Battery Storage Integrators

Background

BPI are very experienced in the design process required for battery storage.
The main components are:

DNO Substation

1. DNO switch house building
2. Step up transformers (applicable based on the type of connection)
3. MV switchgear including protection
4. MV cables
5. Tariff metering
6. ANM system
7. Battery and battery charger 110 V and 48 V
8. LV AC distribution, heating and lighting
9. Plant earthing
10. SCADA

Background

Customer substation and private network

1. Customer switch house
2. MV switchgear including protection
3. MV, LV cables
4. EMS system/system integrator
5. Battery and battery charger 110V and 48V
6. LV AC distribution, heating and lighting
7. Inverter transformers
8. Inverters
9. DC cables
10. Battery bank
11. Customer SCADA

The majority of which BPI have designed in numerous previous schemes.

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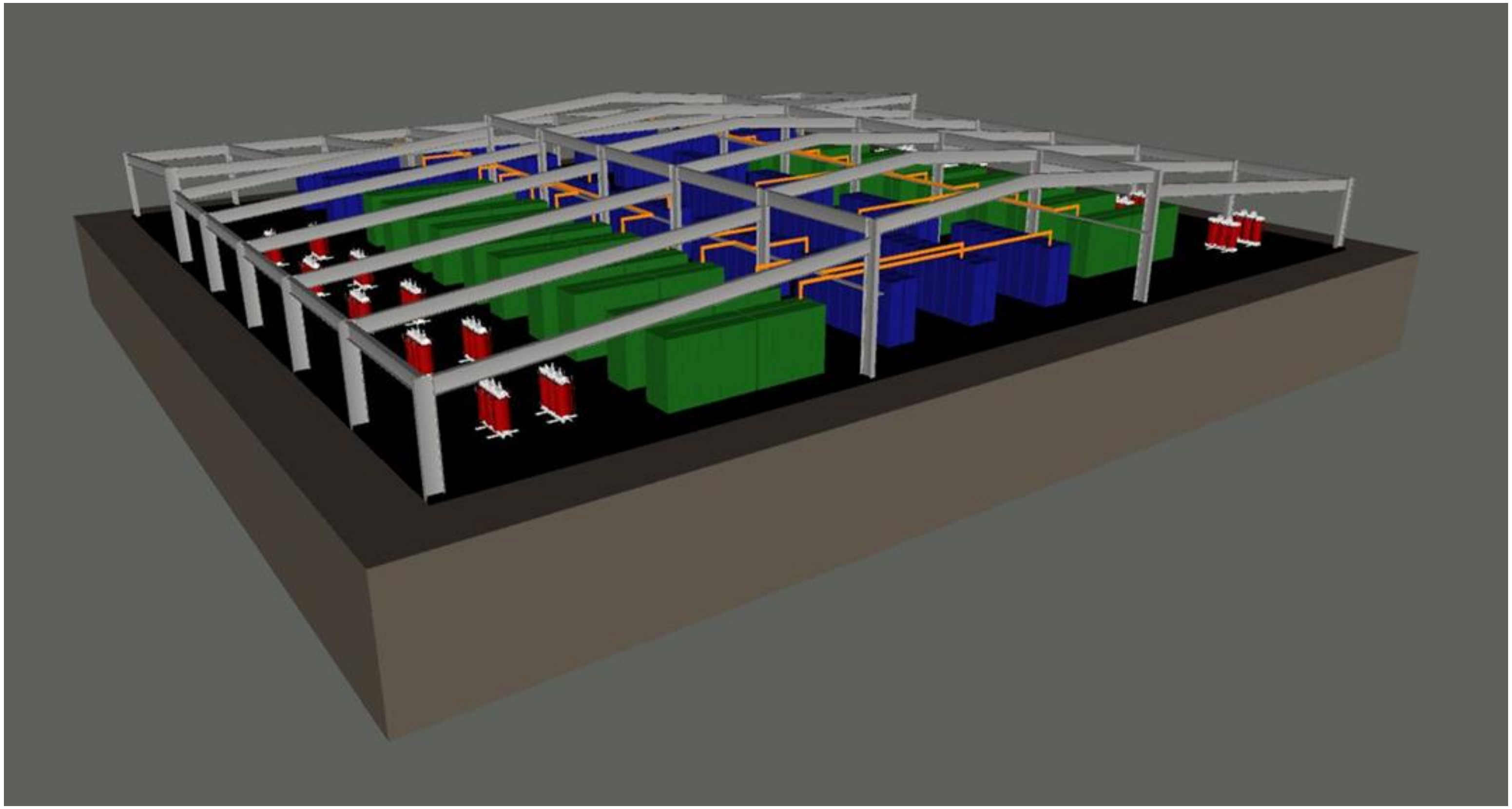
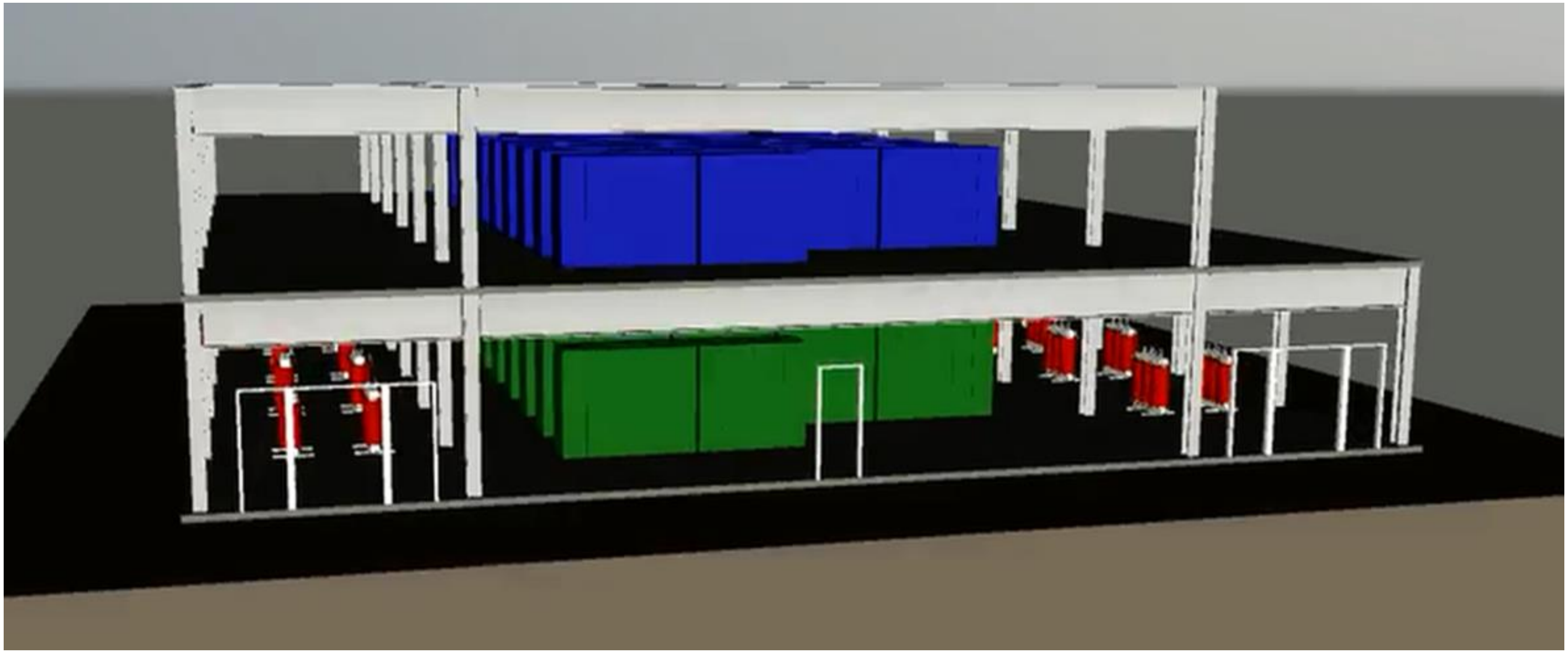
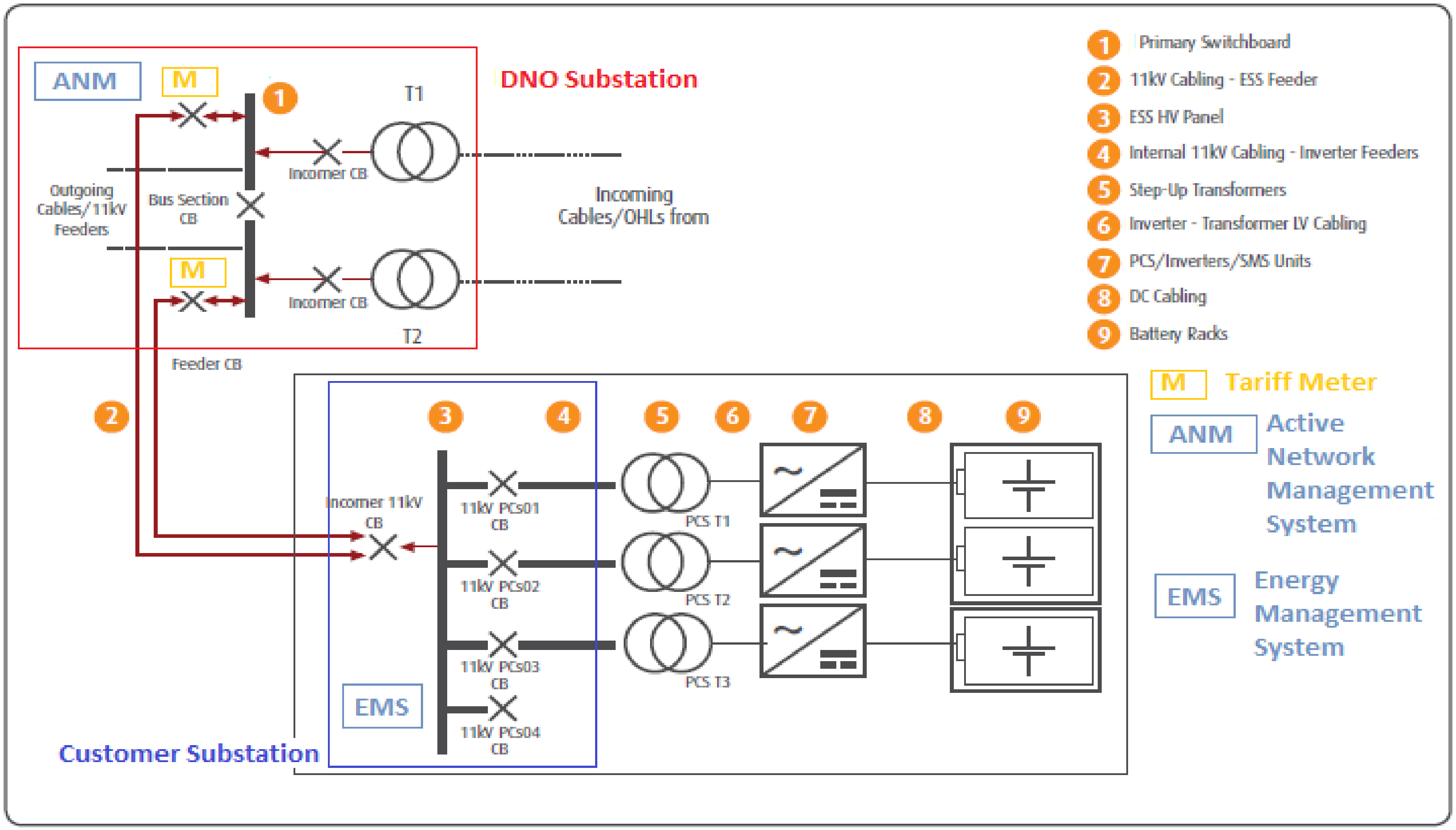
Example of our design 1



Example of our design 2



Concept electrical network



The process

Prior to the planning and design of any energy storage project clients must:

- Identify network issues or operational constraints that require intervention.
- Determine if energy storage could provide an effective solution as an alternative to conventional upgrade. (DNO to decide.)

Once the network is identified, the high level design for the storage will be affected by a number of drivers which will have impacts on the final design.

Nature of the storage technology

The two most fundamental components, the battery and power inverter/converter, shall be based on the following requirements (the DNO may ask for these features in line with NG requirements):

- Short Term Operating Reserve (STOR) - ability to deliver at least 3 MW output for at least 2 hours duration. (Short Term Operating Reserve is needed because at certain times of the day National Grid needs reserve power in the form of either generation or demand reduction to be able to deal with actual demand being greater than forecast demand and/or plant unavailability.)

- Dynamic and non-dynamic Fast Frequency Response (FFR) - ability to provide power output response within 2 seconds.

- Power factor correction.

Battery

- Choice of DC busbar voltage - in a constrained foot print, choice of DC bus-bar voltage can be significant.

- Generally battery are stacked vertically and connected in series so that the potential between battery stack at bottom and top gives bus bar voltage.

- Limited choice of busbar voltage (depending on the inverter DC voltage) therefore determines the height of the stack and thus the building height.

Battery

- Battery selection - the technology offers ranges right across the electro-chemical battery spectrum, from technically and commercially mature lead-acid batteries through nickel cadmium to advanced lithium-ion. The battery shall be selected based on the following criteria:
  - Proven technology with suitable reference sites and safety records, using technology that had no possibility of polluting flood or river course water, environment.
  - Physical size, weight and foot print area aligned with the site location.
  - Quick ramp-up response time solution, allowing for wide range of applications.
  - Ability to house in a variety of structures, including buildings aligned with the site location requirements.
  - Value for money.
  - Performance not affected by temperature (-20^{0}C to + 40^{0}C).
  - Low stand-by loss.
  - Flexibility in sizing and configuration (based on the inverter rating).

Battery

- Several large scale battery energy storage providers offer standardised solutions based on batteries installed in ISO shipping containers. There are a number of design criteria that are required to be considered:
  - Keeping the volume and height of the proposed substation/housing to a minimum. (To have planning permission, so to keep the visual impact of the facility to a minimum.)
  - Construction cost to minimum.
  - Flood risk mitigation.
  - Electrical plant to be 2m away from the fence.
  - Future proofing.

Battery

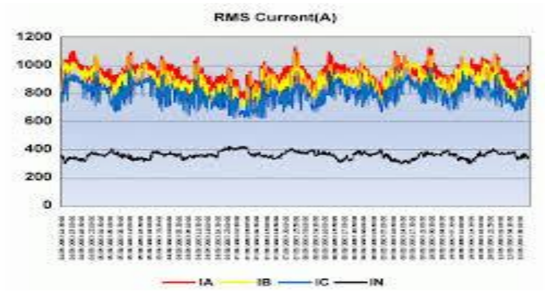
- The battery system can be installed in-rack inside the brick built building. The typical layout shall have two sections, with one half housing the battery racks and the other half housing the inverters and step up transformers.
- Additional separate rooms shall be designed to accommodate MV switchgear, SCADA and control equipment, fire-suppression equipment and heating, ventilation and air conditioning equipment.
- Minimum quantum of storage and rating which installation must have in case of a failure.
- This critically determines the number of and the rating of converters. The number of converters and their separation dictates the space.
- Fire suppression arrangements and maintenance requirements.

Connection studies/requirements

The following connections studies will be required prior to the energisation of the storage plant.

- P28 and flicker studies - depending on the connection to stronger or weaker DNO networks, the voltage dip might exceed the limits defined in the E.R. P28, therefore might need mitigation.
- Stage 2 or 3 G5/4-1 harmonic studies – should the system background harmonics and the emissions from the storage plant leading to it exceed the PL, they may need mitigation (provision of harmonic filters).
- Earthing design - as the storage plant size is very small as compared to the PV solar park, getting the actual potential within the safe potential depending on the earth fault magnitude, clearance time and site specific soil resistivity could be an issue and may need special earthing arrangement.

These are mandatory requirements for any connection.



Additional studies/requirements

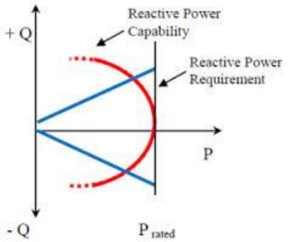
The DNO may require additional studies to be performed:

Reactive power capability studies

Also, the inverter manufacturer must provide the test certificates for the STOR, FFR and Fault Ride through capability requirements.

Systems using energy storage that are connected to the grid (including backup systems) are covered by the new Engineering Recommendation G59/3. This states that “Energy storage systems can be connected to the DNO’s distribution system directly or using inverters” and requires certification for battery inverters in the same way as for PV inverters.

To disconnect the energy storage source from the grid in the event of failure. It must do this in compliance with the G59/2 type verification test or approved commissioning tests, therefore this might require DNO to witness G59 relay testing.



Electrical protection design

- On the AC side the protection design will not be different from the standard connection (solar farm) job. The protection relays shall be used to both protect storage plant from network-fed fault and vice versa.
- On the DC side each inverter should have X battery racks (consisting of Y batteries) connected, each of which should be individually isolatable from the DC busbar.

Battery

The chosen technology, module size and method of housing may well impact both the cooling requirement and noise level. They will also affect the foot print of the plant, and together these will impact the local planning consents required.

Along with the standard planning permission issues, the major health and safety issues under planning permission are:

1. Power cables laid in to the ground.
2. Chemicals used in the batteries could cause a health risk or pollute the environment.
3. Noise levels when being built and when the plant is in operation.
4. Are there any chemicals in the equipment being used which could cause a health risk?
5. Would there be a heavy discharge of electricity if fault occurs?

HEALTH AND SAFETY

The options – containerised or in a building

BPI can provide the design for battery integration into either private or DNO networks.