Annex 2: Technical specification

Ordered research work task

**1. Title of work**

*Building design in minimum composition for the installation of a stationary electric battery storage system in the territory of the CHP-1.*

**2. Purpose of the work**

To develop a building design in the minimum composition (preliminary design) for the installation of a stationary electric battery storage system (hereafter - BESS) in the territory of the combined heat and power production plant No.1 (hereafter - CHP) in Riga. Within the building design it is necessary to clarify BESS technical parameters and technological solutions, to evaluate BESS connection and installation sites in the CHP-1 area, assess building work volumes, BESS connection conditions and costs at 10.5 kV busbars (used for power supply to auxiliary systems) and other engineering communications, compile building project estimates and prepare applications for the transmission system operator's (hereafter - TSO) technical rules and documentation for obtaining a building permit from the building authority.

**3. Justification**

Due to the synchronization of the Baltic power systems with the Continental European system, Latvenergo AS (hereafter - Latvenergo) will have the opportunity on a larger scale to provide electricity reserve products to the operators of the transmission system of the Baltic Sea region to ensure the system's balancing needs. Primarily, TSOs will need frequency containment and restoration reserves (FCR and aFRR). In addition to Latvenergo's existing power plants, battery storage is being considered as one of the technological solutions to ensure FCR. BESS is one of the fastest growing technologies for electricity storage. Due to their fast response times, their power capacity is increasingly used in the ancillary services markets for frequency regulation, including the provision of automatic frequency restoration reserves (aFRR). In addition, electric batteries can be used for several other grid services such as peak load balancing, balancing intermittent power generation (solar and wind power), voltage stability, black start, etc.

**4. Information about the object**

CHP-1 and all its main equipment were commissioned in 2005 (see the Table 1). In 2020, the gas turbines of CHP-1 were upgraded. The main equipment at the CHP-1 plant consists of a combined cycle gas turbine (CCGT) double unit with an installed thermal capacity of 145 MWth and an electrical capacity of 158 MWel. The parameters of the main electrical equipment of CHP-1 are given in the Table 1.

*Table 1. CHP-1 equipment and their main parameters*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Name (type) of equipment | Year of entry into service | Manufacturer | Electric power | Heat output | Main parameters |
| **CHP-1** |
| Gas turbine installations (SGT-800) GT-1, GT-2 | 2005 (2020. – upgraded) | Siemens(Sweden) | 2×51 MW | 145 MW | Exhaust gases G=131,5 kg/s, t=544°C |
| Utilisation boilers HRSG-1, HRSG-2 | 2005 | Alstom Power (Sweden) | - | D= 106 t/h, p=102 bar, t=510°C |
| Steam turbine (SST-700) | 2005 | Siemens (Sweden) | 56 MW | D=207 t/h, p=100 bar, t=510 °C |
| Water heat boilers (КВГМ - 116,3-150) ŪK-1, 2, 3 | 2005, 2005,2010 | ДКЗ (Russia) | - | 3 × 116 MW | G=1250 t/h, t=70/150 °C |
| ŪK-3 flue gas condensing econ. | 2017 | Kelvion (Poland)  |  | 10 MW |  |
| Electric generators GTĢ1, GTĢ2 | 2005 | ABB (Sweden) | 2×56,25 MVA | - | Voltage 10,5 kV |
| Electric generator, TTĢ | 2005 | ABB (Sweden) | 67,5 MVA | - |
| Transformer (TLUN7851) TN3 | 2004 | Siemens(Germany) | 62,5 MVA | - | Voltage 121/10,5 kV, ONAF |
| Transformer (TLUN8151) TN4 | 2004 | Siemens(Germany) | 130 MVA | - | Voltage 121/10,5 kV/10,5 kV, ONAF |

**5. Information on the planned project**

*5.1. BESS technological solutions and indicative parameters*

It is necessary to specify the possible technological solutions and technical parameters of the BESS for ensuring the frequency containment reserve in the Baltic FCR service market. The initial BESS parameters from the pre-feasibility study carried out by Latvenergo have been defined and are shown in Table 2.

*Table 2. Parameters selected for BESS.*

|  |  |  |
| --- | --- | --- |
| Nominal power rating | PBESS\_nom, MW | 12,0 |
| Nominal electric energy rating | EBESS\_nom, MWh | 7,0 |
| Actually available BESS electricity | EBESS\_fakt, MWh (0.8\*EBESS) | 5,6 |
| State of charge (min) | SOCmin | 0,1 |
| State of charge (norm) | SOCnorm | 0,6 |
| State of charge (max) | SOCmax | 0,9 |
| BESS round-trip efficiency | η | 92% |
| Degradation per year |  | 2% |
| Availability |  | 100% |
| Duration of operation |  | 351 days |
| Length of service |  | 10 years |
| Technology |  | Li-ion |

Three types of reserves are planned to be used in the Baltics Load-Frequency Control (hereafter - LFC) block - FCR, aFRR (automatic), mFRR (manual) and the so-called imbalance netting process (TSOs platform). According to a common Baltic methodology, the necessary reserves were assessed and distributed among the countries. On 21 October 2022, at the informal seminar "Electricity Market Forum", AS Augstsprieguma tīkls (the Latvian TSO) reported that Latvia needs an FCR of ±8 MW and an upward aFRR amount of 32 MW and downward aFRR amount of 32 MW. The FCR and aFRR will be reviewed annually.

The FCR service must be able to be fully activated within 30 seconds if the local frequency deviation is at least +/- 200 mHz. Considering the technical characteristics of different battery technologies, as well as the trends in the development and use of those technologies, the pre-feasibility study considered lithium-ion batteries for the provision of FCR services.

According to ENTSO-E requirements, both upward and downward FCRs must be provided for at least 15 minutes. This criterion imposes limits on the SOC (State of Charge) operating range of the BESS. In order to meet the above 15 minutes criterion in both directions, as well as the allowable SOC levels, a minimum battery electric energy rating of 7 MWh (PBES×(2×0.25h)/80%) has been chosen. Furthermore, the normal state of charge (SOCnorm) of the BESS should be kept close to 50% to guarantee full availability of the BESS for FCR both up and down regulation.

On 21 January 2021, an updated Baltic LFC block concept document was published on the Latvian TSO website[[1]](#footnote-1), which, among other things, provides information for the development of common qualification conditions for resources to be used for FCR and aFRR needs. The conditions for evaluating the technical compliance of Baltic LFC reserve suppliers were published[[2]](#footnote-2) on March 21, 2022. The Baltic TSOs plan to establish national rules for the assessment of the technical compliance of LFC reserve providers in accordance with the common Baltic conditions, and to start qualifying LFC reserve providers already in 2023.

Considering the requirements set out in the TSO's public consultation document, there is a risk that BESS with the chosen parameters will not qualify as an FCR supplier. These requirements could serve as a basis for revising the BESS parameters given in the Table 2. In order to ensure the reliability and continuity of the operation of the BESS, the contractor shall assess the need to increase the initial parameters of the BESS as shown in the Table 2: 1) Nominal power rating: **13,75 MW**, 2) nominal electric energy rating: **13,75 MWh**.

Justification:

* The Baltic TSO's document from a public consultation on harmonized principles for Baltic load and frequency control reserve prequalification (hereinafter TSO public consultation) stipulates that each FCR provider (including with a limited reservoir) shall ensure a continuous FCR full activation for a time period no less than 30 minutes (section 4.3.2). In a such case, BESS with 11 MW nominal power for the FCR service must ensure nominal electric energy rating of 13.75 MWh.
* According to the intraday market organization in the Latvian energy system, a market participant may submit its requests and offers no later than one hour before the operating hour. This means that if the BESS reaches the specified state of charge levels (SOCmin or SOCmax), the planned market transactions for SOC restoration will only start after 60 min. During this time, the BESS must be able to continue operating and there is a risk that the SOC levels of the battery will reach its maximums and the provision of FCR will be suspended.
* There is no minimum time between consecutive FCR activations. The TSO's public consultation states that the FCR provider shall be able to operate continuously as long as the system remain in normal state (Section 4.3).
* After synchronization of the Baltic States with CESA and desynchronization from the Russian IPS/UPS system, higher frequency fluctuations are expected (it was another conclusion from the pre-feasibility study). In this pre-feasibility study, difficulties were observed in providing the FCR service at higher frequency fluctuations with the initially selected BESS parameters. It was therefore recommended to increase the BESS charging capacity by 1 MW, for a total of 12 MW/7MWh.
* An FCR providing unit with a limited energy reservoir shall have a ratio of rated power to the prequalified FCR of at least 1.25:1 to ensure that it is able to provide continuous support of FCR during normal state and 30 min during alert state (Section 4.3.3). In this case, the installed power of the BESS should be 13,75 MW.

*5.2. BESS siting options for the CHP-1 site*

BESS can be placed in the territory of CHP-1 (see Figure 1) with a total area of approximately 21 850 m2, which is located on the site of the former power plant building, 50 m away from the 10,5 kV auxiliary systems busbars. The contractor may also propose alternative siting options on the territory of the CHP-1 plant.

*Figure 1. BESS sitting options on the territory of CHP-1*



When assessing where to install BESS, it is important to be aware of the capacity utilization of CHP-1 plant, as the self-consumption costs when the plant is in operation mode are much lower than when the plant receives electricity from the grid (Latvian TSO). Not only the costs for the operation of the BESS, but also the costs for the entire BESS complex, including the microclimate control equipment (HVAC - heating, ventilation and air conditioning), have to be taken into account. It is important to be aware of any additional costs for the installation of the BESS, such as additional utilities, and to take these into account when evaluating different installation sites.

*5.3. BESS connection to the 10.5 kV auxiliary systems busbars of CHP-1*

At the CHP-1 plant, the BESS can be connected to the 10.5 kV auxiliary systems busbars by extending them and installing an additional circuit breaker (Figure 2). Power can be fed into the 110 kV network.

The auxiliary transformers (TN5 and TN6) have a capacity of 15 MVA, which is sufficient to connect an additional 12-14 MW. The step-up transformer TN3 has a capacity of 62.5 MVA. Considering the operating modes of CHP-1 after the upgrading of CHP-1, around 11 MVA remain free in TN3. As an overload of up to 6 MVA for up to one hour is allowed, but the FCR mode lasts 15-30 minutes, the existing transformer can withstand the load. The step-up transformer TN4 has a capacity of 130 MVA and has sufficient free capacity of around 23 MVA, taking into account the operating modes of CHP-1.

*Figure 2. BESS connection diagram for CHP-1 plant at auxiliary systems busbars*



*5.4. Attracting co-financing*

Given the importance of the BESS project for the stability of electricity supply in Latvia and the Baltic region, it is appropriate to attract co-financing from the European Union. At the feasibility stage of the project, it would be most advantageous to apply for funding from the European Structural and Investment Funds. In the construction phase of the project, the Modernization Fund could be the most advantageous. In the construction phase, another source of funding could be the European Innovation Fund, which launches calls for innovative large and small projects (CAPEX > or < EUR 7.5 million, respectively).

One of the objectives of this work is to prepare the necessary documentation and demonstrate the project's readiness for EU co-financing.

The BESS is to be connected to the 10.5 kV auxiliary systems busbars of the CHP-1 plant. It is intended for it to use electricity from the CHP-1 plant when it is in operation mode and electricity from renewable energy sources (via the electricity grid) when the CHP-1 plant is not in operation. In the second case, it is foreseen to use guarantees of origin to prove that the electricity is from renewable energy sources. This could be one of the requirements to be fulfilled in order to receive co-financing from the supporting programs (Modernization Fund, Innovation Fund).

To be eligible for funding from the Innovation Fund, a project must have innovative solutions. Contractors need to consider the feasibility of incorporating innovative solutions in the scope of work.

**6. Scope of work**

6.1. Develop requirements for the technical solution of a stationary electric battery energy storage system (BESS):

* determine the technical parameters of the BESS (nominal power rating, electrical energy rating, normal (working) state of charge (SOC), system and component efficiencies, annual degradation, availability, duration of operation, working life, etc.) in accordance with the requirements of the Latvian transmission system operator;
* provide an overview of the BESS components (energy storage modules, inverters, automatic control systems, SCADA, electrical switchgear, transformer, HVAC);
* provide recommendations on technical solutions, determine technical and other requirements, develop technical specifications for the next procurement of BESS for delivery and installation;
* provide recommendations regarding the organization of equipment supplier tender, including possible tender participants who should be approached personally.

6.2. Choice of construction site:

* choose BESS construction site within the proposed plot of land (site in Figure 1). An alternative siting option may be proposed;
* the following criteria must be taken into account when assessing the construction sites: availability and sufficiency of free land, geology, cost of connection to CHP-1's own and other engineering communications, preparation costs of construction site;
* provision of earthing and lightning protection systems in accordance with building codes and standards;
* provide fire protection systems in accordance with international standards, local norms and experience of working with the specific BESS technology;
* evaluate the compliance of the BESS with noise level requirements, taking into account the noise level generated by the operation of the equipment to be installed;
* evaluate possible places for BESS connection, installation of switchgear, laying of cables.

6.3. Assessment of the construction works:

* provide an overview of the necessary construction work, including for site preparation, equipment installation, electrical installation, etc.
* estimate the scope and cost of construction work.

6.4. BESS connection to the 10.5 kV auxiliary systems busbars at CHP-1:

* evaluate connection to the 10.5 kV electrical system at CHP-1;
* select all necessary electrical equipment for the project - meters, circuit breakers, switching equipment, transformers, etc. that may be required;
* select necessary DC and AC cabling to ensure the lowest possible losses and the highest possible charging/discharging efficiency, as far as economically feasible;
* provide control of BESS from the main control room of CHP-1, including parallel and coordinated operation of BESS and CHP-1 generators;
* provide all necessary command, control, fire protection and electronic communication cables;
* provide surge protection;
* check the adequacy of existing transformer capacity and cable capacity for BESS connection;
* perform other necessary calculations of electrical parameters (short-circuit currents, voltage losses, etc.);
* select the relay protection and its operating parameters to ensure that disturbances in the BESS and its connection do not cause tripping of the CHP-1 generators or step-up transformers, and meet the requirements of the transmission system operator;
* provide electricity metering;
* create a BESS electricity self-consumption scheme.

6.5. Preparation of BESS construction project capital and operating cost assessment:

* provide evaluation of project capital cost estimates (CAPEX);
* assess operating costs (OPEX) of the BESS.

6.6. Preparation of documentation for receiving technical rules and building permits:

* prepare and submit application to the transmission system operator (AS Augstsprieguma tīkls) for the receipt of technical rules;
* prepare building designs in the minimum composition and submit them to the local building authority in the construction information system (BIS), for obtaining a building permit with design conditions.

**7. Executive documentation**

7.1 Original of the project report in paper format (one copy) in Latvian or English;

7.2. Original of the project summary in paper format (one copy) in Latvian or English.

7.3. Graphical part of the project in paper format (one copy) in Latvian or English;

7.4. Building design in minimum composition (in Latvian, one copy);

7.5 Project reports and summary in \*.pdf and \*.doc format (all reports in one file) and graphical part in DWG format on an electronic media or on a file sharing platform, upon prior agreement with the Contracting party.

7.6. The project documentation shall be prepared in accordance with the requirements of the European Union as the project is to be submitted for EU or Latvian program for receiving co-financing.

**8. Requirements for the Contractor who is carrying out the work**

8.1 The Contractor shall comply with the requirements of Latvian legislation relating to the preparation of building design in the minimum composition;

8.2 The Contractor shall have the necessary designers' certificates to submit the building design in the minimum composition to the building authority;

8.3. The Contractor must determine the technical parameters of BESS together with the Contracting party, in consultation with the transmission system operator (AS "Augstsprieguma tīkls").

8.4. while developing BESS technical solution consider synchronous work with Continental Europe, as defined in the Continental Europe Synchronous Area Framework Agreement and complying with the requirements of the ENTSO-E network codes.;

8.5. when selecting the requirements of BESS basic equipment, ensure the most efficient operation both during small power fluctuations and the overall highest efficiency when working at full power.

8.6. when selecting the requirements for auxiliary BESS systems, provide for the determination of their parameters taking into account the actual operating conditions in the area of CHP-1.

8.7 the selection of the BESS control system requirements should include the ability to operate the BESS to provide system services (primarily, FCR) as well as the ability to operate at common power settings with existing CHP-1 generators.

8.8. when developing the building design in the minimum composition, ordering a topographic scheme and geological survey shall be carried out only for the selected construction site, with the prior approval of Latvenergo AS.

8.9. During the development of the work, the Contractor shall coordinate and agree on the main technical solutions and principal issues with the Contracting party.

**9. Deadlines for work**

9.1 The maximum time limit for completion of the work shall be **210 (two hundred and ten) calendar days** from the date of of signing the Agreement.

9.2 Deliverables to be submitted to the CONTRACTING PARTY as part of the execution of the work and estimated deadlines:

9.2.1 within 60 (sixty) days from the date of signing the Agreement, deliver Assignment No. 1, which includes the tasks referred to in clause 6.1;

9.2.2. within 120 (one hundred and twenty) days from the date of signing the Agreement, deliver Assignment No. 2, which includes the tasks referred to in clauses 6.2., 6.3, 6.4, and 6.5;

9.2.3. within 180-210 (one hundred and eighty-two hundred and ten) days from the date of signing the Agreement, submit a final report including the completion of the tasks referred to in clause 6.6.

1. Concept document - <https://www.ast.lv/sites/default/files/editor/Baltic_Load_Frequency_Control_concept_document.pdf> (viewed 31.01.2022) [↑](#footnote-ref-1)
2. https://www.ast.lv/lv/events/atjauninati-elektroenergijas-sistemas-slodzes-un-frekvences-kontroles-rezervju-piegadataju [↑](#footnote-ref-2)