PI-BESS

PLANT INTEGRATED BATTERY ENERGY STORAGE SYSTEM

PI-BESS is a new product offered by GE Power to clients willing to optimize the operation of their plants and to increase their revenues captured from the ancillary services markets.

This patented Plant Integrated Battery Energy Storage System (PI-BESS) is a customized BESS, optimized and fully-integrated to the plant. It is available for all types of power plants, especially thermal power plants, for both new units and for retrofits.

Market for Ancillary Services

An extensive analysis of the ancillary services markets around the world shows that services related to the production of active power are those generating the more revenues.

PI-BESS is the solution developed by GE to answer these needs. Once integrated into the plant, this unique system has no match for increasing revenues generated by providing:

- Operation of the plant closer to base-load,
- Additional Frequency Response capacity,
- Frequency Response capacity when the plant is off,
- Faster Frequency Response,
- Black-Start capacity,
- Improved ramp-rates,
- Load shifting,
- And much more grid services.

Conceptual application of the PI-BESS to a 9HA.02SS CCGT in the UK

The following example shows the benefits of integrating the PI-BESS into a 9HA.02SS combined cycle power plant rated 820MW.

The PI-BESS in this case is designed to provide:

- Operation of the plant closer to base-load,
- Additional Frequency Response capacity,
- Black-Start capability,
- Frequency Response capacity when the plant is off.

CCGT Frequency Response improvement using PI-BESS

The UK NGC requirements for Frequency Response can be summarized as follows:

- 10% Frequency Response within 10s,
- Active power must be maintained during 30 minutes,
- The 10% FR requirement below 80% base-load can be reduced to 0% at base-load (refer to figure 3).

The figure 2 shows how the PI-BESS improves the plant capability to provide Frequency Response by compensating the inertia of the steam cycle.

In this example, the PI-BESS is designed for one 9HA.02SS unit. It will provide a peak power of 19MW within less than 10s so that the sum of the steam turbine power and the PI-BESS power can be considered as additional Primary and Secondary response at the point of connection of the plant to the grid.

It has to be noted that this solution is unique in the sense that other mechanical solutions do exist to increase transient power with the gas turbine and/or the steam turbine (for example using the gas turbine over-firing capacity and/or a steam turbine overload valve), but these may:

- Be limited in power,
- Induce high maintenance factors,
- Degrade the CCGT efficiency.

PI-BESS...How a fully-integrated battery makes the difference.

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PI-BESS benefits vs NGC requirements

The figure 3 shows how the PI-BESS expands the operating area of the plant.

![Figure 3: PI-BESS benefits vs NGC minimal requirements](image)

Using the flexibility of the system, the operator can operate the plant permanently in all the new blue area. For example:
- Case 1 allows to increase the plant FR capacity from 10% to 12.3% below 80% load,
- Case 2 allows operating the plant at higher output permanently.

The best scenario is defined and optimized depending on the valorization of the FR capacity and the plant output & efficiency.

<table>
<thead>
<tr>
<th>Base case (No BESS)</th>
<th>Case 1 primary reserve</th>
<th>Output power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output (MW)</td>
<td>713 MW</td>
<td>713 MW</td>
</tr>
<tr>
<td>Reserve (MW)</td>
<td>82 MW</td>
<td>106 MW (L+24MW)</td>
</tr>
</tbody>
</table>

Black-start capability

Besides the Frequency Response capacity, resulting from GE’s developments in order to reduce the energy required to black-start the unit, the PI-BESS can be designed to provide also this function, allowing thus the plant owner to generate revenues from both services with one single equipment.

Summary of benefits

As it is shown in the figure 4 below, the integration of the PI-BESS into the plant allows generating additional revenues resulting from both the improved Frequency Response capacity of the plant and its Black-Start capability.

<table>
<thead>
<tr>
<th>Standard CCOST</th>
<th>Standard CCOST + Block-Start</th>
<th>Standard CCOST + PI-BESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rating (MW)</td>
<td>820</td>
<td>820</td>
</tr>
<tr>
<td>Operating strategy</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Output for 10% FR (MW)</td>
<td>713</td>
<td>713</td>
</tr>
<tr>
<td>FR: GT (MW)</td>
<td>82</td>
<td>82</td>
</tr>
<tr>
<td>FR: CCOST (MW)</td>
<td>82</td>
<td>82</td>
</tr>
<tr>
<td>FR: plant off-line (MW)</td>
<td>0</td>
<td>24 (+24)</td>
</tr>
<tr>
<td>Revenues</td>
<td>Base</td>
<td>Base</td>
</tr>
</tbody>
</table>

PI-BESS integration into the plant

The figure 5 below shows typical electrical, mechanical and control arrangements for a 24MW block integrated into a 9HA.02SS unit.

![Figure 5: PI-BESS integration into the plant](image)

The PI-BESS system is made up of high power density modular blocks to allow a very reduced footprint. The equipment is delivered in standardized ‘plug&play’ containers. An electrical building can be offered as an option.

The direct integration of the PI-BESS controllers into the plant control network allows fast and real time communication with the major controllers (GT/ST & DCS) and the grid. With the GE Predix platform and the plant load management system, it allows an optimal control of the plant assets, resulting in a unique productivity improvement.

Conclusion

PI-BESS is a new product offered by GE in order to help clients optimize the operation of their plants and to increase their revenues captured from the ancillary services markets.

Thanks to its modular and compact design, PI-BESS can easily be adapted to specific customer needs.

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