Revision and update of the Green Economy Financing Facility (GEFF) Technology Selector Tool for North Macedonia

Acknowledgments

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List of Acronyms

ALB	Albania
BiH	Bosnia and Hercegovina
CRRNM	Central Registry of Republic of North Macedonia
EBRD	European Bank for Reconstruction and Development
EE	Energy Efficiency
EUR	Euro
GEFF	Green Economy Financing Facility
GFF	Green Finance Facility
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
HEMS	Home Energy Management Systems
IEA	International Energy Agency
IOM	International Organization for Migration
MK	Republic of North Macedonia
MKD	Macedonian Denar
MVP	Monitoring and Verification Platform
RE	Renewable Energy
SDG	Sustainable Development Goals
SME	Small and Medium Enterprises
SRB	Serbia
UN	United Nations
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe

Background / Introduction

About the project

UNECE is implementing extrabudgetary project "Improving national capacity on renewable energy (RE) and energy efficiency (EE) technologies for small and medium enterprises (SMEs) and households in North Macedonia". This project is UNECE component of Green Finance Facility to improve air quality and combat climate change in North Macedonia.

The project aims to improve national capacity on renewable energy (RE) and energy efficiency (EE) technologies for SMEs and households in North Macedonia. It is part of a Joint Programme funded by the UN Joint SDG Fund and entitled "Green Finance Facility to Improve Air Quality and Combat Climate Change in North Macedonia". Moreover, the Joint Programme is implemented by UNECE with UNDP (lead agency) and IOM under the overall coordination of the Resident Coordinator Office in North Macedonia.

Supported by the Joint SDG Fund, this Joint Programme will set up and operationalize the Green Financing Facility (GFF). It is a new financial vehicle that will provide access to affordable green financing for SMEs and marketable but underserved target groups of individuals/ households for investments in RE and EE solutions. The GFF-enabled accelerated adoption of RE and EE solutions will contribute to reducing greenhouse gas emissions and air pollution. Furthermore, will strengthen the local ecosystem for RE and EE green finance.

This project is assisted by UNECE. It provides technical assistance and oversees designing and implementing trainings that will be tailored to support consultancy companies in using the updated list of eligible technologies to monitor and verify the projects' performance (planned vs. actual). UNECE aims to revise and update the Green Economy Financing Facility (GEFF) Technology Selector Tool for North Macedonia.

Technology and digitalization continue to transform the way the financial sector is operating. Innovative applications of digital technology for financial services, such as the Green Economy Technology Selector Tool, are altering the interface between financial institutions and their clients while improving access to information about green technologies and climate finance.

GEFF is an online platform that allows users to access a global directory for green technologies. Among the technologies currently included on the platform, the selection ranges from energy efficient heat pumps and solar panels that produce renewable energy to water efficient drip irrigation systems and no-till seeding machines that support sustainable land management.

The platform is creating a marketplace that makes green technologies more easily available while promoting cross-border trade between economies in the region. Manufacturers from around the world can submit their products to the GEFF and local vendors can register their products and locations. Loan recipients (borrowers) will be able to find vendors and manufacturers within minutes. Additionally, they can locate the closest one and submit their purchasing plans to the financial partners such as local banks, leasing companies and microfinance institutions. Thus, it will accelerate processing times for clients' requests and make it easier for them to benefit from financing.

The objective of this analysis is to revise and offer update guidelines and suggestions of high-performing household equipment and materials that meet the performance standards set by EBRD for the GEFF in North Macedonia.

About the Technology Selector Tool

The Green Technology Selector Tool[1] is a huge worldwide database of best-in-class green technologies. Products, vendors and manufacturers registered in the Green Technology Selector are promoted worldwide as best-in-class green technologies and clients are encouraged to choose them among others. It helps vendors sell more high-end products to local clients.

Technology vendors are encouraged to register for free their technologies with this tool to make the best ones more visible to prospective local clients. Performance requirements for technologies and vendors are reviewed on a regular basis and adjusted to reflect market developments.

By selecting to browse products in a country, the Green Technology Selector will list the technologies that meet the minimum performance criteria for that country.

Products listed in the country-specific Green Technology Selector meet technical performance criteria ("pre-approved") and are considered pre-approved for green financing via local financial institutions.

The Green Technology Selector was developed by the European Bank for Reconstruction and Development (EBRD) and supported by the Austrian Federal Ministry of Finance.

Many green financing facilities use the Green Technology Selector to establish eligibility for technologies to be financed as a basis. For example, if the facility is focused on a specific set of technologies, a new front-end page for the facility is created based on the defined criteria (Figure 1).

Figure 1. The process of creating specific Technology Selector Tool

In that view, the Green Technology selector covers a significant number of sectors and products, such as Industry, Agriculture etc. Due to the nature of the analysis and the focus on households in North Macedonia, **a specific facility related front-end page was set as a basis for the research: GEFF Technology Selector Tool**[2]. This new front-end page backed by the Green Technology selector will have categories

[1] https://techselector.com/northmacedonia-en/
[2] https://ebrdgeff.com/macedonia/technologys/go-to-technology-selector/

that were already present in the GEFF tool and new categories that would have a valuable impact on the energy consumption in a typical household in North Macedonia. Using the experience from previous financing facilities in the country focused on energy efficiency technologies used in households allows to broaden the number of categories present in the tool while preserving the legacy of the GEFF tool.

The EBRD Green Economy Financing Facility (GEFF) in Western Balkans provides finance for green economy investments in the residential sector as well as to businesses who provide energy efficiency and renewable energy products and services to households. The total volume of the credit line in the Western Balkans, namely in Albania, Bosnia and Herzegovina, Montenegro, Serbia, North Macedonia and in Kosovo, is EUR 85 million.

Methodology

This report analyses of the need to update and revise the GEFF Technology Selector tool (hereinafter "the tool"), and consists of two independent parts (divided due to differences in the concept, as well as the applied methodological steps): update and revision of the existing technologies currently in the tool and upgrade the tool with new technologies that are viable for the market.

The main goal of the first part of the report is to infer whether there is a need to expand the tool with additional vendors and technologies. Moreover, it provides an overview of the existing state of the tool, including an analysis and comparison of the available vendors, their scope of coverage, as well as existing products and technologies in the market, and their representation in the tool. To assess the size of the market in the country, the analysis in this part presents a comparison of North Macedonian retail market with similar markets according to several criteria in the Western Balkan region.

Considering the information provided, secondary research has been conducted, by analyzing the existing data sources that include statistical publications and databases of the Central Registry of the Republic of North Macedonia, publications from the State Statistics Office, comprehensive business directories and similar public sources of information.

Regarding the second part of the report, the main goal is to infer whether there is a need to expand the tool with additional categories. The analysis of the inclusion of new technologies and categories in the tool was created by literature review and official datasets of technologies presented on the market that still have influence over the quantity of energy used in a typical household in the country. The assessment of the need for these technologies to be included in the tool, are made by comparison of several existing statistics and applying methodologies for calculation of the energy savings (national and widely accepted bottom-up methodologies). When choosing new technologies, international and national strategic determinations are considered, as well as plans developed for emergency situations.

The calculations were made with proven national methods for calculation and verification of energy savings for energy efficiency measures. Initially, the bottom-up method adopted in the secondary legal framework, i.e., the Rulebook on Energy Audits, was used. This methodology, which implies the use of national common values, is a good choice when the calculations do not include a specific technology or product. The utilization of common values even though can represent significant chance for error considering case by case analysis, gives valuable framework for the possibility for generation of energy savings by category.

In situations where it was not possible to use the methodology that is part of the Rulebook on Energy Audits, due to its narrow content, an extended bottom-up method was used, developed by the Horizon2020 project MultEE, coordinated by GIZ. The method was developed by the Austrian Energy Agency and was part of a project whose main goal was to develop an Energy Savings Monitoring and Verification Platform (MVP). These common values have passed a peer review process and public debates and are aligned with expert opinion in the country. The validity of these methods is also seen in the fact that the platform itself - MVP is included in the Law on Energy Efficiency of the Republic of North Macedonia. Although the secondary regulation has not yet been adopted; it is expected that the methodology will be part of the legal framework. The project and platform, in addition to being supported by the European Union and the German government (through GIZ), was also supported by the Energy Community and the platform is used throughout the Western Balkans.

The analysis included the following approach and methodology:

Table 1. Approach and methodology

Approach and methodology
Approach **Deductive/Inductive logic based on quantitative and qualitative data. The methodological approach was composed of 1) Identification of data sources; 2) Data collection; and 3) Data analysis and recommendations.**
Identified data: 0. Governmental documents (state strategies, regulations, intl. treaties and agreements, secondary regulation) 1. Reports or documents containing statistical data on the operation or economy of some sectors (e.g., from State Statistical Office, Central Registry of Republic of North Macedonia) 2. Business catalogues 3. Relevant studies, articles, research papers 4. Online tools (e.g., GEFF Technology Selector in similar countries) **Data collection:** 1. Desktop research 2. Literature review 3. Primary research for target households 4. Primary research for target private companies **Data analysis and recommendations:** 1. Summary 2. Conclusions and recommendations 3. References and data sources 4. New technology baseline study templates

I. Update and revision of the existing situation

1. Situation in North Macedonia

The household sector is the second largest energy consumer in the Republic of North Macedonia as it accounts for 26 per cent of the total final energy consumption[3]. The final energy consumption for this sector is projected to increase up to 50 per cent by 2040[4], as presented in Figure 1. The trend of using biomass (and mostly firewood) and electricity as primary energy fuel will continue to rise unless intentional and planned efforts are made and translated into concrete measures which would stimulate households to invest in energy efficiency and renewable energy. The situation calls for immediate action to improve the transition of the households towards lower consumption of fossil fuels, improvement of energy efficiency and increased utilization of **renewable energy**.

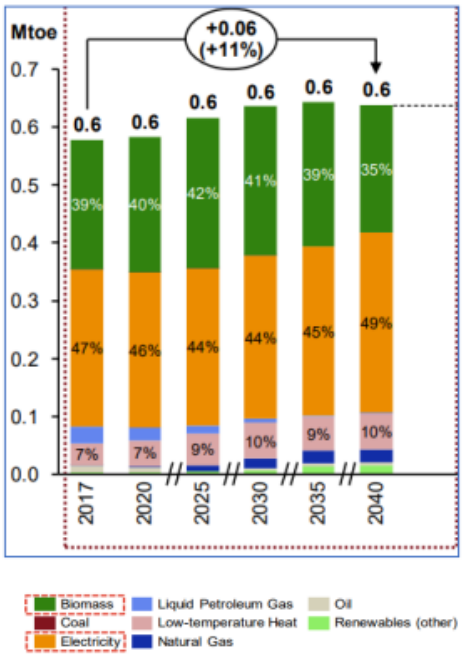

Figure 2. Projection for the final energy consumption in households[2]

Figure 2 shows the share (in %) of final energy consumption in the residential sector by type of end-use.

It becomes evident that the **heating** has a dominant share in the energy consumption of a typical household. Compared to the significant use of firewood and electricity, it represents an urgent and important element to address when it comes to the technologies included in the Technology Selector Tool.

[3] 4th National Energy Efficiency Action Plan, p. 9
[4] Energy Development Strategy for the Republic of North Macedonia until 2040 - Final working version

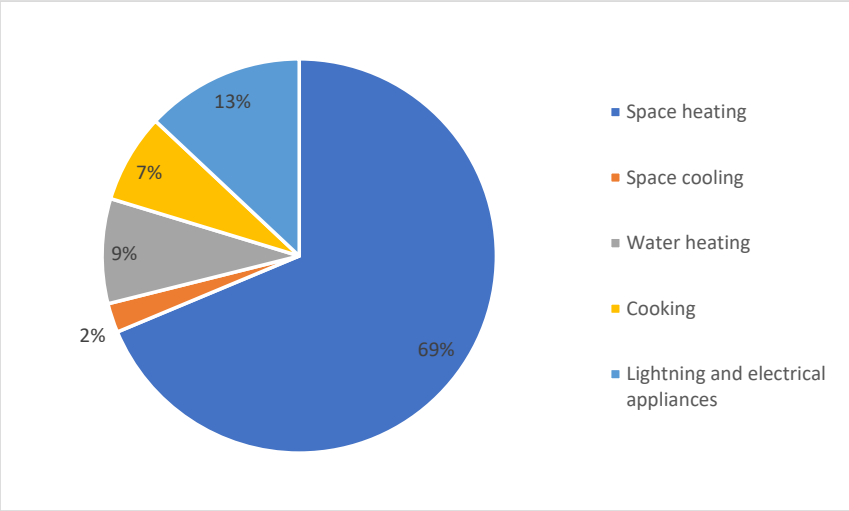

Figure 3. share (in %) of final energy consumption in the residential sector by type of end-use in North Macedonia[5]

Additionally, the existing building stock in North Macedonia is not energy efficient. In terms of buildings' thermal performance, only 32.3 per cent[6] of the buildings have performed insulation (walls and/or roof), while Figure 3 shows that old wooden windows are also dominant among the households in the country. According to this, the **building envelope** of the households is also offering significant potential for improvement when considering technologies for the tool.

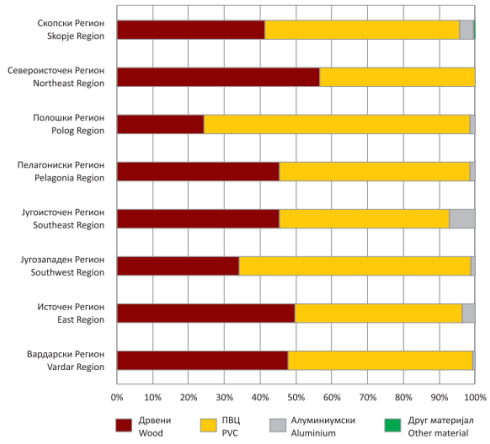

Figure 4. Windows by type of frame[7]

Regarding the energy efficiency of electric appliances and electronic devices used in households, it can be noted that 44.5 per cent of households use electric stoves of one of the A classes (A, A+, A++, A+++), 58.3 per cent of households use washing machines also belonging to one of the A classes, while the most

[5] Disaggregated final energy consumption in households - quantities, Eurostat, online data code: nrg_d_hhq
[6] Energy Consumption in Households, 2019, Statistical review 6.4.21.01/915, State Statistical Office, p. 10
[7] Energy Consumption in Households, 2019, Statistical review 6.4.21.01/915, State Statistical Office, p. 11

commonly used refrigerator is the two-door combined, which covers 64.2 per cent of all A class refrigerators.[8]

Most of the categories present in the current household energy usage by type in the country are included in the tool: Heat generation, Renewables, Building Envelope, Refrigerators. In view of updating the tool, specific analysis is performed that adds other segments of the household energy usage. However, with consideration to expand the categories to include more of the household energy usage, it is noted that apart of the energy generation, other energy, mostly heating systems are not present, such as control, emission and distribution systems (mainly for heating, due to the presented energy demand in the households). The update and revision of the tool should consider these categories to be included to cover more of the household energy consumption, so it can provide guidance for consumers to look for products that will supplement their energy system and provide vendors with a valuable platform to market their best available technologies.

[8] Energy Consumption in Households, 2019, Statistical review 6.4.21.01/915, State Statistical Office, p. 8

2. Target groups

The Green Technology Selector was developed in 2018 under the EBRD Green Economy Financing Facility (GEFF) as a tool that helps in identifying technologies eligible for EBRD financing. The main intent of the tool is to act as the technical eligibility assessment tool to develop green financial products for different types of financial institutions – banks, leasing companies, and microfinance institutes. However, financial institutions are not the only target groups that the tool is meant for. The main concept of the tool is to serve as a catalogue of energy efficient technologies from around the world sorted in a way that enables easy matching between investors, financiers, and vendors.

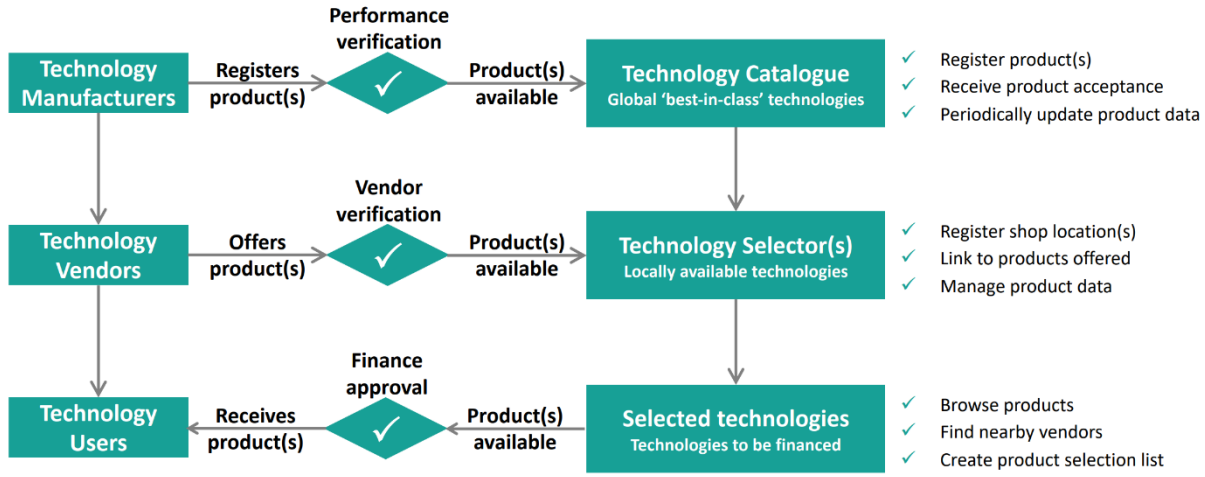

Figure 5. Responsibilities of each target group for of the Technology Selector

Each target group that this tool is meant for has access to parts of the tool that will enable the target group to find its interest.

The first target group is the technology manufacturers, whose main task is to register their product and offer technical specifications that enable the tool to sort products according to usage categories and efficiency parameters. It is of utmost importance for the technology manufacturers to be actively included in the registration of their products to ensure the validity of the specifications and timely updates of any changes of the products.

The next target group that this tool is meant for is the technology vendors which act as intermediary between the manufacturers and the end users of the technology. This group must register their location of distribution of the products, as well as maintaining information on availability of a certain product on the various markets where this tool is being used.

The third target group is the financial institutions that provide finance and support services to project developers and end users. The tool simplifies procedures by offering pre-approved technologies that were previously assessed to the developers and ensures that financial institutions are familiar with the performance of the offered product.

The last target group is the end users – technology users. By using the tool, they could find the most appropriate technology product to make their household more energy efficient while having flexibility to acquire financing and information of availability of desired technology on the market.

3. Analysis of the need to update the existing technologies in the GEFF Technology Selector Tool for North Macedonia

In order to determine the need to update the existing technologies in the tool, a cross comparative analysis was made of the registered vendors in North Macedonia compared to those in the tool itself. In addition, comparison of the technologies and products contained in the North Macedonian version of the tool, with versions of the tool in neighboring countries Serbia, Albania and Bosnia and Herzegovina was done, so it will illustrate and present the gaps of technologies used in the tool for the country with those of comparable markets.

The GEFF Technology Selector Tool contains 461 vendors[9], primarily in the area of retails and installation of systems for exterior facade, heating, cooling, air conditioning, energy generation and household appliances and systems (air conditioners, refrigerators, lighting). The complete list of vendors in the tool is given in Annex II.

On the other hand, according to the Central Registry of the Republic of North Macedonia, and their statistical data for 2021 (last complete set of data), the number of companies in the respective activities is shown in Table 2.

Table 2. Number of legal entities according to activity

Industry/Sector	Activity	Group	Classes	Trade registry for 2020[10]	Trade registry for 2021[7]	Registry of annual accounts for 2021[7]	According to business catalogue[11]
Construction	43. Specialized construction activities	43.2 Electrical, plumbing and sewage installations and other construction plumbing works	43.22 Installation of plumbing, sewage and **gas installations and installations for heating and air conditioning devices**	642	660	563	281
		43.3 Finishing works in construction	43.32 **Installation of carpentry**	214	221	193	415
			43.33 **Installation of floor and wall coverings**	597	630	488	20

[9] GEFF Technology Selector Tool for North Macedonia, available at: http://technology-mk.ebrdgeff.com/http://technology-mk.ebrdgeff.com/

[10] Central Registry of the Republic of North Macedonia – Statistical Bulletin, available at: https://www.crm.com.mk/mk/otvoreni-podatotsi/statistichki-bilten

[11] "ABV of the Macedonian Economy" - Business Catalog, available at: www.abv.mk

Industry/Sector	Activity	Group	Classes	Trade registry for 2020[10]	Trade registry for 2021[7]	Registry of annual accounts for 2021[7]	According to business catalogue[11]
			43.34 **Painting and glazing**	254	245	172	
		43.9 Other specialized construction works	43.91 Roof construction activities	95	95	86	163
Wholesale and retail trade; repair of motor vehicles and motorcycles	47. Retail trade except trade in motor vehicles and motorcycles	47.5 Retail trade of other household equipment in specialized stores	47.54 Retail trade of **electrical household appliances** in specialized stores	205	200	163	156
			47.59 Retail trade of furniture, **lighting equipment** and other household items in specialized stores	514	514	413	76
TOTAL				**2521**	**2565**	**2078**	**1111**

This table provides a glimpse of the market size in the Republic of North Macedonia. But the target group regarding the tool is smaller for several reasons. First, some of the registered legal entities with relevant activity are not active. The officially registered description of activities found in the database of the Central Registry of the Republic of North Macedonia covers wider spectrum of registered activities than what is needed for the analysis of the tool (eg. activity code 47.59 Retail sale of furniture, lighting equipment and other household items in specialized stores, includes a significant number of subjects that are not of interest for the given analysis, like furniture, woodworks etc.), so there is a possibility that one legal entity has several activities that create an overlap in terms of the initial parameters. Therefore the market size is smaller than the entities in the registry, however it encompasses the entire wholesale and retail market.

In order to eliminate the inactive legal entities, an analysis was made according to the submitted annual accounts of the retailers. As shown in Table 2, about 20 per cent of the retailers in the activities of interest are not active. With the data that is available from CRRNM, a provisional size of the market is obtained, but the activities of the retailers cannot be separated in detail, except according to the defined activity codes in the legal framework. Therefore, this provisional market size has been used as a reference for further research through comparison with business catalogs. The last column in Table 2 singles out only legal entities who have interest in updating the tool. For that purpose, the “ABV of the Macedonian

Economy" business catalog was used. Thus, with a reasonable margin of error and elimination of the perceived deficiencies, the target group of companies and retailers that could be included are 1111 legal entities. In comparison, Figure 5 presents the results in terms of the defined target group.

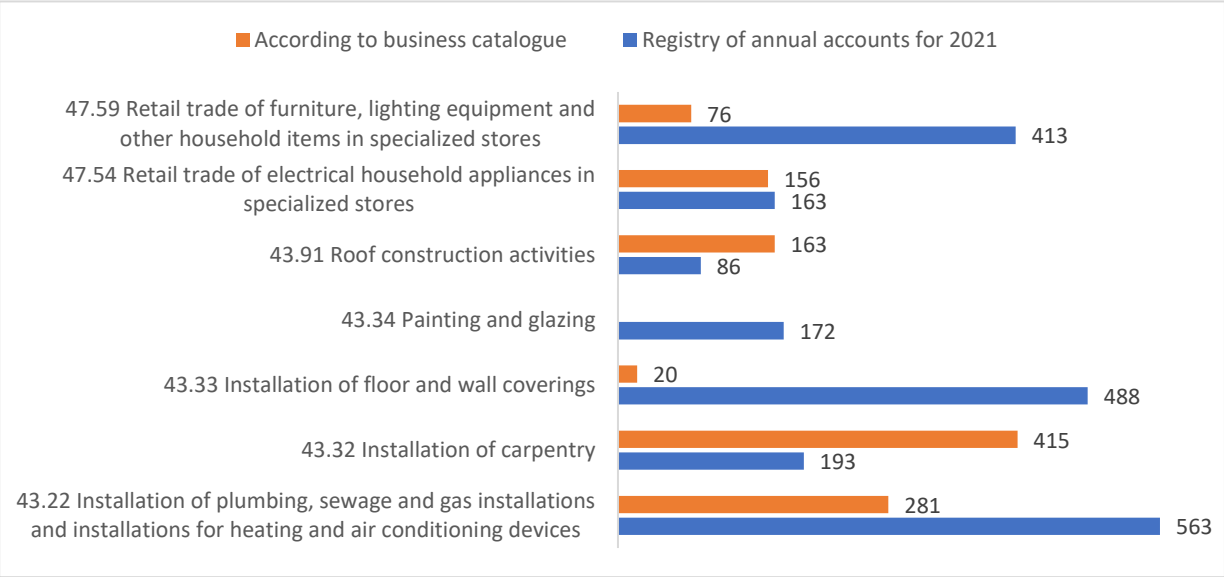

Figure 6. Target group by activity

In conclusion, the tool covers about 42 per cent of the active business entities of interest, which is a significant share of the market in the Republic of North Macedonia. However, this number of business entities that are listed do not provide enough information about the distribution of sales of equipment and technologies, and as can be seen from Annex II, the largest and most widespread vendors, who are also the most accessible to the public, are present in the database of the tool. Therefore, updating the database with new vendors and companies will not significantly change the usefulness of the tool or its comprehensiveness.

Regarding the products that are present and are part of the Technology Selector Tool, there are no complete public data through which a structured analysis of the available products and technologies could be made. Therefore, as explained in the methodology, a comparison was made with similar countries in terms of several parameters. The most important parameter in the analysis was market proximity, due to the fact that a significant number of retailers, distributors and manufacturers (e.g., Rehau and Knauf) operate regionally. Consequently, their products are available in all analyzed markets, or products with very similar technical specifications are distributed by them. For that reason, the markets of Albania, Serbia, North Macedonia and Bosnia and Herzegovina were analyzed.

Another parameter that was decisive was the size of the market, which is why Albania, with 2.8 million inhabitants and Bosnia and Herzegovina, with 3.2 million inhabitants, have similar characteristics to North Macedonia, while Serbia, with 6.9 million, represents a larger market, but according to the regional proximity and similar socio-economic structure, it provides valid information, and it is useful to be taken into consideration.

The comparison of the available technologies included in the tool for each country is made according to the respective Technology Selectors. Although there is no data available on the degree of completion of

the tool in other countries, comparing these figures among the available technologies, and the similarity of the markets, still shows which categories in certain countries have a lower degree of product coverage. The number of technologies covered by category and subcategory are presented in Table 3.

Table 3. Number of included products in the tool by category

Category	Subcategory	MK*	SRB**	BiH***	ALB****
Insulation	*Mineral wool*	258	815	436	385
	Styrofoam (XPS, EPS)	1177	653	1090	1103
	Others	38	-	16	-
Windows and doors	*Windows*	105	381	876	40
	Glazing	12	-	-	12
	Doors	49	25	75	29
Stoves/boilers	*Biomass stoves/boilers*	334	310	282	193
	Gas boilers	112	311	200	38
Heat pumps	*Water heat pump (water/water)*	234	80	303	47
	Air heat pump (air/water)	417	405	463	315
	Air heat pump (air/air)	34	39	67	42
	Ground heat pump (ground/water)	37	72	170	31
Solar thermal water heaters		54	45	42	32
Solar photovoltaics installations (PV)		404	158	47	323
Lighting	*High pressure sodium lamps*	6	-	9	10
	Other gas discharge lamps	2	-	3	39
	LED lighting	208	19	66	89
Ventilation		86	17	54	23
Air conditioners		275	176	305	242
Refrigerators and freezers		43	-	277	84
Hot water storage tanks		290	169	137	87
	Total	4175	3675	4918	3164

* Source: GEFF Technology Selector Tool for North Macedonia, available at: http://technology-mk.ebrdgeff.com/http://technology-mk.ebrdgeff.com/

** Source: GEFF Technology Selector Tool for Serbia, available at: http://technology-rs.ebrdgeff.com/

*** Source: GEFF Technology Selector Tool for Bosnia and Hercegovina, available at: http://technology-ba.ebrdgeff.com

**** Source: GEFF Technology Selector Tool for Albania, available at: http://technology-al.ebrdgeff.com

The comparison of the number of technologies per category is additionally shown graphically with the respective field filled in blue, for easier comparison.

As seen in Table 3, if these figures are looked at from a macro perspective, the respective tools in each country are thoroughly filled, given the similar number of products and the proximity of the market. However, if the individual categories are compared separately, it can be concluded that there are elements that can be further expanded. For example in the case of North Macedonia, this is most clearly observed in the sub-categories: Windows, and Refrigerators and Freezers, as well as to a lesser extent, in the Lightning category. Moreover, the number of products and technologies in these categories is still

significantly high, thus their impact on the evaluation of the completeness and comprehensiveness of the tool is insignificant.

In conclusion, it should be noted that this tool covers a significant part of the market in North Macedonia, as well as significant number of available products. There is room for improvement, especially in the area of cooking appliances and secondary heating system elements but it is insignificant for the practical use of the tool.

It should be noted that the tool is a platform that interacts directly with the vendors, and as such, it should have mechanisms for regular contact with them, offering motivation for regular update. Updating the database of available technology products is sole responsibility of the technology manufacturers or their official distributors, due to validity and verification of the specifications for each technology product. Third party inputs of available products could cause errors in the listed specifications which in turn could cause difficulties in verification of energy performance in the installed equipment.

II. Recommended new categories to be included in the Green Economy Financing Facility (GEFF) Technology Selector for North Macedonia

1. Defining the need for additional categories that would expand the Technology Selector Tool

A general conclusion about the tool is that it is comprehensive and thorough. It is noteworthy that previous experience with similar EBRD tools (e.g., Green Technology Selector aimed at a different target group) was used to develop the tool.

The tool covers the basics of household energy consumption, with several products already available at the market, however there is room for improvement, especially in expanding the existing technology categories. The technology categories that are already present in the tool, along with eligibility criteria, are listed below.

Household technologies that meet the following performance standards are eligible for funding under the GEFF in North Macedonia[12]:

Refrigerators (fridges, freezers, combi fridges/freezers): energy label A++ or better

Air conditioners: energy label A++ or better

Lighting: luminous efficacy

LED lighting ≥ 80 lumens/Watt

High pressure sodium lamps ≥ 80 lumens/Watt

Other gas discharge lamps ≥ 57 lumens/Watt

Gas boilers with or without associated controls, space heating and domestic hot water (DHW) storage systems: thermal efficiency ≥ 90%

Biomass stoves/boilers with or without associated controls, space heating and domestic hot water (DHW) storage systems: thermal efficiency ≥ 85%

Energy efficient windows, doors and glazing: thermal transmittance (U-value)

Windows: ≤1.3 W/m^{2}K

Doors: ≤1.3 W/m^{2}K

[12] GEFF Technology Selector Tool for North Macedonia, available at: http://technology-mk.ebrdgeff.com/http://technology-mk.ebrdgeff.com/

Glazing: ≤1.2 W/m^{2}K

Insulation for outdoor walls, roof, floor, and partition walls dividing areas: thermal conductivity (lambda, λ)

Lamellar structure slabs: ≤0.04 W/mK

Styroasphalt sheets: ≤0.04 W/mK

Mineral wool: ≤0.04 W/mK

Styrofoam (XPS, EPS): ≤0.04 W/mK

Polyurethane: ≤0.04 W/mK

Others: ≤0.04 W/mK

Heat pumps (electricity or gas driven): COP

Water heat pump: ≥4.3

Air heat pump: ≥4.3

Ground heat pump: ≥4.3

Ground water heat pump: ≥4.3

Recycled air heat pump: ≥4.3

Brine heat pump: ≥4.0

Solar thermal water heaters with or without associated controls, space heating and domestic hot water (DHW) storage systems: thermal efficiency ≥75%

Solar photovoltaics installations (PV): electrical efficiency ≥14%

Balanced mechanical ventilation: energy label A or better

It is noteworthy that these categories are identical to the corresponding tools in all countries in the Western Balkan region, therefore the conclusions are also valid for the other considered countries where this tool is used.

Detailed categories are covered in terms of building envelopes (carpentry, exterior wall, ceiling, etc.), energy sources (heat pumps, boilers, photovoltaic systems), household appliances (refrigerators).

In order to determine the need for supplementing the existing categories with new ones, the share of energy consumption in the household sector by types of use was first considered. Thus, Table 4 shows the consumption of energy by households' usage in North Macedonia, as well as in the surrounding countries: Albania, Bosnia and Herzegovina, Serbia and as a reference the average of the EU countries is added.

Table 4. Share (in %) of final energy consumption in the residential sector by type of end-use, 2020[13]

Country	Space heating	Space cooling	Water heating	Cooking	Lightning and electrical appliances	Other end use
EU	62.8	0.4	15.1	6.1	14.5	1.0
Serbia	66.3	0.4	11.8	7.1	14.4	-
Albania	32.6	8	23.6	31.2	4.6	-
Bosnia and Hercegovina	73.4	0.6	9.4	5.1	11.5	-
North Macedonia	68.7	2.4	8.6	7.3	13.0	-

It is noteworthy that almost two thirds of the household energy usage is used for heating in the majority of cases (except for Albania, where the climate characteristics are different from the other considered examples). Therefore, the focus of the offered features should be directed mostly to heating, because of the highest impacts on the total share of energy consumption.

In the case of North Macedonia, water heating and cooking have an almost identical share in energy consumption. Therefore, these two categories are also important to cover with the technologies offered in the tool.

Because of the importance of the heating systems and cooking appliances, according to the energy consumption in the households in North Macedonia, they should be considered for future upgrade of the tool. In addition, in the next section, a justification of the application of these categories in the tool will be provided.

According to the statistical data, from the included technologies in this tool, there is an absence of household appliances intended for cooking, which have a similar share in energy consumption as refrigerators, as well as systems related to the distribution and emission of thermal energy, which have significant impact on the efficiency of heating systems, and influence energy savings on one of the largest shares in the energy balance of a household.

[13] Disaggregated final energy consumption in households - quantities, Eurostat, online data code: nrg_d_hhq

2. Justification for introducing a new category "Heating"

The efficiency of a heating system is mostly dependent on the heat source, such as boiler, furnace, or heat pump. However the heating, cooling and ventilation efficiency (according to statistical data and the situation in the country, the focus of this analysis is on heating) of the space is mainly influenced by the heat distribution and emission systems. Improving these systems and their efficiency is usually a cheap and easy-to-implement measure with a relatively small return on investment, but with a large impact on energy consumption and environmental pollution.

Thus, for example, the total efficiency of the heating system, according to the secondary regulation and adopted methodologies is:

$$\eta_g = \eta_p \cdot \eta_e \cdot \eta_d$$ [14]

η_g – Total heating system coefficient [-]

η_p – Coefficient of efficiency of a heat generator [-]

η_e – Efficiency coefficient of a heat emission system [-]

η_d – Efficiency coefficient of a heat distribution system [-]

Typical and common values at the level of the European Union, as well as in North Macedonia, for existing systems, as well as for energy efficient systems, are given in Table 5.

Table 5. National common values for heating system elements[15]

Heating system element	Default value, existing systems (%)	Available market systems, with less efficiency (%)	Effective solutions, minimal value (%)
Heat generation	82	89	94
Heat emission	78	83	93
Distribution	93	-	97

Therefore, the efficiency of the heating system considering the common market values is:

$$\eta_g = 0.89 \cdot 0.83 \cdot 0.93 = 0.69$$

while the efficiency of the heating system with the application of energy-efficient solutions with minimal values of the corresponding coefficients is:

[14] Rulebook for Energy Audits, Bottom-up Methodology, Official Gazette no. 94 from 4 July 2013, p.112, available at: https://www.ea.gov.mk/images/stories/E_Izdanija/pravilnik_energetski_kontroli.pdf

[15] Rulebook for Energy Audits, Bottom-up Methodology, Official Gazette no. 94 from 4 July 2013, p.113, available at: https://www.ea.gov.mk/images/stories/E_Izdanija/pravilnik_energetski_kontroli.pdf

$$\eta_g = 0.94 \cdot 0.93 \cdot 0.97 = 0.85$$

which represents a **minimum** improvement of the entire heating system of at least 16 per cent compared to the average values of technologies offered on the market and the existing energy efficient solutions. If we consider the share of heating in the total energy consumption, it is clear that the heat distribution and emission system should be part of this tool. In addition, completing the palette of products offered by the tool to include the heat distribution and emission systems allows investments in refurbishing and upgrading the household heating systems to be made either in total or in consecutive upgrades down the road.

Appropriate products and technologies that are part of this category and that directly affect the distribution and emission systems are:

- Pipe insulation
- Thermostatic valves
- Thermostats
- Smart thermostats
- Low-temperature heating, such as radiant heating (for example distribution and emission of heat through the surfaces/floor of the rooms)
- Household energy management systems (although they have a wider application, their influence on heating is dominant, so they are included in this category. They can represent separate category)

In addition, these technologies are part of the strategic planning to deal with the current energy crisis. For example, the International Energy Agency (IEA) adopted a plan: "A 10-Point Plan to Reduce the European Union's Reliance on Russian Natural Gas" which contains 10 most important measures that the IEA has identified, among which is the measure "8. Accelerate energy efficiency improvements in buildings and industry" which strongly focuses on the proposed technologies:

> *„Many households are installing smart heating controls (smart thermostats) to reduce energy bills and improve home comfort, and this is a simple process that can be scaled up quickly. Tripling the current installation rate of about one million homes per year would reduce gas demand for heating homes by an extra 200 mcm a year at a total cost of EUR 1 billion. These devices **can be incentivised through existing programmes** such as subsidies to households or utility obligation schemes."*[16]

These sub-categories are reviewed and attached in an annex through the appropriate form used to propose new categories in the Technology Selector tool, with appropriate calculations, proposed parameters and characteristics of each technology.

[16] A 10-Point Plan to Reduce the European Union's Reliance on Russian Natural Gas, IEA, 2022, p. 9, available at: https://iea.blob.core.windows.net/assets/1af70a5f-9059-47b4-a2dd-1b479918f3cb/A10-PointPlantoReducetheEuropeanUnionsRelianceonRussianNaturalGas.pdf

3. Justification for the introduction of a new category "Household appliances intended for cooking"

In this part of the analysis, the EU energy labeling and eco-design legislation was used, and subsequently the transposed secondary regulation in North Macedonia.

The EU energy labelling and eco-design legislation helps improve the energy efficiency of products on the EU market. The EU legislation for energy labels and eco-design has been estimated to bring energy savings of approximately 230 million tons of oil equivalent (Mtoe) by 2030. For consumers, this means an average saving of up to EUR 285 per year on their household energy bills. Moreover, energy efficiency measures will create EUR 66 billion in extra revenue for European companies.[17]

Eco-design sets common EU wide minimum standards to eliminate the least performing products from the market. The energy labels provide a clear and simple indication of the energy efficiency and other key features of products at the point of purchase. This makes it easier for consumers to save money on their household energy bills and contribute to reducing greenhouse gas emissions across the EU.

Roughly two-thirds of refrigerators and washing machines sold in 2006 were labelled as class A, whereas over 90 per cent of those sold in 2017 were labelled A+, A++ or A+++. Because of that, and as a result of the development of more and more energy efficient products, and the difference between A++ and A+++ is less obvious to the consumer, the EU energy labels categories will be gradually adjusted to reintroduce the simpler A to G scale. For example, a product showing an A+++ energy efficiency class could become a class B or lower after rescaling without any change in its energy consumption. The class A will initially be empty to leave room for more energy efficient models to be developed. Because of that, and because data for the new labeling system is available through the European Commission, a cross reference analysis using both the existing and the changed labels is used.

Taking into consideration the situation in the country, the household appliances intended for cooking have a similar share in energy consumption as refrigerators, as can be seen in Table 4. Considering that refrigerators are part of the categories in the tool, consequently, due to the similar potential for energy saving, but considering the different usage, they should be part of the Technologies Selector.

Due to diverse parameters in this category, general eligibility category is considered A+++ label[18] of the appliance, but the calculations are done separately for every type of equipment. For instance, the labeled energy consumption on some of the appliances is per cycle, while on other is per 100 cycles or annual consumption which shows the necessity to perform separate calculations for every type of appliance or ask the retailer/manufacturer to provide information in a defined standardized format.

For orientational energy savings, market research was done with cross reference to the EPREL - European Product Registry for Energy Labelling, and the following common values (with comparison of products

[17] https://ec.europa.eu/info/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/energy-label-and-ecodesign/about_en

[18] GTS Performance Criteria and Technical Attributes, EBRD

with similar capacity – for example volume of the oven) were obtained for the most used household appliances used for cooking (Table 6).

Table 6. Common values for heating appliances[19] [20]

	Q_{cycle}	$Q_{new.cycle}$
Electric oven (Energy consumption/cycle) A -> A+++	0.91	0.79
Dishwasher* (Energy consumption/100 cycles) C -> A	76	54
Range hoods (annual energy consumption) A -> A+++	45	23

*Even though dishwashers are not cooking appliances, they are kitchen appliances and naturally belong to this category.

Thus, according to the common values, it is obtained that the energy consumption cooking would decrease by 13 per cent, and accordingly, the total energy consumption would decrease by 1 per cent, which corresponds to the data published by the European Union. For example, according to the European Union, by switching to one of the most energy efficient cooking appliances, Europe will be able to save around 1 per cent of the annual energy consumed by households by 2030. This means around 2.7 million tons of CO_2 will be avoided annually by 2030 - about the annual emissions of four medium-sized power plants. [21]

The same calculation for dishwashers shows possibility to reduce the energy consumption for 29 per cent comparing A to A+++ products (the market research showed that the most common product and most available is A, so that was used as basis for the calculation). According to the European Commission, by switching to a more energy efficient dishwasher, it can be saved up to EUR 300 over the average lifetime of the product. With the implementation of the new EU energy labelling and eco-design requirements for efficient dishwashers, the EU will be able to save up to 2.1 TWh of electricity per year by 2030. This will in turn contribute to reducing greenhouse gas emissions by 0.7 metric tons of CO_2 equivalent per year. [22]

According to Table 6, the energy savings possibilities for range hoods, with replacement of a product with class A to A+++ is 49 per cent. It should be noted however that these products have significantly lower annual consumption than the rest of the reviewed products.

[19] Internal market analysis
[20] European Commission. EPREL - European Product Registry for Energy Labelling database. Available at: https://eprel.ec.europa.eu/screen/home
[21] European Commission. A Consumer's Guide to Energy-Efficient Ovens and Range Hoods. Available at: https://ec.europa.eu/info/sites/default/files/consumer_guide_cooking_appliances_en.pdf
[22] https://ec.europa.eu/info/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/energy-label-and-ecodesign/energy-efficient-products/dishwashers_en

III. Selected categories from the Green Selector Technology Tool to be included in the Green Economy Financing Facility (GEFF) Technology Selector Tool for North Macedonia

4. Defining the categories that would be included in the new Green Economy Financing Facility and represent the majority of energy usage in a typical household

The Green Selector Technology (GST) Tool developed by the EBRD is currently set to be the backbone of any future technology selector tools within the region. However, the already present Green Economy Financing Facility Technology Selector (GEFF) tool has been used throughout the region and in North Macedonia customized according to technologies that are present at the market and the interest of vendors to promote and support those technologies. This situation enables us to gather the experience and the information from the already present GEFF tool and add supplement that with the GST in creating a more robust tool that would serve the needs on the new project "Improving national capacity on renewable energy (RE) and energy efficiency (EE) technologies for small and medium enterprises (SMEs) and households in North Macedonia". As the Figure 3 shows, the technologies presented in the tool are covering the majority of end-use energy in a typical household. With the recommended categories from this report, the share of technologies that should be in a new tool will enhance the comprehensiveness of the tool even more.

The technology categories that we recommend that should be included in the new tool for North Macedonia are listed in the table below:

Table 7 Categories of energy efficient products for North Macedonia

Categories of energy efficient products for North Macedonia	
Category	Technology
Windows & Doors	Windows
	Glazing
	Doors
Thermal insulation systems	Building insulation materials
Boilers	Biomass boilers
	Boilers
	Solar thermal collectors
Heat Pumps	Water source heat pumps
	Ground source heat pumps
	Air-to-water heat pumps
	Air-to-air heat pumps

Categories of energy efficient products for North Macedonia	
Heating systems	Thermostatic valves
	Thermostats
	Smart thermostats
Cooling	Comfort chillers
	Condensing units
Motors & Pumps	Water pumps
Appliances	Washing machines
	Dishwasher
	Fridges & Freezers
	Dryers
	Electric ovens
	Range hoods
	Hot water cylinder
	Air Conditioners
Lighting	LED Lighting
	Solar LED Lighting
Ventilation	Residential ventilations units
Power & Cogeneration	Photovoltaics
	Li-Ion batteries
Home energy management systems	Thermal sensors
	Occupancy sensors
	Open/close sensors
	Software

In addition, we recommend that there should be additional analysis done that would provide guidance to best low-cost technologies with high impact on energy usage in a household in North Macedonia. That analysis would help the most vulnerable group of people to tackle energy poverty.

IV. Conclusion and recommendations

The main conclusion regarding the current state of the Technology Selector is that while there is room for improvement in updating the existing product portfolio, the effects on the overall usage of the tool would be minor and negligible due to already large database of products offered. Confirmation of this is the research of the market in the region and the large percentage of coverage of retailers/distributor/manufacturers and technologies. Additionally, similar markets, such as Albania, Bosnia and Herzegovina, and Serbia, show similar results to the North Macedonia version of the tool.

A relatively weak fulfillment of technologies from the categories of windows, refrigerators and freezers, as well as to a lesser extent, lamps, is observed.

On the other hand, to increase the comprehensiveness of the Tool it is necessary to cover in more details categories of technologies in terms of household heating, considering the share in the final energy consumption of energy, and the dominant share of the heating systems (68.7 per cent).There is an absence of technologies in terms of heat distribution and emission systems. It is recommended to include technologies such as thermostatic valves, thermostats, smart thermostats, energy management, as well as distribution systems such as underfloor heating. Notable products that are missing in the Tool are the household appliances intended for cooking, and these products have significant share in the final energy consumption in an average household.

In that regard, this analysis provides the following recommendations for updating the Technology Selector in North Macedonia, but the same applies to similar markets, such as those in Albania, Bosnia and Herzegovina, and Serbia.

Recommendations

- Regular communication with vendors to be established. For the technologies in the tool to be regularly updated by the vendors/distributors, including availability and technical specifications, this communication can offer significant motivation. It is recommended that best practices be presented to them in a form of communication that will be chosen (for example, a monthly newsletter), which will also act as a motivation and contribute to the formation of more active companies, timely updating of data and introduction of new technologies and products.

- Introduction of new categories already analyzed and presented in this report. The introduction of new categories in the tool is a response to the dynamic needs of households. Future updates and introduction of new categories should be in accordance with the changes of the national and regional policies and strategies, as well as when there are special recommendations during an energy crisis.

- Introduction of a parameter on dynamic return of investment per energy saved. This parameter should be used to guide vulnerable categories of the population and those that are affected by

energy poverty to find the most cost-effective products for short term effects on their energy consumption. These recommended products should have the highest cost / kwh saved ratio, instead of recommendations on best energy performance. In addition, any product that would have subsidy or government support mechanism attached to it, should also be available within the tool, to clearly state and support in promotion of those technologies.

- Long term tool development in a special category of products for distributed heating systems for rural areas or multi-apartment housing that would be targeted to municipalities/tenant associations/RE cooperatives, etc.

- Additional analysis should be done that would analyze the typical energy usage patterns in a household and provide guidelines on best practices and technologies that would require least amount of funds to elevate the energy efficiency rating of the household. These guidelines should target the most vulnerable groups of people, provide them with basic understanding of energy efficiency and how that could have an impact on the quality of life in the household and the priority of investments to tackle energy poverty.

V. Data sheets for recommended new technologies to be included in the Green Economy Financing Facility (GEFF) Technology Selector Tool for North Macedonia

The technical description for the recommended new technology categories that should be included in the upgrade of the Green Economy Financing Facility (GEFF) Technology Selector Tool for North Macedonia are listed here.

IV.1 Recommended technologies to be included in the tool

1. Thermostats, Smart Thermostats and Thermostatic Valves

Table 8. Data model for Thermostats, Smart Thermostats and Thermostatic valves

Data model	
Name of technology	(Smart) Thermostatic radiator valves, thermostats and smart thermostats
Technology description	Valves and devices that regulate the temperature and prevent overheating, thus create more healthier environment and energy savings, especially in the building connected to the central district heating.
Impact potential of the technology	• ***Climate Change Mitigation (renewable energy, energy efficiency, low embodied carbon)*** • *Climate Change Adaptation* • *Sustainable use of Water and Marine Resources* • *Circular Economy* • ***Pollution Prevention*** • *Healthy Ecosystem*
Contribution to the environmental objectives	• Saves energy by reducing the overheating and the flow of hot water • Increases the efficiency of the heating system
Relevant technology categories on the Green Technology Selector	Even though this technology can be applicable in the Boilers category, it naturally should be in category: Heating – this category involves other types of heating where the heat source is not located at the premises (e.g., district heating), as well as the distribution of heat through the heating area. For example, the thermostats are reducing the necessary heat. Other technologies, for example, can be surface heating (floor heating), can increase the efficiency of the distribution system.
Applicability	*Buildings sector*
Buyer types	*Households, services*

Photo of the technology	

Table 9. Performance criteria unit for Thermostats, Smart Thermostats and Thermostatic valves

Performance Criteria unit	**It is recommended that all products in this category be considered as acceptable** to be included in the Tool. **The performance should be rated according to reference performance of system without these products, thus no performance criteria unit is suggested. This is due to the current low level of awareness in the market for such products, so utilization of such products is limited and any inclusion of these products in a household system will improve the performance of the system.** **Justification of energy savings compared to reference system without the suggested technologies:** The proposed technology directly affects the efficiency of the heat distribution and heat emission systems. National average for the emission (radiators) is 0.74-0.91, while the same value with implementation of thermostatic valves 0.93 (Bottom-up methodology for calculation and verification of energy savings – Official Gazette No. 94 from 4.07.2013) Level of control can create a more comfortable environment, while increasing energy saving. For example, remote control, or central control in the case of several products can influence significantly energy saving. On the other side, reporting is crucial for changing the habits and learning how to increase the savings while maintaining the comfort level.
Proposed performance for the country in your respective country	21 per cent savings from the heat demand compared to the buildings without thermostatic radiator valves, thermostats, and smart thermostats.

Environmental impact calculation

Considering the defined performance criteria, the energy savings can be calculated with the following method.

The procedure is applicable for new installation of thermostatic valves on radiators that do not have thermostatic valves. It can be applied to residential and non-residential buildings.

The same procedure that is provided for the calculation of energy savings through the installation of thermostatic valves on radiators can be applied to the calculation of energy savings from modernization, the creation of a complete energy-efficient heating system (generation, distribution and emission of heat) or only on one of its parts – (generation of heat, distribution and radiation of heat).

$$TFES = A * SHD * \frac{1}{\eta_{boiler} * \eta_{dis}} * \left(\frac{1}{\eta_{ini}} - \frac{1}{\eta_{new}}\right) \quad [23]$$

Where:

TFES	Total final energy savings [kWh/a]
SHD	Specific heat demand [kWh/m^2/a]
A	Total heat area [m^2]
η_{boiler}	Annual efficiency for energy source
η_{dis}	Annual efficiency of the heat distribution and emission system
η_{ini}	Annual efficiency of the existing system or element for heating
η_{new}	Annual efficiency of the new system or element for heating

In order to calculate energy savings, the following national common values are used, as defined in the secondary regulation of the country:

Table 10. National common values for heating systems[24]

Parameter	Description	Unit	Common value
Life		[yr]	**10**
Conditioned area	A	[m^2]	
Specific heat energy need	SHD	[kWh/m^2/a]	**120**
Annual efficiency of the heat source	η_{boiler}	[-]	**0.83**
Annual efficiency of the heat distribution and emission system	η_{dis}	[-]	**0.93**
Annual efficiency of the existing system or element for heating	η_{ini}	[-]	**0.81**
Annual efficiency of the new system or element for heating	η_{new}	[-]	**0.93**

[23] Ministry of Economy. (2013) Rulebook for Energy Audits, Bottom-up Methodology, Official Gazette no. 94 from 4 July 2013. Available at: https://www.ea.gov.mk/images/stories/E_Izdanija/pravilnik_energetski_kontroli.pdf

[24] Ministry of Economy. (2013) Rulebook for Energy Audits, Bottom-up Methodology, Official Gazette no. 94 from 4 July 2013. Available at: https://www.ea.gov.mk/images/stories/E_Izdanija/pravilnik_energetski_kontroli.pdf

Using the proposed energy calculation method, for example, for a household with total conditioned area of 71m^2 (which is average conditioned area for an average household of 3.7 members according to the State Statistical Office), the energy savings are 1758 kWh/a.

If the conditioned area is set to 1 square meter, the specific savings for the technology can be calculated (and compared to the SHD) – the specific energy savings are 25kWh/m^2/a, or compared to the SHD, it represents **21 per cent savings**.

From other side, according to the European Union, turning down the thermostat in the homes by just 1 °C would save around 7 per cent of the energy that is used for heating.[25] The average temperature in the households that are connected to the district heating is 24°C (assumption based on measurement on small sample), which will amount to 28 per cent savings, which also shows that the above methodology is viable and correct.

Based on the assumption that this technology has the greatest potential to be used in buildings connected to the central district heating, the used CO_2 emission coefficient based on the fuel mix used for the central heating is 0.259 (defined in the national regulation). So, the average annual CO_2 emission reduction from a household, given the above defined assumptions, is 0.455t CO_2/a.

Reference products and details – thermostats/smart thermostats:

Name: Siemens RDS110

Description: Smart thermostat controlled by touch or via mobile application. With built-in sensors of temperature, humidity, air quality, movement of people and light intensity. Intelligent boiler switching.

Technical specification: https://sid.siemens.com/v/u/A6V10807602

Availability/link on local market: http://www.termosistem.com.mk/product/siemens-smart-wi-fitermostat-rds110/

Reference products and details – thermostatic radiator valves/smart thermostatic valves:

Name: Herz TS-98-V

Description: Thermostatic radiator valve for regulation of room temperature

Technical specification:
https://herzmediaserver.com/data/01_product_data/01_datasheets/TS_98_V_EN.pdf

Availability/link on local market: https://herz-mk.com/catalog.php?prodID=1144&lng=mkd

[25] European Commission. (2022). Press Release: Key energy saving actions. Available at: https://ec.europa.eu/info/news/european-commission-and-iea-outline-key-energy-saving-actions-2022-apr-21_en

2. Electric Ovens

Table 11. Data model for electric ovens

Data model	
Name of technology	Electric Ovens
Technology description (1-2 sentences)	Household appliances intended for cooking, generally one of the appliances in a household with greatest energy capacity (above 3kW).
Impact potential of the technology	• ***Climate Change Mitigation (renewable energy, energy efficiency, low embodied carbon)*** • *Climate Change Adaptation* • *Sustainable use of Water and Marine Resources* • *Circular Economy* • ***Pollution Prevention*** • *Healthy Ecosystem*
How does it contribute to the above-mentioned environmental objectives	It contributes to the above-mentioned environmental objectives by energy savings, thus reducing environmental pollution. Additionally, it directly heats up the space and causes additional indirect energy savings (for example, on cooling during summer)
Relevant technology categories on the Green Technology Selector	**Appliances**
Applicability	*Buildings sector*
Buyer types	*Households, services*
Photo of the technology	

Table 12. Performance criteria unit for electric ovens

Performance Criteria unit	Energy label A+++
Top quality product performance	Energy labelled A+++ ovens have significant energy consumption reduction per cycle than average market product (A+). It can save up to 13 per cent electricity compared to an average product available on the market.
Proposed performance for the country in your respective country	13 per cent savings compared to state-of-art products.

Environmental impact calculation

The basis for analysis of this subcategory is its energy label. In order to define the state of the art, as well as more energy efficient products, and compare them, a market analysis was performed and compared to the EPREL – European Product Registry for Energy Labelling. Most available products are labelled as A class, with an average electricity consumption of 0.91 kWh/cycle. The high-end products are classified as A+++, with an average electricity consumption of 0.79 kWh/cycle.

So, according to the common values, it is obtained that the energy consumption for burning would decrease by 13 per cent, That is, the total energy consumption would decrease by 1 per cent, which corresponds to the data published by the European Union. For example, according to the European Union, by switching to one of the most energy efficient cooking appliances, Europe will be able to save around 1 per cent of the annual energy consumed by households by 2030. This means around 2.7 million tons of CO_2 will be avoided annually by 2030 – about the annual emissions of four medium-sized power plants. [26]

Reference products and details – electric ovens:

Name: WHIRLPOOL AKZ9 6270 IX

Description: The Whirlpool built-in oven is characterized by smart clean technology. With just one touch of a button it provides an independent cleaning cycle that ensures ideal cleaning results. , It's the advanced electrical technology that allows you to prepare meals while saving energy. Its halogen lamp enables working with greater energy savings.

Technical specification: https://whirlpool-cdn.thron.com/static/0QZXDL_PR859991530370sr_VPB0TT.pdf?xseo=&response-content-disposition=inline%3Bfilename%3D%22Tehni-ki-list.pdf%22

Availability/link on local market: https://setec.mk/index.php?route=product/product&product_id=70974

[26] European Commission. A Consumer's Guide to Energy-Efficient Ovens and Range Hoods. Available at: https://ec.europa.eu/info/sites/default/files/consumer_guide_cooking_appliances_en.pdf

3. Dishwashers

Table 13. Data model for dishwashers

Data model	
Name of technology	Dishwasher
Technology description (1-2 sentences)	A mix of water and dishwasher detergent is pumped to one or more rotating sprayers, cleaning the dishes with the cleaning mixture. The mixture is recirculated to save water and energy.
Impact potential of the technology	• ***Climate Change Mitigation (renewable energy, energy efficiency, low embodied carbon)*** • *Climate Change Adaptation* • ***Sustainable use of Water*** *and Marine Resources* • *Circular Economy* • ***Pollution Prevention*** • *Healthy Ecosystem*
How does it contribute to the above-mentioned environmental objectives	It contributes to the above-mentioned environmental objectives by energy savings, thus reducing environmental pollution. Additionally, due to its water consumption, efficient products reduce the use of water.
Relevant technology categories on the Green Technology Selector	**Appliances**
Applicability	*Buildings sector*
Buyer types	*Households*
Photo of the technology	

Table 14. Performance criteria unit for dishwashers

Performance Criteria unit	Energy label A+++
Top quality product performance	Energy labelled A+++ dishwashers have significant energy consumption reduction per cycle than average market product (A+). It can save up to 29 per cent electricity compared to an average product available on the market.
Proposed performance for the country in your respective country	29 per cent savings compared to state-of-art products.

Environmental impact calculation

The basis for analysis of this subcategory is its energy label. In order to define the state of the art, as well as more energy efficient products, and compare them, a market analysis was performed and compared to the EPREL – European Product Registry for Energy Labelling. Most available products are labelled as C class, with an average electricity consumption of 76 kWh/100 cycles. The high-end products are classified as A, with an average electricity consumption of 54 kWh/100 cycles.

The calculation for dishwashers shows possibility to reduce the energy consumption by 29 per cent comparing A to A+++ products (the market research showed that the most common product and most available is A, so that was used as basis for the calculation). According to the European Commission, by switching to a more energy efficient dishwasher, it can save up to EUR 300 over the average lifetime of the product. With the implementation of the new EU energy labelling and eco-design requirements for efficient dishwashers, the EU will be able to save up to 2.1 TWh of electricity per year by 2030. This will in turn contribute to reducing greenhouse gas emissions by 0.7 metric tons of CO_2 equivalent per year. [27]

Reference products and details – Dishwashers:

Name: WHIRLPOOL WFO 3P23 PL X

Description: This Whirlpool dishwasher features: i) inox color; ii) outstanding A+++ energy rating, for reduced energy consumption; iii) convenient digital countdown timer, to inform you when the washing cycle is complete: iv) innovative technology ensuring extra silent performance, for a very quiet appliance; v) superb cleaning performance, for ideal washing results

Technical specification: https://whirlpool-cdn.thron.com/static/6RIZIL_PR859991017250en_6EVQTR.pdf?xseo=&response-content-disposition=inline%3Bfilename%3D%22Product-Data-Sheet.pdf%22

Availability/link on local market: https://setec.mk/index.php?route=product/product&product_id=74048

[27] https://ec.europa.eu/info/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/energy-label-and-ecodesign/energy-efficient-products/dishwashers_en

IV.2 Technologies that offer significant potential and should be additionally analyzed

4. Radiant heating (Floor/Surface heating)

Table 15. Data model for radiant heating

Data model	
Name of technology	Radiant heating (Floor/Surface heating)
Technology description (1-2 sentences)	Radiant heating systems supply heat directly to the floor or to panels in the wall or ceiling of a house. The systems depend largely on radiant heat transfer – the delivery of heat directly from the hot surface to the people and objects in the room via infrared radiation.
Impact potential of the technology	• ***Climate Change Mitigation (renewable energy, energy efficiency, low embodied carbon)*** • *Climate Change Adaptation* • *Sustainable use of Water and Marine Resources* • *Circular Economy* • ***Pollution Prevention*** • ***Healthy Ecosystem***
How does it contribute to the above-mentioned environmental objectives	It contributes to the above potential impact by more efficient heating distribution. It also reduces the heating volume, and the temperature of the heat transfer fluid (low temperature heating). It improves comfort by less heat demand and saves energy, creates more healthier environment (no allergens) and reduces the carbon footprint.
Relevant technology categories on the Green Technology Selector	Category: Heating – this category involves other types of heating where the heat source is not located at the premises (e.g., district heating), as well as the distribution of heat through the heating area. For example, the thermostats are reducing the necessary heat. Other technologies, for example, can be surface heating (floor heating), can increase the efficiency of the distribution system.
Applicability	*Buildings sector, service sector*
Buyer types	*Households, services*
Photo of the technology	

Table 16. Performance criteria unit for radiant heating

Performance Criteria unit	Work range is one parameter that can influence the use of the proposed technology in different systems. Thermal conductivity of pipes – [W/(mK) <0.35 Thermal conductivity of slabs floor under the pipes - [W/(mK) <0.035
Top quality product performance	12 per cent energy savings compared to conventional heating emission systems.
Proposed performance for the country in your respective country	Systems with thermal conductivity of pipes of 0.4 compared to 0.35 equals 12 per cent difference

Environmental impact calculation

As a starting point, the following figure shows the share of the energy source in the household sector. The figure shows that most of the households use inefficient boilers with combustion of firewood, while there is significant share of the households that directly use electricity to cover their heating needs. This stresses out the need for measures for more efficient heating.

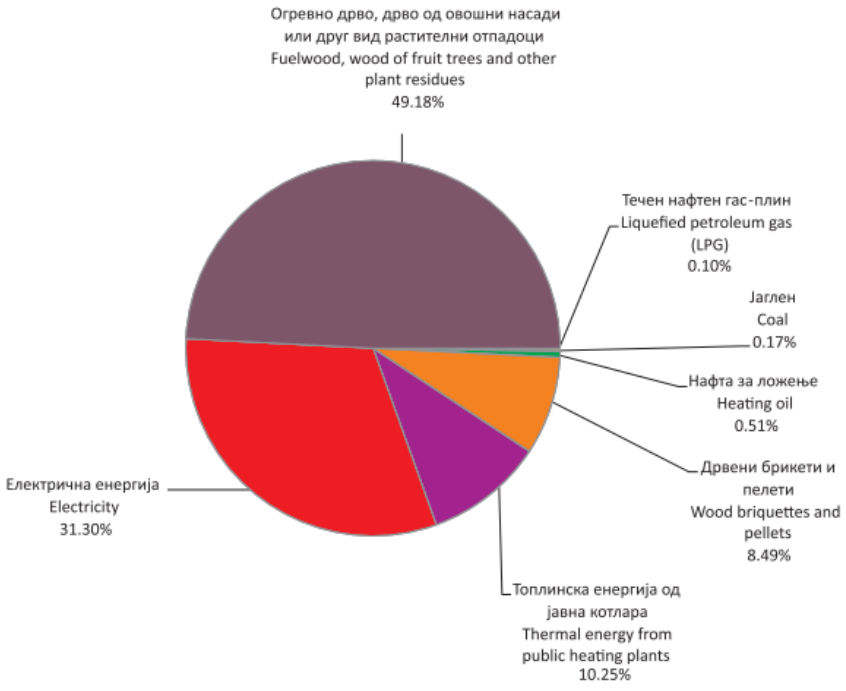

Figure 7. Share of the energy source in the heating in households (2019)[28]

Measures like more efficient heating with heat pumps and floor/surface distribution and emission systems are necessary to improve/reduce the overall energy demand for heating in households (which represents more than 2/3 of the energy demands in households).

[28] State Statistical Office. (2019). Energy Consumption in Households. Statistical review 6.4.21.01/915,

The energy savings potential of radiant heating cannot be represented without detailed analysis of several elements. It is highly dependent on the existing situation in the building – example - the building envelope elements could cause heat fluctuation and provide heat losses, thus influencing the efficiency of the whole system. It also is dependent on the heat source, thus using heat pumps can double the results of the overall system.

Still, compared to more conventional systems, for example radiator system, according to literature review, the savings can be from 10-12 per cent[29] [30]due to its large share of energy radiation surface heating systems, the feeling of coziness for the heating time is already noticeably lower room temperature. It can be reduced by 1 °C to 2 °C. This enables annual energy savings of 10 to 12 per cent.

But apart from the energy savings, even though they are the most important aspect of motivation for installing these systems, there are a wide range of other benefits, like allergen-free environments, increased comfort, etc.

Reference products and details – Radiant heating:

Name: REHAU Rautherm speed

Description: The system is composed of several elements that offer fast installation and an efficient system of distribution of heat through the surfaces of the building.

Technical specification/availability on local market:
https://www.rehau.com/downloads/1120632/%D1%82%D0%B5%D1%85%D0%BD%D0%B8%D1%87%D0%BA%D0%B0-%D0%B8%D0%BD%D1%84%D0%BE%D1%80%D0%BC%D0%B0%D1%86%D0%B8%D1%98%D0%B0.pdf

[29] Rehau. (2021). Technical information – surface heating/cooling. Available at: https://www.rehau.com/downloads/1120632/%D1%82%D0%B5%D1%85%D0%BD%D0%B8%D1%87%D0%BA%D0%B0-%D0%B8%D0%BD%D1%84%D0%BE%D1%80%D0%BC%D0%B0%D1%86%D0%B8%D1%98%D0%B0.pdf

[30] Sabru Ionan, Sebarchievici Calin, "Performance Evaluation of Radiator and Radiant Floor Heating Systems for an Office Room Connected to a Ground-Coupled Heat Pump", Energies, 2016.

5. Home energy management systems (HEMS)

Table 17. Data model for HEMS

Data model	
Name of technology	Home energy management systems (HEMS)
Technology description	HEMS is a combination of hardware (installed in homes) and software that monitors and displays the energy consumption, usually via a smart phone app or website.
Impact potential of the technology	• ***Climate Change Mitigation (renewable energy, energy efficiency, low embodied carbon)*** • *Climate Change Adaptation* • *Sustainable use of Water and Marine Resources* • *Circular Economy* • ***Pollution Prevention*** • ***Healthy Ecosystem***
Contributions to the environmental objectives	It creates direct energy saving from control of different systems, but also indirect savings based on reporting and learning (both from the end of the user and the technology). It is one of the most important aspects defined in the revised Energy Performance of Buildings Directive (EPBD) (European Parliament, 2018) that introduces the 'Smart Readiness Indicator' (SRI) to characterize the buildings' ability to ensure comfort, sustainable energy, effective control and operation, use and optimal interaction with the energy system.
Relevant technology categories on the Green Technology Selector	Category: Heating – this category involves other types of heating where the heat source is not located at the premises (e.g., district heating), as well as the distribution of heat through the heating area. For example, the thermostats are reducing the necessary heat. Other technologies, for example, can be surface heating (floor heating), can increase the efficiency of the distribution system.
Applicability	*Buildings sector*
Buyer types	*Households, services*
Photo of the technology	

Table 18. Performance criteria unit for HEMS

Performance Criteria unit	**Min number of sensor sets >3** Due to the nature of the technology, it is important that every product covers at least the most important systems such as the heating, the lighting, the plug load and occupancy in the room.

Environmental impact calculation

Energy savings as a result of the introduction of computerized systems for energy management, represented by the group of standards ISO 50001 or other standards for energy management, are calculated based on the annual consumption of final energy (separately for electricity and heat energy). before the introduction of the energy management system. The final energy savings are calculated according to the attached formula below. When applying the formula, it is necessary to pay attention to the following:

The method can only focus on specific uses and not on the total final energy consumption, especially when the energy management system is aimed at specific applications (e.g., lighting, cooling). In such cases, the total final energy consumption refers only to the consumption of specific applications. The same applies when energy management refers to specific energy carriers (e.g., gas).

Other factors affecting the final energy consumption should be considered before confirming savings from this measure (e.g., changes in the heating floor area).

Attention will be paid, so that there is no occurrence of double counting when the introduction of the energy management system caused an investment (for example, modernization of the lighting system with the introduction of an energy efficient system). In that case, the savings will be confirmed in one of the measures.

$$TFES = FEC_{EL} * S_{EL} + FEC_{H} * S_{H}$$[31]

Where:

TFES Total final energy saving [kWh/a]

FECEL Final electrical energy consumption [kWh/a] before introduction of the system

SEL Savings factor for electricity as a result of the introduction of the energy management system

FECH Final heating energy consumption [kWh/a] before introduction of the system

SH Savings factor for heating as a result of the introduction of the energy management system

[31] MultEE project. (2017). Bottom-up methodology for the calculation and verification of energy savings and common values for North Macedonia.

The national common values are given in the following table.

Table 19. National common values for HEMS[32]

Parameter	FECEL [kWh/a]*	SEL [%]**	FECh [kWh/a]***	Sh [%]**
National common value	5354	2.8	10116	2.8

*According to the State statistical office, the average household is 84.3 m^2, while the specific electricity consumption is 63 kWh/m^2 a.

** The energy saving factor should be determined for each particular case. As information for comparison is the data according to study research in Austria and Germany which show savings of approximately 2.8 per cent on an annual level.

According to the specified methods and with consideration of the national common values, the introduction of HEMS can result in 434 kWh/a energy savings, which is 2.8 per cent of the total energy demand of a household.

[32] MultEE project. (2017). Bottom-up methodology for the calculation and verification of energy savings and common values for North Macedonia.

6. Range Hoods

Table 20. Data model for range hoods

Data model	
Name of technology	Range hoods
Technology description (1-2 sentences)	A kitchen hood, extractor hood, range hood, or exhaust hood is a device containing a mechanical fan near the stove or cooktop in the kitchen. It removes airborne grease, combustion products, fumes, smoke, heat, and steam from the air by evacuation of the air and filtration.
Impact potential of the technology	• ***Climate Change Mitigation (renewable energy, energy efficiency, low embodied carbon)*** • *Climate Change Adaptation* • *Sustainable use of Water and Marine Resources* • *Circular Economy* • ***Pollution Prevention*** • *Healthy Ecosystem*
How does it contribute to the above-mentioned environmental objectives	It contributes to the above-mentioned environmental objectives by energy savings, thus reducing environmental pollution.
Relevant technology categories on the Green Technology Selector	**Appliances**
Applicability	*Buildings sector*
Buyer types	*Households, services*
Photo of the technology33	

Table 21. Performance criteria unit for range hoods

Performance Criteria unit	Energy efficiency class A+++
Top quality product performance	Energy efficiency class A+++ range hoods have significant energy consumption reduction per cycle than average market product (A). It can save up to 49 per cent electricity compared to an average product available on the market.
Proposed performance for the country in your respective country	49 per cent savings compared to state-of-art products.

Environmental impact calculation

The basis for analysis of this subcategory is its energy label. In order to define the state of the art, as well as more energy efficient products, and compare them, a market analysis was performed and compared to the EPREL - European Product Registry for Energy Labelling. Most available products are labelled as A class, with an average electricity consumption of 45 kWh/y. The high-end products are classified as A+++, with an average electricity consumption of 23 kWh/y. So, according to the common values, it is obtained that the energy consumption for these appliances would decrease by 49 per cent.

Reference products and details – Range Hoods:

Name: AEG DBK8990HG 942051312

Description: The AEG DIK8190HG island hood in anti-fingerprint stainless steel finish measures 100 cm, has a highly powerful and super silent motor that sucks and filters the air of modern kitchen.

Technical specification: https://www.aeg.de/kitchen/cooking/cooker-hoods/islandhood/dik8190hg/

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