TECHNICAL DESCRIPTION

Battery storage at Isfjord Radio

CLIENT

Store Norske Spitsbergen Kulkompani

SUBJECT

Battery storage – request for proposals

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TABLE OF CONTENTS

1 Introduction

The following document describes the required technical specifications for the offer / tender as well as the documentation and deliverables expected from the tender participants.

The document is structured as follows:

Section 2 describes the site and location, the local energy system and special legal requirements in Norwegian territories.

Section 3 covers the interfaces between the battery supplier and other contractors on site and describes the interfaces between each delivery.

Section 4 describes the challenge and scope; Why is the battery storage system required, and what functionality is asked for

Section 5 lists the specific requirements for each component. Where the bidders find information lacking or insufficient, they should use common best practice or contact tender responsible for more information and clarifications.

Section 6 describes the procedures and requirements for commissioning, SAT, handover, training etc.

Section 7 lists the required documentation for handover.

Section 8 covers the warranty. This chapter specifies preferred warranty scheme.

Section 9 lists applicable standards, regulations and norms which are relevant for the delivery

Attachments and their contents are listed and accounted for in the tender description

1.1 Note on actors and notations - definitions

To avoid misunderstandings in the following text, a short note on actors is made:

- Battery supplier - the winning battery system contractor. Be it a single supplier or a consortium
- Battery system – refers to the complete turnkey delivery from the battery supplier and includes both physical components and software solutions - Including necessary customization programming of functionalities and user-interfaces, not just the batteries and inverters.
  Other technologies than batteries may be proposed, should they fulfil the technical requirements listed herein. “Battery system” could therefore be read as “energy storage system”
- Purchaser – Store Norske Spitsbergen Kullkompani (SNSK) which will purchase the system.
- Control Systems – refers to the high-level control system of the energy storage system where the operator can monitor and control the operations of the battery, within the limitations set in the Battery Management System (BMS). The Control System will also provide the operators with live data on the battery state of charge, temperature, and power flow.

1.2 About the project

Isfjord Radio is a radio station about 90 km west-south-west of Longyearbyen in Svalbard. It was constructed in 1933 to serve the local ship traffic, and to communicate with the mainland. Store Norske Spitsbergen Kulkompani (SNSK) purchased the facility in 2006 and have started to transform the local energy system at Isfjord Radio from fully diesel-powered, to a renewable one.

This renewable transition is envisioned in three phases over the years 2021 to 2023:

1. Implementation of battery storage, solar energy, thermal storage and a microgrid controller
2. Implementation of wind power
3. Implementation of a hydrogen system

Isfjord Radio now mainly operates as a tourist destination, but still houses critical technical infrastructure. Thus, a secure and stable energy supply year-round is critical.

The tender described in this document and its attachments encompass Phase 1, with the battery storage, solar energy and microgrid controller. SNSK is looking for solid and qualified contractors, to deliver products as specified, and who to join on the extended process of building a renewable microgrid in the high Arctic.

1.3 Expected delivery

The system which is to be delivered is a full turnkey solution for a battery storage system, including but not limited to batteries, necessary power electronics, necessary transformer(s), cabling, protection, battery management system (BMS) and Control Systems which communicates with the local infrastructure, which includes control of the operation of 3 existing diesel-generators.

Timeline with milestones is included in the tender description.

The Purchaser wants environmentally friendly solutions, and this should be reflected in choice of materials and components. It is not desired that the delivery contains any substances present on the Norwegian "List of Priority Substances[1]", which amongst others includes cadmium and lead.

The delivered battery system shall operate together with present diesel-generators at Isfjord Radio, and with PV-panels, which are also to be acquired now.

1.4 Battery size

The Purchaser has calculated that the necessary battery size is:

- 200 kW available active power on AC side
- 400 kWh available energy storage

It is emphasized that these values are <u>available</u> energy and power. Any limitations in depth of discharge, inverter-losses etc must be dimensioned properly in order to provide the above requirements.

1.5 Collaboration phase

After signed contract, there will be a collaboration phase where the battery supplier, local electrical contractor, operative personnel and other relevant parties are present to finalize the last details in the delivery, and any unclear interfaces.

[1] https://www.environment.no/topics/hazardous-chemicals/list-of-priority-substances/

2 Site information and site description

2.1 Location

The battery storage will be situated at Isfjord Radio, a small site about 90 km west-south-west from Longyearbyen, Svalbard, depicted in Figure 1. It was established as a radio station in 1933, connecting Svalbard to mainland Norway, and to service local ship traffic.

At 78° 3'43.70"N, 13°37'0.04"E the location rests in the high arctic with harsh climatic challenges. The midnight sun shines from April 20th to August 23rd, and the polar night without sunlight lasts from October 26th to February 16th.

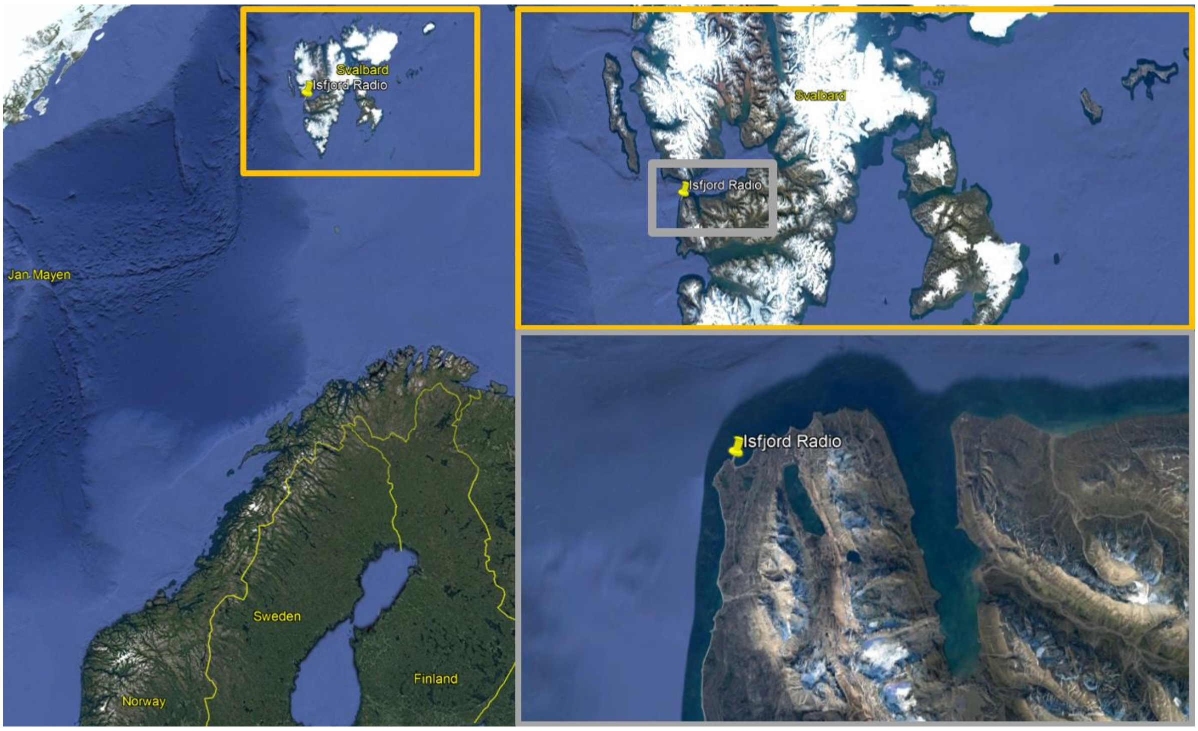

Figure 1 Isfjord Radio location. Photo: Google earth and Norsk Polarinstitutt

Isfjord Radio is today run as a hotel from February 15th to October 1st, with room for 45 guests. The facility is fully closed from November 1st to February 1st, but temperatures inside must be kept above 7°C.

The closest airport is Longyearbyen airport which is open year-round. Here is also a local harbor equipped for larger vessels.

Local climate data is found in Attachment A and will also be briefly presented in the following.

Figure 2 Isfjord Radio main building. The location of the battery will be in the building between the big parabola and the antenna. Photo: Multiconsult

2.2 Site

The battery shall be installed in the west-end of the building-complex in the battery room marked with a red circle in the figure below:

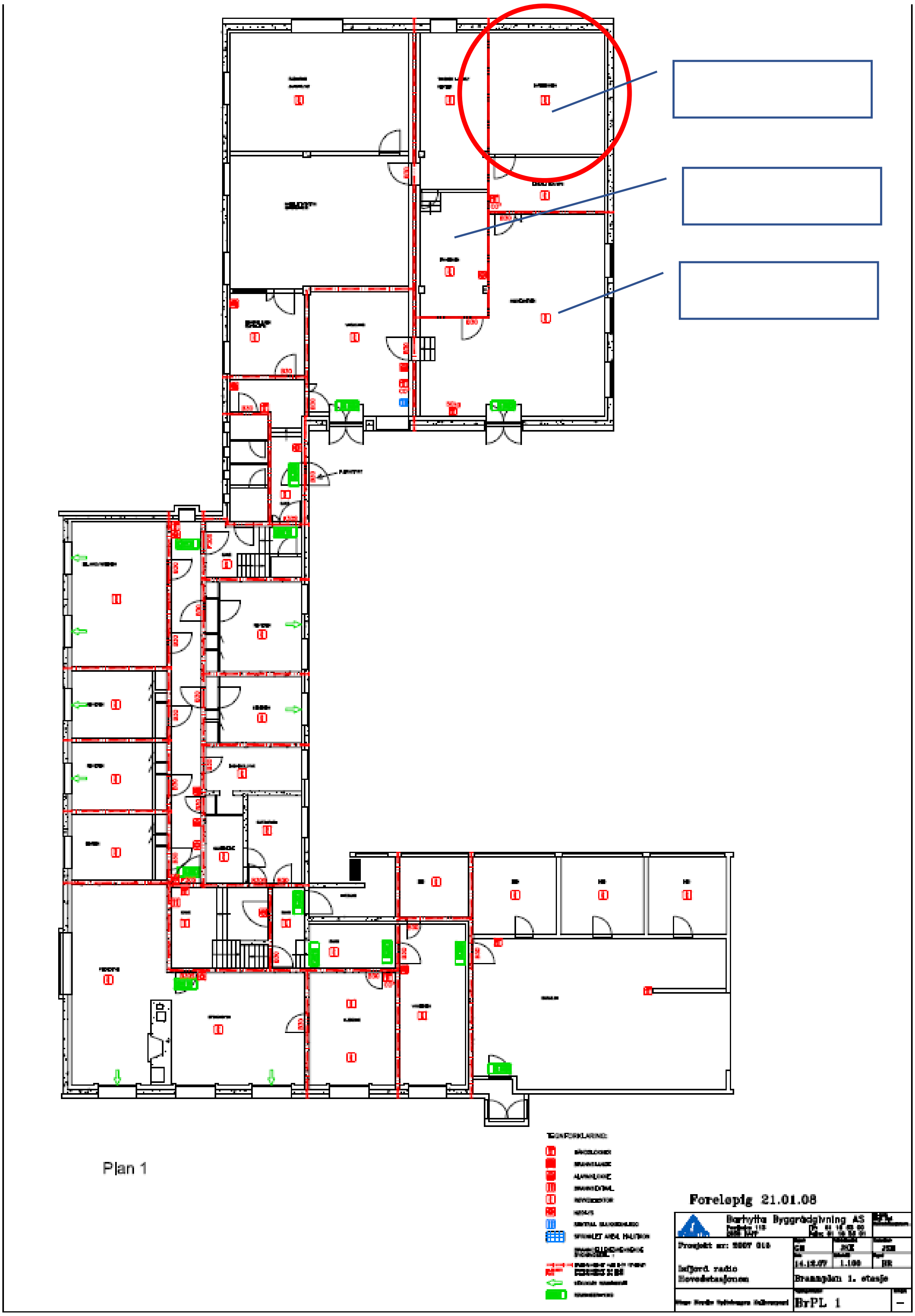

Figure 3: First floor of the main building. The technical building is in the upper part of the figure, and here you will find gensets, a workshop, the battery room, the UPS-room and the main distributor.

The battery room contains the UPS-battery for the telecom-equipment, but there is room for a larger, but more compact battery. A panorama-picture of the room is shown in the picture below.

Figure 4 Panorama picture of the Battery Room

The batteries to the right in the picture are not in use and they will be removed. The batteries seen in the middle of the picture are connected to the UPS and they can be relocated within the same room to give more space for the main battery.

The battery delivery shall be placed in this room. The room is sufficiently ventilated, and heated to avoid negative temperatures. As earlier stated, indoor temperatures during the winter months is expected to be about 7°C.

All relevant information and documents will be provided by the Purchaser.

The site is in near vicinity to the ocean, so salty atmosphere is to be expected.

There will not be arranged a site visit prior to the acquisition.

2.3 Local climate

Svalbard has an arctic climate which demands some special considerations as compared to more tempered climates.

Negative outdoor temperatures must be expected for almost every month of the year, as per Figure 5.

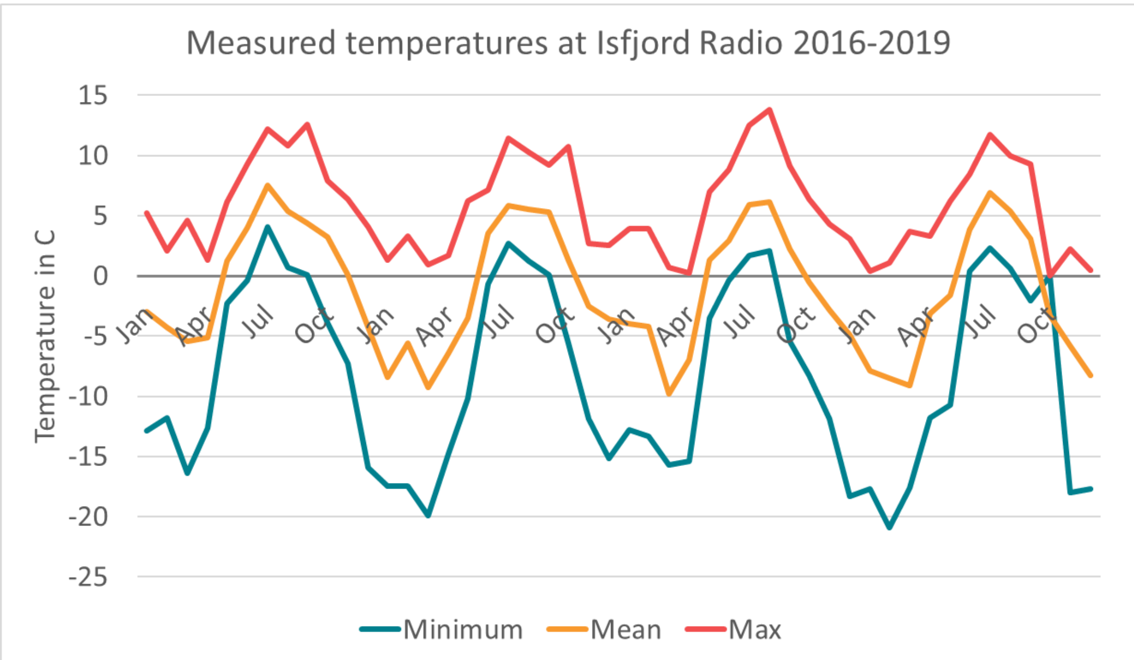

Figure 5 - Monthly temperatures at Isfjord Radio in the period January 2016 to December 2019. Source: Norwegian Meteorological Institute

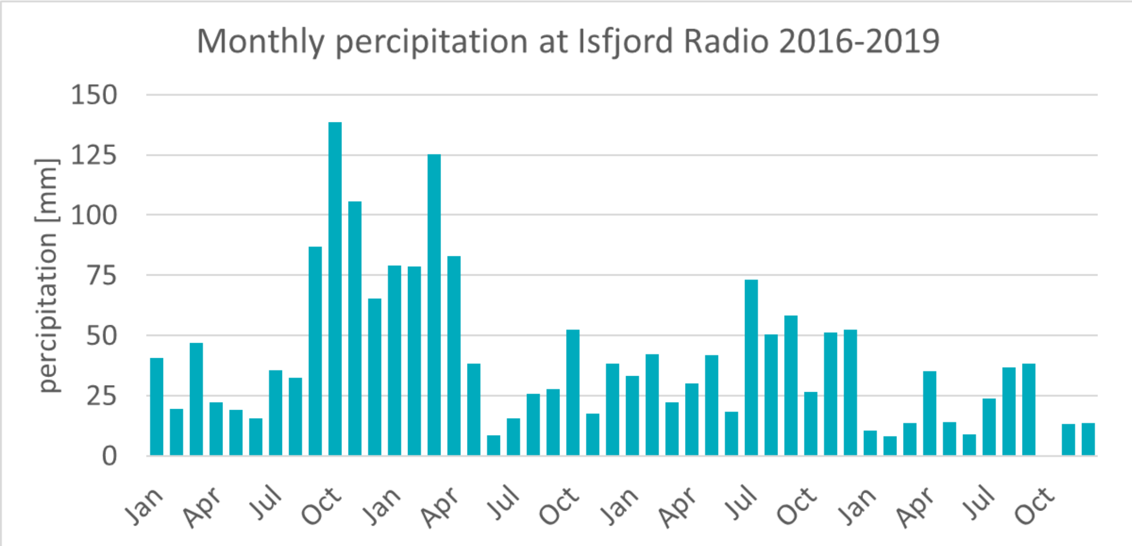

Figure 6 - Monthly precipitation Isfjord Radio in the period January 2016 to December 2019. Source: Norwegian Meteorological Institute

Isfjord Radio resides in an arctic desert with very dry air and generally low annual precipitation. See Figure 6. The dry climate increases degradation rate of gaskets and seals.

The snow which is formed in this climate is often light, is easily carried with wind, and one must expect that it will accumulate around buildings and will find its way in through gaps and openings in building structures.

This must be accounted for in the proposed solution.

There are currently no lightnings at Svalbard due to its northernly position.

Raw data from the local weather station, situated at Isfjord Radio, is available in Attachment A.

Winds are predominantly from the north-east, and seldom of gale force or stronger. Details are given in the figure below, and more detailed data is given in Attachment A.

It is important to note that the battery supplier is responsible to acquire information and plan their installation such that it can withstand the local climatic conditions.

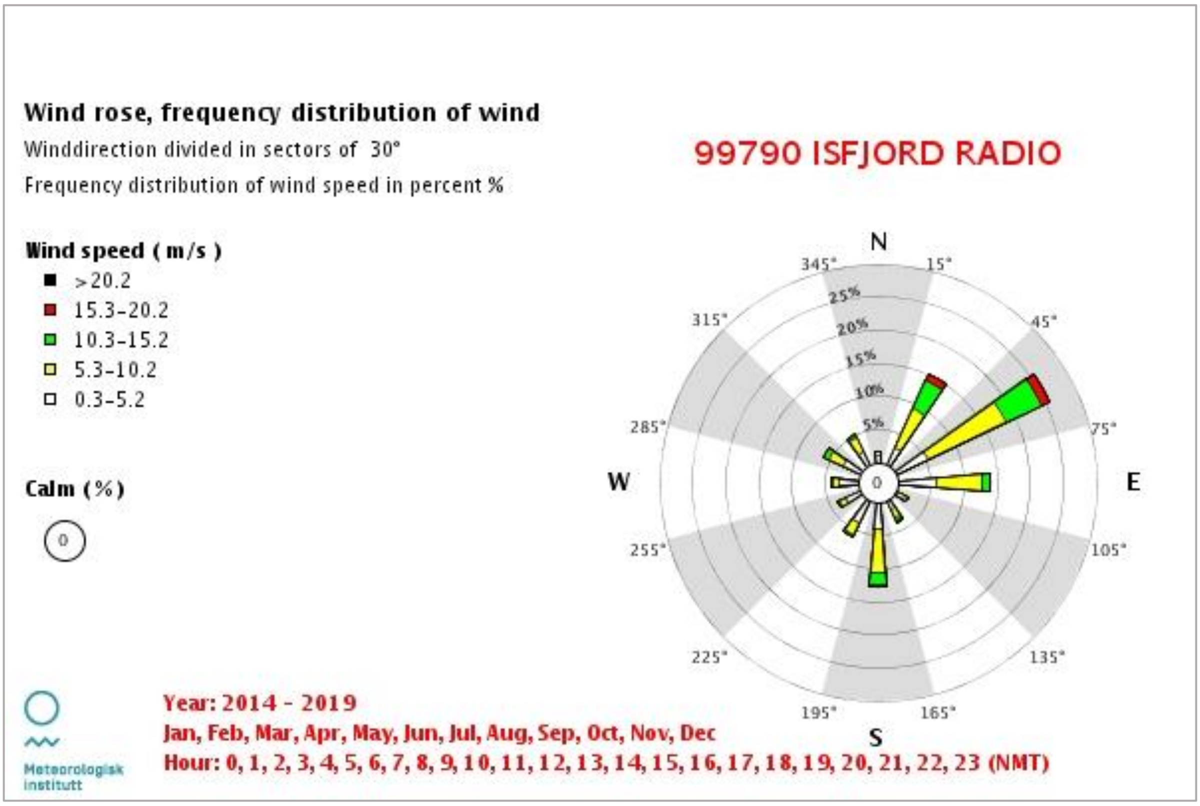

Figure 7 Wind rose, frequency and distribution of wind at Isfjord Radio. Graphic is produced by Norwegian meteorological Institute.

2.4 Permafrost

All land area on Svalbard is currently affected by permafrost[2]. The active layer in the ground (which is the section of the ground which melts during the summer) is steadily increasing, making it more demanding to build good foundations for buildings and structures.

Warmer climates on Svalbard cause thawing of permafrost. It is important to design constructions for warmer climate, and to make robust foundations which will handle the increased depth of the active layer.

2.5 Local energy system

Isfjord Radio, being a remote hotel in the high Arctic, has its own islanded energy supply. Currently this energy system is run by three Stanford diesel generators, each of 245 kVA/ 195 kW power. One generator is sufficient to cover all the local loads, but security of supply is crucial, and hence the system is dimensioned for redundancy should a generator fail. Additionally, communication equipment is installed with uninterruptable power supply (UPS).

Excess heat from the generators is used to heat the buildings and melt snow in the winter, providing the facility with fresh water.

[2] Permafrost at Svalbard http://www.mosj.no/en/climate/land/permafrost.html

The future energy system at Isfjord Radio will comprise of solar energy and wind-power with a battery, thermal accumulator and hydrogen for storage. When all of this is fully implemented, the ambition is to run the power system at 90 – 100 % renewable energy.

A local battery and solar power system constitute the first move in his transition. The battery, and its functions described herein must be seen as a part of a whole, and a long-term ambition of an almost fully renewable (autonomous) energy supply to Isfjord Radio.

The battery will be a central part of the new microgrid, balancing production and consumption.

The primary function of the battery at this first stage is to smoothen operation of the diesel-generators and balance the energy production from the PV-panels. The battery will be combined with a thermal storage to enable the diesel gensets to run in a start/stop-mode during winter in order to save fuel.

In the future, the battery will be the central part of the microgrid-controller and should be dimensioned and planned for such operations accordingly.

The required battery functions are described in more details in later chapters.

2.6 Control system and communications

Currently, there is a simple control system at Isfjord radio, controlling the operation of the local diesel-generators.

As part of this acquisition, the Purchaser want an integrated microgrid controller in the battery system, which will take over the control of the local power system.

Requirements for this microgrid controller is presented in Section 4.2.11.

2.7 Legal requirements in Norway

Any company performing electrical works in Norway must be an approved electrical entrepreneur, and registered in the national registry, “Elvirksomhetsregisteret”. Applications can be done through the web-portal of The Norwegian Directorate for Civil Protection (DSB)[3]. The application process is estimated to take about 4-6 months to process, somewhat less for Swedish companies.

The same application process holds for companies doing the electrical engineering.

A local electrical contractor hired by the Purchaser will connect the battery to the local energy system according to the specifications and instructions given by the battery supplier.

All construction, electrical and mechanical, detailed engineering, environmental and social issues and human resourcing must be performed in accordance with Norwegian law.

In addition to adhering to Norwegian law and regulations, the acquisition needs to be in accordance with Norwegian electrotechnical norms, such as NEK400:2018. Of particular importance are the IEC 62485-X norms concerning safe operation of battery installations.

The delivery needs to adhere to the relevant IEC 62485 and its indispensable references.

[3] https://www.dsb.no/lover/elektriske-anlegg-og-elektrisk-utstyr/artikler/work-as-electrician-or-electro-professional-in-norway/electro-profassionals-abroad/

3 Interfaces

3.1 Delivery

The delivery asked for is a complete turnkey energy storage system, with necessary batteries, inverters, cabling, BMS and a microgrid controller. This list is not exhaustive, and the battery supplier shall suggest a complete system that covers the needs and requirements as described by the Purchaser.

All acquisition or use of materials, tools and equipment needed to perform the installation shall be included in the offer.

Costs for necessary travels to Longyearbyen, participation in meetings, and local presence shall be included in the offer. The Purchaser will cover travel-costs from Longyearbyen to and from Isfjord Radio, as well as diet and accommodation at site.

The battery supplier shall state the expected number of persons they need on site, and how long they will use to complete the work.

Prices in the offer shall be detailed according to provided template and shall be given in Norwegian Kroner (NOK) without value-added tax (VAT).

Conversion rate used shall be included, and portion of offer exposed to exchange rate changes shall be indicated.

If the battery supplier has any conditions regarding change in the conversion rate, this shall be stated in the offer.

SNSK sees this as the first of many potential similar projects, and will be looking for long term partnerships in order to complete the future systems, should they be satisfied with this delivery.

3.1.1 *Transport of materials*

There are no roads to Isfjord Radio, and transport to site is somewhat complicated. The Purchaser will use Pole Position Logistics for transport of all material from Tromsø to Isfjord Radio. Thus, the battery supplier shall only include costs for transport to Tromsø in mainland Norway.

The battery supplier must provide the following information to the Purchaser, in order to plan secure transport. All values to be given in metric units:

- Size – length, width and height of items to be transported
- Weight of items to be transported
- Any special considerations of items to be transported, e.g.:
    - Requirements for ambient temperature, mechanical shock, vibrations etc during transportation and handing.
    - Requirements for temporary storage during transportation and at Isfjord Radio prior to installation.

The battery supplier is responsible for installation at Isfjord Radio, and until the battery system is approved by an independent third party after completed Site Acceptance test (SAT).

Pole Position Logistics will also take care of transport of any construction waste after installation. Expected amounts for waste is to be stated in the offer.

3.2 Electrical interface

The battery system will be connected to the local islanded energy system, operating at 230 V IT. It is important to note that the local grid is in IT configuration, and the delivery must be compatible with connecting to this system. Additional components to ensure compatibility, such as a 400V/230V transformer must be provided by the Battery supplier.

The electrical interface for the Battery supplier is 230 V busbar in the battery room as indicated earlier.

Consequently, the Battery supplier must deliver the full electrical infrastructure up to this point. The delivery thus includes, but is not limited to; batteries, inverter, DC-cables, AC-cables, protections, switches and transformer.

The Purchaser will be responsible for connecting the system to the grid. Sizing of the components outside of the Battery supplier's delivery will be done in collaboration with the Battery supplier.

3.2.1 *Grounding/earthing*

For the period late September until mid-June, the ground is frozen solid at Isfjord Radio. Frozen ground does not conduct electricity and can therefore not be used for proper grounding.

To overcome this issue there is a local grounding system connecting all grounding cables to the nearby fjord, which provide the grounding potential for the grid.

The grounding system for the battery installation must also be connected to this system.

3.2.2 *Harmonics*

The Purchaser is not familiar with problematic harmonics on site.

It is however emphasized that the battery storage shall not produce harmonics above threshold values as presented in Section 5.9.

3.3 Mechanical interface

As earlier described, the local conditions on Svalbard are somewhat extreme. Local weather data is present in Attachment A, and the system must be designed for this.

The battery will be placed indoors at Isfjord Radio, on a concrete floor. The battery supplier must provide mounting structures which is compatible with the conditions, for all their equipment. This includes, but is not limited to batteries, inverters, cables and transformers.

The smallest door into the room is about 1.5m wide and 2m tall, so all components must fit through this.

3.4 Communications and control interface

The battery supplier shall provide a microgrid controller, that will operate the local power system.

The microgrid controller is a key element in the delivery. It will communicate and control the local battery, solar panels, diesel generators and thermal storage. The only pre-existing components are the diesel generators, which are controlled by a DCU 305-R1 engine controller.

It is important that the microgrid controller can communicate with different systems, and also send data to the Purchasers data systems.

3.5 General consideration regarding interfaces and choice of overall system solution

The battery energy storage system will be purchased as a turnkey solution. Consequently, there are different possible system solutions that may be offered by the battery supplier up to the interface of the delivery.

The battery supplier should propose the most optimal solution and is encouraged to utilize the flexibility within the interfaces.

4 Challenge and scope

The challenge, scope and required functionality of the battery system is presented in the following.

Considering the location of Isfjord Radio, its relative isolation and the harsh Arctic conditions, it is of the utmost importance that the solutions provided are robust and will not jeopardize security of supply and system stability. In fact, the aim of the battery is to enhance security of supply and power quality.

The battery shall be dimensioned for optimal hybrid operations of solar energy and diesel generators. The battery supplier shall also consider the future development of Isfjord Radio, with implementation of wind power and hydrogen when planning the battery, and ensure that the battery system can easily be expanded and optimized for this future situation at a later stage.

<u>The battery contractor shall clearly state when they can deliver the battery system</u>

4.1 Battery supplier resource offering

The battery supplier shall include necessary project meetings, meetings with the Purchaser, and coordination with the other participants in the project. This shall also include all travel costs.

The winning battery supplier will be asked to participate in a collaboration workshop with other relevant parties for the project. This workshop will be hosted in Longyearbyen, Svalbard. The battery supplier shall include all costs for participation in one such workshop in their offer.

4.2 Required battery functionality

This tender is to be considered technology neutral. Any energy storage unit which can deliver described functionality and uphold relevant standards, will be considered. In the text however, the word “battery” will be used to describe the energy storage.

The battery’s main purpose is to assist in a renewable transition at Isfjord Radio. This entails integration of renewable energy sources, reduction of diesel, and in general more optimized operation at site. The following functionalities are points identified by the Purchaser as important to realise this potential, however the battery supplier may suggest added functionality to help fulfil the project ambition. An example of such added functionality is to implement better control algorithms to improve the scheduling of local energy management.

4.2.1 *Peak shaving / load shifting*

The battery system shall have the capability of reducing peaks in the power system.

4.2.2 *Dynamic voltage control*

The battery system must provide dynamic voltage control to the grid. The battery System shall be able to deliver dynamic voltage control for the full range of its' active power range.

4.2.3 *STATCOM functionality*

The inverter shall be able to deliver reactive voltage control also when no active power is being exchanged with the grid.

4.2.4 *Frequency control*

The battery system shall provide frequency control to the power system. This will be done by adjusting the active power the battery feeds in, or absorbs, from the system.

4.2.5 *Phase balancing*

The battery system shall provide phase balancing capabilities, should there be voltage imbalances between the phases.

4.2.6 *Grid forming unit / Black start*

The battery will operate as the local grid forming unit. It shall also include a microgrid controller which will control the local energy system, including the existing 3 diesel generators and PV panels.

The battery must be able to also act as the grid forming unit during a black start. To ensure the operation of the microgrid controller during a black start, this component shall be equipped with a separate UPS with minimum 24hour (TBD) power-supply capacity.

4.2.7 *Prioritized functionality*

The battery is expected to handle several different functions, as mentioned in the introduction of this document. The following list gives the current order of priority. It must be possible to change this setup at a later stage if desired by the Purchaser.

1.) Grid-forming and regulation capacity within tolerances (FEL)
    a. Voltage control
    b. Frequency control
2.) Black start capability
3.) Regulation of diesel-generators
    a. Capacity regulation of operating generator
    b. Alternating between the 3 generators
    c. Periodic operation according to maintenance-schedule
4.) Overload power dumping
    a. Start dumping excess PV-power to heat-storage when battery is fully charged
    b. Start dumping excess PV-power to air / ambient when both battery and heat-storage is fully charged

4.2.8 *Manual override*

The control system shall allow for manual override from local or remote operators. They must be able to send manual override signals to the battery system.

These signals will be:

1) Fixed charging power
2) Fixed discharging power
3) "Default" programs
    a) Should the battery have different operational modes / programs, the operators must be able to choose which one is running.

The battery shall still operate as grid forming during manual override.

4.2.9 *Graceful degradation*

It is required that the battery system is constructed in such a way so that errors will not propagate and cause cascading faults. I.e. if the input data is erroneous, the battery system will have to work around the error and not shut down.

4.2.10 *Internet access/connectivity*

It is required that the battery system can operate without internet connection, or connection to a central control system for a prolonged period. During which period, it shall enter a default-state, determined by the Purchaser.

4.2.11 *Microgrid controller*

The battery system shall include a microgrid controller, which will run the local energy system at Isfjord Radio.

The controller shall, as a minimum, have the following functionality:

- Control system's voltage and frequency
- Control the operation of the local diesel generators
- Control the operation of the local solar panels
- Black start capabilities
- "Cross compatibility" with new system components
- Control the heat-production in the thermal storage unit
- Ready to integrate future energy sources, such as wind power and hydrogen production

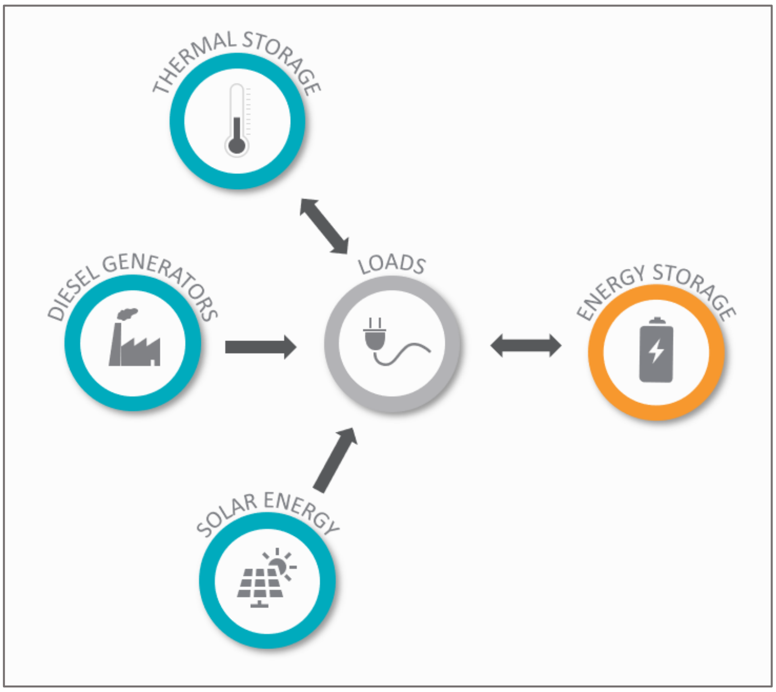

Figure 8 Simple topological view of the local energy system when completed. Blue circles represent units in grid following mode, orange circles represent unit in grid forming modes. Grey circle represents loads.

4.3 "Smart grid readiness"

As the battery system described herein will be part of a future renewable microgrid featuring load- and power production forecasting with energy management optimization. It is important that the battery control system includes open protocols and modifications that facilitates this future expansion.

This is described by the Purchaser as "smart grid readiness", and it is expected that the acquired battery system with its current design is set up to simplify additional services or control features in the future.

4.4 Expansion strategy

As there will be later expansions of the renewable energy system at Isfjord Radio, it is expected that the need for energy storage will change in the future. To take this into consideration, the battery supplier shall include an "expansion strategy" in their offering.

This needn't be lengthy, just a simple notation of how it would be done.

The expansion strategy shall include:

- Deployment strategy of additional battery storage on site
- Connection of additional storage
- Integration to control systems
- Needed extra hardware and software

4.5 Decommissioning

It is required that the installer includes a description of how decommissioning will be handled.

This description shall as a minimum include:

- Required expertise for handling the components
- Recycling of components
- Expected decommissioning costs

4.6 Options

The following extra deliveries shall be provided as options in the bid.

4.6.1 *New diesel generator controllers*

In the event that the microgrid controller is incompatible with existing diesel generator controllers, the battery supplier shall provide new controllers for the diesel generators, which are compatible with the provided microgrid controller.

The battery supplier shall provide price for components, and installation costs.

4.6.2 *Filter*

In case the battery system does not fulfil the harmonic requirements given in Section 5.9, the battery supplier must install a filter.

Price and sizing of such a filter shall be given as an option.

The description of this option shall include:

- Size of filter
- Type of filter
- Costs

4.6.3 *Added storage capacity*

The Purchaser want an option for added 100 kWh of storage capacity.

It shall be priced both as installed together with the current delivery, and as a separate delivery at a later stage.

5 Requirements for the installation

In the following, the technical requirements for the installation are listed.

Unless otherwise specified, all parts of the described systems, equipment and works shall be complete and comply with all Norwegian laws and regulations for this type of installation. This technical description with specifications is perceived as minimum requirements.

5.1 Electrical work and work in general

The general electrical work, systems and equipment that shall be part of the delivery includes all the necessary components that are required for the full function of the battery system.

All electrical design, work and documentation shall be done according to NEK400:2018, NEK EN 50549-1:2019, FEL 98 and FoL in addition to other relevant standards. List of standards and norms applicable for the acquisition is given in Section 9.

All external equipment must have a suitable class according to classification made using NEK400:2018, Table 51A.

The battery supplier shall prepare the installation drawings well in advance of the work being started. The installation drawings shall be subject for approval by the Purchaser before work can start.

Equipment included in the delivery must be installed in accordance with the manufacturer's guidelines and instructions. All equipment that requires maintenance and service must have sufficient accessibility on all sides. The battery supplier shall provide an annual maintenance schedule, including costs and expected hours of work, for the complete delivery.

Planning regarding existing infrastructure which ensures good access to the electrical systems and enables later expansion is the responsibility of the battery supplier.

The battery supplier must carefully agree to terms of appointments of planned power shutdown for works on/in existing main power distributions. These works must be planned to minimize the inconvenience for the Purchaser. Costs related to shutdowns must be included in the assessment.

All electrical works must be executed by skilled labour.

The local HSE-regulations for the construction site must be followed. These are of the same standard as for mainland Norway.

See also Chapter 2.7 for special Norwegian requirements.

5.2 General equipment requirements

The Purchaser is expecting that the battery supplier in general chooses equipment and material of high quality and which is easily replaceable, should any component fail during the lifetime of the complete system.

5.3 Atmosphere

Isfjord Radio is in close vicinity to the ocean, creating a salty atmosphere. The equipment shall be rated according to IEC 60068-2-52:2017.

5.4 Battery system

The battery system shall abide by current applicable Norwegian norms and regulations, such as NEK400 and NEK EN IEC62485.

For battery types not yet fully described in NEK EN IEC 62485, the battery system provider must deliver a user manual and guidelines for their battery system with the same detail level and content as NEK EN IEC IEC62485.

Additionally, Attachment C “Battery system – requirement matrix” shall be answered / filled out. It covers important information about battery characteristics.

5.5 Inverters

The inverter shall deliver specified power within the given boundaries for normal voltage variations, power quality, and under the given climatic conditions.

The inverters shall be approved for use in battery system applications, and shall fulfil the requirements in NEK EN 50549-1:2019 for Type A.

The inverters shall have a TÜV certification or equivalent and as a minimum comply with the standards listed in Section 9 of this document.

The inverters shall be CE-certified.

The inverters shall be correctly sized in order to provide the required functionality as described in Section 4.

The inverters shall be located so that daily operation and periodic maintenance and inspection can be easily performed.

All inverters shall be labelled in order to ease the operations and maintenance.

5.6 Mounting System

All components shall be properly mounted and secured. The interface is as described in Section 3.3, and the battery system contractor must provide all mounting structures not described there.

The mounting structure shall retain its integrity and function for the entirety of the battery systems lifetime.

The mounting structure shall be dimensioned to handle the local conditions.

5.7 Cabling

All cables shall meet the requirements of the Norwegian norm NEK400:2018.

DC cables shall be double insulated.

The cables shall be fixed (with UV-resistant plastic strips, for example) to avoid movement and mechanical damage. The cables must also be protected against sharp objects (edges) that could harm the insolation of the cable.

All cables shall be labelled in order to ease the operations and maintenance. Product specific requirements for wiring of battery modules and inverters must also be followed as per product manuals.

Any AC cables shall be of halogen free type and shall be of flame-retardant isolation, i.e. of IFSI type.

The current-carrying capacity of all cables shall be calculated based on NEK400:2018, Table 52.

5.8 Fault Ride Through (FRT)

The battery system inverter shall be able to handle fault ride through in accordance with EN 50549-1:2019, type A.

5.9 Harmonics and power quality

The battery inverter harmonic voltage distortion shall not exceed the given values in the table below. This is regulated by the Norwegian law “Regulation on power quality in the power system” (FoL). The regulation is managed by The Norwegian Water Resources and Energy Directorate (NVE). Of particular importance are §3-6 and §3-7, covering asymmetries and harmonics.

It is emphasized that the regulation holds for total power quality in the grid, so that the limits cannot be exceeded after the battery system is in place.

Table 1 Regulations for harmonic voltage distortion at the connection point, as described in FoL

Odd harmonics				***Even harmonics***	
Non-multiples of 3		***Multiples of 3***			
Order h	**U_h**	**Order h**	**U_h**	**Order h**	**U_h**
5	6,0%	3	5,0%	2	2,0%
7	5,0%	9	1,5%	4	1,0%
11	3,5%	>9	0,5%	>4	0,5%
13	3,0%				
17	2,0%				
19, 23, 25	1,5%				
>25	1,0%				

5.10 Earthing / grounding

All equipment shall be connected to the local grounding system.

Necessary equipotential grounding shall be established for all exposed parts, such as encapsulations, mounting structures, inverters, cable trays, etc, according to NEK400:2018.

5.11 Communications and control

The battery system shall include a microgrid controller to control the battery, diesel generators, solar inverters and thermal storage.

The microgrid controller shall keep the system frequency at 50Hz ± 2%, and system voltage at 230 V ± 10%.

The microgrid controller, and other relevant controls and communications for the Purchaser, shall utilise open protocols, such as MODBUS.

A complete system for real time monitoring and control of the battery shall be included in the delivery.

Cabling and communication systems shall be done according to the NEK700:2020 series, which is the Norwegian adaption of EN50173

Other suggestions from the battery supplier for a reliable, secure and scalable system controller is appreciated by the Purchaser.

5.12 Data and data-handling

The battery system shall be delivered complete with all necessary measuring equipment to secure operations of internal protection and regulation systems.

It shall be simple to collect data and produce structured data files based on the data produced by the battery system.

No data shall be sent from the battery system to the battery supplier without the Purchasers written consent.

The battery supplier has the right to request data from the battery system through the Purchaser. This data is not to be forwarded to any 3rd parties.

5.13 Fire Protection and considerations

There shall be enough ventilation around the batteries to avoid possible exploding or hazardous atmosphere, as described in NEK EN IEC IEC62485.

Special considerations and measures shall be made to prevent thermal runaway in the battery packs.

The battery supplier shall describe their fire concept, which shall include detection and extinguishing of fires, required safety distances around the perimeter and necessary adaptions made to the surroundings.

At commissioning, the battery supplier shall be available for a walk-through of the complete system with the local fire department and explain how they are to handle a fire in the facility. The contractor shall present the information in a manual and provide this to the local fire department.

5.14 Operation and maintenance

The battery system shall be constructed in such a way that requires minimum operation and maintenance. This includes, but is not limited to, easy exchange of parts that need periodic replacement, fault warnings in data system and limited overall maintenance.

The battery system shall be constructed in such a way that compatible spare parts are available to get hold of throughout the expected lifetime of the battery system. Essential wear-parts should be provided the Purchaser at commissioning.

In order to estimate OPEX costs, it is required that an operation and maintenance schedule is included in the offer. It must be specified if the Operation and Maintenance can be handled by trained local personnel or if it required that the installer performs the maintenance.

5.15 Spare Parts

The system installer must suggest a list and amount of necessary spare parts for the system which will be needed during normal operation and maintenance for the full lifetime of the system.

The list shall include a price estimate for each spare component, as well as total sum without VAT.

Critical spare parts shall be part of the delivery, and shall be stored at Isfjord Radio. Necessary special tools to replace the spare parts shall be part of this delivery.

Local operative personnel shall be trained in replacing spare parts.

5.16 Labelling

Labelling of the components and cables in the system shall be made according to the regulations for electrical systems.

All cables and all equipment shall be labelled with distribution group and switch / cable number. The marking shall be permanent, meaning that the marking shall have the same longevity as the installation part.

Marking of technical components and equipment with signs indicating:

- Manufacturer, type designation, approval mark for equipment subject to special approval requirements, production year and month.
- Information about commissioning date and information about name, address and phone number for service.

- Colour marking of rails and cables in distributions and main markings of distribution according to numbering in NS3420.

6 Commissioning, testing and future responsibilities

In the following, required steps prior to handover are presented. This includes training of local personnel, a site acceptance test, and a trial period. It is expected that the battery supplier collaborates with the Purchaser in this phase, and includes the Purchaser in the process, and possible necessary modifications of the system.

6.1 Training

During construction, commissioning and trial period, it is required that the local operators are invited to participate in order to understand how the battery system is composed, how fail search is conducted and corrected and proper operation of the power plant. It is required that the installer organises workshop(s) where relevant scenarios are tested and

The battery supplier shall provide training to the Purchasers operative personnel.

The training shall include:

- Participation throughout the construction phase. Two or more of the Purchasers personnel will participate.
- Walkthrough of the operations manual
- General operations of the battery system
- Capabilities and limitations of the battery system
- Inspection routine of the system
- Maintenance routine
- Procedures in fault situations

Costs of training shall be part of the offer.

6.2 Site acceptance test (SAT)

At completion of the installation there shall be conducted a complete test of the battery system with the Purchaser present. The battery supplier shall present a complete test schedule for approval to the Purchaser at least 4 weeks in advance of the testing.

The test shall as a minimum include:

- Visual control of the battery system
- Complete test of all functions
- Complete test of communication systems and data transfer to / from the Purchasers systems
- Verification of promised capacity
- Verification of promised system efficiency
- Control and update of drawings
- Start-up and trial operation

- Measuring of power quality

The test-report shall as a minimum include:

- Time and date
- Participants
- Description of conducted test(s)
- Test setup and measurement setup
- Calibration of utilized instruments
- Test result
- Description of how the test result fulfills contractual agreements

6.3 Trial period

After SAT is completed and approved by Purchaser, the trial period will start. The battery supplier shall make a plan for the trial period, to be delivered to the Purchaser prior to the SAT.

The duration of the trial period is set to 2 months. Should significant faults or errors occur during this period, the trial period may be extended corresponding to the error correction time.

If minor errors or anomalies are present at commissioning, a due date for rectification of named errors shall be noted in the handover protocol.

6.4 Damages

All accrued damages must be paid or repaired prior to completed handover

6.5 Handover

An independent 3rd party controller (Purchaser's consultant) will inspect the installation and finally approve the installation if no major flaws and / or shortcomings are found.

The handover will not be approved as complete before all documentation described in Section 7 is present, and procedures as described in Section 6 are approved.

The system warranty will not start until the installation is complete and approved as such by the 3rd party controller.

Also, part of the payment for the installation will also be withheld until the installation is approved by the 3rd party controller.

6.5.1 *Follow up inspection*

The battery supplier shall return to the installation after the first full winter season to assess the installation, and to ensure that everything is in order and as expected.

Any anomalies shall be reported to the Purchaser immediately for correction.

7 Required documentation at handover

In the following, required documentation at handover is described.

7.1 General

Final documentation shall be delivered digitally to the client, both in pdf-formats, and in native formats (.doc, .xls, .dwg, etc) where applicable. This shall as a minimum include:

- Data for the battery system, including dimensional sketches, bill of materials, wiring diagrams, communication diagrams, and datasheets
- As-built drawings
- Data sheets for all components used in the installation
- Installation manuals for all components used in the installation
- Reports documenting calculations, including:
  - Short circuit currents
  - Short circuit voltages
  - Mechanical loads and stresses
- Test-report from conducted site acceptance test (SAT), and from trial period
- Operation and maintenance descriptions, including:
  - User manuals
  - Start / stop procedures, including reset and start-up after faults
  - Inspection- and maintenance procedures for everyday maintenance sufficient to uphold the given warranties
  - Procedures for fault-situations
  - Procedures for fire department
- Declaration of conformity in accordance with Norwegian regulation
- Simple overview of all components and their respective warranty, expected lifetime and maintenance intervals

7.2 Operation Manual and Maintenance Instructions

In addition to the product specific manuals, the battery supplier shall develop an operation manual and maintenance instructions for the full system.

Its’ contents shall as a minimum include:

- Procedures for fault situations
- Errors and subsequent measures
- Inspection- and maintenance-procedures

8 Warranty requirements

- The Operation Manual shall include an overview of the different components, warranties and warranty terms.
- The product warranty for the whole installation shall be 10 years.
- If the battery system or any of its components does not meet the specifications during the warranty period, it shall be rectified without any delay and at no additional cost for the Purchaser
- The warranty shall apply in case of any component showing a malfunction or a significant change in its mechanical or electrical function that can increase the risk of a malfunction.
- The warranty period will start at the first day after the commissioning with the approval of the third-party consultant, or if any major outstanding issues are disclosed during commissioning, the warranty period will start once these issues have been corrected and approved by the third party consultant.
- The battery supplier shall clearly state in their documents any limitations to their offered warranty
- If any service level agreement with the battery supplier is a prerequisite for the warranty, this shall be clearly stated in the offer

9 Standards

- NEK400:2018 - Electrical low voltage installations
- FEL98 – Forskrift om elektriske lavspenningsanlegg[4] («Regulation on electric low voltage installations»)
- FoL – Forskrift om leveringskvalitet i kraftsystemet[5] («Regulation on power quality in the power system») (FOR-2004-11-30-1557)
- IEC 62485-X Safety requirements for secondary batteries and battery installations
- NEK EN 50549-1:2019 Requirements for generating plants to be connected in parallel with distribution networks. Part 2: Connection to a MV distribution network.
- NS 3420 Specification texts for building, construction and installations Part W: Low voltage power and signal installations. (Beskrivelsestekster for bygg, anlegg og installasjoner Del W: Elkraft og teleinstallasjoner)
- NS-EN 1991-1-3:2003+A1:2015+NA:2018 (Eurocode 1: Actions on structures - Part 1-3: General actions - Snow loads)
- NS-EN 1991-1-4:2005/NA:2009 (Eurocode 1: Actions on structures – Part 1-4: General actions - Wind actions)
- FSE Forskrift om sikkerhet ved arbeid i drift og av elektriske anlegg (FOR-2006-04-28-45B)
- NEK700:2020 Information technology - Package with NEK 701:2020 Generic cabling systems - NEK 702:2020 Cabling installation - NEK 703:2020 Data centre facilities and infrastructures
- EN 50173 Information technology - Generic cabling systems
- IEC 60068-2-52:2017 Environmental testing - Part 2-52: Tests - Test Kb: Salt mist, cyclic (sodium chloride solution)
- NEK IEC 62477 1:2012 (Safety requirements for power electronic converter systems and equipment – Part 1: General)

<u>Other:</u>

- IEC 61000-2-4:2002, "Electromagnetic compatibility (EMC) - Part 2-4: Environment - Compatibility levels in industrial plants for low-frequency conducted disturbances.
- IEC 61000-6-3 (Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments)

The battery supplier can deliver according to a different set of standards, but it is then the responsibility for the battery supplier to prove the equivalence between these standards and those specified.

[4] https://lovdata.no/dokument/SF/forskrift/1998-11-06-1060
[5] https://lovdata.no/dokument/SF/forskrift/2004-11-30-1557

10 Attachments

- Attachment A - Meteorological data
  - Raw data from the Norwegian meteorological service. It contains monthly winds, temperatures, precipitation and snow-depth from 2009 to 2018.
- Attachment B – Annual load profile
  - Synthesized load profile for rehabilitated buildings at Isfjord Radio
- Attachment C – requirement matrix
- Area-plan
- Single-line diagram for connection point