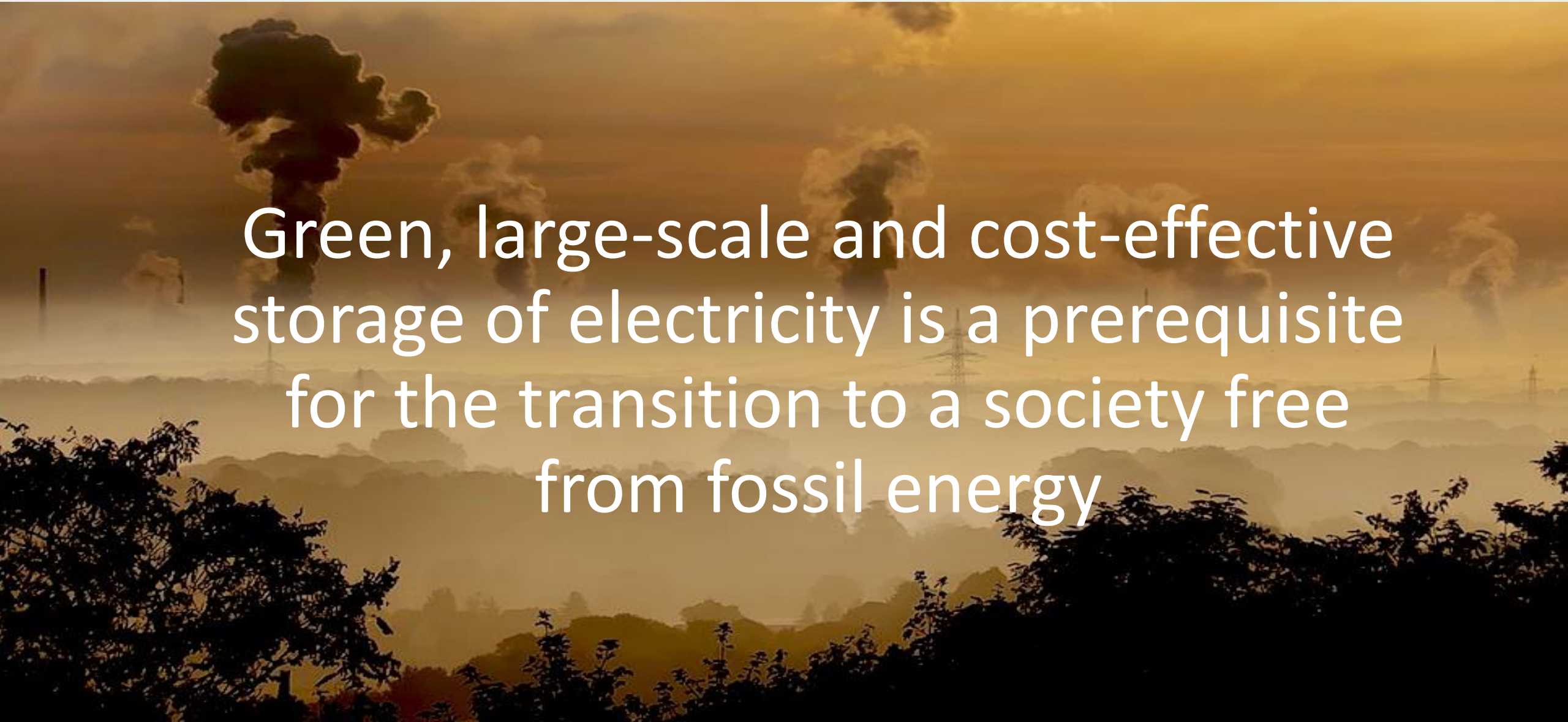
COST EFFICIENT

ENVIRONMENTALLY FRIENDLY

VASTLY SCALABLE

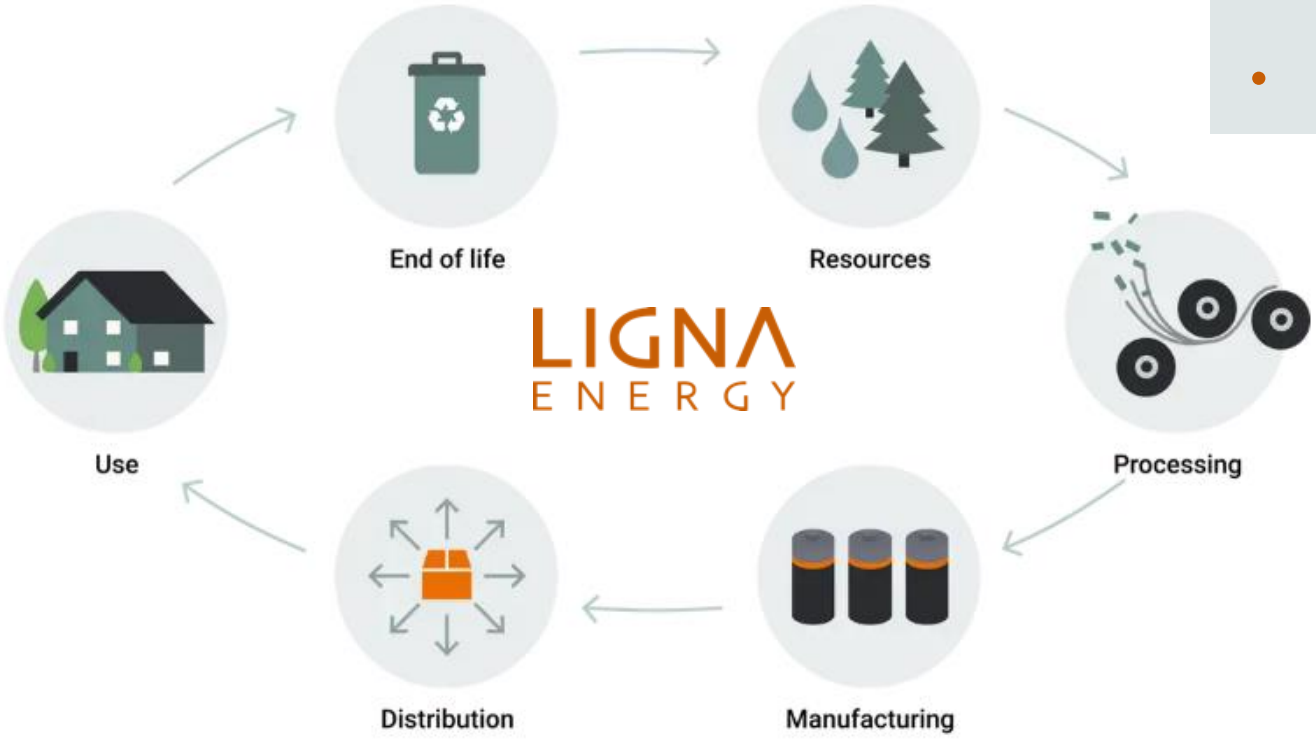
Enabling the transition to fossil free energy

Society Challenge



WHAT IF
– we could use forest waste-products for energy storage?

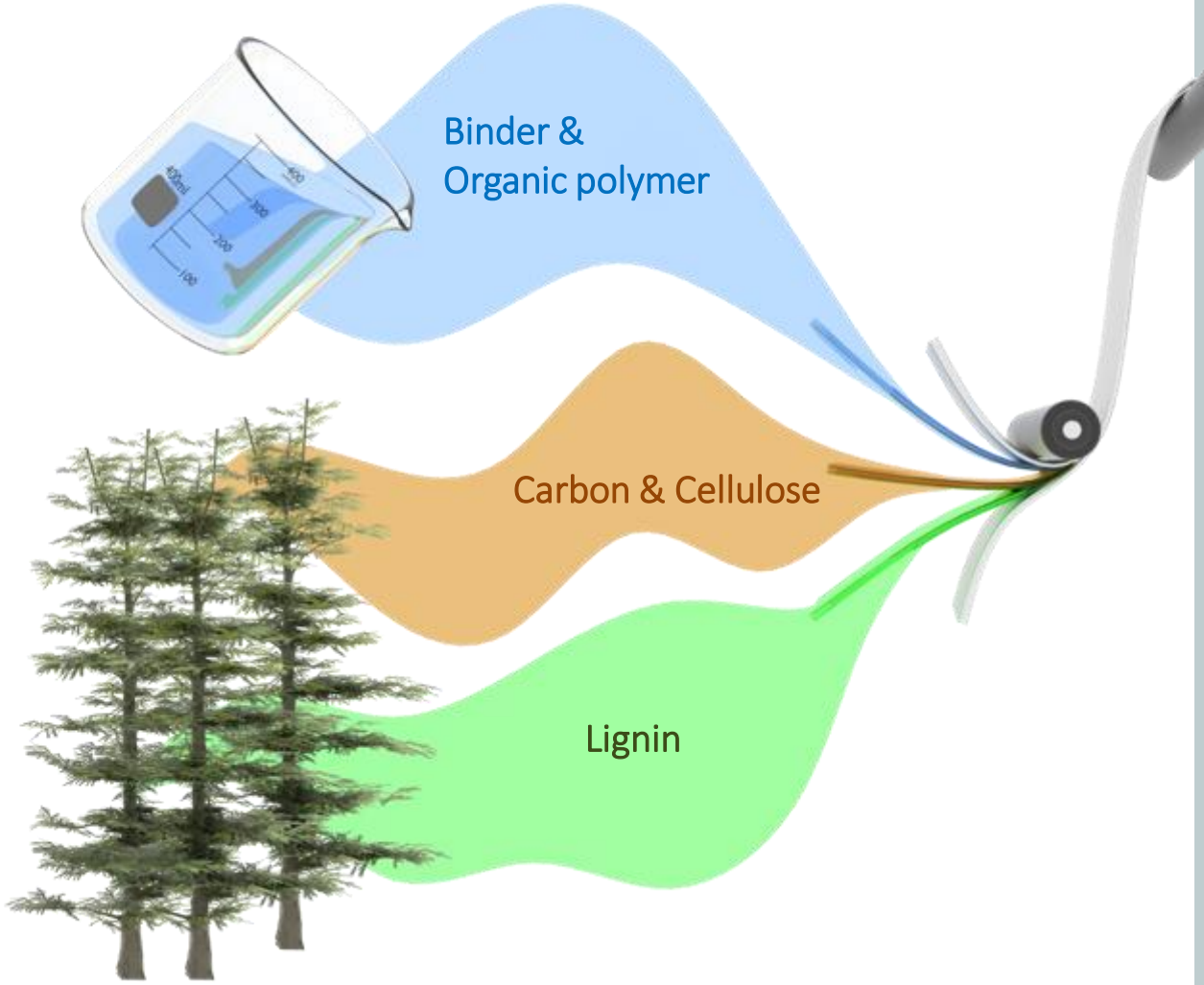
LIGNA ENERGY



- Make batteries from forest materials
- Use them for 10 years +
  Enable use of Solar and Wind power
- Recycle and burn at end of life

THE **CUSTOMER** VALUE:
COST MINIMISED Energy Storage ($/kWh/cycle)
OUTSTANDING ENVIRONMENTAL Footprint!

A sustainable battery energy storage solution – Forest based and Organic



- Forest based & Organic electrode materials
- Water based electrolyte & metal collectors
- Proven manufacturing technologies, Simplified
- IPR protected by Ligna Energy

Ligna have verified the technology

BATTERY CELLS MANUFACTURED AND TESTED:

- Energy Density: >20Wh/kg (at >1C)
- Power Density: >3000W/kg
- Cycling Stability: >2500 cycles

Evaluated successfully in a demonstrator for IoT application in collaboration with Epishine indoor solar cells.

Both electrodes printed industrially 2019-2020. In-house Cylindrical cells manufactured 2020.

"I believe this is a very promising sustainability technology"

Marcus Wigren
CEO, Nilar AB

Commercial Battery Sales and Manufacturing

Scalability & Market Opportunity

Storage Growth of 30 GWh per year for >10 years

- Energy increase
- Renewables
- Smaller grids
- Grid & Residential applications

Market growth

10 % BESS Market share targeted

- Environmental
- Abundant
- Cost efficient
- Safe

Market share

Large but feasible volumes

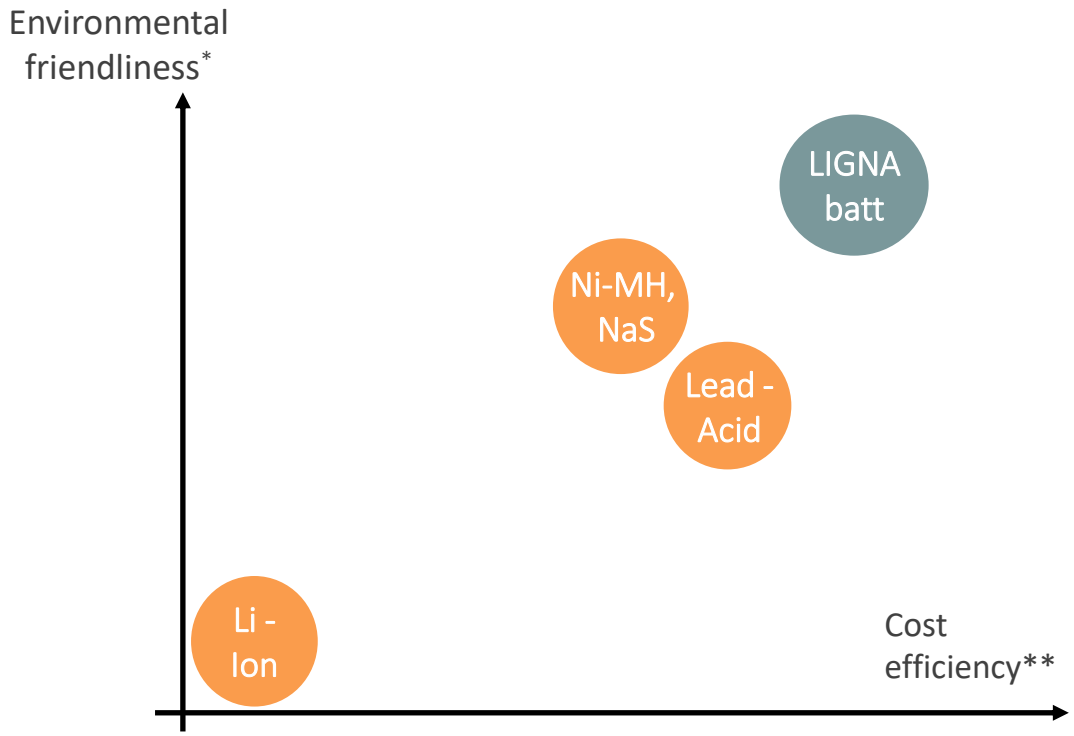
- 150 000 tonnes of electrodes/year
- “1 paper machine”
- 12 000 containers
- Manufacturing tech re-use

Volumes

BESS = Battery Energy Storage System

Battery Technology Competition

Environment versus Cost
- for 5000 cycles



* Life cycle impact, Ecological footprint

** $/kWh at 5000 cycles, DoD % varies per cell technology

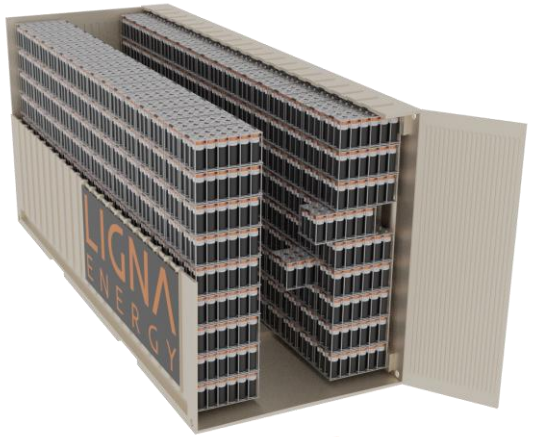
LIGNA ENERGY TECHNOLOGY ADVANTAGES

- Abundant supply of raw materials
- Environmentally friendly materials and production
- Safer and cheaper than lithium-ion and lead-acid batteries
- High power capabilities

LIGNA ENERGY Solution
Tested and Demonstrated in well performing battery cells

Stationary Energy Storage applications
- with storage turnover within 7 days

LIGNA ENERGY



Ligna Energy Storage Applications
- for Demonstration and Commercialistion

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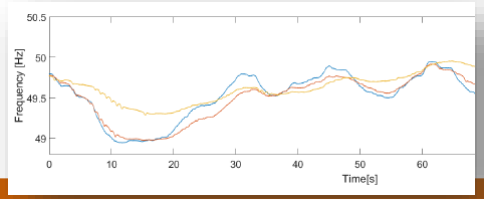
	Residential Solar systems	EV fast charge station	Grid Frequency control
DESCRIPTION:	 ”Balancing local supply / demand”	 ”Enabling fast charging with limited grid power”	 ”Reducing frequency variation in the fossil free grid”
BENEFIT $:	• Power tariff reduction • Managing grid cut off • Enabler to Off-grid operation	• Power tariff reduction • Enabler to deliver at all	• Supply quality promise • Penalties prevention
APPLICATION PARTNER (LOI):	PPAM SOLKRAFT	CTEK	VATTENFALL
ADDITIONAL PARTNER:	SANKTKORS	SANKTKORS	Tekniska verken

Development & Commercialisation plan - technology proven by Ligna

LIGNA ENERGY

Basic Technology

- Gen 1-2 Tech/IPR
- Testing capability
- Device capability
- Collaboration network

2019

Prototypes produced

- Battery cell/pack capability
- Company visibility
- Production projecting
- Equity 1M€

2021

First series production

- Production tuning
- Product certification
- Pack verification
- Sales

Production Upscaling

- 2018

Foundation stabilzation

- Gen3 Tech/IPR
- Prototype design
- Production partners
- Company visibility
- Equity 0.5M€

2020

Product Demo/Marketing

- 10kg demonstrators
- Series design set
- 100+kg supply batch
- Pilot Production
- Sales promotion
- Equity 5M€

2022

Main components in 2020/21

- Product validation by industrial production of 10kg demonstrators

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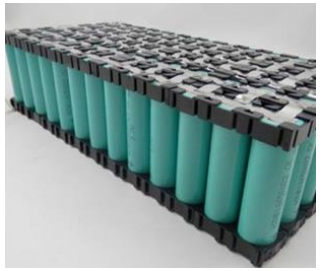
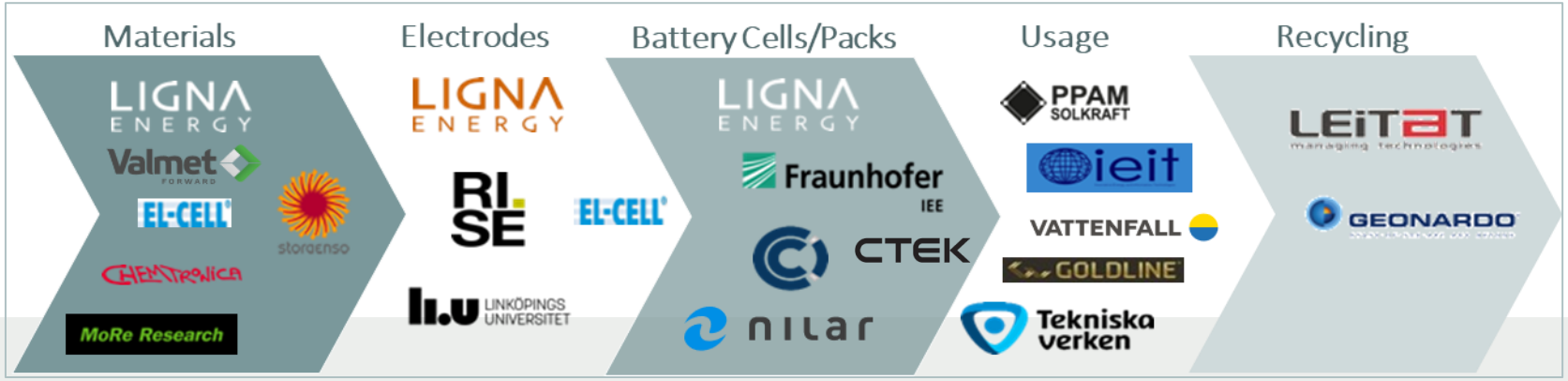
Production of Electrodes	Production of Cylindrical cells	Cell and Pack design, testing and validation	Validation of battery pack
Real coating line at CustomCells / Ynvisible	External/Internal production facilities	In-house testing facilities	in Customer applications

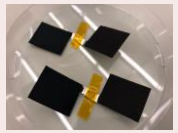
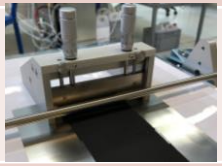
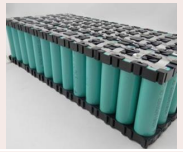


PPAM SOLKRAFT

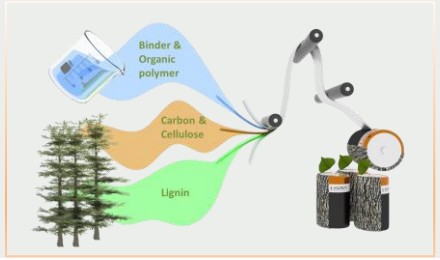
VATTENFALL



Ligna Design Scaling Roadmap – short time to market

	Research	Lab prototype	Prototype	Product	Mature/Volume
Electrode/Comp	Lab scale	PEA lab coating	External industrial	Internal industrial	Large factory
					
Cell design	Beaker	Coin, Pouch	Cylindrical 18650	Cylindrical Large	Automated
		 			
Pack design			18650 Pack	Designed cyl pack	Enhanced cyl pack
					
System design				BMS/Rack	Container
					
	2018	2019	2020	2022	2024-25

Proven Manufacturing concept



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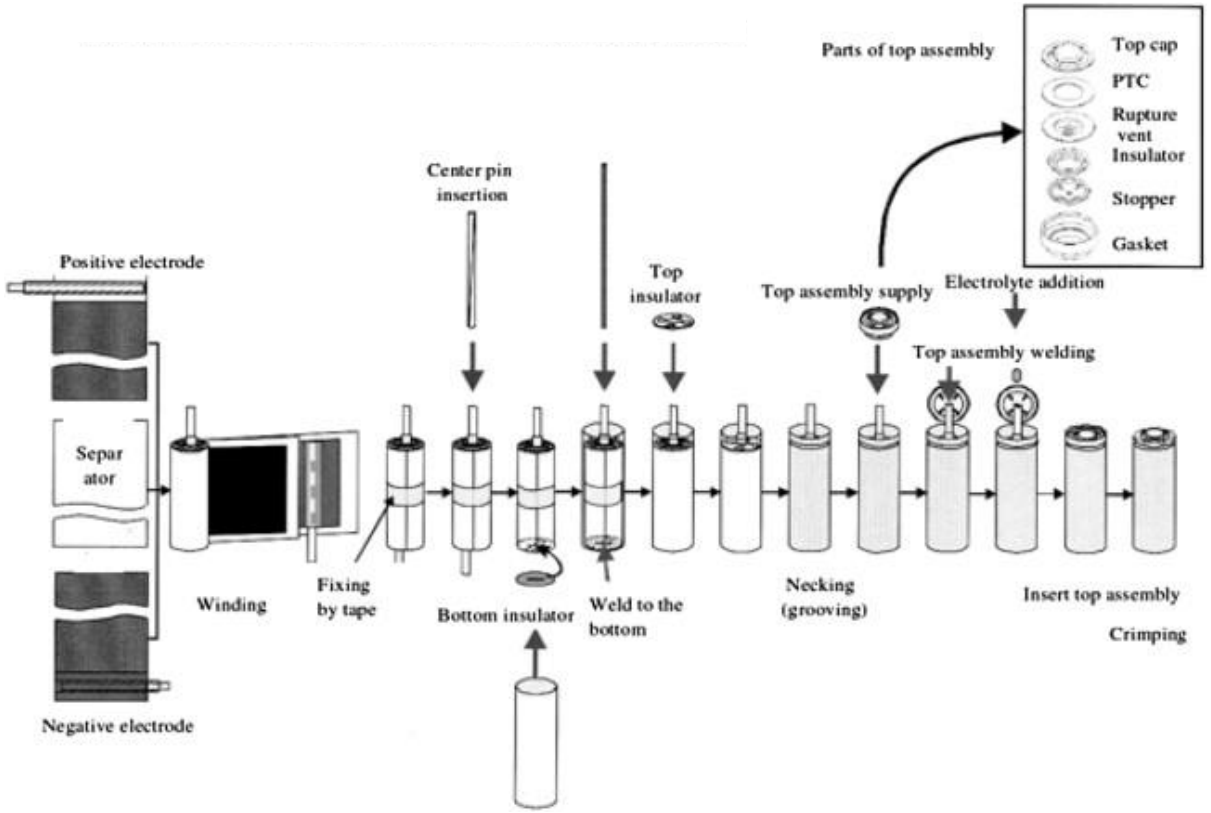
COATING OF ELECTRODE MATERIAL

Coated Manufacturing at Customcell/Consensum

ASSEMBLY OF CYLINDRICAL CELLS

Cell assembly at Supplier, In house filling and sealing



A strong Team and Competence foundation

LIGNA ENERGY TEAM 2019

Peter Ringstad*
CEO, *Co-Founder*
Project Manager

Professor Xavier Crispin
Scientific Lead, *Co-Founder*
Scientific Lead Electrochem

PhD Jakob Nilsson*
CTO, *Printed electronics expert*
Product Manager

Anders Hägerström*
Test & Validation Mgr,
Electronics expert
Test and Validation Lead










ADVISORY BOARD

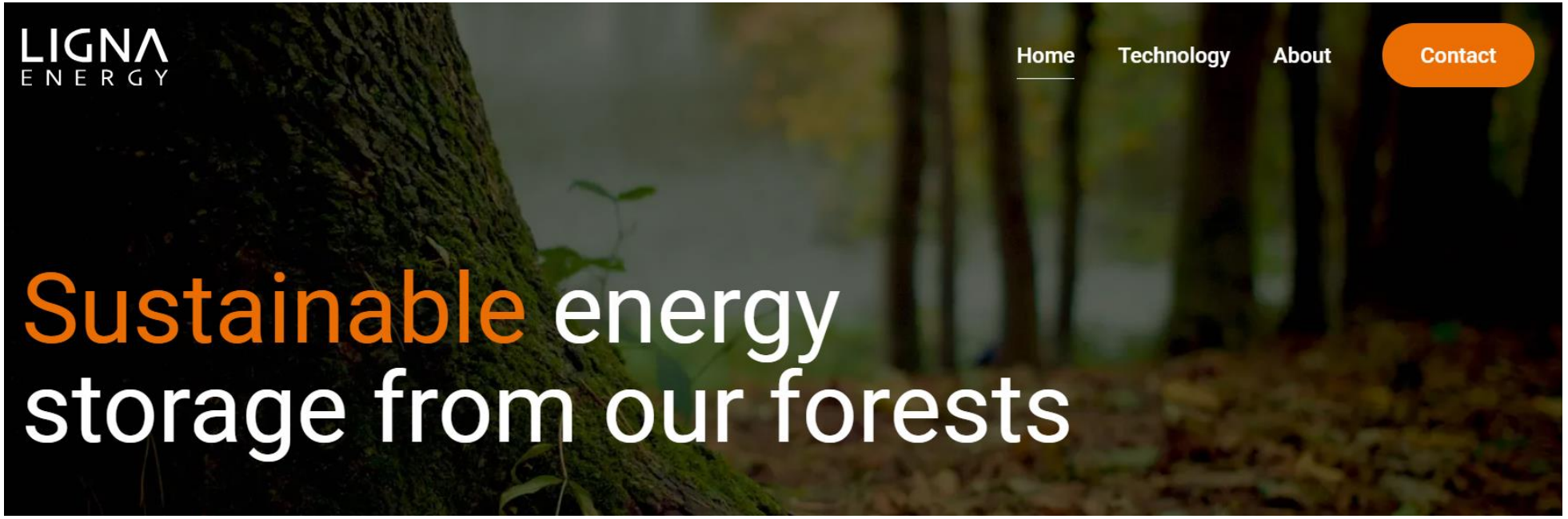
Marcus Wigren
CEO, Nilar AB
Commercial Battery Sales and Manufacturing

Professor Magnus Berggren
Head of Lab of Organic Electronics
Linköping University
Electrochemistry and Printed electronics

PhD Mats Billstein
Product Manager, Vattenfall AB
Grid System application

* Former company names indicated

WWW.LIGNAENERGY.COM



Peter Ringstad
CEO
(+46)70-212 45 88
peter.ringstad@lignaenergy.com

Ligna Energy Company Overview

Founded: 2016-11

Number of employees:

- 3 (+ consultants on topic/demand)
- 6 researchers at Linkoping University working on electrode chemistry

Funding sources:

- Wallenberg foundations
- Swedish Energy Agency, Vinnova
- Shares

Location:

Bredgatan 33

60221 Norrköping