FINAL EVALUATION REPORT

on the thematic evaluation of

the Rural Development Programme 2014-2020

Improving energy efficiency in agriculture and the food processing industry

Updated version (2023)

in the scope of project "Provision of IT and administrative expert consultancy services to support the development of IT systems supporting the implementation of the Rural Development Programme, as well as monitoring planning and expert consultancy services related to CAP 2020"

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Completed: 28 June 2024.

QUALITY ASSURANCE DECLARATION[1]

In the first Final Evaluation Report titled *"Increasing the efficiency of energy use in agriculture and the food processing industry"*, which was prepared by a consortium led by Field Consulting Services Zrt. on behalf of the Ministry of Agriculture with a closing date of 30 June 2021, the quality expectations examined in the framework of the quality assurance built into the evaluation process were met:

1. ***The methodology and approach of the*** evaluation complies with the guidelines and rules published by the European Commission, and with international and national evaluation standards. The evaluator has revised the report in accordance with the comments made on certain qualitative aspects.
2. The findings are supported by the facts presented in the evaluation. The applied methodology and the handling of data sources are professional. Findings, conclusions, and recommendations are coherent. The proposals are well developed and practical.
3. The ***evaluation questions are relevant, testable and they cover the following topics***:
   a. a statement of the results, net impact of the VP
   b. formulating suggestions for further improvements to the criteria of calls for proposals, and selection criteria to increase the effectiveness and achievability of the indicators,
   c. production of impact and additional outcome indicators
   d. evaluation of the LEADER contribution (if relevant)
   e. synergies with other operational programmes
   f. examining historical data to support the planning of the CAP Strategy and the production of indicators
   g. interim changes in the policy environment
   h. the VP's contribution to national and EU strategic objectives, and the expected and some unanticipated economic, social, environmental/sustainability impacts
4. The evaluation ***answers the evaluation questions*** set out in the adopted Inception Report. In cases where the evaluation does not answer the evaluation question, an appropriate justification is provided in the report under the relevant sections.
5. The report is professional, for the most part it’s comprehensible and clear, but at some points its use requires in-depth professional expertise.

Overall, the Final Evaluation Report titled *"Improving energy efficiency in agriculture and the food processing industry"* meets the expected quality standards.

[1] Annex 1 details the purpose, aspects, tasks and integration of quality assurance into the evaluation process. The quality assurance statement is issued by the external expert involved in the quality assurance after the finalisation of the Final Evaluation Report. The Quality Assurance Statement will cover the first two evaluation phases in 2020 and 2021.

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LIST OF ABBREVIATIONS

AKI	Institute of Agricultural Economics
AM	Ministry of Agriculture
CMEF	Common Monitoring and Evaluation Framework
EC	European Commission (European Commission)
EFOP	Human Resources Development Operational Program
EMVA	European Agricultural Fund for Rural Development
ÉNGY	Collection of Construction Standards
ENRD	European Network for Rural Development
YEAR	Annual Implementation Report
GREX	Expert Group
GINOP	Economic Development and Innovation Operational Program
IACS	Integrated Administration and Control System
IH	Managing Authority
IIER	Integrated Administration and Control System
IJ	Inception Report
IKOP	Integrated Transport Operational Program Plus
KAP	Common Agricultural Policy
KEOP	Environment and Energy Operational Program
KEHOP	Environment and Energy Efficiency Operational Program
KHM	Environmental Impact Monitoring
KMOP	Central Hungary Operational Program
KÖJ	Intermediate Report
KSH	Central Statistical Office
kW	Kilowatts
kWh	Kilowatt hours
kWp	Kilowatt peak (maximum generation capacity)
MAHOP	Hungarian Fisheries Operational Program
MÁK	Hungarian State Treasury
MW	Megawatts
NAK	National Chamber of Agriculture
NAV	National Tax and Customs Office
NEKT	the National Energy and Climate Plan
NVT	National Rural Development Plan
OP	Operational Program
PJ	Petajoule
PMEF	Performance Monitoring and Evaluation Framework
R.14	Increasing energy efficiency in agriculture and food processing in projects supported under the Rural Development Program (=PMEF R.16)
R.15	Renewable energy produced by supported projects (=PMEF R.15)
ROP	Regional Operational Program
STÉ	Standard Production Value
TEÁOR	Single Activity Classification System
SECTION	Fruit and vegetable producer organizations
THÉT	Areas with natural handicaps
TJ	Terajoule

TOE	Ton of oil equivalent
TOP	Operational Program for Spatial and Urban Development
ÚMVP	New Hungary Rural Development Program
VEKOP	Competitive Central Hungary Operational Program
VP	Rural Development Program
W	Watts
ZÉJ	Final Evaluation Report
TÉSZ	Producer Sales organization

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EXECUTIVE SUMMARY

Introduction and objectives

Improving energy efficiency and increasing the use of renewable energy sources will benefit economic operators (households, businesses, governments) through cost savings and will also contribute to reducing greenhouse gas emissions and thus to climate protection. The present document is the Final Evaluation Report of the evaluation, which is mainly intended to support the development of the planned interventions in the field of energy efficiency and renewable energy in the CAP Strategic Plan (2023-2027) and to inform the ex post evaluation of the RDP with the results of the 2023 update.

Why is this topic important?

The challenges the EU faces in the field of energy policy include growing import dependence, limited diversification, high and volatile energy prices, increasing global energy demand, security concerns for producer and transit countries, the growing threat of climate change, decarbonisation, **slow progress on energy efficiency**, **challenges in increasing the share of renewable energy sources, and the** need for greater transparency, further integration and interconnection of energy markets. The EU's energy policy focuses on a variety of measures aimed at an integrated energy market, security of energy supply and sustainability of the energy sector.[2] EU Directive 27/2012/EU set a target of a **20 percent reduction in energy consumption by** 2020 compared to planned energy consumption levels, and Member States have developed their own **energy strategies and action plans to** achieve this. When this directive was amended in 2018, the energy reduction target for 2030 (2002/2018/EU) was increased **to 32.5 percent,** in the spirit of the Paris Climate Change Convention. The EU has set a target for renewable energy production of **32 percent** of total energy production by 2030.

The Government of Hungary has set out the strategic directions and targets to be followed in the National Energy Strategy 2030 and the current National Energy and Climate Plan to address changes in the energy sector and to reduce greenhouse gas emissions and meet EU obligations.

According to the **Rural Development Programme (RDP**), in order to ensure the sustainable development of rural areas, particular attention should be paid to **increasing resource efficiency and moving towards a carbon-neutral economy in the agricultural, food and forestry sectors**. This has been achieved through the measures of the RDP to promote energy efficiency and the development of renewable energy production potential.

How was the evaluation carried out?

The energy evaluation of the RDP was carried out in three separate phases, in 2020, 2021 and 2023, under the guidance of three expert teams. The **first phase (2020)** could not produce well-evaluated results, so **in the second (2021) a** methodologically correct, but necessarily limited estimate was produced (due to the available data) using the current Environmental Impact Monitoring (EIM) validation. It is important to underline that although the methodologies of these assessments and validations were in line with the Commission's regulations and expectations (indicator fiche descriptions) at that time, based on the sampling technique as prescribed and the available data set, the possibilities of using them obviously limited the expected results.

[2] Source: https://www.europarl.europa.eu/RegData/etudes/fiches_techniques/2013/050701/04A_FT(2013)050701_HU.pdf

In the **third phase (2023),** the results of the recent energy validation of the 2023 EIM allowed a comprehensive analysis of the renewable energy topic. When the study was carried out, the almost complete final set of the RDP 5B and 6A focus areas was already available, so the validation experts commissioned by the Managing Authority did not carry out the validation on a sample, but on the whole set of data, with calculations and estimates, with a much larger effort. The present evaluation thus covers the renewable energy in focus area 5B (complemented by focus area 6A). Other focus areas contribute to the R.15 indicator and may be assessed later by the ex post evaluation of the RDP, as planned.

In the present revised evaluation report, the results of the 2023 *renewable energy* analysis, based on the almost complete 5B and 6A focus area data, using advanced and in-depth estimation methods, are included alongside the 2020 and 2021 *energy efficiency and renewable energy* methods and results.

What and how did the evaluation examine?

In the first stage, the evaluation was based on the sample of the final status as of 31 December 2020, in the second stage on the sample of the final status as of 31 December 2021 and the energy validation of the 2021 EIM, while in the third stage the evaluation was based on the Hungarian State Treasury (HST) IACS beneficiary population as of 15.06.2023, which is considered almost final for the renewable energy determinant 5B and the additional focus area of 6A.

The presentation of the beneficiaries' investments, developments and activities in energy efficiency and renewable energy production **was** only **available in textual format** (e.g. business plans, construction lots, technical data, etc.), so the analysis of the documents and the resulting determination of the R.14 and R.15 indicator values required the development and consistent application of data collection methods based on **text mining methods** and then statistical and energy estimation methods.

To carry out the 2020 estimation, after filtering the data from the HST beneficiary data request, the experts formed a sample, which was assigned to the total population **by weighting the data according to the standard production values (SPV) of the beneficiaries**. They then assessed the energy efficiency and renewable energy production achieved by the operations in the studied groups and among all beneficiaries, and showed how the results achieved contributed to the achievement of the targets set in the national energy management plans/strategies, together with the other OPs supporting energy efficiency.

The expert interviews carried out in the first phase aimed to **verify the** data, summarise the **experience** and make **recommendations.** Structured in-depth interviews were conducted with beneficiaries and stakeholders (representatives and members of producer organisations), experts in writing applications and representatives of professional stakeholders.

The second assessment phase in 2021 was supported by the development by Field Consulting of an Environmental Impact Monitoring (EIM) concept to prepare data collection and processing solutions to address the challenges identified in the availability of data on environmental impacts. As part of this, around 10 percent of the energy and renewable energy investment projects in rural areas were selected in 2021, where the energy savings and renewable energy production data provided were validated by experts (both from a statistical and energy point of view). The methodology used is described in detail in Annex 2.

The third phase of the evaluation was carried out between June and October 2023, using the 2023 analysis of the RDP renewable energy results based on the EIM energy validation carried out by DevEco Consulting. The database used for the validation and analysis was the 5B and 6A queries of 15.06.2023, received from the HST.

This includes **projects with renewable energy activities and costs supported or under commitment in focus area 5B and 6A**, where **only investment items are** included in the cost categories, the other items (general, project management, publicity, etc.) are excluded. In order to broaden the scope of the data, the experts extended the filtering criteria to include parameters that could include renewable energy development (see Annex 4).

The analysis was carried out in three stages: firstly (1) it was necessary to prepare the database properly, to identify the technologies used, secondly (2) to estimate the capacities (kW) of the developments and from this, taking into account the technological differences, (3) to determine the energy produced (electricity and heat, in kWh) in the focus area 5B, which contributes most to the R.15 CMEF indicator, and also considering the minor and complementary focus area of 6A.

What has RDP achieved in the field of energy efficiency?

Based on the estimation made in the first phase of the evaluation (2020), 5B beneficiaries have achieved a total of 16 434 729 kW of energy savings in the period 2014-2020.

It is worth noting that there **was a** clear policy intention and therefore a **basic expectation that beneficiaries should reduce** their energy use by at least **10 percent**, so the mandatory 10 percent specific energy efficiency improvement achieved by the investments in focus area 5B also had a positive impact on the specific energy efficiency improvement of Hungarian agriculture, forestry and processing. Farms that made **additional commitments** mostly committed to **energy savings of more than 30 percent** (611 business plans), with savings between 15 - 30 percent in 161 cases and below 15 percent in 77 cases. The **majority of farms did not make any additional commitment and only achieved the mandatory 10 percent energy savings** (Table 3).

Figure 1 Specific energy efficiency improvements committed in business plans (2020)

Consultation group	> 30 %	15-30%	15-10 %	10 %	Total
Livestock farms	252	45	14	1,033	1,344
Small crop storage	21	9	8	705	743
Modernisation of horticulture - greenhouse and mushroom house	15	10	3	250	278
Improving the energy efficiency of plants	130	57	41	120	348
Winery	85	9	5	339	438
Adding value to agricultural products	55	16	5	432	508
Agricultural value addition and resource impact.	53	15	1	424	493
Total	611	161	77	3,303	4,152

Source: IAE, based on 31.12.2020 HST data

Based on the first analysis phase in 2020, beneficiaries who undertook **building modernisation activities**, **renovation of buildings** (cladding, insulation, drainage, windows, gates, support systems, roofing, etc.), the **renovation of existing infrastructure** (water, electricity, gas and sewage networks, waste water treatment, etc.) and the **extension of technical building installations** (condensing boiler, heat pump, building cooling, thermal well, compressor, condenser, hot water production, etc.).

The **investments aimed at energy savings** typically **involved the purchase of new, more modern machinery and equipment** (packing equipment, ripening equipment, processing equipment, fruit processing, fruit washing, cold storage, logistics equipment, irrigation controllers, pasteurisation tanks, field machinery, milk processing, vacuum packing, sorting equipment, etc.).

The most common equipment purchased by livestock and processing plants was cooling and heating equipment. Air conditioning and condensers were often installed to cool the buildings, but separate refrigeration chambers were also used.

Among the field machinery, the purchase of **balers, graders, mowers, loaders and electric shears was reported**. Purchases by processors included **vacuum packing, juice cleaning, drying, pressing, berrying, cleaning and sorting equipment.**

In the case of buildings, the beneficiaries have purchased equipment and mechanical solutions for **greenhouses and foil or lightweight structures,** and have installed water intake and irrigation systems. In the case of equipment modernisation, energy efficiency was improved by upgrading electrical and water networks and heating systems.

What progress has RDP made in the field of renewable energy production?

The purpose of the energy validation of the 2023 EIM, which was carried out between June 2023 and October 2023 and is one of the bases of this evaluation, was to collect, analyse and present the renewable energy generation developments supported by investments that (also) included renewable energy development during the period of the RDP.

9nt he basis of the results, the experts have prepared an analysis, which has been **broken down by technology, which is** crucial for renewable energy development. The analysis was thus able to answer the question of the **share of subsidies and results that each technology received**.

Table 1 Summary table of analysis results by technology (2023)

Determinant renewable energy technology of the development	Number of projects pcs	Net expenditure billion HUF	Installed capacity MW	Annual energy produced GWh
biogas	6	0.69	0.15	**2.57**
biomass	152	10.06	131.02	**196.43**
geothermal	51	11.56	53.25	**159.75**
heat pump	171	3.21	9.75	**6.42**
solar panel	3,950	70.82	203.28	**243.51**
solar collector	269	1.04	9.47	**2.79**
other renewable	120	2.60	8.48	**10.18**
Total	**4,719**	**99.98**	**415.40**	**621.65**

Source: DevEco, based on 2023.06.15. HST data

The 4,719 projects examined, using **a total of** HUF 99.98 billion of net expenditure, generated **an estimated nominal installed renewable energy generation capacity of 415.40 MW, with an estimated annual** (cumulative, but not cumulated) **energy production of 621.65 GWh.**

Based on the CMEF fiche R.15, the indicator is defined and targeted as "Capacity created in terms of petroleum equivalent (toe) for VP renewable energy supported programmes". Since the official conversion rate of the International Energy Agency (IEA) under the OECD is 1 toe = 11.63 MWh, the contribution of the VP renewable energy production in focus area 5B, and complementary focus area 6A, to the value of the R.15 CMEF indicator R.15 is 621,654.96 MWh, corresponding to 53,452.71 toe, based on the database and analysis examined. The value of the R.15 CMEF indicator will be fully established once the other relevant focus areas of this indicator have been examined, expectedly in the RDP ex post evaluation.

In the case of the renewable energy development projects examined, 71 percent (HUF 71 billion) of the total HUF 99.98 billion of net expenditure was mainly for solar PV, 11 percent (HUF 12 billion) for geothermal and 10 percent (HUF 10 billion) for biomass developments.

Of the 415.40 MW of installed nameplate capacity, 49 percent (203 MW) was predominantly solar PV, 32 percent (131 MW) was predominantly biomass boiler, 13 percent (53 MW) was predominantly geothermal, and a smaller proportion was other renewable energy development (2 percent heat pump, 2 percent solar collector, 2 percent other renewables, less, than 1 percent biogas).

Out of the 621.65 GWh of renewable energy generated annually, 39 percent (243,5 GWh) came predominantly from solar PV developments, 26 percent (160 GWh) from geothermal developments, 32 percent (196 GWh) from biomass developments, with a smaller share from other renewable energy developments (2 percent other renewables, 1 percent heat pumps, 1 percent sub-solar and biogas).

Detailed charts and tables with breakdowns are provided at the end of the executive summary.

How have the RDP measures related to the priority areas examined served the objectives of the national energy management plans/strategies?

Hungary's energy efficiency target for 2020 was that its final energy consumption in 2030 should not exceed the 2005 level (785 PJ). Beneficiary plants of the measures in focus areas 5B and 6A of the RDP achieved annual energy savings of 0.0591 PJ in the period 2014-2020, based on the first evaluation phase estimate.

Based on the National Energy and Climate Plan, Hungary aimed to increase the share of renewable energy in electricity consumption to at least 20 percent by 2030, with a new target of 29 percent by 2020 (updated in 2023). A key element of renewable energy production is the expansion of solar panel capacity, which should increase from 680 MW in 2016 to 6,500 MW in 2030 and exceed 10,000 MW by 2040, according to the 2020 plan (2023 fresh target: 12,000 MW of solar PV by 2030).

The result of the analysis: **4,719 projects with a total of HUF 99.98 Bn of net expenditure have generated an estimated installed nominal renewable energy generation capacity of 415.40 MW (of which 203.28 MW is solar panel)**, thus contributing significantly to the achievement of the policy objectives.

What lessons can be learnt from the implementation of the measures related to the priority areas examined to improve future measures?

For most of the investment-type aid for energy efficiency improvements, the first round of applications were **assessed after one year** (e.g. for the modernisation of poultry farms), **but for the later submission periods the assessment period was typically reduced to 3-4 months**.

In the project selection process, the evaluators found that applicants often submitted insufficiently documented proposals, with a high **incidence of beneficiary omissions**, mainly related to the clients' documentation of energy efficiency calculations, which the beneficiaries were unable to manage properly.

There is a mix of activity targets for energy efficiency and renewable energy production, where renewable energy is produced, energy savings cannot be accounted for, and these activities should be treated separately. With the involvement of the energy expert, the beneficiaries were able to successfully certify the savings and production, but many inaccuracies were found in the data received.

As part of the fight against the coronavirus, the **government expected the IHs to simplify procedures**, e.g. in the context of on-site inspections they tried to minimise the number of visits and carried out risk analysis. **During on-site inspections, only a final on-site inspection was carried out, with intermediate inspections being resolved by photo documentation**, templates and descriptions being provided to inspectors. Administrative checks were also simplified and accelerated.

What proposals can be made to achieve more effectively the results expected by the CAP in the next period?

Beneficiaries and applicants made suggestions to simplify energy calculations. Despite the fact that the calculations were carried out by engineers who are members of the Chamber, many erroneous items were identified during validation. The calculation of the indicators was also not presented due to the lack of beneficiary data, and the calculation of the value of the indicators was estimated by the experts in the first stage of the evaluation. **By simplifying the calculation**, by providing the typical energy consumption and production capacities of the technology and equipment used, and by designing a data recording interface that verifies the data at the time of recording, more accurate values can be collected, which can be more easily analysed, evaluated and help to produce indicator values.

Beneficiaries, tenderers and stakeholders agreed on the need **to reduce direct invoicing (invoice-based accounting)** and the administrative burden for bids and certificates below HUF 1 million.

The technical assistance was based on feedback from the beneficiaries. Information was provided to clients through portal questions available on the MÁK website and through information leaflets on palyazat.gov.hu. The national roadshow was organised with experts from the technical departments of the HST, MA and NChA, and during the events beneficiaries were able to ask questions related to accounting. The **faster feedback from the authority** (several months passed before they received feedback on the acceptance of the application) was a common beneficiary request.

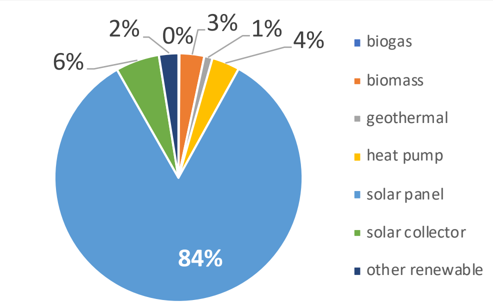
Renewable energy production was popular among the beneficiaries and further support for such activities was suggested, and the experience of the RDP and the previous period shows that the **purchase and installation of solar equipment, which** is the easiest to manage from the beneficiary and institutional side, is more common. In contrast, the installation of biomass heating systems that can be directly linked to agricultural activities and biogas production equipment were not common, although they would significantly support the take-up of the circular economy.

It is proposed to use **the database and analytical results** provided for the validation of focus areas 5B and 6A from June 2023 to October 2023 for other purposes, for ex post evaluation of the RDP, for reporting on the Partnership Agreement, for Green Bond reporting, for analytical and CAP ST and next CAP periodic planning, as well as for baseline data, reference database and deeper analysis for CAP periodic evaluations. Further focus areas related to indicator R.15 are planned to be investigated by the Ministry of Agriculture (MoA) in the ex post evaluation of the RDP.

Table 2 Rural Development Programme renewable Energy analysis main results (2023)

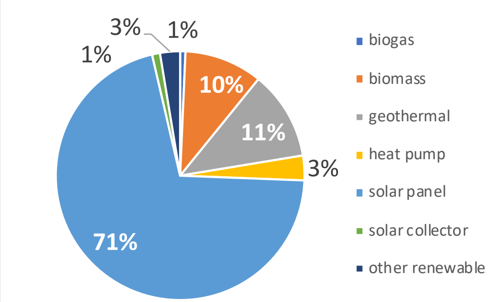
	NUMBER OF PROJECTS	NET EXPENDITURE (BILLION HUF)	INSTALLED CAPACITY (MW)	ANNUAL ENERGY SAVINGS (GWh)
biogas	6	0.69	0.15	2.57
biomass	152	10.06	131.02	196.43
geothermal	51	11.56	53.25	159.75
heat pump	171	3.21	9.75	6.42
solar panel	3,950	70.82	203.28	243.51
solar collector	269	1.04	9.47	2.79
other renewable	120	2.60	8.48	10.18
	4,719	**99.98**	**415.40**	**621.65**
				53.45

NUMBER OF PROJECTS



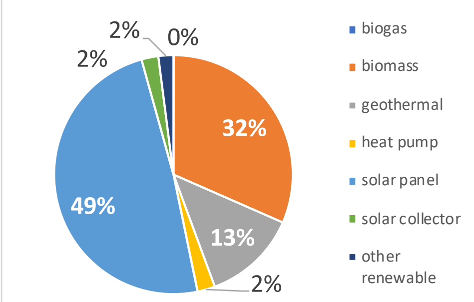
In terms of the number of renewable energy development projects, 84% (3 950) of them are predominantly solar development projects.

NET EXPENDITURE (BILLION HUF)



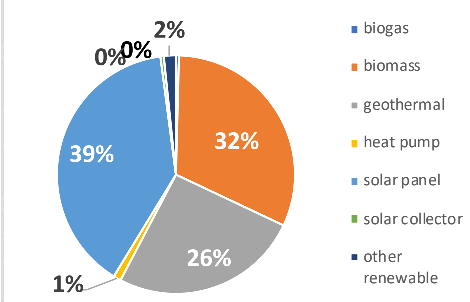
71% (HUF 71 billion) of the renewable energy development project net expenditure solar panels, 11 % (HUF 12 billions) was allocated to geothermical and 10% (HUF 10 billion) to biomass.

INSTALLED CAPACITY (MW)



49 % (203 MW) of the installed capacity was mainly solar, 32 % (131) mainly biomass, 13% (53 MW) geothermal.

ANNUAL ENERGY SAVINGS (GWh)



39% of the energy generated (243,5 GWh) is mainly from solar panel developments, 26 % (160 GWh) from geothermal developments, 32% (196 GWh) from biomass developments.

Source: DevEco, based on 2023.06.15. HST data

1. INTRODUCTION

Background

EU legislation governing the use of the European Agricultural Fund for Rural Development (EAFRD) requires regular evaluation of the effectiveness, impact, and experience of the subsidies. To comply with this requirement, the Managing Authority (IH) of the 2014-2020 Rural Development Programme of Hungary (hereinafter referred to as Rural Development Programme / VP / Programme) has commissioned the consortium led by Field Consulting Services Zrt. to prepare the following evaluation report on the subject of the evaluation tasks set out in Chapter 9.3 of the Programme Evaluation Plan for the years 2020 and 2021, , with the content described in the Evaluation Plan and the Inception Report[3] , taking into account the framework set out in these documents:

"Improving energy efficiency in agriculture and food processing"

The scope of the contract is the framework contract "Provision of IT and public administration related expert consultancy services to support the development of IT systems supporting the implementation of the Rural Development Program, and the provision of monitoring planning and technical consultancy services related to the Common Agricultural Policy (KAP) 2020".

This document is an updated version of the Final Evaluation Report on the evaluation task for 2020 and 2021, updated in 2023.

Delimitation

Topic: the evaluation covers the achievements of the VP in a) efficiency regarding energy-consumption and b) renewable energy production in the fields of agriculture and the food processing industry.

Subject: Measures and calls for proposals listed in Chapter 4

Period: 1 January 2014 - 31 December 2019, updated with data, information and analysis for 2021 and 2023 (indicated separately in the titles and the text)

Criteria: relevance of the interventions, effectiveness of implementation, efficiency and effectiveness of the measures (For an explanation of each evaluation criterion, see the detailed description of the evaluation methodology in Annexes 2-3-4, for specific evaluation questions see Chapter 2.3.)

Target audience: policy makers, planners, IH, MÁK, general public

Necessity

Version 7.0 of Chapter 9.3 of the Evaluation Plan in the Rural Development Programme, which is relevant for the evaluation, defines the content and framework of the evaluation tasks to be carried out. The thematic evaluations, as a complement to the Annual Implementation Reports, enable actors to summarize the experience gained in the 2014-2020 programming period, and these results can provide a valuable starting point and additional supporting information for the implementation of the program for the current period, and, in particular, for the ongoing planning of the next period's CAP Strategic Plan.

[3] The Inception Report of the evaluation exercise was prepared by the consortium Field Consulting and Collectivo for the Ministry of Agriculture in 2020. The use and publication of this document is at the discretion of the Ministry of Agriculture.

Target

The aim of the evaluation is to assess the relevance, efficiency, effectiveness and impact of the individual measures of the VP under Priority 5B, 5C (and from 2023 onwards under Priority 6A), along the evaluation questions (see chapter 2.3), in order to improve the implementation of the current Programme and the planning for the period to come.

Workflow

The first output of the evaluation was the Inception Report (IJ) a professional and project management tool, which was prepared and approved in September 2020. The Interim Report (KÖJ) was intended to facilitate the use of the existing evaluation results by planners. The Inception Report and the Interim Report were prepared for internal use and are published by the Ministry of Agriculture. The professional product of the evaluation is the present Final Evaluation Report (ZÉJ). The timeline of the professional workflow for the preparation of the ZÉJ was as follows (see Table 3), followed by an update at the end of 2023.

1Table 1: Workflow

Months Activities	202003	202004	202005	202006	202007	202008	202009	202010	202011	202012	202101	202102	202103	202104	202105	202106	202107
Treaty																	
Inception Report (IJ)																	
Intermediate Reporting (IRR)																	
Final Report (FR)																	

Source: AKI edit

Cooperation

During the implementation of the project, evaluators worked closely with the relevant institutions (AM, IH and MÁK) and other partners (NAK, KSH).

From the institutional aspect, enhanced involvement in evaluation was necessary in two main areas: ensuring the availability of data, information, documents and interviewees required to carry out the evaluation, and commenting on, iterating and final approval of the draft texts and other evaluation outputs (IH).

In the context of the actions of the main data provider, the MÁK, the evaluation expected that, in addition to providing the relevant data, there should also be verbal consultation with the experts conducting the evaluation to ensure the consistent interpretation of the applied terminology and methodology for both the MÁK and the evaluator.

At all stages of the evaluation process, MÁK actively supported the evaluation process with data, with coordination options on the applied methodology and with feedback on several occasions.

Quality assurance

In the first phase of the evaluation, the evaluator, via built in quality assurance, and with the involvement of a quality assurance specialist, ensured that the evaluation report met the expected professional and formal quality standards.

The purpose, aspects, functions and integration of quality assurance in the evaluation process are described in detail in Annex 1. A *Quality Assurance Statement on the* fulfilment of quality expectations is provided on the page following the cover page of the evaluation report.

Construction

The Final Evaluation Report is structured in the following chapters:

Table 2: Structure of the Final Evaluation Report

Address	Short content
Executive summary	Executive summary of the Final Evaluation Report.
1. Introduction	Background, delimitation, necessity, purpose, methods, workflow of the evaluation, institutions involved in the cooperation, structure and quality assurance of the Final Evaluation Report
2. Objective	The purpose of the evaluation, based on the Evaluation Plan, and the evaluation questions.
3. Methodology	Presenting the methods, the indicators, the data and the information needed to answer the evaluation questions and the availability of these aspects
4. Measures under examination	Presenting the place of the measures under evaluation in the strategic and legislative framework, the related support programmes and the planning status for the period 2021-2027. A summary description of the measures assessed. Presentation of financial progress and procedures, monitoring and indicators
5. Findings, conclusions and recommendations	Analysis and results with respect to the evaluation questions. Responses and suggestions related to the evaluation questions
6. Summary of proposals	Tabular summary of proposals
Annex 1	The purpose, aspects and tasks of quality assurance
Annex 2	Detailed test methodology (2020)
Annex 3	Detailed test methodology (2021) - Energy validation of the CMM (2021)
Annex 4	Detailed test methodology (2023) - Energy validation of the CMM (2023)
Annex 5	Resources used
Annex 6	Renewable energy technologies in agriculture

Source: own editing

2. TARGET

2.1. Evaluation background

The European Union is committed to implement policy programs supporting economic and regional development for sustainable development, with particular attention to the environment and social problems. In the framework of the KAP, the VP (Regulation (EU) No 1305/2013) states that, to ensure the sustainable development of rural areas, particular attention should be paid to **increasing resource efficiency and to moving towards a carbon-neutral economy in the agricultural, food and forestry sectors**. This will be achieved through VP measures to promote energy efficiency.

Improving energy efficiency not only benefits actors in the economy (households, businesses, governments) through cost savings, it also contributes to reducing greenhouse gas emissions and thus to climate protection. To this end, Directive 27/2012/EU has set a target of 20% reduction in energy consumption compared to the projected level of energy use by 2020, and to achieve this goal, Member States have developed their own energy strategies and action plans. When this directive was amended in 2018, the energy reduction target for 2030 (2002/2018/EU) was increased to 32.5%, in the spirit of the Paris Climate Change Convention. In the information document on the revision of the Directive, the European Commission underlines that by improving energy efficiency in households, in the transportation sector and in the industry, the EU will make a significant contribution to achieving the Paris Agreement goals.

In the National Energy Strategy 2030 (Ministry of National Development, 2012), the Government sets out the strategic directions to follow to respond to changes in the energy sector and to reduce greenhouse gas emissions and to comply with EU obligations. The National Energy and Climate Plan (NEKT), the Renewable Energy Utilization Action Plan 2010-2020, the National Energy Strategy for Buildings, the National Energy Efficiency Action Plan 2020 are all designed to achieve this goal, considering the needs of economic development. The latter was published in November 2017 and reports an estimated energy saving of 27 278 TJ (reduction in final energy use) in 2015 compared to 2013. This included trade and public services (15,136 TJ), industry sector (7,660 TJ) and the residential sector (4,482 TJ). The estimated final energy use of agriculture, forestry and fisheries was 21,375 TJ in 2013 and 24,186 TJ in 2015. An increase of about 0.5 PJ was observed in the agriculture, forestry and fishing sector, calculated with the M8 indicator.

Hungary has introduced alternative policy measures to reduce the required final energy consumption by 1.5% per year for final utilizers. For the operational programs starting in the 2014-2020 programming period, Government Decision 2010/2016 on policy measures leading to energy savings provided that certain calls for proposals must include a minimum energy savings requirement and (where applicable to the specific proposal) an energy certification or energy audit obligation and other specific conditions ensuring accountability.

After the realization of the investments funded through the applications, the actual energy savings must be demonstrated in accordance with the subsidy contract (through invoices, measurements, calculations and the calculations of the energy expert on the efficiency). The Beneficiary prepares a report on the use of the budgetary support, and accounts for the use of its own resources on the investment. The results of the energy savings of these energy efficiency investments made through this measure can therefore be monitored through a combined assessment of the data provided in the pre-application and the reporting obligations in the grant contract.

The three main priorities for VP subsidies supporting the utilization of energy efficiency and renewable energy sources set out in the Action Plan are:

1. Promote the organisation of the food chain (including the processing and marketing of agricultural products, animal welfare and risk management in agriculture) (action M16)

2. Promoting resource efficiency and supporting the shift towards a low-carbon and climate change adaptable economy in the agriculture, food and forestry sectors (Action M4)
3. Promoting social inclusion, poverty reduction and economic development in rural areas

The value of energy savings achieved by the primarily energy-efficiency-scoped programs funded by the OperationalPrograms (KEOP, ROP, KMOP, KEHOP, TOP, VEKOP, GINOP), amounted to 4.1 PJ by 2015. The value of energy savings achieved by the policy measure "Operational Programs with a primary non-energy efficiency objective (TOP, VEKOP, EFOP, IKOP, KEHOP, VP)" was 1.2 PJ until 2015.

2.2. Evaluation objective

The aim of the evaluation is to assess the relevant measures of the VP in terms of relevance, efficiency, effectiveness and impact, along the evaluation questions (see chapter 2.3), in order to further improve the implementation of the Program and the planning for the next period.

The results of the final evaluation report (based on the evaluation) will be channeled into the ongoing 2021-27 CAP Strategic Plan's professional and content planning process to further enhance the evidence-based planning approach. Accordingly, the focus of the evaluation will be on the results, the effectiveness of their achievement and the assessment of the currently observable impacts (for more details see Chapter 4).

2.3. Evaluation questions

The evaluation questions adopted in the evaluation's Inception Report are:

1. What impact have the developments of the VP measures related to Priority 5B had on energy use in agriculture and the food industry?
    a. What are the energy efficiency characteristics of the developments - by type of investment;
    b. To what extent have the programs contributed to improving the energy efficiency of the beneficiary farms?
    c. The main results of the investments made through the developments, and the impact of these results on the achievement of the specific objectives;
2. What are the impacts of the developments of the VP measures related to Priority 5B, and what impacts has it made on renewable energy production in agriculture and food industry?
    a. What kind of renewable energy generating characteristics do these developments have, by type of investment;
    b. To what extent have the newly announced programs contributed to improving the renewable energy production of the beneficiary plants?
3. How do VP measures, related to the priority areas under review, serve the fulfilment of the objectives set by the national energy management plans/strategies?
    a. The contribution of the programs announced and implemented to the fulfilment of energy management policies;
    b. The Identification of similarities and differences, and possible synergies, between the measures aiming energy efficiency and renewable energy production in VP development and other Operational Programs;

4. What lessons can be learnt from the implementation of the measures related to the observed priority areas, in order to improve future measures?
    a. Which eligible actions in the calls for proposals, aiming energy efficiency improvement and renewable energy production, will be favored by the beneficiaries?
    b. What problems did the applicants encounter during the submission, evaluation, implementation and accounting of the applications, which had a definite impedimental effect on the successful implementation of the supported developments?
    c. How has the popularity of the measures changed over the examined period?
5. What proposals can be made to increase the effectiveness in achieving the results anticipated by the CAP in the next period?

Note: during the 2023 update, the scope of the evaluation questions has been extended to include focus area 6A in addition to focus area 5B, which also incorporates relevant renewable energy developments, upon request of the Contracting Authority.

3. METHODOLOGY

To prepare the first phase of the evaluation, experts used quantitative and qualitative methods, following the guidance of the CMEF and the relevant recommendations (EC 2018a, 2018b, 2018c). The results of the qualitative and quantitative methods were synthesized to answer the evaluation questions.

3.1. Quantitative methods

In the frame of the first phase of the evaluation in 2020:

1. Presentation of the context of the evaluation topic

The objectives of energy efficiency and renewable energy production have already been addressed in the evaluations of previous rural development and other programmes, thus experts analyzed the findings of the ex post evaluation of the ÚMVP (2016), the Partnership Agreement and the findings in the Annual Evaluation Reports of the VP.

2. Domestic and international energetics data

Experts have examined the data extractable from the operational database and other data sources (e.g. KSH, EUROSTAT, data and analyses of energy research institutes, etc.) and presented the status of fulfilment of energy efficiency improvement, renewable energy production and specific objectives relevant to the beneficiary groups.

3. Data mining methods

Experts used data mining methods to present the characteristics of the activities undertaken by the beneficiary farms. Data mining aims at extracting latent information from imperfectly structured databases, and in this case the technical data and construction lot data submitted as part of the application documentation were evaluated. A detailed description of the methodology is presented in Annex 2.

In the second phase of the evaluation in 2021, an additional quantitative method was used:

4. Application of KHM (EIM) 2021 validation coefficient

Based on the small sample-based results of the energy validation of the KHM (EIM) 2021, for both energy efficiency and renewable energy based investments and developments, a coefficient was defined to correct the difference between the energetics values of the elements in the sample and the estimate of the experts. The utilization of the applicable coefficients used in the sample to assess data for the whole population was in line with the indicator calculation methodology and regulations in force at the time. The limitations were the small sample size and the data purity problems originating from difficulties in the interpretation of the database data on the beneficiary side. The methodology is described in detail in Annex 3.

In the third stage of the assessment, during the 2023 update, the analysis was based on a thoroughly documented methodology for the whole focus group:

5. Database testing and analysis (validation of the whole focus group, with calculations and estimations)

The aim of the KHM (EIM) Energy Validation 2023, carried out between June 2023 and October 2023, was to collect, analyze and present renewable energy developments subsidized through investments focusing on (among others) improving the utilization of renewable energy in the period of the VP.

The analysis was conducted in two sub-sections. In the first sub-section, experts examined the 15.06.2023 database received from MÁK for the purpose of analysis and set the filter criteria (focus area, target area, intervention, activity, cost category, cost type) specifically dedicated to support renewable energy developments. In the second sub-section, based on the discussions conducted after finalizing the analysis developed in the first sub-section, experts extended the filtering criteria to include parameters that may have included renewable energy development.

The analysis of the second sub-section's focus group revealed that the number of energy efficiency based and "empty" sets, i.e. sets that are not categorized or have no category value, but also contain renewable energy items, is approximately the same as the first sub-section's base set. The experts have prepared the analyses of the first and second subsections in a uniform way, following the same methodology.

The analysis was carried out in three stages: first (1) the database had to be prepared properly, through identifying the technologies used in detail, and second (2) the capacities (kW) of the developments had to be estimated, and from this, taking into account the technological differences, (3) the amount of energy produced (electricity and heat, in kWh) had to be quantified, as this is the value of the R.15 of the focal areas 5B and 6A that is the final result of the validation, contributing to the R.15 CMEF indicator, being searched as a consequence of the final result of validation

The methodology is described in detail in Annex 4.

3.2. Qualitative methods in the first and second evaluation phases

The first (2020) and second (2021) phases of the evaluation used the following qualitative methods:

1. **Through literary and document analysis, the** examination and analysis of the findings of scientific publications related to the priority area of VP calls for proposals and the documents of the calls, related calls for proposals of other operational programs and the examination and analysis on publications on the subject can help to replicate methods that have already been used successfully elsewhere, and can serve as a source for the formulation of proposals for eligible activities, selection criteria and monitoring possibilities for new calls.

   Operational programs that have been analyzed in the evaluation in terms of energy efficiency and renewable energy production are:

   - GINOP-4: Energy
   - KEHOP-5: Increasing energy efficiency, use of renewable energy sources
   - VEKOP-5: Support for energy efficiency, intelligent energy use and the use of renewable energies
   - MAHOP-2: Supporting environmentally sustainable, resource-efficient, innovative, competitive and knowledge-based aquaculture
   - TOP-3: Implementation of energy supply adapted to the local conditions, in the framework of complex development programs, for the exploitation of renewable energy sources, energy modernization of buildings

2. Conducting **expert interviews on the** following topics. Examining the experience based on subsidy programs and development in the field of energy efficiency improvement and renewable energy production:

   a. to what extent have the calls for proposals served the development needs of farmers?

b. did the content of the calls for proposals and the applied evaluation criteria serve the objectives well?

c. have there been any obstacles to the implementation of the programs?

Conducting structured interviews, both in person and/or by telephone, with beneficiaries and stakeholders (representatives and members of producer organizations), project management professionals and representatives of business federation organizations. The number of interviews carried out was 18, distributed as follows:

- Interviews with representatives of farmers' and food processing organizations: 8.
- Interviews with representatives of producer organizations: 3.
- Interviews with experts involved in proposal evaluation and monitoring: 5.
- Interviews with experts from project management companies: 2.

3. Estimating the realization of indicators:

At the beginning of the evaluation, a grouping of energy efficiency investments and **developments** was made according to whether the actions contribute **directly** or **indirectly to** the achievement of Priority 5B. It was shown how the beneficiaries within each group were able to achieve energy efficiency improvements and renewable energy production.

For the 2014-2020 period, Member States collected the following data to provide the value of indicator R.14: identification and main features of projects with an energy saving/energy efficiency component; assessment before project implementation (technology used, type and amount of energy used); coefficients of energy consumption of different production technologies.

In contrast, for the post-2020 planning period, Member States use a sample survey to determine the fulfilment of the indicator. Regarding R.15, a survey on installed capacity has been carried out in the period of ÚMVP, whereas the EU plans to survey the installed capacity and actual use in the new CAP. In Hungary, the sample-based data definition according to the fiche (EC, 2014) was not used, but beneficiary-based data were provided.

During the **first phase of** the **evaluation in 2020,** assessing the fulfilment of indicators R.14 and R.15, the beneficiary data of the selected samples from the operational database of the MÁK were collected, in the framework of which the annual energy savings achieved by the investment and the amount of energy produced per annum by the newly established renewable energy production capacity were also collected.

It is important to note that since the beneficiary data reporting started in December 2019, the energy results of projects terminated before this date could not be collected, therefore these are not included in the data reporting, as the additional data collection would have resulted in a significant administrative overload for both the institutional system and the beneficiary.

In the beneficiary data submission, the beneficiaries provided the energy savings or renewable energy production capacity increase achieved during the development, and then presented the potential annual energy savings achieved by the investment and the annual energy produced by the newly established renewable energy production capacity, both calculated in kWh.

In the second phase of the 2021 evaluation, the data collection of 19 March 2021 resulted in 3 234 beneficiaries completing the survey, of which 346 respondents indicated investments in energy saving and 1 002 presented investments containing the installation of renewable energy production capacity. Only those observations were included in the sample that were mathematically validated and had already realised a payment by 31 December 2020, had received support related to focus area 5B and had a STÉ value or data available for the STÉ calculation. Due to the lack of complete data, a sample was drawn from the result of the data collection.

In the evaluation, two methods were used to determine the indicator values R.14 and R.15:

Based on the sample, AKI carried out an experimental calculation by grouping farms according to size and sub-sector and determining the energy efficiency values for the Standard Production Value (STÉ) categories used in the economic evaluation, and then they weighed these values. Using the STÉ value provided by the beneficiary farms in the base focus group at the time of application, the typical energy efficiency level for the size and sub-sector of the farms in the sample was weighted to determine the typical energy efficiency level for the farm categories in the sample. The missing STÉ values were calculated and filled in based on the values determined in the tax returns of the beneficiaries.

Among the limitations of the beneficiary data request, it should be mentioned that the full scale data collection was not completed and the low evaluable response rate validated by an energy expert meant that the default sampling methods could not be applied. Due to the low number of data they could use in the sample, fully establishing weighing data compliant with the size categories used in the calls and by MÁK it was not feasible.

The **second assessment phase in 2021** was supported by the fact, that Field Consulting has developed an Environmental Impact Monitoring (KHM/EIM) concept to prepare data collection and processing solutions to address the challenges identified in the availability of data on environmental impacts. This included the selection of around 10 percent (115 projects) of the then existing energy and renewable energy investment projects in rural development back in 2021, where the energy savings and renewable energy production data provisions were validated by experts (statistical and energy). In the framework of this review, the energy-related documents submitted by the beneficiaries were examined and, upon necessity, the beneficiaries were also contacted for clarification.

3.3. Data (2020, 2021, 2023)

In the first phase of the **evaluation, in 2020,** a detailed table of data and information needs for the thematic evaluation was compiled, which included a breakdown of data by beneficiary, grouped according to calls and measures concerned (based on the 31.12.2020 query of the MÁK)

The cleaned data on energy savings/reductions for the calculation of indicator R.14 were produced by the thematic evaluator based on data provided by the MÁK.

The cleaned data on renewable energy production for the calculation of indicator R.15 were produced by the thematic evaluator based on data provided by the MÁK.

In the second stage of the assessment, in 2021, the calculation based on the KHM (EIM) validation coefficient for the 31.12.2021 data set of the MÁK formed the basis of the estimation.

In the third phase of the **evaluation, 2023, the** experts carried out their analysis on the focus area data series 5B and 6A of 15.06.2023.

Data used to calculate output and outcome indicators from operational databases

- **First evaluation phase 2020:** 298 data/descriptions of the 15 VP operations were requested from the MÁK for the period 2014-2020, broken down by individual beneficiary/project. For 19 data sets, the respective and required application documents were also collected from the MÁK, and they were reviewed and analyzed by AKI experts in cooperation with Field Consulting.

- **Second evaluation phase 2021:** Beneficiary data provision: the data required to establish indicators R.14 and R.15 were collected by the MÁK, submitted for analysis by 31.12.2021 and validated by Field Consulting with the involvement of an external statistics and energy expert.
- **Third, 2023 evaluation phase: the** basis for the manifold used for the studies from June 2023 to October 2023 was the data set received from the MÁK on 15.06.2023, analyzed by Field Consulting with the energy experts of DevEco Consulting and validated by the energy expert of Field Consulting.

Specialized statistics used for secondary data analysis

Tax returns databases of the KSH, Eurostat, NAV, payment databases of operational programs and other domestic programs listed under qualitative methods, other data sets (based on data from the Annual Implementation Reports 2015-2019).

4. MEASURES EXAMINED

4.1. Background, current environment, expected future (2020)

Strategic, policy and legislative background

Hungary's energy policy is summarized in the **National Energy Strategy 2030** (hereinafter referred to as the Energy Strategy) adopted by the Hungarian Parliament in Resolution 77/2011 (X. 14.). The Energy Strategy is intended to ensure long-term sustainability, security, and economic competitiveness of Hungary's energy supply. It aims to guarantee the security of supply, considers the principle of least cost, and enforces environmental aspects. The government has made the security, long-term sustainability, and competitiveness of domestic energy supply key objectives of the Strategy. The Energy Strategy to 2030 contains detailed proposals for the Hungarian energy sector and decision-makers, as well as a roadmap to 2050, which puts the measures proposed up to 2030 in a global, longer-term perspective.

To achieve the main objectives, the Energy Strategy foresaw the use of five key instruments:

1) Increasing energy efficiency and energy savings.
2) Increasing the share of renewable energy utilization.
3) The long-term, peaceful use of nuclear energy.
4) Connectivity to regional energy infrastructure.
5) Strengthening the role of the state in the energy market.

The system of energetics has become increasingly complex in recent years, given its links with other policies (transport, environment protection, agriculture, water management, education and employment). For this reason, public energy policy and engagement has had to adopt a complex ‘crossover’ approach. The **new National Energy Strategy 2030 with a view to 2040** (Ministry of Innovation and Technology, 2020) and the **National Energy and Climate Plan** (preceded by Government Decision 1772/2018 (21.12.2018) on the decisions to lay the foundations for the new National Energy Strategy) were adopted at the cabinet meeting of 9 January 2020.

The new Energy Strategy also puts a strong emphasis and attention on consumer focus, climate-friendly transformation of the energy sector and harnessing the potential of innovation. In the National Energy and Climate Plan, Hungary sets the following objectives for 2030:

- Achieve at least a 40% reduction in greenhouse gas emissions (on 1990 basis),
- achieving a 20 percent share of renewable energy use,
- in the field of energy efficiency, the final energy consumption should not exceed the 2005 energy consumption of 785 PJ,
- reduce projected energy consumption without national policy measures to improve energy efficiency by 8-10%,
- reduce the share of gas imports to close to 70 percent by 2030 and below 70 percent by 2040.

Reducing energy consumption and energy waste is an increasingly important priority for the European Union: in 2007, it set a target to reduce annual energy consumption by 20 percent across the EU by 2020.In 2018, as part of the *Clean Energy for All Europeans* package, a new target of reducing energy consumption by at least 32.5 percent by 2030 was set. Energy efficiency measures are not only means to achieve sustainable energy supply, to guarantee security of supply, and to reduce import costs, but they also enhance the EU's competitiveness. Energy efficiency is therefore a strategic priority for the European Union.

The topic of this evaluation is related to the EU Thematic Objective 4 (Partnership Agreement 2014-2020) "*Supporting the shift towards a low-carbon economy in all sectors*".

The 2014 **Partnership Agreement** identifies Hungary's key challenges and sets its main development priorities, and presents the relevant messages of the country-specific recommendations of the EU development funds coming to Hungary. The document addresses Hungary's key challenges in achieving energy efficiency.

Hungary is vulnerable in terms of energetics, with a significant use of natural gas in both electricity generation and heat supply (37% of primary energy consumption in 2011 is gas based; Eurostat), while domestic hydrocarbon reserves are limited. $_2$As a result, the country has a high dependence on external energy imports, with a total of 52 percent of primary energy, 65.57 percent for natural gas and 82.28 percent for oil (Eurostat, 2011). Infrastructure-energetics and production technology are key drivers of energy savings: more than 40 percent of energy is used in Hungary for the heating and cooling of buildings, making it the largest CO emitter sector. Meanwhile, 70 percent of the buildings do not meet modern energy requirements (Building Quality Control and Innovation Nonprofit Ltd., 2015). During this period, the use of renewable energy sources has lagged behind the EU average (HU: 9.6 percent; EU average 14.1 percent in 2012, Eurostat, nrg_ind_335a table). Given Hungary's natural conditions, the document identifies the increased use of biomass and geothermal energy as a priority development objective.

Results of previous evaluations

1. Increasing energy efficiency

The **ex-post evaluation of** the **New Hungary Rural Development Program (ÚMVP)** shows the distribution of investments in machinery and equipment related to the priority areas of **improving food safety and environmental protection, rationalizing energy use and modernizing farm management,** with applicants in the agricultural sector receiving HUF 469.9 million and applicants in the food industry sector receiving HUF 5 065.4 million in subsidies. As a result of the realization of modern and innovative improvements, farmers have been able to produce better quality products and thus realize higher prices on the market, while the use of **more energy-efficient equipment has reduced unit costs.** The most important call under this priority is the measure "Aid for the purchase of stand-alone non-constructional machinery and technological equipment", which aims to modernize farms by improving the age composition of the agricultural machinery stock and increasing energy savings, environmental protection, and energy efficiency through the purchase of environment friendly machinery and technology equipment. The rapid take-up of the total amount of subsidies (HUF 66.6 billion) also showed the high demand for technological modernization. The submission period had to be terminated 3 months after the launch due to the exhaustion of funds. 37.2 % of the machinery purchases under this title were for the purchase of power equipment, representing an average investment of HUF 36.7 million and a subsidy of HUF 10.2 million per eligible farm (ÚMVP Ex-post evaluation, 2016).

According to VP (2014-2020), agricultural buildings in Hungary are outdated and in need of renovation. Energy costs are a significant part of farm production costs, so there is a need to improve the energy efficiency of agricultural buildings and installed technologies to reduce production costs and carbon emissions. In addition to modernization of infrastructure services, energy efficiency improvements in agricultural buildings include insulation, renovation and replacement of windows and doors, installation of energy screens and shading devices, and modernization of heating systems. The geographical conditions in Hungary allow the utilization of geothermal energy. Not many agricultural sites are heated, so only a few of them have invested in heat pumps for this purpose, and geothermal energy is not yet widespread (except in horticulture, but the number of such sites is not significant). Geothermal energy can reduce gas consumption, but the disadvantage is that it is only relevant at a larger scale.

The **VP'2014-2018 mid-term report** also addressed energy efficiency issues in the agri-food processing industry. Efficiency gains in energy use can be observed in the agricultural and food processing sectors. The role of agriculture, forestry and fishing and the food industry in final energy use decreased by 2.5 percent between 2014 and 2016, according to the results of the 2019 assessment, with a 10 percent increase in total energy use (15,873 thousand toe to 17,394 thousand toe). The change is explained by the fact that, according to the data publication of the Central Statistical Office (KSH), the number of active enterprises in these branches of the economy increased by 13.5 percent to 34 595 thousand between 2014 and 2016. Based on this figure, we can determine that the aggregate final energy consumption of enterprises operating in agriculture, forestry and fishing, and food industry decreased by 6.3 percent from 0.038 thousand to 0.035 thousand toe over this period.

When preparing the **mid-term evaluation report on VP,** no exact values related to energy efficiency were available for the calculation of the indicator R.14 CMEF (*Increasing energy efficiency in agriculture and food processing in projects supported under the Rural Development Program*), so the evaluators estimated the energy efficiency improvement based on the minimum required energy saving level. The report found that the investments in energy efficiency improvements financed by the VP had met the minimum energy savings required by the VP, therefore the supported farms increased energy efficiency by 10 percent. With respect to livestock farm modernization, the biggest impact in terms of energy efficiency was achieved by renovating farms with a production value of less than €92-154 thousand (STÉ). The specific 10 percent improvement in energy efficiency achieved by these investments had a positive impact on the specific energy efficiency improvement of the Hungarian agriculture, forestry and food industry. The target value of total energy efficiency investments (CMEF indicator T.15) to be achieved by 2023 is €888.3 million, of which 3.5 percent, or €30.7 million, had been paid out to beneficiaries by the end of 2018.

2. Use of renewable energy

According to the final evaluation of the ÚMVP, heating and cooling represented the largest share of renewable energy use in Hungary, although their combined share fell from 81.9% to 74.9% between 2007 and 2013, while producing electricity increased from 13.8% to 14.2%. The evaluation of the NRP supported renewable energy production under the measure categories of **modernization of agricultural holdings** (121) and **improvement of the economic value of forests** (122). The final evaluation of the ÚMVP concluded that the program had contributed in part to increasing the use of renewable energy. Livestock farmers and horticulturists who have benefited from the support have partially or totally decoupled their production from fossil fuels, reduced their exposure to energy price volatility and improved their competitiveness, and contribute to reducing the negative effects of climate change. Some entitlements have made a modest contribution to the development of other renewable raw material production, mainly through indirect effects resulting from the modernization of machinery.

Based on the mid-term report of the **VP 2014-2018, the indicator R.15 CMEF** (*Renewable energy produced by supported projects*) for facilitating the transfer and use of renewable energy sources, by-products, waste, residues and other non-food raw materials for biomass-based economic purposes (5C) was **estimated at 22 toe**. By the end of 2018, 1,479 applications had been supported under this focus area. (The available funding envelope for focus area 5C was 22.49 million toe, 85.5 percent of which had already been approved by the end of 2018. The total number of applications received was 1 484.)

4.2. Actions, calls for proposals (2020)

The evaluation looked at the impact of the following measures on energy efficiency and renewable energy production:

2Table 1: 5B measures under review (2020)

Action code	Calls for proposals in focus area 5B
VP-M01	VP1-1.1.1-17 Agribusiness training and preparatory training
VP-M01	VP1-1.2.2-16 Information services
VP-M01	VP1-1.3.1.-17 Study visits and exchanges
VP-M02	VP1-2.1.1-2.1.2-17 Individual and group advisory services related to agriculture, forestry and food processing
VP-M04	VP2-4.1.1.1-16 Modernization of livestock farms
VP-M04	VP2-4.1.1.2-16 Modernization of poultry farms
VP-M04	VP2-4.1.1.3-16 Modernization of cattle farms
VP-M04	VP2-4.1.1.4-16 Modernization of sheep and goat farms
VP-M04	VP2-4.1.1.5-16 Modernization of pig farms
VP-M04	VP2-4.1.1.7-20 Improvement of disease control systems in poultry and pig farms
VP-M04	VP2-4.1.2-16 Construction and modernization of a small-scale crop storage, drying and cleaning facility
VP-M04	VP-2-4.1.3.1.-16 Modernization of horticulture - installation of glass and foil houses, increasing energy efficiency by using geothermal energy
VP-M04	VP-2-4.1.3.2.-16 Modernization of horticulture - support for planting with the possibility of irrigation
VP-M04	VP5-4.1.3.4-16 Creation of cold storage facilities for mushrooms, modernization of existing cold storage facilities for mushrooms
VP-M04	VP2.-4.1.4-16 Development of the agricultural water management sector
VP-M04	VP5-4.1.6-4.2.3-17 Improving the energy efficiency of agricultural and processing plants
VP-M04	VP-3-4.2.1-15 Adding value to agricultural products and promoting resource efficiency in processing
VP-M04	VP3-4.2.1-4.2.2-18 Adding value to agricultural products in processing
VP-M04	VP3-4.2.2-16 Support for product development and resource efficiency in the wine sector
Degression	
VP-M01	Vocational training (NRDP)
VP-M01	Demonstration plant programs (New Measures)
VP-M01	Complex information (New information and communication policy)
VP-M02	Specialist advice (New MSFP)
VP-M04	Modernization of livestock holdings (New Meat and Veal Plan)
VP-M04	Support for dryers (New Hungarian Medium-Term Strategy)
VP-M04	Modernization of horticulture (New Hungarian Horticultural Modernization Program) (+VP-M04 Horticultural machinery (New Hungarian Horticultural Modernization Program))
VP-M04	Irrigation (ÚMVP)
VP-M04	Increase in the value of Mg. products (NRP)

Source: AKI edit

3Table 1: 5C measures under review (out of scope) (2020)

Action code	Calls for proposals in focus area 5C
VP-M08	VP-5-8.6.2-16 Activities to mobilize forest production potential
VP-M08	VP5-8.6.1-17 Investments in forestry technologies and processing and marketing of forest products
Degression	
VP-M08	VP-M08 Forest Management (New Forest Management Program)

Source: AKI edit

In the 2023 update of the assessment, in addition to the above, the relevant interventions in focus area 6A have been included in the analysis.

4.3. CMEF and PMEF indicators (2020)

4.3.1. INDICATORS TESTED

- O.1 Total public expenditure EUR
- O.2 Total investment, EUR
- O.3 Number of operations supported to make an investment in agricultural holdings, processing and marketing of agricultural products
- O.12 Number of participants in training
- O.13 Number of beneficiaries receiving advice
- T.15 Total energy efficiency investments, EUR
- T.16 Total renewable energy investment, EUR
- R.14: Improved energy efficiency in agriculture and food processing in the framework of projects supported by the VP (PMEF R.16)
- R.15: Renewable energy from supported projects (PMEF R.15)

The data collected by the MCC have been verified and missing data have been filled in, based on uniform expert methods.

The evaluation also looked at the 2014-2020 CMEF and 2021-27 PMEF outcome indicators related to the evaluation theme. Based on the findings of the evaluations for the previous period, the experts have proposed milestones and targets for the outcome indicators for the next period and unit costs for the output indicators.

4.3.2. CHANGE IN RESULT INDICATORS (2020)

The Common Monitoring and Evaluation Framework (CMEF) used in the 2014-2020 period of the VP has been replaced by the Performance Monitoring and Evaluation Framework (PMEF) for the next programming period. The aim of this chapter is to present the indicators of the two programming periods relevant to the topic of this evaluation, to identify similarities and differences, and upon identifying possible challenges, to make suggestions for addressing them, based on the information available on the PMEF indicators at the time of reporting.

The comparison is made between the 2014-2020 CMEF indicators and the proposal on indicators by the Council of the European Union WK 10149/2020 INIT 2020 of 25 September 2020.

Performance indicators

The indicator **CMEF R.14: Improved energy efficiency in agriculture and food processing in the framework of projects supported by the Rural Development Program 2014-2020** has been replaced by the indicator PMEF R.16 in the next programming period.

PMEF **R.16** *Enhance energy efficiency: energy savings in agriculture* was proposed for deletion in the new framework by the Bureau at the 21st GREX meeting on 1 October 2020. The reason for this was that the Bureau noted that there were obstacles in measuring this indicator and in designing the indicator targets, and that Member States did not want it to be part of the *performance review* framework and thus have financial implications.

The indicator from that point was reported in the following indicators:

R.16: Climate-related investments: share of farms receiving investment support under the CAP for climate change mitigation and adaptation to climate change, and to produce renewable energy or biomass-based products

R.27: Environmental/climate policy performance through investments: *Share of farms benefiting from CAP investment support related to care for the natural resources*

The changes to the results indicator used in the previous programming period concerned the following points:

- R.16 is limited to directly related investment and sectoral measures (in the previous period, training and advisory services had to be considered)
- The indicator shows the cumulative value over the financial period
- The sample data collection of the previous period will be replaced in the new period by the methodology described in Article 7 and Annex V of the Energy Efficiency Directive

The main changes for the renewable energy production indicator R.15 were:

- Renewable energy capacity is expressed in megawatts.
- The indicator shows the cumulative value over the financial period and is reported annually.

To calculate the indicator, Member States need to collect data.

Table 1: Changes in energy efficiency indicators i (CMEF - PMEF) (2020)

Name of indicator	CMEF R.14 Improved energy efficiency in agriculture and food processing in projects supported by the VP 2014-2020	PMEF R.16 Improving energy efficiency: energy saving in agriculture 2021-2027
Definition and purpose	Energy efficiency improvements in the agricultural and food processing industries in projects supported by the VP [toe/t of oil equivalent saved per standard unit of output]	Quantify potential energy savings due to CAP support.
Interventions concerned	M01 - Knowledge transfer and information activities (Article 14) M02 - Advisory services, management and replacement services (Article 15) M04 - Investment in tangible fixed assets (Article 17)	The following interventions may be involved, unless the specific requirements or conditions of the intervention supports them: -Investments (Article 68) Interventions of a sectoral nature
Unit of measurement	Petroleum equivalent	Petroleum equivalent
Date of data collection	Three times during the programming period (2016; 2018; ex-post)	Investment operation for which a payment has been made in the current financial year. The indicator shows the cumulative value over the financial period.
Methodology	To calculate the indicator, Member States should collect data on installed capacity through a sampling procedure.	The most relevant way to measure the impact of investments and other interventions on energy consumption is to estimate them according to the methodology presented in Article 7 and Annex V of the Energy Efficiency Directive. This procedure allows the energy savings in agriculture to be determined in accordance with the requirements of the Directive. This will require an estimate of the expected savings to be made before the intervention. *Comment:* *To provide the value of the indicator, Member States must collect the following data:* *Identification of projects with an energy saving/energy efficiency component and their basic characteristics (size, type)* *Assessment of the situation prior to project implementation (technology used, type and amount of energy used)* *The coefficients for the energy consumption of different production technologies, as well as the coefficients for the conversion of different energy sources are available*

		at Directive 2009/28/EC; International Energy Agency (http://www.iea.org/interenerstat_v2/energy_unit.asp)

Source: AKI edit

Table 1: Change in the indicator on renewable energy production (CMEF-PMEF) (2020)

Name of indicator	CMEF R.15 Renewable energy from supported projects 2014-2020	PMEF R.15 Green energy in agriculture and forestry: Investment in capacity expansion of renewable energy production, including bio-based energy production (MW) 2021-2027
Definition and purpose	Capacity created in terms of oil equivalent (toe) for programs supporting VP renewable energy use	Quantifying the capacity of a given renewable energy technology developed with CAP support for use on farms or in rural enterprises.
Interventions concerned	The indicator is linked to the agri-environmental indicator 24 (*Renewable energy production*)	Investments (Article 68); Sectoral interventions with an investment component
Unit of measurement	Petroleum equivalent (All savings must be converted, values in Watts are collected separately)	Megawatts
Date of data collection	Three times during the programming period (2016; 2018; ex post)	Investment operation for which the first payment has been made in the current financial year. The indicator shows the cumulative value over the financial period.
Methodology	In close alignment with the focus area, the evaluators will select a sample to assess the renewable energy capacity and the amount of energy generated during the implementation of the program. The results need to be extrapolated. Note: In Hungary, data are not defined based on the fiche sample, but based on beneficiary reporting	The annual installed capacity of the renewable energy technology (hydro, solid, liquid and gaseous biomass, biogas, wind, solar, geothermal and heat pumps) resulting from the investment in the operation for which aid is granted. *Note: To calculate the indicator, Member States must collect data on installed capacity.*

Source: AKI edit

4.3.3. CHALLENGES RELATED TO INDICATORS AND PROPOSALS TO ADDRESS THEM

For both R.14: Improved efficiency of energy use in agriculture and food processing in projects supported by rural development programs (Priority 5B) (toe) and R.15: Renewable energy produced in supported projects (Priority 5C) (toe), the following challenges were identified during the production of the indicators:

- **Precise data or figure on energy savings or renewable energy production was not requested from beneficiaries at the application or payment phase. The** relevant calls for proposals required the submission of an expert opinion on energy performance in PDF format or, in the case of building renovation, an energy performance certificate.
- **The expert opinions submitted were of different structures.** Only a trained energy expert could extract the necessary information from these, involving time-consuming document analysis methods.
- **The energy performance certificate only provided information on the energy category classification of the completed renovated building**, it did not provide information on the energy savings achieved through other linked energy improvements or renewable energy production.
- If the amount of energy savings/renewable energy production could be identified from the submitted documents, the **data was not available in the database and could not be retrieved**.

For the abovementioned reasons, at the closure of each project phase in 2020, the beneficiaries were asked to provide the amount of the achievable annual energy savings through the investment, based on an energy calculation (in kWh), and the annual energy produced by the installed renewable energy production capacity, based on an energy calculation (in kWh). However, as the beneficiary data reporting started in December 2019, the energy results of those projects that have been completed before the date of reporting, were not requested and could not be included in the data reporting, as requesting additional data would have been a significant administrative burden for both the institutional system and the beneficiary.

Furthermore, for indicator R.15, it was not possible (and therefore not included in the scope of the evaluation questions) to define the indicator using data from priority area 5C, so it could also be defined using investments on renewable energy production from priority area 5B (using the "secondary effect" as defined in fiche (EC, 2014)). The reason for this was:

The indicator plan of the VP included the measure M08 - Investments to improve forest areas and the viability of forests (Articles 21-26) in the priority area 5C.

Two calls for proposals were relevant to the measure:

- VP5-8.6.1-17 Investments in forestry technologies
- VP5-8.6.2-16 Activities to mobilize forest production potential

It was not possible to quantify the exact amount of renewable energy produced by the investments or to provide a reliable estimate. In investments in machinery, it was not possible to estimate the volume of timber gained during the extraction, handling and processing of the newly obtained machinery, as this was not the only task performed by said machinery. In the case of the regeneration of young forests, it is not known what proportion of the harvested timber (typically thin timber, which is often not profitable to harvest and therefore needs to be subsidized) was collected and utilized. The calls for proposals did not put an obligation on the subsidized enterprises to undertake such activity, nor did they require them to provide data in this aspect. **For the above reasons, it was not worthwhile to design forestry interventions with renewable energy production objectives.**

The experts suggested that in the next programming period, the beneficiary in the application for support should also indicate the planned nominal capacity (in MW) of the renewable energy production equipment to be installed, and attach a certificate issued by an energy expert, and also indicate the actual installed energy producing capacity of the equipment at the end of the project.

4.3.4. INTERNATIONAL EXPERIENCE (2020)

At the "Good Practices" workshop organised by the European Evaluation Helpdesk on 28-29 September 2020 (ENRD Evaluation Helpdesk, 2020), Eric Marcus presented the **calculation of the R.14 indicator** through **a Swedish case study.** In the Swedish example, the examination of the indicator was linked to the objectives and budgets of Priority Area 5B and Priority Area 5C, and they examined actions related to measures M04 (Investment) and M16 (Cooperation). The experience so far shows that Swedish farmers have installed mainly heating, cooling, lighting, ventilation, etc. The indicator was calculated both before and after implementation. The presentation explained that both primary and secondary data (operational data, where farmers were asked to provide data before and after the investment, Eurostat Standard Output Value (STÉ) regional data, energy conversion factors issued by national authorities, IACS data) were used in the evaluation, where both primary and secondary energy efficiency changes were introduced. The rapporteur presented the main challenges and the responses to them:

- Beneficiaries' energy use was available in different units of measurement: using energy conversion factors to represent different energy carriers in a uniform way.
- Inaccurate or incorrect information provided by the beneficiary: establishment of an alignment scheme by type of production and grouping of similar investments in the same group.
- The evaluation of the available data was necessary on a project-by-project basis: it is extremely time-consuming, therefore evaluation should be automated as much as possible, and small group queries should be carried out.

At the event, Mati Mötte presented the **Estonian case on the calculation of indicator R.15**, which examined the amount of "Renewable energy produced by funded projects". In Estonia, renewable energy production in 2016 was higher than planned (29.2 percent instead of 23.7 percent planned), with beneficiaries mainly investing in solar, wind and thermal energy. For the calculation of R.15, nominal energy capacity was calculated, and the values obtained per project were aggregated in the end. The following problems and proposed solutions were identified in the case study:

- The amount of renewable energy produced was available in different units of measurement: the decision must be made whether to use the project (kWh) and/or the macro (GWh) units of measurement used.
- Clustering of applications: close cooperation is necessary between the Managing Authority, the Paying Agency and the evaluators.
- Lack of control data: calculation of nominal energy and comparison with renewable energy production in the sector.

The following suggestions were made during the group work:

- The involvement of farmers is an essential element of the evaluation work.
- The inclusion of control data helps to verify the results.

- The process of evaluation could be facilitated by the Commission's publication of good practices and case studies (e.g. as part of the Helpdesk or by creating a database of good practices).

The outcome of the workshop showed that the availability of data on energy efficiency and renewable energy production capacity was a problem in most Member States. In the case of energy efficiency, the problem was solved by a "before-after" estimation, where energy production and use was quantified by applicants at the time of handing in the application and at the time of closing the project. Most experts supported this approach and agreed on the fact that it would be useful to move the methodologies in this direction for the future. Another suggestion was that energy efficiency should be calculated in terms of standard production value_ a suggestion that could also be used in the ex-post evaluation of the ÚMVP (2016) was that.

Technological changes, such as the shift from conventional to environmentally sound organic farming practices and the use of precision agriculture have contributed to increasing energy efficiency in agricultural production. Smith - Williams - Pearce (2015) had reviewed cca. 50 comparative studies on agricultural energy efficiency and concluded that for most arable crops, energy use is more efficient in organic farming than in conventional agriculture per unit of agricultural area. When looking at the energy efficiency per unit of output, the energy efficiency gap between conventional and organic production is smaller due to lower organic yields. It means that in the CAP period from 2021 onwards, when the weight of organic production in agricultural production should be increased, this change will also serve the improvement of energy efficiency.

The dispersion of precision production technologies in agriculture supports the improvement of input utilization efficiency and thus energy efficiency (Kemény et al., 2017). In Hungary, more and more farms are using precision technologies, and, considering that it is already a dominant production technology in the United States, Canada and Western European countries, its diffusion is expected to become more widespread in Hungary, which will also improve the energy efficiency of agricultural production (Gaál et al., 2020).

4.4. Processes, procedures, institutions (2020, 2021)

In the first phase of the evaluation, experts conducted interviews with experts from MÁK to explore the processes, procedures and institutional experience of the energy efficiency and renewable energy calls. The **most common challenges identified by the beneficiaries were the length of the evaluation period, the completion of the energy calculations required for submission, and the item of the report.** In most cases of investment subsidy for energy efficiency, the **first round of decision making took almost** one year (e.g. for the modernization of poultry farms). However, especially for small-scale farms and the modernization of livestock farms, the government expected the decision-making process to be shorter. The restructuring, fragmentation and merging of institutions prevented the assessment process from commencing rapidly. In many cases, the backlog was caused by delays in meeting commitments and an increase in expenditure and associated costs. **For the later submission periods, the time needed to process the commitments has typically been reduced to 3-4 months.**

In the frame of project evaluation, project evaluators found that **applicants often submitted insufficiently documented applications, which frequently resulted in requests for corrections**, mainly concerning the clients' documentation on energy efficiency calculations. The calculation was too complicated for the beneficiaries. According to project evaluators, the system that has been introduced in the 2007-2013 cycle has created a clearer and more straightforward situation, and it was easier to follow for clients too. The evaluators did not check the quality of the energy calculations, but it would be useful to have a template on energy efficiency calculations, both for the beneficiaries and for the data processors.

Among the problems they encountered there were obstacles related to the Collection of Construction Standards (ÉNGY). The purpose of the use of the ÉNGY was to facilitate the professional assessment of applications for aid co-financed by the European Agricultural Fund for Rural Development (EMVA) as part of the New Rural Development Program, to provide a professional assessment on the reality of costs and to provide sufficient giudance for clients, consultants, contractors and evaluators. The provision of the ÉNGY and the machinery catalogue has greatly assisted implementation. The latter has been removed from the system, although it was useful, for example, when an applicant wanted to purchase a different machine, other than the one originally listed in the application. Now, decision (approval or denial) is in the jurisdiction of county level authorities. The ÉNGY used in VP is not consistent with the set of standards defined in other OPs. Compliance with the content and form requirements of the ÉNGY, as well as shortcomings in the way the calculations were carried out, often necessitated corrections.

Professional support worked well. In the internal procedure guidelines of the MÁK, the typical questions for the new titles were collected and sent to the county departments, which were then obliged to prepare draft answers. A guide was issued to help them check the eligibility of applications. Information to clients was provided through portal questions available on the MÁK website and through information leaflets on palyazat.gov.hu. The national roadshow was organized with experts from the professional departments of the MÁK, IH and NAK.

Among the monitoring lessons learned, it should be mentioned that while the beneficiaries reported the energy saving in percentage terms, the expectation for the present evaluation (based on the result indicators) was an absolute amount in tons of oil equivalent. In some cases, hidden technological improvements were attempted. In the case of investments in energy efficiency, there was a problem that needed to be clarified to applicants: new construction and new capacity could not be created, which resulted in many rejections.

As part of the fight against the coronavirus, the government has eased the procedure. For example, on-site inspections have been carried out to minimize the number of visits, and risk analysis has been carried out. On-site inspections were limited only to final inspections were carried out, with intermediate inspections being resolved by photo documentation, for which templates and descriptions were issued to inspectors. Administrative checks were simplified and accelerated. The intensity of payments to clients by the SAI has not slowed down, with record monthly payment invoices during the first wave of restrictions.

5. FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1. What impact have the developments of the VP measures related to Priority 5B had on energy use in agriculture and the food industry?

5.1.1. FRAMEWORK AND FINANCIAL PROGRESS (2020)

In the 2020 assessment, experts concluded that energy efficiency aims to reduce primary energy consumption, energy imports and greenhouse gas emissions, and it contributes to energy security and mitigate the effects of climate change too. The transition to a more energy-efficient economy will accelerate the spreading and deployment of innovative technologies, improve competitiveness, promote economic growth, and contribute to the creation of quality jobs.

Table 9 : Domestic energy statistics 2014-17 (2020)

Indicator	2014	2015	2016	2017
Total primary energy consumption (*TJ*)	1 005 080	1 062 422	1 078 710	1 125 044
Final energy use (*thousand toe)*	15 873	16 958	17 394	17 944
Of which, agriculture, forestry, and fishing (*thousands toe)*	599	583	647	611
Amount of electricity generated (*million kWh)*	29 403	30 360	31 902	32 871

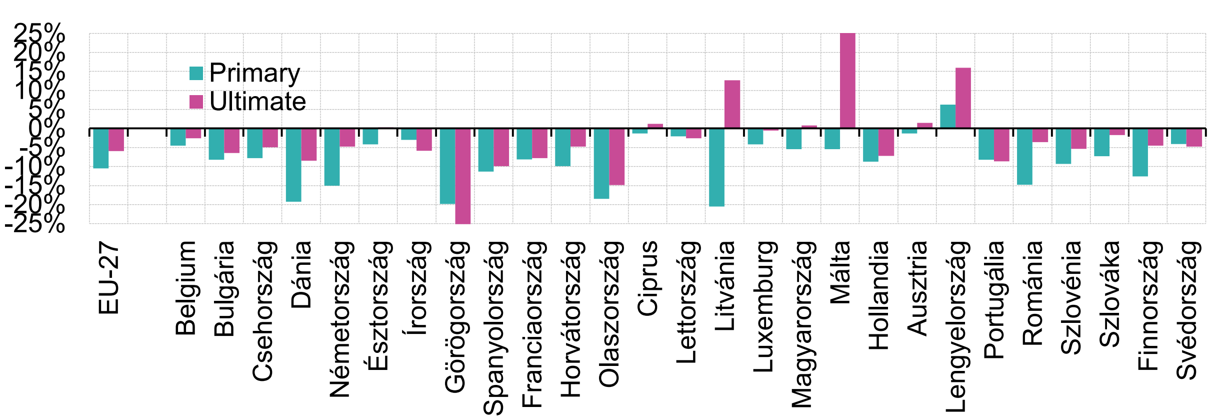
Source: KSH, 2021

Primary energy use is the total amount of energy consumed in the form of electricity, heat and other available energy sources, as shown in Table 9. An increase in primary energy use can be observed in the period 2014-2017.

Final energy consumption shows the amount of energy delivered to end users for energy use. End user energy consumption, and hence use for agricultural purposes, has increased over the period 2014-2017. The amount of electricity generated describes the amount of electricity generated by all power plants in the country, the extent of depletion of non-renewable resources caused by electricity generation and the modernization process of supply systems.

EU countries have set energy efficiency targets of 20 percent by 2020 and 32.5 percent by 2030. The distance to the targets is shown in Figure 1. Hungary achieved primary energy savings of 5.4% and a final energy surplus of 0.8% between 2006 and 2019.

Figure 2: Change in energy use 2006-2019 (2020)



Source: EUROSTAT, 2021

Question *"5.1. What impact have the developments of the Priority 5B VP measures had on energy use in agriculture and food?"* examined the main financial results of investments in energy efficiency improvements and their impact on the achievement of specific objectives.

Priority 5B aims to *improve the efficiency of energy use in agriculture and the food processing industry*.

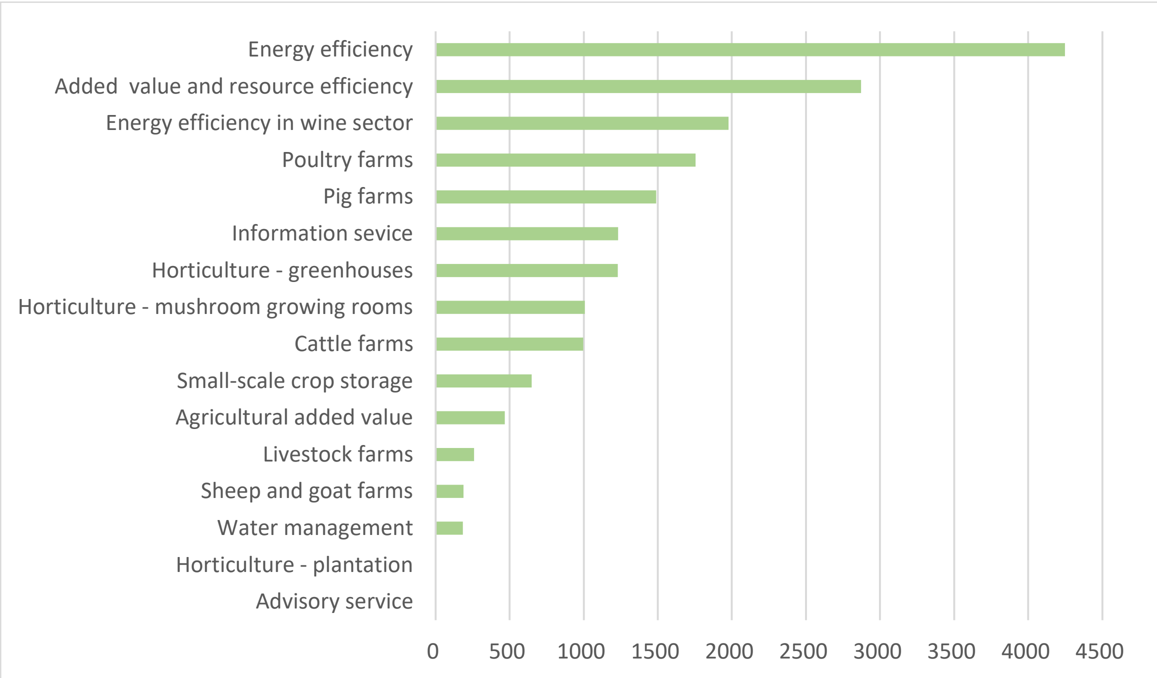
By 31 December 2020, a total of €64.7 million (HUF 21.9 billion) had been **paid out to** 2 052 beneficiaries under Priority 5B. This corresponded to an average grant amount of HUF 11 million per subsidy contract. Under measure M04, €10.5 million (HUF 3.3 billion) was paid out for the ÚMVP measures, benefiting 512 beneficiaries. The average amount per subsidy decision for the ÚMVP measures was HUF 7.1 million.

In terms of payments per project under the 5B envelope of the VP and the ÚMVP, an average of 1.44 payments per project were made, with a total of 2 947 payments registered by the end of 2020. For the VP, the highest number of payments was made in 2020 (1 393 payments, 57.2 percent), while for the ÚMVP the highest intensity was in 2016 (433 payments, 84.6 percent).

For 5B, the **average length of the implementation period** was 404 days, with beneficiaries implementing the commitments in the subsidy contract in a minimum of 63 days (e.g. call *VP2-4.1.1.2-16 - Modernisation of poultry farms*) and a maximum of 1 743 days (e.g. call *VP2.-4.1.4-16 - Development of the agricultural water management sector*).

T15 indicator set the 2023 target for energy efficiency investments for focus area 5B. The target is €888 306 248, of which €64 702 029 has been paid by the MÁK until 31 December 2020, representing a 7 percent resource uptake. In terms of commitments, the subsidy contracts signed by the end of 2020 resulted in a 22.37 percent commitment of the target amount.

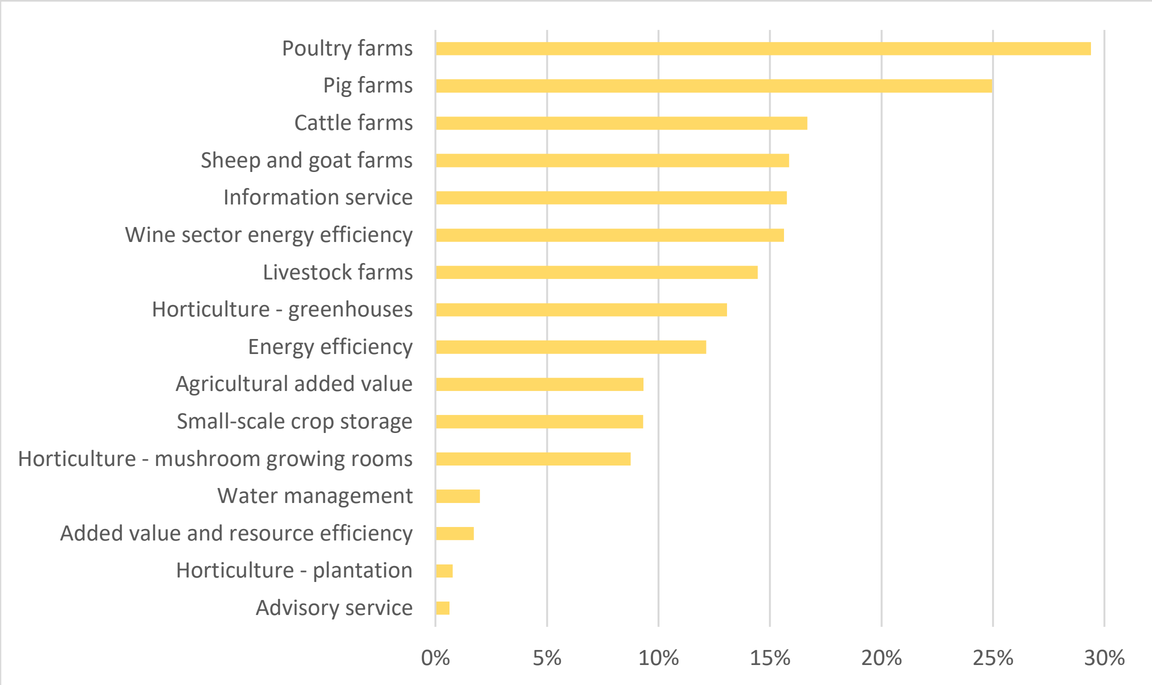
Figure 3: Grants paid out in thousands of HUF for focus area 5B under the 2014-2020 VP (2020)



Source: based on 31.12.2020 data of the Ministry of Agriculture, Forestry, Environment and Water Management

As shown in Figure 3, by the end of 2020, **most payments** were **made** under the calls VP5-4.1.6-4.2.3-17 - Improving energy efficiency in agricultural and processing enterprises (HUF 4.2 billion), VP-3-4.2.1-15 - Adding value to agricultural products and promoting resource efficiency in processing (HUF 2.9 billion) and VP3-4.2.2-16 - Supporting product development and resource efficiency in the wine sector (HUF 2.0 billion).

Figure 4: Use of the envelope for focus area 5B in relation to resources under the 2014-2020 VP (2020)



Source: based on 31.12.2020 data of the Ministry of Agriculture, Forestry, Environment and Water Management

As shown in Figure 4, the highest **use of** available **funds** allocated to focus area 5B was for calls VP2-4.1.1.2-16 - Modernization of poultry farms (29 percent), VP2-4.1.1.5-16 - Modernization of pig farms (25 percent) and VP2-4.1.1.3-16 - Modernization of cattle farms (17 percent).

Table 10: Grants available for Focus Area 5B by call, 2014-2020 (2020)

Call for proposals	Aid paid HUF	Aid paid EUR	Commitment EUR
VP-M01 Demonstration Operational Programs (ÚMVP)	1 050 378	3 411	-
VP-M01 Complex information (ÚMVP)	184 159	590	-
VP-M01 Vocational Training (ÚMVP)	38 793	124	-
VP-M01.2.2-Information service	1 232 430 836	3 633 293	4 080 474
VP-M02 Specialist consultancy (ÚMVP)	3 322	11	-
VP-M02.1.1-Individual specialist consultancy	962 195	2 656	794 388
VP-M04 Modernization of livestock farms (ÚMVP)	181 010 159	572 311	-
VP-M04 Modernization of horticulture (ÚMVP)	79 501 519	249 152	-
VP-M04 Horticultural machinery (ÚMVP)	2 620 041 167	8 349 123	-
VP-M04 Adding value to Agr. products (ÚMVP)	400 115 432	1 266 523	-
VP-M04 Irrigation (ÚMVP)	12 259 608	40 142	-
VP-M04 Support for dehumidifiers (ÚMVP)	6 816 340	21 704	-
VP-M04.1.1.1 Animal husbandry - Livestock Farms	258 523 723	763 760	1 892 308
VP-M04.1.1.2-Animal husbandry - Poultry farming	1 755 146 944	5 159 514	15 350 856
VP-M04.1.1.3 - Animal husbandry– Cattle	995 598 500	2 928 613	8 191 595
VP-M04.1.1.4 - Animal husbandry - sheep and goats	188 767 151	562 986	1 441 038
VP-M04.1.1.5 - Animal husbandry Pigs	1 489 743 671	4 409 617	10 592 322

VP-M04.1.1.7-Poultry and porcine epidemic prevention	-	-	246 262
VP-M04.1.2-Small-scale crop storage, drying, cleaning	649 436 526	1 869 174	4 474 233
VP-M04.1.3.1-Horticulture – Greenhouse	1 229 005 778	3 653 163	6 473 140
VP-M04.1.3.2-Horticulture – plantation	3 315 500	9 243	77 494
VP-M04.1.3.4-Horticulture - mushroom house,-cold storages	1 006 315 838	2 974 031	5 741 890
VP-M04.1.4-Water management	184 869 074	543 643	1 565 586
VP-M04.1.6-Improving energy efficiency - Agr. plants	3 605 488 732	10 117 454	78 658 639
VP-M04.2.1-Adding value to agricultural products	2 872 844 480	8 600 683	25 500 397
VP-M04.2.1-Value added to Agr. products-Food	435 331 577	1 220 635	12 727 663
VP-M04.2.2-Winery	1 977 400 034	5 867 495	10 136 374
VP-M04.2.2-Value added to Agr. products-Wineries	31 219 127	88 174	3 161 198
VP-M04.2.3-Energy efficiency improvement-processors	641 783 326	1 794 804	7 614 331

Source: based on 31.12.2020 data of the Ministry of Agriculture, Forestry, Environment and Water Management

Table 10 shows the amounts paid out in HUF and EUR per call for proposals that can be linked to focus area 5B, as well as the amount committed until the end of 2020. **Under measures M01 and M02,** VP-M01 Demonstration Operational Programs (ÚMVP), VP-M01 Complex Information (ÚMVP), VP-M01 Vocational Training (ÚMVP), VP-M01.2.2-Information Services, VP-M02 Technical Assistance (ÚMVP) and VP-M02.1.1 Individual specialist consultancy have contributed to the energy efficiency goals of focus area 5B. By the end of 2020, **EUR 3 637 417.94 (HUF 1 234 669 683) had been paid for 5B** under measures M01 and M02. **Under measure M04, the measures** VP-M04 Modernization of Livestock Farms (ÚMVP), VP-M04 Modernization of Horticulture (ÚMVP), VP-M04 Modernization of Horticultural Machinery (ÚMVP), VP-M04 Adding value to Agr. products (ÚMVP), VP-M04 Irrigation (ÚMVP), VP-M04 Support for dryers (ÚMVP) received payments to fulfill the goals of priority area 5B. Up to the end of 2020, **EUR 10 498 954,83 (HUF 3 299 744 225) of aid under** measure M04 **has been paid out under** measure M04 for ÚMVP measures from VP funds..

Table 11: Number of beneficiaries and average amount of payments in focus area 5B (2020)

Call for proposals	Number of beneficiaries	Average payout
VP-M04.1.1.1 Animal husbandry - Livestock Farms	26	9 943 220
VP-M04.1.1.2- Animal husbandry - Poultry farming	80	21 939 337
VP-M04.1.1.3 - Animal husbandry -– Cattle	229	4 347 592
VP-M04.1.1.4 - Animal husbandry -- sheep and goats	90	2 097 413
VP-M04.1.1.5 - Animal husbandry -Pigs	80	18 621 796
VP-M04.1.2-Small-scale crop storage, drying, cleaning	229	2 835 967
VP-M04.1.3.1-Horticulture-Greenhouse	43	28 581 530
VP-M04.1.3.2-Horticulture – plantation	1	3 315 500
VP-M04.1.3.4-Horticulture - mushroom house-cold storage	41	24 544 289
VP-M04.1.4-Water management	74	2 498 231
VP-M04.1.6-Improving energy efficiency - Agr. plants	169	25 131 787
VP-M04.2.1-Adding value to agricultural products	261	11 007 067
VP-M04.2.1-Adding value to agri-products-Food processing	38	12 277 650
VP-M04.2.2-Winery	221	8 947 511

Source: based on 31.12.2020 data of the Ministry of Agriculture, Forestry, Environment and Water Management

Table 11 shows the number of beneficiaries in focus area 5B and the average amount paid out for the focus area activities.

In the 2014-2020 period of the VP, the budget available for the activities of the call for proposals **VP2-4.1.1.1-16 Modernization of livestock farms under measure M04** was HUF 1.79 billion for priority area 5B. The aid disbursed for this purpose until the end of 2020 amounted to HUF 258.52 million (EUR 763 760.30), representing a 14% budget uptake. Under the call for modernization of livestock holdings, 26 payments were made for Objective 5B. On average, the farms received payments of HUF 9.94 million for the corresponding activities.

Within the M04 measure, the available funding for the call for proposals **VP2-4.1.1.2-16 Modernization of poultry farms for** priority area 5B was HUF 5.97 billion. By the end of 2020, the total amount of aid paid out for this purpose was HUF 1.76 billion (EUR 5 159 514.32), representing 29% of the budget. Under the call for poultry farms, there were 80 farmers who applied for 5B aid and received payments. The average amount paid for Objective 5B activities was HUF 21.94 million.

Under measure M04, the budget allocated to priority 5B of the call for proposals **VP2-4.1.1.3-16 Modernization of cattle farms** was HUF 5.96 billion. By the end of 2020, HUF 0.99 billion (EUR 2 928 613.35) had been used for this purpose, representing a 17% uptake of the budget. Among the beneficiaries of the call for cattle farmers, 229 farmers have contributed to energy efficiency targets, with an average payment of HUF 4.35 million.

Under measure M04, under the call for proposals **VP2-4.1.1.4-16 Modernization of sheep and goat farms,** HUF 1.19 billion was available for priority area 5B. By the end of 2020, payments amounting to HUF 0.19 billion (EUR 562 986.48) had been made, representing a 16% uptake of the budget. Under the call for sheep and goat holdings, 90 livestock farmers applying for 5B aid received payments. These holdings received an average payment of €2.10 million for Objective 5B activities.

For the call for proposals **VP2-4.1.1.5-16 Modernization of pig farms, the** available budget for priority area 5B was HUF 5.97 billion. By the end of 2020, investments in energy efficiency for pig farmers amounted to HUF 1.49 billion (EUR 4 409 616.69), representing a 25 percent uptake of the budget. For the purposes of Call 5B for Pig Farmers, 80 livestock farmers applying for aid have received payments. On average, the farms received payments of HUF 18.62 million for Objective 5B activities.

For measure M04 call for proposals **VP2-4.1.2-16 Construction and modernization of small-scale crop storage, drying and cleaning facilities,** the available funding for priority area 5B was HUF 6.98 billion. By the end of 2020, the investment disbursed under this call for Priority 5B activities amounted to HUF 0.65 billion (EUR 1 869 173.89), representing a 9 percent uptake of the budget. The number of small-scale crop storage, drying and cleaning facilities, construction and modernization applicants under 5B was 229. On average, the farms received payments of HUF 2.84 million for activities corresponding to Objective 5B.

Under measure M04, under the call for proposals **VP-2-4.1.3.1.-16 Modernization of horticulture - installation of glass and foil houses, increasing energy efficiency by using geothermal energy,** HUF 9.40 billion was allocated for energy efficiency. By the end of 2020, the value of investments paid for the activities of priority area 5B under the call for proposals reached HUF 1.23 billion (EUR 3 653 163.02), representing a 13% budget utilization. Under the call for the creation of glass and foil houses, 43 claims were supported under Priority 5B. For Objective 5B activities, the average amount paid to the holdings was HUF 28.58 million.

The total budget available for the call **VP-2-4.1.3.2.-16 Modernization of horticulture - support for planting with the possibility of irrigation** was HUF 0.43 billion for the 5B objective. By the end of 2020, payments of HUF 3.36

million (EUR 9 242.59) had been made from this source, representing a budget uptake of almost 1%. One beneficiary has benefited from this support.

Under measure M04, the available budget for the call for proposals **VP5-4.1.3.4-16 Modernization of horticulture - creation of mushroom houses - cold storage, modernization of existing mushroom houses - cold storage, for** priority area 5B was HUF 11.50 billion. By the end of 2020, the investment disbursed under the call for proposals under Priority 5B amounted to HUF 1.65 billion (EUR 2 974 030.86), representing a 9 percent uptake of the budget. In total, 41 claims were supported under 5B for the modernization of mushroom houses - cold storages. The average amount paid to the holdings for Objective 5B activities was HUF 24.54 million.

Under the call for proposals **VP2.-4.1.4-16 Development of the agricultural water management sector,** HUF 9.31 billion has been earmarked for energy efficiency. By the end of the period under review, payments amounting to HUF 0.18 billion (EUR 543 643.06) had been made, representing a 2% uptake of the budget. Of this amount, 74 holdings have received payments, spending an average of HUF 2.49 million on 5B.

Under the M04 measure, under the call for proposals **VP5-4.1.6-4.2.3-17 Improving the energy efficiency of agricultural and processing plants,** the planners allocated HUF 35.00 billion for 5B. By the end of 2020, the value of investments paid out for the 5B priority area activities under the call reached HUF 4.48 billion (EUR 11 912 258.2), representing a 12 percent budget uptake. The targeted support to improve the energy efficiency of agricultural and food processing holdings was used by 169 beneficiaries, with an average payment of HUF 25.13 million.

For the call **VP3-4.2.1-4.2.2-18 Adding value to agricultural products in processing,** HUF 5.00 billion was earmarked for 5B. By the end of 2020, HUF 0.47 billion (EUR 1 308 808.95) had been used for this purpose, representing a 9 percent uptake. Under the call for proposals for adding value to processing, energy efficiency targets were implemented in 261 plants, receiving an average payment of HUF 11.00 million.

Under the measure M04, **VP-3-4.2.1-15 Adding value to agricultural products and promoting resource efficiency in processing, a** total of HUF 167.37 billion was allocated for Call 5B. By the end of 2020, payments amounting to HUF 2.87 billion (EUR 8 600 683.43) had been made, representing a budget utilization of 2 percent. Under the call for food processing holdings, 38 livestock farmers applying for 5B aid received payments. These farms received an average payment of 12.27 million HUF for Objective 5B activities.

Under the call **VP3-4.2.2-16 Support for Product Development and Resource Efficiency in the Wine Sector,** HUF 12.66 billion was allocated to energy efficiency-related activities. By the end of 2020, payments amounting to HUF 1.98 billion (EUR 5 867 494.70) had been made, representing a 16% uptake of the budget. 221 livestock farmers applying for aid under the call for support for winery holdings received payments for 5B purposes. These holdings received an average payment of HUF 8.95 million for Objective 5B activities.

5.1.2. CHARACTERISTICS OF INVESTMENTS (2020)

The applications submitted, in response to the calls for proposals under the VP, were evaluated in accordance with the standard selection procedure set by Government Decree 272/2014 (XI.5.). The Managing Authority was involved in the preparation of the decision on the projects and it convened a Decision Preparation Committee to prepare the ground for the decision on the aid applications. The submission of aid applications was linked to the prerequisite of the submission of a business plan, and the selection procedure, selection criteria and content evaluation criteria for said business plan were set out in the calls for proposals.

For the calls under focus area 5B, applicants have demonstrated in their business plans the extent to which energy savings have been achieved so far in their activities. The minimum requirement for the beneficiaries of the calls in this focus area was a 10% specific energy efficiency improvement. The reduction in energy use was demonstrated by an electricity and/or heat energy calculation carried out by an expert registered with the

Hungarian Chamber of Engineers and/or the Hungarian Chamber of Architects. In the context of the content evaluation criteria, it is possible to check the extent to which the energy saving commitments have been made in line with the objectives of Focus Area 5B for the following calls:

- VP2-4.1.1.1-16 Modernization of livestock farms
- VP2-4.1.1.2-16 Modernization of poultry farms
- VP2-4.1.1.3-16 Modernization of cattle farms
- VP2-4.1.1.4-16 Modernization of sheep and goat farms
- VP2-4.1.1.5-16 Modernization of pig farms
- VP2-4.1.2-16 Construction and modernization of a small-scale crop storage, drying and cleaning facility
- VP-2-4.1.3.1.-16 Modernization of horticulture - installation of glass and foil houses, increasing energy efficiency by using geothermal energy
- VP5-4.1.3.4-16 Creation of cold storage facilities for mushrooms, modernization of existing cold storage facilities for mushrooms
- VP5-4.1.6-4.2.3-17 Improving the energy efficiency of agricultural and processing plants
- VP-3-4.2.1-15 Adding value to agricultural products and promoting resource efficiency in processing
- VP3-4.2.1-4.2.2-18 Adding value to agricultural products in processing
- VP3-4.2.2-16 Support for product development and resource efficiency in the wine sector

Calls for proposals for the modernization of livestock holdings (VP2-4.1.1.1-16, VP2-4.1.1.2-16, VP2-4.1.1.3-16, VP2-4.1.1.4-16 and VP2-4.1.1.5-16) and horticulture (VP-2-4.1.3.1.-16 and VP5-4.1.3.4-16), 3 points were awarded for energy savings above 30 percent, 2 points for specific energy efficiency improvements between 15 and 30 percent, and 1 point below that (Table 12).

For small-scale crop storage (call VP2-4.1.2-16), 4 points were awarded for energy savings of more than 30 percent, and 2 points for specific energy efficiency improvements between 15 and 30 percent, below which the business plans were awarded 1 point (Table 12).

In the case of improving the energy efficiency of farms (call VP5-4.1.6-4.2.3-17), 14 points were awarded for energy savings of more than 30 percent, 10 points for specific energy efficiency improvements between 15 and 30 percent, and 8 points for energy savings below that (Table 12).

In the case of the winery (call VP3-4.2.2-16) and the value added of agricultural products (call VP-3-4.2.1-15), the commitments in the business plans were assessed with 8 points for energy savings of more than 30 percent and 5 points for specific energy efficiency improvements between 15 and 30 percent, and 2 points for energy savings below that level (Table 12).

The highest point value for energy efficiency commitments in the call for proposals VP3-4.2.1-4.2.2-18 Value added to agricultural products in processing was 18 points for energy savings of more than 30 percent, and 13 points for specific energy efficiency improvements between 15 and 30 percent, with 3 points below that (Table 12).

Table 12: Specific energy efficiency improvements committed in business plans[4] (2020)

Consultation group	> 30 %	15-30 %	15-10 %	10 %	Total
Livestock farms	252	45	14	1033	1 344
Small crop storage	21	9	8	705	743

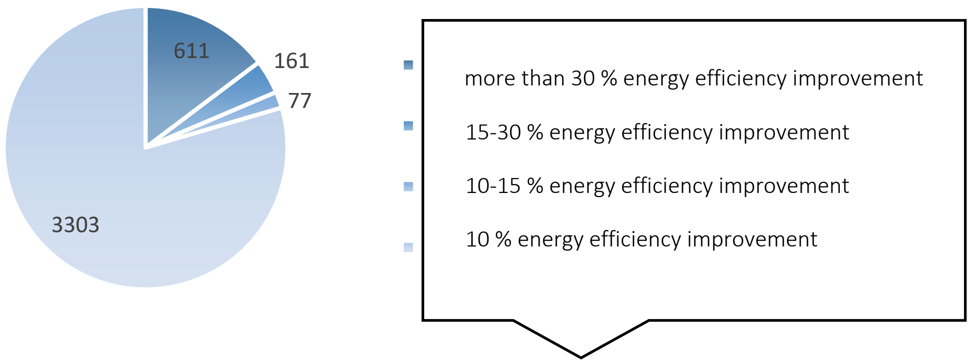
[4] The rows represent groups with the same point value

Modernisation of horticulture - greenhouse and mushroom house	15	10	3	250	278
Improving the energy efficiency of plants	130	57	41	120	348
Winery	85	9	5	339	438
Adding value to agricultural products	55	16	5	432	508
Agricultural value addition and resource efficiency	53	15	1	424	493
Total	**611**	**161**	**77**	**3 303**	**4 152**

Source: based on 31.12.2020 data of the Ministry of Agriculture, Forestry, Environment and Water Management

Considering the content evaluation criteria of the farms that received support under the calls for proposals in Focus Area 5B, the farms that did not only commit to the minimum requirement committed to: energy savings of more than 30 percent in most cases (611 farms), between 15-30 percent in 161 cases and below 15 percent in 77 cases (Figure 5). 80 percent of the farms (3,303) did not make any additional commitment and only achieved the mandatory 10 percent energy savings.

Figure 5: Distribution of commitments in the business plan (2020)



Source: based on 31.12.2020 data of the Ministry of Agriculture, Forestry, Environment and Water Management

Activities undertaken by the beneficiaries

The experts used a data mining methodology to describe the characteristics of the activities undertaken by the beneficiary holdings (see Annex 2 for a detailed description of the methodology). In this study, due to the scope of the analyzed documents and the nature of the methodology, the activities aimed at improving energy efficiency and developing renewable energy production in the documentation submitted for the calls for proposals for focus areas 5B and 5C were examined together.

The text fills of the business plans were analyzed using text mining methods. The content of the business plan and the related technical specifications is presented in the so-called document-expression matrix (Table 13), with file names in the rows and terms in the columns. The content of the cells shows how many times the term in a given column appears in the document. According to the document expression matrix of the commitments in the technical plan, farmers have mainly made capital (investment) improvements, purchased new technology and equipment, and in many cases produced renewable energy. The frequent use of the term cost indicates a high level of investment and associated costs.

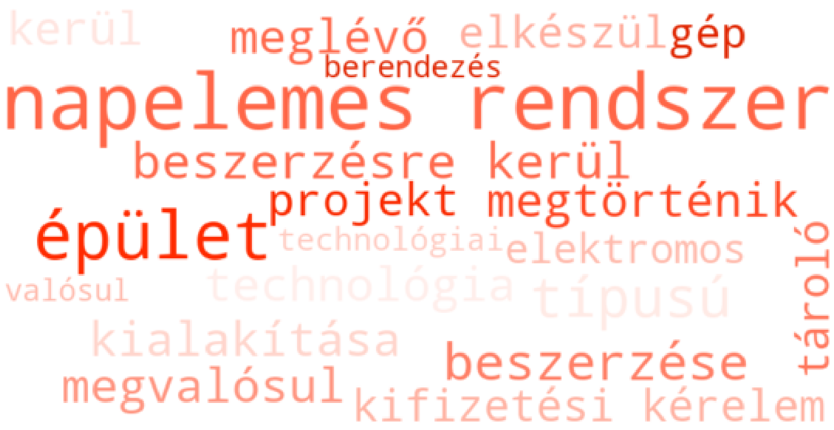
Table 13: Documentary matrix of commitments in technical plans (2020)

	development	investment	project	Result	system	Procurement	Cost	technology	energy	Tool	renewable	solar
Characteristics of the result	865	670	626	538	525	461	444	360	360	337	312	303
Description of the result	463	611	635	323	1410	1402	580	370	384	469	268	792
Name of the result	233	337	564	87	723	1091	377	214	94	297	120	493

Source: based on 31.12.2020 data of the Ministry of Agriculture, Forestry, Environment and Water Management

A word cloud has been used to graphically represent the most common terms within the document collection (corpus) of business plans (Figure 6). Figure 5 shows the terms of the technical specifications submitted for calls for proposals related to focus areas 5B and 5C, which have been granted funding and have received payments by the end of 2020. The figure shows that the most common terms are related to the acquisition of energy efficiency and renewable energy technologies, upgrading and expansion of existing equipment.

Figure 6: Most common elements in the technical specifications of calls under focus areas 5B and 5C (2020)



Source: based on 31.12.2020 data of the Ministry of Agriculture, Forestry, Environment and Water Management

The following graph illustrates those project categories that were most frequently applied for in the subsidy claims according to the call data: beneficiaries most often undertook activities related to the modernization of livestock buildings, renewable energy production, extension works to existing buildings and storage activities.

Figure 7: Most common elements of the construction lots for calls in focus areas 5B and 5C (2020)

Source: based on 31.12.2020 data of the Ministry of Agriculture, Forestry, Environment and Water Management

Based on the description of the **technical results,** the most frequently occurring terms have been classified according to the nature of the investment. Five classes were identified: **(1) construction of a new building** (*construction, being built, building*), **(2) modernization of a building** (*system, plant, storage, investment, design, barn, construction, tank, renovation, frame, modernization, electrical, installation, existing, electrical, crop storage, storage, construction*), **(3) acquisition of new equipment** (*acquisition, machinery, plant, technology, power, investment, tool, equipment, shift, installation, power*), **(4) upgrading of existing equipment** (*system, upgrade, modernization, electrical, existing, electrical, improve, energetics, repair*), **(5) renewable energy generation** (*system, solar, energy, solar, deployment, renewable, energy source, environmentally friendly*).

Table 14: Frequency of technical specifications by type of investment (2020)

	Frequency of occurrence	Number of beneficiaries
Construction of a new building	4 696	1 895
Modernization of a building	8 487	4 817
Acquisition of new equipment	9 842	5 506
Upgrading of existing equipment	3 622	2 124
Renewable energy production	5 765	3 590

Source: based on 31.12.2020 data of the Ministry of Agriculture, Forestry, Environment and Water Management

Table 14 shows the keywords that characterize the documents of the five groups created for the M04 measure related to focus areas 5B and 5C. Words in the new equipment term class appear most frequently and are the terms most frequently mentioned by beneficiaries when describing the technical content.

Beneficiaries who have undertaken **building modernization activities**, have completed the renovation of buildings (cladding, insulation, drainage, windows, garage doors, support systems, roofing, etc.), the renovation of existing infrastructure (water, electricity, gas and sewage networks, wastewater (sewage) treatment plants, etc.) and the extension of building services (condensing boiler, heat pump, building cooling, thermal well, compressor, condenser, hot water production, etc.).

The **investments in energy saving and renewable energy production** were typically aimed at the purchase of even more upgraded modern machinery and equipment (packaging equipment, ripening equipment, processing equipment, fruit processor, fruit washer, cold storage, logistics equipment, irrigation controllers, pasteurization tanks, field machinery, milk processing unit, vacuum packaging unit, sorting equipment, etc.).

Beneficiaries have typically **generated renewable energy** through solar energy production. Based on the available technical specifications, 531 beneficiaries have reported at least one type of energy production indicators (in units of W, Wp, kW, kWh, kWp). 452 of these cases include a reported on the description of solar energy production performance.

The solar panels purchased and installed are typically operating on polycrystalline technology and beneficiaries most often preferred installations with a capacity of 50 kW, hence due to the 5 kW technology threshold (no grid development required for licensing), smaller capacity (typically below 5 kW), small-scale household-sized installations were also frequently purchased.

The most common equipment purchased by **livestock and processing plants** was cooling and heating equipment. Air-conditioning systems and condensers were frequently installed to cool the buildings, but separate refrigeration chambers were also installed, typically with a capacity of 18 to 46 kW. Fans of varying power (1,1 to 28,7 kW) were installed to move the air in the livestock buildings, and air purification equipment was also installed to reduce emissions from the buildings. In the case of wineries, the purchase of wine chillers of around 5 kW capacity has been introduced.

Among the **field machinery**, the beneficiaries reported the power of balers (~5.50 kW), graders (~8.82 kW), mowers (~50 kW), loaders (~60 kW) and electric shepherd (~50 kW). Among the equipment used for irrigation, beneficiaries reported in the technical specifications the machines of water pumps with power ranging from 22 to 55 kW and irrigation equipment with power ranging from 7 to 90 kW.

The processors' purchases included vacuum packaging, juice cleaning, drying, pressing, berrying, cleaning and sorting equipment.

Based on the description of the **construction results,** the most frequently occurring terms were classified according to the nature of the investment: **(1) construction of a new building** (*construction, build, building, establishment*), **(2) modernization of a building** (*system, plant, storage, investment, design, barn, frame, modernization, electrical, installation, existing, electrical, crop storage, storage, construction*), **(3) acquisition of new equipment** (*acquisition, machinery, installation, technology, performance, investment, tool, equipment, shift, installation, performance*), **(4)** upgrading of **existing equipment** (*installation, expansion, system, upgrade, modernization, electrical, existing,*), **(5) renewable energy generation** (*system, solar, deployment, renewable*).

Table 15: Frequency of construction lots by type of investment (2020)

	Frequency of occurrence	Number of beneficiaries
Construction of a new building	5 068	983
Modernization of a building	10 268	1 258
Acquisition of new equipment	3 892	865
Upgrading of existing equipment	3 388	1 029
Renewable energy production	4 985	1 090

Source: based on 31.12.2020 data of the Ministry of Agriculture, Forestry, Environment and Water Management

For the new building or part of a building, beneficiaries have established or constructed greenhouses, social and service rooms, storage rooms, tanks, stables, handling/packing areas, drying rooms, cold storage rooms, access roads, walkways, fire water tanks.

In the case of payments for energy efficiency and renewable energy production in measure M04, investment in building modernization was the most frequently mentioned category by beneficiaries. For building modernization, the activities included modernization of roof structure and ceilings, establishment of fence and cladding, insulation of buildings, replacement of windows and doors.

In the case of new technology, the aid was targeted at the installation of greenhouses and foil or lightweight structures, and mechanical solutions, water intake and irrigation equipment. In the case of equipment modernization, beneficiaries have improved energy efficiency, for example by upgrading electrical and water networks and heating systems.

The technical content and construction items of the activities undertaken by beneficiaries in the VP were available in the form of a large amount of unstructured text. The goal of the categories defined during the analysis was to classify the data elements into a predefined class. The classification may have had limitations, the classifications may have been incomplete or there may have been the possibility of multiple classifications. When they defined the content of each category they developed, the experts could lean on their personal experience based on reading through the texts and on respondent patterns. Automatic machine analysis on the large amount of unstructured text available was also used to try to draw conclusions about the text which, given such a large amount of data, could provide a much more precise and in-depth analysis compared to manual assessment and a more complete picture on the content of the activities undertaken and on the links between these activities.

5.1.3. INDICATOR ACHIEVEMENT (2021)

The R.14 CMEF indicator aimed to measure the improved energy efficiency in the agricultural and food processing sector in the 2014-2020 period through projects supported by the VP.

Based on the logic of the call for proposals, energy efficiency improvement activities are, by their very nature, energy efficiency measures, and the call did not set a requirement for the proof of the extent of these activities (a description, plan, calculation or documentation supporting compliance with the relevant assessment criteria had to be submitted at the time of the handing in of the aid application), on the assumption that the modernization would essentially result in energy savings. As the beneficiaries were not instructed to provide the energy savings in the form of precise data at the application or payment stage, the MÁK requested the following data from the beneficiaries to define the indicator:

1. Did the development include an investment to save energy?

1.1. Date of implementation of the energy improvement / Date of installation of the energy equipment

1.2. Annual energy savings achieved by the implemented investment based on energy calculation (in kWh)

The 19 March 2021 survey resulted in 3,234 beneficiary submissions, of which 346 respondents indicated that they had made an energy saving investment. Only the following observations were included in the sample:

- Observations considered correct during validation
- Details of holdings already making payments by 31 December 2020
- Beneficiaries who may be eligible for support in focus area 5B or 5C
- observations with STÉ values or plants with data available for STÉ calculation (to be suitable for sample training)

Due to data collection and accuracy constraints, the best available methodology was used: a sample of the available data was drawn, weighted by the total population. The standard production value (STÉ) used in the European Union from 2010 onwards was used to determine the size of each holding. The STÉ included sales, consumption in the holding, usage in the holding and income from changes in goods on hand. In the database provided by the MÁK, the STÉ of the beneficiaries concerned was not always available, so the STÉ of the beneficiary holdings was calculated according to the Typology Manual published by the Commission (European Commission, 2020). The basis for the calculation of the STÉ values were the data tables from the corporate tax returns of the NAV. The value dates on which the payment was made, and the development was carried out were considered when determining the STÉ.

The purpose of this methodological experiment was to allow experts to assess whether the sample obtained by screening the population as described above is suitable for projecting the whole population and thus drawing conclusions about the unknown population without data as well.

For **livestock farms**, the experts have identified a size range of small-scale below €150 000 and STÉ above €150 000, based on the following calls:

- VP2-4.1.1.1-16 Modernization of livestock farms
- VP2-4.1.1.2-16 Modernization of poultry farms
- VP2-4.1.1.3-16 Modernization of cattle farms
- VP2-4.1.1.4-16 Modernization of sheep and goat farms
- VP2-4.1.1.5-16 Modernization of pig farms
- VP2-4.1.1.7-20 Improvement of disease control systems in poultry and pig holdings

For calls in the field of **crop production, the** experts followed the size classification of EUR 100 000, as follows:

- VP2-4.1.2-16 Construction and modernization of a small-scale crop storage, drying and cleaning facility
- VP-2-4.1.3.1.-16 Modernization of horticulture - installation of glass and foil houses, increasing energy efficiency by using geothermal energy
- VP-2-4.1.3.2.-16 Modernization of horticulture - support for planting with the possibility of irrigation
- VP5-4.1.3.4-16 Creation of cold storage facilities for mushrooms, modernization of existing cold storage facilities for mushrooms
- VP2.-4.1.4-16 Development of the agricultural water management sector

Among the **processing plants**, the following calls were examined by the experts, based on the size threshold of €50 000 for the STÉ:

- VP5-4.1.6-4.2.3-17 Improving the energy efficiency of agricultural and processing plants
- VP-3-4.2.1-15 Adding value to agricultural products and promoting resource efficiency in processing
- VP3-4.2.1-4.2.2-18 Adding value to agricultural products in processing
- VP3-4.2.2-16 Support for product development and resource efficiency in the wine sector

Table 16: Pattern of energy efficiency investments (2020)

Call categories	Sample item number	Energy savings (kWh)	Weight
Livestock farms			
Over EUR 150 000	17	15 678,66	40,53
Below EUR 150 000	17	15 359,46	69,76
Processing plants			
Over EUR 50 000	13	45 174,48	30,46
Below EUR 50 000	17	35 674,65	27,82
Crop production			
Over EUR 100 000	6	7 335,30	50,56
Below EUR 100 000	16	108 163,89	110,83

Source: based on 31.12.2020 data of the Ministry of Agriculture, Forestry, Environment and Water Management

Table 16 shows the call categories based on the sample, the energy savings of the beneficiaries in each category and the sample weights. The defined sample is also consistent with the median value of the population. The weight expresses the number of farms in the sample that represents the number of farms in the corresponding group in the population.

According to the call categories of the base population, farms that have made a payment in the VP until 2020 and have undertaken a 5B activity have achieved the following energy savings based on the sample.

Table 17: Estimated annual energy savings from investments (2020)

Call categories	Energy savings (kWh)	Energy savings (toe)
Livestock farms		
Over EUR 150 000	635 446,75	54,64
Below EUR 150 000	1 071 548,38	92,14
Processing plants		
Over EUR 50 000	370 891,17	31,89
Below EUR 50 000	11 988 164,11	1 030,80
Crop production		
Over EUR 100 000	1 376 084,11	118,32
Below EUR 100 000	992 594,80	85,35
Total:	16 434 729,32	382,34

Source: based on 31.12.2020 data of the Ministry of Agriculture, Forestry, Environment and Water Management

Beneficiaries provided the amount saved in kWh in the data request. According to the methodology of indicator R.14, the value should be given in toe, therefore the conversion factor '1 toe = 11,63 MWh' was used by the experts.

The biggest savings, equal to more than 1 000 tons of oil equivalent, were achieved by small processing plants with a STÉ of less than €50 000. Also, for livestock farms, small farms with a size below the standard production threshold of €150,000 achieved the largest energy savings of more than 90 tons of oil equivalent. For crop producers, farms in the larger size range of €100,000 STÉ were the most efficient, achieving more than 118 tons of oil equivalent in savings.

The results show that the beneficiaries have achieved a total energy saving of 16 434 729 kWh over the period 2014-2020, which corresponds to 0.0591 PJ in petajoules (1 PJ = 277 777 777.78 kWh).

It should be noted that the basic requirement for receiving the aid was that the beneficiaries should reduce their energy consumption by at least 10 percent, so the mandatory 10 percent specific energy efficiency improvement already positively influenced the specific energy efficiency improvement of Hungarian agriculture, forestry and food processing through the investments in focus area 5B.

5.1.4. PROPOSED METHODOLOGY BASED ON THE VERIFICATION AND INTERPRETATION OF THE CALCULATED RESULTS (2020)

It is important to point out that the methodological experiment presented above, although it is sound in terms of its process and the methods it used, did not yield the expected results. The main reasons for this are the poor beneficiary data quality which served as base for sample creation and the small number of projects with a given STÉ value, which resulted in a sample that could not represent the population properly.

The methodologically correct process did not ultimately lead to the expected result, since, compared to the energy validation of the KHM (EIM) carried out by Field Consulting, the projection calculated based on the established sample led to a lower value than the cumulative result from the implemented projects examined by the expert review.

In line with this, the following methodological proposal was made for the calculation of R.14, incorporating the steps of the energy validation carried out in the framework of the KHM (EIM) into the evaluation process.

Steps to determine the R.14 indicator

The *amount of energy saved in* all relevant and completed projects is collected by the MÁK through the reporting of data by the beneficiaries, with the following data:

- Did the development include an investment to save energy? (yes/no)
- Date of implementation of the energy improvement / Date of installation of the energy equipment
- Annual energy savings achieved by the investment based on energy calculation (in kWh)

Projects that have been awarded a point for energy efficiency commitment in the project screening phase or have carried out an eligible activity related to Priority 5B must be considered relevant.

For indicator R.14, only projects funded under Priority 5B can be considered as primary impacts. Other projects can be considered as secondary impacts.

MÁK collects the available beneficiary data for a given date and submits it in an Excel spreadsheet to the IH for evaluation. The spreadsheet contains the time of the installation of the energy equipment per project and the annual energy savings in kWh that can be achieved with the investment.

The data in the table should first be cleaned, validated and outliers or data that appear to be significant for the overall result should be marked. These should be subject to validation against the background documents. During the data validation, those projects should be flagged, where:

a) the legal form of the beneficiary is not in line with the amount of savings claimed (e.g.: significant amount of savings is reported, and the status of the beneficiary is self-employed, or farmer),
b) the energy savings and the renewable energy production capacity declared by the beneficiary are quantifiably equal,
c) the energy savings provided are so significant that the project is ranked, in descending order of energy savings, among those which, together, account for 20 percent of the total value.

Projects flagged in the data cleaning should be reviewed by an energy expert. During the review, an expert estimate should be made considering the energy calculations, quotations, invoices and technical certificates submitted as annexes to the application. If necessary, the beneficiary should also be contacted directly for further information. Based on the information gathered, an expert estimate shall be carried out. Where the estimate deviates from the reported value, the expert estimate should be considered.

The validation exercise carried out in 2021 found that in the examined projects, around 54% of the value declared by the beneficiaries was acceptable. As a result, beneficiary data in the beneficiary reporting for the validated projects should be adjusted to comply with the validated value and the value provided by beneficiaries in all other non-validated projects should be multiplied by a correction factor of 0.54. The corrected values are then aggregated to give the value of the indicator in kWh. The beneficiaries have provided the amount saved in kWh in the data request. According to the methodology of indicator R.14, the value had to be given in toe, therefore the conversion factor ‘1 toe = 11,63 MWh’ had to be applied.

If expert validation could not be performed, a data validation had to be carried out and the data of projects corresponding to cases (a) and (b) had to be deleted from the database. For the other projects, the correction factor of 0.54 defined during validation had to be used.

Projects closed before December 2019

Since the beneficiary data reporting started in December 2019, the energy results of projects closed before this date were not collected and were not included in the data reporting, as it would have been a significant administrative burden for both the institutional system and the beneficiary to request additional data.

No change to standard emissions

The purpose of using standard emission data was to include data characterizing the economic performance of beneficiaries to determine energy savings against changes in their performance, thus the possibility that changes in energy consumption are caused by changes in performance rather than by improvements in energy efficiency could also be detected. It means, that it was necessary to determine a standard change in emissions when the amount of energy saved was calculated by subtracting the energy use per unit of output at the starting date from the energy use per unit of output at the ending date.

However, this approach was only applicable if the beneficiaries' economic performance could be measured by the same type of indicator. The energy efficiency incentive was widely available in the VP calls for proposals, therefore the range of beneficiaries was also so wide that it could not be covered by a single output indicator. The scope of beneficiaries ranged from agriculture to the food industry to energy project companies, meaning that the Standard Production Value (STÉ), widely used in agriculture, was not applicable. And the turnover was influenced by a number of other externalities, so it can be misleading.

5.1.5. RESULTS CALCULATED USING THE PROPOSED METHODOLOGY (2021)

Using the proposed methodology presented in Section 5.1.4, the following calculated results were obtained.

The annual amount of energy saved through energy efficiency improvements implemented with VP support is 1 086.2 toe/year, converted to 12 630 333 kWh/year. These data were extracted and collated from the data provided by the MÁK on 19.03.2021 and included projects closed until 31.12.2020 (335 of which had an energy efficiency project element as claimed by the beneficiary), with outliers cleaned and validated and corrected by an energy expert (see 5.1.4. for details of the methodology)

The values of indicator R.14 reported in 2020 were 520,789 toe/year and 6 055 729,00 kWh/year respectively, based on the Paying Agency data provision of 15.09.2020, which was produced by cleaning the outliers and it only includes data taken after the December 2019 beneficiary data reporting went live. The difference (+109%)

with the previous year's indicator value R.14 is due to the increase in the number of closed projects and the refinement of the data during the energy validation.

5.2. What impact have the developments of the VP measures related to Priority 5B had on renewable energy production in agriculture and food?

5.2.1. FRAMEWORK AND FINANCIAL PROGRESS (2020)

The use of renewable energy sources showed the amount of primary energy produced using wind, water, geothermal, solar, biomass (firewood) and landfill gas, sewage gas and biogas. There was a typical increase in energy production in the 2014-2018 period (from 29 403 million kWh to 32 004 million kWh), but the penetration of renewable resources slightly followed this expansion.

Table 18: Percentage share of energy from renewable energy sources in Hungary (2020)

	2014	2015	2016	2017	2018
Amount of electricity generated, million kWh	29 403	30 360	31 902	32 871	32 004
Renewable electricity generation as a share of total electricity consumption (%)	7,4	7,3	7,3	7,6	8,1
Biomass (percentage)	54,0	51,4	45,8	47,3	48,1
Biogas (percentage)	9,1	9,1	10,2	10,0	8,8
Wind (percentage)	20,8	21,5	21,0	21,8	16,2
Water (percentage)	9,6	7,2	8,0	6,3	5,9
Day (percentage)	2,1	4,4	7,5	10,1	16,6
Renewable fraction of municipal waste (%)	4,3	6,4	7,5	4,6	4,3

Source: KSH, 2018

In 2018, Hungary reached the 8 percent share of renewable electricity generation in total electricity consumption (Table 18). In 2018, biomass accounted for the largest share of our renewable energy generation (48 percent), followed by solar (17 percent) and wind (16 percent), and the share of biogas, landfill gas, and sewage gas in total generation were also significant (KSH, 2018).

In terms of end-use, in 2019 Hungary almost reached the 13% target set for 2020, with a share of 12.6% (Eurostat, 2021).

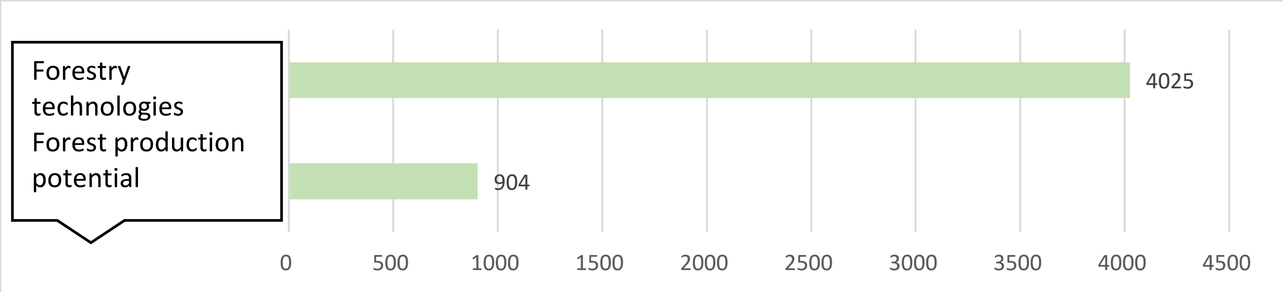
The question *"5.2 What impact have the developments of the Priority 5B VP measures had on renewable energy production in agriculture and food?"* examined the main financial results of the investments made through the developments in renewable energy production and their impact on the achievement of the specific objectives.

Priority 5C aims at *facilitating the transfer and use of renewable energy sources, by-products, waste, residues, and other non-food raw materials for bio-economic purposes*.

A total of HUF 4.9 billion (€14 844 562.70) has been paid out to achieve the objectives of Priority 5C up to 31 December 2020, with 1 525 beneficiaries having received support under this budget. The amount paid was on average HUF 3.2 million in funding per farm.

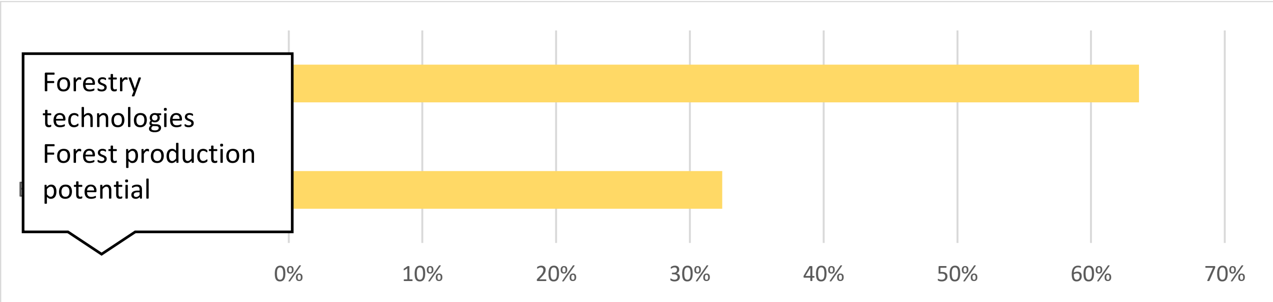
For 5C, the average length of the implementation period was 204 days, with a minimum commitment of 27 days (e.g. *VP-5-8.6.2-16 Activities to mobilize forest production potential*) and a maximum of 1 289 days (e.g. *VP5-8.6.1-17 Investments in forestry technologies and processing and marketing of forest products*).

Figure 8: Grants paid out in thousands of HUF for focus area 5C under the 2014-2020 VP (2020)



Source: based on 31.12.2020 data of the Ministry of Agriculture, Forestry, Environment and Water Management

Figure 9: Use of the framework for the 2014-2020 VP 5C focus area (2020)



Source: based on 31.12.2020 data of the Ministry of Agriculture, Forestry, Environment and Water Management

As shown in Figures 8 and 9, the budget utilization of VP-5-8.6.2-16 - Activities to mobilize forest production potential was 64%, totaling HUF 4.0 billion, and the budget utilization of VP5-8.6.1-17 - Investments in forestry technologies and processing and marketing of forest products was 32%, totaling HUF 0.9 billion.

The T16 indicator set the 2023 target for investments in renewable energy production for focus area 5C. The target was €37 805 276, of which €14 849 075 has been disbursed by 31 December 2020, corresponding to a resource uptake of 39%.

Table 19: Payments for grants that can be linked to Focus Area 5C per call 2014-2020 (2020)

Call for proposals	Aid paid HUF	Aid paid EUR	Commitment EUR
VP-M08-Young Forest Restocking Grants (ÚMVP)	1 375 844	4 512	-
VP-M08.6.1-Forestry technologies and processing of forest products	4 024 865 287	12 138 066	29 071 373
VP-M08.6.2-Actions to mobilize forest production potential	904 313 278	2 706 497	6 699 303

Source: based on 31.12.2020 data of the Ministry of Agriculture, Forestry, Environment and Water Management

Table 19 shows the amounts paid out in euros and in forints per call for proposals that can be linked to focus area 5B and Table 20 for focus area 5C, as well as the amounts committed until the end of 2020.

Table 20: Number of beneficiaries and average payment amount in focus area 5C (2020)

Call for proposals	Number of beneficiaries	Average payout HUF
VP-M08-Young Forest Restocking Grants (ÚMVP)	1	1 375 844
VP-M08.6.1-Investments in forestry technologies and processing and marketing of forest products	144	27 950 453
VP-M08.6.2-Actions to mobilize forest production potential	1383	653 878

Source: based on 31.12.2020 data of the Ministry of Agriculture, Forestry, Environment and Water Management

Table 20 shows the number of beneficiaries in focus area 5B and the average payment amount for the focus area activities. For action M08, payments were made under the heading **VP-M08 Support for the regeneration of young forests**. One beneficiary has received a payment for this item for Objective 5C until the end of 2020.

For measure M08, the available funding for priority area 5C of the call for **investments in forestry technologies and processing and marketing of forest products VP5-8.6.1-17** was HUF 6.33 billion. By the end of 2020, the investment disbursed under the call for actions under Priority 5C amounted to HUF 4.02 billion (EUR 12 138 065.93), representing 64% of the budget allocation. Under the Investment in forestry technologies (Focal Area 5C), 144 operations had been implemented by 31 December 2020. On average, holdings have received payments of HUF 27.95 million for operations under Objective 5B.

For the priority area of **VP-5-8.6.2-16 Mobilizing forest production potential for** renewable energy production, the planners have earmarked HUF 2.79 billion. By the end of 2020, HUF 0.90 billion (EUR 2 706 496.77) had been used by beneficiaries, which corresponds to a 32% utilization of the budget. In the context of improving forest production potential, 1 381 beneficiaries have undertaken to produce renewable energy.

5.2.2. INDICATOR ACHIEVEMENT (2021)

The CMEF indicator R.15 aims to show the amount of renewable energy generated by supported projects, where the renewable energy use generated by the VP beneficiaries was examined in petroleum equivalent.

As the beneficiaries were not requested to provide the exact data on energy savings or renewable energy production at the application or payment stage, the MÁK carried out a beneficiary related data request to determine the indicator, during which the following data were requested from the beneficiaries:

- Has renewable energy generation capacity been developed as part of the development?
- Date of implementation of the energy improvement/date of installation of the energetics equipment
- Amount of energy per annum, produced by the renewable energy production capacity installed, based on energy calculation (in kWh)

The survey of 19 March 2021 resulted in 3 234 beneficiary submissions, of which 1 002 respondents provided the amount of energy that had been generated by the investment in renewable energy capacity. Only the following observations were included in the sample:

- During the validation, the energy expert considered the observations to be correct
- Details of holdings already making payments by 31 December 2020
- Beneficiaries who may be eligible for support in focus area 5B or 5C
- observations with an STÉ value or holdings with data available for the STÉ calculation

Due to the limitations of data collection and outliers, a sample of the available data was drawn and weighted with the data of the entire population. Table 21 shows the call categories formed from the sample, the amount of energy produced by the beneficiaries in each category with annual renewable energy production capacity and the weights formed from the sample. The defined sample is also consistent with the median value of the population. The weight expresses the number of farms in the sample that are representative of the number of farms in the corresponding group in the population.

Table 21: Pattern of investments in renewable energy production (2020)

Call categories	Sample item number	Renewable energy production (kWh)	Weight
Livestock farms			
Over EUR 150 000	46	19 313,90	14,98
Below EUR 150 000	40	9 637,69	29,65
Processing plants			
Over EUR 50 000	13	32 485,89	7,07
Below EUR 50 000	17	12 932,11	11,00
Crop production			
Over EUR 100 000	6	9 314,82	12,64
Below EUR 100 000	16	11 262,69	14,78

Source: based on 31.12.2020 data of the Ministry of Agriculture, Forestry, Environment and Water Management

The examined beneficiaries have developed the following renewable energy production capacity based on the amount of energy produced per year (in kWh):

Table 22: Annual renewable energy production from investments (2020)

Call for categories	Renewable energy capacity (kWh)	Renewable energy capacity (toe)
Livestock farms		
Over EUR 150 000	289 288,65	24,87
Below EUR 150 000	285 757,45	24,57
Processing plants		
Over EUR 50 000	229 721,46	19,75
Below EUR 50 000	142 253,19	12,23
Crop production		
Over EUR 100 000	117 745,16	10,12
Below EUR 100 000	166 437,47	14,31
Total:	1 231 203,38	105,85

Source: based on 31.12.2020 data of the Ministry of Agriculture, Forestry, Environment and Water Management

The beneficiaries provided the amount of energy produced by the investment in kWh in the frame of data submission. According to the methodology of indicator R.15, the value had to be given in toe, therefore the conversion factor '1 toe = 11,63 MWh' was applied. The largest renewable energy production of almost 290 thousand kWh was achieved by large livestock farmers with a STÉ of over 150 000 euros. The amount of renewable energy produced by livestock farmers with installed capacity ranged around 25 toe per year for both small and large farms. For crop farmers, the smaller farms, below the size threshold of €100,000 p.a., performed more efficiently, with these farms being able to produce more than 14 toe. During the period 2014-2020, the beneficiaries of the investments in the creation of renewable energy production produced a total of 1 231 203,38 kWh, corresponding to a total production of 105,86 toe.

The values of indicator R.15 published in the VP 2020 Annual Implementation Report (1.2 GWh or 105.85 toe) were based on the abovementioned calculation, which was later revised based on the results of the validation carried out in the framework of the Environmental Impact Monitoring (KHM/EIM) as described in chapter 5.2.3.

Results of the validation of the Environmental Impact Monitoring (KHM/EIM)

Under the KHM (EIM), 115 projects were subject to detailed expert review. Table 23 below shows the number of projects, the hypothesized justifications and the aggregation of the values initially provided for the "Annual energy produced by the renewable energy production capacity developed, based on energy calculation (in kWh)" (39,312,844.96 kWh) and the aggregation of the values corrected during validation (21,300,224.05 kWh).

Table 23: Scope of projects validated under the FMP and corrected results (2021)

Presumed reasons	Number	Annual energy produced by the renewable energy production capacity installed, based on energy calculation (kWh)	Corrected annual energy produced by the renewable energy production capacity installed (kWh)
in question	60	7 127 736,96	6 422 640,00
The renewable value seems to be an outlier.	4	5 416 750,00	4 702 300,00

Presumed reasons	Number	Annual energy produced by the renewable energy production capacity installed, based on energy calculation (kWh)	Corrected annual energy produced by the renewable energy production capacity installed (kWh)
The renewable value is very high compared to the energy savings.	1	81 738,25	50 000,00
The renewable value is zero, the investment is in 2019, and there is probably no accounting year.	1	0,00	3 000,00
The renewable value is zero, the investment is in 2020, there is no accounting year.	1	0,00	0,00
The energy savings figure seems to be an outlier compared to renewable.	4	76 890,68	93 050,00
The energy savings figure seems to be an outlier.	1	14 520,00	14 520,00
The energy savings part seems to be extremely high, but the company is the implementer.	1	55 000,00	55 000,00
The energy savings part seems to be extremely high.	1	2 000,00	2 000,00
Both types of investment were the same, the values are the same, renewable seems to be the outlier.	2	295 340,00	184 842,00
Both types of investment were of the same value.	41	770 116,03	902 546,00
Both types of investment have been implemented, energy savings are zero, there is value for renewables. It is likely that the energy savings have not yet reached one accounting year, the renewable is an estimate.	2	32 192,00	32 192,00
Both figures seem to be outliers.	1	383 190,00	383 190,00
filter	55	32 185 108,00	14 877 584,05
Only energy-saving investments have been made, the values are zero, the commissioning is in 2019, probably not even one accounting year has passed yet.	2		55,00
Only renewable energy investments have been made, the values are zero, the commissioning is 2018-2020, in some cases probably not even one accounting year has passed yet.	33	0,00	403 727,05
Investment in renewable energy generation capacity only - an outlier.	2	24 557 069,00	9 557 069,00
Both types of investments have been implemented, the values are zero, the commissioning is 2019-2020, probably not even one accounting year has passed yet.	8	0,00	71 500,00
seems like an outlier	10	7 628 039,00	4 845 233,00

Presumed reasons	Number	Annual energy produced by the renewable energy production capacity installed, based on energy calculation (kWh)	Corrected annual energy produced by the renewable energy production capacity installed (kWh)
Total	115	39 312 844,96	21 300 224,05

Source: based on 31.12.2021 data of the Ministry of Agriculture, Forestry, Environment and Water Management, Energy validation, Field

The largest share of the validated projects, 80 (69.57%), included solar investments. Other types of renewable energy sources were also included: 8 solar (6.96%) and 7 biomass (6.09%) investments, with a small number of thermal wells, heat pumps and associated gas. The aggregated original and corrected performance figures by technical classification of the projects are presented in Table 32. In 13 cases (11.30%) it was indicated that renewable energy was not yet relevant, no renewable equipment was installed, the investment included machinery purchase or construction but no renewable energy or no information on renewable energy.

Table 24: Aggregated initial and corrected performance by technical classification of projects (2021)

classification	Darab	Annual energy produced by the renewable energy production capacity installed, based on energy calculation (in kWh)	Adjusted annual energy produced by the renewable energy production capacity installed (in kWh)
Solar panel	80	3 720 738,96	2 968 260,05
Solar collector	8	137 261,00	52 263,00
Biomass	7	9 808 323,00	7 537 778,00
Thermal well	4	25 470 203,00	10 470 203,00
Heat pump	2	0,00	0,00
Associated gas	1	165 318,00	271 720,00
Not relevant	13	11 001,00	0,00
Total	**115**	**39 312 844,96**	**21 300 224,05**

Source: based on 31.12.2021 data of the Ministry of Agriculture, Forestry, Environment and Water Management, Energy validation, Field

In most cases (46, 40%) the original power calculation was correct. In 20.87% of the projects (24), corrections were made, i.e. the values given were corrected. In 18.26% (21), corrections were made, i.e. the originally provided 0 value was replaced by a calculation. The estimation category includes 6 projects (5.22%) where the original value was also 0, but the value was estimated during validation. 2 projects have a power value that cannot be calculated due to occasional operation, 5 projects for which no information could be obtained and 11 projects (9.57%) had no renewable investment. The 13 projects marked as not relevant included 12 projects that did not make a meaningful commitment, while one project made a commitment of 11 001 kWh but did not provide any data (the beneficiary did not respond to any query). No expert opinion could be given based on assumptions alone.

In approximately half of the solar, solar thermal and biomass projects, the calculation was correct. Values that could not be calculated due to occasional operation occurred only in the heat pump projects.

5.2.3. PROPOSED METHODOLOGY BASED ON THE VERIFICATION AND INTERPRETATION OF THE CALCULATED RESULTS (2020)

It is important to underline that the methodological experiment presented above, although it is sound in terms of its process and the methods used, did not deliver the expected results in 2020. The main reasons for this were the poor beneficiary data quality underlying the sample creation and the small number of projects with a given STÉ value, which resulted in a sample that was not representative enough of the population.

The methodologically correct process did not lead to the expected result, since, compared to the energy validation of the KHM (EIM) carried out by Field Consulting Services Zrt., the projection calculated based on the assessed sample led to a lower value than the cumulative result from the implemented projects examined by the expert review.

In line with the above, and incorporating the step-by-step validation of the KHM (EIM) into the evaluation process, the experts made the following methodological suggestion for the calculation of R.15.

Steps to determine the indicator R.15

For indicator R.15, only projects funded under Priority Area 5C can be considered as primary impacts. Relevant projects funded from other priority areas may also be considered as secondary impacts.

Priority 5C financed the expansion of forestry renewable energy production capacity. The results of these projects will be reported based on a project-level assessment to be carried out in 2021 under the KHM (EIM).

The amount of renewable energy generated as secondary impact in relevant finished projects financed from other priority areas is collected by the MÁK through the reporting of data by the beneficiaries, with the following data:

- Has renewable energy production capacity been developed as part of the development? (yes/no)
- Date of implementation of the energy improvement/date of installation of the energy equipment
- Annual energy produced by the renewable energy production capacity installed, based on energy calculation (in kWh)

Projects that have been awarded a renewable energy commitment point in the project selection process will be considered relevant.

MÁK collects the beneficiary data for a given date and sends it to the IH in an Excel spreadsheet. The spreadsheet contains the date of installation of the energy equipment per project and the annual amount of the energy produced by the installed renewable energy production capacity, expressed in kWh.

The data in the table should first be validated, and any outliers, or data that appear to be significant for the overall result should be marked. These should be subject to validation against the background documents.

The data return should indicate the projects for which:

a) the legal form of the beneficiary is not in line with the amount of renewable energy capacity granted (e.g. significant amount of savings is reported, and the status of the beneficiary is self-employed, or farmer status),
b) the energy savings and the renewable energy production capacity declared by the beneficiary are quantifiably the same,
c) the declared renewable energy capacity is so significant, that, the project is ranked in descending

order of renewable energy capacity, among those which, together account for 20 percent of the total value.

Projects flagged in the data cleaning should be reviewed by an energy expert. The review shall be carried out by considering the energy calculations, quotations, invoices, technical certificates submitted as annexes to the applications. If necessary, the beneficiary should also be contacted directly for further information. Based on the information gathered, an expert estimate should be carried out. Where the estimate differs from the reported value, the expert estimate should be considered.

The validation exercise carried out in 2021 found that around 54% of the value provided by beneficiaries is only the actual acceptable value.

As a result, the beneficiary data in the beneficiary reporting for validated projects should be adjusted to comply with the validated value and the value provided by beneficiaries for all other non-validated projects should be multiplied by a correction factor of 0.54. By summing the corrected values, the value of the indicator in kWh is obtained. The beneficiaries have provided the amount saved in kWh in the data request. According to the methodology of indicator R.15, the value had to be given in toe, therefore the conversion factor '1 toe = 11,628 MWh' had to be applied.

Although the selected projects, and thus the data and analyses derived from them, were not representative, the expert validation provided a reasonably accurate approximation of the value of the indicators to be defined based on the available data.

The value declared in the beneficiary's data was determined by the beneficiary based on an energy calculation carried out by an energy expert involved in the investment and registered with the Hungarian Chamber of Engineers and/or the Hungarian Chamber of Architects. The energy calculation made by the energy expert or the contractor had to be attached to the information.

Projects closed before December 2019

Since the beneficiary data reporting started in December 2019, the energy results of projects finished before this date were not collected and will not be included in the data reporting, as it would have been a significant administrative burden for both the institutional system and the beneficiary to request additional data.

5.2.4. VALIDATED RESULTS CALCULATED USING THE PROPOSED METHODOLOGY (2021)

Using the proposed methodology presented in Section 5.2.3, the following calculated results were obtained.

The annual energy produced by the renewable energy production capacity developed with VP support is 2 505,057 toe/year, converted to 29 128 798 kWh/year. These data were extracted from the Paying Agency (MÁK) data of 19.03.2021 and included projects that have been closed until 31.12.2020 (of which 982 had a renewable energy project element as claimed by the beneficiary), with outliers cleaned and validated and corrected by an energy expert (see 5.2.3 for details of the methodology)

The values of indicator R.15 reported in 2020 were 937,712 toe/year and 10 903 717,04 kWh/year, respectively, based on the Paying Agency data of 15.09.2020, which was produced by cleaning the outliers and which did not include data before the commencement of the December 2019 beneficiary data reporting. The difference (+167%) with the previous year's indicator value R.15 is due to the increase in the number of closed projects and the refinement of the data during the energy validation.

5.3. Updated renewable energy analysis for projects with renewable energy activities and costs supported or under commitment in focus areas 5B and 6A (June 2023 - October 2023)

5.3.1. FRAME (2023)

This chapter provides a quick overview analysis based on the mid-2023 Rural Development Program database of renewable energy generation capacity development projects (also) for focus areas 5B and 6A, which can be considered as a virtual closing data-set.

The primary task of this energy validation is to make raw information and data suitable for analysis for management reporting, monitoring and evaluation. Accordingly, the present energy validation will only provide a quick analysis of the database, but it can be used for further in-depth analysis and will provide a suitable benchmark for the content, progress and distribution of the interventions of the CAP Strategic Plan for renewable energy development, given the preparation achieved through the validation.

The aim of the rapid analysis is to draw the first, management-level, public conclusions on the composition of the database and the results of the projects implemented.

The rapid analysis **was carried** out **according to the technological classification that is** crucial for renewable energy development. Hence, the analysis can answer the question of the share of subsidies and results for each technology. The criteria for the rapid analysis were:

1. Number of subsidized developments (number of projects, by relevant case ID-s)
2. Value of aid for subsidized developments (aid, HUF billion)
3. Nominal installed renewable energy capacity (MW)
4. Annual volume of renewable energy produced by capacities (GWh)

Overall quick analysis results

The table below summarizes and tabulates the values for the abovementioned rapid analysis criteria, by determining technology. As explained in the methodology chapter, the technology classification includes not only improvements that are purely related to a specific technology, but also improvements that are predominantly linked to that technology. Thus, a development that is predominantly solar based on its contribution to annual energy production, and contains to a lesser extent heat pump based production, has all values assigned to the dominant solar PV technology. These were not disaggregated due to the lack of data on internal technologies and it’s shares in the whole project, which can be determined for all developments.

Table25: Summary table of rapid analysis by technology (2023)

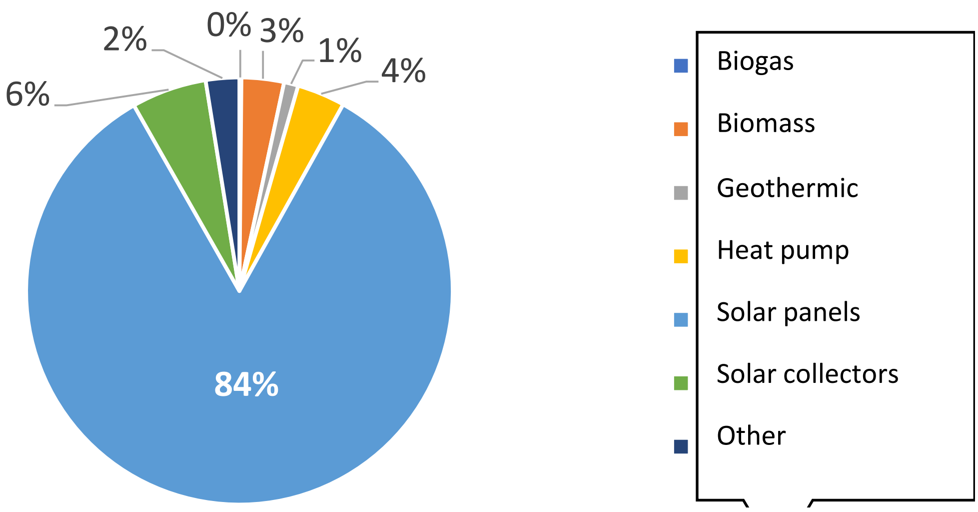
A defining technology within renewable development	Number of projects pcs	Net expenditure HUF billion	Installed capacity MW	Annual energy produced GWh
biogas	6	0.69	0.15	2,57
biomass	152	10.06	131.02	196.43
geothermal	51	11.56	53.25	159.75
heat pump	171	3.21	9.75	6.42
solar panel	3950	70.82	203.28	243.51
solar collector	269	1.04	9.47	2.79
other renewable	120	2.60	8.48	10.18
Total	**4,719**	**99.98**	**415.40**	**621.65**

Source: DevEco, based on 2023.06.15. HST data

Number of developments benefiting

The analyzed, filtered, de-duplicated and consolidated database, contains **4,719 projects.** The breakdown of these projects by technology is shown in the following pie chart.

Figure 10: Number of beneficiary developments (2023)



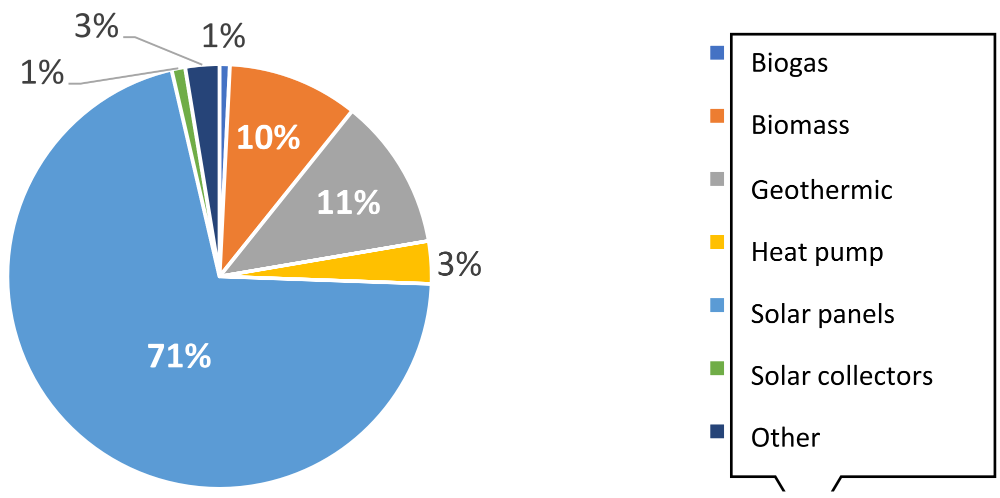
Source: DevEco, based on 2023.06.15. HST data

Out of the total number of renewable energy development projects, 84 percent (3,950) of these renewable energy development projects are solar PV development projects. **Solar PV projects account for the vast majority of the supported renewable energy projects.**

Net expenditure on beneficiary improvements

The examined database, which has been filtered, cleaned, de-duplicated and consolidated several times, contains **99.98 billion HUF net expenditure.** The breakdown of these projects by technology is shown in the following pie chart.

Figure 11: Net expenditure on beneficiary improvements (2023)



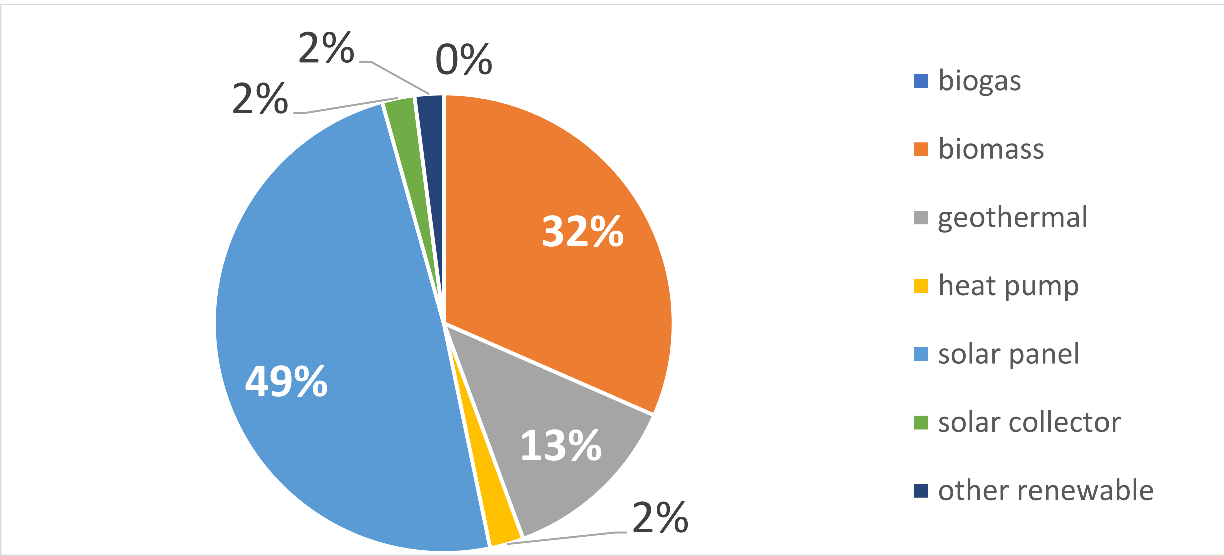
Source: DevEco, based on 2023.06.15. HST data

In the case of renewable energy development projects, 71 percent (HUF 71 billion) of the net expenditure was mainly for solar PV, 11 percent (HUF 12 billion) for geothermal and 10 percent (HUF 10 billion) for biomass.

installed renewable energy capacity

The analyzed, filtered, de-duplicated and consolidated database, contains **415.40 MW of** developments with **nominal installed** capacity. The technological breakdown of these is as follows:

Figure 12: Nominal installed renewable energy capacity (2023)



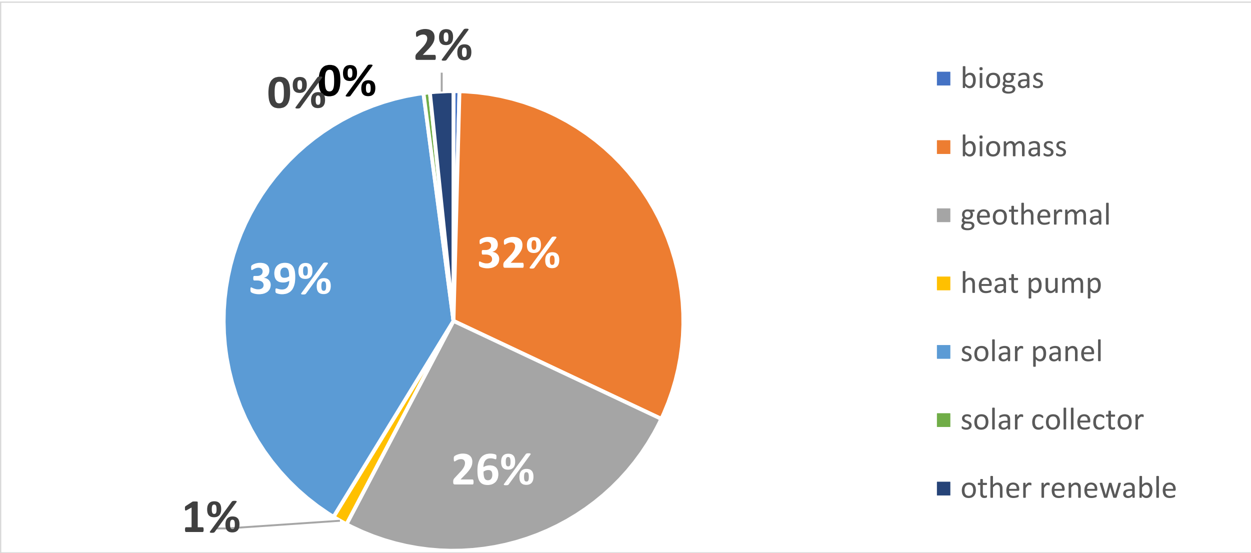
Source: DevEco, based on 2023.06.15. HST data

Of the installed capacity, 49 percent (203 MW) is predominantly solar, 32 percent (131 MW) is predominantly biomass boiler, 13 percent (53 MW) is predominantly geothermal, with a smaller share of other (2% heat pump, 2% solar collector, 2% other renewables, less, than 1 % biogas) renewable energy development.

Annual volume of renewable energy produced

The supported projects in the analyzed, multi-filtered, cleaned, de-duplicated and consolidated database **generate 621.65 GWh of energy per year.** Accordingly, the contribution of focal areas 5B and 6A **to the value of the CMEF indicator R.15 is 621,654.96 MWh, while the** technological breakdown is shown in the following pie chart.

Figure 13: Annual volume of renewable energy generated by capacities (2023)



Source: DevEco, based on 2023.06.15. HST data

Of the annual renewable energy generated, 39% (243,5 GWh) came predominantly from solar PV developments, 26% (160 GWh) from geothermal developments, 32% (196 GWh) from biomass developments, with a smaller share from other renewable energy developments (2% other renewables, 1% heat pumps, less than 1% solar collectors and biogas).

5.3.2. FINANCIAL PROGRESS (2023)

The 4,719 projects, using a total of HUF 99.98 billion of net expenditure, have generated an estimated installed nominal renewable energy generation capacity of 415.40 MW, with an estimated annual (cumulative, but not cumulated) energy production of 621.65 GWh.

5.3.3. INDICATOR ACHIEVEMENT (2023)

Based on the R.15 CMEF fiche, the definition and purpose of the indicator is: Capacity created for the VP Renewable Energy Supported Programs in oil equivalent (toe). Since the official conversion rate of the International Energy Agency (IEA) under the OECD is 1 toe = 11.63 MWh, the contribution of focus areas 5B and 6A to the VP R.15 CMEF fiche is based on the database and the rapid analysis. The CMEF indicator value is: **621654.96 MWh, which is 53,452.71 toe.**

5.4. How do VP measures related to the priority areas under review serve the achievement of objectives set in the national energy management plans/strategies?

In the fight against climate change, the EU has set ambitious policies, and in line with the EU's objectives, Hungary has also created the National Energy Strategy 2030 (OGY Resolution 77/2011 (X. 14.)) and the Renewable Energy Utilization Action Plan of Hungary (NFM, 2012).

According to the National Energy Strategy, the cornerstones of Hungary's energy independence are energy saving and domestic renewable energy production. An important aspect of this is the creation of a bipolar agriculture, where the market can switch, easily and with great flexibility, between food production and biomass production for energy purposes, based on actual market needs. This can also support the integration of agricultural land that is currently not economically viable into production, as well as rural job creation. The key objective of the National Energy Strategy is to enable Hungary to reduce its current energy dependence. The Renewable Energy Utilization Action Plan aims to promote the use of renewable energy sources in line with other national economic objectives (e.g. job creation, natural gas import substitution, increasing competitiveness). By recognizing the rapidly changing energy demand and supply, the Government adopted the new National Energy Strategy 2030, looking ahead to 2040, and the National Energy and Climate Plan documents at its meeting on 9 January 2020.

The measures in the focus areas 5B and 5C of the VP, which aim to increase energy efficiency and the use of the produced renewable energy, have positively influenced the achievement of the energy targets by achieving a 10 % improvement in specific energy efficiency. At the macroeconomic level, this contributes to reducing fossil dependence, increasing energy security, reducing vulnerability to external energy dependence, improving the external trade balance and the country's competitiveness.

The country's energy efficiency target is to have a final energy consumption by 2030 that does not exceed the 2005 level (785 PJ). Achieving the energy savings target set by the Energy Efficiency Directive is a major challenge in all areas. The energy efficiency programs and measures introduced in the period 2014-2020 will result in final energy savings of around 3-4 PJ per year for end-users.

Based on indicator T.15, the use of the 2023 target for energy efficiency investments in focus area 5B corresponds to a 7 percent use of resources by 31 December 2020. Based on the National Energy and Climate Plan, Hungary aims to increase the share of renewable energy in total electricity consumption to at least 20 percent by 2030. A key element of renewable energy production is the expansion of solar PV capacity, which should increase from 680 MW in 2016 to 6,500 MW in 2030 and to more than 10,000 MW by 2040. **The annual amount of energy saved through energy efficiency improvements implemented with VP support is 1 086.2 toe/year, converted to 12 630 333 kWh/year.**

In the VP, calls in focus area 5C and one ÚMVP item (VP-M8-Support for the regeneration of young forests, VP5-8.6.1-17-Investments in forestry technologies and processing and marketing of forest products and VP5-8.6.2-16-Actions to mobilize forest production potential) are primarily linked to renewable energy production targets. In addition to these calls which are primarily considered for this purpose, the beneficiaries of the calls related to focus area 5B have also committed to develop production capacities for renewable energy production, and these investments have been taken into account in the estimation. In the period 2014-2020 under review, the beneficiaries' investments in renewable energy production totaled 2 505 057 toe/year, or 29 128 798 kWh/year.

5.5. What further lessons can be learnt from the implementation of the measures related to these analyzed priority areas to improve future measures?

Other feedback from the evaluation, not presented above, included:

- Energy calculations: the involvement of an energy expert was necessary for most applicants. Most of the applicants were required to use the services of an energy consultant. The difficulty was not the involvement of an energy expert, but rather finding the right one.
- The different nature of the calls (cattle, pigs, plantations, etc.) created barriers to energy savings, as extensive livestock farmers have lower energy requirements than intensive farmers, and thus they were able to plan for energy savings at a more modest level.
- The questions on energy efficiency calculations were not clear and were difficult to follow. Stakeholders had to submit difficult and complex calculations and sometimes had problems with the conversion of units.
- Specific cases that can be used as lessons learned
    - The farmer was a member of a producer sales organization (TÉSZ), but during the implementation period the TÉSZ ceased to exist. The farmer received extra points for his application on the basis of his membership of the TÉSZ, but after the TÉSZ ceased to exist he could no longer prove his membership, so he lost points and the paying agency claimed a deduction of about 3 percent when making the payment.
    - It took 3 years between the submission of the application and its implementation. During this time, costs have increased and this has resulted in additional costs for the farmer. The beneficiary in many cases considered not to implement the application and withdraw the subsidy claim. In addition to the increase in costs, the emergence of newer technologies was also a barrier, but there was limited scope to change the procurement requirements.
    - In the case of investments in solar panels for renewable energy production, the problem was that the equipment could only be installed on the roof structure, and in the case of older buildings, there were structural obstacles.
- During the application period, the organization that launched the call for proposals changed, and beneficiaries did not always know who to contact. It took a very long time to get answers to their questions.
- It was difficult to keep track of the repeated changes to the call for proposals.
- Any questions about the application were answered by email within 1-2 days. Both personal/phone contact was missed.
- The ÉNGY is not consistent across the operational programs in place. There is a need for harmonization with respect to the relevant construction standards, however, e.g. the working time standard is completely irrelevant as it is not counted in the ÉNGY and therefore has no place in the call.
- It took time to find the right suppliers and contractors. During the implementation of the project, problems were focused primarily on contractors and subcontractors (late deadlines, inadequate professional work).
- The targets for energy efficiency and renewable energy production are mixed, where renewable energy is produced, energy savings cannot be accounted for, they must be treated separately.

- A lot of documentation was requested for the on-the-spot check. Because of Covid, photographic proof of implementation had to be sent in the first round, and later the on-the-spot check was carried out, where everything was requested in detail (general ledger extracts, payroll).

5.6. What proposals can be made to achieve more effectively the results expected by the CAP in the next period?

Based on the experience of the evaluation, the following recommendations have been made:

- Verification of energy savings

  With the involvement of the energy expert, the beneficiaries were able to successfully validate the savings and production, however, even though the calculations were carried out by a chamber member engineer, the validation process identified many results with significant errors. Based on the methodology presented in chapters 5.1.4 and 5.2.3, the results of the calculations are a good approximation of the values achieved.

- Improving data collection

  To define the result indicators (R.14, R.15), the beneficiaries were not asked to provide energy savings or renewable energy production rates in the form of precise data at the application or payment stage. To perform the estimation, after validating the data based on the data collection from beneficiaries carried out by the MÁK, an experimental sample was formed and assigned to the total population by weighting the total population based on the standard production values of the units. We then evaluated the energy efficiency and renewable energy production achieved by the operations. During the validation process, many inaccuracies were found, and most of the values provided in the data request could not be considered in the evaluation, which affected the results. However, this calculation and the energy validation of the KHM (EIM) allowed us to propose a methodology that could be applied well under the circumstances.

  The calculation of the indicator requires the development of a data request interface that filters out erroneous or incorrectly measured values at the time of application or monitoring. It is advisable to include in the business plan documentation, the energy consumption of the plant, and the projected energy savings of the newly obtainable equipment (at least in the form of a simple calculation).

- Simplification, reduction of administrative burden

  In the project selection process, the evaluators found that applicants often submitted insufficiently documented proposals, which resulted in frequent requests for missing documents, mainly due to the complexity of the documents to be submitted.

  There is a need to reduce direct invoicing and the administrative burden, e.g. 3 quotes for each purchase, is unnecessary, a flat rate or unit cost could be used to replace the need for quotes for smaller purchases. The non-compliance of producers with tendering conditions was sometimes due to institutional changes, e.g. the consequences of the dissolution of the TÉSZ and the withdrawal of aid payments affected producers adversely.

- Shortening the assessment period

  For most investment aid for energy efficiency improvements, the first round of applications was assessed after one year. For later submission periods, the time for assessment was shortened. The experts identified a change in the institutional system as the reason behind the reduction in the time taken to assess. There is a need to simplify and speed up the application process to avoid a significant increase in investment costs.

- Differentiation of expected energy savings

  The extent to which energy efficiency performance can be certified varies based on the type of the unit, and the 10 percent energy savings required in the application can be achieved with different levels of efficiency, in terms of the amount of energy saved and the energy produced.

- Introduction of new schemes

  Renewable energy production has been popular among beneficiaries and further support for this type of activity is recommended, and the experience of the current and previous rural development programs shows that the purchase of solar installations is more common. The installation of biomass heating systems and biogas production equipment was not common.

  To design the measures, it is recommended to develop dedicated, well-planned application schemes that users can adapt to their own capacities and forms of activity, e.g. by setting specific amounts of support, following the example of the GINOP, which is working well in Hungary.

- Information and advice

  In general, the technical support worked well. Information to clients was provided through the portal questions available on the MÁK website and through the information leaflets on palyazat.gov.hu. The national roadshow was organized with experts from the technical departments of the MÁK, IH and NAK, and during the events, beneficiaries were able to ask questions related to accounting. However, beneficiaries complained about the lack of direct contact in person and/or by telephone that was available in the previous programming period. More information sessions on calls for proposals are needed, where questions can be asked in person (or even online due to Covid). Beneficiaries also expect more information from the village managers.

- Coherence between the VP and other national energy programs

  The objectives set out in the VP must be consistent with the objectives set out in the country's other strategies and operational programs. Based on the draft 2021 Partnership Agreement for the period 2021-2027, energy improvements (energy efficiency, renewable energy sources) for operational programs follow the following delimitation:

  - KEHOP Plus: In the field of energy efficiency building renovation, the beneficiaries can be businesses, residents, non-municipal public buildings, small business sites. Renewable energy is relevant for the above beneficiaries and solar parks.
  - TOP Plus: In both energy efficiency and renewable energy, buildings owned by the municipality or majority-owned by the municipality are eligible.
  - GINOP Plus: In the case of business development, GINOP Plus supports technological improvements in small businesses, but only if the project is less than 50% of the value of the project, i.e. not primarily energy-related.

The above-mentioned programs underline that intervention in the food and agri-food sector can only be coordinated with rural development, biomass-based economic objectives, and agricultural subsidies to avoid mutually reinforcing processes. It is necessary to introduce a support for technological developments in small businesses that enable them to operate in an environment-friendly way and via environment-awareness and encourage the development and implementation of sustainable product policies. Support for business infrastructure in the rural economy, complementing agri-rural development support, e.g. municipal infrastructure and services related to agri-rural development activities (e.g. infrastructure and equipment for municipalities' public catering functions), majority-owned municipal agri-logistics infrastructure related to local market organization, local product production, activities facilitating the regional market access of agricultural products (so-called "post harvest manipulation" activities, e.g. storage, cooling, sorting, washing, packaging).

6. SUMMARY OF PROPOSALS

Findings	Conclusions	Proposals
The beneficiaries have been introduced to the possibilities of implementing energy efficiency at project level in the current program. In the case of the ÚMVP, farmers could also strive for cost reduction and the associated energy savings, but the program did not provide specific funding for energy efficiency.	VP has contributed to improving energy efficiency, but due to the start-up nature of the program, the savings achieved are small.	Encouraging more efficient use of energy will meet national objectives of energy security and reducing energy dependence, the Rural Development Program should therefore strengthen support for related activities of farmers and processors.
The measures have contributed to the achievement of energy efficiency and renewable energy production targets and the transition to carbon neutral agriculture.	Although the uptake of resources is low so far (22% commitment level), there is still potential to support farm activities in this area, thereby increasing the contribution to national targets.	The experience gained during the programming period will be helpful in further improvement of the take-up of the results of the activities.
The objectives of energy efficiency and renewable energy production are blended.	Where renewable energy is produced, the amount produced cannot be accounted for as energy savings, these activities should be treated separately. Due to the nature of the technology, it is more popular to use renewable energy production processes than energy efficiency improvements.	By further strengthening our approach to energy efficiency, we can move closer to meeting our climate and energy targets.
For most of the investment aid for energy efficiency improvements, the first round of applications was assessed after one year. For the later submission periods, the time for evaluation was reduced to 3-4 months.	The investment nature of the aid has led to a significant increase in costs over the period covered by the evaluation.	Shorter evaluation times and more operational administrative processes can improve the attractiveness of applicants and the delivery of activities related to the objectives.
The applicants vary in size, scope of activity, technological background and energy saving potential.	The 10 percent energy savings expected in the tender can be achieved with varying degrees of efficiency between holdings, in terms of the amount of energy saved in the tender and the energy produced.	In designing measures, dedicated, well-planned funding schemes should be introduced so users can adapt these to their own capacities and forms of activity, e.g. by setting specific amounts of funding, along the lines of the GINOP, which works well in the domestic context.

Findings	Conclusions	Proposals
The most popular renewable energy generation technology is the purchase of solar PV installations. The installation of biomass heating systems and biogas production equipment was not a common technology.	Candidates prefer technologies that are easy to install and adapt ("out of the box") and do not interfere with day-to-day activities.	In line with the objectives of the energy strategy and the circular economy, there is a need to further strengthen technologies for the use of by-products of production (biogas, biomass) by introducing new measures.
National targets for energy savings and renewable energy production are a real challenge to achieve energy security and reduce energy dependence.	In the food and agriculture sector, the objectives of the Rural Development Programme should be coherent with other operational support policy instruments in order to avoid any contradictory developments.	Achieving energy efficiency and renewable energy production targets requires coordination between the activities of the Rural Development Programme and other national energy management programmes, highlighting good practices that have been proven to work well in the domestic context.
With the involvement of the energy expert, the beneficiaries were able to successfully certify the energy savings and energy production, but the data were incorrect in form and content.	The demonstration of energy savings meets the requirements of the call, however, during the validation process, many false results were identified.	By simplifying the calculation, providing the typical energy consumption and production capacities of the installations and designing a data collection interface that verifies the data at the time of recording, inaccurate values can be avoided and thus be made suitable for monitoring and planning support.
Many inaccuracies were found in the validation of the additional data collection to estimate the values of indicators R.14 and R.15.	Some of the values provided in the data request are not suitable for measuring indicator values.	The calculation of the indicator requires the development of a data request interface that filters out false or incorrectly measured values at the time of application or monitoring. It would be advisable to include in the business plan documentation the energy consumption of the plant and the projected energy savings of the equipment to be invested in (at least in the form of a simple calculation).
Calls for applications are complex and change frequently, and the transformation of the institutional system makes it difficult to meet the criteria for the application process .	In the project selection process, the evaluators found that applicants often submitted insufficiently documented proposals, with frequent requests for missing information.	Simplifying the application documentation and reducing the administrative burden will improve the implementation of energy efficiency and renewable energy production activities.

Findings	Conclusions	Proposals
Technical and administrative issues often arise during implementation.	Beneficiaries missed the possibility of direct contact.	Further channels for information and advice need to be developed. Providing the possibility to contact directly (e.g. by telephone) will improve the flow of information and help to answer applicants' questions quickly, thus reducing the number of incomplete applications.

ANNEXES

Annex 1: Purpose and aspects of quality assurance, its tasks and its integration in the evaluation process (2020)

The aim of quality assurance is to ensure that the documents involved in quality assurance

- meet the quality requirements specified in the quality assurance terms of reference,
- contain findings adequately supported by facts and methodology.

Quality assurance is an integral part of the evaluation work, in which *all colleagues* involved in the evaluation are involved, are familiar with the quality criteria developed and aim to apply them in their work. The formal requirements are met by the evaluators.

The *Quality Assurer is responsible for* the uniform examination of the quality aspects in the documents involved in quality assurance: during the planning of the evaluation, he/she gives an opinion on the first reading of the draft Inception Report, and then gives a written opinion and textual proposal on the first reading of the Final Evaluation Report (FER). The *Quality Assurer* will check in the draft Final Evaluation Report that the methodology and approach of the evaluations are in line with the guidelines and rules published by the European Commission, international and national evaluation standards and international best practice. The evaluator consults with the *Quality Assurer* on the issues raised and revises the Final Evaluation Report on the basis of the *Quality Assurer* 's comments.

The quality aspects considered by the quality assurer in the draft Final Evaluation Report:

1. The evaluation fully answers the questions set out in the adopted Inception Report.
2. The evaluation questions are relevant, testable and cover at least the following:
    a. a statement of the results, net impact of the Rural Development Program
    b. evaluation of the LEADER contribution (where relevant)
    c. interim changes in the policy environment
    d. synergies with other operational programmes
    e. production of impact and additional outcome indicators
    f. examining historical data to support the design of the CAP Strategy and the production of indicators (e.g. 14-20 runs, unit costs)
    g. proposals to further develop the call and selection criteria in order to improve the effectiveness and the performance of the indicators
    h. the Rural Development Programme 's contribution to national and EU strategic objectives and the demonstration of expected and unanticipated economic, social, environmental/sustainability impacts
3. The findings are supported by the facts presented in the evaluation, which are convincing to a reader who is not necessarily familiar with the specific field
4. Professional management of the data sources used, the methodology applied
5. Coherence of findings, conclusions and proposals
6. The proposals are well developed and practical
7. The report is professional, understandable and clear

A quality assurance statement on the Final Evaluation Report, taking into account the comments of the *Quality Assurer* is published by the evaluator on the page following the cover page of the evaluation.

Annex 2: Detailed test methodology (2020)

Data mining methods

Data mining methods were used to describe the characteristics of the activities undertaken by the beneficiary holdings. Data mining aims at extracting latent information from imperfectly structured databases (Mészáros-Sebők, 2018). As part of data mining, text mining is a field of computer science dealing with the processing and analysis of electronic textual documents, in which qualitative content can be analysed quantitatively (Tikk, 2007).

The databases available for the evaluation of the Rural Development Programme include financial data on applicants, the amounts of funding awarded in the deed, the focus areas of the activities, payment claims, payments made and other relevant data. However, most of the documents submitted in the application process are available in text format, e.g. business plans, construction items, technical data, etc.

The evaluation assessed the activities related to energy efficiency (indicator CMEF R.14) and renewable energy production (indicator CMEF 15) according to the following protocol:

As a first step, we have identified which of the farms included in the "construction" and "technical" tables have already received aid for the activities undertaken by the end of 2020 and have already made payments, or join the targets set for focus areas 5B (Increasing energy efficiency in agriculture and food processing) and 5C (Facilitating the transfer and use of renewable energy sources, by-products, waste, residues and other non-food raw materials for bioeconomy purposes).

In the second step, we looked at the most frequently occurring terms and pairs of terms. The available textual data have been analysed according to a stopword list created in the Pyton programming.

In text mining, we look at the text as data, so we can characterise each document by the frequency of words and phrases it contains. The preparation of texts for analysis consists of at least three steps: stopword elimination, tokenisation and conjugation removal.

In the first part of the text analysis, the incoming data was sorted by setting the data type of the empty fields, which are taken from the single database based on the text data. To determine the word frequencies, we used the stopwords of the Python programming language in Hungarian, a list of filler words whose frequency is both irrelevant and, due to the structure of the Hungarian language, frequently appear in the textual responses of the business plans.

We combined all the text responses into a single list, and then tokenised the resulting string, which means that we removed punctuation and broke it down into words and phrases.

The next step is stemming, which is the removal of conjugation, unfortunately the Python language is not the most perfect at this, it cannot distinguish typical Hungarian conjugations from words that end with the characters of the given conjugation, sign or suffix

For the most common word sets (descriptions of technical and construction data in the business plan), we used tokenised text to count the number of occurrences and the number of beneficiaries who wrote them.

The word cloud was created by putting the tokens into a single large list, separated by spaces, and then removing the stopwords to display the most common words or two-word phrases in order of their frequency of occurrence.

The most frequently occurring terms have been grouped into multi-criteria categories according to the nature of the activities carried out and paid for by 31 December 2020: (1) construction of a new building, (2) energy modernisation of a building, (3) acquisition of new technology, (4) modernisation of existing technology, (5) production of renewable energy.

Finally, we examined the energy efficiency characteristics of the improvements made by the beneficiaries for each type of activity, broken down by type of investment.

Qualitative methods of analysis are also needed to answer the evaluation questions and to examine the criteria to be applied in the evaluation.

Annex 3: Detailed Methodology (2021) – Environmental Impact Monitoring Energy Validation 2021

Expert validation carried out in the context of the environmental impact monitoring assessment

The validation has been carried out along the following steps for the annual energy savings (**CMEF R.14 INDICATOR**) that can be achieved with the investment implemented

1. As a first step, the beneficiary data is requested from the MÁK (Paying gency) with the assistance of the IH (Managing Authority).

2. The data reported by the beneficiaries should be examined to determine which values are considered to be different in relation to the nature of the beneficiary or the size of the project, or which values contribute significantly to the overall savings. These beneficiary data should be subject to validation.

3. The validation covers two groups of projects. Those for which no correlation between the type of beneficiary, the size of the project and the level of savings can be observed, and those for which the value of the overall energy savings is significant.

4. Validation starts with the review of the documentation submitted by the beneficiary with the aid application and the payment claim. The first step is to identify the relevant documents:

- The document submitted in support of the energy performance commitment: in some cases, this will include an appropriate calculation, which will allow an expert to verify the technical background of the reported value, based on the invoices. In the majority of cases, however, these documents only demonstrate what was requested in the call for project selection criteria, i.e. that the energy savings will be at least 10 %.
- Supporting document for the report on energy efficiency at the end of the project: the beneficiary's data submission required the submission of a supporting document signed by a professional engineer or by the contractor, who is a member of the Chamber of Engineers, supporting the reported value with a calculation. This will allow an expert to verify the adequacy of the reported value on the basis of the invoices.
- The energy certificate submitted by the beneficiary. If the beneficiary has renovated a building, it had to submit an energy performance certificate for the state of the building after renovation. The energy performance certificate classifies the buildings according to their energy consumption and contains a description of the building technology. It may contain information that will help a professional to validate the reported energy saving data. However, the energy performance certificate itself cannot be used to produce an energy saving value.
- Invoices and their annexes submitted by the beneficiary with the payment claim: select those that relate to the energy investment. With the appropriate expertise, the energy equipment can be identified. This can help to estimate energy savings based on the manufacturer's data available on the equipment. This also requires knowledge of the technology being replaced. If this is not included in any of the documents submitted by the beneficiary, this should be requested from the beneficiary.

5. As part of the validation process, it may be necessary to contact the beneficiary by telephone. Given that the beneficiary is unlikely to be technically proficient, this should be a brief discussion of simple clarification questions.

6. Based on the information collected, the expert determines whether the magnitude of the energy

saving is consistent with the reported value. If not, either an estimate of the amount of energy saving is made (if the data allow) or the project is removed from the sample.

7. The energy saving per thousand HUF subsidy are determined on the basis of the sample or values corrected during the validation. Multiplying this unit value by the subsidy value gives the value of the energy saving that can be reported for the period.

For the annual renewable energy produced by the investment (CMEF R.15 indicator), the validation steps and methodology are basically the same as for the annual energy savings by the investment, with the following differences:

- In the case of renewable energy capacity, there is no need to know the technical history, as it is new capacity. Therefore, in this case, it is only necessary to contact beneficiaries by telephone if the documents do not allow to establish the amount of capacity created.
- The energy certificate is not relevant in this case.
- The renewable energy generation capacity created is highly concentrated.

Although the selected projects, and thus the data and analyses derived from them, are not representative, the expert validation provides a reasonably accurate approximation of the value of the indicators to be defined based on the available data.

Annex 4: Detailed Methodology (2023) - Energy validation of the Environmental Impact Monitoring 2023

FIRST PHASE: DATABASE PREPARATION, TECHNOLOGY IDENTIFICATION

Query based on the scope of validation

The basis of the population used for the analysis required to complete the Rural Development Program energy assessment was **the database received from the Paying Agency on 15.06.2023.**

In this there are **projects from focus areas 5B and 6A with renewable energy activities and costs supported or under commitment,** where **only the investment items have been** left in the cost categories, the other items (general, project management, publicity, technical, etc.) have been removed.

With this filtering, from the original 56,002 rows, **5,307 rows** were available for analysis (see the attached Excel "Base table" tab, filters under hidden columns), from which **4,719 rows** contain validated energy data, after subtracting and merging the "irrelevant" and "accessory" items (see 2.1.2.).

Identifying renewable energy production technology

The second step of the first stage of the analysis was to **identify the renewable energy technology** supported by the investments under review. This step was necessary in order to provide robust, calculated estimates of capacity based on the parameters specific to the technology in question- where the database did not contain a field-level or even textual value.
To define the "Defining technology" (column M) and the "Secondary technology" (column N) used for the analysis, the following steps were taken:

1. Additional columns have been created based on columns K (Description - expenditure item) and L (Net expenditure - based on approved items (HUF)). In column M, we included the renewable energy technology used by the project (investment), where available, based on column K, for a total of ten categories: of these, **six real analysis categories were defined: biogas, biomass, geothermal, heat pump, solar panel and solar collector**, and **four additional categories were created: geothermal accessory, heat pump accessory, renewable energy, not relevant.** For several claims, an investment was broken down into items (e.g.: labour, cable, solar inverter, etc.), where for those items that were not related to a capacity value (but were part of the investment), we wrote one of the accessory technologies. For the geothermal and heat pump categories, we have created a subcategory called **"geothermal accessories" and "heat pump accessories".** These categories were created for those additional technologies that were clearly linked to geothermal or heat pump technology (e.g. buffer tank, thermal well, recovery well). The category **"renewable energy"** was used for cases where it was not possible to clearly identify which technology was involved. The category **"not relevant"** was created because the opening of the second analysis phase has led to the inclusion of a number of non-renewable energy development lines (but also their additional costs or completely unrelated items).

2. In cases where the investment had more than one technology identified in column K (expenditure item) and included solar (e.g. solar and heat pump), but the figures could not be separated, **solar was identified as the dominant technology**. Where a capacity value was given for at least one of the two technologies indicated, we were able to estimate the other capacity value. In these cases, the

secondary technology (N) column also includes a technology and a capacity value is estimated for each technology. Each technology is indicated on the same row but in a separate column (M and N).

3. In the first stage of analysis, in a small number of cases, which were negligible compared to the number of cases, column K contained the term "renewable energy system" or a similarly generic term. For these investments, the category "renewable energy" was temporarily entered in the technology field. Investments with this generic designation were split into two groups. In cases where a more detailed description of the item suggested that it included solar or partially solar (e.g. electricity generation, power generation, electricity demand response), we moved them from the "renewable energy" category to the "solar" category. This is also advantageous from the point of view that multiple and explicitly accurate capacity estimates can be applied to solar PV, even if only based on the cost value of the solar PV system. On the other hand, we selected those non-identifying, large-scale renewable energy development items with a net investment amount **above HUF 50,000,000 (5 items in total) and specifically for these we launched a more in-depth data request (from the PA).**

4. **All of the** solar **lights, electric fences and other insular investments of negligible size (capacity and energy production) are classified as solar PV technology**, as they are all solar PV, with the energy produced being used locally to power the device, typically with the addition of a battery to provide a balancing function. They therefore invariably generate electricity using a small-scale solar system.

5. In many cases, the beneficiaries had dissected the content of the investment to such an extent that certain lines were not directly related to renewable energy development (but to construction works, equipment, components not directly related to renewable development). **These lines were classified as 'not relevant', even if they were not clearly interpretable as a need**.

6. For the geothermal and heat pump categories, we have created two subcategories: **geothermal accessories, heat pump accessories**. These categories have been created for items clearly related to geothermal or heat pump technology (e.g. buffer tank). If, for example, a buffer tank was found, we searched to see if there was a technology to which it could be linked based on the same claim ID, and if there was, we added the net expenditure amount (column L) for the buffer tank to the net expenditure amount for the related technology and deleted the net amount next to the buffer tank and entered buffer in the secondary technology (N) column. If the buffer tank was not linked to any technology by claim ID, it was also checked by client ID and if no link was found, it was ignored and classified as not relevant. This method ensured that there was no duplication in either amount or number of items between the sums of the improvements that were related on separate rows and that these two values remained related.

For the analysis, the "Defining Technology" (column M) classification was used, so **all capacity and energy produced were classified as "Defining Technology" (**column **M),** regardless of the "Secondary Technology" (column N), which captures the additional technology.

SECOND PHASE: CALCULATION OF INCREASING ENERGY PRODUCTION CAPACITIES (kW)

The aim of the analysis is to estimate the installed nominal renewable energy production capacities (kW, kWp, kVA) and through this, in stage 3, the generated heat and electricity (R.15, kWh).

In the Excel file, which contains the database and the analysis, all columns with energy relevance in the original table received from the Paying Agency are listed in the "Basic table" tab. The not relevant items along the filter criteria have been hidden.

Among the elements of the population under consideration:

1. in some cases, the capacity (kW) value is contained in the Paying Agency export (column K),
2. in other cases, the capacity (kW) value **could be estimated** from the investment value (column L), and
3. there are some where no energy data were available at all in this query, so **we had to request additional data** from the Paying Agency.

In the following, the method and process of estimating capacities per technology is presented.

Solar panel

The solar rows were grouped into several categories based on the data content available:

1. In the first group (column N - Capacity), those rows were included for which the **capacity of the solar panel(s) could be read from column K** (e.g. 11 kWp, 49 kW, 60 kVA). In all cases, these were already shown in the table as a uniform kW value.

2. In cases where column K did not contain a clear capacity value for the investment, but column K contained the **capacity and number of panels, the** capacity value of the total solar PV system was **calculated** (and not estimated) by **multiplying these values.**

3. Where **only the number of solar panels** was given, but not the capacity, we used **an average panel capacity (370 kWp/panel)** and estimated the system capacity.

4. For items that cannot be classified in the above groups but have an investment amount, **we estimated on the basis of the investment amount**. In these cases, the power was calculated by dividing the investment amount in column L by a coefficient (based on the market for the period and the eligibility criteria of GINOP Priority 4) **of HUF 300,000/kWp**. By cross-checking the coefficient against the existing values (i.e. estimated vs. given where the capacity value was in the database), we can state that the coefficient value differs on average only by a few percent from the real values. It should be noted that the accuracy of the estimate weakens as the size of the system increases, as the share of unit costs in the total investment cost becomes higher and quantity discounts become more prevalent. Thus, for a large system, the coefficient typically infers a slightly lower capacity - but this is acceptable in order to maintain the principle of conservative estimation used in the analysis.

5. For those rows where the **renewable energy** category was used (because it was not possible to clearly identify which technology), solar capacity was calculated based on the estimate in the previous section.

Identifiable capacity values for additional technologies

For the majority of the non-solar rows, only the technology was entered in column M, but in some cases the **non-solar rows also had a capacity (kW value) in column K, so the name of these technologies was entered in column N of the table and the corresponding capacity value in the corresponding capacity column**, which gave the capacity value needed to estimate the indicator R.15 indicator for the given investment.

Interval treatment of biomass and heat pumps

In the case of biomass boilers and heat pumps, the description in the database did not give an exact value (e.g. 100 kW), but an interval (e.g. 100-250 kW). In these cases, **an average was calculated to provide a conservative estimate**, as this ensures that both the volume and the unit cost are averaged. This also halves the maximum associated margin of error.

Estimating the capacity of solar collectors and heat pumps

Based on the database of solar and heat pump projects with identifiable capacities, and supplemented by literature research, specific values were determined, based on which the capacity value was estimated for both technologies using a proxy based on the investment cost.

This estimation method was chosen because of its ease of use and communication, also taking into account that the whole manifold would be more distorted if these items had 0 capacity (and thus 0 R.15) than if a technically sound estimation based on "only" proportionalization was performed.

Biogas capacity estimation

Each biogas project is usually unique. There were 7 projects in the data table, a new installation and 6 auxiliary developments of operating biogas plants. The project documentation of the largest on of these 7 projects, the one that accounts for more than two-thirds of the total RDP biogas expenditure, the new installation project, was made available for the evaluators by the HST (paying agency). Based on the net expenditure and capacity data in this documentation, revelant data for the remaining 6 development projects was estimated together, using their net expenditure data and project title. The aggregate result of the estimation for these 6 projects was validated by the sectoral partner participating at the RDP Monitoring Committee.

Categories of geothermal accessories and heat pump accessories

No capacity value was calculated for items classified as geothermal and heat pump accessories. Expenditure items in the supplies categories were added to the lines that served as supplies. Thus, the capacity value does not change and the investment amount is allocated to the corresponding investment.

Not relevant category

No capacity value was calculated for the items in the non-relevant category, as they did not contain values to be taken into account for the analysis on the basis of the available information.

Further clarification of energy capacities with additional data request

In the first stage, we could not calculate or estimate a capacity (kW) value from the manifold in 294 cases. The vast majority of the capacity values for the projects in the database (87% on a per unit basis and 83% on a per forint basis for the first stage population) could still be calculated or estimated. This in itself is an outstanding proportion, especially compared to the small samples of historical validation and evaluations, but it was precisely for the highest value projects that information was not available.

Our suggestion was to request more detailed documentation from the Paying Agency for the 294 items in question, which amounted to 29 items in total, for those above HUF 50,000,000. In addition, we also required further data on the 5 items above HUF 50,000,000, which were temporarily and for lack of information classified as "renewable energy", and from which we expected further clarification of the estimation.

Our methodological proposal above was supported by the Ministry of Agriculture and external energy experts. **Thus, detailed business plan data for a total of 34 (29+5) projects were requested from the Paying Agency. The** new information received allowed to identify or estimate the capacity value in 24 out of 34 cases. In the

remaining 10 cases, the complete scanned project documentation was requested from the Paying Agency and the estimate was based on the information obtained manually and therefore through time-consuming text mining. As a result of this process, we were able to estimate all the items in question above HUF 50,000,000.

Among the remaining projects with no capacity value below HUF 50,000,000 (from the 294 items), only solar and heat pump projects remained at this point. **Specific values were determined on the basis of individually estimated solar collector and heat pump projects** in the large number of projects additionally requested from the Paying Agency, **supplemented by a literature search.** Accordingly, for these approximately 250 items (less than 5 percent of the population on a per item basis and less than 3 percent on a per subsidy basis), the estimation error is likely to be larger, but insignificant for the overall population.

As a result of the analysis, the database created contains calculated or estimated energy capacity data for all Rural Development Programme projects under focus areas 5B and 6A supported for renewable energy development.

THIRD PHASE: ESTIMATION OF AMOUNT OF RENEWABLE ENERGY PRODUCED (R.15, kWh)

The nominal installed renewable energy generation capacity values, segmented by technology, were the basis for estimating the amount of renewable energy generated by these capacities during the period of the Rural Development Program, also segmented by technology.

The output of renewable energy installations varies throughout the year, or produces different amounts of energy in successive years. However, based on many years of experience, a good approximation of the annual energy value can be estimated from the installed capacity. The following factors were used for the estimation:

- The **utilisation factor** is a percentage value that shows how the energy actually produced compares to the energy of one year's continuous operation at rated capacity, i.e. what percentage of that energy.
- The most important **peak hour number** for estimation is the **number of hours in which the energy produced in a year would have been produced if the equipment had been operating at rated capacity.** Multiplying this number of hours by the rated capacity gives the annual energy produced.

Although the six technology categories considered may include technology subcategories and differences, this method is internationally accepted.
On this basis, the calculation and estimation methodology for each technology was as follows:

Biogas

Biogas systems are usually designed for continuous electrical operation. As a guide, we can expect **7,500 peak hours of use** per year.

The figures for one specific project supported also validate this value:

- 100 kW installed electrical power
- The heat generated is used to maintain the process plant and is therefore not relevant for project accounting
- The daily gas output of the digester reaches 1390m .^{3}
- 52-56 volume percent methane content calorific value 17.6-19 MJ/m^3.
- (the average calorific value of gas containing 50-65 volume percent methane is 17.2-22.4 MJ/m^3.)
- mechanical (nearly electrical) efficiency 30 percent

Efficiency	m3/day	MJ/m3	days/year	kWh/MJ	annual kWh
0.3	1,300	19	365	3.6	751,292

kW	peak hours	annual kWh
100	7,500	750,000

Biomass

There were several supported biomass projects in the data set, with the purposes of heating and grain drying. There is a significant difference in biomass projects aiming at building and water heating purposes and technology heat for grain drying, primarily in seasonality, refelecting in the number of hours they operate at full capacity. Having discussed and agreed on with the sectoral partner participating at the RDP Momnitoring Committee, and with the support of the Ministry of Agriculture, the originally planned, conservative, 750 hours / year coefficient (an assumption well matching mostly grain drying capacities) was increased to 1,500 hours / year, to better cover building heating purpose projects in the data set.

Geothermal

The renewable heat extracted and harnessed from geothermal wells is well measurable and quantifiable. It can be assumed that, for reasons of economic rationality, the technical solutions adopted use only the necessary quantities of thermal water. Accordingly, geothermal water use is well below the theoretical potential.

A typical domestic thermal well has a utilisation heat pipe of 80-50 °C, i.e. 30 °C, where a heat output of about 1 MW can be achieved at 500 l/min. It is advisable to approach the amount of heat produced from the use side. It is also possible to start from the amount of natural gas extracted.

Feed mixing and heat treatment technology is almost continuous throughout the year, but is typically concentrated mostly on working days. Drying is not necessary in all seasons, although heat treatment is. Therefore, we assume four times the crop drying, **3000 hours/year of peak geothermal hours.**

Heat pump

Most heat pumps use electricity to transfer heat energy from a colder place to a warmer place. This can be used for cooling and heating. For heating, the electrical power input is added to the heating output. An average heat pump can heat 3-3.5 times the electricity input (SCOP, SPF > 3-3.5) in a year of operation. This means that it takes 2-2.5 times the amount of electricity from the environment, which is considered as clean renewable energy. However, international and national practice is to count all heating energy (3-3.5) as renewable, so this is what we have used.

The heat pump therefore has a $_{\text{Pvillamos}}$ power input and a $P_{\text{fűtő}}$ and $P_{\text{hűtő}}$ power output. The $P_{\text{fűtő}}$ is usually given.

An average household is heated by a 27 kW gas boiler and consumes about 1000 m^3 of gas a year (9,500 kWh). This amount of heat can be provided by a 15 kW heat pump.

Accordingly, for an average heat pump, we can calculate **650 peak heat pump hours** per heat output

Solar panel

In the case of solar panels, at the latitude and climate of Hungary, 1,100 – 1,250 hours/year are usually expected. In our estimate we used **1,200 peak hours.**

Solar collector

For similar physical reasons as solar panels, the amount of heat energy that can be extracted per year can be well estimated for solar collectors. However, the actual use is rather seasonal and therefore the actual is usually far below the annual maximum energy.

Instead of the maximum energy (which, after testing and typing the technology in use, is estimated to be 5 kWh/panel/day), we have conservatively calculated a value of 4 kWh/panel/day, i.e. **1460 kWh/panel/year, taking into account the** sizing, weathering and usage conditions and demands of the ideal.

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Annex 6: Renewable energy technologies in agriculture

Geothermal heat production

Hungary has an outstanding geothermal potential, which is why there are many thermal baths in certain regions. There are several geothermal district heating plants in the country and a geothermal power plant in Tura (50 km from Budapest).

It is important to distinguish between geothermal-based electricity generation (which has a lower potential in Hungary) and geothermal heat generation for heating purposes (thermal water), in which Hungary is very rich.

The geothermal heating system uses hot thermal water extracted from the deep aquifer to provide heat to connected consumers. The thermal water is drawn up from the aquifer through a well (1500-3000 m deep) and is then transported through a pressurised, sealed pipeline to the heat centre, where it transfers heat to the heating system. After the heat recovery, the cooled thermal water is returned to the same thermal water reservoir through a pressurised pipeline via a return well to reheat it and ensure the long-term sustainability and circulation of the system. The main elements of the geothermal system are the production and recovery wells, the pipes connecting the wells and the thermal centre. Several other pieces of equipment (pumps, degassers, filters, heat exchangers, etc.) help the system to operate.

Geothermal energy is best extracted in the south and east of the country. Geological investigation is needed to determine whether geothermal heat is available on site. In almost all cases, deep geothermal waters are chemically aggressive, destroying surface aquatic life. From an environmental and water resource management point of view, the electrification of large quantities of extracted thermal water back to the extraction well (typically within a few hundred metres) is of fundamental interest.

In the south-east of our country, thermal waters of different temperatures are available at depths of 1000-1300 m. It should be emphasised that this is not the same as heating water injected from outside (e.g. dry-rock technology used in geothermal power plants), and that it is not practical to generate electricity from the thermal energy of thermal waters because of their 'low' temperature. A further possibility, which is still rarely used in Hungary, is to use the gas present in large quantities in dissolved form in the thermal water (e.g. methane in the case of the Fábiánsebestyén project) to operate a gas-engine electricity generating unit after 'gasification' of the water.

In Szentes and its surroundings there are 32 thermal wells.

The thermal water obtained from these is used for heating

- apartments
- public buildings
- industrial buildings
- greenhouse and foil tent
- turkey coop, hatchery
- grain dryer
- thermal bath.

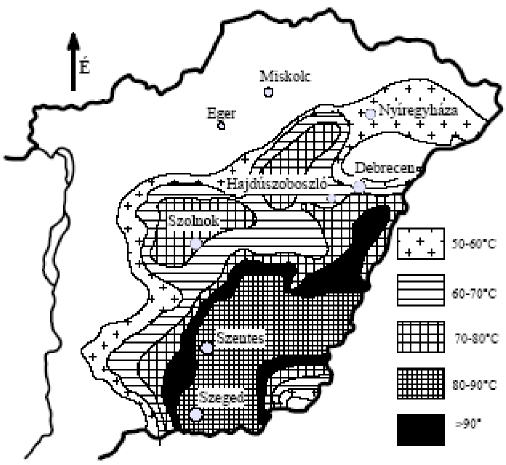


Figure 14: Temperature of domestic thermal waters[5]

Heat pump

[5] Kozák M.: The possibility of exploiting geothermal potential

A heat pump is a device that raises low-temperature heat sources that are not suitable for direct heat supply to a higher temperature suitable for heat recovery by investing a relatively small amount (10-25%) of external energy.

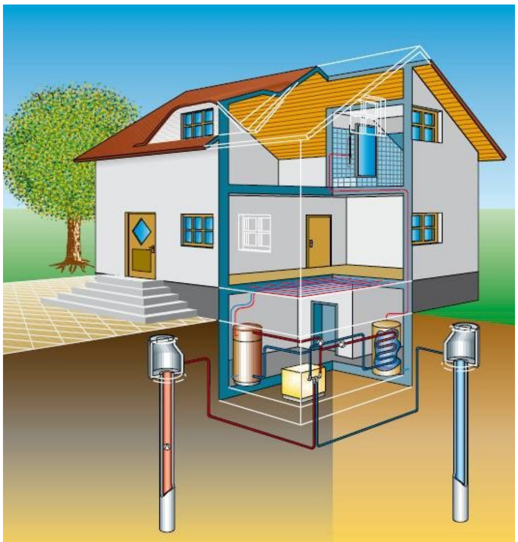
Heat pumps use electricity to move thermal energy in the opposite direction to spontaneous heat transfer, by transferring heat from a cold space to a warmer medium (e.g. 10 °C swimming pool water flow -> 40 °C underfloor heating). The heat source causes the working fluid to evaporate in the evaporator (low boiling point liquid), i.e. to absorb the heat, and then a compressor compresses the working fluid to a higher pressure (simultaneously increasing its temperature) than the ambient. The vaporous medium entering the condenser then condenses and releases the absorbed heat. The working fluid flows through an insulated pipeline between the evaporator and the condenser, avoiding significant heat loss during the process. By reversing the connections, the heat pump can also serve the cooling demand in summer (depending on whether the condenser or evaporator side is used).

The efficiency of a heat pump is expressed by the COP (Coefficient of Performance), which is the ratio of the heat power and electricity consumed by the heat pump. For cooling, the EER (Energy Efficiency Ratio) is used. In annual terms, the SPF - Seasonal Performance Factor is used to describe the machine. Most of the energy required for heating comes from the external environment and only a fraction comes from electricity (or other mechanical energy sources).

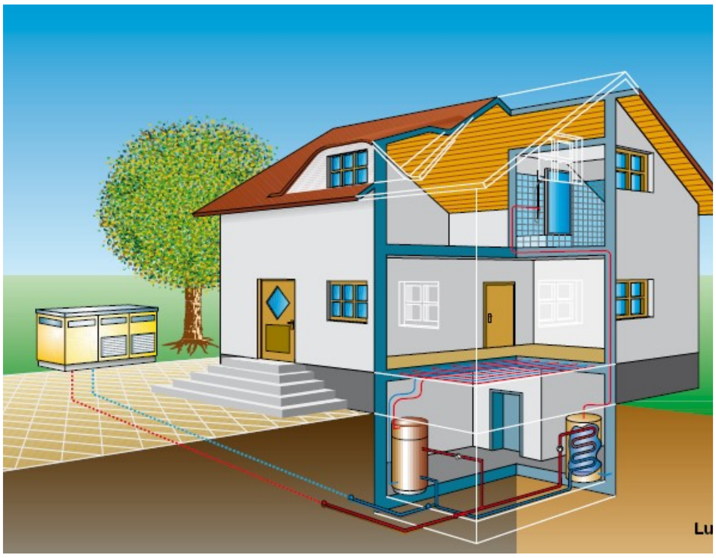
The advantage of heat pump systems is that they can be installed for both heating and cooling.

There are three different types of heat pumps in terms of the heat transfer medium:

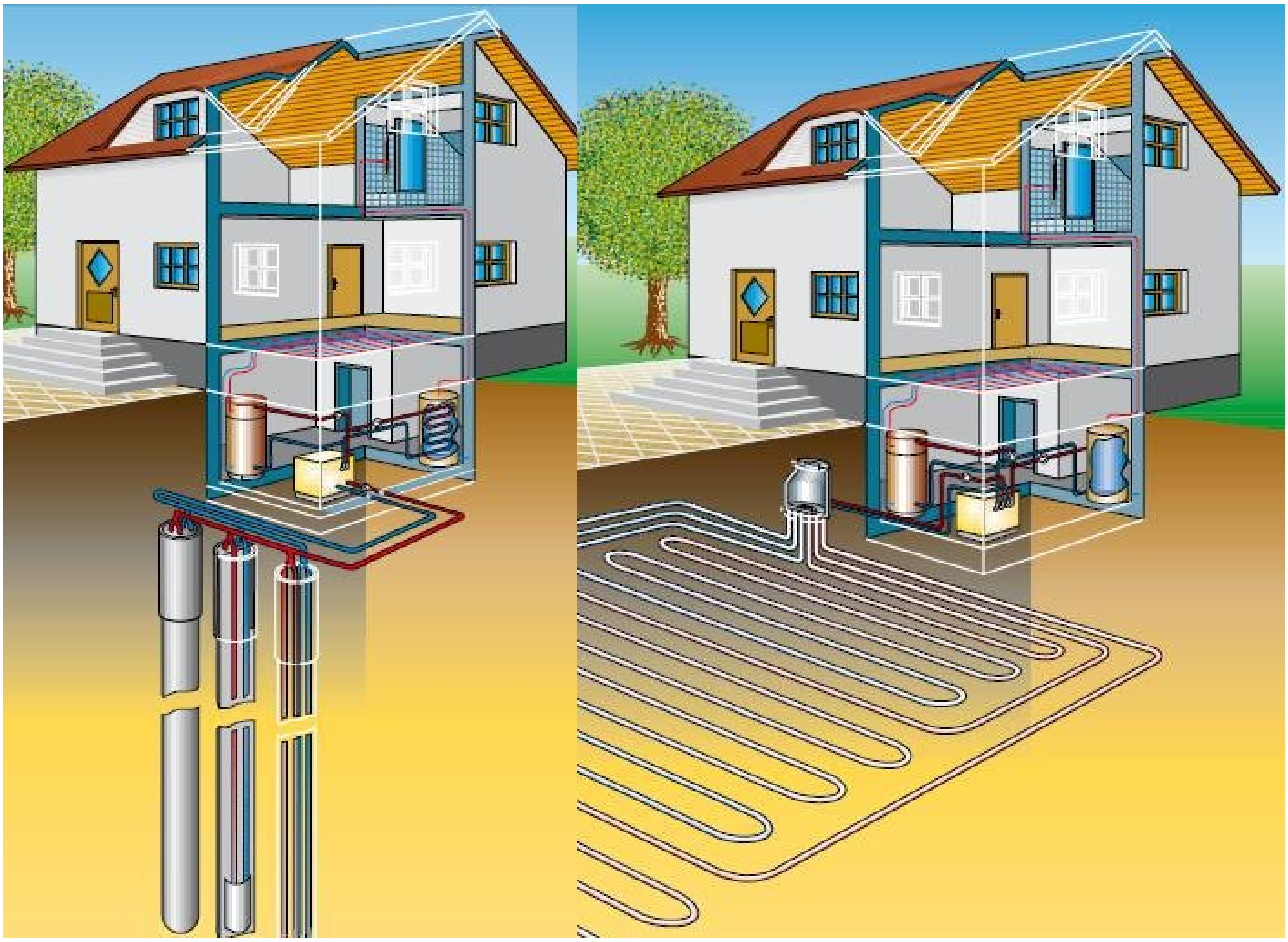
- air-to-air heat pump
- air-to-water heat pump
- water-to-water heat pump



Groundwater probe (water well)



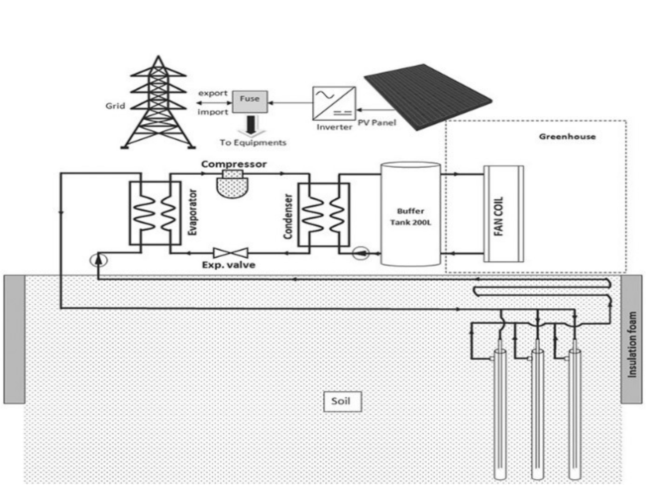
Internal heating in winter with external air cooling and internal cooling in summer with external air heating



Vertical loop geothermal system Horizontal loop geothermal system

Figure 15: Heat pump combinations[6]

Increasingly complex greenhouse technologies use solar photovoltaic (PV) electricity to drive a heat pump, while heat is extracted from the ground. The gap between PV production potential and use is bridged by heat storage.[7]



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1Figure 61: Greenhouse heated/cooled by heat extracted from soil probes using a solar heat pump[7,8]

In Hungary, in 2020, about two thousand hectares of agricultural land were under foil and greenhouse[9] , but only one tenth of this is the so-called Dutch-type, four-season heated-cooled greenhouse.

You can use heat pump heating

- office or social room heating ('home heating solution')
- technology for heating
    - drying
    - stables, incubator heating
    - foil tent/glasshouse

Several solutions can be used to heat the foil tent/greenhouse:

- an open heat pipe system near the ground, above the surface
- piping system in the soil to heat the root system
- fan coils (fan blowers)

Heat pumps multiply the heating output of the electricity used, but they require electricity. Therefore, where there is a lot of available heat (e.g. thermal water), heat pumps are rarely used. Electricity can be generated from solar photovoltaic (PV) systems, but without energy storage, electricity can only be continuously available from the grid.

The heat pump does not produce energy. The heat pump helps to use an external (and even free) energy source. Accordingly, the investment value and operating costs should be based on the energy consumed by the agricultural technology. The central component of a heat pump is the compressor, which has a lifetime of 10-12 years depending on its use.

Solar collector

There are many ways to use solar energy.

Of these from solar radiation

- **solar thermal power plants** generate large amounts of electricity (usually with steam cycle power plants)
- **solar collectors** provide a small amount of hot liquid
- **solar panels** directly generate electricity

are produced.

Solar heating is an effective way to reduce energy costs in winter and summer. Solar heating uses solar radiation to heat water or air in buildings. In some cases, the water heated by the collectors can be stored in the ground and used later when heat is needed. In frost-free regions, the water used is heated directly by solar collectors (open-loop). In Mediterranean countries, 1-2 panel or 10-20 vacuum tube systems are widely used. They require minimal maintenance and are simple. In the Hungarian climate, however, an intermediate antifreeze medium can only be used for outdoor units, so a closed-loop system is also included.

[8] PV-powered geothermal heat pump system for greenhouses - pv magazine International (pv-magazine.com) https://www.pv-magazine.com/2021/08/16/pv-powered-geothermal-heat-pump-system-for-greenhouses/
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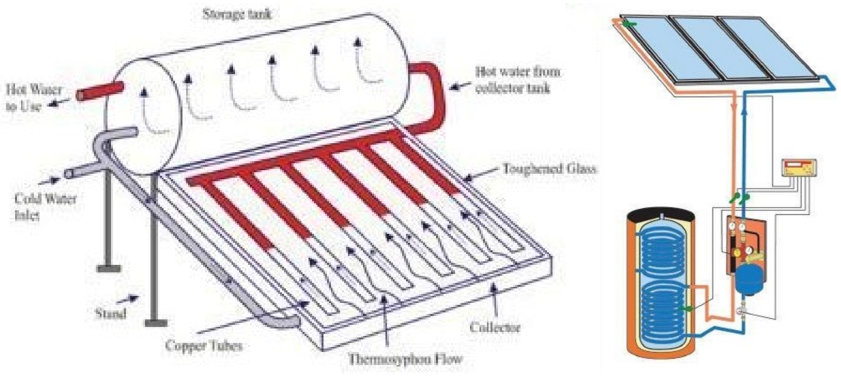

Figure 71: Open loop and three-collector closed-loop systems

Two main types of collectors are used to collect solar heat and heat the fluid: flat tube and vacuum tube collectors. Solar collectors are also known, but are mainly used in solar thermal power plants. Vacuum tube collectors heat the intermediate antifreeze medium through a heat pipe. A heat-pipe is a closed tube that transfers heat to a "cooling head" at the top of the tube.

Figure 18: Flat plate and vacuum collectors

As can be seen from the above, increasingly complex systems require more and more maintenance and attention.

Solar collectors in our country should be applied in two size categories: as individual dwelling systems with 2-3 panels or as supplementary heat collectors for public institutions or agriculture with 50-100 panels.

There is a large literature on the use of solar collectors in agriculture, but they are not widespread due to their complexity, maintenance requirements and, above all, their need for an additional heat source.[10] Direct air heating "air collectors" are used for drying[11] and conventional liquid collectors for hot water production (e.g. Austria, Berger meat plant, water preheating).[12]

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[10] Ding Ding: Integration of Active Solar Thermal Technologies in Greenhouses: A Mini Review Front. Energy Res., 16 November 2021 | https://doi.org/10.3389/fenrg.2021.757553

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Biogas and biomass-based heat and power generation

Biomass

Biomass is the term used to describe organic matter, mostly agricultural, which can be used for energy production (heat and/or electricity).

Biomass can be used to produce energy through burning, pyrolysis and fermentation gasification, among others. Some of the latter are presented here.

Biomass can be grouped into the following categories based on its energy use:

- Burning: combustible biomass has a low moisture content and therefore a very high calorific value. The most common combustible biomass fractions are sawdust, pellets, straw, firewood chips, etc.
- Biogas production: the biomass to be gasified has a higher moisture content (e.g. green vegetable waste, animal manure).
- Automotive fuel: liquid biomass is used as a fuel for internal combustion engines.

The use of biomass is becoming increasingly indispensable because it can replace fossil fuels and its production and use is sustainable. In our country, the use of biomass for energy purposes is mainly concentrated on forestry and agricultural by-products.

Biogas

Biogas can be produced from organic waste through anaerobic biodegradation (anaerobic fermentation, digestion). During anaerobic digestion, micro-organisms produce methane (50-70%) and carbon dioxide (25-40%). All organic materials are suitable for biogas production (except organic chemicals), such as manure, faeces, food by-products and waste, plant parts, municipal waste, sewage, etc.

Anaerobic digestion can be carried out in a staged or continuous process. In the case of feedstock such as plant, litter or municipal waste, a staged process is usually used, while for wastewater and slurry with lower organic matter content, a continuous process is used.

The thermal energy of 1 m^3 of biogas (21.5-22.6 MJ/m^3) without purification is equivalent to about 0.66 m^3 of natural gas. When biogas is purified, its calorific value is equal to that of natural gas.

Biogas-based electricity is mainly generated by gas engines. Gas engines are internal combustion engines that convert the energy content of the gas into mechanical energy, which is then converted into electricity by the generator. The heat generated by the gas engine can be further used for heating purposes.

Also to be mentioned is the neutral dry matter resulting from the gasification of municipal sewage sludge, which is much sought after in agriculture for soil improvement.

The most suitable biogas is diluted organic manure, waste from animal farms. Similarly, it is also possible to produce gas from sewage sludge, agricultural waste and silage maize. After homogenisation and dilution, the manure is fed into large fermentation tanks where bacteria are added to produce gases. The process can be precisely controlled or regulated by the temperature of the liquid. The process is heated by burning the biogas produced, which accounts for about 30% of the total heat produced.

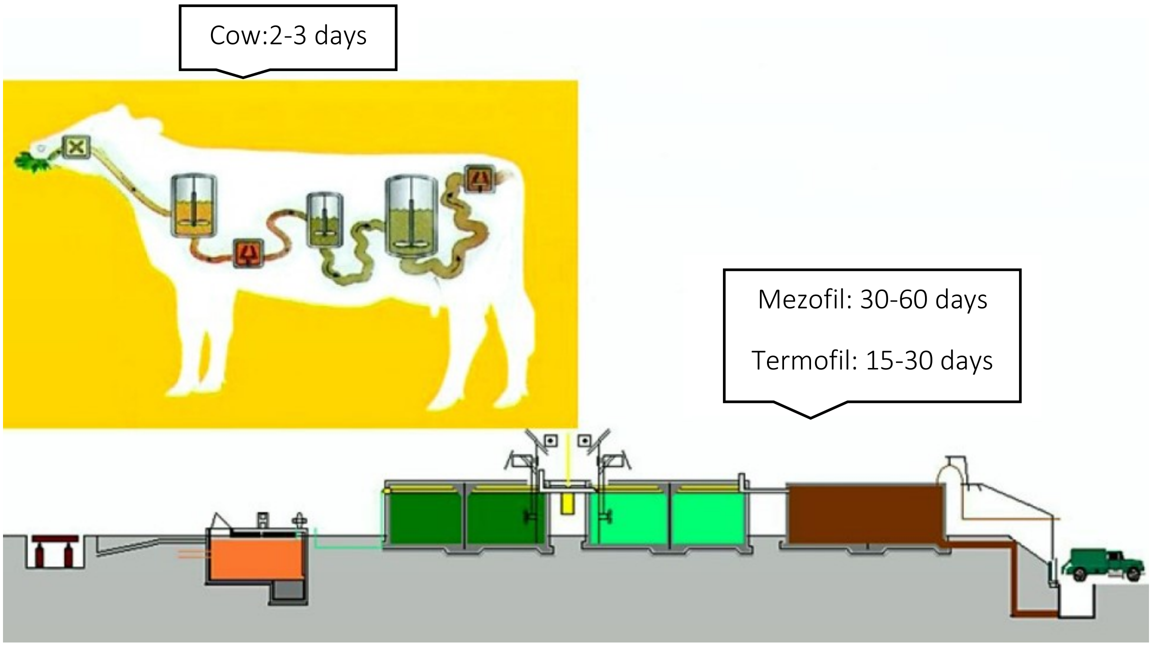

Figure 19: Biogas analogy[13]

For the energy balance, it should be noted that

- the priority is hazardous waste disposal - not energy production,
- the energy balance of the technology is typically net negative for wastewater, i.e. only 30-50% of the electricity demand of the disposal technology can be generated,
- the variable amount of heat should be used to heat the fermenters in winter (even using additional gas energy),
- the equipment must be located away from settlements (see volatile matter), so that at most the excess heat can only be used for process space heating.

The main units of a biogas power plant:

- biomass storage
- biomass dispatcher
- fermentor
- gas filter, desulphuriser
- gas tank
- gas engine
- final product resting, storage

Solar panels (PV - Photovoltaic power generation)

A solar cell is a photovoltaic cell that converts the sun's radiant energy directly into electricity, with the energy conversion taking place in the semiconductor material. Different types of solar modules are available:

- Monocrystalline silicon solar cell
- Polycrystalline silicon solar cell
- Thin-film solar
- additional technologies such as dye sensitized, Perovskite, bifacial, etc.

[13] Kornél Kovács:Biogas and biohydrogen production potentials; Department of Biotechnology, SzTE TTK

There are several categories and technical solutions for solar electricity generation. In Hungary, as a result of the development of the last decades, the following application categories can be mentioned:

- Household-Sized Generating Stations (HSGS) with a capacity of less than 50 kVA - for the generation of electricity for partly own use
- Small power plants with a capacity of less than 0.5 MW - exclusively for grid power generation
- Power plants below 0.5 MW - producing partly or entirely for own consumption - mainly for agricultural and municipal purposes
- Small power plants below 50 MW - exclusively for grid power generation
- there are also hybrid systems for autonomous power supply, typically with a power of 10 kVA.

From an agricultural point of view, the most relevant are the HSGS' s and the power plants below 0.5 MW for own consumption.

Developments in recent years have led to the installation of solar PV capacity accounting for half of the consumption (output) of the Hungarian electricity system, which sometimes causes problems in balancing the Hungarian electricity system.

For energy production, mono- and polycrystalline solar cells can be used, while in combination with building/roof cladding, lower-efficiency but significantly cheaper dye-sensitised (DS) and amorphous solutions may be justified.

Traditionally, a panel combining 20-60 cells is installed in a fixed orientation, but there are also single-axis and dual-axis solar tracking solutions. This is little used today because the cost of panels has fallen to a fraction of what it was in the last decade, while the cost of otherwise high-maintenance rotating equipment has remained the same.

In our country, panels are typically installed on agricultural land taken out of production (available: about 0.75 MWp/ha) or on the roofs of stables, factory buildings, farm buildings.