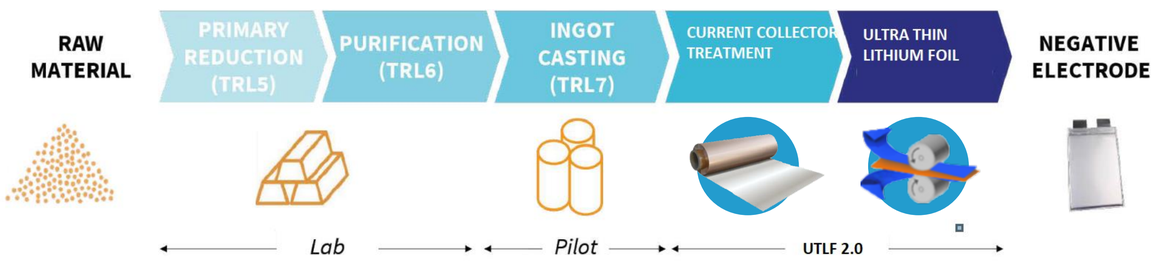
TRINITY

ULTRA THIN LITHIUM FOIL PROGRAM AT HYDRO-QUÉBEC

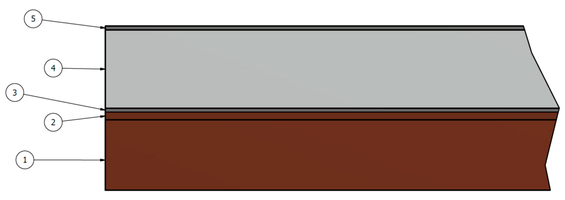
HQ has been using exclusively Li metal as anode material for all of its solid state battery technologies. The UTLF 1.0 anode which is a free standing lithium foil with a thickness of 25-50 µm, has already been tested with different generations of the SSB batteries. UTLF 1.0 is produced at a very high speed (30 m/min) with a low tolerance (±1 µm) in thickness variation and the manufacturing process has already been scaled up to industrial level. In recent years, in order to reduce the lithium anode cost and improve its performance, HQ has focused on the development of a new generation of Li anode (UTLF 2.0) with a thickness of 2-5 µm of Li metal on each side of a current collector. The total thickness of the anode foil can be as low as 12 µ which results in an improvement in volumetric energy density and a reduction in material cost. The development of the UTLF 2.0 R-2-R manufacturing process is currently at lab scale (TRL5) and will be scaled up to continuous pilot scale (TRL8) by the end of 2026.

TRINITY PROJECT

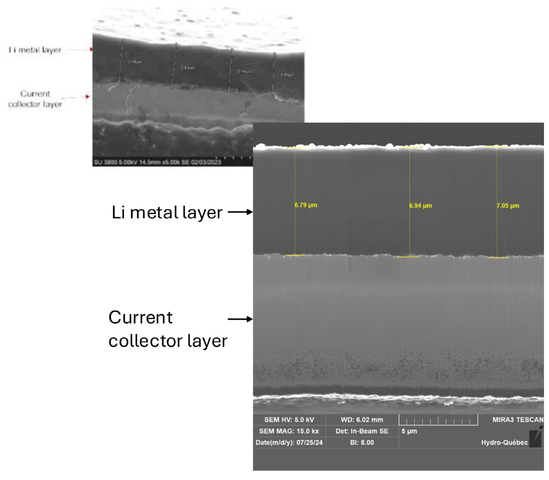
LITHIUM PRODUCTION, PURIFICATION AND ULTRA THIN LITHIUM FOIL (UTLF2.0)



MULTILAYERED CURRENT COLLECTOR



Single-sided multi-layered anode
(Patent HQ844)



PRIMARY REDUCTION

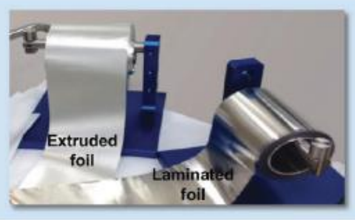
MOLTEN SALT ELECTROLYSIS

Lithium precursor

METALLOREDUCTION

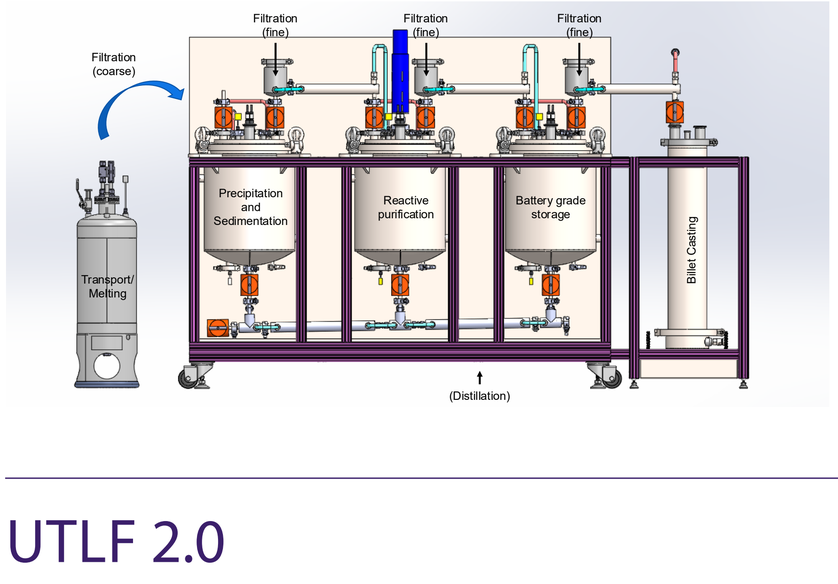
Test rig bench marking with Mg stablished

UTLF PRODUCT SPECIFICATIONS

	UTLF 1.0	UTLF 2.0
Specifications	❑ Free-standing lithium foil without substrate ❑ 25-50 µm thickness ❑ 145 mm width	❑ Thin lithium metal layer deposited on current collector ❑ Thickness of lithium can be lowered to 2 µm ❑ Free to increase the foil width > 200 mm
Visual		
End-markets	❑ Next generation lithium batteries	❑ Next generation lithium batteries
Availability	❑ In-house production capability at industrial speed ❑ No limit on sample quantity	❑ The first R2R machine is under development (lab scale) ❑ External samples are expected to be available from the end of 2023
Electrolyte compatibility	❑ Designed and validated for HQ's Gen1 solid-state battery ❑ Most compatible with polymer-based solid electrolyte	❑ Open for providing customized formulations and surface treatments according to the electrolyte chemistry

LITHIUM METAL PURIFICATION

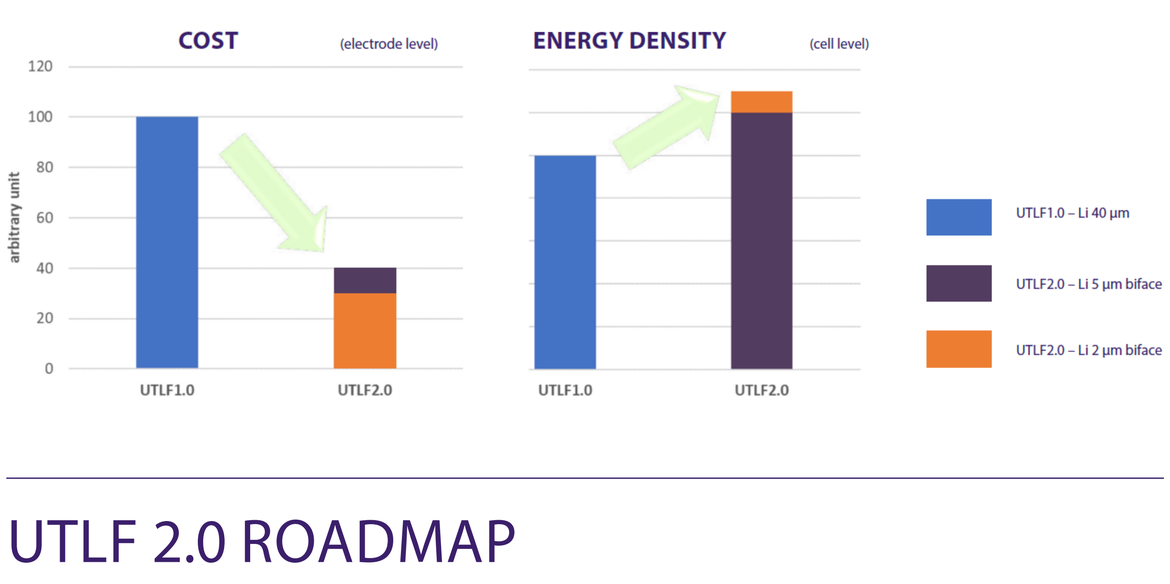
Lab scale advanced prototype (TRL5) in fabrication



Li metal

UTLF 2.0

ENERGY DENSITY AND COST ADVANTAGES



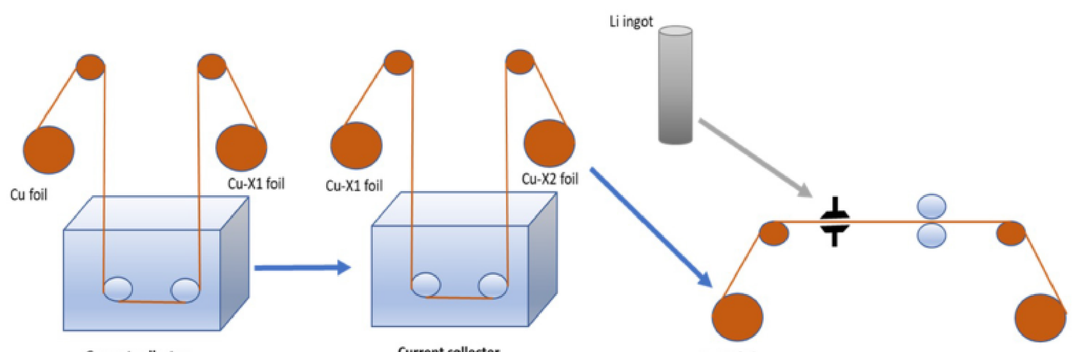
UTLF 2.0

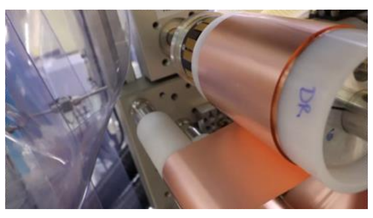
PATENTED ROLL-TO-ROLL MANUFACTURING PROCESS

Hydro-Quebec is actively working on a breakthrough technology to produce ultra thin lithium metal foil utilizing a highly scalable R2R process.

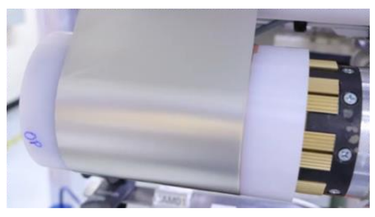
Thickness of lithium can be lowered to 2 um, allowing for higher energy density of battery with lower material cost.

Lithium deposition is processed directly from lithium ingot using an affordable high-speed technique.

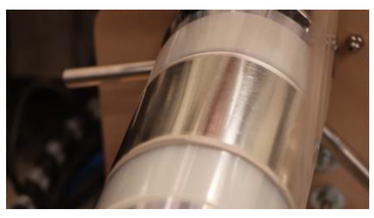




Cu foil



Cu foil + treatments



ULTF 2.0 foil

UTLF 2.0 ROADMAP

Lab scale prototype – partial (TRL5): Q4 2023
Continuous production in a roll-to-roll process (10-30 meters)

Qualification line (TRL8): Q4 2026
Continuous production in a roll-to-roll process: >100 meters long roll

Next step
Supply UTLF 2.0 at large scale to demonstrate a fully automated qualification line with EcoPro Innovation

CONCLUSIONS

PRINCIPAL ADVANTAGES OF UTLF 2.0 COMPARED TO FREE STANDING LI FOIL

Thin Li layer
Lower cost and higher volumetric energy density

Scalable R-2-R manufacturing process
High speed and easy to scale up

Size adaptability
The width of the foil can be adapted to a wide range from 50 mm to more than 500 mm according to the battery design

Thickness adaptability
The thickness of the Li layer can be adapted to a very thin layer (2-5 µm for solid state electrolytes) to a much higher thickness (15 µm for liquid electrolyte applications) without affecting the productivity

Electrolyte chemistry adaptability
The surface treatment and the thickness of the Li layer can be adapted according to the electrolyte nature and composition

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EcoPro

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