Creating Cost-Effective Sustainable Electrode Manufacturing Platform

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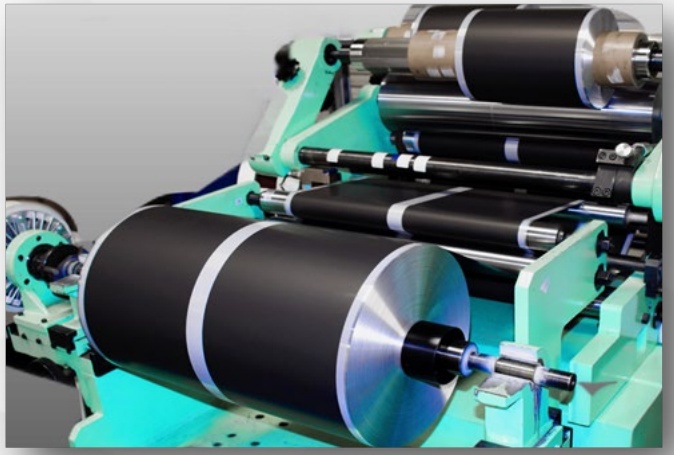
NAATBatt INTERNATIONAL

Welcome to LiCAP

LICAP Technologies, Inc.

- Sacramento, California, USA
- 3000 m^2 facility, 40+ employees
- Activated Dry Electrode™ development and production
- Lithium-Ion Capacitor development and production
- Activated Dry Electrode™ equipment design and demonstration

LiCAP Technologies Inc. in Sacramento



LICAP New Energy Technology, Ltd. In Tianjin

LICAP New Energy Technology, Ltd.

- Tianjin, China
- 33900 m^2 facility, 100+ employees.
- Ultracapacitor cell assembly
- Development of ultracapacitor modules

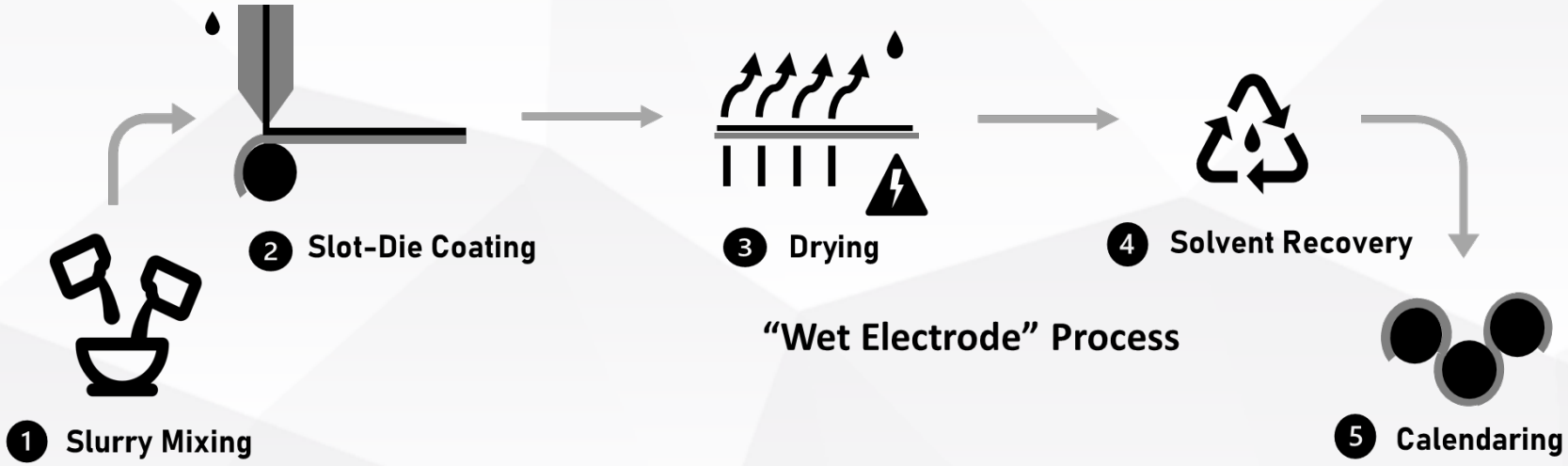
Battery Manufacturing Chain

Energy storage is an exponentially growing industrial opportunity that depends on the **cost-competitiveness and sustainability** of manufacturing processes along the battery value chain.

Raw Materials Extraction	Raw Materials Processing	Electrode Materials Synthesis	**Electrode Manufacturing**	Battery Cell/Pack Assembly

Current Technology:

- High Manufacturing Footprint
- Toxicity & Safety Issues
- High Energy Demand
- Carbon Emissions
- Waste Stream



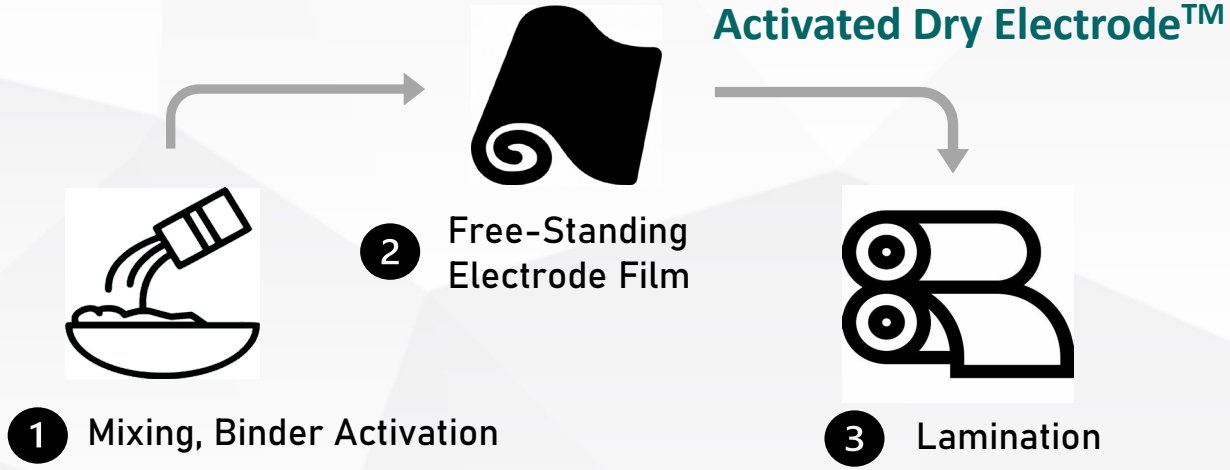
Our Solution - Activated Dry Electrode™

Energy storage is an exponentially growing industrial opportunity that depends on the **cost-competitiveness and sustainability** of manufacturing processes along the battery value chain.

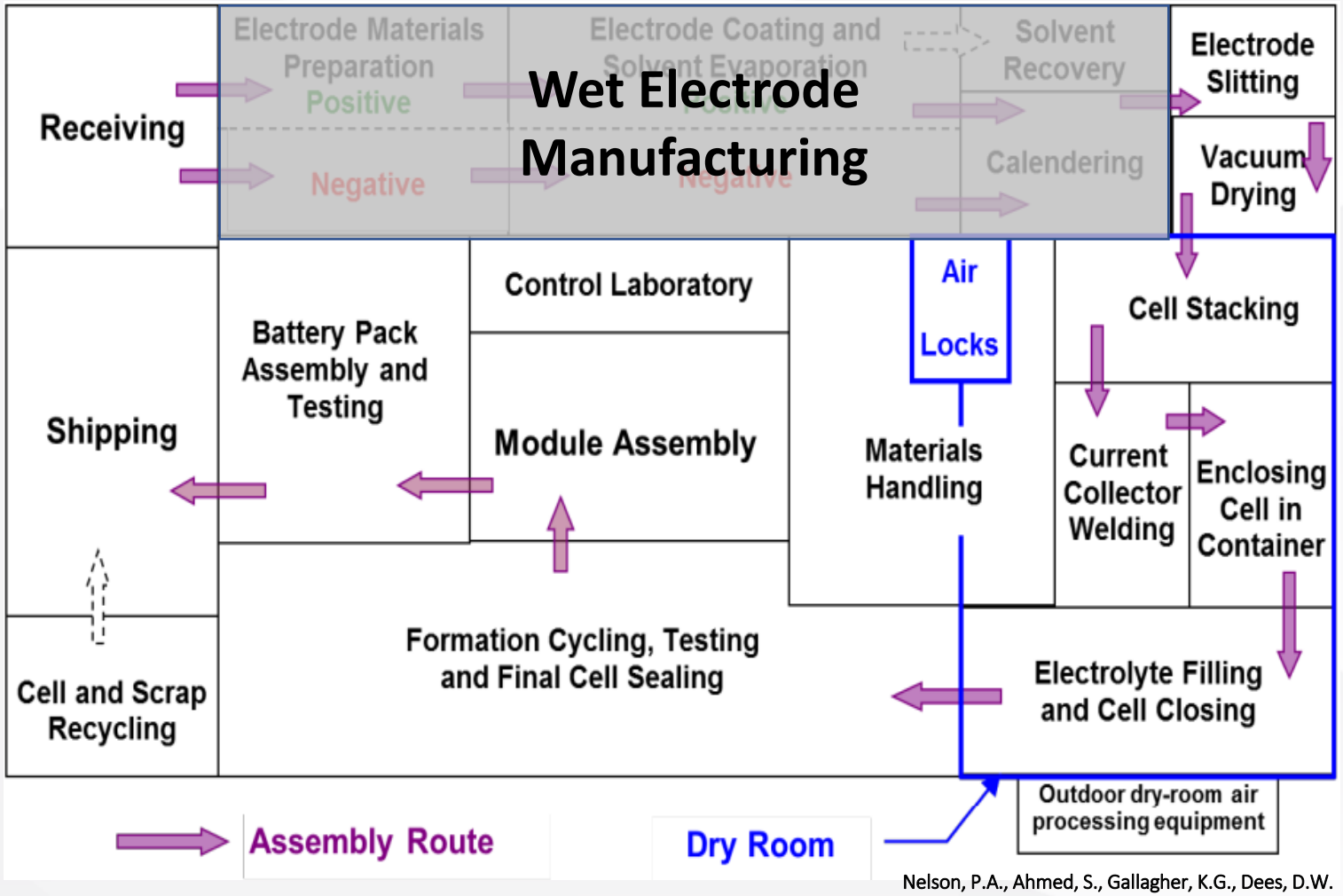
Raw Materials Extraction	Raw Materials Processing	Electrode Materials Synthesis	**Electrode Manufacturing**	Battery Cell/Pack Assembly

Activated Dry Electrode™ process skips the slurry-formation, drying, and solvent recapturing steps and offers a low-cost sustainable solution.

- **Removal of solvents, such as NMP, from manufacturing**
- **Lowering CAPEX and OPEX costs of electrode manufacturing**
- **Lowering of equipment size to 1/3 of the common industry standards for LIB electrode manufacturing**
- ***Commercialization path for new SSB materials that would otherwise be incompatible with solvents***



Wet Electrode vs. Activated Dry Electrode™



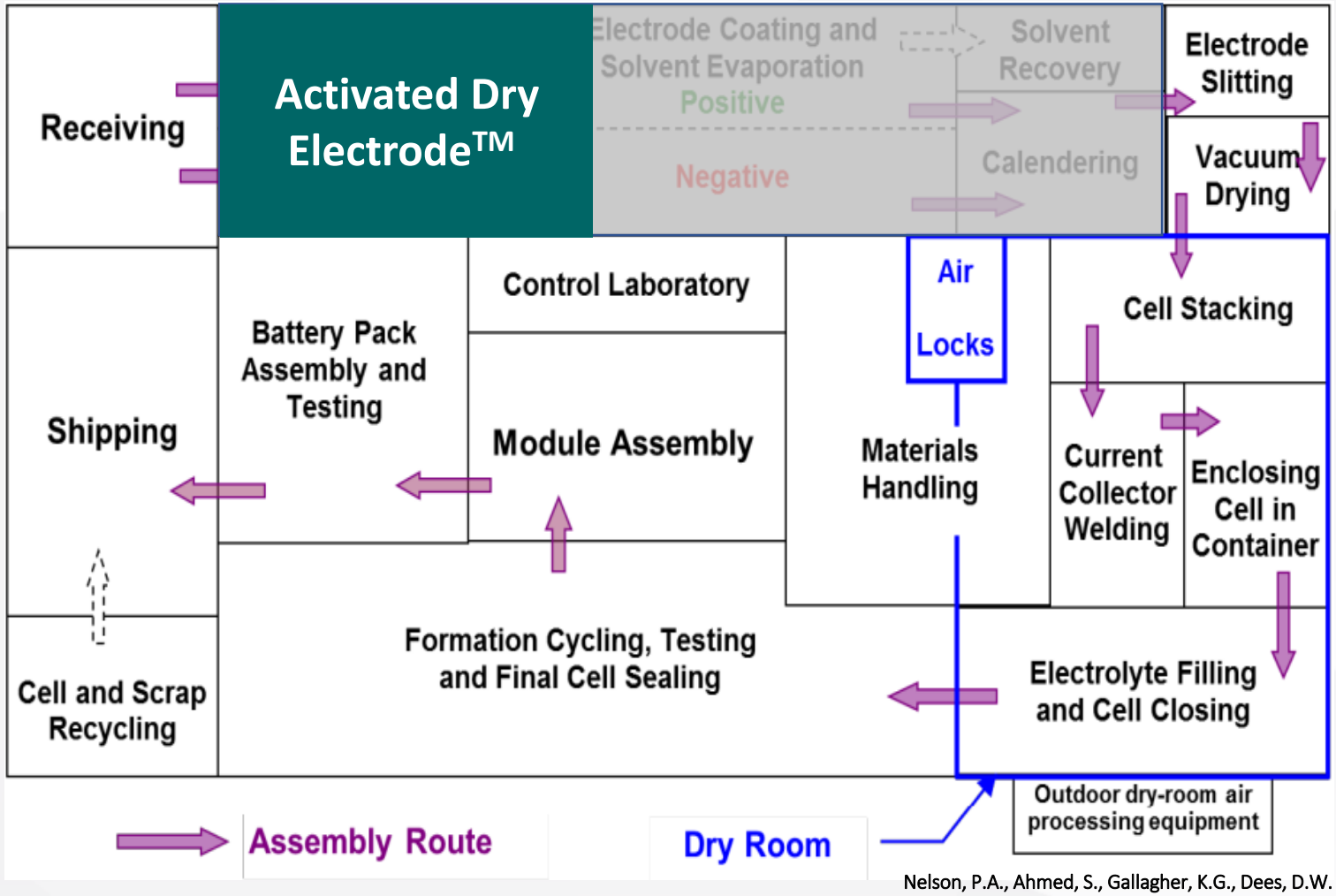
Nelson, P.A., Ahmed, S., Gallagher, K.G., Dees, D.W. "Modeling the Performance and Cost of Lithium-Ion Batteries for Electric-Drive Vehicles," Third Edition, ANL/CSE-19/2, 2019.

"Wet" process dominates battery electrode production. It's energy/ capital intensive and uses toxic and explosive NMP solvent.

Estimations for wet electrode process, 10GWh/y manufacturing capacity:

CAPEX: $110M
Manufacturing footprint: 8,800m^2
Labor Hours: 312,000
Energy consumption: 275 GWh

Wet Electrode vs. Activated Dry Electrode™



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LICAP aims to accelerate transition to electric transportation by delivering the world's most cost-effective and sustainable electrode manufacturing platform.

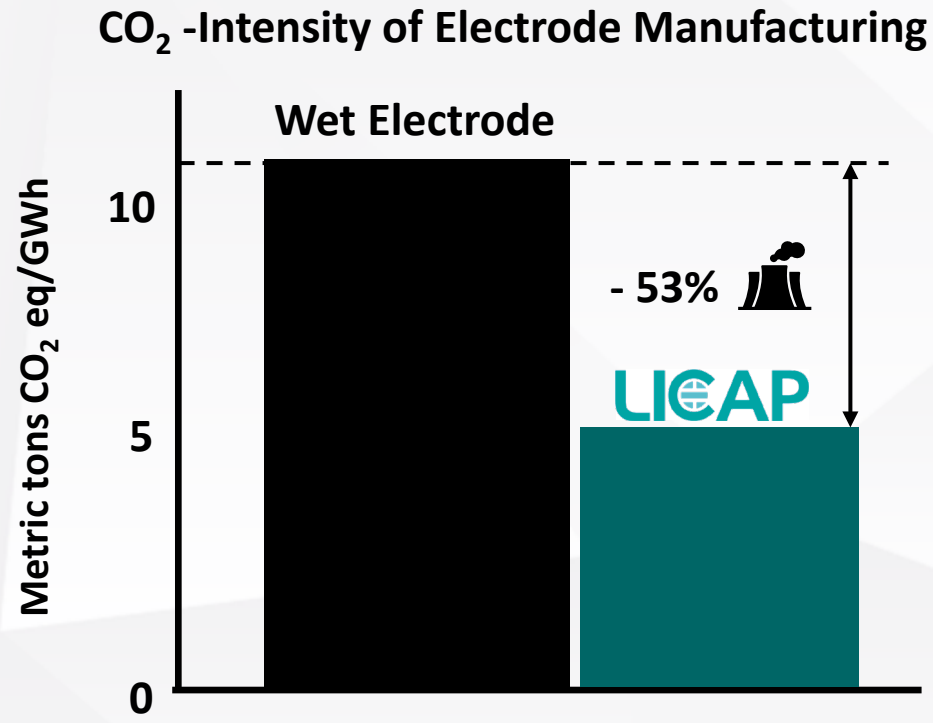
Estimations for Activated Dry Electrode™ manufacturing process, 10GWh/y capacity:

CAPEX: $52M (↓**53%**)
Manufacturing footprint: 2,4000 m^2 (↓**73%**)
Labor Hours: 288,000 (↓**8%**)
Energy consumption: 16GWh (↓**94%**)

Environmental Performance of Activated Dry Electrode™

Wet electrode manufacturing is the most energy-consuming step of EV battery production.

Estimated **57% of Gigafactory energy needs** are due to the processes involved with electrode manufacturing (slurry mixing, drying, solvent recovery, calendaring).* LiCAP reduces energy consumption in electrode manufacturing by 94%, and overall energy needs of Gigafactory by 53%



	Metric tons CO_2 eq. per 1 GWh of Battery Capacity		Avoided Emissions, metric tons CO_2 eq per 1 GWh Battery Capacity
	Gigafactory with Wet Electrode Process	Gigafactory with Activated Dry Electrode™ Process	
US Electricity Mix	20,305	9,485	9,300
EU Electricity Mix	11,005	5,141	4,345

417 g/kWh of CO2 in electricity mix, 2019

226 g/kWh of CO2 in electricity mix, 2019

Activated Dry Electrode™: Cell Performance

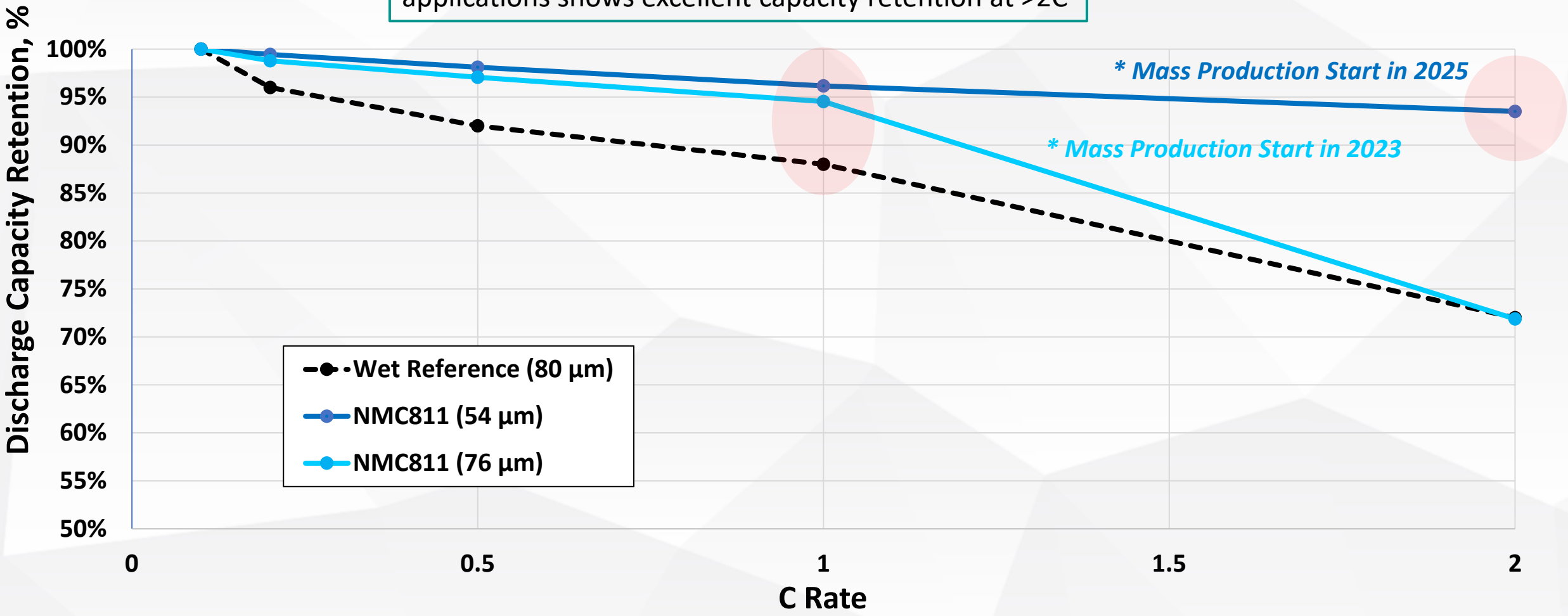
Pouch cells with Activated Dry Electrodes™: NCM811/Graphite

Cathode				Anode				Formation Cycle			1st Cycle		
Active Material	Active Layer (µm)	Loading (mg/cm^2)	Loading Capacity (mAh/cm^2)	Active Material	Active Layer (µm)	Loading (mg/cm^2)	Loading Capacity (mAh/cm^2	Charge Capacity (mAh/g)	Discharge Capacity (mAh/g)	Eff. (%)	Charge Capacity (mAh/g)	Discharge Capacity (mAh/g)	Eff. (%)
Activated Dry NCM811 (94%)	76	24.6	4.9	Activated Dry Graphite (96%)	113	16.5	5.9	226.5	198.3	87.5	198.0	197.5	99.3
Activated Dry NCM811 (94%)	54	17.9	3.6	Activated Dry Graphite (96%)	84	12.5	4.3	224.5	195.1	86.9	198.5	195.7	99.3

Testing Conditions: 0.1C, 2.7-4.2 V

C-Capability: Activated Dry Electrode™ vs. Wet Electrode

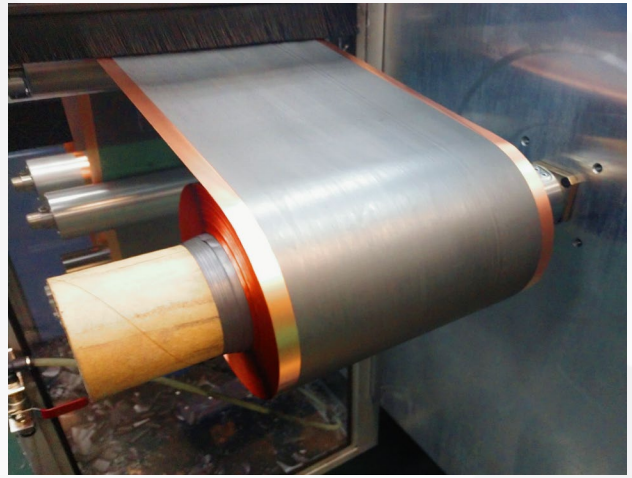
Activated Dry Electrode™ for fast charging applications shows excellent capacity retention at >2C



Activated Dry Electrode™ - Equipment Roadmap

2021: Pilot Line. In-House Design. Demonstration of Scalability

- ✓ Proof of scalability: roll-to-roll process
- ✓ Electrode length: 20-200 m
- ✓ Speed: 2-5 m/min uninterrupted
- ✓ Thickness control: in later stage
- ✓ Thickness uniformity control: in later stage



200 m Roll of Graphite Anode

2023: Demo Line I. In-house Design. Demonstration of 1C -2C Capability

- ✓ Cathode thickness: 70-150 µm
- ✓ C-Rate Capability: 1C -2C applications
- ✓ Thickness variation: controlled
- ✓ Speed: 20-60 m/min
- ✓ Tests started in December 2021

2025: Demo-Line II. In-house Design. Demonstration of 2C+ Capability (4C Pulse)

- ✓ Cathode thickness 55 -65 µm
- ✓ C-Rate capability > 2C
- ✓ Thickness variation: controlled
- ✓ Speed: 60 m/min

Activated Dry Electrode™ – Materials Roadmap

Active Material	Electrode Properties			Status
	Active Material Content (%)	Active Mass Loading (mg/cm^2)	Capacity Loading (mAh/cm^2)	
LMO	94-96	43.2 - 53.0	4.5 - 5.6	Ready for scale up
NMC811/NCM622	94-96	17.3 - 58.3	3.7 – 12.4	Ready for scale up
Graphite	94-96	12.4 - 32.6	4.2 - 11.1	Ready for scale up
NCA	92-95	21.7 - 75.8	4.6 – 16.1	Ready for scale up
LFP	90-94	14.1 - 52.2	2.1 – 7.8	Testing in pilot line
LNMO	94-96	42.7 - 50.8	5.9 - 7.0	Improving
NMC/LGPS	85	35	Starting in 02/2022	