IE5- Analysis and Determination of Cost-Effective Battery Module Packaging

Joshua Erwin, Madison Boyle, Stephen Crawford, Esther Mnuey

Background
Aggreko is currently releasing the next generation energy storage system and is looking into the process of installing these systems on a global scale. The company will be changing their strategy by navigating from asset sales to a rental model for the energy storage systems. Upon the end of the rental period, battery modules will have to be removed from the system, repackaged and transported to a different project site. An effective solution is projected to impact the company for the next 3-5 years.

UN regulations
UN codes 38.3 includes several tests such as vibration, external short circuit and impact test which are required prior to transporting lithium ion batteries.

Current Packaging
Using Microsoft Excel the storage area and cost required per Y Cube container is as follows:
- YCube 2.0 Var 0 requires approximately 141 square feet with storage cost of $1,128 per container.
- YCube 2.0 Var 1 requires approximately 215 square feet with storage cost of $1,720 per container.

According to our research, it costs around $3,400 to buy a used 30 ft. storage container and around $163 per month to rent one.

Packaging Proposals
Our team developed four proposals for packaging alternatives as Aggreko navigates away from asset sales and into a rental model. (Shown Below).

Analysis of Packaging
The images below display the maximum quantities of battery modules and pallets per 30-foot shipping container of the different packaging proposals. We have assumed a 10% variance space within the shipping containers for realistic spacing between pallets (shown in the table below).

<table>
<thead>
<tr>
<th>Plastic Bulk Container</th>
<th>NEFAB</th>
<th>Samsung Cardboard</th>
<th>LG Cardboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Pallets per Shipping Container:</td>
<td>66</td>
<td>72</td>
<td>27</td>
</tr>
<tr>
<td>Max Pallets After 10% Failure:</td>
<td>60</td>
<td>65</td>
<td>25</td>
</tr>
<tr>
<td>Max Samsung Modules per Shipping Container</td>
<td>240</td>
<td>288</td>
<td>270</td>
</tr>
<tr>
<td>Max LG Modules per Shipping Container</td>
<td>360</td>
<td>360</td>
<td>N/A</td>
</tr>
<tr>
<td>Max Samsung Modules per Pallet</td>
<td>4</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Max LG Modules per Pallet</td>
<td>6</td>
<td>5</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Conclusion & Future Work

Summary of Results

- The graph below compares the differences in cost of Samsung packaging dependent on quantity of Y.Cube 2.0 Var 0.
- The graph below compares the differences in cost of Samsung packaging dependent on quantity of Y.Cube 2.0 Var 1.

Future Work
- Develop a contract with suppliers for a cardboard buy-back
- If plastic containers are selected:
  - Create Custom molds and test under UN 38.3 regulations