Support to the renovation wave - energy efficiency pathways and energy saving obligation in Estonia

Deliverable 6: Catalogue of energy saving measures and calculation methodologies

(REFORM/SC2022/067)

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(REFORM/SC2022/067)

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In association with:

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1 Introduction

This catalogue of energy saving measures and calculation methodologies is composed of

- one excels sheet per energy saving measure with all calculation's assumptions and formulas, that have directly fed in the overall model
- this report which develops and explain into details all parameters of the measures and expresses them in a comprehensive way to allow every user of the catalogue to understand the logic of the measures.

The catalogue is structured by sector, i.e., residential, non-residential, industry, transport, and agriculture/forestry. It is focusing on the final energy consumption, i.e. the total energy consumed by end users, such as households, services, transport, industry and agriculture. Final energy is the energy which reaches the final consumer's door and excludes that which is used by the energy sector itself.

All together 45 energy saving measures are included with standardised calculation methodologies and indicators for calculating energy savings in line with Article 7 and Annex V of the EED and adapted to the Estonian context.

In the following summary table 1, all measures with annual volumes and energy savings as well as with a unit cost are reported. It should be noted that there are considerable differences in the unit cost and in the cost allocation. Depending on the sector and the type of measure, 100% of the cost may come to the government, or smaller fraction of government may mobilise private sector investments or 100% may be covered by end users, making direct cost comparison complicated. Differences in the unit costs in principle show variations in the efficiency, but evidently the targets cannot be achieved with low-cost measures only. The total row in the table sums costs and savings of all measures which is indicative, because obviously all measures cannot be applied at the same time as some of them operate with similar target groups and summing can lead to double counting. Therefore, the summary table aims to present a complete palette of possible measures with key performance indicators, from which different energy efficiency pathways may be constructed as it is done in Deliverable D3 report: 'Deliverable 3: Comprehensive study of energy efficiency pathways for Estonia'.

Table 1. Summary table of the energy saving measures

			Cost and savings per year			2024-2030 cumulative			
			Cost (M€/a)	Savings (GWh/a)	Unit cost, first year (€/MWh)	Cost (B€)	Savings (TWh)	Unit cost (€/MWh)	Cost allocation
Residential	nR1	Obligation scheme for residential sector	379.7	109.0	3483	2.4	2.3	1046	Energy provider (billed to end user)
	nR2	MEPS targeting rented + sold dwellings	337.5	55.3	6102	2.1	1.2	1833	Building owner
	nR3	MEPS for all dwelling (regulatory requirements for EPC class E, F, and G or above)	1108.1	181.6	6102	7.0	3.8	1833	Homeowners
	nR4	Renovation grants for single family houses (20-30% support)	10.0	8.0	1250	0.1	0.2	325	30% government 70% homeowners (government cost reported)
	nR5	Tax deduction for renovation works by private persons (=parallel track for single family)	3.0	7.2	417	0.0	0.1	123	Tax deduction to homeowners (lost tax for the government)
	nR6	Renovation grants for multifamily buildings/housing associations (30% support)	150.0	117.6	1275	1.1	3.2	325	30% government 70% homeowners (government cost reported)
	nR7	Property tax (according to EPC levels)	50.0	40.0	1250	0.3	0.8	369	Homeowners
	nR8	CO2 tax for end energy use of residential buildings	50.0	40.0	1250	0.3	0.8	369	Homeowners
Service	nS1	Obligation scheme for service sector	152.6	56.0	2726	1.0	1.2	819	Energy provider (billed to end user)
	nS2	Central government buildings renovation support (100% support)	15.0	1.8	8333	0.1	0.1	2213	80% government
	nS3	Public and municipality buildings renovation support (60% support in average)	66.0	13.2	5000	0.4	0.3	1502	60% central government 40% local government (government cost reported)
	nS4	Commercial buildings energy performance investments support	50.0	72.0	694	0.3	1.5	205	30% government 70% building owners (government cost reported)
	nS5	CO2 certificate sales based on energy savings from commercial buildings renovation, income invested as renovation support	10.0	14.4	694	0.1	0.3	205	Businesses buying certificates
	nS6	CO2 tax for end energy use of commercial buildings	50.0	72.0	694	0.3	1.5	205	Building owners
	nS7	Property tax (according to EPC levels)	50.0	72.0	694	0.3	1.5	205	Building owners
	nS8	Minimum energy performance standards for non-residential buildings (regulatory requirements for EPC class E and F)	70.0	30.2	2315	0.4	0.6	695	Building owners
Industry and agriculture	nI1	Voluntary scheme for the industry, with binding targets based on incentives	4.1	81.9	50	0.0	0.5	50	Industry
	nI2	Promotion of resource-efficient green technologies of industrial enterprises (RRP)	0.2	0.6	407	0.0	0.3	71	government + industry (government cost reported)
	nI3	Energy savings from electro intensive companies	1.7	4.1	407	0.0	0.1	116	government + companies (government cost reported)
	nI4	Investment support for the food industry to ensure security of energy supply	1.4	3.4	407	0.0	0.1	116	government + companies (government cost reported)
	nI5	Supporting energy efficiency investments in companies	5.8	14.1	407	0.0	0.3	116	government + companies (government cost reported)
	nI6	Energy consulting and networking events for small and medium enterprises (SMEs)	0.7	1.0	688	0.0	0.0	197	100% government
	nA2	Energy efficiency measures in the fisheries sector	1.4	6.8	200	0.0	0.1	80	government + companies (government cost reported)
Transport	nT1	Promotion of clean and energy efficient road transport vehicles in public procurement	87.5	13.8	6321	0.6	0.3	1899	100% government
	nT2	Subsidy for public transport usage instead of personal vehicle	0.4	23.3	17	0.0	0.1	16	100% government
	nT3	Priority lanes for micromobility	16.0	23.3	686	0.1	0.5	196	100% government
	nT4	Electric charging infrastructure for existing inhabitance areas	3.4	-1.0	-3507	0.0	0.0	-1002	50% government
	nT5	Biomethane infrastructure	5.4	-1.0	-5355	0.0	0.0	-1530	50% government
	nT6	Hydrogen infrastructure	2.7	0.0	-72292	0.0	0.0	-20655	50% government
	nT7	Vehicle tax for registration	0.2	-4.2	-36	0.0	-0.1	-2	Vehicle owners
	nT8	Annual vehicle tax	0.2	-11.2	-13	0.0	-0.1	-2	Vehicle owners
	nT9	Development of convenient and modern public transport	3.3	43.6	75	0.0	0.9	48	100% government
	nT11	Developing the railroad infrastructure (includes the building of Rail Baltic)	420.0	339.4	1237	1.4	1.4	995	100% government
	nT12	The railroad electrification	200.0	46.7	4283	0.4	0.7	570	100% government
	nT13	Promoting the use of biomethane in buses	0.0	-0.8	0	0.0	0.0	0	100% government
	nT14	Promoting the use of electricity in buses	2.5	0.5	5401	0.0	0.0	6751	100% government
	nT15	Acquisition of additional passenger trains	20.0	21.6	926	0.1	0.3	206	100% government
	nT16	New tram lines in Tallinn	55.0	59.9	919	0.1	0.4	153	100% government
	nT17	Subsidy for micromobility usage instead of personal vehicle	0.4	23.3	17	0.0	0.3	7	100% government
	nT18	All Tallinn and Tartu taxis run on electricity	0.0	0.8	0	0.0	0.0	0	50% government 50% taxi companies
	nT19	Tallinn and Tartu congestion charge	0.1	0.0	-	0.0	0.0	-	Road users
	nT20	Mileage-based road use fee for heavy vehicles.	0.0	-1.1	0	0.0	0.0	0	100% government
	nT21	Subsidizing biofuel that meets the criteria of sustainability or imposing the obligation to sell it to filling stations	43.3	66.6	650	0.3	1.4	186	100% government
	nT22	Replacing existing street lamps with LED lamps	3.8	5.9	641	0.0	0.1	183	100% government
Total			**3431**	**1652**		**19.2**	**26.8**		

2 EE measures for the residential sector

Calculation method for residential building measures

A significant share of energy usage in Estonia is linked to buildings due to the cold climate and the aging building stock. Energy saving in this category is mostly achieved through renovation. Since all renovation in residential buildings are similar, one type of calculation is used. The calculations for all measures primarily rely on data from two comprehensive studies based on KredEx renovation grants for apartment buildings described in this work as nR6. In the study a 5 storey 3000m^2 building with 60 apartments is fully renovated to EPC level C including improved insulation, a heat recovering ventilation ensuring proper indoor climate and 50kW photovoltaic panels. This renovation costs 450€/m^2 and saves 102kWh/m^2 of heat and 6kWh/m^2 electricity every year. For economic impact and tax return a statistical study involving integrated and energy and investment analyses of Estonian building stock. The volume of a measure is chosen according to objectives and the area of corresponding building stock The savings and cost are calculated over a period to find cumulative values over ten years including the effect of inflation 2%/y. In measures where cost is allocated between different parties total volume of investments mobilised is calculated as well as cost for government. Jobs created is calculated from total investment volume. Unit cost €/MWh is calculated from government cost and sum of energy savings.

In the calculation table underneath the savings and cost calculation, there is a table that shows the necessary renovation area per year and what percentage of total building stock area it comprises. These calculations are for the measure nR6 and adapted to other measures to accommodate for different levels of renovation and different sections of the building stock. Specific adaptions are described under each measure.

2.1 nR1 – Obligation scheme for residential sector

2.1.1 Principle of the measure

Obliges the energy supplier to take energy efficiency actions (stimulate investments in building stock). To meet their obligation, energy suppliers or distributors must invest in or promote energy efficiency measures and programs for residential buildings. This will be achieved through renovation of the worst performing buildings to EPC level D and installation of PV panels.

2.1.2 Calculation of energy savings

Energy savings are calculated as 80% of nR6, because renovation is to EPC level D.

Energy savings	Value
Heating energy savings	**64 kWh / m^2** (EPC level D renovation)
Electricity savings	**5 kWh / m^2** (EPC level D renovation and PV panels)
Total energy savings	**69 kWh / m^2**

2.1.3 Calculation of volume of the measurement

The target is to bring 1% of additional energy savings every year, on the residential building stock.

Target of energy saving	Value

Total energy consumption of all dwellings	10900 GWh/y
Yearly additional savings	90 GWh/y heat 19 GWh/y electricity (1%/y)
Total residential building stock	53 400 000
Yearly additional renovated area	1 400 000 m2 (2,6%/y)

2.1.4 Calculation of costs

Costs are calculated as 60% of nR6 cost as energy suppliers focus on energy savings over indoor climate. The average investment cost of renovation for dwellings is expressed per m2, and then converted to the total stock to be renovated (according to the previous target). Cost is allocated to energy provider and billed to consumers as part of energy price.

Cost of renovation	Value
Investment per m2 renovated	**270 EUR/m2 (incl. VAT)**
Correspond to total yearly investment	**M 380 EUR/y**
Increase of energy price (investment/total energy consumption)	**3.5** Ct / kWh
Tax return for investments	**122 M€/y**
New jobs created	**6450 man-year**

2.2 nR2 -MEPS targeting rented and sold dwellings

2.2.1 Principle of the measure

Minimum Energy Performance Standards (MEPS) for buildings. Building owners who want to sell or rent a building must renovate building to EPC level D. This does not require PV panels. This means that electricity consumption increases due to ventilation required for indoor air quality.

2.2.2 Calculation of energy savings

Heating energy savings are calculated as 80% of nR6, because renovation is to EPC level D. Electricity energy is calculated as in nR6, but without PV panels.

Energy savings	Value
Heating energy savings	**64 kWh / m²** (EPC level D renovation)
Electricity savings	**-5 kWh / m²** (EPC level D renovation and PV panels)
Total energy savings	**59 kWh / m²**

2.2.3 Calculation of volume of the measurement

The target is to renovate all building are that are rented. In Estonian census data 30% of dwellings are rented. The standards have 10 years to take effect, so the calculations are based on renovating 10% of all rented apartments within a single year.

Target of energy saving	Value
Total energy consumption of all dwellings	10900 GWh/y
Yearly additional savings	60 GWh/y heat -4.7 GWh/y electricity

Total rented apartment building stock (30%)	9 375 000
Yearly additional renovated area	937 500 m2 (10%/y)

2.2.4 Calculation of costs

Costs are calculated as 80% of nR6, because renovation is to EPC level D.

Cost of renovation	Value
Investment per m2 renovated	**360 EUR/m2 (incl. VAT)**
Total yearly investment	**M 338 EUR/y**
Increase of rent price	**M 360** EUR/m2 y
Tax return for investments	**M 108 EUR/y**
New jobs created	**5700 man-year**

2.3 nR3 -MEPS targeting all residential buildings

2.3.1 Principle of the measure

Minimum Energy Performance Standards (MEPS) sets requirements for existing buildings. Building owners who want to sell or rent a building must renovate building to EPC level D. This does not require PV panels. This means that electricity consumption increases due to ventilation required for indoor air quality.

2.3.2 Calculation of energy savings

Heating energy savings are calculated as 80% of nR6, because renovation is to EPC level D. Electricity energy is calculated as in nR6, but without PV panels.

Energy savings	Value
Heating energy savings	**64 kWh / m^2** (EPC level D renovation)
Electricity savings	**-5 kWh / m^2** (EPC level D renovation and PV panels)
Total energy savings	**59 kWh / m^2**

2.3.3 Calculation of volume of the measurement

The target is to renovate all residential building. The standards have 10 years to take effect, so the calculations are based on renovating 10% of all residential within a single year.

Target of energy saving	Value
Total energy consumption of all dwellings	10900 GWh/y
Yearly additional savings	60 GWh/y heat -4.7 GWh/y electricity
Total residential building stock	53 400 000 **m^2**
Yearly additional renovated area	3 078 000 m^2 (6%/y)

2.3.4 Calculation of costs

Heating energy savings are calculated as 80% of nR6, because renovation is to EPC level D. Cost is allocated to building owners.

Cost of renovation	Value
Investment per m2 renovated	**360 EUR/m2 (incl. VAT)**
Total yearly investment	**M 1108 EUR/y**
Tax return for investments	**M 355 EUR/y**
New jobs created	**18 800 man-year**

2.4 nR4 - Renovation grants for single family houses

2.4.1 Principle of the measure

The objective of this measure is to enhance residential building energy performance by offering renovation grants for single-family homes. KredEx already administers a similar grant program with success.

2.4.2 Calculation of energy savings

Heating energy savings are calculated as 33% of nR6, because detached house renovations are not well regulated. 25% of renovations are deep renovation and 75% is light renovation with some PV panel installations.

Energy savings	Value
Heating energy savings	**34 kWh / m²** (25% light 75% deep renovation)
Electricity savings	**2 kWh / m²** (25% light 75% deep renovation)
Total energy savings	**36 kWh / m²**

2.4.3 Calculation of volume of the measurement

The volume of the measure is chosen to be 10 M€/y. This allows to renovate 222 222 m² of detached houses per year. The volume can be changed.

Target of energy saving	Value
Total energy consumption of all detached houses	4800 GWh/y
Yearly additional savings	7.6 GWh/y heat 0.4 GWh/y electricity
Total detached house building stock	22 400 000 **m²**
Yearly additional renovated area	222 222 m² (1%/y)

2.4.4 Calculation of costs

Costs are calculated as 33% of nR6, because detached house renovations are not well regulated. 25% of renovations are deep renovation and 75% is light renovation with some PV panel installations. The cost is allocated 30% to government and 70% to houseowner.

Cost of renovation	Value
Investment per m2 renovated	**150 EUR/m2 (incl. VAT)**
Government cost	**M 11 EUR/y**
Total yearly investment	**M 33 EUR/y**
Tax return for investments	**M 11 EUR/y**
New jobs created	**570 man-year**

2.5 nR5 - Tax deduction for renovation works

2.5.1 Principle of the measure

Instead of a renovation grant, households who are engaging in renovation works can benefit from a tax deduction. This tax deduction would take the form of reduced VAT (from the standard Estonian VAT rate of 20%, starting from 2024 VAT rate of 22%).

2.5.2 Calculation of energy savings

Heating energy savings are calculated as 33% of nR6, because detached house renovations are not well regulated. 25% of renovations are deep renovation and 75% is light renovation with some PV panel installations.

Energy savings	Value
Heating energy savings	**34 kWh / m²** (25% light 75% deep renovation)
Electricity savings	**2 kWh / m²** (25% light 75% deep renovation)
Total energy savings	**36 kWh / m²**

2.5.3 Calculation of volume of the measurement

The volume of the measure is chosen to be 3 M€/y. This corresponds to renovation rate 0,9% per year which is similar to nR4. The work costs are assumed to be 50% of renovation costs. 20% of work costs is lost tax revenue for government. The volume depends on how popular the measure will be.

Target of energy saving	Value
Total energy consumption of all detached houses	4800 GWh/y
Yearly additional savings	6.8 GWh/y heat 0.4 GWh/y electricity
Total detached house building stock	22 400 000 **m²**
Yearly additional renovated area	200 000 m² (1%/y)

2.5.4 Calculation of costs

The volume of the measure is chosen to be 3 M€/y. The work costs are assumed to be 50% of renovation costs. 20% of work costs is lost tax revenue for government.

Cost of renovation	Value
Investment per m2 renovated	**150 EUR/m2 (incl. VAT)**
Government cost	**M 3 EUR/y**
Total yearly investment	**M 30 EUR/y**
Tax return for investments	**M 7 EUR/y**
New jobs created	**510 man-year**

2.6 nR6 - Renovation grant for apartment buildings

2.6.1 Principle of the measure

The aim of this measure is to enhance energy performance in apartment buildings through a renovation grant program. Applicants must meet predefined criteria related to the nature of work, energy performance, and construction year. The grant, currently covering approximately 30% of renovation costs, is like one already offered by KredEx in Estonia.

2.6.2 Calculation of energy savings

Savings are calculated as described at the beginning of the chapter.

Energy savings	Value
Heating energy savings	**102 kWh / m²** (renovation to EPC level C)
Electricity savings	**6 kWh / m²** (renovation to EPC level C and PV panels)
Total energy savings	**108 kWh / m²**

2.6.3 Calculation of volume of the measurement

The volume of the measure is chosen to be 150 M€/y. The volume can be changed.

Target of energy saving	Value
Total energy consumption of all apartment buildings	6100 GWh/y
Yearly additional saving	113.3 GWh/y heat 6.7 GWh/y electricity
Total apartment building stock	31 000 000 **m²**
Yearly additional renovated area	1 111 100 m² (4%/y)

2.6.4 Calculation of costs

Costs are allocated to 30% government and 70% to building owner.

Cost of renovation	Value
Investment per m2 renovated	**450 EUR/m2 (incl. VAT)**
Government cost	**M 150 EUR/y**
Total yearly investment	**M 500 EUR/y**
Tax return for investments	**M 160 EUR/y**
New jobs created	**8500 man-year**

2.7 nR7 - Property tax (according to EPC levels)

2.7.1 Principle of the measure

This measure aims to offer property tax incentives to building owners meeting predefined energy performance criteria, verified through an EPC. The tax revenue is directed to KredEx style renovation grants. Calculation is based on invested money in nR6 measure.

2.7.2 Calculation of energy savings

Savings are calculated as described at the beginning of the chapter.

Energy savings	Value
Heating energy savings	**102 kWh / m²** (renovation to EPC level C)
Electricity savings	**6 kWh / m²** (renovation to EPC level C and PV panels)
Total energy savings	**108 kWh / m²**

2.7.3 Calculation of volume of the measurement

The volume of the measure is chosen to be 50 M€/y, what corresponds to average of 1EUR/m²y for property owners. The volume can be changed.

Target of energy saving	Value
Total energy consumption of all residential buildings	10900 GWh/y
Yearly additional saving	37.8 GWh/y heat 2.2 GWh/y electricity
Total residential building stock	53 400 000 **m²**
Yearly additional renovated area	370 370 m² (0.7%/y)

2.7.4 Calculation of costs

Costs are allocated to 30% government and 70% to building owner.

Cost of renovation	Value
Investment per m2 renovated	**450 EUR/m2 (incl. VAT)**
Government cost	**M 50 EUR/y**
Total yearly investment	**M 167 EUR/y**
Tax return for investments	**M 53 EUR/y**
New jobs created	**2800 man-year**

2.8 nR8 -CO2 tax for end energy use of residential buildings

2.8.1 Principle of the measure

This fiscal measure taxes CO2 emissions from residential building energy use to promote energy efficiency and reduce greenhouse gas emissions. Emissions are quantified based on energy consumption, and the tax is typically collected through energy bills by energy providers on behalf of the government. The tax revenue is directed to KredEx style renovation grants. Calculation is based on invested money in nR6 measure.

2.8.2 Calculation of energy savings

Savings are calculated as described at the beginning of the chapter.

Energy savings	Value
Heating energy savings	**102 kWh / m²** (renovation to EPC level C)
Electricity savings	**6 kWh / m²** (renovation to EPC level C and PV panels)
Total energy savings	**108 kWh / m²**

2.8.3 Calculation of volume of the measurement

The volume of the measure is chosen to be 50 M€/y, what corresponds to average of 1EUR/m²y for property owners. The volume can be changed.

Target of energy saving	Value
Total energy consumption of all residential buildings	10900 GWh/y
Yearly additional saving	37.8 GWh/y heat 2.2 GWh/y electricity
Total residential building stock	53 400 000 **m²**
Yearly additional renovated area	370 370 m² (0.7%/y)

2.8.4 Calculation of costs

Costs are allocated to 30% government and 70% to building owner.

Cost of renovation	Value
Investment per m2 renovated	**450 EUR/m2 (incl. VAT)**
Government cost	**M 50 EUR/y**
Total yearly investment	**M 167 EUR/y**
Tax return for investments	**M 53 EUR/y**
New jobs created	**2800 man-year**

3 EE measures for the services sector

Calculation method for residential building measures

Energy saving in this category is mostly achieved through renovation. Renovation work in service sector buildings varies quite a lot. Renovation in this category usually use ESCO model, what allows a company to invest in and finance another company's energy renovation, with repayment coming from energy cost savings over time. The calculations are based on a study on existing office building renovation. The study looked at different improvements energy performance, including lighting upgrades, HVAC enhancements, PV system installation, and window replacement. Costs and savings were computed for each measure per heated area. Calculations use combinations of different improvements by adding up savings and cost per m^2. Energy savings and cost of renovation for government buildings is taken from Estonian long term renovation strategy.

3.1 nS1 - Obligation scheme for service sector

3.1.1 Principle of the measure

Like nR1, this measure obliges the energy supplier to take energy efficiency but for the service sector. Each obligated party's energy savings target is based on its market share or total energy supplied during a specified baseline period. This will be achieved through renovation of the worst performing buildings to EPC level D and installation of PV panels.

3.1.2 Calculation of energy savings

Energy savings are calculated as renovation is to EPC level D. Calculation for this measure include lighting improvements, HVAC and automation upgrades.

Energy savings	Value
Heating energy savings	**23 kWh / m^2** (EPC level D renovation)
Electricity savings	**19 kWh / m^2** (EPC level D renovation and PV panels)
Total energy savings	**100 kWh / m^2**

3.1.3 Calculation of volume of the measurement

The target is to bring 1% of additional energy savings every year, on the non-residential building stock.

Target of energy saving	Value
Total energy consumption of all non-residential buildings	5190 GWh/y
Yearly additional savings	27 GWh/y heat 29 GWh/y electricity (1%/y)
Total non-residential building stock	22 650 000volu
Yearly additional renovated area	1 525 000 m2 (6,7%/y)

3.1.4 Calculation of costs

Costs are calculated as sum of all improvements necessary to achive EPC level D. Calculation for this measure include lighting improvements, HVAC and automation upgrades. Cost is allocated to energy provider and billed on to consumer.

Cost of renovation	Value
Investment per m2 renovated	**100 EUR/m2 (incl. VAT)**
Correspond to total yearly investment	**M 153 EUR/y**
Increase of energy price (investment/total energy consumption)	**3.0** Ct / kWh
Tax return for investments	**1 M€/y**
New jobs created	**2600 man-year**

3.2 nS2 -Central government buildings renovation support

3.2.1 Principle of the measure

The central government has pledged to increase the area of buildings that meet minimum energy efficiency requirements by 3% annually through renovation or new construction, ultimately reaching nearly 50% of the total volume. This will be done through renovating lower performing buildings to EPC level C. This is achieved with deep energy renovation and remodelling which includes improved insulation, HVAC systems and PV panels. Since government has strict standards on indoor climate this measure also improves productivity and wellbeing for users of government buildings.

3.2.2 Calculation of energy savings

Energy savings	Value
Heating energy savings	**85 kWh / m²** (EPC level C renovation)
Electricity savings	**5 kWh / m²** (EPC level C renovation and PV panels)
Total energy savings	**90 kWh / m²**

3.2.3 Calculation of volume of the measurement

The target is to renovate 3% of central government building stock annually.

Target of energy saving	Value
Yearly additional savings	1.7 GWh/y heat 0.1 GWh/y electricity
Total central government building stock	660 000
Yearly additional renovated area	20 000 m2 (3 %/y)

3.2.4 Calculation of costs

Costs are calculated as sum of all improvements necessary to achieve EPC level D. Calculation for this measure include lighting improvements, HVAC and automation upgrades. Cost is allocated totally to the government.

Cost of renovation	Value
Investment per m2 renovated	**750 EUR/m2 (incl. VAT)**

Correspond to total yearly investment	**M 15 EUR/y**
Tax return for investments	**5 M€/y**
New jobs created	**250 man-year**

3.3 nS3 - Public and municipality buildings renovation support

3.3.1 Principle of the measure

The central government has pledged to increase the area of buildings that meet minimum energy efficiency requirements by 3% annually through renovation or new construction, ultimately reaching nearly 50% of the total volume. This will be done through renovating lower performing buildings to EPC level C. This is achieved with deep energy renovation and remodelling which includes improved insulation, HVAC systems and PV panels. Since government has strict standards on indoor climate this measure also improves productivity and wellbeing for users of government buildings.

3.3.2 Calculation of energy savings

Energy savings	Value
Heating energy savings	**85 kWh / m^2** (EPC level C renovation)
Electricity savings	**5 kWh / m^2** (EPC level C renovation and PV panels)
Total energy savings	**90 kWh / m^2**

3.3.3 Calculation of volume of the measurement

The target is to renovate 3% of central government building stock annually.

Target of energy saving	Value
Yearly additional savings	12.5 GWh/y heat 0.7 GWh/y electricity
Total local government building stock	5 300 000
Yearly additional renovated area	146 500 m2 (2.8 %/y)

3.3.4 Calculation of costs

Costs are calculated as sum of all improvements necessary to achieve EPC level D. Calculation for this measure include lighting improvements, HVAC and automation upgrades. Cost is allocated totally to the government.

Cost of renovation	Value
Investment per m2 renovated	**750 EUR/m2 (incl. VAT)**
Correspond to total yearly investment	**M 110 EUR/y**
Tax return for investments	**21 M€/y**
New jobs created	**1870 man-year**

3.4 nS4 -Commercial buildings energy performance investments support

3.4.1 Principle of the measure

This measure aims to enhance the energy performance of commercial buildings by offering renovation grants. Applicants, including companies, must meet predefined eligibility criteria related to the type of work, energy savings, company size, energy performance, and construction year. The grant covers a portion of renovation costs, with levels varying based on criteria like enterprise size and potential VAT deductions.

3.4.2 Calculation of energy savings

Energy savings	Value
Heating energy savings	**29 kWh / m²** (EPC level C renovation)
Electricity savings	**25 kWh / m²** (EPC level C renovation and PV panels)
Total energy savings	**54 kWh / m²**

3.4.3 Calculation of volume of the measurement

The volume of the measure is chosen to be 50 M€/y. The volume can be changed.

Target of energy saving	Value
Yearly additional savings	38.7 GWh/y heat 33.3 GWh/y electricity
Total non-residential building stock	22 650 000
Yearly additional renovated area	1 333 300 m2 (5.9 %/y)

3.4.4 Calculation of costs

Costs are calculated as sum of all improvements necessary to achieve EPC level D. Calculation for this measure include lighting improvements, HVAC and automation upgrades. Cost is allocated totally to the government.

Cost of renovation	Value
Investment per m2 renovated	**125 EUR/m2 (incl. VAT)**
Correspond to total yearly investment	**M 167 EUR/y**
Tax return for investments	**53 M€/y**
New jobs created	**2850 man-year**

3.5 nS5 – CO2 certificate sales based on energy savings from commercial buildings renovation, income invested as renovation support

3.5.1 Principle of the measure

This measure promotes commercial building renovation and self-sufficiency by selling saved CO2 certificates. The government invests in renovation projects, including insulation upgrades and energy-efficient systems, quantifying CO2 reductions as certificates that can be sold on the carbon market, ultimately contributing to a future market in Estonia for public buildings linked to the EU ETS from 2027 onward.

3.5.2 Calculation of energy savings

Energy savings	Value
Heating energy savings	**29 kWh / m²** (EPC level C renovation)

Electricity savings	**25 kWh / m²** (EPC level C renovation and PV panels)
Total energy savings	**54 kWh / m²**

3.5.3 Calculation of volume of the measurement

The volume of the measure is chosen to be 10 M€/y. The volume can be changed.

Target of energy saving	Value
Yearly additional savings	7.7 GWh/y heat 6.7 GWh/y electricity
Total non-residential building stock	22 650 000
Yearly additional renovated area	266 660 m2 (1.2 %/y)

3.5.4 Calculation of costs

Costs are calculated as sum of all improvements necessary to achieve EPC level D. Calculation for this measure include lighting improvements, HVAC and automation upgrades. Cost is allocated totally to the government.

Cost of renovation	Value
Investment per m2 renovated	**125 EUR/m2 (incl. VAT)**
Correspond to total yearly investment	**M 33 EUR/y**
Tax return for investments	**11 M€/y**
New jobs created	**550 man-year**

3.6 nS6 - CO_2 tax for end energy use of commercial buildings

3.6.1 Principle of the measure

This fiscal measure taxes CO2 emissions from commercial building energy use to encourage energy-efficient practices and reduce greenhouse gas emissions. Emissions are quantified based on energy consumption, with the tax typically collected through energy bills by utilities on behalf of the government.

3.6.2 Calculation of energy savings

Energy savings	Value
Heating energy savings	**29 kWh / m²** (EPC level C renovation)
Electricity savings	**25 kWh / m²** (EPC level C renovation and PV panels)
Total energy savings	**54 kWh / m²**

3.6.3 Calculation of volume of the measurement

The volume of the measure is chosen to be 50 M€/y. The volume can be changed.

Target of energy saving	Value
Yearly additional savings	38.7 GWh/y heat 33.3 GWh/y electricity
Total non-residential building stock	22 650 000

Yearly additional renovated area	1 333 300 m2 (5.9 %/y)

3.6.4 Calculation of costs

Costs are calculated as sum of all improvements necessary to achieve EPC level D. Calculation for this measure include lighting improvements, HVAC and automation upgrades. Cost is allocated totally to the government.

Cost of renovation	Value
Investment per m2 renovated	**125 EUR/m2 (incl. VAT)**
Correspond to total yearly investment	**M 167 EUR/y**
Tax return for investments	**53 M€/y**
New jobs created	**2850 man-year**

3.7 nS7 – Property tax (according to EPC levels)

3.7.1 Principle of the measure

This measure proposes property tax incentives for buildings meeting specific energy performance levels as determined by their Energy Performance Certificate (EPC). Owners of qualifying buildings in the services sector can benefit from these incentives, resulting in energy savings for those who upgrade their structures to the required performance level. The measure primarily targets building owners/taxpayers eligible for property tax exemptions, reductions, or rebates based on their building's energy performance.

3.7.2 Calculation of energy savings

Energy savings	Value
Heating energy savings	**29 kWh / m^2** (EPC level C renovation)
Electricity savings	**25 kWh / m^2** (EPC level C renovation and PV panels)
Total energy savings	**54 kWh / m^2**

3.7.3 Calculation of volume of the measurement

The volume of the measure is chosen to be 50 M€/y. The volume can be changed.

Target of energy saving	Value
Yearly additional savings	38.7 GWh/y heat 33.3 GWh/y electricity
Total non-residential building stock	22 650 000
Yearly additional renovated area	1 333 300 m2 (5.9 %/y)

3.7.4 Calculation of costs

Costs are calculated as sum of all improvements necessary to achieve EPC level D. Calculation for this measure include lighting improvements, HVAC and automation upgrades. Cost is allocated totally to the government.

Cost of renovation	Value
Investment per m2 renovated	**125 EUR/m2 (incl. VAT)**

Correspond to total yearly investment	**M 167 EUR/y**
Tax return for investments	**53 M€/y**
New jobs created	**2850 man-year**

3.8 nS8 - MEPS for non-residential buildings

3.8.1 Principle of the measure

Aligned with nR2 and nR3, this measure introduces Minimum Energy Performance Standards (MEPS) for non-residential buildings in Estonia, necessitating building owners to obtain an Energy Performance Certificate (EPC) of a specific class or higher. Non-compliance results in penalties. Building owners achieve energy savings when renovating their structures to meet the required energy performance level, with a progressive approach to reach predefined EPC thresholds within a specified timeframe.

3.8.2 Calculation of energy savings

Energy savings	Value
Heating energy savings	**29 kWh / m²** (EPC level C renovation)
Electricity savings	**25 kWh / m²** (EPC level C renovation and PV panels)
Total energy savings	**54 kWh / m²**

3.8.3 Calculation of volume of the measurement

The measure targets worst performing 25% of building stock. The volume is chosen to renovate targeted buildings in 10 years.

Target of energy saving	Value
Yearly additional savings	16.2 GWh/y heat 14.0 GWh/y electricity
Total non-residential building stock	22 650 000
Yearly additional renovated area	560 000 m2 (2.5 %/y)

3.8.4 Calculation of costs

Costs are calculated as sum of all improvements necessary to achieve EPC level D. Calculation for this measure include lighting improvements, HVAC and automation upgrades. Cost is allocated totally to the government.

Cost of renovation	Value
Investment per m2 renovated	**125 EUR/m2 (incl. VAT)**
Correspond to total yearly investment	**M 70 EUR/y**
Tax return for investments	**22 M€/y**
New jobs created	**1200 man-year**

4 EE measures for the transport sector

4.1 nT1 – Promotion of clean and energy efficient road transport vehicles in public procurement

4.1.1 Principle of the measure

Public procurement standards for public sector for leasing or buying new vehicles based on energy efficiency.

4.1.2 Calculation of energy savings

Energy consumption is calculated as a percentage of total fuel energy consumption based on estimated public sector fleet size. Savings are calculated assuming constant turnover of vehicles and increased efficiency of replaced vehicles.

Energy savings	Value
Fuel energy savings	**4746 kWh per vehicle**
Total energy savings	**4746 kWh per vehicle**

4.1.3 Calculation of volume of the measurement

Public sector is replacing their fleet based on lease length. Thus, the volume is calculated as yearly turnover.

Target of energy saving	Value
Total energy consumption of public vehicles	55.4 GWh/y
Yearly additional savings	13.8 GWh/y

4.1.4 Calculation of costs

Car prices are estimated to increase based on yearly 2% inflation. However, this cost is not as extraneous, as fleets are updated with or without clean vehicle requirement.

Cost of fleet renewal	Value
Investment per new vehicle	**30000 EUR (incl. VAT)**
Correspond to total yearly investment	**M 87.5 EUR/y**

4.2 nT2 – Subsidy for public transport usage instead of personal vehicle

4.2.1 Principle of the measure

To reduce car usage and thus conserve energy, directly subsidize car users to choose public transport.

4.2.2 Calculation of energy savings

Energy consumption is calculated as a percentage of total fuel energy consumption based on estimated fleet size and affected travels. Savings are calculated assuming average energy consumption of passenger cars.

Energy savings	Value
Fuel energy savings	**605 MWh per vehicle**
Total energy savings	**605 MWh per vehicle**

3. *Calculation of volume of the measurement*

The savings are only assumed to last as long as the subsidies continue with only minuscule amount of people changing their habits in the long term. This can be considered only in a small scale with no more than 100€ per year per person.

Target of energy saving	Value
Total energy consumption of public vehicles	23.3 GWh/y
Yearly additional savings	0.2 GWh/y

4. *Calculation* of costs

Car prices are estimated to increase based on yearly 2% inflation.

Cost of subsidy	Value
Investment per new person	**100 EUR**
Correspond to total yearly investment	**M 0.4 EUR/y**

4.3 NT3 Priority lanes for micro mobility

4.3.1 Principle of the measure

To reduce car usage and thus conserve energy, create routes where micromobility has either priority or full usage.

4.3.2 Calculation Calculation of energy savings

Energy consumption is calculated as a percentage of total fuel energy consumption based on estimated fleet size and affected travels. Savings are calculated assuming average energy consumption of passenger cars. Estimated 0,5% of total urban transport should convert to micromobility instead of cars.

Energy savings	Value
Fuel energy savings	**5366 MWh per car-year**

Total energy savings	**5366 MWh per car-year**

4. Calculation of volume of the measurement

The savings are assumed to be cumulative as each new route constructed provides more support for micromobility.

Target of energy saving	Value
Total energy consumption of trips converting to micromobility	23.3 GWh/y
Yearly additional savings	23.3 GWh/y

5. Calculation of costs

Costs are based on current unit prices

Cost of investmen	Value
Construction of 1 km of road	**M 0.2 EUR**
Correspond to total yearly investment	**M 16 EUR/y**

4.4 NT4 Electric charging infrastructure for existing inhabitance areas

4.4.1 Principle of the measure

Construction of charging stations at densely populated areas.

4.4.2 Calculation of energy savings

Energy consumption is calculated as a percentage of total fuel energy consumption based on estimated fleet size and average energy consumption. Savings are estimated based on increased efficency of electric vehicles compared to average ICE vehicle in use.

Energy savings	Value
Fuel energy savings	**4746 kWh per vehicle**
Total energy savings	**4746 kWh per vehicle**

5. Calculation of volume of the measurement

The savings are assumed to be cumulative as each new route constructed provides more support for micromobility.

Target of energy saving	Value
Total energy consumption of trips converting to micromobility	1.2 GWh/y
Yearly additional savings	1.2 GWh/y

6. Calculation of costs

Costs are based on current unit prices

Cost of investmen	Value
Construction of 1 charging station	**M 0,014 EUR**
Correspond to total yearly investment	**M 3,36 EUR/y**

4.5 NT5 Biomethane infrastructure

This measure is not applicable here as it will increase total energy consumption. According to IEA report[1], using biomethane results in 27% higher energy consumption per kilometer.

4.6 NT6 Hydrogen infrastructure

This measure is not applicable here as it will increase total energy consumption. According to IEA report[2] and ICCT working paper[3], using hydrogen results in 1% higher energy consumption per kilometer.

4.7 NT7 Vehicle tax for registration

Due to the proposed tax structure being significantly higher than in neighbouring countries for specific vehicles, all new vehicles are incentivized to be registered elsewhere and thus creating more energy consumption due to mandatory trips across the border for technical inspections.
This conclusion was reached through following steps:

- Estimation of energy use reduction caused by registration taxation. According to report “Riikliku energiasäästukohustuse täitmiseks sobilike finantsmeetmete arvutusmetoodikate väljatöötamine ja energiasäästu potentsiaali hindamine” EU member states in general do not associate registration tax with energy savings.
- Estimation of tax flight based on tax rates in neighbouring countries and *post hoc* analysis of previous commodity tax hikes.
- Estimation of additional energy usage based on average distance to neighbouring countries.

4.8 NT8 Annual vehicle tax

Due to the proposed tax structure being significantly higher than in neighbouring countries for specific vehicles, roughly 80% of vehicles are incentivized to be registered elsewhere and thus creating more energy consumption due to mandatory trips across the border for technical inspections.
This conclusion was reached through following steps:

- Estimation of energy use reduction caused by registration taxation. According to report “Riikliku energiasäästukohustuse täitmiseks sobilike finantsmeetmete arvutusmetoodikate väljatöötamine ja

[1] https://task37.ieabioenergy.com/wp-content/uploads/sites/32/2022/02/IEA_transport_T37_END_HIGH.pdf

[2] https://task37.ieabioenergy.com/wp-content/uploads/sites/32/2022/02/IEA_transport_T37_END_HIGH.pdf

[3] https://theicct.org/wp-content/uploads/2022/07/fuel-cell-tractor-trailer-tech-fuel-1-jul22.pdf

energiasäästu potentsiaali hindamine" EU member states in general do not associate vehicle tax with energy savings.

- Estimation of tax flight based on tax rates in neighbouring countries and *post hoc* analysis of previous commodity tax hikes.
- Estimation of additional energy usage based on average distance to neighbouring countries.

4.9 NT9 Development of convenient and modern public transport

This measure is reported in: "ENERGIATÕHUSUSE DIREKTIIVI ÜLEVÕTMISEST TULENEV KOHUSTUS ENERGIASÄÄSTUMEETMETE LOOMISEKS, MÕÕTMISEKS, SEIREKS KONTROLLIKS JA RAPORTEERIMISEKS" https://kliimaministeerium.ee/energeetika-maavarad/analuusid-ja-uuringud#energiatohusus

4.10 NT11 Developing the railroad infrastructure (includes the building of Rail Baltic)

This measure is reported in: "ENERGIATÕHUSUSE DIREKTIIVI ÜLEVÕTMISEST TULENEV KOHUSTUS ENERGIASÄÄSTUMEETMETE LOOMISEKS, MÕÕTMISEKS, SEIREKS KONTROLLIKS JA RAPORTEERIMISEKS" https://www.mkm.ee/media/431/download https://kliimaministeerium.ee/energeetika-maavarad/analuusid-ja-uuringud#energiatohusus

4.11 NT12 The railroad electrification

This measure is reported in: "ENERGIATÕHUSUSE DIREKTIIVI ÜLEVÕTMISEST TULENEV KOHUSTUS ENERGIASÄÄSTUMEETMETE LOOMISEKS, MÕÕTMISEKS, SEIREKS KONTROLLIKS JA RAPORTEERIMISEKS" https://www.mkm.ee/media/431/download https://kliimaministeerium.ee/energeetika-maavarad/analuusid-ja-uuringud#energiatohusus

4.12 NT13 Promoting the use of biomethane in buses

This measure is not applicable here as it will increase total WtW energy consumption.

4.13 NT14 Promoting the use of electricity in buses

This measure is reported in: "ENERGIATÕHUSUSE DIREKTIIVI ÜLEVÕTMISEST TULENEV KOHUSTUS ENERGIASÄÄSTUMEETMETE LOOMISEKS, MÕÕTMISEKS, SEIREKS KONTROLLIKS JA RAPORTEERIMISEKS" https://www.mkm.ee/media/431/download https://kliimaministeerium.ee/energeetika-maavarad/analuusid-ja-uuringud#energiatohusus

4.14 NT15 Acquisition of additional passenger trains

This measure is reported in: "ENERGIATÕHUSUSE DIREKTIIVI ÜLEVÕTMISEST TULENEV KOHUSTUS ENERGIASÄÄSTUMEETMETE LOOMISEKS, MÕÕTMISEKS, SEIREKS KONTROLLIKS JA RAPORTEERIMISEKS"

https://www.mkm.ee/media/431/download https://kliimaministeerium.ee/energeetika-maavarad/analuusid-ja-uuringud#energiatohusus

4.15 NT16 New tram lines in Tallinn

This measure is reported in: "ENERGIATÕHUSUSE DIREKTIIVI ÜLEVÕTMISEST TULENEV KOHUSTUS ENERGIASÄÄSTUMEETMETE LOOMISEKS, MÕÕTMISEKS, SEIREKS KONTROLLIKS JA RAPORTEERIMISEKS" https://www.mkm.ee/media/431/download https://kliimaministeerium.ee/energeetika-maavarad/analuusid-ja-uuringud#energiatohusus

4.16 NT17 Subsidy for micro mobility usage instead of personal vehicle

4.16.1 Principle of the measure

In order to reduce car usage and thus conserve energy, directly subsidize car users to choose micromobility[1] i.e. walking or using small mechanically or electrically motivated vehicles.

4.16.2 Calculation of energy savings

Energy consumption is calculated as a percentage of total fuel energy consumption based on estimated fleet size and affected travels. Savings are calculated assuming average energy consumption of passenger cars.

Energy savings	Value
Fuel energy savings	**605 MWh per vehicle**
Total energy savings	**605 MWh per vehicle**

4.16.3 Calculation of volume of the measurement

The savings are only assumed to last as long as the subsidies continue with only minuscule amount of people actually changing their habits in the long term. This can be considered only in a small scale with no more than 100€ per year per person.

Target of energy saving	Value
Total energy consumption of public vehicles	23.3 GWh/y
Yearly additional savings	0.2 GWh/y

4.16.4 Calculation of costs

Car prices are estimated to increase based on yearly 2% inflation.

Cost of subsidy	Value
Investment per new person	**100 EUR**
Correspond to total yearly investment	**M 0.4 EUR/y**

[1] https://research.tue.nl/en/publications/conceptualizing-micromobility

4.17 NT18 All Tallinn and Tartu taxis run on electricity

4.17.1 Principle of the measure

Taxi licensing requirements to only give new permits to electric vehicles. This means only tightening the existing requirements.

4.17.2 Calculation of energy savings

Energy consumption is calculated as a percentage of total fuel energy consumption based on estimated taxi fleet size. Savings are calculated assuming constant turnover of vehicles and increased efficiency of replaced vehicles.

Energy savings	Value
Fuel energy savings	**3340 kWh per vehicle**
Total energy savings	**3340 kWh per vehicle**

4.17.3 Calculation of volume of the measurement

Current requirements set limits on allowed vehicle age. Therefore, average turnover of vehicles

Target of energy saving	Value
Total energy consumption of public vehicles	0.8 GWh/y
Yearly additional savings	0.8 GWh/y

4.17.4 Calculation of costs

Car prices are estimated to increase based on yearly 2% inflation. However, this cost is not as extraneous, as fleets are updated with or without clean vehicle requirement. Therefore price differences[4] between mid-size EV and ICE car are used.

Extra cost of fleet renewal	Value
Average yearly cost per vehicle	443€
Total additional cost of vehicles	**1 M€**

4.18 NT19 Tallinn and Tartu congestion charge

Based on current knowledge this measure has no measurable effect on energy consumption, rather it will reallocate the transportation activities within the same timeframe.

[4] https://nickelinstitute.org/media/8d9058c08d2bcf2/avicenne-study-tco-eu-and-uk-automotive.pdf

4.19 NT20 Mileage-based road use fee for heavy vehicles.

There is no final energy saving in this measure.

4.20 NT21 Subsidizing biofuel that meets the criteria of sustainability or imposing the obligation to sell it to filling stations

There is no final energy saving in this measure.

4.21 NT22 Renovation of street lighting to LED light sources

4.21.1 Principle of the measure

Replacement of existing street lamps with energy efficient LED lamps.

4.21.2 Calculation of energy savings

Based on different sources, such as OpenStreetMap[5] and municipal reports, estimated number of sodium-vapor street lights is 75 000. Annual energy consumption is therefore 63,647 GWh. If all those lamps were replaced with LED lamps, the energy consumption would by only 4,546 GWh. Total costs for replacing 500 street lamps was estimated as 170 000 € in 2020. Taking into account the inflation and increased costs, this can be considered to equal 250 000 € today. It is important to point out that these kinds of projects have been only done with EU financing and thus it cannot be considered as a part of free market. Therefore. without an active measure, this energy saving won't happen.

Energy savings	Value
Electricity savings per lamp	**780 kWh per lamp per year**

6. Calculation of volume of the measurement

The savings are assumed to be cumulative as more lighting locations are converted to LED lamps.

Target of energy saving	Value
Yearly additional savings	5.85 GWh/y

7. Calculation of costs

Costs are based on current unit prices of building street lighting section of 500 lighting points

Cost of investmen	Value
Construction of 500-lighting point section	**M 0,25 EUR**
Correspond to total yearly investment	**M 3,75 EUR/y**

[5] https://planet.openstreetmap.org/

5 EE measures for the industry sector

Energy efficiency measures in the industrial sector are basically all support measures, where the amount of state support is between 40-50%, depending on the measure. However, a plan has been proposed that only those companies that have previously signed so-called voluntary agreements with the government to increase energy efficiency will receive support.

5.1 nI1 – Voluntary Agreements for Industry

5.1.1 Purpose of the measure

Voluntary agreements are collaborative agreements between governments and industries where individual firms or groups negotiate and commit to specific targets and timelines for enhancing energy efficiency. These agreements often incorporate enforceability measures, defining rewards and penalties for compliance. The aim of the measure is to increase energy efficiency in industry.

Type of measure: voluntary agreement

5.1.2 Calculation of energy savings

The calculation formula[6]:

$$TFES = EC_{jc} * EST \quad (1)$$

$$EC_{jc} = EC * p_{jc} \quad (2)$$

where,

Abbreviation	Unit	Explanation
EC	GWh	Energy consumption of Industry sector
EST	%	Energy saving target
p_{jc}	%	Percentage of joint companies
EC_{jc}	GWh/a	Energy consumption of joint companies
ES	GWh/a	Annual energy savings
$TFES$	GWh/a	Total annual final energy savings

The energy saving target increases year by year until it reaches 1.9% by 2030.

	2025	2026	2027	2028	2029	2030
Energy saving target, %	0.1	0.5	0.8	1.2	1.5	1.9

[6] https://kik.ee/et/toetatavad-tegevused/ettevotete-ressursitohusus-rrf

Target of energy saving	Value
Yearly additional savings	38.2 GWh/y

5.1.3 Calculation of costs

Since these are voluntary agreements, the state's contribution to support this measure is zero. If additional support is given (tax rebates), the cost of energy will be increased for other consumers or there will be a need for state contribution.

5.2 nI2 – Promotion of resource-efficient green technologies of industrial enterprises

5.2.1 Purpose of the measure

More complete use of resources and recycling of waste saves the environment and human health on the one hand and increases the competitiveness of companies through efficient use of resources and energy savings on the other. The purpose of the measure is to increase the energy efficiency of industrial enterprises.

Type of measure: support

5.2.2 Calculation of energy savings

The calculation formula:

$$TFES = B * ESF \quad (3)$$

where,

Abbreviation	Unit	Explanation
$TFES$	GWh/a	Total Final Energy Savings
B	M€	Support of the measure
ESF	kWh/€	Energy saving factor

Calculation methodology

The assessment of energy savings is based on the actual data of the previous four application rounds (in the period 2014-2020). A total of 173 projects were financed in the amount of 59.48 MEUR and the actual measured energy savings was 146.25 GWh. The energy efficiency factor (ESF) was therefore 2.459. The evaluation was based on the specific energy use before and after the end of the project as a ratio to the production volume.

Target of energy saving	Value
Yearly additional savings	9.7 GWh/y

5.2.3 Calculation of costs

It has been calculated that if the amount of support is 5.75 MEUR per year, the measure can reduce the energy consumption of the industry by approx. 9.7 GWh per year.

Cost of subsidy	Value
Unit costs	**71 €/MWh**
Investment per year	**5.75 EUR/y**

5.3 nI3 – Energy savings from electro-intensive companies

5.3.1 Purpose of the measure

The objective of this measure is to stimulate energy savings from electro-intensive companies by supporting the implementation of energy efficiency measures. Electro-intensive companies are businesses or industries that have high electricity consumption as a significant part of their production processes or operations. These companies rely heavily on electricity to power their equipment, machinery, and facilities, and electricity costs can be a substantial portion of their overall operating expenses.

Type of measure: support

5.3.2 Calculation of energy savings

The calculation formula:

$$TFES = B * ESF \quad (3)$$

where,

Abbreviation	Unit	Explanation
$TFES$	GWh/a	Total Final Energy Savings
B	M€	Support of the measure
ESF	kWh/€	Energy saving factor

Calculation methodology

Based on the results of already implemented energy saving projects, the value of the energy saving factor has been taken as 2.459 kWh/€.

Target of energy saving	Value
Yearly additional savings	4.1 GWh/y

5.3.3 Calculation of costs

It has been calculated that if the amount of support is 1.67 MEUR per year, the measure can reduce the energy consumption of the industry by approximately 4.1 GWh per year.

Cost of subsidy	Value
Unit costs	**116 €/MWh**
Investment per year	**1.67 EUR/y**

5.4 nI4 – Investment support for the food industry to ensure security of energy supply

5.4.1 Purpose of the measure

The primary objective of this measure is to enhance the security of energy supply within the food industry by encouraging and supporting energy efficiency investments.
Under this measure, a grant program would provide financial assistance and incentivize food industry companies to implement energy efficiency measures. The grant would serve as a means to facilitate the adoption of energy-saving technologies and practices, which can lead to significant reductions in energy usage and operational costs for businesses in the food industry.

Type of measure: support

5.4.2 Calculation of energy savings

The calculation formula:

$$TFES = B * ESF \quad (3)$$

where,

Abbreviation	Unit	Explanation
$TFES$	GWh/a	Total Final Energy Savings
B	M€	Support of the measure
ESF	kWh/€	Energy saving factor

Calculation methodology

Based on the results of already implemented energy saving projects, the value of the energy saving factor has been taken as 2.459 kWh/€.

Target of energy saving	Value
Yearly additional savings	3.4 GWh/y

5.4.3 Calculation of costs

It has been calculated that if the amount of support is 1.4 MEUR per year, the measure can reduce the energy consumption of the industry by approximately 3.4 GWh per year.

Cost of subsidy	Value
Unit costs	**116 €/MWh**
Investment per year	**1.4 EUR/y**

5.5 nI5 – Supporting energy efficiency investments in companies

5.5.1 Purpose of the measure

The objective of this measure is to support energy and resource efficiency investments in industries via a grant, to make industries more resource- and energy efficient. To apply to the grant, industries must conduct energy- and resource audits as prerequisite. After implementation of the project, a KPI (resource use per production unit) is monitored up to 5 years. If required results are not achieved, explanations are required, in some cases grant can be requested back if the results are not achieved.
The beneficiaries of the measure are industrial companies. Only the measures that are listed in the eligibility list may benefit from the grant.

Type of measure: support

5.5.2 Calculation of energy savings

The calculation formula:

$$TFES = B * ESF \quad (3)$$

where,

Abbreviation	Unit	Explanation
$TFES$	GWh/a	Total Final Energy Savings
B	M€	Support of the measure
ESF	kWh/€	Energy saving factor

Calculation methodology

Based on the results of already implemented energy saving projects, the value of the energy saving factor has been taken as 2.459 kWh/€.

Target of energy saving	Value
Yearly additional savings	9.7 GWh/y

5.5.3 Calculation of costs

It has been calculated that if the amount of support is 0.23 MEUR per year, the measure can reduce the energy consumption of the industry by approximately 9.7 GWh per year.

Cost of subsidy	Value
Cost per unit	71 €/MWh
Investment per year	0.23 EUR/y

6 Energy saving measures' catalogues in other countries

6.1 Introduction

This chapter provides a comprehensive analysis of the catalogues of energy saving and renovation measures in Finland, Latvia, and Lithuania. Measures for Finland, Latvia, and Lithuania as a reference for Estonia have been chosen, due to the shared climatic conditions among these countries, ensuring that the proposed measures are specifically tailored to the challenges and opportunities presented by the regional climate. Additionally, the geographical proximity and common connection to NordPool, the energy market shared by Nordic and Baltic countries, enhance the relevance of these catalogues for Estonia. The analysis consists of descriptions of the measures of each field of application, calculation formulas and expected results calculated according to these formulas. The analysis also provides a comparison of the differences in the catalogues for these three countries.

The first part of the analysis provides a description of each catalogue analysed. The second part analyses the measures by application areas. The measures analysed in the second part do not represent all the measures implemented in the country, only those measures that are included in the analysed documents have been analysed. The third part contains a discussion of the analysis and its results.

6.2 Description of the examined catalogues

6.2.1 Finland

For Finland the document "Carbon Neutral Finland 2035 – national climate and energy strategy"[7] and its summary report with discussions and conclusions was examined.

The document itself consists of description of the starting points and baselines, political guidelines, impact assessments, regional plans and regional development funds, and a strategy for adaptation to climate change. In total there are five parts in the document that provide research methods, materials and computational and more detailed descriptions of qualitative analyses.

The calculations and impact analysis prepared in the project are mainly based on scenario analysis, in which the current development has been compared with a policy scenario that realizes Finland's goal of carbon neutrality by 2035. The scenario describing the current development is called WEM (with existing measures) and the policy scenario accordingly WAM (with additional measures).

In the document chapter 2 are given Climate and Energy Strategy policy guidelines that involve the following sectors:

- Greenhouse gases emissions reduction and sinks
  - Emissions trading sector
  - Shared load sector
  - LULUCF sector
- Promotion of renewable energy
- Hydrogen and electro fuels

[7] Ministry of Economic Affairs and Employment Energy. Carbon neutral Finland 2035 – national climate and energy strategy. 2022. https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/164323/TEM_2022_55.pdf?sequence=4

- Promotion of energy efficiency
- Energy resiliency and security of supply
  - Electricity
  - Gas
  - Heat
  - Oil and oil products
  - Cyber security of energy systems
- Use of nuclear energy
- Development of energy market
  - Development of energy infrastructure
  - Development of electricity market
  - Development of gas market
  - Development of heat market
- Scientific research and competitiveness and innovation
- Taxation
- Strengthening adaptation to climate change

The document is more of strategic document and does not actually show the equations for the calculations of the results.

6.2.2 Latvia

For Latvia the examined document was the catalogue of energy savings which is an Excel file that allows to calculate energy savings using previously estimated energy savings methods[8].

The catalogue is based on the European Union research and innovation program Horizon 2020 project "*Facilitating multi-level governance of energy efficiency. mulltEE*" and the study commissioned by the Ministry of Economy of Latvia "*Development of methodological guidelines for consumer research achieved as a result of information and education measures for evaluating energy savings and updating the catalog of energy savings*".

The catalogue consists of 47 energy efficiency measures in six different categories:

- Lightning
- Heating (also domestic hot water) and buildings
- Supply
- Information events, monitoring
- Transport, ecological driving
- Ventilation

In addition Latvian List of planned policies and implementing measures (Annex 4 of Latvian National Energy and Climate Plan 2021-2030[9] have been studied.

6.2.3 Lithuania

In Lithuania, energy efficiency measures and policies are presented in five documents, which were discussed in this analysis.

The documents cover issues for energy poverty, renewable energy generation, transport, and user behaviour. The examined documents are:

[8] Latvian Ministry of Economy. Catalog of Energy Savings Developed by Ministry of Economy 2022. https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali#energijas-ietaupijumu-katalogs

[9] Latvian National Energy and Climate Plan 2021-2030, Annex 4: Planned policies and implementing measures 2020. https://www.em.gov.lv/en/media/8849/download?attachment

1. National Energy and Climate Action Plan of the Republic of Lithuania for 2021–2030 [10]
   The plan integrates the provisions, objectives, targets and measures implemented and planned in Lithuanian national legislation, international commitments, strategies and other planning documents.

2. Description of the procedure for setting up energy savings agreements[11]
   The main focus of the document is on energy saving agreements, which are concluded between the Ministry of Energy of Lithuania and operators of electricity and gas transmission and distribution systems and networks. Agreements contain energy saving goals, procedure, rights and obligations of the parties, execution of agreements, submission of saved energy reports and principles of calculating saved energy.

3. Description of the procedure for calculating and monitoring energy savings from energy efficiency improvement measures[12]
   This document determines the methodology and control procedure for calculating the amount of energy resources and energy saved after the implementation of energy efficiency policy measures.

4. Description of renewable energy resources for the electricity needs and for the replacement of heating equipment[13]
   The document is aimed at physical persons. The description of the climate change program measures procedure determines the submission of costs, project registration forms, evaluation, submission of payment requests, allocation and commitment procedures, and the conditions of performance supervision, and establishes general requirements for eligible costs.

5. Long-term (until 2025) strategy for the development of the Lithuanian transport system[14]
   In the Lithuanian transport and transit development strategy, only strategic goals, and measures for the development of individual modes of transport are outlined in more detail. The main guidelines to develop passenger transport and freight transport are described in detail.

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[10] National Energy and Climate Action Plan of the Republic of Lithuania for 2021–2030, 2020, https://energy.ec.europa.eu/system/files/2022-08/lt_final_necp_main_en.pdf

[11] Ministry of Energy of the Repuclic of Lithuania. Order on the Approval of the Description of the Procedure for Conclusion of Energy Saving Agreements. Teises Aktu Registras 2017. https://www.e-tar.lt/portal/lt/legalAct/cd89c430688011e7827cd63159af616c/asr

[12] Ministry of Energy of the Repuclic of Lithuania. Order of Approval of the Description of the Calculation of Eenergy Saved and Maintenance Procedure for Measures for Increasing the Efficiency of Energy Consumption. Teises Aktu Registras 2016. https://www.e-tar.lt/portal/lt/legalAct/c3eb4b20bbb911e688d0ed775a2e782a/asr

[13] Ministry of Environment of the Repuclic of Lithuania. Order on the Approval of the Description of the Procedure for the Measures of the Climate Change Program for Individuals "Use of Renewable Energy Resoursces for the Electrical Energy Needs of Poor Individuals and Replacement of Heat Installations Using Fo. Teises Aktu Registras 2021. https://e-seimas.lrs.lt/portal/legalAct/lt/TAP/268436a0dfac11eb866fe2e083228059?positionInSearchResults=0&searchModelUUID=a9c5c543-4451-48d3-b6eb-32b24bfe881a

[14] The Government of The Republic of Lithuania. Resolution of the Approval of the Long-Term (Until 2025) Lithuanian Transport System Development Strategy 2005. https://e-seimas.lrs.lt/portal/legalActPrint/lt?jfwid=&documentId=TAIS.258496&category=TAD

6. Description of the procedure for compensatory payments under the climate change programme for the modernisation of domestic heating and hot water systems in multi-apartment buildings[15]

The procedure description determines the application submission, assessment, grant allocation and modernization, the maintenance procedure and conditions of the internal heating and hot water systems of apartment buildings.

7. Description of procedures for concluding energy consumer education and advice contracts[16]

This document includes list of values of energy saving coefficients for education and consulting measures.

6.3 The measures by the application area

6.3.1 Renewable energy sources and production promotion

In Finland the following measures are used:

- The aid scheme for electricity production on wind power, biogas, and small-scale CHP – *phased out for wind power from 1 November 2017 and form 1 January 2019 for biogas and small-scale CHP. The plants will receive aid up to 12 years from the start of production.*
- New Production Aid for Electricity from Renewable Energy Sources provides new premium system which is based on competitive tendering process and investments in different renewable energy sources to take account the cost-effectiveness target.
- Aid for the use of forest chips is granted to compensate for the higher production costs of electricity from forest chips compared to fossil fuels.
- Energy aid scheme is primarily targeted at the commercialisation of new technologies and to the non-ETS sector, including plants producing advanced biofuels for transport, and non-ETS electricity and heat production of companies. Aid is paid up to 30% for mature technologies and up to 40% for new technology projects.
- Energy taxation - renewable fuels are not taxed on heat production, fossil fuels are taxed according to their energy content as well as CO2 content. Energy taxation provides an incentive for the use of bioenergy in CHP production and building-specific heat production.
- Energy advisory services is directed to regional activities.
- Energy Efficiency Agreements
    - Customer Advice Services
    - Increasing the coverage
    - Improved reporting
- obligation to supply light fuel oil used in heating with 10% of bioliquid.
- Energy Audit Programme – SMEs and municipalities

In Latvia:

- Installation of photo-voltaic panels for electricity production
- Implement transnational projects for offshore wind parks (in cooperation with Lithuania/Estonia)

[15] Ministry of Environment of the Repuclic of Lithuania. Order on the Approval of the Description of the Procedure for the Climate Change Program Mearure „Modernisation of Interior Heating and Hot Water Systems of Multi-Room Houses“ („Minor Renovation“)“. Teises Aktu Regist 2019. https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/4f3893820a0a11eaa727fba41f42a7e9/asr

[16] Ministry of Energy of the Repuclic of Lithuania. Order on the Approval of the Description of the Procedure for Conclusion of Energy Education and Consulting Agreements. Teises Aktu Regist 2017. https://www.e-tar.lt/portal/lt/legalAct/95f761a09c4a11e78bd78a8ea3cd0744/asr

- Promoting the development of energy communities.

In Lithuania:

- Energy efficiency agreements

6.3.2 Energy efficiency in building sector and space heating

For energy savings from energy efficiency measures in the building sector and space heating, a universal formula (Equation 1) is used in all cases.

$$\Delta E = (E_{before} - E_{after}) \cdot y \quad (1)$$

Where

ΔE is total final energy savings from implementation of the measure (Wh).

E_{before} is the annual amount of energy required in the system of measure application before (Wh).

E_{after} is the annual amount of energy required in the system of measure application after (Wh).

y is the implementation period in years.

In Finland:

- Heat pumps for detached and terraced houses
- Waste heat project
- Implementation of eco-design directive
- Building code, energy efficiency in new buildings
- Building code, energy efficiency in renovation
- Promotion of energy efficiency at system level by considering in the planning of networks and in tariffs and regulations
- Maintaining the prerequisites for combined power and heat generation
- Communication and training to promote energy efficiency.

The estimated energy savings in Finland resulting from the implementation of the measures are shown in Table 2

Table 2. Energy savings from the building sector measures in Finland

Energy efficiency measure	Savings 2030 GWh/y
Waste heat project	1.60
Heat pumps for detached and terraced houses	11.96
Building code, energy efficiency in new buildings	9.34
Building code, energy efficiency in renovation	3.81
Implementation of eco-design directive	7.07
Total	**33.77**

In Latvia:

- Installation or replacement of a ventilation system with heat recovery.
- installation of ground, water, and air heat pumps.
- installation of solar collectors in an existing or newly constructed building using oil products, gas or biomass, in addition to the existing heating system for domestic hot water and additional heat production.
- improvement of the thermal indicators of residential boundary structures.
- wall insulation, replacement of windows, roof insulation in residential and public buildings.
- replacing an old gas or oil boiler with an efficient gas or oil boiler or replacing an old boiler with an efficient biomass boiler in residential buildings and public buildings.

- installation of biomass boilers as an additional heating source to old existing boilers in residential buildings and public buildings.
- renovation of the heating system in residential buildings as well as in public buildings: improving the thermal insulation of hot water tanks, improving the insulation of heating system pipes, installing radiator thermostatic valves.
- regulation of hydraulic systems: the heat supply system is improved by introducing a new control system or by modernizing the existing one.
- connection to district heating network
- improving the heating market.

The estimated energy savings in Latvia gained with provided measures are given in Table 3.

Table 3. Energy savings by measures in Latvia

Energy efficiency measure	Number of applied technologies	Annual energy savings (MWh/a)
Ventilation with heat recovery	Per 1 unit per 100 m^2	1.068
Ground, water, and air heat pumps	1 heat pump per building	26.4
Solar collectors	Per 1 m^2	0.625
Improvement of residential boundary systems	Per 100 m^2	2.632
Single construction elements replacement (windows, walls, ceiling)	Per 10 m^2	5.5 for windows 16.6 for walls 2.0 for ceiling
Replacing an old gas or oil boiler	Per 1 unit per 100 m^2	40
Installation of biomass boilers as an additional heating source	Per 1 unit per 100 m^2, share of biomass boiler 100%	2.5
Renovation of the heating system: insulation of hot water tanks	Per 1 unit	5.5
Renovation of the heating system: insulation of heating system pipes	Per 100 m	28.0
Renovation of the heating system: installing radiator thermostatic valves	per 100 m^2	2.2
Regulation of hydraulic systems	per 100 m^2	2.0

In Lithuania:

- Replacing old fossil fuels powered heating systems by up 10 kW solar photo-voltaic power plants.
- Installation of new biomass boiler or heat pump to replace fossil fuel boilers.
- Modernization of internal heating and hot water systems of apartment buildings.
- Renovation/modernisation of multi-apartment buildings.
- Renovation of individual houses.

In Lithuania, no numerical data for calculations was found.

6.3.3 Energy efficiency in lighting and appliances

In Finland:

- Energy efficiency agreements
- Energy audit programme
- For energy savings see Table 4.

Table 4. Energy savings in Finland by efficient appliance measures

Energy efficiency measure	Savings 2030, GWh/y
Energy Efficiency Agreements	25.77
Energy Efficiency Agreements: Customer advice services	83.00
Energy Efficiency Agreements: Improved reporting	1.08
Energy Efficiency Agreements: Increasing the coverage	1.10
Energy audit programme	1.42
Energy audit programme: increasing volumes	1.81
Total	**114.18**

In Latvia:

- replacement of electric motors in an industrial enterprise
- replacing rotor motors with lower power motors
- installing electric motors with frequency converter in industries
- exchange of household appliances (dishwashers, washing machines, fridges, freezers) before the end of their useful life for the highest energy efficiency class available on the market (class A)
- energy-saving lighting in residential buildings, catering establishments, hotels, non-residential buildings, and industries
- energy efficient street-lighting
- awareness and information campaigns that disseminate information on energy efficiency and energy saving and target specific target groups
- installation of smart meters
- implementation of energy monitoring and management system in companies

The estimated energy savings in Latvia gained with provided measures are given in Table 5.

Table 5. Energy savings from appliances efficiency in Latvia

Measure	Number of applied technologies	Annual energy savings (MWh/a)
Replacement of electric motors in an industrial enterprise	Per 1 unit	176
Replacing rotor motors with lower power motors	Per 1 unit	247
Installing frequency converters	Per 1 unit	141

Exchange of household appliances	Per 1 unit	Washing machine 0.18 Dishwasher 0.15 Fridge 0.38 Freezer 0.31
Energy saving lighting	Per 100 m^2	2.4
Installation of smart meters	Saving factor up to 12 %	
Energy monitoring systems in companies	Saving factor up to 3% for electricity, 5% for heat	

In Lithuania:

- Education and counselling measures for energy end-users

In case of Lithuania, no numerical data for calculations was found.

6.3.4 Transport

In Finland:

- Promotion of the use of biofuels in transport
- Transport fuel taxation/car traffic
- Mass and measure modifications in truck transport
- EU binding CO2 threshold
  - Cars
  - Light-duty vehicles
  - Heavy-duty vehicles
- Campaign of wrecking old cars
- State aid for full-electric vehicles
- Fuel tax for cars

The total energy savings from transport measures in Finland can be seen in Table 6.

Table 6. Energy savings from transport measures in Finland

Energy efficiency measure	Savings 2030, GWh/y
EU binding CO_2 thresholds: Cars	8.67
EU binding CO_2 thresholds: Light-duty vehicles	285.00
EU binding CO_2 thresholds: Heavy-duty vehicles	604.00
Campaign of wrecking old cars (2015 and 2018)	35.00
State aid for full electrical vehicles (until 2021)	0.10
Fuel tax for cars	1.24
Mass and measure modifications in truck transport	20.00
Total	**953.90**

In Latvia, Table 7:

- Purchase of a car using alternative fuel (replacing a car using conventional fuel).
- The use of lubricants that increase the efficiency of the engine in cars, trucks and buses, and heavy trucks.
- Use of fuel-efficient tires for cars, trucks, buses, and heavy trucks.
- Conducting theoretical and practical eco-driving training in both group and individual lessons.

Table 7. Energy savings from transport measures in Latvia

Energy efficiency measure	Number of technologies applied	Annual energy savings MWh/a
The use of lubricants that increase the efficiency of the engine	Per 1 vehicle	Car 0.28 Light freight 0.55 Heavy freight 0.47 Busses and heavy trucks 1.23
Purchase of a car using alternative fuel	Per 1 vehicle	16.3
Use of fuel-efficient tires	Per 1 vehicle	Car 0.28 Light freight 0.55 Heavy freight 0.47 Busses and heavy trucks 1.46

In Lithuania:

- Replacing freight transport with more efficient ones.

In case of Lithuania, no numerical data for calculations was found.

6.4 Conclusions

In this analyse the energy saving measure documents of Finland, Latvia and Lithuania were examined. The documents were vastly different by their level of detail and their usage purpose. As for Finland, the examined document was more like a governmental strategy and guidelines, while the Latvian document was more like calculation tool for creating strategies. In case of Lithuania, the only accessible documents were governments regulations and orders, where no energy savings estimations were given.

All the analysed measures had many similar traits, but their level of detail was different. For example, Finland measures had more freedom of choice while Latvian measures were more precise. Both Finland and Lithuania had measures for Voluntary Energy Efficiency Agreements that obliges companies to implement energy efficiency measures. The Energy Efficiency Agreement can provide remarkable amount of energy savings, according to Finnish results.

In the building sector, in all countries, the most of measures are support measures for energy efficiency investments, while in transport sector the savings were mostly gained with taxation and adding biofuels.

While conducting a comprehensive analysis, we have discerned that a significant number of energy efficiency measures implemented in Latvia, Lithuania, and Finland are already part of suggested measures or have been successfully implemented in Estonia before. However, there are some measures, that can be undertaken in the future in Estonia, but further investigation is needed to evaluate the potential impact of these unadopted measures on energy efficiency. As an example, heating market improvement in Latvia, large demonstration energy-efficiency projects' support in Finland and waste heat from district cooling in Lithuania should be mentioned.

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