Opinion of the author of the Energy Assessment for SC 5.1 on the Final Evaluation of the Project (hereinafter referred to as FEP)

1. Identification

1.1. Issuer of the opinion on the FEA

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1.2. Opinion author (energy specialist)

Name and address: Jiří Nezhoda, Slezská 755, 74283 Klimkovice Name of energy specialist: Jiří Nezhoda
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1.3. Subject of the opinion on the ZVA

Subject:	Installation of KGJ in the ELI Beamlines building, Dolní
Břežany Type of building:	Research institute
Construction site:	Za Radnicí 835, 252 41 Dolní Břežany Owner: Extreme Light Infrastructure ERIC (ELIERIC)

1.4. Basis for issuing the opinion

- Energy assessment (hereinafter referred to as EA) dated June 28, 2023, prepared by Ing. Jiří Nezhoda, Ph.D.
- Project documentation from December 2022, prepared by Ing. Jiří Kunc
- Decision on the provision of a subsidy dated November 16, 2023
- Outputs from the implemented Energy Management (information on the operation of the building)
- Readings of electricity and heat production within the framework of the implemented Energy Management

2. Opinion of an energy specialist on the ZVA

The opinion of an energy specialist on the ZVA (hereinafter referred to as the "Opinion on the ZVA") has been prepared for the purpose of evaluating the benefits arising from the implementation of the project, for which a subsidy was drawn from the Operational Program Environment 2014–2020. The actual benefits achieved are compared with the estimated values calculated in the EP, which was submitted as an annex to the grant application.

1.1. Proposed energy-saving measures in the EP for subsidy applications

Proposed measures - Cogeneration unit including optimization of measurement and control

Cogeneration units enable the production of heat and electricity from a single source. They combine a combustion engine, generator, heat exchanger system, and control system, which allows the units to be controlled both locally and remotely using a PC. From a thermodynamic point of view, cogeneration units reduce the consumption of primary energy in the form of fossil fuels. This is achieved by generating electricity during heat production. Otherwise, electricity would have to be generated in conventional coal or nuclear power plants with lower efficiency. Another major advantage directly related to primary energy savings is the positive impact on the environment. This is mainly due to lower fuel consumption, which would otherwise be consumed in the separate production of heat and electricity, and thus significantly lower negative consequences of their extraction and combustion. First and foremost, the amount of greenhouse gases (carbon dioxide) produced is reduced. Furthermore, the production of harmful oxides, such as nitrogen and sulfur oxides, is reduced.

For the purposes of analyzing the savings potential, a cogeneration unit with an electrical output of 530 kW and a thermal output of 630 kW was designed. The total efficiency of combined production is 89.3%. The number of operating hours per year was set at 5,500, taking into account the operating hours on the premises and the consumption of electricity and natural gas for heating.

The implementation of the measures will ensure compliance with the parameters of Commission Regulation (EU) No. 813/2013 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to the ecodesign requirements for space heaters and combination heaters (requirements from September 26, 2018).

Optimization of measurement and control

The main objective of the project is to find the right solution for maintaining the sustainability of the measurement and control system (MaR) – building monitoring system (BMS) at the ELI Beamlines Facility DOLNÍ BŘEŽANY. The existing MaR control system is technically obsolete, with support from the manufacturer coming to an end. The goal is to find a solution for replacing the M&R control system in such a way as to minimize the costs of replacing the hardware and software of the M&R control system, to ensure the openness and portability of the software, to enable easy expansion in connection with the installation of KGJ, and to provide algorithms that enable optimization of regulation from an energy savings perspective. The installation of KGJ will ensure the production of electricity for own consumption, as well as the production of heat for own consumption, while reducing the consumption of energy produced from fossil fuels. At the same time, it is necessary to ensure the expansion of the MaR control system.

By using the right tools and procedures, it is possible to extract valuable information from the measured data, leading to the optimization of energy consumption. A key feature of these algorithms is the minimization of the time required to perform the evaluation. The goal is to automate data preprocessing so that the dispatcher only interprets the results and makes suggestions for optimizing operations, all in real time if possible. This involves using machine understanding of the meaning of the measured data, for example, through tagging and similar methods.

The replacement of the existing control system will be a generic replacement with a new control system. Modular, freely programmable automation stations with a redundant processor and a web server, supplemented with expansion modules, will be used. Communication between the automation station and the expansion modules takes place via Ethernet using the ModBus TCP/IP protocol for control and the MQTT protocol for telemetry data collection.

Local control units located on the front panels of individual switchboards are used for local operation and control of the automation stations. The control units have a TFT LCD touch screen. The existing IRC controllers will be replaced with new IRC controllers. Communication between the automation station and IRC controllers takes place via Ethernet using the ModBus TCP/IP protocol for control and the MQTT protocol for telemetry data collection.

1.2. Opinion on changes to the project during implementation

Notified changes according to change list OZ 01 dated December 13, 2023 – the changes listed do not affect the parameters and evaluation criteria of the project

1.3. Expected benefits of the project as stated in the EP

1.3.1. Energy savings (GJ/year)

The total savings were calculated based on the total energy consumption of the building

Energy consumption before project implementation	GJ/year	63,349.84
Energy consumption after project implementation	GJ/year	60,734.84
Reduction in energy consumption	GJ/year	2,615.00
Reduction in energy consumption	%	4.12

1.3.2. Emissions savings (tons/year)

Only relevant emissions monitored within the project.

Greenhouse gas emissions before project implementation	tons/year	11,187.7
Greenhouse gas emissions after project implementation	tons/year	9,276.9
Reduction in greenhouse gas emissions	tons/year	1,910.84
Reduction in greenhouse gas emissions	%	17

TZL emissions before project implementation	tons/year	0.437
TZL emissions after project implementation	tons/year	0.363
Reduction in TZL emissions	tons/year	0.074
Reduction in TZL emissions	%	17

1.3.3. Energy production from renewable sources (GJ/year)

Electricity production from renewable sources	GJ/year	0

1.4. Project status after implementation of proposed measures

1.4.1. Energy-saving measures implemented

The KGJ installation is located in a building designated for scientific and research purposes. The building, numbered 835, is located on plots 1095 and 1096 in the cadastral area of Dolní Břežany (28797), which are owned by

the applicant. The cogeneration unit has an electrical output of 530 kW and a thermal output of 630 kW. The total efficiency of combined production is 89.3%.

MaR optimization

Replacement of the existing control system with a new control system. Modular, freely programmable automation stations with a redundant processor and a web server, supplemented with expansion modules, are used. Communication between the automation station and the expansion modules takes place via Ethernet using the ModBus TCP/IP protocol for control and the MQTT protocol for telemetry data collection.

Local control units located on the front panels of individual switchboards are used for local operation and control of the automation stations. The control units have a TFT LCD touch screen.

The existing IRC controllers will be replaced with new IRC controllers. Communication between the automation station and IRC controllers takes place via Ethernet using the ModBus TCP/IP protocol for control and the MQTT protocol for telemetry data collection.

Energy management

Following the findings and proposed energy management system outlined in the energy assessment for the building in question, the existing energy management system will be secured as described above.

From the perspective of ensuring the existence of records enabling the control and management of energy consumption, energy management will be ensured and implemented in such a way that continuous measurement will be ensured in the building in question in accordance with the adopted Operating Rules. Readings will be taken automatically by remote reading and the values will be archived at specified intervals, at least in monthly totals, in the energy management information system, which will in any case ensure and enable access by authorized persons, analysis, evaluation, subsequent export, and display of tabular and graphical overviews of consumption.

Readings will be taken at the measuring points listed below in the building in question. List of secondary measuring points in the building

- 1 x main power supply
- 1 x backup power supply
- 1 x main natural gas supply
- 1 x KGJ calorimetry
- 1 x KGJ electricity generation
- 1 x TUV calorimetry
- 1 x heating calorimetry (supply + return)
- 1 x drinking water

Within the framework of the organization's operating rules, an authorized employee performing activities related to energy management, specifically in the position of , is responsible for data evaluation and subsequent energy consumption management. The employee in this systemic position is employed and performs his/her duties on the basis of a full-time employment contract for an indefinite period.

1.4.2. Energy production in the evaluated period

At the time of preparing the final opinion on the project, the KGJ had not been in operation for a full year. The calculated energy savings are based on KGJ data for the period May 31, 2024-February 28, 2025, and are converted to a full year based on a comparison of actual heat and electricity production.

Cogeneration unit		
Total installed electrical capacity of the KGJ	kWe	530
Total installed thermal capacity of the CHP unit	kWt	630
KGJ power consumption in natural gas	kWpl	1,348
Gas consumption in KGJ	m^3 /hour	142.7
Electrical efficiency of KGJ	%	39.3
Thermal efficiency of KGJ	%	50

Benefits of installing a cogeneration unit (KGJ)		
Operating hours	hours/year	5,500
EE production	$MWh/year^{-1}$	2,915
HEAT production	$MWh/year^{-1}$	3,465
Natural gas consumption for KGJ operation	$MWh/year^{-1}$	7,414
Project benefits – installation of a cogeneration unit (KGJ)		
EE output	kWe	530
HEAT output	kWt	630
KGJ power consumption in natural gas	kW	1,348
Operating hours	hours/year	5,500
Primary energy consumption before implementation	MWh/year	7,414.0
Primary energy consumption after implementation	MWh/year	5,786.6
Primary energy savings	MWh/year-1	1,627.4
	%	21.95

2.5. Actual benefits of the project achieved through its implementation

Energy savings (GJ/year)

At the time of preparing the final opinion on the project, KGJ had not been in operation for a full year. The calculated energy savings are based on KGJ data for the period May 31, 2024-February 28, 2025, and are converted to a full year based on a comparison of actual electricity production with data from the simulation program.

Based on documented energy production and consumption readings for the period from May 31, 2024 to February 28, 2025, converted to a full year, the following energy production after implementation of the measures and the resulting reduction in energy consumption were reported.

Energy consumption before project implementation	GJ/year	63,349.84
Energy consumption after project implementation	GJ/year	55,753.20

Reduction in energy consumption	GJ/year	7,596.64
Reducing energy consumption	%	12

Confirm whether the requirement has been met and quantify the achievement in %.

Required reduction in energy consumption	GJ/year	2,615.00
Actual reduction in energy consumption	GJ/year	7,596.64
Requirement fulfillment	%	290

Emissions savings (tons/year)

Based on the actual reduction in energy consumption, the following reduction in emissions was achieved.

Greenhouse gas emissions before project implementation	tons/year	11,187.7
Greenhouse gas emissions after project implementation	tons/year	9638.45
Reduction in greenhouse gas emissions	tons/year	1549.25
Reduction in greenhouse gas emissions	%	13.8

TZL emissions before project implementation	tons/year	0.437
TZL emissions after project implementation	tons/year	0.377
Reduction in TZL emissions	tons/year	0.06
Reduction in TZL emissions	%	13.7

3. Final assessment and recommendations

In 2024, measures were implemented in the evaluated ELI Beamlines building in Dolní Břežany to the extent recommended in the submitted EP.

The annual production of electricity and heat from KGJ and the annual savings in CO2/TZL emissions specified in the EP were achieved after implementation.

In conclusion, it is recommended to continue with the established energy management in the building, which consists of checking the function of thermoregulatory valves, checking the internal temperature in rooms (prevention of overheating) and ventilation in relation to operational requirements, as well as performing regular energy consumption readings, archiving and evaluating invoiced energy consumption. The building's technical equipment should be regularly inspected, and its maintenance and repair should be well thought out, etc.