Regional Energy Agency North

OUR-CEE
Overcoming Underperforming Renovations in Central and Eastern Europe

RENOVATION ROADMAP

BUILDING:

Music School Jan Vlašimsky Virovitica

March, 2025.

CURRENT STATE

ENERGY CERTIFICATE

Building information

new	existing	reconstruction
☐	☑	☐

Building name	Music School Jan Vlašimsky		
Street and house number	Antuna Mihanovića 21		
Zip code	33000		
Place	Virovitica		
Building type	Educational buildings		
Building type according to the complexity of technical systems	Building with a complex technical system		
Owner/Investor	City of Virovitica		
Cadastral no.	465		
Area of the useful surface of the heated part of the building Ak [m2]	888,05		
Gross building area [m2]	1.098,64		
Shape factor f_0 [m-1]	0,31		
Year of construction/reconstruction	1960/2009		
Building usage pattern	5 days a week (Mon-Fri), 8:00 a.m. - 8:00 p.m.		
Relevant meteorological station	Bjelovar		
Reference climate	Continental		
The source of energy of the current state	Non-renewable energy source	electricity	natural gas
	Renewable energy sources	-	-

Energy needs	**REFERENCE CLIMATE DATA**		**ACTUAL CLIMATE DATA**	
	Total [kWh/a]	**Specific [kWh/(m^{2}a)]**	**Total [kWh/a]**	**Specific [kWh/(m^{2}a)]**
Annual energy demand for heating $Q_{H,nd}$	73.019,30	82,22	75.022,27	84,48
Annual energy demand for cooling $Q_{C,nd}$	22.965,44	25,86	23.798,70	26,80
Annual energy demand for lighting EL	30.956,04	34,86	30.956,04	34,86
Annual energy delivered E_{del}	148.047,30	166,71	151.587,91	170,70
Annual primary energy E_{prim}	197.451,10	222,34	202.027,37	227,50

Renewable energy sources on site

Annual electricity produced from RES at the location of the building [kWh/a]	0,00
Annual thermal energy produced from RES at the building location [kWh/a]	0,00
Share of renewable energy sources in the total energy delivered for the operation of thermo-technical systems [%]	0%

Energy class of the building	**Specific annual energy demand for heating Q"$_{H,nd}$ [kWh/(m^{2}a)]**	**Specific annual primary energy E_{prim} [kWh/(m2a)]**
	82,22	222,34
	C	**F**

Enter "nZEB" if the energy performance of the building (E_{prim}) meets the requirements for nearly zero-energy buildings	-
Specific annual CO_2 emission [kg/(m^{2}a)]	37,83

Validity period of the certificate/information about the energy auditor

Energy certificate mark	P_294_2013_10496_NSZ2		
Date of issue	21.8.2024.	**Validity date**	21.8.2034.
Energy auditor	Stipica Zivkovic		
Name of authorized legal entity	QUANTUM STUDIO doo		

STEP-BY-STEP RENOVATION PLAN

	ENERGY CLASS	ENERGY CLASS	ENERGY CLASS	ENERGY CLASS	ENERGY CLASS
	C	C	A+	A+	A+
	Implemented measures - **current state**	**STEP 1**- 2025 - 2030	**STEP 2**- 2030 - 2040	**STEP 3**- 2040 - 2050	**STEP 4**- 2040 -2050
MEASURES	5 cm thermal insulated external walls Replaced windows and doors	Lighting system reconstruction Thermal insulation of the building Replacing or improving windows and doors	Reconstruction of heating and cooling systems Ventilation system with heat recovery Installation of renewable energy sources	Building energy management system	
ENERGY CONSUMPTION	**Primary energy consumption (kWh/a)**	**Primary energy consumption (kWh/a)**	**Primary energy consumption (kWh/a)**	**Primary energy consumption (kWh/a)**	**Primary energy consumption (kWh/a)**
	202.027,37	157.924,12	-79.608,83	-72.371,67	
	Main energy source	**Main energy source**	**Main energy source**	**Main energy source**	**Main energy source**
	Natural gas	Natural gas	Electricity	Electricity	
	Final energy of the main energy source (kWh/a)	**Final energy of the main energy source (kWh/a)**	**Final energy of the main energy source (kWh/a)**	**Final energy of the main energy source (kWh/a)**	**Final energy of the main energy source (kWh/a)**
	151.587,91	71.508,91	-49.446,48	-44.951,35	
	Auxiliary power source	**Auxiliary power source**	**Auxiliary power source**	**Auxiliary power source**	**Auxiliary power source**
	Electricity	Electricity			
	Final energy of auxiliary energy source (kWh/a)	**Final energy of auxiliary energy source (kWh/a)**	**Final energy of auxiliary energy source (kWh/a)**	**Final energy of auxiliary energy source (kWh/a)**	**Final energy of auxiliary energy source (kWh/a)**
	69.438,53	49.332,01			
	Renewable energy sources	**Renewable energy sources**	**Renewable energy sources**	**Renewable energy sources**	**Renewable energy sources**
	-	-	Heat pump Photovoltaics	Photovoltaics Heat pump	
	Cost of energy (€/a)	**Cost of energy (€/a)**	**Cost of energy (€/a)**	**Cost of energy (€/a)**	**Cost of energy (€/a)**
	9.860,83	7.405,67	0,00	0,00	
CO_2	**CO_2 emissions (t/a)**	**CO_2 emissions (t/a)**	**CO_2 emissions (t/a)**	**CO_2 emissions (t/a)**	**CO_2 emissions (t/a)**
	34,39	27,33	0,00	0,00	
COST OF MEASURES	**Investment cost of the renovation step (€)**	**Investment cost of the renovation step (€)**	**Investment cost of the renovation step (€)**	**Investment cost of the renovation step (€)**	**Investment cost of the renovation step (€)**
		100.900,00	265.000,00	13.350,00	
	Investment cost of the renovation step (€/m²GBA)	**Investment cost of the renovation step (€/m²GBA)**	**Investment cost of the renovation step (€/m²GBA)**	**Investment cost of the renovation step (€/m²GBA)**	**Investment cost of the renovation step (€/m²GBA)**
		91,84	241,21	12,15	
	Maintenance cost (€/m²GBA per year)	**Maintenance cost (€/m²GBA per year)**	**Maintenance cost (€/m²GBA per year)**	**Maintenance cost (€/m²GBA per year)**	**Maintenance cost (€/m²GBA per year)**
	10,00	4,10	0,91	0,45	

Renovation roadmap

STEP 1

Planned measures from 2025 to 2030:

MEASURE: RECONSTRUCTION AND REPLACEMENT OF INTERIOR LIGHTING
Supply, installation and connection of LED interior lighting fixtures, together with light sources, connection and assembly accessories. Surface-mounted fixture, LED light source, UV-stable polycarbonate housing, UV-stable polycarbonate diffuser, effective luminous flux or luminous flux of the fixture with losses in the optical system included according to the calculation, system power max. 35W (LED source + driver), total luminous efficiency of the fixture with losses in the optical system included according to the calculation, LED module lifetime ≥50,000 operating hours with 90% maintenance of the initial luminous flux, color rendering Ra>80, light color temperature 4000K, protection min. IP54, mechanical protection of the fixture min. IK10, operation at maximum ambient temperature +35°C, ENEC certificate.

MAINTENANCE MEASURES: 1. Regular checks and visual inspection (every 3-6 months), 2. Replacement of faulty bulbs and lighting fixtures (as needed), 3. Cleaning of lighting fixtures (at least once a year), 4. Maintenance of outdoor lighting (annually or as needed), 5. System optimization and energy efficiency, 6. Professional service and safety checks (every 1-2 years).

MEASURE: REPLACEMENT OF EXTERNAL WINDOWS AND DOORS
Manufacturing, delivery and installation of new PVC windows and doors in the color of the investor's choice, UV stable in accordance with the Technical Regulation for Windows and Doors OG 69/06 (Croatia). Profile min. 6 chambers, three seals, with a profile wall thickness of not less than 2.7 mm. All items must be reinforced with a metal core with a thickness of at least 1.5 mm, or in accordance with the static calculation and instructions of the profile manufacturer. Heat transfer coefficient for the window Uw≤1.00 W/m²K, and for the door Uw≤1.80 W/m²K. Heat transfer coefficient for glass Ug≤0.90 W/m²K. Noise protection min. PROTECTION CLASS 2. Glazing: thermally insulating triple glass, filled with argon, Low-E coating. Standard hinged-turning hardware with multiple closure and ventus hardware in accordance with the manufacturer's standards. The price includes the purchase of materials, production and installation of window sills, internal PVC and external made of plasticized aluminum sheet in the color of the investor's choice. The item includes the supply and installation of all auxiliary materials necessary for the performance of high-quality sealing of connections to facade. Assembly and installation using three-level sealing: - internal waterproof and vapor-impermeable sealing tape - external waterproof and vapor-permeable sealing tape - the space around the perimeter of the item completely filled with insulating material. Included sun protection in planned positions. Calculation per piece.

MAINTENANCE MEASURES: Maintaining a building's external windows and doors is essential for the longevity of window frames, glass and seals, as well as for energy efficiency and safety. Regular maintenance measures include: 1. Regular inspection (at least twice a year) 2. Window cleaning 3. Seal maintenance 4. Checking and lubricating fittings and mechanisms 5. Maintaining wooden, PVC and aluminium frames 6. Checking air tightness and energy efficiency 7. Repairing damage and protecting against weathering 8. Professional inspections and servicing.

MEASURE: THERMAL INSULATION OF EXTERNAL WALLS - ROCK WOOL
Implementation of the ETICS system for thermal insulation of the external walls of the building with all necessary preparatory work, including scaffolding (assembly, disassembly, depreciation) and preparation of the surface. Thermal insulation is performed with 15 cm thick rock wool, thermal conductivity ≤ 0.035 W/mK. For the installation of sloping sills, cut extruded polystyrene 0-12 cm, thermal conductivity ≤0.040 W/mK, is installed, and is processed in the same way as the rest of the facade system. Reinforced based coat is 0.5 cm thick, highly resistant to impacts and other mechanical damage up to 15 J and hail resistance class 5, applied in two layers and reinforced with alkali-resistant glass mesh between the layers. The final coating is performed with silicone plaster with a granulation of max. 1.5 mm, layer thickness 3 mm on a previously impregnated surface (the system primer), in the color chosen by the investor. The rock wool boards are bonded to the surface and mechanically fixed with fasteners with wide heads (including the installation of covers made of the same material as the thermal insulation), and held at the plinth level with 15 and 10 cm profiles, all according to the manufacturer's recommendation. The ETICS system at the plinth level with all necessary preliminary work and preparation of the surface is performed with extruded polystyrene (XPS) 15 cm thick, thermal conductivity ≤0.036 W/mK. The finishing is performed with silicate waterproof plaster with a granulation of max. 1.5 mm, layer thickness 3 mm, in the color chosen by the investor.

MAINTENANCE MEASURES: 1. Regular reviews and inspections, 2. Cleaning of the facade, 3. Repair of cracks and damage, 4. Maintenance of paint and coating 5. Maintenance of thermal insulation layers.

Advantages:

Reduced heating and cooling costs – Insulation reduces heat loss in winter and overheating in summer, significantly reducing energy bills.
Increased energy efficiency – Lower energy consumption contributes to sustainability and reduced CO_2 emissions, which is important for environmental protection.
Improved living comfort – Maintains a stable indoor temperature without large fluctuations, which increases the quality of life.
Prevention of condensation and moisture – Reduces the risk of mold and moisture, which improves indoor air quality.
Durability and structural protection – Reducing temperature differences protects the facade and building materials from decay and cracks.
Increased property value – Energy-efficient buildings are more attractive to buyers and landlords.

Estimated cost of measures:

100.900,00 €

Estimated maintenance cost:

4.500,00 €

Financial support:

Energy renovation of public sector buildings within NRRP,
https://mpgi.gov.hr/o-ministarstvu/djelokrug-50/energetska-ucinkovitost-u-zgradarstvu/energetska-obnova-zgrada-8321/energetska-obnova-zgrada-javnog-sektora/energetska-obnova-zgrada-javnog-sektora-npoo/15230

Local sources of financing
Credits and loans from private banks

STEP 2

Planned measures from 2030 to 2040:

MEASURE: HEAT PUMP INSTALLATION

Compact high-efficiency air-to-water heat pump intended for heating and cooling and for preparing domestic hot water. It consists of two functional elements, outdoor and indoor unit. The first functional element - an outdoor unit intended for outdoor installation - protected from weather influences, with built-in hermetic DC inverter compressors, an air-cooled condenser and all necessary elements for protection, control and regulation of the device and functional operation. The working fluid for the heat pump must comply with Regulation (EU) No. 517/2014 of the European Parliament and of the Council on fluorinated greenhouse gases and GWP≤ 2270. The indoor unit is the second functional element consisting of a high-efficiency heat exchanger that transfers heat to water, and a high-pressure water pump of class A, an electric heater and an expansion tank and all valves required for switching, designed as a compact unit intended for indoor installation, in a designed cover/armor. With an additional 9 kW electric heater. Minimum requirements for the seasonal energy efficiency of a heat pump for space heating in average climate(s) according to EN 14825 expressed as SCOP, [kW/kW] or ηs,h, [%] in accordance with Commission Regulation (EU) 813/2013: SCOP (W35) = min. 3.60; SCOP (W55) = min. 3.20, or ηs,h (W35)=min. 140 %; ηs,h (W55)=min. 125%.

MAINTENANCE MEASURES: 1. Regular visual inspections (every 1-2 months), 2. Cleaning of heat exchangers and fans (every 3-6 months), 3. Maintenance of air filters (monthly or according to manufacturer's instructions), 4. Checking the refrigerant (annually or as needed), 5. Maintenance of heating and heat distribution systems, 6. Seasonal inspections and preparation for winter/summer, 7. Professional servicing (once a year).

MEASURE: INSTALLATION OF PHOTOVOLTAIC SYSTEM

Supply and installation of a photovoltaic system. Efficiency of photovoltaic solar modules at least 18 %. Photovoltaic module with the following characteristics: -peak power min. 445W -permitted power deviation: 0/+3% -dimensions 1762x1134x30mm ±5%. Includes supply and installation of a photovoltaic inverter with the following characteristics: -3x230V, 50Hz -number of MPP inputs min. 3x2 -maximum efficiency min. 98.4%; supply and installation of MC4 connector set 4mm2 - male-female connector set, gasket and housing, for connecting module strings. Junction box for overvoltage protectors for protecting DC circuits (strings), installation next to the inverter, equipped with: - disconnect switch 10x38 gPV16A, 1000V 2p (pcs. 4) - surge protection DC side B+C 25/1100 (2+0) (pcs. 4) - plastic channels and connecting material, conductors for wiring the main and auxiliary circuits, insulating panels and partitions - verification of correct installation, and testing of functional operation, issuance of a test protocol by an authorized tester and all necessary certificates and attestations. Includes supply and installation of solar installation cables, cable from the inverter to the main electrical junction box, aluminum structures for mounting FN modules, all mounting material and costs of delivery to the construction site, installation, testing and commissioning.

MAINTENANCE MEASURES: 1. Regular check-ups and visual inspection (every 3-6 months), 2. Panel cleaning (1-2 times a year, depending on location), 3. Performance monitoring and data analysis (continuously or monthly), 4. Inverter maintenance (annually or according to manufacturer's recommendations), 5. Grounding and surge protection system inspection (at least once a year), 6. Professional technical servicing (at least once a year).

MEASURE: INSTALLATION OF VENTILATION WITH HEAT RECOVERY

Supply and installation of a ventilation system with heat recovery for internal ceiling installation, equipped with EC fans, 100 % bypass, F7 filtration on pressure and M5 exhaust, plastic counter-flow exchanger, integrated water heater, integrated water cooler, regulation function based on constant flow, shut-off damper with return spring on the fresh air intake side. Supplied with a control system with integrated frost protection and wall-mounted controller. The item includes the supply and installation of a flexible ventilation joint for connecting the air recuperator and ventilation ducts, a sound attenuator for installation on the ventilation duct, a ceiling swirl air distributor with adjustable slats for air intake, ventilation grilles for air intake for installation on the ventilation duct, air spiro ducts made of galvanized steel sheet, production of fittings and transition pieces, air ducts, rectangular cross-section, made of galvanized sheet, insulation of ventilation ducts, wall exhaust fans and a draft-proof facade grid with a protective mesh. The price includes all necessary elements for full control functionality and all necessary connecting and mounting material until full completion.

MAINTENANCE MEASURES: 1. Regular checks and visual inspection (every 3-6 months), 2. Cleaning and replacement of filters (every 3-6 months, depending on conditions), 3. Maintenance of heat exchangers (at least once a year), 4. Cleaning and maintenance of ventilation ducts (every 1-2 years), 5. Checking fans and electrical components (annually), 6. Maintenance of condensate drain and drain pump (annually), 7. Professional service and optimization of the system (at least once a year).

Advantages:

Heat pumps: Heat pumps use renewable energy sources for heating and cooling, achieving a high efficiency coefficient (COP 3-5) and reducing electricity consumption. Although they require a higher initial investment, they reduce heating and cooling costs in the long term and increase energy independence. They reduce CO_2 emissions, contribute to environmental sustainability and can be combined with renewable energy sources such as solar panels.
Photovoltaic system: Solar panels make it possible to produce own electricity, reducing electricity bills and increasing energy self-sufficiency. They use clean, renewable energy, reducing the carbon footprint and CO_2 emissions, which contributes to environmental protection. They are profitable in the long term because they have a long service life (25-30 years), and with incentives and subsidies, the initial investment becomes more affordable.
Heat recovery ventilation (MVHR): Provides continuous air exchange, removes CO_2 and impurities, and improves indoor air quality. Reduces energy consumption by using heat recovery, which reduces heating and cooling costs. Helps maintain optimal temperature and humidity, prevents mold, and contributes to a healthier and more productive environment.

Cost estimate:

265.000,00 €

Estimated maintenance cost:

1.000,00 €

Financial support:

Energy renovation of public sector buildings within NRRP,
https://mpgi.gov.hr/o-ministarstvu/djelokrug-50/energetska-ucinkovitost-u-zgradarstvu/energetska-obnova-zgrada-8321/energetska-obnova-zgrada-javnog-sektora/energetska-obnova-zgrada-javnog-sektora-npoo/15230

Local sources of financing
Credits and loans from private banks

STEP 3

Planned measures from 2040 to 2050:

MEASURE: INSTALLATION OF A BUILDING ENERGY MANAGEMENT SYSTEM
Supply, installation, programming and commissioning of a building energy and management system (BEMS). The system includes centralized monitoring and control of thermo-technical systems such as heating, cooling, ventilation, lighting, security systems etc. The works include: - Procurement and installation of control units, sensors, actuators and connected devices - Implementation of a software solution for remote monitoring and management of systems - Integration with existing electrical installations and infrastructure of the facility - Configuration and optimization of the system for maximum energy efficiency - Testing, calibration and commissioning of the system - User training and preparation of technical documentation. The works are carried out in accordance with the applicable technical regulations, norms and standards for smart buildings.

MAINTENANCE MEASURES: 1. Regular inspections and system testing (every 3-6 months), 2. Updating software and security settings (at least once a year) 3. Maintenance of sensors and controllers (every 6-12 months), 4. Optimization of settings and energy efficiency (annually), 5. Checking connected systems and external networks (annually or as needed), 6. Professional servicing and system analysis (at least once a year).

Advantages:

Key benefits of smart building management systems: Energy efficiency and cost savings – Systems automatically optimize energy consumption, reduce bills and maintenance costs.
Security and control – Enable access control, hazard detection (fire, gas) and remote control via applications.
Sustainability and increase property value – Reduce CO_2 emissions, improve working conditions and increase the attractiveness of the building on the market.

Estimated cost of measures:

13.350,00 €

Estimated maintenance cost:

500,00 €

Financial support:

Energy renovation of public sector buildings within NRRP,
https://mpgi.gov.hr/o-ministarstvu/djelokrug-50/energetska-ucinkovitost-u-zgradarstvu/energetska-obnova-zgrada-8321/energetska-obnova-zgrada-javnog-sektora/energetska-obnova-zgrada-javnog-sektora-npoo/15230

Local sources of financing
Credits and loans from private banks

VERIFICATION AND MONITORING

Verification and monitoring of the implementation of measures for the energy renovation of public sector buildings are key to ensuring the quality of the work performed and achieving the expected energy savings. This process includes several steps:
1. Verification before the implementation of measures
Review of project documentation - analysis of technical solutions and compliance with regulations.
Energy audit of the building - initial state of energy consumption and identification of potential savings.
2. Monitoring during implementation
Supervision of works - checking the quality of performed works and compliance with the project.
Control of used materials - checking the energy efficiency of installed materials and systems.
3. Verification after implementation
Final energy audit - comparison of energy consumption before and after renovation.
Testing the effectiveness of measures - analysis of savings and improvements in energy efficiency.
Preparation of the final report - documentation of results and recommendations for further monitoring.
4. Long-term monitoring and maintenance
Monitoring of energy consumption and verification of achieved savings - use of smart systems for continuous monitoring and verification (ISGE and SMiV).
Regular inspections and optimization of the system - periodic controls to ensure a permanent reduction in consumption.
This approach ensures that energy renovation measures are not only properly implemented, but also they bring the planned energy and financial savings in the long term.

The city/municipality will establish an operational “green transition” team to monitor and follow up on the implementation of the planned renovation measures. The team will be composed of the following departments and organizations: Department of Finance, Economy and European Affairs, Department of Spatial Planning and Construction, and the Regional Energy Agency North. The Department of Finance, Economy and European Affairs will be responsible for overall coordination during the monitoring and verification phase, while the Department of Spatial Planning and Construction, together with the Regional Energy Agency North, will provide technical support. The project team will be formed from these organizational units with the following roles: – Monitoring and Verification Process Manager, Technical Expert for Energy Efficiency, Technical Expert for RES and Financial Expert. The key tool that will be used in this process is the Energy Management Information System – ISGE, which is an online application for monitoring and analyzing energy and water consumption in public sector buildings and serves as an indispensable tool for systematic energy management. ISGE greatly facilitates the process of systematic energy management in public buildings because it enables easy access to data on energy consumption and costs, easy graphical and tabular display and printing of data and results of conducted analyses, and simpler preparation of data necessary for the development of local energy efficiency improvement plans and associated reports.

STEP 1: 2025 - 2030	DONE (mark)	STEP 2: 2030 - 2040	DONE (mark)	STEP 3: 2040 - 2050	DONE (mark)
Thermal insulation of the building	☐	Reconstruction of heating and cooling systems	☐	Building energy management system	☐
Replacing or improving windows and doors	☐	Installation of renewable energy sources	☐		☐
Lighting system reconstruction	☐	Ventilation system with heat recovery	☐		☐
	☐		☐		☐
	☐		☐		☐