

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

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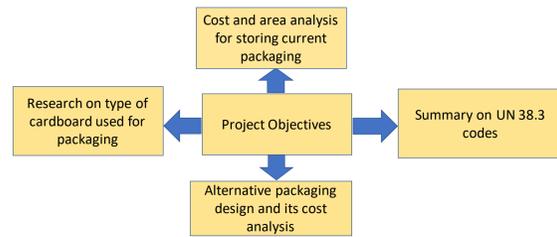


Background

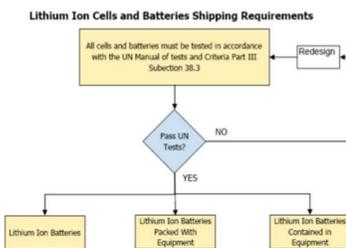
Aggreko is currently releasing the next generation energy storage system and is looking into the process of installing these systems on a global scale. The company will be changing their strategy by navigating from asset sales to a rental model for the energy storage systems. Upon the end of the rental 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.



Figure 1-2 - Y.Cube Energy Storage Solution



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;

- Y.Cube 2.0 Var 0 - requires approximately 141 square feet with storage cost of \$1,128 per container.
- Y.Cube 2.0 Var 1 - requires approximately 215 square feet with storage cost of \$1,720 per container.



Battery module cardboard waste at project site

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).



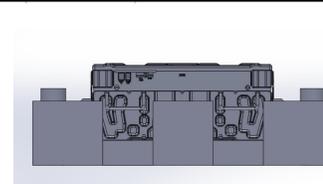
	Cardboard		NEFAB		Plastic Bulk Container		
	LG	Samsung	LG	Samsung	Design A Samsung / LG	Design B LG	Design B Samsung
Pallet	37" x 29" x 5.25"		Included		Included		
Packaging	37" x 29" x 33"	18.5" x 28.5" x 9.5"	29" x 29" x 34"		TBD		
Modules/Pallet	5	10	5	4	TBD		
Material	Corrugated Cardboard		Plywood		100% Polyethylene		
Life expectancy	1.5 years		5-10 years		15-20 years		



Samsung Cardboard



NEFAB



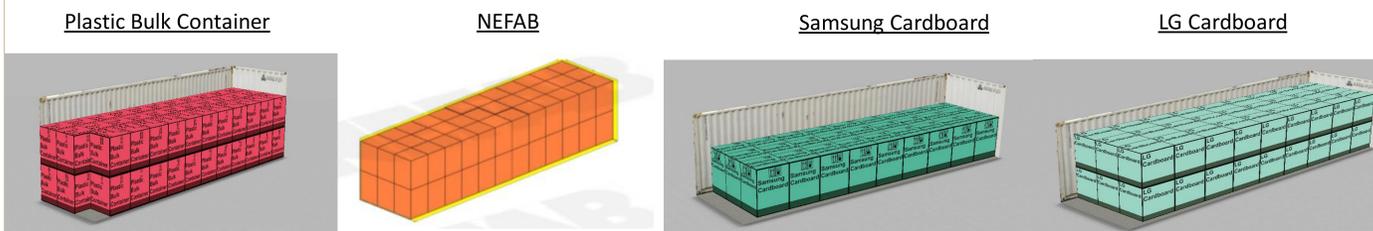
Design A



Design B

Analysis of Packaging

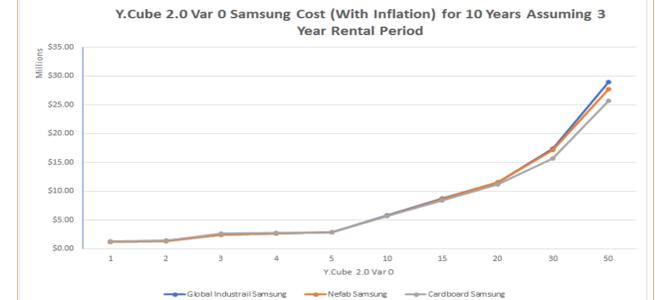
The images below display the maximum quantities of battery modules and pallets per 30-foot shipping container of the different packaging proposals. We have assumed a 10% variance space within the shipping containers for realistic spacing between pallets (shown in the table below).



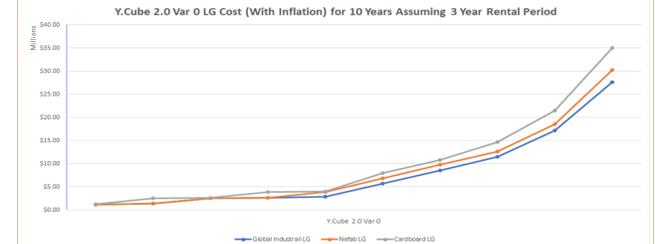
	Plastic Bulk Container	NEFAB	Samsung Cardboard	LG Cardboard
Max Pallets per Shipping Container:	66	72	27	54
Max Pallets After 10% Failure:	60	65	25	49
Max Samsung Modules per Shipping Container	240	288	270	N/A
Max LG Modules per Shipping Container	360	360	N/A	360
Max Samsung Modules per Pallet	4	4	10	N/A
Max LG Modules per Pallet	6	5	N/A	5

Summary of Results

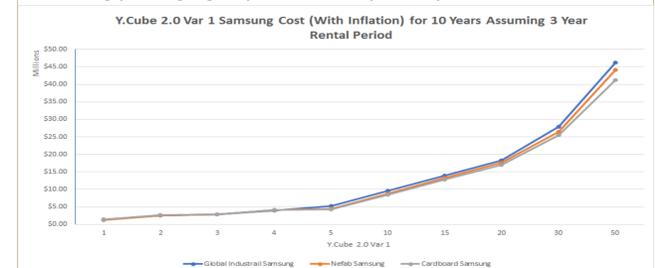
The graph below compares the differences in cost of Samsung packaging dependent on quantity of Y.Cube 2.0 Var 0.



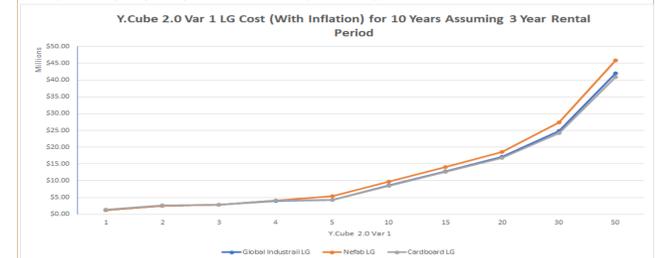
The graph below compares the differences in cost of LG packaging dependent on quantity of Y.Cube 2.0 Var 0.



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



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



Conclusion & Future Work

Conclusion

- Cheapest packaging:
 - Y.Cube 2.0 Var 0 LG are the Plastic Bulk Containers
 - Y.Cube 2.0 Var 0 Samsung is cardboard
 - Y.Cube 2.0 Var 1 Samsung is cardboard
 - Y.Cube 2.0 Var 1 LG is cardboard
- Most sustainable packaging:
 - Plastic Bulk Container

Future Work

- If cardboard is selected:
 - 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