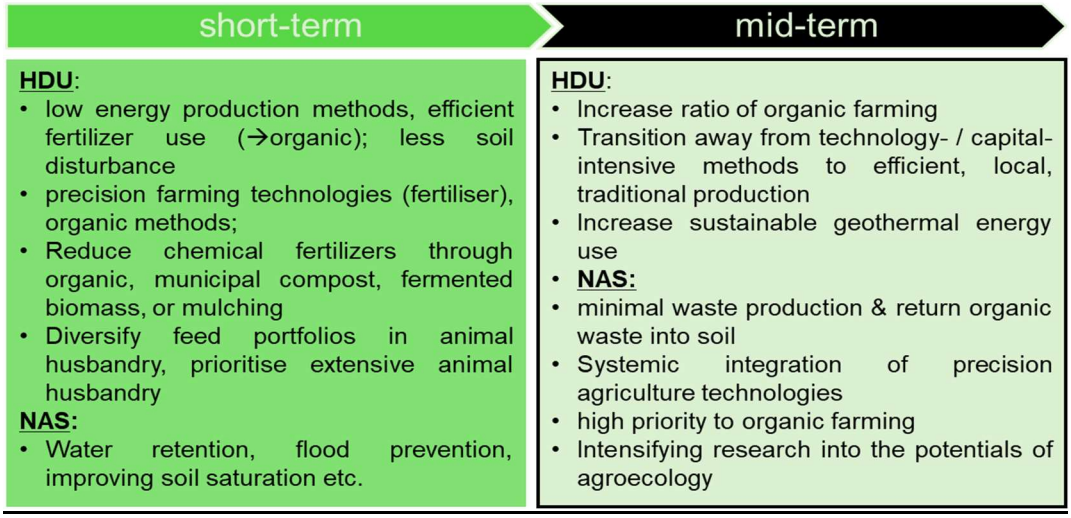

Figure 18. short- and mid-term action plans under Hungary's HDU and NAS

(Own figure based on official documents)

National Energy and Climate Plan (NECP)

The National Energy and Climate Plan (NECP) of Hungary is a direct response to the reporting requirements that the European Commission for its member states. In Hungary, the Ministry of Energy is responsible for planning. However in line with the cross-sectoral nature, a broad set of ministries, agencies or research institutions implementing and monitoring, e.g.: the Ministry of Agriculture, Ministry of Foreign Affairs, Ministry of Construction and Transport and its Building Quality Control Nonprofit kft., Ministry of Economic Development or the Hungarian Energy and Public Utility Regulatory Authority; or the Eötvös Lóránd Research Network Research Centre for Energy Sciences; Hungarian Meterological Service; Ministry of Finance (Government of Hungary, 2023b, p.37).

Effort sharing contribution and agricultural targets

Hungary's EU-wide effort sharing pledge was largely absent from the Climate Protection Law of 2020 and the National Energy and Climate Plan (NECP). However, in the revised version NECP of 2023, it appears more prominently. Until 2023, Hungary's ESR emissions reduction target was -7% compared to 2005. After revision, the target increased to -18,7% compared to 2005 levels (European Commission, 2023; European Parliament, 2021). However, overall "Hungary's Climate Protection Law of 2020 and its NECP" were found to "not yet reflect the new 55% EU-wide GHG emissions reduction target for 2030" and the country was expected "to update its NECP with the 2030 ambitions […] to support the EU-wide 55% reduction target' (International Energy Agency, 2022,p.25). In practice, emissions covered by the ESR decreased by 5.1% compared to 2021 in Hungary (European Commission, 2023e). The 2023 draft of Hungary's NECP recognises that in combination with transport, buildings and waste management, agriculture accounted for 'the largest share of ESD emissions' (Government of Hungary, 2023a, p.145). As reflected in table 4 (ESR), "agricultural emissions increased by 18% compared to 2005 and contributed 17% to total ESD emissions in 2020." In Hungary, CH4 and N20 produce the largest share of N20 emissions (83% including LULUCF); and GHG emissions from agriculture have been increasing almost continuously since 2011, mainly because of fertiliser use and more cattle (ibid, p.146). Table 9 provides an idea of the increase in relation to fertiliser use and emissions deriving thereof.

Table 9. Fertiliser sales, per ha use (2000-23) and related acidifying gas emissions (1990-2021)

Year	Fertilizer (N) in kt[a]	Fertilizer use, kg per ha UAA	Emissions, NO_x from fertilizer, kt	Year	Fertiliser (NO_x) in kt[a]	Fertiliser use, kg per ha UAA	Emissions, NO_x from fertilizer, kt
1990	n.d.	n.d.	14	2007	320	87	13
1991	n.d.	n.d.	6	2008	294	74	12
1992	n.d.	n.d.	6	2009	275	64	11
1993	n.d.	n.d.	6	2010	281	72	11
1994	n.d	n.d	9	2011	302	77	12
1995	n.d.	n.d.	8	2012	313	82	13
1996	n.d.	n.d.	8	2013	336	93	14
1997	n.d.	n.d.	8	2014	341	93	14
1998	n.d.	n.d.	10	2015	378	101	15
1999	n.d	n.d	10	2016	404	112	16

Year	Fertilizer (N) in kt[a]	Fertilizer use, kg per ha UAA	Emissions, NO_x from fertilizer, kt		Fertiliser (NO_x) in kt[a]	Fertiliser use, kg per ha UAA	Emissions, NO_x from fertilizer, kt
2000	258	61	10	2017	424	123	17
2001	275	67	11	2018	424	122	17
2002	303	74	12	2019	416	119	17
2003	289	75	12	2020	445	133*	18
2004	293	77	12	2021	456	136*	18
2005	260	67	10	2022	326	90*	n.d.
2006	289	78	12	2023	265	73*	n.d

[a] amount of fertiliser sold, just nitrogen compound

* Methodological changes in data collection from 2020, data only from respondents beyond 'economic threshold'

Sources: National Climate Service, Research Institute of Agricultural Economics, AKI Institute of Agricultural Economics; (KSH, 2022).

Land use, land use change and forestry (LULUCF, AFOLU)

In Hungary, GHG emission reductions from agriculture were 37% between 1990 and 2022 (European Commission, 2023e), but only 4% for the period from 2015 to 2022. In 2022, LULUCF net removals ranged at 11.3% of total GHG emissions. While the draft (Government of Hungary, 2023a) failed to include specific projections for LULUCF, the revised (Government of Hungary, 2023b) sets Hungary's LULUCF carbon sequestration targets to increase by almost 20%: from an average value -4791 kt CO 2eq for the reference period 2016-2018 to -5724 kt CO2eq by 2030 (Green Policy Center, 2023). For emissions from agriculture, the Plan proposes two scenarios models for both energy use and non-energy related emissions: a) with existing measures (WEM) and with additional measures (WAM). The difference between the WEM and WAM scenarios are expected to be achieved through the National Air Load Reduction Program (so called Országos Levegőterhelés-csökkentési Program). According to the WAM, the foreseen surplus emissions-reduction targets for 2030 primarily relate to reducing fertilizer use (Government of Hungary, 2023a). In terms of agricultural energy use, the draft version projects decarbonisation in agriculture primarily through electrification, and not biomass as (available) energy source (Green Policy Center, 2023). With the National Air Load Reduction Programme adopted in 2020, the Hungarian government fulfils its obligation under Directive 2016/2284 on the reduction of national emissions of certain atmospheric pollutants. While providing guidance on sectoral regulations and subsidies in the coming years, the Decision sets targets for industry, agriculture, transport and energy to reduce emissions from the most important air pollutants by 2030 (Government of Hungary, 2023b, p.34):

- small particle emissions by 55 per cent,
- emissions of ammonia by 32 per cent,
- emissions of sulphur dioxide by 73 per cent,
- emissions of non-methane volatile organic matter by 58 per cent,
- emissions of nitrogen oxides are reduced by 66 % compared to 2005 levels in the country'

Renewable energy and energy efficiency policies

The NECP (Government of Hungary, 2023b) projects energy efficiency and decarbonisation outcomes, for both, WEM and WAM, scenarios amount to a decrease in energy consumption of 12% between 2019 and 2030, and 21% by 2050. For achieving short- to long-term decarbonisation targets, investments in energy efficiency and electrification are to gradually replace fossil fuels (Government of Hungary, 2023b). Numerous policies and measures outside the NECP target renewable energy use in agriculture through biomass, as part of the national implementation of the RED (NAK, 2022).

Although the NECP outlines measures and concrete targets in accordance with the Energy Efficiency Directive, measures and policies targeted at the agricultural sector are absent. Still, a number of measures on buildings and facilities concern farm buildings or utility facilities indirectly: Since 2017 up to 70% of the Company Tax Allowance (TAO) may be spent on energy efficiency enhancing investments; granted as a tax relief / retention; covering between 30% (large) and 50% (small enterprises) of the total investment costs (p.86) Among others, the Hungarian Chamber of Engineers provides free energy advice and monitoring to small businesses, encourages energy audits (implementation), provides information on energy efficiency tenders and energy performance certificates for buildings and corresponding renovation advice and support. Targeting the processing industry, the Production Programme provides grants to large companies for energy efficiency and energy production investments (aid intensity: 30 % in Budapest; 45 % in rural area, max €15 million /company) with a total volume of HUF 150 billion in 2022 (gyármentő program) (Deloitte, 2022).

The National Energy Strategy 2030 published by the Government of Hungary in 2011 speaks extensively of using geothermal energy in agriculture (Government of Hungary, 2011, p.15). Despite the potential of the renewable energy source, geothermal energy takes no role in the revised NECP of 2023 (Government of Hungary, 2023c). However, it is considered as an option in the National Climate Change Strategy's National Decarbonisation Roadmap, which outlines (but does not specify any numbers for) an increased, but sustainable use of geothermal energy as a mid-term action plan.

Mandatory energy monitoring for agricultural companies

In 2021 the Hungarian Energy and Public Utility Regulation Office developed a new regulation for optimizing energy use, and increasing efficiency while reducing energy use (Agraragazat, 2021). Agricultural companies that own and use mechanical installations whose output reaches the levels set out in the regulation; or companies that use corporate-tax benefits for energy efficiency renovations or investments must install sub-meters to relevant mechanical instruments and machines, and must handle the data measured appropriately as to achieve precise and up-to-date operational information for achieving energy efficiency goals (see table 10).

Table 10. Energy use levels for mandatory energy monitoring for agricultural companies

Type of device	Mandatory from 01.01.2021	Mandatory from 01.01.2022
Electrical equipment	Above 100 kW	Above 50 kW
Heating/cooling equipment	Above 140 kW	Above 70 kW
Equipment fed through one point	-	Above 100 kW
Lower threshold for installing monitoring device	< 2000 operating hours/ year	< 1000 operating hours/ year

Source:Agraragazat (2021).

Common Agriculture Policy

Hungary's latest Strategic Action Plan for the period 2023-27 was submitted in 2022 and has the overall aim to implement policies that 'serve a greener future' and help improving resource efficiency in agricultural production, and increasing the acceptance and application of environmentally friendly farming practices and precision technology amongst farmers. Soil, its nutrient content and its water retention abilities are of significant attention. The measures of the Hungarian CAP SP span five layers:

- Expanding the 'subsidizable hectare' definition (AÖT) I-II. Pillar
- Mandatory environmental conditions (conditionality) I-II. Pillar
- Voluntary agro-ecology program (AÖP, eco-scheme): I. pillar
- Voluntary advanced agro-ecological transition supporting schemes: II. Pillar
- Other interventions with environmental- and climate protection and adaptation effects: II. Pillar

The Strategic Plan identifies a number of 'Sectoral Needs' and corresponding funding measures for transforming energy use in agriculture and reducing chemical fertilizer use (summarised in Table 11)

Table 11. CAP strategic plan needs and funding measures: energy and fertilizer Use

<table>
<tr><th colspan="4">Measures to increase renewable energy use, improving energy efficiency in agriculture</th></tr>
<tr><td>4.3.1. Increase renewable energy use</td><td colspan="2">4.3.3 Increase energy use efficiency</td><td>4.3.2. Increase biomass-based energy resources production</td></tr>
<tr><td colspan="4">Relevant funding schemes/interventions</td></tr>
<tr><td>• Adaptation measures (SC18_G02_FVL_47)
• Organic/integrated production – horticulture (SC13_G01_FVO_47)</td><td colspan="2">• Increasing the value of agricultural produce (RD04a-b_E02_FON_73)
• Investments more efficient circulation / storage -horticulture (SC20_I02_FVV_47)</td><td rowspan="2">• Subsidies forest plantations / reforestation interventions (RD38_F05_AFI_73)</td></tr>
<tr><td colspan="3">Sustainable development (small, RD09a-b_B05_SML_73) production facilities (RD01a-e_E01_FRM_73)
<u>Horticulture specific:</u>
• Consultancy & technical guidance (SC11_A03_FVA_47)
• Courses/best practice exchange (SC12_A04_FVT_47)
• Support of cooperatives (SC28_E01_FVI_47)</td></tr>
<tr><th colspan="4">Measures to (indirectly) reduce fertiliser use (soil protection, management)</th></tr>
<tr><td>5.1.1. Precision-based soil-/nutrient management</td><td>5.1.2. Reduce nutrient loss/leaching (blocking technologies /products)</td><td>5.1.3. restore degraded soils/ organic soil content, water retention, soil erosion protection</td><td>5.1.5 circularity: reuse wastewater, compost, food waste, biomass</td></tr>
<tr><td colspan="4">Relevant funding schemes/interventions</td></tr>
<tr><td>• Digital transition of agricultural facilities (RD02_D01_FRM_73)</td><td>• Agro-ecology Program (AÖP) (DP17_G01_ECOS_16)
• Investment into sustainable water use in agricultural facilities (RD12_W01_WTO_74)</td><td>• Agro-ecology Program (AÖP) (DP17_G01_ECOS_16)</td><td rowspan="2"></td></tr>
<tr><td colspan="3">• Replanting orchards – horticulture (SC22_I04_FVR_47)</td></tr>
<tr><td colspan="4">• Agro-environmental Payments (AKG) (RD19_G01_AEC_70)
• Support of organic farming (RD20_G02_ORT_70)</td></tr>
</table>

Sources: own figure based on official documents (Strategic Action plan)

In addition, the Strategic Plan outlines agricultural practices with the aim to support a reduction in fertilizer use under Conditionality, 3.10.3 (Soil Protection and Quality), demanding minimal soil cover

in vulnerable periods, areas or after crop harvesting; mulching or annual crops in between rows in plantations located on slopes above 12%; and ensuring soil cover in between the removal of the old and planting of the new plantations (Strategic Plan, p.339).

Agro-Ecology Programme 2023-2027 [Agro-Ökológiai Program - AÖP]

With its Agro-Ecology Programme (Agro-Ökológiai Program – AÖP) Hungary is implementing a range of green ambitions of the 2023-2027 CAP Strategic Plan in accordance with the Green Deal, the Farm-to-Fork Strategy, the 2030 Biodiversity Strategy or to fulfil the standards for good agricultural and environmental conditions of land (GAEC standards 7 and 8 for the claim year 2023) (NAK et al., 2024). Annual, hectare-based payments are to incentivise farmers to voluntarily implement good practices aimed at climate- and environmental protection goals. A scoring system allows monitoring and distinguishing between ambition levels of various interventions, while still paying producers with a single uniform value. Five out of 11 broader AÖP environmental goals related to water, soil or biodiversity protection as well as climate mitigation are related more or less directly to the reduction of fossil energy or fertiliser:

- soil cover methods to increase carbon sequestration capacities and reducing erosion
- reduction of ammonia emissions
- reduction of ammonia emissions with nitrate-capturing products
- reduction of fertilizer use and pesticide use
- reduction of GHG emissions

While eligibility is not tied to land size, arable lands or grasslands above 5 ha and plantations above 1 ha must mandatorily apply environmentally friendly practices worth at least 2 (and max 4) points.

Table 12. Relevant interventions under AÖP

Specific interventions	Description
Environmentally friendly use of urea fertilizers	For ammonia emissions reduction/ reduction of substance loss and ammonia emissions: immediate incorporation of urea into soil through rotation. Urease inhibitors when using liquid urea. Requires application on at least one parcel, on a minimum of 5% of all arable lands. Minimum /maximum rates for nitrogen agents: 35 / 90 kg/ha. Not on parcels with soil rotation-free tillage. Same rules and guidelines for use in plantations
Use of microbiological products, creating a favorable soil structure:	Aims at improving soil biodiversity & water retention abilities, restore soil organic matter, reduce nutrient loss; thereby contributes to a reduction in the use of fertilizers and pesticides: use of (certified) microbiological products on >50% of arable lands prior. Also applicable in plantations.
Use of soil and crop conditioning products, use of nitrogen fixing products	Reduced use of fertilisers & pesticides: use of (certified) nitrogen fixing products on >50% of arable lands in dosages listed by the MA to improve soil conditions. Also applicable in plantations, > 50% (p.42).
Tillage without soil rotation	To preserve soil's carbon stock and thereby reduce GHG emissions from arable lands: minimal tillage, zero-till, direct sowing on at least 50% of arable lands, accompanied by reduced pesticide use. (p.28)
Cover crops, soil covering in plantations for preserving carbon capture ability of soil	To ensure carbon capture capacity of soil: Ensure constant soil cover on land used for crop production until start of spring sowing (past 28 February). Plantations: sowing perennial herbaceous plants at plantation edges and in between plantation rows (p.46)

Agricultural and Environmental Management Payments (AKG, 2022-2024)

With its Rural Development Programme Hungary seeks to achieve sustainable development of rural areas in collaboration with agricultural producers and address key goals like climate adaptation, risk prevention, improvement of crucial natural resources, water, soil and biodiversity, and strengthening agri-environmental protection. The 3-year voluntary payment scheme covers the transition period between two CAP periods from January 2022 to December 2024. Up to 23.000 farmers are expected to benefit from the 360 million HUF fund (co-financed by EAFRD and the Hungarian government) across eight land use categories (arable, grasslands, plantations, reeds, high nature value farmlands, arable lands with water protection use, high nature value grasslands, grasslands with water protection use). Farmers may develop practices in a maximum of two (out of 16) thematic categories that are distinct from existing CAP or EAFRD practices and conform with the rules set out in the national CAP strategic plan.

Relevant specific thematic categories regarding fossil energy dependence are:

Crops and Plantations:

- Soil & leaf analysis for better understanding specific needs of specific parcels
- Nutrient-management plan, incl. expected fertilizer output, type & maximum N, P, K amounts /ha
- Green fallow (sown exclusively for green manure), prohibited use of chemical fertilizer & pesticides
- Production of green manure crops; use of stable manure, crop residue management
- Use of environmentally friendly plant protection products

Farmers already subsidised under the AÖP program, or receiving funding from EAFRD or EAGF, are not eligible. In addition, farmers are required to keep a farming log for entire subsidised period; partake in at least one agro-environmental training; and contribute to monitoring.

Climate mitigation under CAP

The main need to reduce GHG and other pollutant gas emissions through agricultural tools (4.1) is at the heart of the Strategy and it indirectly guides several of the (above) CAP measures. The plan spells out two relevant sub-needs and related (funding) instruments (table 13):

Table 13. CAP Strategic Plan: needs and funding measures focused on GHG emissions (4.1)

Sub-need	Funding mechanism, policy proposals, interventions
4.1.1. Improve carbon capture of soils & ecosystems: creating pasture lands, non-productive areas, water habitats, buffer habitats, field-protecting treelines, improving agro-technological practices, change manure output	Agro-ecology programme DP17_G01_ECOS_16
	Agro-environmental Payments (AKG) RD19_G01_AEC_70
	Support of organic farming RD20_G02_ORT_70
	Agro-ecological non-production investment RD21_G04_LCI_73
	Encourage agro-ecological land use RD22_G05_LCP_70
4.1.2. Developing animal husbandry (specifically feed- and rearing technology) in the direction of GHG emissions reduction	Sustainable development of agricultural production facilities RD01a-e_E01_FRM_73 and of Small Agricultural Production facilities RD09a-b_B05_SML_73
	RD Cooperation for short supply chains RD49_R09_SCC_77

National Action Plan for Developing Organic Farming (2022-2027)

The Action Plan, developed by the Ministry of Agriculture, puts special emphasis on systematically aligning national CAP subsidy tools for the development of organic farming (Ministry of Agriculture, 2022). It sets out 7 main targets:

1. Assisting the transition to organic farming and boosting supply
2. Developing the organic value chain and local food supply chains
3. Increase demand for organic produce; develop marketing & communication for organic
4. Green procurement of organic produce
5. Strengthen R&D in organic farming Strengthening expertise and consultancy
6. Modernise monitoring and certification.

Strongly linked to the Biodiversity Strategy, target 1 is oriented at the goal to increase the land under organic cultivation by 15% by 2030. The Plan seeks to double the amount of land under organic cultivation, i.e. 10% of all agricultural land compared to 6.1% currently, by 2027 (Ministry of Agriculture, 2022). The Action Plan also aims to increase the number of young organic farmers to 2000 by 2027; launch an 'ÖKO' call for tenders by 2025 and develop sector-specific technological guidelines from 2022. Funding sources include payments under the Agro-environmental Management Payments, the Agro-Ecology Program and the Transition to and Maintenance of Organic Farming Payments (→ CAP Strategic Plan) (Government of Hungary, 2021). Despite the ambitious figures outlined above, the most recent data by the Central Bureau of Statistics suggests that after 2020 a general stagnation has characterized the transition to organic farming (KSH, 2022), mostly due to political reasons. Politically affiliated land grabbing is reported to prioritise large-scale conventional farming practices over organic or more sustainable farming (Gonda & Bori, 2023; Gonda, 2019).

Payments for transitioning to and maintenance of organic farming (ÖKO)

Converting conventional farming areas into organic production units, as well as maintaining organic production units is a major focus of the Government's Partnership Agreement to increase agro-biodiversity, and fight climate change through protecting grasslands and stabilising carbon storage. The call under the Rural Development Programme is linked to the 4th rural development priority and follows three key aims as described in the Rural Development Program:

- A: Restore & improve biodiversity, by managing high nature value areas & agricultural challenges
- B: Improved water management, incl. through improved fertilizer- & pesticide use
- C: Organic farming to improve soil conditions.

The call indirectly relates to reducing fertilizer use through adopting organic farming techniques resulting in more efficient land use through improved soil conditions, and increasing biodiversity. The subsidy scheme starting in 2018 and extended until end of 2024 is implemented by the Ministry of Agriculture (with support from organic certification bodies Biokontroll Hungária Nonprofit Kft and Bio Garancia Kft, National Land Centre, National Park Directorates and the National Property Fund

Manager). Beneficiaries are producers on arable lands, grasslands or plantations with a minimum land size of 1 ha (0,25 ha per subsidised parcel) commit to organic agricultural practices for a minimum of five years.

The specific guidelines are similar to AKG guidelines (nutrient-management plans, soil- /leaf analysis, nutrient management plans with type/amount of fertiliser, incl. allowed in organic farming; and related N, P, and K components). Farmers are required to partake in mandatory trainings on organic farming as well as to keep a farming log. Parcels receiving subsidies under the AKG program cannot apply.

More than 5,500 agricultural producers could submit subsidy requests over 275.000 hectares to receive conversion and maintenance subsidies worth 40 billion HUF in total for the following land uses:

Table 14. Conversion & maintenance payments under ÖKO

Land use	Arable	Vegetables	Apple orchard	Grapes	Other fruits	Grasslands
€/ha/a	458	1097	1840	1132	1762	204

Agricultural Crisis Insurance Scheme: price fluctuations

Following the drastic price explosion seen in the world markets the risk management schemes under the Strategic Plan was extended with an **Agricultural Crisis Insurance Scheme** as of 2021 ((National Treasury, 2024). So far risk reduction primarily related to weather- and climate-related risks and income fluctuations covered by **I.** EC notified, but nationally financed agricultural damage reduction system and **II.** EU co-financed insurance scheme. The new scheme also covers a hale damage reduction system (Wolters Kluwer, 2020). Membership in the Scheme is voluntary, but requires a minimum 3-year commitment; the separation of income- and expense accounting; and a minimum of 3 years of active operations where incomes haven't been negative. Annual fee was 3500 HUF/year for arable land, 9000 HUF/year for plantations, 40.000 HUF/year for unheated greenhouse (foil) tunnels, 2000 HUF/year/dairy cow, 500 HUF/year/sow, 15 HUF/year/breeding duck. Farmers receive a compensation of 69.9% of the income loss if in a given year losses are at least 30% compared to previous years (National Treasury, 2024a; 2024b; Novekedes, 2022).The Strategic Plan sets an overall target for Risk Management aiming to reach 24.840 farms (or 10.31% of the 241.000 total number of farms). Currently up to 97% is achieved by the second pillar, while the Crisis Insurance Scheme only contributes marginally likely owed to its novelty. The Strategic Plan anticipates that by 2027 1050 farmers will have joined (20% also supported in the second pillar).

National Strategy for Preserving Biodiversity Until 2030

Hungary's 3rd National Biodiversity Strategy (first 2009-2014, second 2014-2020) covers the period up to 2030 and was developed in line with the EU's 2030 Biodiversity Strategy (COM/2020/380) (Kormany (Hungarian Government), 2023). Supporting the UN Sustainable Development Goals – SGD15, SDGs 11-13– the Strategy is also aligned with the 3d National Sustainable Development Framework Strategy, the 5th National Environmental Protection Program, and the embedded National Environmental Protection Base Plan.

Developed by the Ministry of Agriculture, the Strategy outlines a number of goals, measures and indicators to measure progress (figure 19)

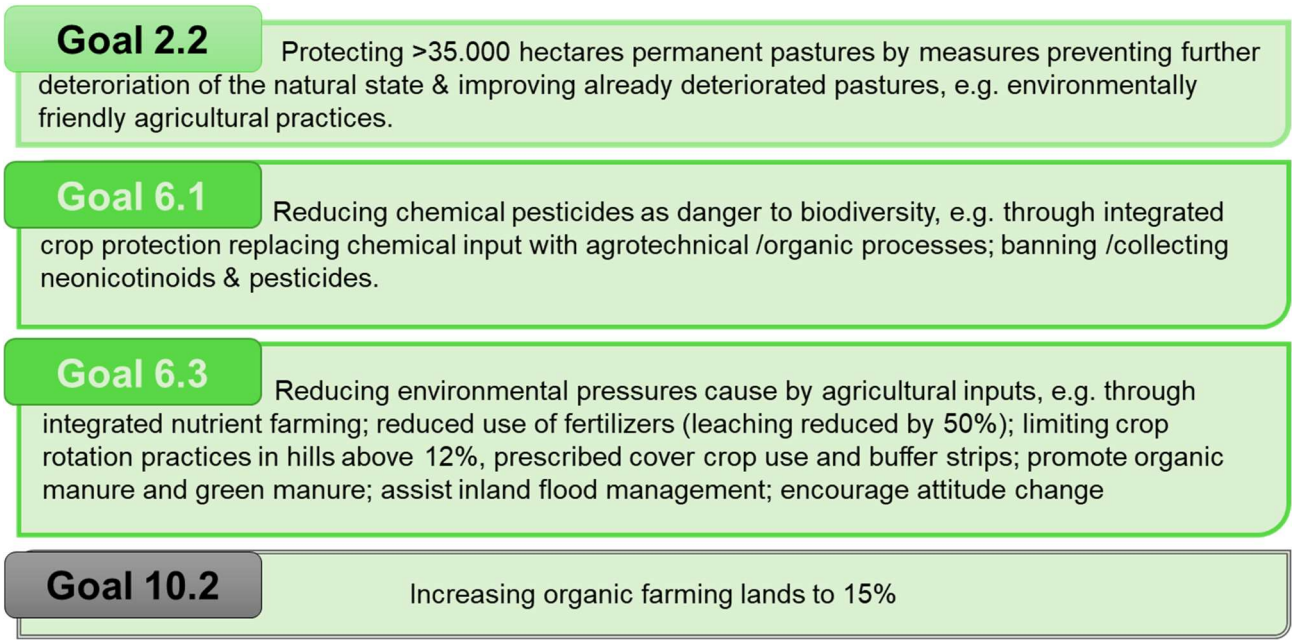

Figure 19. Goals under the Biodiversity Strategy

(own figure, based on official documents)

Other relevant policies

Refundable tax on diesel

As a result of the turmoil in the European agricultural sector, the Hungarian government has brought forward a decree (decision 95/2024) valid from 1st of May 2024 that changes the percentage of refundable tax on diesel used in agriculture from previously 86 % /87 % to 90 % in accordance with and adjusted to world market prices of petroleum. 90% denote the maximum refundable tax value paid on 97 liter/ha/year (NAK, 2024). The decision forms part of the government's five-point package of measures to improve the situation in the grain sector as announced by Minister of Agriculture István Nagy (Hungary Today, 2024). The measure is expected to lead to an average increase of around HUF 400 (EUR 1.03) per hectare, and in total 'will result in additional annual support of HUF 1-2 billion (EUR 2.5-5 million) for the agricultural sector' (Hungary Today, 2024).

Western Europe II: The Netherlands

Summary

In the Netherlands, measures for reducing the use of fossil-energy (directly or indirectly) in agriculture are mostly of voluntary nature implemented in form of stimulating support programs or cooperative agreements including at regional levels or on the basis of agricultural cooperatives. There are, however, concrete plans for more compulsory policies and they are about to be put in practice, such as green gas blending obligations, or of CO2-taxation in greenhouse horticulture.

As in many other countries, the measures for reducing the use of fossil-energy in agriculture are embedded in key climate law as well as agricultural and (agri)enviromental law.

Climate policies

Dutch agriculture contributes with 15% to the total greenhouse gas (GHG) emission of the Netherlands. The contribution of the individual components of GHG emission from agriculture however differ a lot. Whereas the share of methane en nitrous oxide from agriculture in total emission of these gases is about 75%, the share of carbon dioxide form agriculture in total CO_2- emission is not even 5%. Since 1990 greenhouse gas emission from agriculture is steadily declining. In 2022, Dutch agriculture (including greenhouse horticulture) emitted 24,5 ton million CO2-eq (figure 1). More than 50% of the GHG emission from agriculture consists of methane from livestock farming. Carbon dioxide mainly emits due to the use of fossil fuels (in particular natural gas) in greenhouse horticulture.

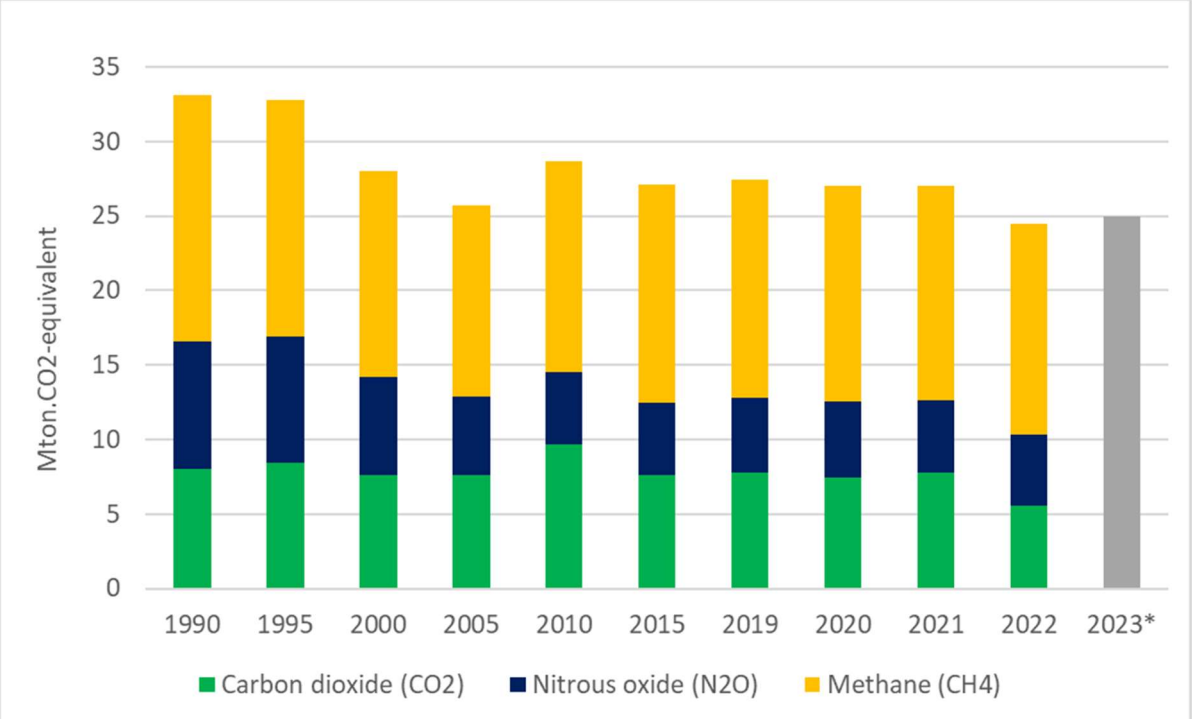

Figure 20. greenhouse Gas emissions from Dutsch Agriculture, 1990-2023, Mt CO2e

Source: Emissieregistratie (2024) *and* CBS (2024).
**) Preliminary data*

Climate targets

In the Netherlands, the European Green Deal is elaborated in the National Energy and Climate Plan 2021-2030. The most important goals of this plan is a reduction of the greenhouse gas (**GHG**) emission **by 36%** and a share of **renewable energy sources** in total energy consumption **of 27%** by 2030 (Rijksoverheid, 2024). The indicative GHG emission target for Dutch agriculture is 17.9 million t CO2-eq. in 2030. Regarding the information in figure 20, it becomes obvious that quite a gap is still to be bridged in order to reach the emission target, namely 7,5 Mt CO_2-eq. (Information and policy targets concerning land use will be addressed in paragraph on LULUCF).

Livestock farming versus greenhouse horticulture

For the agricultural sector, the main climate issues are the emission of methane and nitrous oxide in livestock farming and the CO2 emission due to the use of fossil fuels (natural gas) in greenhouse horticulture. Eligible measures for livestock farming are related to the reduction of the total amount of livestock (and in particular cattle) and to manure processing and manure management. The new government in the Netherlands pronounced that it will cease to focus on reducing the amount of livestock. Instead, they want to stimulate technical and (farm)management solutions for reaching the greenhouse gas emission goals (PVV et al., 2024). Concerning greenhouse horticulture, policy measures are related to renewable energy sources in combination with energy saving technologies (ECN & PBL, 2016). The Energy Efficiency Regulation plays an important role here.

The government and the greenhouse horticulture sector have agreed upon an separate track, the co-called Covenant Energy Transition Greenhouse Horticulture 2022-2030 (Convenant Energietransitie Glastuinbouw 2022-2030). The ultimate goals is a climate-neutral greenhouse horticulture sector in 2040 (EZ & Klimaat, 2023).

In the following we review the implementation of the particular European Policies in the Netherlands. The Effort Sharing Regulation, LULUCF/AFOLU, Renewable Energy Directive, Energy Efficiency Directive, Farm-to-Fork Strategy and Biodiversity Strategy.

Effort Sharing Regulation (ESR)

Agriculture and horticulture belong to the group of sectors that fall under the Effort Sharing Regulation, along with the sectors built environment, mobility and small industries. Under the ESR, the binding national target for the Netherlands is the reduction of greenhouse gases by 48% in 2030 compared to 2005 (note the different reference year as compared to what is mentioned at the start of the introduction). This is a cumulative target between 2021 and 2030. This makes the way by which this target is reached very important. The are already several policy measures for these sectors. However, no concrete sector specific goals in terms of emission ceilings have been installed yet (CE Delft, 2024). Such goals and concrete measures are currently discussed (also depending of the new cabinet in the Netherlands that has just been installed).

LULUCF

Emissions from land use are not covered by the ESR, but are included in the European Land Use Regulation (LULUCF). However, credits that have been booked in either of these two strategies may be used to (partly) compensate the remaining targets of the other strategy. Since the revision of the LULUCF in May 2023, the periods 2021-2025 and 2026-2030 needs to be distinguished. The

obligation for the period 2021-2025 is according to the original EC regulation 2018/841[1]: no increase in emission and maintenance of already sequestered carbon. For the period 2026-2030 each member state will receive a budget for net carbon storage, in addition to a binding target in 2030. Net carbon storage implies that more carbon needs to be stored than there is emitted in 2030 (no debit rule). The joint EU target is a net carbon storage of at least 310 megatons in 2030. The national budget and binding target will be determined on the basis of emission figures that are submitted in 2025 (PBL, 2023). The (preliminary) target for the Netherlands for 2030 is a carbon emission reduction or additional carbon sequestration of at least 0,435 megaton CO2-eq. compared to the average emission in the period 2016-2018. This comes down to a residual emission target of 4 megaton CO_2-equivalent in 2030. This target can be tightened if the Netherlands exceeds the budget for 2026-2029.

In the Netherlands, greenhouse gas emission from land use is mainly determined by CO_2-emission due to peat oxidation. This emission is still larger than the carbon sequestration by forests or other carbon sinks (table 5). The most important measure to increase carbon sequestration is afforestation.

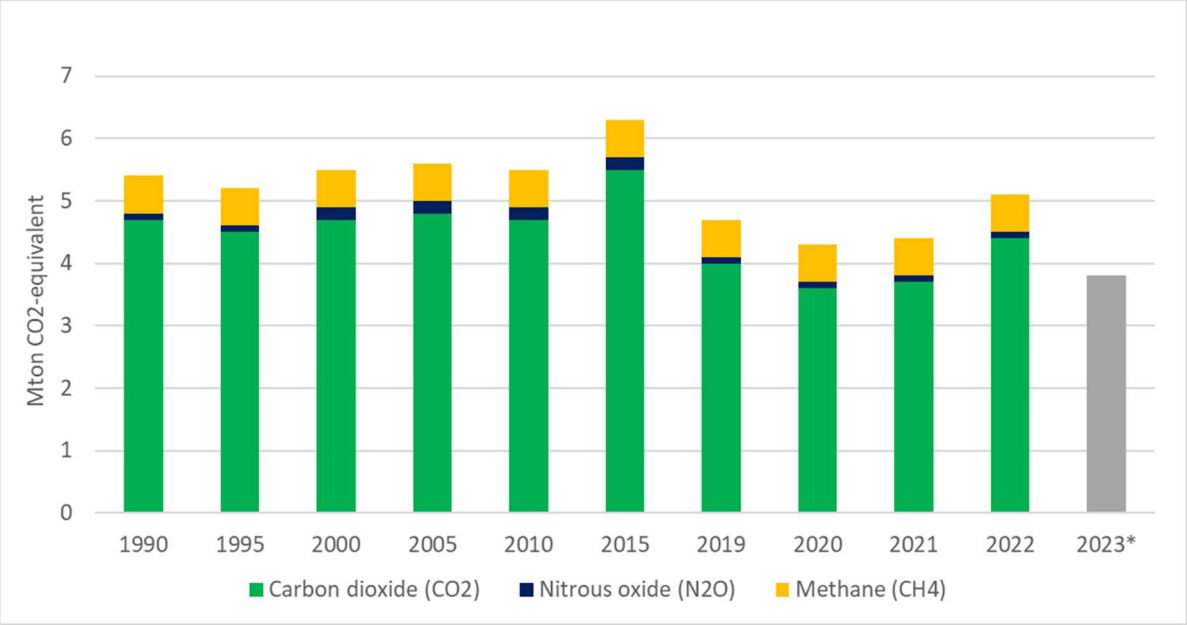

Figure 21. Greenhouse gas emission from land use in the Netherlands, 1990-2023, in MtCO2e

Source: Emissieregistratie (2024) *and* CBS (2024).
**) Preliminary data*

Renewable Energy Directive (REDIII)

In REDIII agreement has been reached on the ambition to increase the share of renewable energy in European energy consumption to 42,5%, with an indicative additional top-up of 2,5%, such that a share of 45% may be possible. In the **Netherlands**, the Renewable Energy Directive (REDIII) is translated into four national targets (PBL, 2023).

[1] Regulation (EU) 2018/841 of the European Parliament and of the Council of 30 May 2018 on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry in the 2030 climate and energy framework, and amending Regulation (EU) No 525/2013 and Decision No 529/2013/EU

- Dutch contribution to EU-target for renewable energy: Indicative target **share of renewable** energy in total energy use **38%.**
- Use of hydrogen and **renewable fuels** of non-biological origin (RFNBOs) in **industry** in 2030: **42%** (60% in 2035).
- Use of **renewable energy in mobility** in 2030: **29%** share renewable and **14,5% reduction of greenhouse gas intensity.**
- **Growth** of **renewable heating and cooling**: 0,8% between 2021 and 2025, **1,1% between 2026 and 2030**. Indicative top-up of 1,1 percentage point **per year** between 2021 and 2025 and 0,8 percentage points between 2026 and 2030.

The four national targets show that there are *no direct targets for agriculture or horticulture*, but only for the sectors mobility, built environment, renewable heat and district heating. Concerning the first target mentioned above, figure 22 (dots) shows that the share of renewable energy in total energy use in The Netherlands was 18% in 2023.

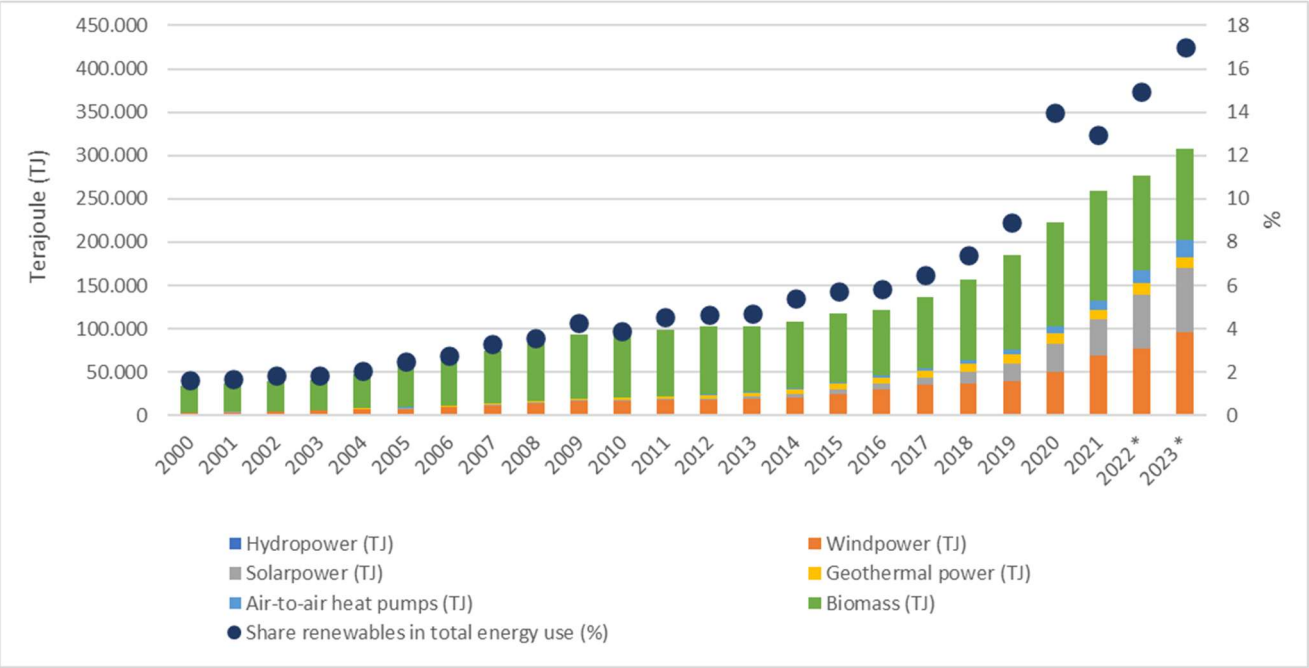

Figure 22. Generation of renewable energy (TJ) and share of RE in total energy use in the Netherlands (%, 2000-2023)

**) preliminary; Source: (CBS Statline, 2024)*

Figure 22 also depicts that the generation of renewable energy as well as its share in total energy use has steadily risen since the beginning of the millennium. The strongest increase has been achieved in the last ten years, when the generation of renewable energy and its share in total energy use has tripled. Biomass has always shown and still shows the largest share in renewable energy production. However, since around 2017, solar and wind power are making huge progresses, such that in 2023 their shares have been approaching the share of biomass in renewable energy generation.

According the Climate and Energy Outlook of the Netherlands 2023 (PBL, 2023), the Netherlands should be able to reach the national target of 38%, taking into account all established and proposed

policies for stimulating renewable energy generation. The Dutch ambition is 100% renewable energy consumption in 2050.

Energy transition towards renewable energy sources in the Netherlands is embedded in the National Programme for **Regional Energy Strategies** (NP RES). There are 30 Regional Energy Strategies in which decentralised authorities (provinces, municipalities and water boards) work together with residents, businesses, grid operators, energy cooperatives and social organisations on the generation of renewable energy on land and on the implementation of sustainable heat sources. There are several subsidy and incentive schemes for stimulating renewable energy and heat sources. The most important ones are (PBL, 2023):

- Netting scheme for households and small and medium enterprises (SME)
- Subsidy scheme for cooperative energy generation (SCE)
- Sustainable energy Production Incentive Scheme (SDE++)
- Sustainable energy investment subsidy (ISDE)

Role for agriculture

Although agriculture and horticulture are not directly addressed in the four Dutch national targets of REDIII, the agricultural sector can play a crucial role in the energy transition to renewable sources and decentralized energy generation. The sector has the space to produce renewable energy in sufficient quantities. The biggest challenge is locally matching the production of sustainable energy to demand. A measure that has not been implemented yet, but which will be a very important one for agriculture is the green gas blending obligation.

Green gas blending obligation

Green gas is biogas that has been upgraded to the same quality as natural (fossil) gas. The introduction of the green gas blending obligation has recently been postponed by one year. The original year of introduction was January 2025, but is now set on January 2026. Additionally, the original policy target has been downsized in the revised policy paper from 1,6 billion cubic meters (BCM) in 2030 to 1,1 BCM in 2030, which represents a CO_2-reduction of 3,8 megatons (Mt) CO_2 within the chain.

Biogas (and green gas) is the product of manure digestion, which is used by livestock farmers to get rid of surplus manure and to develop new business models. Manure digestion also contributes to the reductions of methane emission from livestock farming, especially in combination with the daily removal of slurry from the shed to the digester. Additionally, manure digestion and processing can produce substitutes for artificial fertilizers (RENURE products), which may result in a decrease in the use of artificial fertilizers (and eventually to a decrease in the production of artificial fertilizer).

Energy Efficiency Directive (EED)

Article 7 of the Energy Efficiency Directive obliged the Netherlands to realize an efficiency improvement of 1,5% per year in period 2014-2020 (Daniëls et al., 2013), which was translated to a **national saving target** for the Netherlands of **482 PJ** for the mentioned period. This target is pursued by a wide range of policy instruments, such as subsidies, incentives schemes and fiscal allowances. Furthermore, since 2015, *large enterprises are obliged to perform an energy efficiency audit every four year* (RVO, 2024). In total these instruments have reached energy savings up to 672 PJ in the

period 2014-2020. Which means that national target of 482 PJ of energy savings have been exceeded (Bollen et al., 2023).

MIA, VAMIL and EIA

The most important EED instruments for agriculture and horticulture are the Environmental Investment Allowance (MIA (Milieu-investeringsaftrek), introduced in 2000), the Random Depreciation of Environmental Investments Scheme (VAMIL (Willekeurige afschrijving voor milieu-investeringen), introduced in 1991) and the Energy Investment Allowance (EIA (Energie-investeringsaftrek), introduced in 1995).

MIA, VAMIL and EIA are **fiscal instruments** for stimulating entrepreneurs to invest in sustainable technologies. MIA and EIA offer tax deductions for investments in sustainable assets, whereas EIA is specifically focusing on energy saving technologies. In 2022, up to *45% of the investment sum was deductible from the taxable profit.* The deduction depends on the expected environmental effects. VAMIL offers entrepreneurs liquidity and interest advantages by bringing forward depreciation and deferring tax payments. Depreciation can be set flexibly over time, with a maximum of 75% of the total investment in one year. In recent years, and in contrast to earlier programming periods, the total amount of tax allowances of the applications exceeded the available budget. The urge to invest in energy saving technologies seems stronger. We consider the assigned budget as the policy target.

Within MIA and VAMIL, around 500 million Euro has totally been invested by agricultural and horticultural companies for which tax allowances had been applied. The investments mainly concern "*Green Label Greenhouses*" in greenhouse horticulture and *sustainable pig sheds* with heat-power-coupling and air scrubbers, of which the washing water can be used as mineral nitrogen fertilizer. Within EIA, around 400 million Euro has totally been invested, mainly for *LED systems* in greenhouse horticulture, *photovoltaic* cells for electricity and *heat pumps*.

EU Emission Trading System (ETS)

The EU ETS has been implemented in the Netherlands through a provision in the Dutch Environment Management Act. The Dutch Emission Authority (Nederlandse Emissie Autorieit, NEa) is responsible for the functioning of the ETS. The Netherlands participate in the common auction platform for the emission permits in the period up to 2020. In 2020, 419 installations in the Netherlands were subject to the EU ETS. Together they are responsible for 74.1 Mton CO2 emissions in 2020. Several policies have been implemented to facilitate the reduction of greenhouse gas emissions among ETS sectors in the Netherlands, as well as to address the targets under RED and EED. These policies are therefore mostly aimed at the deployment of renewable energy and the stimulation of energy efficiency. Examples of these policies are subsidies for renewable energy (SDE+) and long-term agreements in industrial sectors on energy savings (Bollen et al., 2023).

Common Agriculture Policy

The Netherlands has a unique approach to CAP implementation. For instance, it has chosen a farmer collectives-based implementation of the agri-environmental measure (area-oriented cooperation in pillar 2). Also the way of eco-scheme implementation under pillar 1 is unique, because it applies a results based point and payment scheme with 3 tiers (bronze to gold) and seeks to address issues of overcompensation via an "income forgone" rule (Jongeneel & Gonzalez-Martinez, 2023). Numerous of the EU CAP policy measures in the Netherlands related to Specific Objective SO4 focus on

reducing GHG emissions, improving carbon sequestration, sustainable energy generation and energy saving. The country employs in this area the result indicators: carbon storage, climate investment, forested land, environmental and climate investments in rural areas and climate adaptation. Most important contributions of the CAP support are through its land-based schemes (pillar 1) with eco-schemes, and a range of CAP related investment schemes: area-oriented cooperation, sustainable investments, nitrogen and climate tasking peat meadow and transition areas N2000 and Young farmers schemes.

CAP Pillar 1 – Land-based schemes

The following schemes fall under this category:

Basic income support - good agricultural and environmental conditions

With an overall budget of 1,693 million EUR the basic income support under CAP is considerable for the programming period. There are numerous relevant obligatory good agricultural and environmental conditions for farmers to receive support (not only in the Netherlands): The most relevant in relation to energy use are permanent grassland, peat meadow and wetlands and crop rotation. Additional deployment is being investigated such as the use of a regionally differentiated basic payments.

Eco scheme for climate and living environment

Countries have to earmark a considerable amount of their CAP budget (25%) for voluntary eco-schemes. In the case of The Netherlands, it amounts to 963 million Euro (355 million Euro in 2028). The country has chosen a unique results-based payment “eco-scheme” approach where farmers can pick from a set of 22 eco-activities across 5 categories (1) main crop, 2) bottom crop, 3) cultivation measures, 4) non-productive agricultural land, 5) sustainable farming). It includes the choice ‘organic farming’ for the duration of the CAP programming period in two of these categories. While not all practices are applicable to every farm (reflecting sector specificity, like arable vs. grassland) they are rated according to the related environmental and climate benefits on five key objectives set on the basis of EU regulation (i) climate, ii) soil&air, iii) water, iv) landscape, v) biodiversity). Typical values in productive uses range between 0 and 4. More value (and payments) can be generated with non-productive agricultural practices (e.g., buffer strips, green fallows or wooded banks) with high values on the v) biodiversity and iv) landscape categories (values 10-60), reflecting the higher ‘income forgone’ of non-use. Farmers must reach a minimum point and payment threshold to enter a bronze, silver or gold tier and respectively high payments. Organic farming qualifies ‘automatically’ for payments. Depending on the selected measure, payments per eco-point may be seen to vary between €2.80 and €307 per point. A number of the activities – apart from organic agriculture – provide more or less direct incentives for reduction of fertilizer /leakage (e.g. nitrogen fixing crops, catch crops, buffer strips) or the reduction of additional animal feed (e.g, extended grazing, permanent pasture) (European Union, 2024b).

The point system is able to reflect regional differences and there are currently efforts to improve the tool further to further regionalize the tool. The scheme was taken up by farmers representing 63% of the eligible agricultural area, higher than anticipated. This success is linked to the fact that the points system with 22 practices provides enough flexibility and is not prescriptive to farmers how to achieve the different objectives. That thresholds could be easily achieved for the 3 objectives, climate, soil, water evokes the question whether the system stimulates farms enough to act. The annual contract

was seen to partly stand in the way for long term business changes and to rather lead to short-sighted measures (Jongeneel & Gonzalez-Martinez, 2023).

CAP Pillar 2

Area-oriented cooperation (Pillar 2)

In the area-oriented approach, new areas have been designated within the Agricultural Nature and Landscape Management (ANLb) for climate and water, where activities that promote climate adaptation can be deployed. ANLb makes use of the work of groups of farmers and other land managers, a so-called collective. An agricultural collective is a partnership in a specific area. Farmers and other land users in that area come together voluntarily in order to implement agricultural nature and landscape management. This encourages the use of agricultural production methods with beneficial effects on climate, although the main aim of the intervention is maintaining biodiversity on and next to agricultural land.

Due to the above-mentioned additional efforts, the ANLb will grow from 110,000 to 135,000 ha in the coming CAP. ANLb activities with an expected positive impact on climate are e.g. related to GAEC8 (leaving 4% of the arable land non-productive). Certified agricultural collectives apply for the subsidy for ANLb. Farmers therefore do not apply for subsidies individually. The collectives themselves conclude the contracts with the agricultural nature managers (farmers and other land managers).

The area-specific cooperation includes the following arrangements:

Agricultural Nature and Landscape Management (ANLb)

- Budget: 560 million Euro
- Result indicators: Carbon storage, climate adaptation

Cooperation for rural development – LEADER

- Budget: million Euro
- Result indicators: tbd

Collaboration for integrated area development

- Budget: 93 million Euro
- Result indicators: carbon storage, forested land, climate investment, environment and climate investments in rural areas

Nitrogen and climate tasking peat meadow and transition areas N2000, Collaboration between peat meadow and Natura2000

- Budget: 397 million Euro (of which 120 million Euro in 2028)
- Result indicators: climate investment, environmental and climate investments in rural areas

To increase groundwater level under peat meadows, area processes are supported by using art. 77 to facilitate cooperation, compensate farmers for reduced yields and subsidize necessary investments

as a result of this approach. This may be further developed using land-based subsidies, including compensation for area-specific disadvantages that has not yet been programmed. The current area processes in the peat meadow area aim to raise the water level on 15,000 hectares of agricultural land.

Sustainable investments

There are various investment schemes that support farmers in their development, both in terms of sustainability and improving their earning capacity. The following schemes fall under this category:

Productive investments "Green – Blue" and "animal welfare"

- Budget: 51 million Euro
- Result indicators: climate investment, taking into account animal welfare goals.

With the goal to increase the sustainability of agricultural businesses, the scheme supports investments into precision agriculture, water management and nature-inclusive agriculture. The investments are suggested to improve profitability of business operations.

Non-productive investments on agricultural holdings

- Budget: 109 million Euro
- Result indicators: climate investment

Target group: land owners, land users, agricultural organizations, nature and landscape organizations, provinces, water boards, municipalities and other natural and legal persons who contribute to the goals of the aforementioned beneficiaries

The investments are oriented at all sorts of investments to avoid or reduce emissions from farm buildings, constructing dams, water basins, timber stands and precision agriculture. Smaller investments for land-based activities are part of the 'cooperation component' to strengthen the land-based GBA structure. The scheme foresees a possibility to draw up a business sustainability plan, in which the climate effects of farm operations are taken into account. This way, all farmers in the Netherlands can contribute to the climate objectives.

Subsidies on energy saving investments also fall under this category. To this end subsidies from CAP may be used complementing other national subsidy schemes. For example, stable adjustments necessary to increase the efficiency of producing biogas could be financed from the CAP; the biogas installation itself from national schemes such as the "SDE++ scheme".

Young farmers, including horticulture

Productive investments for young farmers

- Budget: 34 million Euro
- Result indicators: climate investment, forested land

Young farmers are a special target group of CAP investment support to support business development in (more sustainable) ways. They are eligible for an increased subsidy under the above

mentioned investment schemes. This subsidy amounts to 55% of the eligible costs. The aid for previous productive investments amounts to 40% of the eligible costs. Everything else is equal to Productive investments Green – Blue and animal welfare schemes.

Other relevant policies

Farm-to-Fork Strategy: crop protection

Within the framework of the Farm-to-Fork strategy, up to now, the Netherlands have elaborated concrete indicators concerning the use of crop protection products (LNV, 2023). The strategy's aim with respect to crop protection set by the EU is reducing the overall use of chemical pesticides and associated risk by 50% and reducing the use of more dangerous pesticides also by 50% in 2030 (European Union, 2021b).

The two indicators that have been defined in the Netherlands are the so-called F2F-1 and F2F-2. The F2F-1 shows the trend of the quantity sold in terms of active chemical substance. Active substances based on micro-organisms are not included in F2F-1. F2F-2 gives the trend of quantity sold of active substances that are to be replaced. The Netherlands chose to set the reference period for both indicators on the period 2015-2017. Between this reference period and 2021 both indicators show a declining trend of about 15%.

Other policy fields have yet not been considered for the Farm-to-Fork strategy in the Netherlands.

Nitrate Directive

The Nitrate Directive aims to protect water quality in EU Member States. It states that the nitrate content in groundwater should not exceed 50 mg per litre. The Nitrate Directive is the basis for Dutch manure policy. It is a rather elaborated policy concept with measures such as use standards for nitrogen and phosphate, manure production ceilings, phosphate rights and buffer stripes.

Eliminating mineral fertilizer

Within the framework initiatives that has been developed due to the Nitrate Directive and the Dutch manure policy, there is an interesting case study called "Kunstmestvrije Achterhoek", a project that stands for agricultural practices without mineral fertilizer in the Achterhoek, a district in the East of the Netherland at the border to Germany. The aim of the project "Kunstmestvrije Achterhoek" is to substitute mineral fertilizer with circular fertilizer that has been produced in the district as a co-product in the process of manure digestion (RENURE products). The project is well documented and supervised by scientific researcher. The project is supported by the Dutch government. Farmers participating in the project get exemption for using RENURE products as mineral fertilizer (up to now RENURE products can only be used within the use standard for nitrogen from manure (170 kg/ha) and not within the general use standard for nitrogen).

Poland

Summary

Poland implemented a number of policies aimed more or less directly at reducing the use of fossil fuels and fertilizers within the agricultural sector. Key policies included in the Strategic Plan for the Common Agricultural Policy for 2023-27 are the “Eco-schemes”, “Investments contributing to environmental and climate protection” and “Investments in farms in the field of renewable energy sources and improvement of energy efficiency”. Some of the relevant national policies are implementing European Union framework regulation, some function independently. The most notable policies concern (1) the production of biofuels (implementing the RED II Directive), “Blue certificates - support for agricultural biogas plants”, “Environmental Impact Assessment of Agricultural Biogas Plants”, “Support for biogas plants – FIT/FIP (Feed in Tariff, Feed in Premium)”; (2) renewable energy production (“Support of RES - Photovoltaic Installations”, “Energy co-operatives”, “Energy for the Rural Areas”, “National Energy and Climate Plan 2021-2030”), (3) reduction of energy costs in agriculture (“Refund of excise tax on diesel oil used by farmers”, “Regulation of preferential electricity prices (“energy shield”)” and (4) proper fertilization production: “Best Available Techniques (BAT)”).

EU Green Deal implementation in Poland

National Energy and Climate Plan 2021-2030

In its National Energy and Climate Plan for 2021-2030 Poland has specified key national goals and assumptions in the area of climate and energy policy as well as the policies and actions to achieve them. The objectives are set according to the five dimensions of the EU's Energy Union:

- Decarbonisation,
- Improvement of energy efficiency
- Energy security,
- Intra-EU energy market (and social aspects),
- Research, innovation and competitiveness.

The three most important goals of the “aKPEiK” concern the reduction of emissions, the share of renewable energy sources in gross final energy consumption and the improvement of energy efficiency –key policy objectives and numbers on (projected) performance are summarised in a comparative fashion (vs. EU targets) in figure 23.

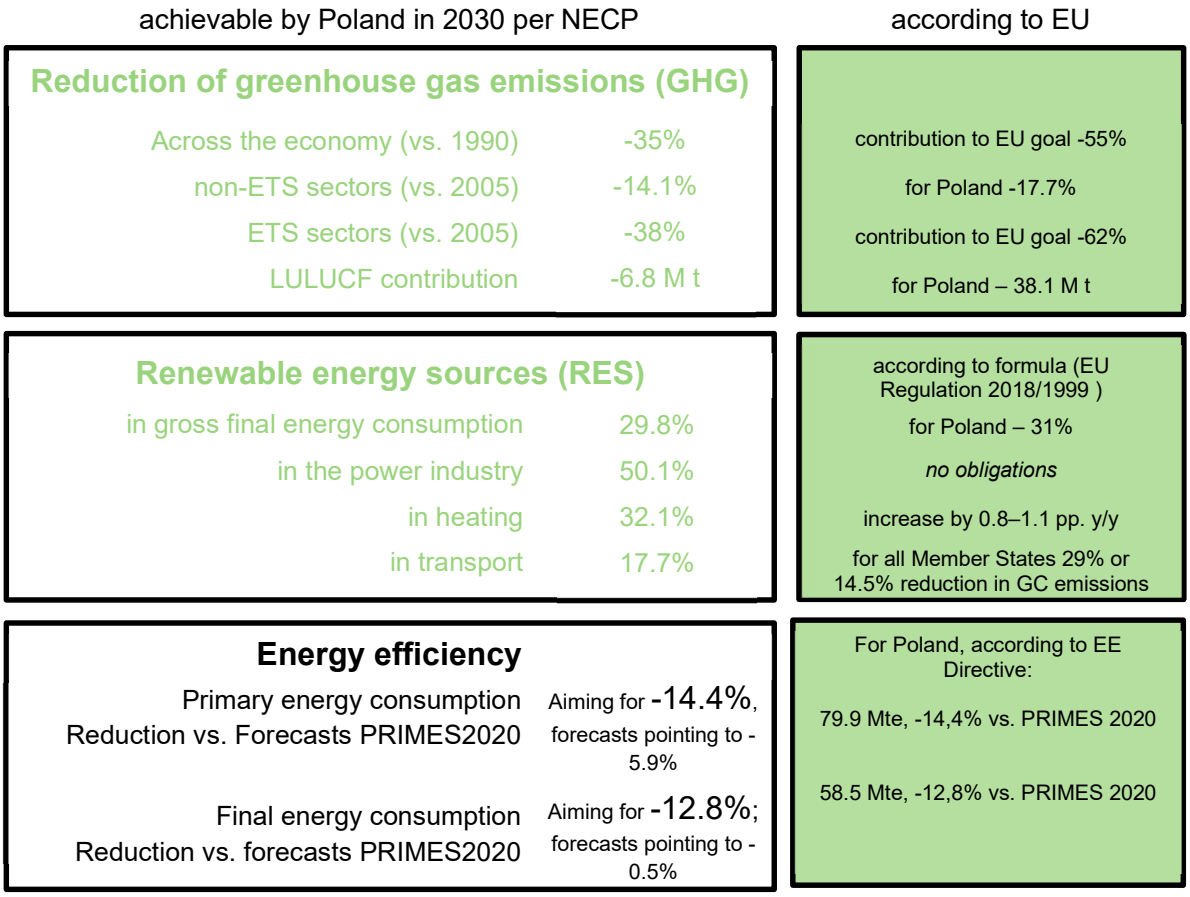

Figure 23. Key objectives of National Energy and Climate Plan 2021-2030 vs EU targets for Poland

Source: Ministerstwo Klimatu i Środowiska (MKiŚ) (2024).

Renewable energy and energy efficiency policies

RED II Directive

The Renewable Energy Directive (RED) is a key policy to pursue the support of renewable forms of energy in the Member States as spelled out already in the Treaty on the Functioning of the European Union (TFEU, Art. 194.1). The increased use of energy from renewable sources is an integral part of the package of policy measures in Poland targeted at the objective to reduce greenhouse gas emissions. Following the RED II Directive, the aim is to increase the share of renewable energy in transport to 14% in 2030, using already developed biofuels and biocomponents produced from food and fodder plants, as well as new technologies – such as advanced biocomponents and electricity in transport (Topagrar, 2024). According to data from the National Support Centre for Agriculture, Poland is one of the leading European producers of biocomponents, i.e. fuel additives made from biomass (Topagrar, 2024).

In 2023, Poland produced (Topagrar, 2024):

- 339,390 tons of bioethanol, mainly based in corn (59% of total raw materials used), waste starch suspension with waste code 02 03 80 (30%), and other;

- 971,170 tons of methyl ester, mainly based on vegetable oils (90% of total raw materials used),
- 5,330 tons of liquid bio-hydrocarbons, based mainly on vegetable oil (58% of total raw materials used) and waste alcohols and distillates (42%).

Blue certificates (support for agricultural biogas[2] plants)

The support of biogas as an alternative to fossil fuels plays an important role in Polish energy policies. Following the Energy Law[3] it is possible to obtain certificates of origin for energy produced from a renewable source, such as biogas, energy generated in cogeneration. Certificates may also be obtained for gas production in a biogas plant and its introduction into the gas network and are meant to incentivise additional biogas production in the country. Up to now, green certificates have been available on the market for all electricity produced in biogas plants at a comparably low price (average in 2023: PLN 148.46/MWh/ approx. €35/MWh). Meant to increase demand, additional legal provisions introduced in 2016 impose a separate obligation for network operators to purchase energy from agricultural biogas plants at the level of 0.65 per cent of total energy, while maintaining current levels of the general obligation to purchase green energy. Moreover, alternative ways of implementing the so-called RES obligation are restricted and substitution fees apply (Cire, 2016). To address the low prices for green certificates, blue certificates were introduced on the Polish Power Exchange in 2016 with first transactions at the level of 280 PLN/MWh (approx. 66 €/MWh) which translated into greater interest of the biogas producers in providing certificates. Higher demand led to higher market prices for certificates and, thus, higher revenues for biogas plant owners that were at risk of bankruptcy before the policy was introduced (Cire, 2016). Data from the National Support Centre for Agriculture suggests that in March 2023 146 agricultural biogas plants were registered in Poland. The total installed electrical capacity was over 142 MWe (Ciszewski, 2023).

Environmental Impact Assessment of Agricultural Biogas Plants

For building agricultural biogas plants with a capacity of over 500 kWe and an area of more than 1 ha (0.5ha in Natura 2000 areas) a decision on environmental conditions must first be obtained to ensure that the construction is in accordance with all applicable (environmental) regulations (Sejm RP (Polish Parliament), 2008) 4. In concrete it is required for [Journal of Laws of 2023, item 1597]:

- Planned projects that may always have a significant impact on the environment;
- Planned projects that may potentially have a significant impact on the environment

The bureaucratic burden resulting from this need to obtain a decision on environmental conditions is described to be considerable. Based on the views of biogas owners, the process may take between

[2] Agricultural biogas - gas obtained in the process of methane fermentation: a) agricultural products and agricultural by-products, including animal excrements, b) products from the processing of agricultural products and by-products, c) food products that are out of date or unfit for consumption, d) fats and oil mixtures from oil/water separation containing only edible oils and fats, e) plant biomass collected from areas other than those registered as agricultural; for details see Ustawa z dnia 20 lutego 2015 r. o odnawialnych źródłach energii (Dz.U. 2015 poz. 478); (Sejm RP (Polish Parliament), 2015)

[3] [Journal of Laws 54, item 348 of 1997 with subsequent amendments)], (Sjem RP (Polish Parliament), 1997)

[4] [Journal of Laws 2008, item 1227], (Sejm RP (Polish Parliament), 2008)

3-5 years for new biogas plants. This may explain why an increase in the share of smaller biogas plants is observed in newly developed installations (Figure 24).

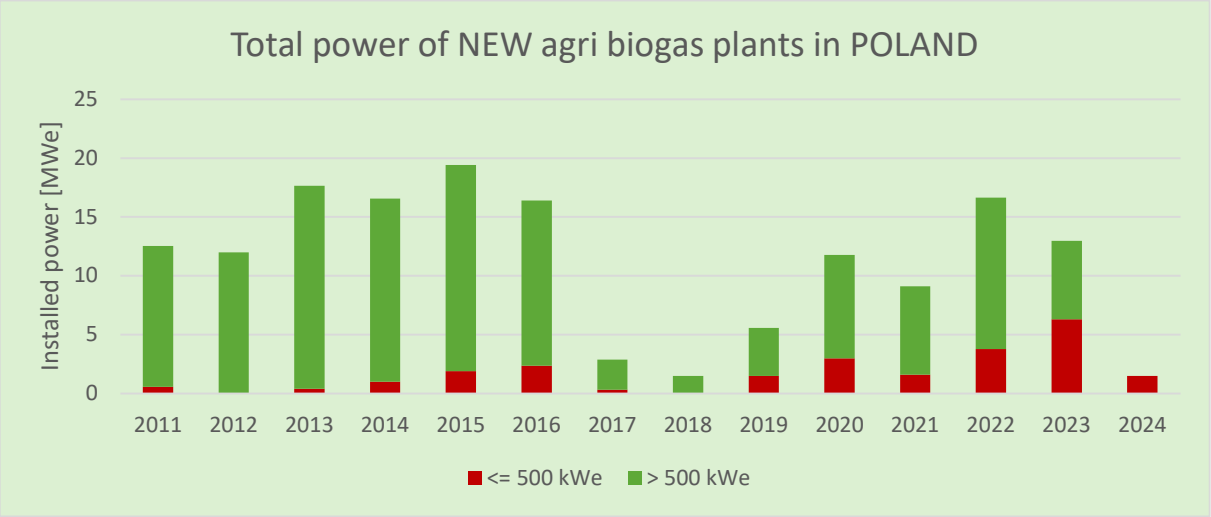

Figure 24. Total power of new agri-biogas plant installations in Poland in MWe

Source: own elaboration based on the Krajowy Ośrodek Wsparcia Rolnictwa (KOWR) (2024) data.

However, it is difficult to assign this change only to environmental restrictions as the existing support measures (e.g. FIT/FIP – see chapter 5) also impact the structure of developed agricultural biogas plants.

Support for biogas plants – FIT/FIP (Feed in Tariff, Feed in Premium)

Poland has a system in place to support the development of renewable energy sources and exemptions for energy-intensive users[5] (Sejm RP (Polish Parliament), 2018). It builds on the provisions of the Act of February 20, 2015, on renewable energy sources[6] (Sejm RP (Polish Parliament), 2017a)and the provisions on state aid, that Poland is committed (as of European Commission notification procedure)[7] (Sejm RP (Polish Parliament), 2017b) – the so called "FIT/FIP" system is a combined system of guaranteed tariffs (feed-in tariff) and of subsidies to the market price (feed-in-premium). The FIT/FIP system is intended for (Szwarc, 2021):

- agricultural biogas plants,
- biogas plants using biogas obtained from landfills,
- biogas plants using biogas obtained from sewage treatment plants,
- biogas plants using another type of biogas and
- hydroelectric power plants.

RES (renewable energy sources) installations with less than 500 kW capacity may join the feed-in tariff (FIT) system. If producers obtain a certificate from the President of the Energy Regulatory Office for selling unused electricity under the FIT system, producers obtain the right to sell the generated

[5] Justification, Print No. 2412, (Sejm RP (Polish Parliament), 2018)
[6] (Sejm RP (Polish Parliament), 2017a)
[7] In case SA.43697 [2015/N], (Sejm RP (Polish Parliament), 2017b)

electricity to the so-called ‘obligated seller' (i.e. the largest electricity trading company operating in the territory of a given distribution system operator), at prices equal to 95% of the reference price applicable on the date of submission of the FIT/FIP declaration (Szwarc, 2021). Operators with a total installed electrical capacity of up to 1 MW are eligible to the highly beneficial market price (FIP) subsidy and it covers up to 90% of the negative balance, i.e. the difference between the reference price and average electricity prices on the market (Szwarc, 2021). By the end of 2020, the Energy Regulatory Office issued a total of 483 certificates enabling entry into FiT/FiP systems for installations with a total capacity of 157 MW, including 72 certificates related to installations using only agricultural biogas in high-efficiency co-generation to generate electricity. (49.5 MW) and three certificates concerned agricultural biogas plants not classified as cogeneration with a total capacity of 1.98 MW (Gramwzielone, 2021).

Support of Renewable Energy Sources - Photovoltaic Installations

The first system for trading energy generated by photovoltaic installations in Poland was "net-metering". The surplus energy produced by farmers was ‘stored’ in the network and could be used when needed. For this service the network company ‘charged’ operators at 20-30% of the stored energy (20% for installations < 10 kW; 30% for larger ones). If the energy production from the photovoltaic power plant covered the farmer's needs for one year, the farmer paid the network company only fixed costs. In 2022, changes were introduced concerning the handling of ‘prosumers’ in accordance with the provisions of Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on ‘Common rules for the internal market in electricity, amending Directive 2012/27/EU. The changes aimed at connecting new prosumers more easily while protecting existing users. In the "net-metering" model, automatic shutdowns of installations occurred on sunny days or when there were too many installations in a given network leading to network congestion (Ministerstwo klimatu i Środowiska (MKiS), 2021)[8].

In April 2022, the current "net-billing" electricity trading system was introduced that allows to export surplus energy produced on farms to the electricity grid. Depending on the monthly market price, suppliers purchase surplus energy at variable prices (e.g. in February 2024: PLN 324.25/MWh (approx. €76), in April 2024: PLN 253.69/MWh (approx. €60)) (Ministerstwo klimatu i Środowiska (MKiS), 2021). Since 1st of July 2024 the value of energy fed into the grid is determined based on the hourly exchange rate of the next day market [MKiŚ 2021]. In the past, the income from electricity sales was transferred to farmers' accounts as a ‘deposit’ reducing the own electricity bill (at current prices of PLN 858.5/MWh (approx. €200)). Unused funds could be transferred to the next month. If there is a surplus at the end of the accounting year, farmers could withdraw 20% of the amount without tax; the remaining surplus was not refundable. With recent changes in the billing method (in April 2022) the number of additional PV micro-installations dropped considerably (Redakcja GLOBEnergia, 2023).

[8] (Ministerstwo klimatu i Środowiska (MKiS), 2021)

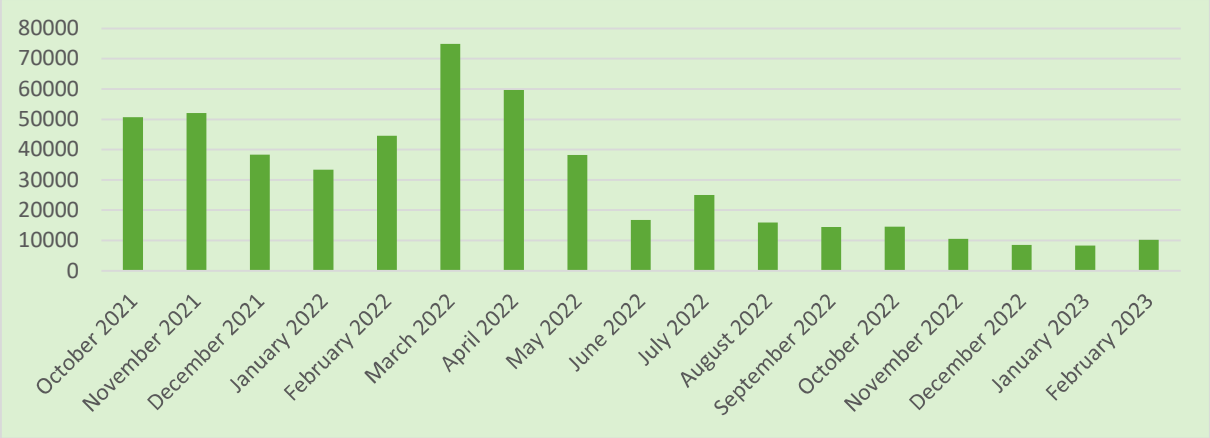

Figure 25. Number of new PV micro-installations in Poland

Source: Redakcja GLOBEnergia (2023).

On the other hand, the importance of industrial PV farms, which benefit from the economies of scale, is growing. According to the report "Operating photovoltaic installations in Poland 2024", prepared by the Institute for Renewable Energy, there were 4,870 PV installations above 50 kW in the first quarter of this year, of which 262 were farms above 0.5 MW. The total installed capacity in this group (i.e. without micro-installations) reached 5.4 GW. In 2023, there was a 41% increase in new installed capacities compared to 2022 (Magazynfotowoltaika, 2024).

Energy co-operatives

According to the law on renewable energy sources (Art. 38f of the Act of February 20, 2015 on) (Sejm RP (Polish Parliament), 2023g)[9], energy cooperatives may generate electricity or biogas, or agricultural biogas, or biomethane, or heat, in renewable energy installations owned by the energy cooperative or its members once registered in the list of energy cooperatives by the General Director KOWR. A cooperative is a voluntary association of natural persons (minimum of ten persons) or legal persons (minimum of three persons), with a variable composition and a variable share of funds engaging in joint economic activities in the interest of its members (Spoldzielnia-energetyczna, 2024). In essence, energy cooperative may be created by individuals, small and medium-sized enterprises, local authorities or social organisations. The cooperative aims at producing energy for its own use, as to meet the energy needs of its members in rural and urban-rural areas. They may cover a maximum of three neighbouring communes and allow offering cheap energy to their members. Energy cooperatives do not pay the seller any fees for the distribution service or settlement fees. Likewise, no fees apply (for 'renewable energy', 'capacity' or 'cogeneration') for electricity generated from renewable energy installations held by energy cooperatives and consumed by its members. Energy cooperatives do not require certificates of origin or fulfilment of energy efficiency obligations. Moreover, the electricity produced (and consumed) by energy cooperatives is exempt from excise tax, given that the installed electrical capacity of all RE installations does not exceed 1 MW (Heliosstrategia, 2023). Currently, there are 35 energy cooperatives in Poland consisting of 111

[9] Journal of Laws 2023, item 1436 (Sejm RP (Polish Parliament), 2023g)

members and operating a total of 144 photovoltaic installations with a capacity of 6.63 MWe (Spoldzielnia-energetyczna, 2024).

Energy for the Rural Areas

Energy for Rural Areas is a Polish support programme for farmers aimed at increasing the use of renewable energy sources in rural and rural-urban municipalities. The budget of the programme is PLN 1 billion (€240 million). Potential beneficiaries of the programme are energy cooperatives and their members (i.e. entrepreneurs, emerging energy or farmer cooperatives producing electricity, biogas or heat based on renewable energy source installations as to balance the own demand for electricity, biogas or heat) as well as farmers (Gov.pl, 2022)[10].Beneficiaries may apply for both a grant or a loan. The grant scheme covers investments related to the construction of hydroelectric power plants, installations for generating energy from agricultural biogas in high-efficiency co-generation conditions, and energy storage. The loan scheme relates to all investments listed in the form of subsidies and wind installations. The condition for granting support for an energy storage facility is its integration with an energy source implemented as part of the investment. The programme also assumes that the investment cannot be started before the date of submission of applications.

Poland's Strategic Plan for the Common Agricultural Policy (2023-27)

In line with the Regulation (EU) 2021/211 that spells out the rules on support for CAP strategic plans that Member States may draw on under the EAGF or EAFRD (referring to regulation (EU) No 1305/2013 and (EU) No 1307/2013) Member States are to ensure that their CAP policies contribute to climate change mitigation and adaptation, including by reducing greenhouse gas emissions and increasing carbon sequestration, as well as promoting sustainable energy and supporting sustainable development and efficient management of natural resources such as water, soil and air, including by reducing dependence on chemical products (European Council & European Parliament, 2021)[11]. Numerous aspects are specified in relation to adaptation to climate change and the reduction of environmental burdens of more or less direct relevance for fossil energy independence, such as the reduction of the use of plant protection products or fertilizers, the reduction of pollutant emissions, including greenhouse gases, ammonia and odours, increasing sequestration and soil biodiversity through proper land use, etc. The regulation underpins the implementation of various environmental and climate protection related provisions systems in Poland programmed under the first and second pillars of the CAP Strategic Action Plan, in particular the eco-schemes as well as the agri-environmental-climate commitments (European Council & European Parliament, 2021).

On farm investments into sustainable and resource efficient management

As part of the national CAP programme (pillar 2), investments are supported that help to reduce the use of plant protection products or fertilizers through new machinery or equipment. These cover, *inter alia,* a more precise and resource-efficient use of plant protection products, low-emission applications of fertilizers, mechanical or biological control of weeds or pests, preparation of places for washing sprayers or utilisation of residues of working liquid, and reducing emissions of pollutants, including GHGs and odours by equipping farms with plates, tanks or devices for storing manure or hay, as well

[10] (Gov.pl, 2022)

[11] (European Council & European Parliament, 2021)

as purchase or installation of air purification systems from livestock buildings, low-emission maintenance of livestock (excluding cattle and pigs). The investment programme also provides support for the improvement of water management through the construction, purchase or installation of technical infrastructure elements necessary for the collection, storage (in closed tanks) and management of rainwater, the construction or purchase of installations for water recirculation or economic water management, and the increase in sequestration and soil biodiversity through proper land use.

Support is provided through a grant (reimbursement of eligible costs incurred by the beneficiary) or unit costs for an operation with a planned amount of costs eligible for support above PLN 20,000 and below the maximum of PLN 200,000 (approx. € 50.000) [(MRiRW (Polish Ministry of Agriculture and Rural Development), 2022)]. The results measured under R.16 as proportion of households (%) benefiting from CAP support for investments in climate change mitigation and adaptation and renewable energy or biomass generation have not yet been published [(MRiRW (Polish Ministry of Agriculture and Rural Development), 2022)].

On farm investments into renewable energy sources and energy efficiency

Aimed at reducing the pressure of agriculture on the environment, Poland supports under CAP the use of energy from renewable sources, proper management of waste and by-products from agriculture, and improvement of energy efficiency [(MRiRW (Polish Ministry of Agriculture and Rural Development), 2022)]. The intervention supports (tangible or intangible) investments, in particular those related to the construction or purchase of new equipment for the production of energy from agricultural biogas (electricity, heat, or gaseous fuel) up to 50 kW or installations producing energy from solar radiation (PV) up to 50 kW – together with energy storage and energy management systems or heat pumps (as integral part of the installation producing energy from solar radiation). The scheme covers costs of various types of energy production installations (area A) or systems improving the energy efficiency of farm buildings used for agricultural production, such as construction, reconstruction or purchase of biomass boilers, heat recovery systems (e.g. from milk, livestock buildings, bedding, slurry), roof glazing, LED lighting, as well as thermal modernisation of farm buildings used for agricultural production (area B) [(MRiRW (Polish Ministry of Agriculture and Rural Development), 2022)].

Results are measured by the following CAP indicators [(MRiRW (Polish Ministry of Agriculture and Rural Development), 2022)]:

- R.15: Supported investments in renewable energy generation capacity, including biomass (in MW),
- R.16: the proportion of households benefiting from CAP support for investments in climate change mitigation and adaptation and for the production of energy from renewable sources or biomass;
- R.9: share of farmers benefiting from support for investments in restructuring and modernisation, including for more resource efficiency.

Eco schemes

In the recent CAP programming, five eco-schemes were introduced under the Polish Common Agricultural Policy. Detailed provisions of the eco-schemes are included in the country's Strategic Plan for the Common Agricultural Policy for 2023-2027 (MRiRW (Polish Ministry of Agriculture and Rural Development), 2023), as well as in the Act of 8 February (Sejm RP (Polish Parliament), 2023d; 2021) [12][13] and the Sejm RP (Polish Parliament (2023e) [14], and Sejm RP (Polish Parliament (2023g)[15].

As a voluntary element of the direct payment system (Pillar 1), eco-schemes are meant to reward the implementation of practices beneficial to the environment, climate and/or animal welfare. In line with EU regulation, the budget allocated to eco-schemes constitutes a minimum of 25% of the annual direct payments. Payment rates under eco-schemes are specified in EUR and converted into PLN according to the PLN/EUR exchange rate established on the last business day of September of a given year. In Poland, eco-schemes have been designed to promote practices that translate into agricultural income by increasing soil fertility, rational fertilisation, and improving the quality of crops. Farmers may choose suitable eco-schemes in line with their needs from different management practices, such as: i) Carbon farming and nutrient management, ii) Eco-scheme Areas with melliferous plants, iii) Water retention on permanent grasslands, iv) Integrated Plant Production and v) -scheme Biological protection of crops (MRiRW (Polish Ministry of Agriculture and Rural Development), 2023). Regarding the reduction of fossil energy (particularly mineral fertilizer) dependence, the most important eco-scheme is Carbon Farming and Nutrient Management, which includes eight agricultural sub-practices listed in table 15. Payment rated for agricultural practices under this eco-scheme are subject to a point system based on assumptions for rates that would compensate for additional costs and/or lost income imposed by implementing a given practice. Each specific practice was assigned a specific, appropriate number of points, accordingly (1 point being the equivalent of EUR 22.47, approx. PLN 100). Points are (table 15) (MRiRW (Polish Ministry of Agriculture and Rural Development), 2023).

Table 15. Scoring for specific practices in relevant ecoscheme practices

No.	Eco-scheme practices Carbon farming and nutrient management	Number of points
1	Extensive use of permanent grasslands with livestock	5
2	Winter catch crops or undersown crops	5
3a	Development and compliance with a fertilisation plan – basic variant	1
3b	Development and compliance with a fertilisation plan - variant with limited	3
4	Diversified crop structure	3
5	Mixing manure on arable land within 12 hours of its application	2
6	Using natural liquid fertilisers using methods other than splashing	3
7	Simplified cultivation systems	4
8	Mixing straw with soil	2

Source: MRiRW (Polish Ministry of Agriculture and Rural Development) (2023).

[12] Journal of Laws 2023, item 412, (Sejm RP (Polish Parliament), 2023d)

[13] Journal of Laws 2021, item 1530, (Sejm RP (Polish Parliament), 2021)

[14] Journal of Laws 2023, item 493 (Sejm RP (Polish Parliament), 2023e)

[15] Journal of Laws 2023, 1926, (Sejm RP (Polish Parliament), 2023f)

The implementation of the eco-schemes is aimed at increasing the level of organic matter in the soil and improving the ability to capture and store carbon in the soil – better carbon sequestration, achieving an improved soil structure protected against reducing surface water runoff, facilitating water infiltration deep into the soil, and retaining more nutrients and increased protection of the soil surface against water and wind erosion, improving the soil's resistance to drought and floods (MRiRW (Polish Ministry of Agriculture and Rural Development), 2023). According to the Ministry of Agriculture and Rural Development, the eco-scheme on carbon farming was the most frequently chosen practice by farmers in 2023. Among the eight sub-practices mixing straw with soil was the most popular with almost 230,000 submissions (Kobus, 2023).

Other national policies

Refund of excise tax on diesel oil used by farmers

In response to the Council Directive 2003/96/EC of 27 October 2003 (European Union, 2003)[16] on restructuring the Community framework for the taxation of energy products and electricity Poland introduced a corresponding law in 2006 (Journal of Laws 2023, item 1948) (Sejm RP (Polish Parliament), 2023c)[17]. The law was legally enforced from 2013 onwards (Journal of Laws 2013, item 1339) (Sejm RP (Polish Parliament), 2013)[18]. The corresponding financial assistance instrument was introduced in response to rising costs for agricultural fuel and this way reduce production costs on farms. In concrete, farmers can apply for a refund of excise duty included in the price of diesel oil used for agricultural production. The maximum refundable value is currently:

- PLN 160.60 (approx. €37.8) multiplied with the number of hectares of agricultural land and
- PLN 5.84 (approx. €1.37) multiplied with the average annual number of pigs and
- PLN 58.40 (approx. €13.74) multiplied with average annual number of large cattle units, goats, sheep, or horses. The limits have been increased several times since 2013 (see table 16).

Table 16. Fertiliser Rates and limits of excise tax refund for agricultural farms (2013-2024).

	Excise tax reimbursed PLN/l diesel.	Max reimbursement PLN per ha
2013	0,95	81,7
2014	0,95	81,7
2015	0,96	82,56
2016	1	86
2017	1	86
2018	1	86
2019	1	100
2020	1	100
2021	1	110
2022	1	110
2023	1,2	110

[16] (European Union, 2003)

[17] (Sejm RP (Polish Parliament), 2023c)

[18] (Sejm RP (Polish Parliament), 2013)

2024	1,46	160,6

Source: own study based on the Regulations of the Ministry of Agriculture and Rural Development (Journal of Laws 2023, item 2674) (Sejm RP (Polish Parliament), 2023b)[19].

Farmers are obliged to apply for a refund of excise duty to the head of the community head, mayor or city president, depending on the location of the agricultural land, together with VAT invoices (or their copies) 'verifying' the purchase of diesel in the period from February 1 to July 31 of the following year (Sejm RP (Polish Parliament), 2024). Act of 21 April 2023 requires Polish farmers to intensify animal production on small family farms and large-scale farms by applying modern technologies. These mechanical devices increase the share of fuels in performing work on the farm (Sejm RP (Polish Parliament), 2023a). In 2022, the instrument's total cost was estimated at PLN 1.3 billion (Polskieradio24, 2021) and PLN 1.34 billion in 2023 (Tygodnik-rolniczy, 2022).

Figure 26. Trend of diesel consumption per ha agricultural land, 2005-2021

Source: own data based on FADN database and Central Statistical Office (Statistics Poland, 2023)[20].

The Central Statistical Office' data suggests a certain 'rebound effect' of the tax refund subsidy on agricultural diesel. After introduction in 2013 diesel consumption per ha of agricultural land increased considerably at a level close to maximum refunding through the Excise Tax Refund Act (figure 26).

Preferential electricity price regulation ('energy shield')

As an emergency response measure to the price surge for electricity in relation to the Russian invasion of Ukraine the Polish government has set up a financial support measure to protect households and family farms against significant energy price increases. As in other EU MS (like Germany), the policy supports citizens and businesses in the form of a frozen electricity price. In concrete terms, farms using less than 4,000 kWh per year pay PLN 412/MWh (approx. €96.94/MWh),

[19] (Sejm RP (Polish Parliament), 2023b)
[20] (Statistics Poland, 2023)

and after exceeding this limit, a maximum of PLN 693/MWh (approx. €163.06/MWh) (Sejm RP (Polish Parliament), 2022)[21].

Access to cheap energy is considered necessary to ensure food production in sufficient quantities and profitability of agricultural production (Sejm RP (Polish Parliament), 2022). The operation of the so-called 'energy shields', introduced to stabilise electricity prices, ended in July 2024 and is replaced by a new support system. An increase of energy prices for households and family farms to the level of PLN 500/MWh (ca. 125€) is expected (Forsal, 2024).

The effectiveness or results of the instrument are not measured. Every household and family farm in Poland is principally eligible for assistance. The Ministry of Environment estimates the total cost of the measure in Poland to be about 100 bln PLN (ca. 25bln €; Bankier, 2023) including costs of preferential energy prices for all private and public entities (schools, hospitals ect.). No detailed data exists on spending for supporting farmers.

[21] (Sejm RP (Polish Parliament), 2022)

North Europe: Sweden

Summary

There are numerous policies in Sweden targeted at the reduction of greenhouse gases which have a more or less direct relevance for energy dependence in the agricultural sector. While policies on energy efficiency hardly apply to Swedish farms, numerous of the initiatives or support schemes on renewable energy are also relevant to the agricultural sector like Fossil Free Sweden or "NextGenerationEU". While biofuels have a comparative tax advantage in the country, Sweden also has numerous political instruments in place (like tax refunds on energy and diesel) that counteract more ambitious climate action. As in many other countries, CAP support, particularly under eco-schemes as well as through the national investments programmes, is a key vehicle for implementing objectives on more sustainable nutrient management, organic farming or expansion of renewables (including bio-energy) in the sector. A considerable part of the activities is related to knowledge exchange and capacity building (regarding renewables and management).

Climate law

Effort Sharing Regulation

As stated in the Effort Sharing Regulation, Sweden should reduce their emissions by 50% by 2030 compared with the year 2005 (Swedish Environmental Protection Agency, 2023a).

Sweden's national climate target is to have no net GHG emissions into the atmosphere by 2045. By 2045, emissions from activities in Swedish territory are to be at least 85% lower than emissions in 1990. These targets do not contain any specific targets for the agricultural sector. The milestone targets for achieving this goal are the following (Swedish Environmental Protection Agency, n.d.-a):

- By 2020, GHG emissions from activities not included in EU Emissions Trading Scheme (ETS), are reduced by 40% compared with 1990. (Goal achieved; Sveriges miljömål n.d. a).
- By 2030, GHG emissions in Sweden outside of the EU ETS should be at least 63% lower than emissions in 1990.
- By 2040, GHG emissions in Sweden outside of the EU ETS should at least be 75% lower than emissions in 1990.

Energy Efficiency Directive

The Energy Efficiency Directive resulted in the following changes to Swedish regulations (Swedish Environmental Protection Agency, 2023b,p. 20):

- "Large enterprises[22] must conduct an energy audit every fourth year,
- Electricity suppliers must invoice customers for the measures of consumption of electricity, if the supplier has access to measurements,

[22] Companies in any sector who employs at least 250 people and either i) have an annual turnover over 50 million euro or ii) a balance sheet total over 43 million euros annually (Swedish Energy Agency, 2018).

- New requirements are established on the measurement of energy consumption in apartments,
- Requirements are tightened on authorities to use energy more efficiently”

In addition, network operators had to adjust tariffs and other practices to promote energy efficiency. Since many farms are below the threshold, this policy mainly concerns the upstream food industry and few large livestock producers.

Renewable Energy Directive

The previous target from the Renewable Energy Directive was to have 49% renewable energy in Sweden by 2020, while the nationally set target was 50% (Swedish Environmental Protection Agency, 2023b). This target was **reached** in the year 2012, with the **share being 60% in 2020**. The most recent data shows that the share had increased to 66% by 2022. A target for the year 2030 will be set following the revision of the directive in 2023, but is not yet set (Sveriges miljömål, n.d.).

In 2018, Sweden implemented the **reduction obligation** (‘Reduktionsplikt’), which requires a minimum level to which fossil fuels should be mixed with renewable fuels, including the agricultural sector (SFS 2017:1201). This is stated to contribute to achieving the requirements in the Renewable Energy Directive (Prop. 2020/21:180). The required minimum level was reduced in 2024 from 7.8% for petrol and 30.5% for diesel to 6% for both fuel types (Bet. 2023/24:MJU5). The decision for the reduced reduction obligation came from the new government formed in 2022, with the argument that costs should be reduced for households as well as companies and the agricultural sector in particular (Regeringskansliet, 2023a).

National policy: Fuel, energy and carbon tax

Sweden has had a tax on fuels since the 1920s, an energy tax since the 1950s, and in 1991 the carbon tax was implemented (Swedish Environmental Protection Agency, 2022).

In Sweden, farmers can apply to receive tax refunds for fuel and electricity (Swedish Tax Agency, n.d.-a). For electricity, the amount of tax refunded is the difference between the current tax level and 0.006 SEK / kWh (depending on currency, 1SEK is ~0.085€, or reversely, 1 € ca 11 SEK). As of now, the current energy tax on electricity is 0.428 SEK / kWh, with a somewhat lower tax in some of the northern parts of Sweden (Swedish Tax Agency, n.d.-b). Farmers may receive a tax refund on electricity if the total amount refunded for that year is at least 500 SEK (Swedish Tax Agency, n.d.-a).

For fuel, the refund depends on the type of diesel as well as the purchase date. To receive the refund, the total amount refunded must be at least 500 SEK for that year. For “green diesel” used in 2024, it is possible to get a refund of up to 2,456 SEK / m^3 on the carbon tax. The table below shows the tax refund possible for other diesel used in 2024. The amount in the table shows the maximum amount which can be received per m^3 (Swedish Tax Agency, n.d.-a). These tax reduction levels of agricultural diesel were increased in 2024 (Bet. 2023/24: SkU7), and there is a proposal for further increasing the tax refunds on diesel in agriculture in 2025: from 2,456 to 2,461 SEK / m^3 refund on carbon tax and from 1,470 to 1,615 SEK / m^3 refund on energy tax (Fi2024/01010).

Table 17. Overview of level of energy or carbon tax refunds between 2022-2024

Purchase date	Refund on energy tax	Refund on carbon tax	Total refund
2023-2024	1,470 SEK / m^3	2,456 SEK / m^3	3,926 SEK / m^3
1 Oct – 31 Dec 2022	1,470 SEK / m^3	2,292 SEK / m^3	3,762 SEK / m^3
1 May – 30 Sep 2022	1,061 SEK / m^3	2,292 SEK / m^3	3,353 SEK / m^3
1 Jan – 30 Apr 2022	1,470 SEK / m^3	2,292 SEK / m^3	3,762 SEK / m^3
Specific tax levels on diesel in 2024 for different environmental classes			
Type of diesel	Energy tax	Carbon tax	Total tax
"Green"	305 SEK / m^3	3,887 SEK / m^3	4,192 SEK / m^3
Environment class 1	1,470 SEK / m^3	2,723 SEK / m^3	4,193 SEK / m^3
Environment class 2	1,868 SEK / m^3	2,723 SEK / m^3	4,591 SEK / m^3
Environment class 3	2,074 SEK / m^3	2,723 SEK / m^3	4,797 SEK / m^3

Source: Swedish Tax Agency, n.d.-c.

Under a new government, the tax levels for petrol and diesel were reduced in 2024 (i.e. not specifically for the agricultural sector but in Sweden as a whole). The tax on petrol was reduced by 0.6 SEK per litre compared to the year 2023. For green diesel, the tax was reduced by 259 SEK / m3 compared to what was initially planned to be the tax level for 2024. For other diesel, this was reduced by 341 SEK / m^3, corresponding to a 120 SEK / m^3 higher tax level than in 2023 (Bet. 2023/24: SkU7).

National initiative: Fossil Free Sweden

Fossil Free Sweden was launched in 2015 as initiative of the Swedish government ahead of the major UN climate conference in Paris, aiming to provide a platform for dialogue and cooperation between major operators for a competitive climate transition i.e. companies, municipalities and government. The government appointed a national coordinator acting as a bridge between operators and government to remove obstacles and accelerate reduction in GHG emission, increasing the pace of achieving national and EU-level climate targets (Fossil Free Sweden, n.d.).

As part of this initiative, there is a roadmap for the agricultural sector, led by the Federation of Swedish Farmers. In this roadmap, companies in the agricultural sector have set their own targets for the use of fossil-free energy in the sector (Fossil Free Sweden, 2020):

- 2020: 25% fossil-free fuel, drying and heating - this target was achieved
- 2025: 40% fossil-free fuel, drying and heating
- 2030: 100% fossil-free fuel, drying and heating

In addition, the initiative and the agricultural roadmap serve as platforms for companies to collaborate with each other, as well as to influence and provide suggestions to policymakers. Eventually, it is a private-sector initiative with targets that are legally non-binding. There is also limited information on the monitoring and achievement of goals.

NextGenerationEU

NextGenerationEU is partly funding 'Klimatklivet', an investment support programme for technology free from fossil fuels and a green transition that started in the year 2015**.** It is voluntary, not exclusively

for the agricultural sector, and administered by the Swedish Environmental Protection Agency (n.d.-b). In specific, support can be received for the following investment types: hydrogen fuel; agriculture (such as renewable energy for drying or biogas production); charging stations for electric vehicles; fossil-free solutions for shipping, aviation and heavy transport; circular flows; changing to fossil-free fuels; utilisation of excess heat and energy efficiency; and biogas, biofuels and electro fuels.

To receive financial support, the investment needs to significantly contribute to reducing GHG emissions, and proof that the investment cannot be done without the support (Swedish Environmental Protection Agency, 2024a). Companies can receive support for 20-65% of the investment cost, while other organisations (such as municipalities and NGOs) can receive up to 50% of the investment cost. Companies in special support areas can receive up to 5% extra funding support (Swedish Environmental Protection Agency, 2023c). In total, 25,565 recipients had been granted investment support by May 15 2024 (Swedish Environmental Protection Agency, 2024b).

As of March 2024, 842 actors in the agricultural sector had been granted investment support, and according to the Swedish Environmental Protection Agency (2024c), the supported investments should result in a reduction of 235,000 tonnes of CO2e from the agricultural sector annually. The most common investment type by agricultural companies is switching from fossil energy to renewable energy, with other common investment types including investing in biogas production and measures for improving energy efficiency (Swedish Environmental Protection Agency, 2024d).

Agricultural law

Farm-to-Fork: Organic target

The Swedish national food strategy from 2017 (i.e., before the Farm to Fork Strategy) contained the targets to have 30% of agricultural land being used for organic production and 60% of food purchased for public kitchens being certified organic by the year 2030. These targets were, however, removed in 2024 (Swedish Board of Agriculture, 2024a). In the budget for 2023, the new government from 2022 motivated their decision to remove organic targets by saying that there is no need for organic targets as Swedish food production should be demand-driven (Prop. 2023/24:1).

The strategic plan for the implementation of the CAP in Sweden (2023-2027) states that important measures in Sweden to help the EU achieve its target of 25% organic production include compensation for organic production as well as facilitating collaborations and skills development (Regeringskansliet, 2023b). See “Compensation for organic production” under “CAP: Eco-schemes” below for specifics on the compensation.

CAP: Eco-schemes

For the 2023-2027 implementation of the CAP, Sweden has introduced three eco-schemes: compensation for organic production, precision farming, and carbon sequestration and reduced nitrogen leakage (Regeringskansliet, 2023b). These are all administered by the Swedish Board of Agriculture.

Compensation for organic production

Certificated organic farms or farms that are switching to organic production can apply for a voluntary one-year compensation. Planned compensation for 2024 (Swedish Board of Agriculture, 2024b):

- Cereal/oilseeds/protein crops/other 1-year crops: 126 euros per hectare
- Potatoes, sugar beets, and vegetables: 541 euros per hectare
- Fruit and berries: 677.47 euros per hectare
- Animal production: 177 euros per animal unit

Compensation for precision farming

Farms can apply for a voluntary one-year compensation for planning crop cultivation, e.g. fertilisation strategy, to avoid excess nutrient leaching. This is currently available for only some regions of Sweden (so-called nitrate sensitive areas) but will be available for the entire of Sweden as of 2025. Planned compensation for 2024: 25 euros per hectare (Swedish Board of Agriculture, 2024c).

Compensation for carbon sequestration and reduced nitrogen leakage

Farms can apply for a voluntary one-year compensation for improving carbon sequestration and reducing nitrogen leakage by spring tillage or by growing catch or intermediate crops. These are three separate compensations (Swedish Board of Agriculture, 2024d):

Farms in nitrate-sensitive areas can apply for compensation for growing catch crops. Planned compensation for 2024: 147 euros per hectare of arable land (Swedish Board of Agriculture, 2024e).

Farms within given areas support areas (these areas consist of the plain districts of Sweden, as a contrast to the forest districts) can apply for one-year compensation for storing carbon in soil by growing intermediate crops. Planned compensation for 2024: 128 euros per hectare of arable land (Swedish Board of Agriculture, 2024f).

Farms located in nitrate-sensitive areas can apply for one-year compensation for reducing nitrogen leakage by spring tillage. Planned compensation for 2024: 69 euros per hectare of arable land (Swedish Board of Agriculture, 2024g).

CAP: Financial support

Financial support for biogas production from agricultural raw materials and efficient plant nutrient utilisation

Authorities, municipalities, regions, associations, other organisations, and companies are eligible to apply for this support, with private individuals being ineligible. It is administered by the Swedish Board of Agriculture, which will grant support for up to two projects. The first project should have the goals to 1) improve collaboration and knowledge sharing between biogas plants, in particular ones connected to agricultural companies, and 2) evaluate the production, economy and environment of the participating plants to help the individual plants improve as well as improve the general knowledge of biogas plants. The second project should have the goal of improving knowledge and collaborations in questions related to efficient plant nutrition utilisation or reduced emissions of ammonia from biogas plants. The total cost for a project should be 3-7 million SEK but can be up to 10 million SEK if the project includes all three goals mentioned above. Total budget: SEK 10 million (Swedish Board of Agriculture, 2023a).

Investment support for building facilities for the production of manure-based biogas

Companies engaged in non-agricultural activities in the countryside, with an annual turnover of no more than 10 million euros and a maximum of 50 employees or companies engaged in agricultural business that want to produce manure-based biogas can apply for financial support for the following expenses (up to 40%) (Swedish Board of Agriculture, 2023b):

- *Conversion, new, and extension of facilities for producing / using biogas from stable manure.*
- *Conversion, new and extension of facilities to handle digestate*
- *Upgrade facility*
- *Pipelines and culverts*

Investment support for renewable energy 2015-2022

This support comes partially from the former rural program within CAP and the rest of support came from the Swedish state. This support is closed to new applicants, but applicants who have received a decision on support can still apply for payment.

Companies in the agricultural, horticultural or reindeer sector can apply for investments for producing as well as selling renewable energy. Other companies in rural areas are also to some extent eligible for support. Support can be received for up to 40% of the costs, and the expenditures must be at least 100,000 SEK to receive support (Swedish Board of Agriculture, 2023c).

Financial support to producer organisations for fruits and vegetables

Producer organisations for fruits and vegetables can apply for financial support for various investments. The requirements for the financial support include that their investment programme must cover four mandatory target areas: concentration of the supply; research and development of sustainable and innovative production methods and technologies; promote, develop and implement measures to protect the environment; and climate mitigation and adaptation. The latter could include investments such as for increasing energy efficiency and getting advice on energy or logistics. Any produced organisation for fruits and vegetables can apply and receive support for 50, 60 or 80% of the costs for the programme, which should be 3-5 years long (Swedish Board of Agriculture, 2023d).

There was an equivalent programme between 2017-2024 but with no mandatory target areas included. Support could be received for 50% of the cost for a 3-5 programme (Swedish Board of Agriculture, 2023e).

CAP: Other support

Focus on Nutrients (‘Greppa Näringen’) is a free and voluntary advisory service for farmers founded in 2001, and it is financed through the CAP. It is led by the Swedish Board of Agriculture, in collaboration with the County Administration Boards and the Federation of Swedish Farmers (Greppa Näringen, n.d.-a). When it started in 2001, the ambition was to reduce nutrient leakage by increasing nutrient efficiency. Today, the vision is broader and also includes the idea to reduce GHG emissions (Swedish Environmental Protection Agency, 2023b). In specific, the purpose of Focus on Nutrients is to (Greppa Näringen, n.d.-b):

- "*Reduce losses of the GHG gases: nitrous oxide, methane and carbon dioxide*
- *Reduce losses of nitrate from farmland*
- *Reduce ammonia emissions from manure*
- *Reduce losses of phosphorus from farmland*
- *Avoid losses of pesticides into surface and groundwater*
- *Increase energy efficiency on farms*"

In the strategy for Focus on Nutrients 2023-2027, it is stated that their work should contribute to Sweden reaching the goals for various EU policies: Nitrates Directive, Water Framework Directive, Directive on the reduction of national emissions of certain atmospheric pollutants, Green Deal, and REPowerEU. Additionally, they help achieve national environmental targets, in particular, the targets zero eutrophication, a non-toxic environment, and reduced climate impact (Greppa Näringen, 2022a).

In a report from 2022, Focus on Nutrients present some results from their first 20 years of activity. Over **10,300 farmers** have received recurring farm visits, corresponding to almost half of the of arable land area. In total, around 65,000 farm visits have been conducted. Some examples of results include (Greppa Näringen, 2022b):

- On conventional farms receiving advice on nutrient balances, the average reduction in nitrogen surplus *after six years was 3.6 kg N per ha for crop* farms, 6.4 kg N per ha for milk farms, and 16.3 kg N per ha at pig farms.
- Of the farms receiving advice on improving energy efficiency, around *half had increased their share of renewable electricity, and 35% had increased their share of renewable fuels*.
- Of the farms that received advice on wetlands, a fourth had created wetlands.

Discussion and conclusion on policy & implementation experience

The case studies (Part 2) confirm the impression from section 1 regarding the high relevance of particularly the *climate related measures* (RE and EE Directives) that seek to support and spur the application of renewable energy and energy efficiency in all sectors, though typically not with a *particular* focus on the agricultural sector. This may in some cases deserve more attention as now also taking shape in Germany with certain legal force and a notable financing backing. The situation seems comparable in Poland though considerable legal and procedural hurdles persist. Beyond that it is particularly CAP that plays a principal role for reaching the objective of energy independence on farms because it incentivises investments into renewable energy or energy efficiency measures. There are various measures (most importantly as part of the eco-schemes and rural development support schemes with agri-environmental climate measures) in place that also incentivise minimised fertiliser use, reduced tillage or grass feeding of animals. High variances exist between the countries in terms of uptake rates and implementation design, though (e.g. results based vs activity based). Also, the voluntary nature of most ecological measures under pillar 1 and 2 limits the "forcefulness" as possible levers towards energy independence. In numerous countries the activities are not used (yet) at broad scale because of the complexity or novelty of the measures but also the fact that the financial incentives seem to not outbalance the additional effort or income forgone. Amendments of the systems are already seen in the first year of the CAP programming period.

With this, the EU-wide statutory management requirements (SMR) applying to all farmers as well as the good agricultural and environmental conditions (GAEC) that establish "conditionality" for receiving direct payments serve as the (*minimum*) key common bottom line in all countries. Referring to the Water framework (with nitrate and ammonium as key pollutants of water bodies) or Nitrate Directive, SMR indirectly limit the use of fertilizers more generally. In the GAEC standards maintaining soil fertility is of high importance among other things, e.g. through crop rotation or minimum soil cover requirements, and thus indirectly foster practices that may reduce fertiliser use at least on all farms that are subject to CAP payments. However, recent changes (watering down) in the GAEC in response to farmer protests may undermine the effect of conditionalities for basic income support under pillar 1. Because the recent CAP period has just started it is too early to assume that measures would translate into actual reductions of fertiliser, animal feed or other fossil energy uses. This also evokes the question if farmers maintain practices considering that most of the relevant measures are of voluntary nature (eco-schemes or other AECM) and seem partly plagued with issues such high administrative load for little financial compensation. Most importantly, energy independence is no genuine objective present in CAP in its *own right*, and only indirectly presented and translated through other objectives (in relation to climate change, soil health or rural development) adding to the inconsistencies.

A notable commonality across the country case studies is that **energy price** focused policy measures are in place – and have partly been revived in the course of the energy crisis and war and Ukraine – that may cement rather than address fossil energy dependence in the agricultural sector. Often meant as an immediate "relief from price surges" or as a general social income support, numerous countries have detrimental subsidies on (agrarian /all) diesel/fossil fuels. These subsidies create a competitive advantage for fossil fuels as energy source (including for transport, cooling or heating on farms). They appear in different designs, but create more or less similar incentives to not change energy supply. Either taxes are low, or not applied (to agricultural use) or are refunded. Incentives to lock-in are particularly perverted where refunding is tied to a particularly high use profile (i.e. thresholds). In some

cases, low or no taxes apply also to renewable alternatives or regulation is in place that obliges the mix with bio-based fuels. In exceptional cases (like Germany), there seems to be a clear will to remove climate-destructive subsidies.

Playing into this incoherence, countries have seen their governments moving further "right" in the political spectrum more recently which spurred according to the expert opinion a certain loss in policy commitment. A situation of political volatility creates additional risks to sustainable investment and may impact on farmers' willingness and interest in changing farming practices. High land prices added to the lock-in in some countries, like the Netherlands, because it forces farmers into certain possibly less sustainable, but highly profitable practices to maximize production outputs. Such situation left limited manoeuvre for transitions or high investments.

Inconsistencies and trade-offs exist between policy objectives and corresponding policy measures and partly hold only little or limited potential for win-win outcomes. For instance, nature protection law and related interest groups were elaborated as standing in the way of pursuing renewable energy projects at scales and at speed in certain countries (e.g. Poland). Interestingly also in the case of biogas capacity development at local and communal structures, political resistance was portrayed as a major problem that may be addressed, though, with a focus on strengthening cooperation at local level.

Depending on national policy priorities specific policy measures may be favoured at the expense of alternative measures. For Greece, a focus was seen to be on wind and solar energy measures. Also, organic agriculture took an ambivalent role in implementation because it seen to not be a prime pathway for energy sufficiency/independence, because of major structural hurdles, like that in some countries (like Poland or the Netherlands) there was a lack of consumer markets, infrastructure or/and labour force which required more than an ambitious political target and higher subsidies (under CAP). Farmers are reported to only convert for obtaining subsidies not for developing a sustainable production model, leading to another dependence situation. A primary focus on organic was deemed limiting the options, including of alternative approaches to integrated land use or for investments into precision technologies in certain countries.

Against this backdrop renewable energy projects have an ambivalent role. On one side, they are an important aspect in achieving energy independence of whole country and may also increase farm resilience, because photovoltaic or 3rd generation biofuel installation offer additional income streams (incl. through subsidies for maintenance). As value-adding assets, however, they also put additional pressure on land prices and may be counterproductive for other activities. Here a certain policy 'void' exists that required urgent answers while a loss of support for renewable energy policy in agriculture is seen already in some countries.

For the further work in the project and subsequent work, the analysis was key to specify the key policy areas and getting a clearer picture of their direct or indirect relevance to farm-level practice and behaviour in relation to fossil-fuel uses, including risk considerations. For policy, the analysis helped identify pertaining political blind spots, limitations and inconsistencies in policy frameworks, including the role of political dynamics – such as the farmer protests and energy price surges – at national level. It was possible to carve out very practical and political challenges of implementing ambitious targets towards more energy independence in member states for the agricultural sector. CAP measures although of very high and direct relevance to the objective of fossil energy independence remain often voluntary and under-financed. Against this backdrop, a more general question to be answered is what

form(s) of agriculture Europe wants and needs to have in the near to medium future and whether the matter of energy independence deserves *attention in its own right*. in line with the conclusions from the mapping of EU policies in the first section and as validated in the stakeholder engagement the national analyses reaffirmed the pivotal role of the RE and EE policies. In fact, there are clear and binding objectives tied to the RE and EE Directives. However, national implementation here too is a question of member states' priorities (including focus which is often not explicitly agriculture as a sector). Compliance is addressed mostly based on reporting and reviewing rather than penalizing, which adds to the slow progress towards fossil energy independence of the sector. Some countries, like Germany stand out in terms of the "additional" financial support to establish key incentives to invest in renewables (just) for the agricultural sector or Greece in terms of ambition towards renewables. It proves the critical role of political national agendas and political will, correspondingly.

Finally, the overall sustainability of different pathway(s) towards energy independence or resilience in the agricultural sector remains a major concern for evaluating concrete policies and corresponding farming practices. From the objective of achieving energy in dependence some policies may score high, e.g. SUR or organic targets in terms of reducing fossil fertilizer use. When considering other sustainability objectives (e.g. high yields per ha for food security or emission reductions) policies on energy resilience may create substantial tradeoffs, e.g. when supporting animal husbandry, as a major source of methane emissions or practices that considerably reduce yields and production. However, even in the case of policies with highly focused or singular objectives – as seen with the ad hoc interventions in response to the Ukrainian war – countries may opt for integrated solutions and tie national policies into broader policy frameworks in coherent ways.

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Annex 1 Guidance for partners on national policy

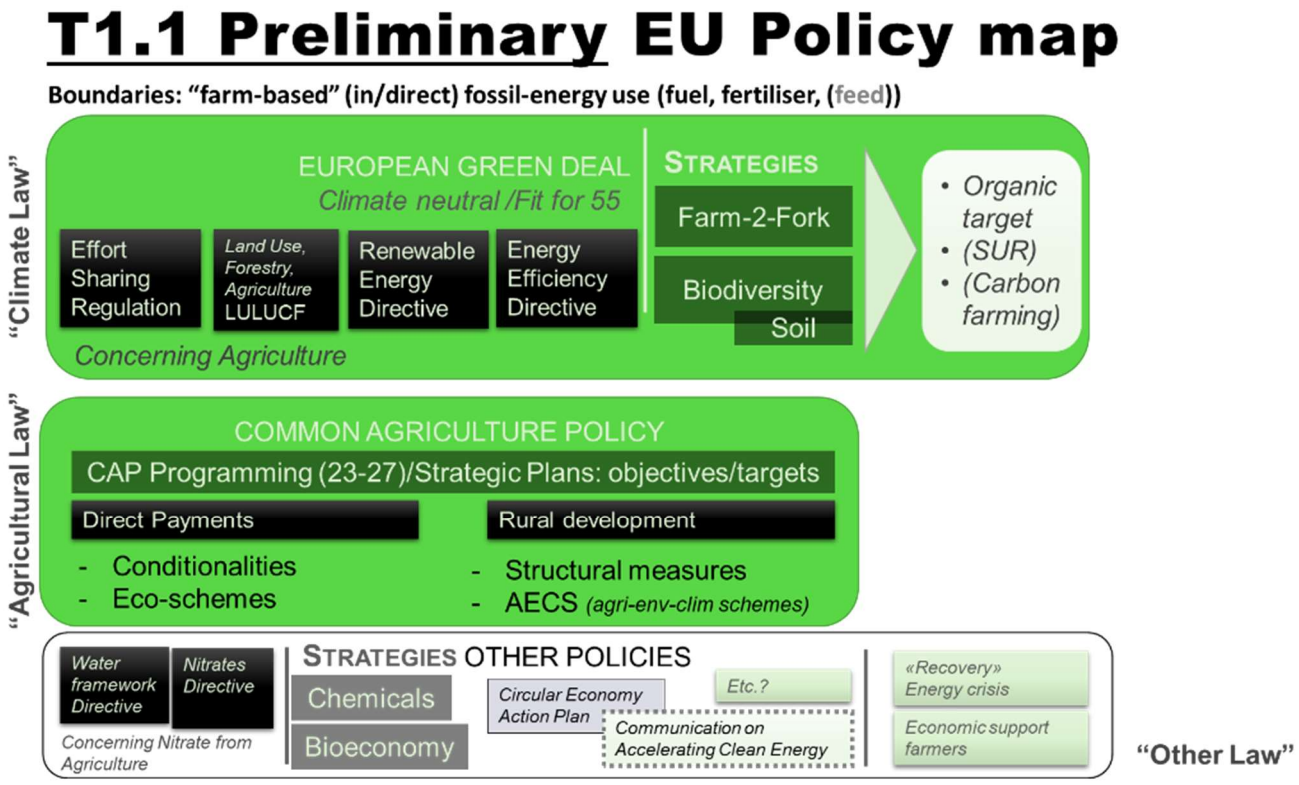

Figure 1: most relevant EU policy framework
(which we need to check for variances in national implementation incl. indicators)

Please help us specify how the above EU frameworks are/have been implemented in the focus country(ies) with a ½-/1-pager on implementation per scheme: being specific about concrete policy targets, institutional set up (e.g. is it voluntary) & means of achieving and monitoring
Please be aware that only in some cases the relevant policies will be specific for Agriculture. Some are explicitly for the «energy» sector but with direct relevance /application to agricultural (fuel/energy use/efficiency) or they may concern carbon as a value to be traded and thereby working on incentives to become more climate friendly (and energy independent) in practices

Deductive approach (Step 1):

Please concentrate your research on the listed policies (above) for now.
What "specifics" can you find out for each policy for your country beyond what our EU level analysis already offers "across the board" and as a EU27 overview (where applicable):

1. **European Green Deal**
    a. Climate /fit for 55 (for all these provisions there is typically a EU target which is differentiated at national level)
        i. Effort sharing regulation (specifying how overall diff. member states will contribute to the EU wide 40% target for 2030 (compared to 2005)
        ii. Land use, land use change and forestry (LULUCF, sometimes called AFOLU) – only very indirectly relevant mostly as "offset" /CDR to cover unabated GHG emissions
        iii. Renewable energy directive: which concrete targets, which measures want to promote a higher application of RE exactly (including on farms)

iv. Energy efficiency directive: which concrete targets (how is energy. Efficiency translated into a specific policy goal), which policy schemes /measures are chosen to achieve more energy efficient practices (specifically but also including on farms, thinking of farms as general businesses, or places where vehicle are used that combust fossil fuels)

b. "linked" agricultural/environmental strategies/frameworks under the EGD:
   i. Biodiversity Strategy: with EU wide reduction target for substance use
      1. Nation states have biodiversity strategies that may spell out targets for less substance use (incl. nitrogen/fertiliser)
      2. Partly this is to be found in the national response to the EU wide "soil strategy"
   ii. F-2-F Strategy: Organic target (25%), □ reduction of nitrogen
      1. *Here it is particularly important to check on:* organic target policy /national organic action plans
      2. While the Sustainable Use regulation is currently halted at EU level, national legislations may be in place handling nitrogen e.g. as part of water /nitrate directives or (hazardous) chemical laws
      3. Carbon farming: While not specified yet, an EU market for carbon certificates for carbon farming is likely (e.g. under ETS); there may already be nation states, regions/municipalities experimenting with a removal scheme (e.g. soil carbon, trees, or biochar), further incentivising financially the substitution or offering additional income streams (from removals through trees, biochar on farm) to "outbalance" high energy costs

2. **Common Agriculture Policy**
   a. We expect high variation in CAP implementation
   b. □ please check the CAP **Strategic Action Plans**
      i. Specify Pillar 1 specific measures of relevance for fossil energy /fuel dependence (eco-schemes or conditionalities translated in a way that they are relevant for project perspective on resilience/energy efficiency/fuel/fertiliser reductions)
      ii. Specify Pillar 2 (rural dev, e.g. structural investments in fuel/energy dependence, e.g. renewable energy or energy efficiency appliances or precision farming)

3. **Other Policy**
   a. Esp. policies oriented at energy price stability (Ukraine war response), but also general/agriculture related fossil fuel subsidies matter that are hardly regulated at EU but a clear focus at national level
   b. Another set of "other policies" relates to water bodies, soil quality (esp. chemical, nitrate loads) that may (also indirectly) impact on attractiveness of fossil energy

When you write down your **national policy narrative** please be specific on the following dimensions in each case (*allowing cross case comparison*):

Genesis & development

- When was it decided upon/enforced
- Which other national policies is it linked to, e.g. is it the result of /part of a specific national policy program or really just EU implementation ?
- □ It may be worth checking if as part of this bigger "programme" on agriculture, energy, transport etc. there are ***other*** sub-policies, provisions of relevance (please add what find, "snowballing")

Description general (e.g. institutional logics and structure)

- What are specific policy targets and sub-targets and how may they relate to our project focus
- How is it organized exactly, e.g. is it translated into state-based or even local strategies or programmes, is it compartmentalized, i.e. organised sectorally across specific ministries?
- Also ask: How is it financed exactly (this may direct you to a funding scheme that has other policies of relevance, to allow snowballing other relevant policies, please check!)

Aspects of relevance for AgEnRes variables and indicators: THINK: (1) fossil fuel/energy and 2) fertiliser use, 3) energy price fluctuations (or 4) very indirectly land or production related climate mitigation which may be used to outbalance the bill)

With a view on farm-level fossil energy/ fuel dependence (and the goal to achieve resilience) please specify how the concrete measures put in place may help achieve more resilience, e.g. how exactly do the schemes, measures, incentives of the policy work towards promoting sustainable farming practices and address environmental concerns especially through specific programs aimed at supporting agroecological practices (4?), precision farming (2?), and the use of renewable energy (1?) in agriculture etc.

Additions (e.g. lit review delivers insights on effectiveness towards AgEnRes relevant "mechanisms")

It will be interesting to learn how a specific measure /policy has already helped or not to achieve specific objectives relevant to AgEnRes, e.g. if there are assessments about the reduction in energy use that are attributed to the policy.

One approach may also be to specify how the country intends to or does measure the "success" of the measures. Some of these indicators refer to a broader EU wide indicator framework (like under CAP), others may be very country specific. This helps us with task 1.3

References

Please do always provide references not only in a reference section but (in text reference; name, year)) alternatively with numbers: [e.g. No. 2]

No. 1

No. 2

“Template” (Hungary Pilot): “Renewable Energy Law for agriculture in ‘example land’”

Genesis & development

A few words where this policy originates from

“As a result of xxx Process/Treaty country x has established policy abc as a result of.

Since xyz the regulation... The current cycle runs from year a -year b [Reference No.1]

Description general (e.g. institutional logics and structure)

- The CAP is the key policy framework to support European agriculture in EU member states.
- Member states develop National CAP strategies that are then implemented, e.g. at federal state level
- Under Pillar 1 xxx and under Pillar 2 xxx [No. 1

Aspects of relevance for AgEnRes (1) energy and 2) fertilizer use,3) energy price fluctuations or 4) indirectly land or production related climate mitigation)

In the course of its reforms measures have been added e.g. under the ecoschemes, that promote sustainable farming practices and address environmental concerns especially through specific programs aimed at supporting agroecological practices (4?) , precision farming (2?), and the use of renewable energy (1?) in agriculture. [e.g. No. 2]

Find out which provisions exactly

Additions (e.g. lit review delivers insights on actually effectiveness towards AgEnRes relevant mechanisms)

Add e.g. if insights exist as to in how far the measure has already been successful in achieving the objectives relevant to AgEnRes, e.g. if there are assessments about the reduction in energy use that are attributed to the policy

References

No. 1

No. 2

Annex 2: Stakeholder Workshop discussion

The online based AgEnRes workshop with stakeholders in task 1.1 on "Policies for Energy Independence and Resilience in Agriculture" took place on 17 June 2024 and lasted 90min. 25 external participants confirmed participation by 16 June with a certain drop out by the actual date or for certain parts of the workshop. An additional 14 experts from the consortium joined the discussions. The workshop was oriented at researchers, policy makers, or civil society representatives who work on climate, energy and/or agricultural policies – either at EU or at national level (in Europe). While for data protection reasons we cannot share a list of participants or their names, they represent a broad range of relevant sectors from EU to national level including academia, farming associations, policy making and administration.

After a short introduction to the project and work package, participants were invited to engage in 2 rounds of discussion to explore: 1) the **relevance of policies** on the "long list" and sharing key arguments for why policies are deemed relevant and possibly which policies were missing. 2) **Policy impact**: considering the variation in authority of different measures (Opinion vs Regulation) and that policies are implemented at Member state level, elaborate on the actual impact of policies towards the objective of energy independence

Figure 27. discussion rounds in stakeholder workshop on relevance and implementation of policies

Source: Miro Board screen shot

National peculiarities – national implementation

Already in the first round, stakeholders elaborated repeatedly on implications of national level implementations of the key policies as a basis for judging their relevance and on this basis highlighted most prominently the Renewable Energy and Energy Efficiency Directives as well as CAP (distinguishing the two pillar approaches) as the most relevant policies in line with the objective of energy independence. Partly also the Nitrates Directive was highlighted or certain national pathways to address the energy price surge in the context of war in Ukraine.

The EU strategies – especially the mentioned – are seen as relevant. But they typically are not directly implemented. Often remaining rather at the theoretical level of carving out overall objectives and targets there is typically a considerable time lag between strategy and actual practice. Eventually they rely on the member state policies put in place for their implementation. In this respect, the current changes in the CAP payments (programming period 2023-27) are partly seen as not really in action yet. Still they are highlighted across all discussion group as a major "hook" for changing farmer behavior across all countries – and on both pillars. Xxx RE investments, energy saving, regional discretion,

Figure xyz: Selected posts by stakeholders discussing national implementation in round 1

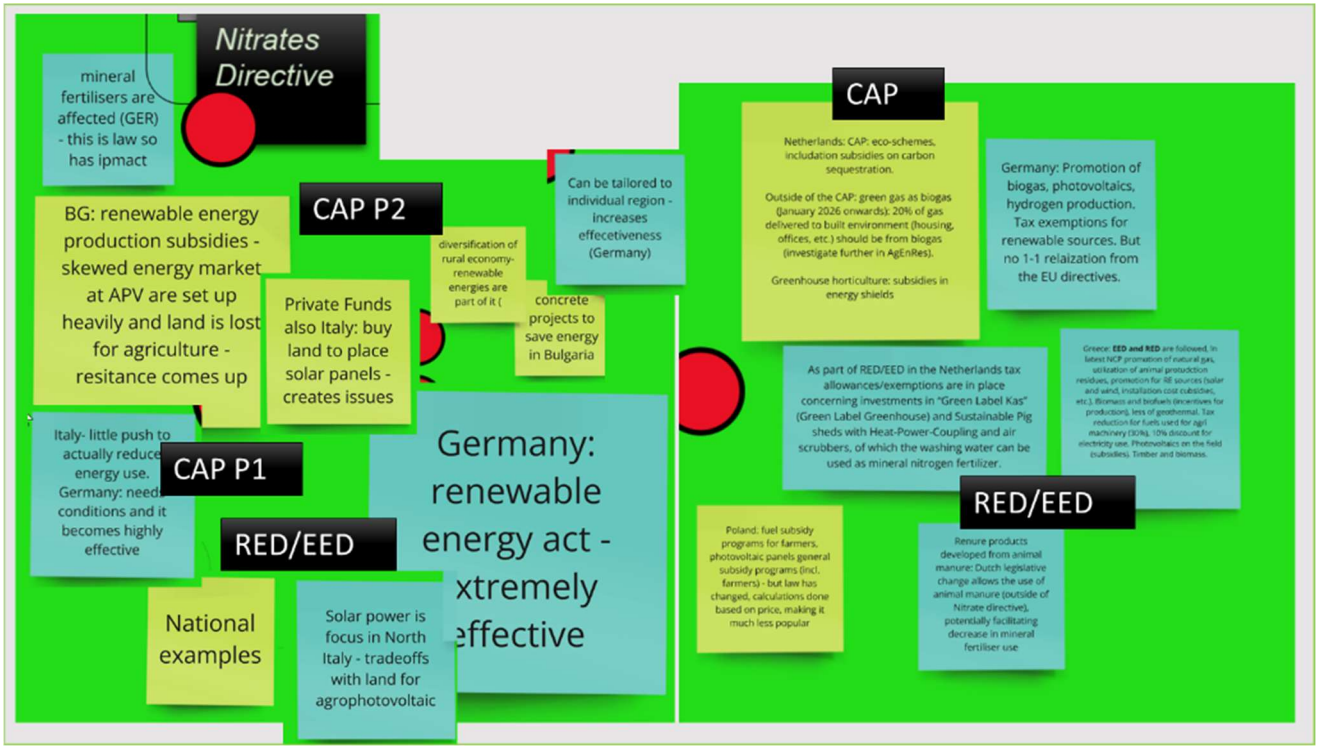

Figure 28. Major policy areas with narrative of discussions in stakeholder workshop

Source: Miroboard discussion on 16 June 2024 in 3 breakouts

Different energy mixes and considerable variances in socio-economic conditions exist among member states with an impact on the profitability of switching to alternatives. Playing into this is that the structure of national energy markets and smallholder farmers or communities as addressees of renewable energy or energy saving investments may exert a certain incompatibility under current conditions in some countries (e.g. prosumers being too small to be connected to the grid). In a similar vein, biogas production was seen to require high investment costs and therefore favoured farms of certain big sizes. The German approach to renewable energy was seen as a primary example of effective implementation

Trade-offs and lock-ins

Across all discussion groups, stakeholders discussed inconsistencies and trade-offs between policy objectives and related policy measures and that different targets based on multiple objectives carry contradictions in objectives with partly little potential for win-win outcomes. For instance, nature protection law and related interest groups were elaborated as standing in the way of pursuing renewable energy projects at scales and at speed in certain countries (e.g. Poland). Interestingly also in the case of biogas capacity development at local and communal structures, political resistance was portrayed as a major problem that may be addressed, though, with a focus on strengthening cooperation at local level.

Depending on national policy priorities there was also a certain favour seen for specific policy measures at the expense of “alternative measures”. For Greece a focus was diagnosed to be clearly on wind and solar energy measures. Also organic agriculture took an ambivalent role in implementation in the eyes of some stakeholders. It may – in this view – not in any case be as the primary pathway for energy sufficiency/independence as often suggested, partly because of major

structural hurdles, like that in some countries (like Poland or the Netherlands) there was a lack of consumer markets, infrastructure or/and labour force which required more than an ambitious political target and higher subsidies (under CAP). Farmers are reported to only convert for obtaining subsidies not for developing a sustainable production model, leading to another dependence situation. The prime focus on organic was evaluated as partly blocking thinking in additional alternatives to integrated approaches or investments into precision technologies in certain countries.

In the context of the role of national priorities, the persisting subsidies for fossil energy including and especially for the agricultural sector pertain another major implementation hurdle and one that was somewhat revived in the context of the energy crisis. High land prices add to the lock-in in some countries, like the Netherlands, because it forces farmers into certain possibly less sustainable, but highly profitable practices to maximize production outputs. Such situation left limited manoeuvre for transitions or high investments.

Against this backdrop renewable energy projects have an ambivalent role. On one side, they are an important aspect in achieving energy independence of whole country and may also increase farm resilience because photovoltaic or 3rd generation biofuel installation offer additional income streams (incl. through subsidies for maintenance). As value-adding assets, however, they also put additional pressure on land prices and may be counterproductive for other activities. Here a certain policy 'void' exists that required urgent answers while a loss of support for renewable energy policy in agriculture is seen already in some countries, like Bulgaria. Against this backdrop a more general question to be answered is what form(s) of agriculture Europe wants and needs to have in the near to medium future.

Policy coherence and data gaps

Already in the first round of discussions, stakeholders noticed that and how energy dependence is lacking consideration in the policy frameworks in its own right. The legally not binding RePowerEU may be directly related, but it relies on a "piecemeal" policy approach in member states for implementation meaning that the answer is scattered across different policy measures (RED, EED, CAP) that follow other – more or less indirectly related – objectives (climate mitigation, rural development, sustainable agricultural production etc.). No policy has a singular and final goal of energy independence whereas indirect pressures such as water or consumption ("protein transition") provide indirect pressures towards more sustainable practices. A pertaining challenge may be that such subjects of relevance lie outside the realm of agricultural policies. On top also the legal void on the matter of bio-economy, incl. concrete biomass production criteria, creates a legal void.

Another aspect in the discussions were the prevailing data gaps, and unsuitable indicators as to also capture energy resilience related matters with a certain level of uncertainty regarding impacts on the energy bill, e.g. whether transitioning to pastures or reducing imports would decrease or increase energy dependence (because of more machinery use on own farm)


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