Checklist for single-customer procurement of second life EV-batteries for energy storage systems

Introduction and purpose of the checklist

This is a checklist for the procurement of second life electric vehicle batteries for energy storage purposes as part of a construction project (renovation, refurbishment, new project).

The checklist consists of

- a pre-analysis section: this covers questions related to information that the building owner must obtain internally to decide and clarify the strategy and goals that the battery energy storage system should serve and set good functional requirements for the battery.
- a section with questions for market inquiry: This consists of relevant questions to suppliers and contractors about what information they can offer both for the capacity and functionalities of the battery energy storage system and on the type of climate footprint information they can provide for the battery energy storage system.
- A section on suggestions for requirements and criteria that contracting authorities can set for second life battery energy storage systems, both for cost efficiency and circular concerns.

The checklist is based on the work on demo sites in TREASoURcE and a SINTEF conceptual study for battery energy storage system for an educational institution. .

1. Pre-analysis

To assess the capacity and size of the battery needed, the contracting authority must make a pre-analysis to clarify the goals for using the battery and the desired strategies for managing the battery's connection and disconnection to the grid. In the following sections you will find some information you should consider.

Question	Suggested follow-up action and considerations
Frequency services: Do you want to use the battery energy storage system mainly for peak shaving or are other services and purposes	Frequency reserve markets can add considerably to the income from the use of the battery energy storage system and reduce payback time.

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relevant, i.e. frequency reserve regulation purposes?	If you consider taking part in the market for frequency reserve purposes, you also might need to procure and install different measurement systems– check the table “measurement systems needed for frequency reserve purposes.” You should at an early stage contact the grid operator to check requirements for taking part in the market. If frequency reserve purposes are not relevant, go to the next question in the table.
Peak shaving and grid connection Do you mainly consider using the battery energy system for peak shaving? If yes, what are your desired strategies for connecting and disconnecting the batteries from the grid?	To define the optimal capacity of the battery it is necessary to define limit values and clarify the desired strategies for managing the connection and disconnection of batteries and the purchase and sale of electricity on the grid. Important parameters can be: • the desired maximum power output during a month • the limit for being a plus customer (a customer who can supply surplus energy to the grid). • Whether the system is connected to the building's SD system and to weather forecasts
Strategies for managing grid connection What are examples of strategies you can follow for managing the connection?	You can define for instance two seasonal strategies: summer mode and winter mode. . **In summer mode**, the battery is used to

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	avoid selling too much electricity from the solar system to the grid on an hourly basis. If you feed more than x kW of power into the grid, you can no longer be a plus customer, which has financial consequences. Therefore, you can choose to control the system to avoid this with the battery storage. You can also curtail the production from the PV (photo voltaic) panel. **In winter mode**, the battery is used to avoid power peaks when purchasing electricity from the grid. You can choose to do this to reduce your grid rental costs.

Measurement systems needed for frequency reserve purposes:

Frequency (Hz): The main requirement for the frequency market. The system must measure and be able to respond to the grid frequency (e.g. 50 Hz) to deliver or absorb power to stabilise the frequency.
SOC (State of Charge): Calculated based on voltage, current and history to determine how full the battery is.
These meter systems are needed: **Smart meters:** Standardised meters that deliver real-time data on current, voltage and energy to the grid operator.
Frem-meters: (Frequency Market meter): Specialised meters or functions in EMS systems that continuously monitor and report the grid frequency to the system operator.
Energy Management System (EMS)/Bids system: Software that interprets data from BMS and smart meters, predicts demand, communicates with frequency auctions and controls charging/discharging to maximise revenue and grid security.

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2. To determine the optimal size of the battery energy storage facility, clarify strategies and find relevant information on energy use and consumption.

To define the internal needs that the procurement is intended to meet and the requirements that should be imposed on the battery solution, *for instance the size and capacity of the battery energy storage system*, it is important to gather relevant information on the relevant building's energy use and requirements. It is also important to consider how the battery should interact with other internal energy systems and solutions.

i – How to find information on your current building's energy consumption and needs

Perform calculations or simulations prior to procurement. Consider the buildings energy use and collect relevant information, using for instance the questions below

Questions on energy use
What are the total energy requirements for the building over the course of a year in kWh or MWh?
What share of the energy requirements are connected to heating and what share is connected to ventilation?
Are there other energy requirements and needs for the building and what share of the total energy consumption do they constitute?
What is the seasonal variation in energy consumption between the two coldest months and the two warmest months?
What are the energy requirements that must be met on the coldest days? Specify the energy requirements that must be met on the coldest days and in the coldest month in kWh/MWh.

ii – Considerations for existing buildings with solar energy solutions installed

- **If you have solar power installed**: to manage the energy system in line with objectives, you should collect and process data from various sources to make calculations and simulations. Relevant input data for simulations and calculations can be found in the table "Information on renewable energy production, power consumption and tariffs."

  If you do not have this energy source installed – go to step iii – needs for thermal heat.

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Information on renewable energy production, power consumption, and tariffs

Theme and questions
User settings, technical parameters, limit values
Measured PV production (kW)
Measured power consumption (kW)
Measured surplus power supplied to the grid (kW)
Updated tariffs with prices for energy and power
Forecasts for electricity prices for the next 24 hours
Forecasts for PV production for the next 24 hours, or an estimate based on weather forecasts and time of day/year, forecasts, or historical data for consumption

Assessment of energy needs for a new building with planned production of solar power	
These are some assessments and data that should be taken into consideration when calculating the energy use requirements for new buildings, see column to the right	• Simulation of energy consumption • Simulation of energy production from PVs using forecasts for PV production • Forecasts for electricity prices

iii – Needs for thermal heat

Does the building meet its current energy needs partly or mostly by thermal heating?

- If yes: collect information to assess the energy consumption needs that must be met by thermal heat and the composition of the consumption, see information in the table "Collecting information on thermal heating needs" below.

- If no – go to step 3 – **setting requirements for battery energy storage rooms**

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Collecting information on thermal heating needs

Theme	Question
Need for (thermal) heating	Find the need for (thermal) heating per year and for different seasons, composed by need for heating and need for ventilation
Need for thermal heating	How are these covered today: by district heating or by other means?
Need for thermal heating	What is the annual amount in kWh or MWh for the two categories?
Seasonal variations	What is the maximum number of kWh or MWh per day covered by district heating on the coldest winter days?
Heat storage system provision	Could part of the needs for heating be covered by installing a PCM latent heat storage system? Can the contractor supply a PCM latent heat storage system or similar solutions as part of the tender?

3. Setting requirements for battery energy storage rooms

To address safety requirements, space needed for the battery energy storage system and other relevant issues in the building, the technical and facility management staff of the public building can find relevant information and descriptions in the article below:

How to Install a Second-Life EV Battery in a Municipal Building - Replication Handbook

4. Assess the capacity and size needed for the battery energy storage system

As a rule, second life batteries will have a capacity corresponding to between 70–80% and 50–60% of their original capacity and that of a corresponding new battery. To assess the capacity needed for the battery energy storage system and what kind of requirements and circularity criteria that can be set for the battery energy storage system, you should enter market inquiry or dialogue with relevant actors. A table of selected questions for market dialogue can be found in the table below “Questions for market dialogue.”

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Examples on specification of minimum requirements for the capacity of the battery energy storage system is found in the table “Suggested minimum requirement for battery energy storage capacity”

Table - Questions for market dialogue on the capacity, size, and safety aspects of the battery

1. What is the maximum power output and charging capacity of the battery systems offered? 2. What is the maximum discharge effect of the battery? 3. Can you provide information on the climate footprint of the second life battery? What kind of documentation or verification can be given? 4. What type of safety barriers are included in the system (i.e. integrated gas, smoke, or fire detection)? 5. Does the battery have an integrated cooling system? 6. How is temperature variations monitored (cell level, module level, etc.)? 7. What is the operational temperature window for the battery system? (Depending on heat produced by the battery during use, temperature/climate control of the battery room must be considered) 8. Can modules be easily replaced in the case of a faulty cell or module, or must the whole battery rack be replaced?

Table - Suggested minimum requirement for battery energy storage capacity

Suggested minimum requirement specifications for battery storage capacity	**Award criterion on battery storage capacity**
The power effect of the battery must as a minimum have a capacity in x kW The capacity offered must be based on the current condition The original capacity and year of manufacture must be stated	The bidder will be awarded based on the capacity in kW of the provided battery. The bidder will be awarded for submitting higher power/effect in kW than the minimum requirement. The capacity offered must be based on the current condition.

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5. Make requirements and award criteria for cost efficiency and circularity of the battery energy storage system

Guidance:
The next step will be to make requirements and award criteria to evaluate the circularity and cost efficiency of the battery energy storage system. Base your choices on minimum requirements vs award criteria on the responses from market inquiries. Relevant aspects that are given weight can be life cycle costs, remaining charge cycles and guarantees for remaining life cycle. Below you will find examples of relevant award criterions that can be used directly in the tender.

Cost-effectiveness award criteria

Wording of criterion
The bidder will be evaluated based on the procurement costs, service costs and remaining lifetime costs of the battery system offered. Submit the costs of the battery system offered:
Levelized costs of storage, including investment/procurement costs per kWh, operational management costs and costs adjusted for remaining lifetime pr kWh. Remaining capacity shall be calculated according to full equivalent cycles.
Total estimated service costs pr. year, including worktime costs, travel costs, costs for replacing a battery module. Costs for replacing a battery module shall be listed, including costs of module, worktime costs, and travel costs.

Battery energy storage systems - circularity criteria for second life systems

Depending on the responses given in the market inquiry on estimated remaining lifetime, consider awarding the contractors for supplying batteries with a long remaining life cycle. Use for instance, the examples in the tables below.

Wording of criterion	**Verification requirements**
The bidder will be awarded based on the longevity of the battery system supplied. Guarantees for estimated remaining lifetime will be given weight. The bidder shall submit:	Cradle to cradle certification systems

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• The estimated remaining charging cycles of the battery, given in equivalent full cycles • Guarantees of estimated remaining lifetime of the battery	

Award criterion – recycling of batteries at end-of-life

Wording of criterion	Verification requirements
The bidder will be awarded for how the recycling of battery components will be handled by the end-of life of the battery. The bidder will be assessed on the following criteria: Share of delivery of material for recycling for specific materials at end-of-life Share of delivery of material for recycling from specific components at end-of-life Design for recyclability of the battery systems and components	Make verification requirements based on the responses in the market inquiries on the quality and kinds of documentation that can be given.

Award criteria for latent heat storage systems

Question	Suggested follow-up action
Do you intend to procure latent heat storage systems?	If yes, consider making requirements or criteria to evaluate the efficiency and functionality of the latent heat storage system, see table “suggestions for award criteria of a heat storage system” If no, go to the last step – step 6

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If I intend to procure a heat storage system, how can I evaluate the usefulness of a latent heat storage facility?	To evaluate the usefulness of a PCM latent heat storage facility, one can calculate district heating costs over the course of a year. District heating costs are based on Statkraft thermal (insert national heating tariff platforms) heating's tariffs, which, like electricity costs, are calculated using an energy component and a power component.

Suggestions for award criteria of a heat storage system

Theme	Wording of the criterion
Capacity	The bidder will be awarded for providing heat storage capacity higher than the minimum requirement. The bidder shall submit the latent heat storage capacity in kWh. The minimum capacity of the heat storage capacity shall be x kWh
Discharge effect	The bidder will be awarded based on the size of the maximal discharge effect of the latent heat/heat storage system. The bidder shall submit the *maximal discharge effect* of the latent heat/heat storage system in kWh
Further comments	Other criteria to assess the efficiency of the heat storage systems can be volume and weight, building requirements, establishment of storage facilities, e.g. ambient temperature, groundwork, etc.

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6. Make functional requirements for the operational management system of the battery

Guidance: As the last step you make functional requirements for the operational management system of the battery to secure that it fits the desired purposes of the strategies for the battery energy storage system. A selection of relevant requirements can be found below.

Wording of requirement specification
• The control system must be able to integrate seamlessly with SD systems (GK Cloud), both in terms of software and hardware
• It must have secure access control and protection against unauthorised changes
• Time resolution – how often must the system be able to update the control signal? The time resolution in the control system should be at least as high as the time resolution for price settlement on the purchase and sale of energy, i.e. at least 1 hour
• Limit power supplied to the grid to a maximum of 100 kW (plus customer) [possible change in progress]

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