



Ultrasonic Battery Inspection & Metrology

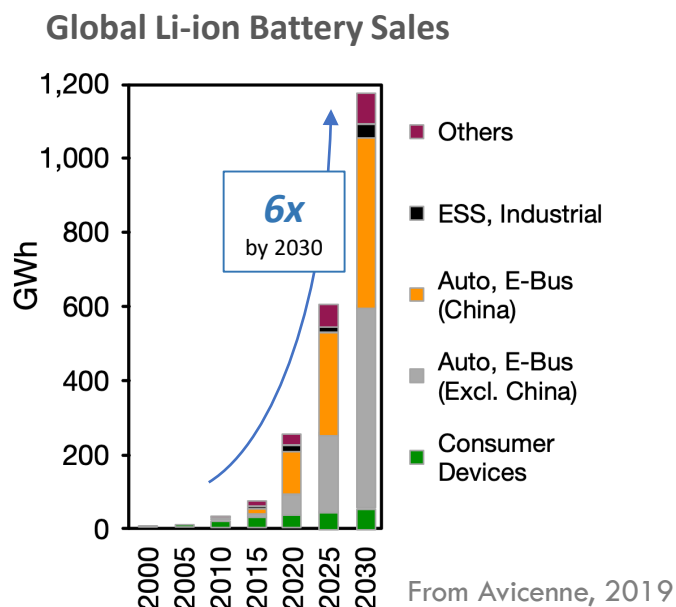
Andrew Hsieh

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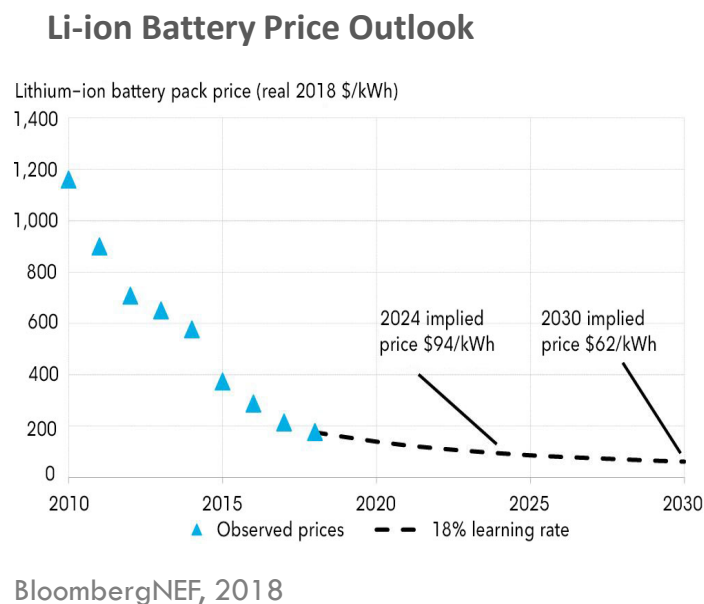
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Strong Market Trends in Batteries

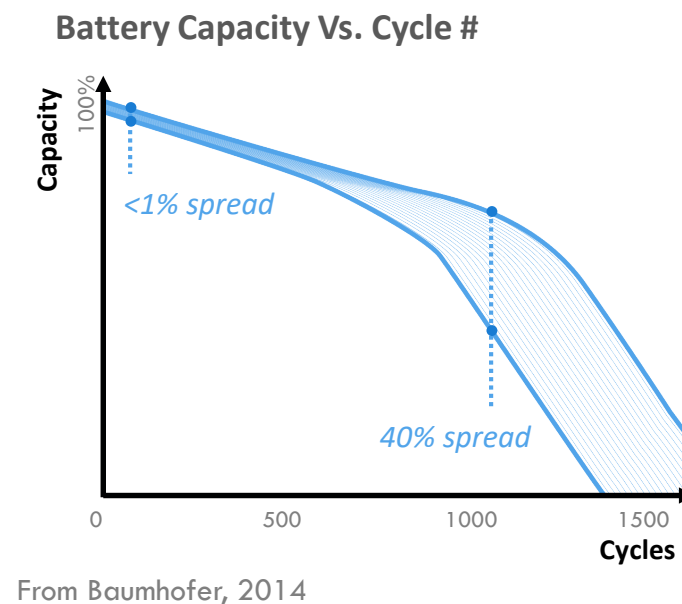
Accelerating growth in global demand for batteries



Battery production costs need to drop by >30% for affordable EVs



Larger cells + faster charging needs higher quality and reliability



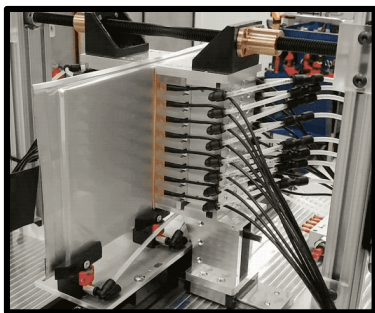
There is a strong need for better methods for battery inspection & intelligence

The EchoStat™ Platform

Ultrasound + Analytics = unique, real-time insights about batteries

Hardware

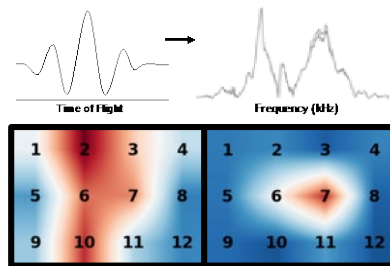
Data collection



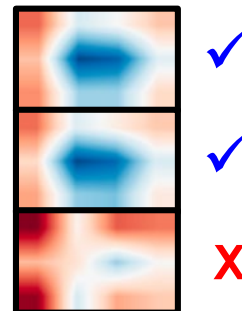
*Measure battery condition
w/ ultrasound*

Software

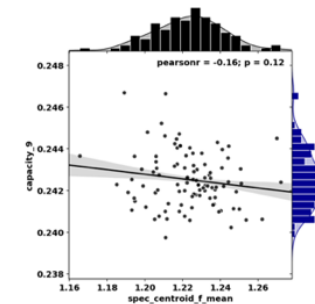
Data Analytics



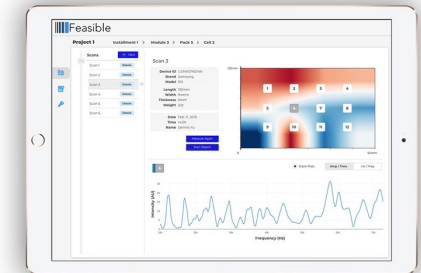
*Create feature sets and
visual maps*



*Identify anomalies in
cells & processes*



*Quantify variances in
key metrics*



*Enable intuitive,
actionable insights*

5 Patents, 8 Pending

The EchoStat™ Platform

Ultrasound + Analytics = unique, real-time insights about batteries

Pulse



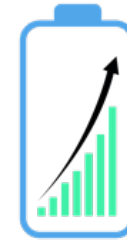
Listen



Learn



Improve



Cell Production

- Increased yield
- Enhanced detection of defects and drift
- Faster process times
- Accelerated process development times

Pack Production

- Better cell qualification and inbound QC
- Fewer field failures
- Safer, more reliable fast-charging

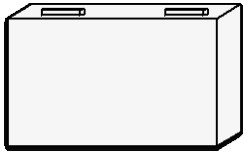
In-use Monitoring

- Enhanced, real-time measure of SOC/SOH
- Early warning of safety maintenance issues
- Ensure performance reliability and lifetime

2nd life / Reuse

- Fast, accurate eval. of re-use potential
- Better estimates of xEV resale value
- Better bankability

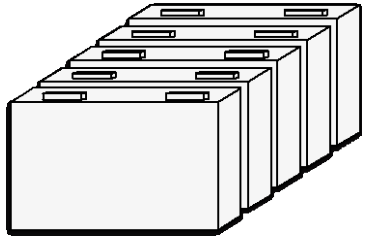
Current focus: process- and cell-level inspection



**Cell
Production**

Improve yield, detection of errors/drift

- Process inspection (e.g. electrolyte fill/soak, slurry coating)
- Cell inspection (e.g. during formation, outbound QC)

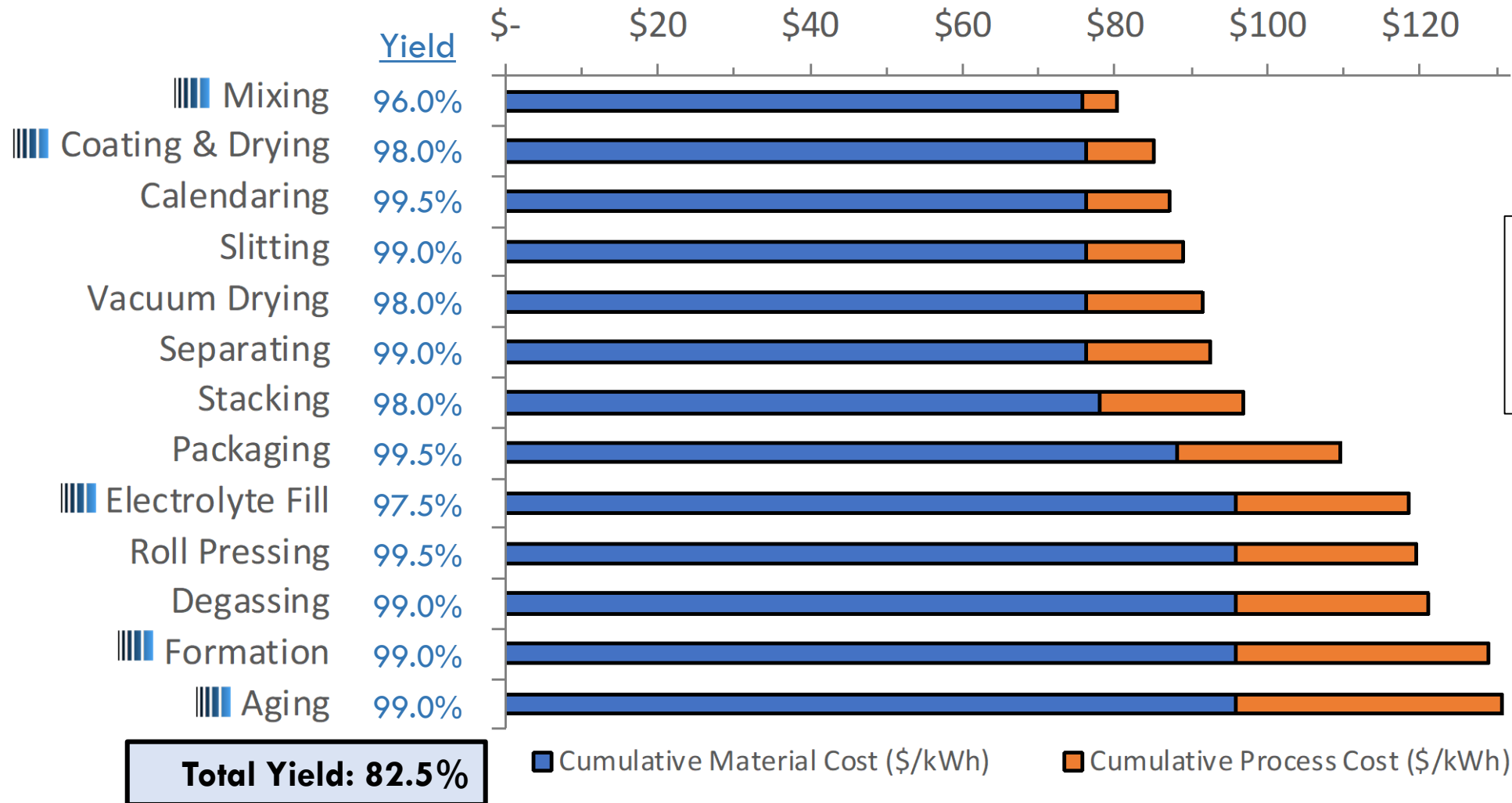


**Pack
Production**

Decrease warranty costs and improve reliability

- Cell inspection (e.g. vendor qualification, inbound QC)

EchoStat™ in Cell Production

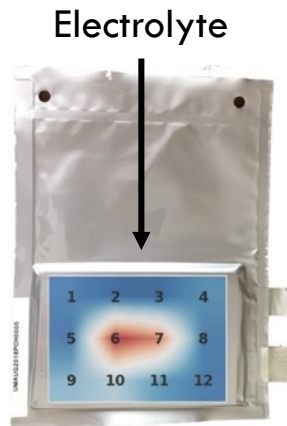


Assumptions:

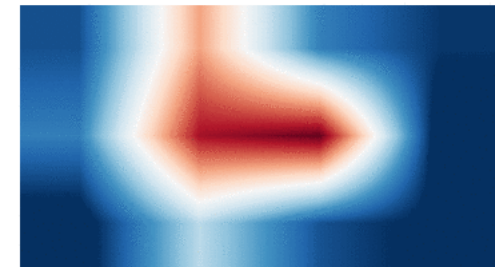
- 5 GWh facility
- NMC-622/Graph.
- Pouch cells

From Cairn ERA, Li-ion Battery Cell Manufacturing Cost Model and Analysis (2019)

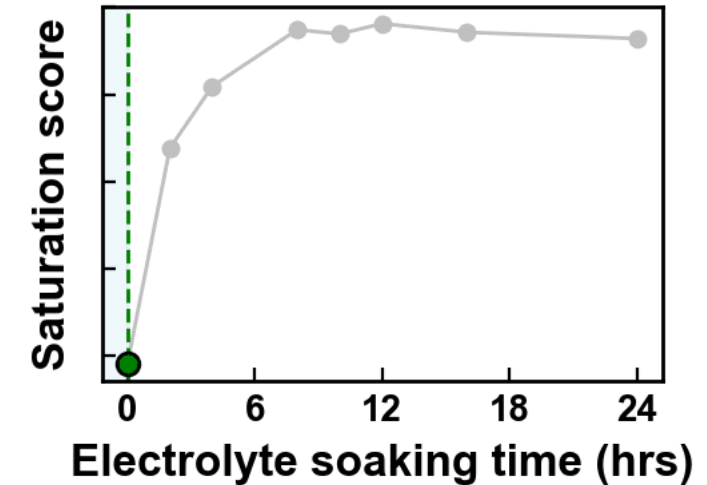
EchoStat™ during electrolyte fill/soak



Elapsed time = 0.0 hrs



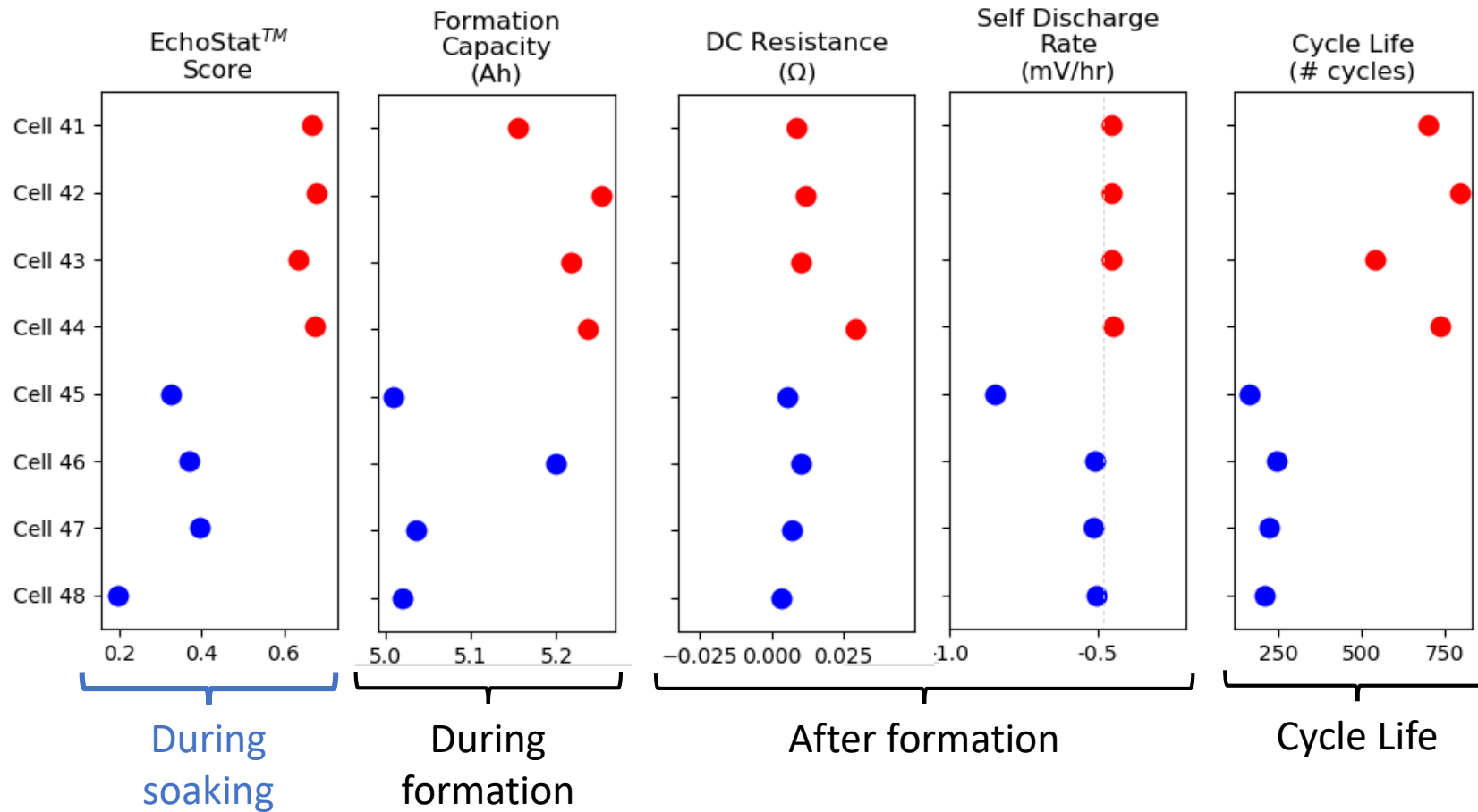
Dry Wet



- Data collected at 12 places across cell in < 4 sec

- Electrolyte injected at top of pouch cell (~6 Ah)
- Repeated measurements taken during 24-hr soak
- Color map visualizes electrolyte distribution across cell
- Aggregate “score” represents saturation quality numerically

EchoStat™ during electrolyte fill/soak



EchoStat during soaking picks up issues with cycle life earlier and more strongly than formation capacity, self-discharge rate, and DCR

EchoStat™ for end-of-line inspection

Cell 1



Cell 2



Cell 3

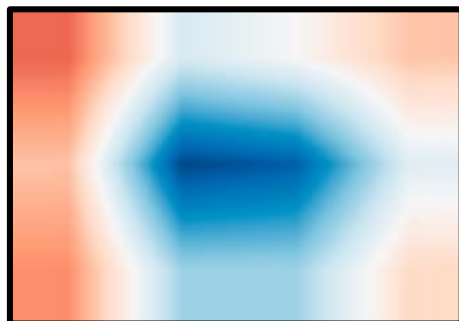


Average of 148 cells

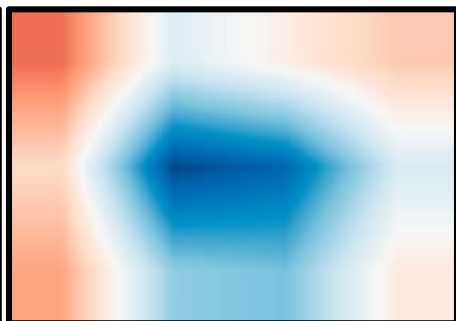
3.627 V
+/- 5 mV

OCV: all cells
pass inspection

Cell 1



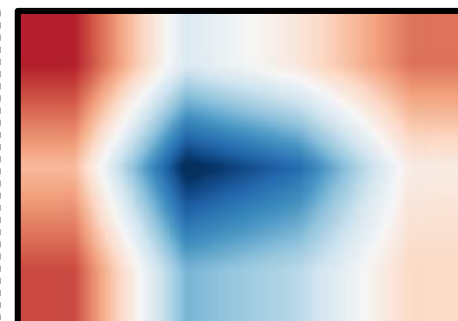
Cell 2



Cell 3



Average of 148 cells



EchoStat: Cell 3
flagged

Let's work together!

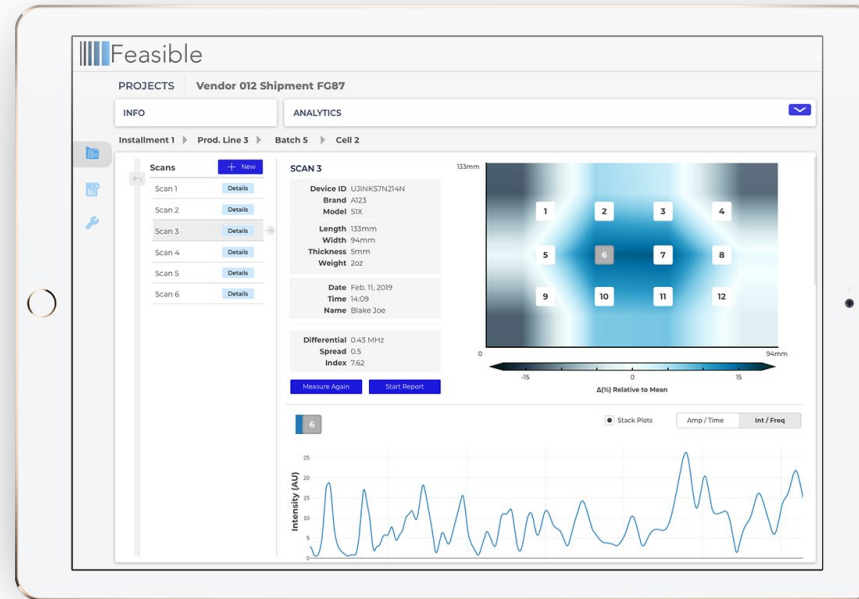
Currently in discussions with:




- 2 leading EV OEMs
- A top-5 cell manufacturer
- Several Tier 2+ cell manufacturers

Ways we could engage:

1. Off-site assessment
2. On-site PoC/evaluation
3. On-site pilot testing

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-  **Accurate**
Deep insights for unprecedented knowledge of battery condition
-  **Non-Invasive**
Valued components are not impacted by testing
-  **Rapid**
Batteries screened in seconds

PARTNERS:

