WKO
AUSSENWIRTSCHAFT AUSTRIA

WEBINAR

Energy Storage
Teil 1

AussenwirtschaftsCenter Zürich
AussenwirtschaftsCenter Paris

WIR STARTEN IN KÜRZE

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AUSSENWIRTSCHAFT AUSTRIA

WEBINAR

Energy Storage
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AussenwirtschaftsCenter Zürich
AussenwirtschaftsCenter Paris

02.11.2020

DREI ZENTRALE FRAGEN

WAS PASSIERT ÜBERMORGEN?

WO AUF DER WELT SPIELT DIE MUSIK?

WIE KANN ICH DAVON PROFITIEREN?

Webinarreihe Energy Storage

- **Future of Energy Storage – Teil 1**
  2. November 2020; 13:00 – 14:00 Uhr
  AußenwirtschaftsCenter Zürich und Paris
  Schwerpunkt: Aktueller Stand der Forschung sowie mögliche Zukunftsvisionen und Marktchancen; Materialien für eine nachhaltige Batterien-Wertkette
- **Future of Energy Storage – Teil 2**
  9. November 2020; 13:00 – 14:00 Uhr
  AußenwirtschaftsCenter London und München
  Schwerpunkt: Neue Batterielösungen und Anwendungsbeispiele, Speichertechnologien für den Mobilitätssektor
- **Future of Energy Storage – Teil 3**
  24. November 2020; 9:00 – 10:00 Uhr
  AußenwirtschaftsCenter Tokio und Paris
  Schwerpunkt: Energiespeicherlösungen für den Smart Home Bereich in Japan und Frankreich

ENERGY STORAGE TEIL 1, ABLAUF

1

STEFAN FISCHEREDER

ORGANISATORISCHES UND TECHNIK

TOBIAS SCHMIDT

STAND DER FORSCHUNG/ MARKTCHANCEN

2

3

MELCHIOR FAURE

INTRO „AIRBUS DER BATTERIEN“

JULIEN FREY

MATERIALIEN FÜR EINE NACHHALTIGE BATTERIEN-WERTKETTE

4

5

Q & A

BEANTWORTUNG IHRER FRAGEN

ORGANISATORISCHES

Fragen:

- Werden am Ende des Webinars live beantwortet. Bitte stellen Sie Ihre Fragen über die Chat-Funktion der Webinar-Software.
- Spätere Fragen können Sie uns gerne an **zuerich@wko.at** senden.

Präsentation zum Download

- **wko.at/aussenwirtschaft/ch** → wählen Sie die Schlagzeile **„Webinar | Energy Storage - Teil 1“** - Downloadbereich rechts

Aufzeichnung des Webinars

- **www.youtube.com/user/aussenwirtschaft**

Follow-up-Email

- mit Aufzeichnung und Unterlagen

Präsentations- und Sprecheransicht vergrößern

1

TOBIAS SCHMIDT

STAND DER FORSCHUNG/ MARKTCHANCEN

ETH zürich

Energy Politics Group

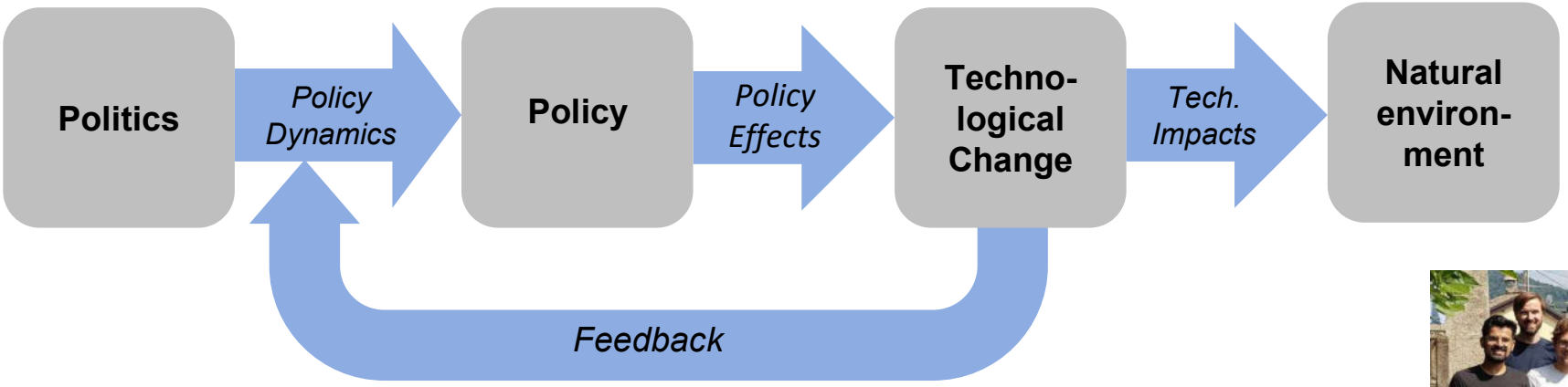
Erneuerbare Energie, Energiespeicher und Batterietechnologie

Prof. Dr. Tobias Schmidt
Professor für Energiepolitik, ETH Zurich

2. November 2020

AT EPG, we analyze the interaction of energy policy, its politics and technological change in the energy sector

EPG's research framework



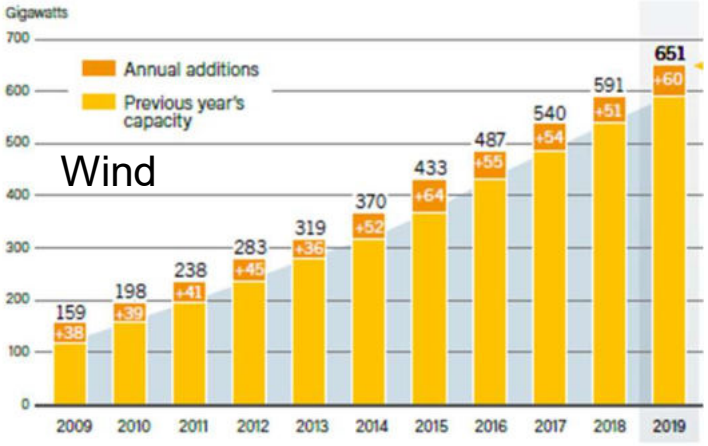
Sectors/Technologies	• Primarily electricity generation, storage, and grid • Also: transport, energy efficiency in buildings
Regions	• Global: OECD and non-OECD countries
Research design and methods	• Confirmatory and exploratory designs • Modelling; quantitative & qualitative empirical analyses

Interdisciplinary framework => interdisciplinary team (engineers, economists, political scientists)

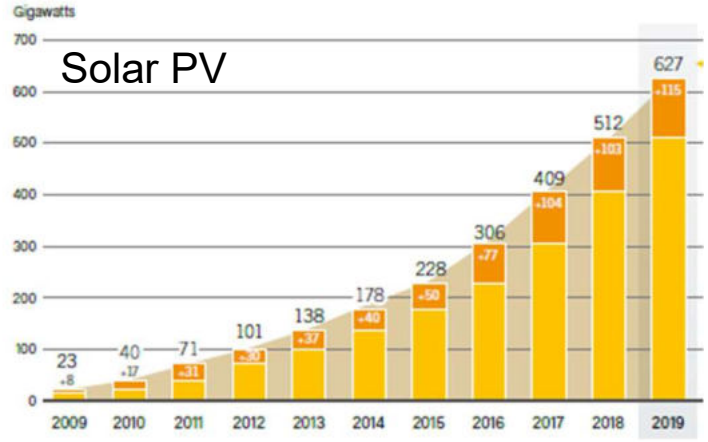
Agenda

- **Einleitung: Megatrend Erneuerbare Energien**
- Warum (grüne) Technolgien günstiger werden
- Nächster Megatrend: (Batterie-) Speicher
- Batterie-Zell-Produktion in Europa: wie fördern

Growth in renewable energy has been very robust



Source: REN21



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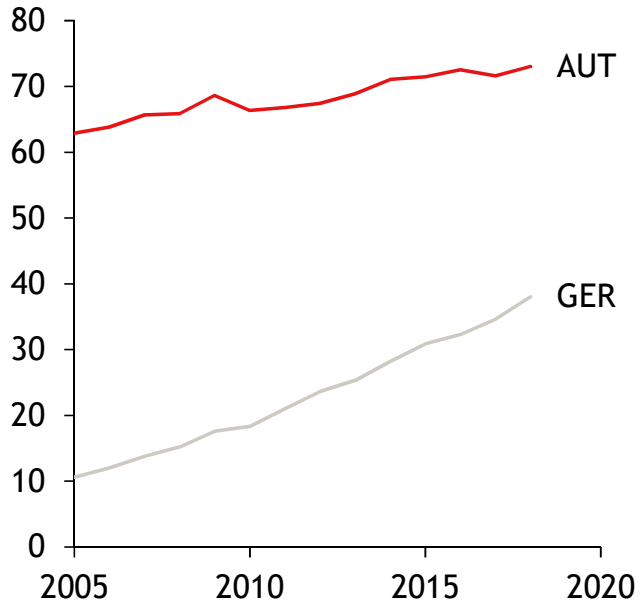
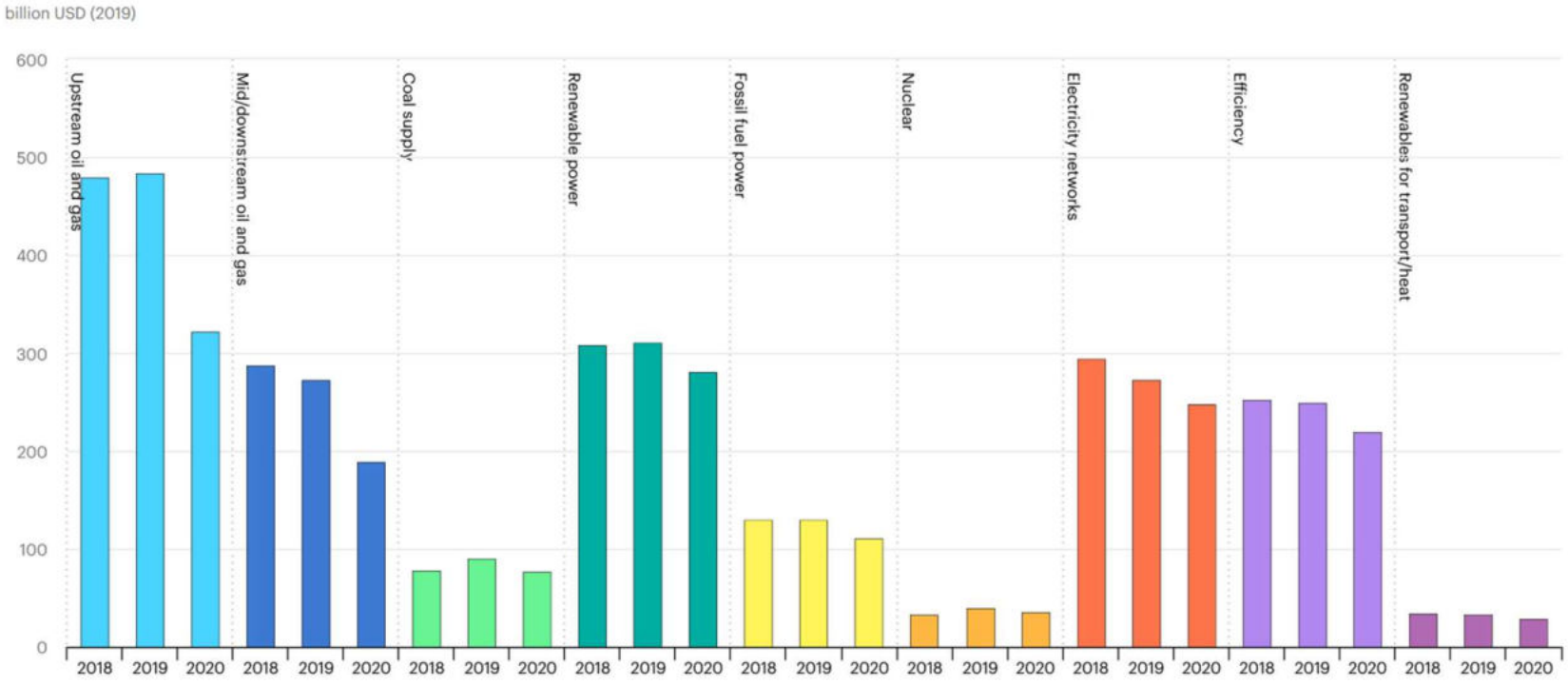


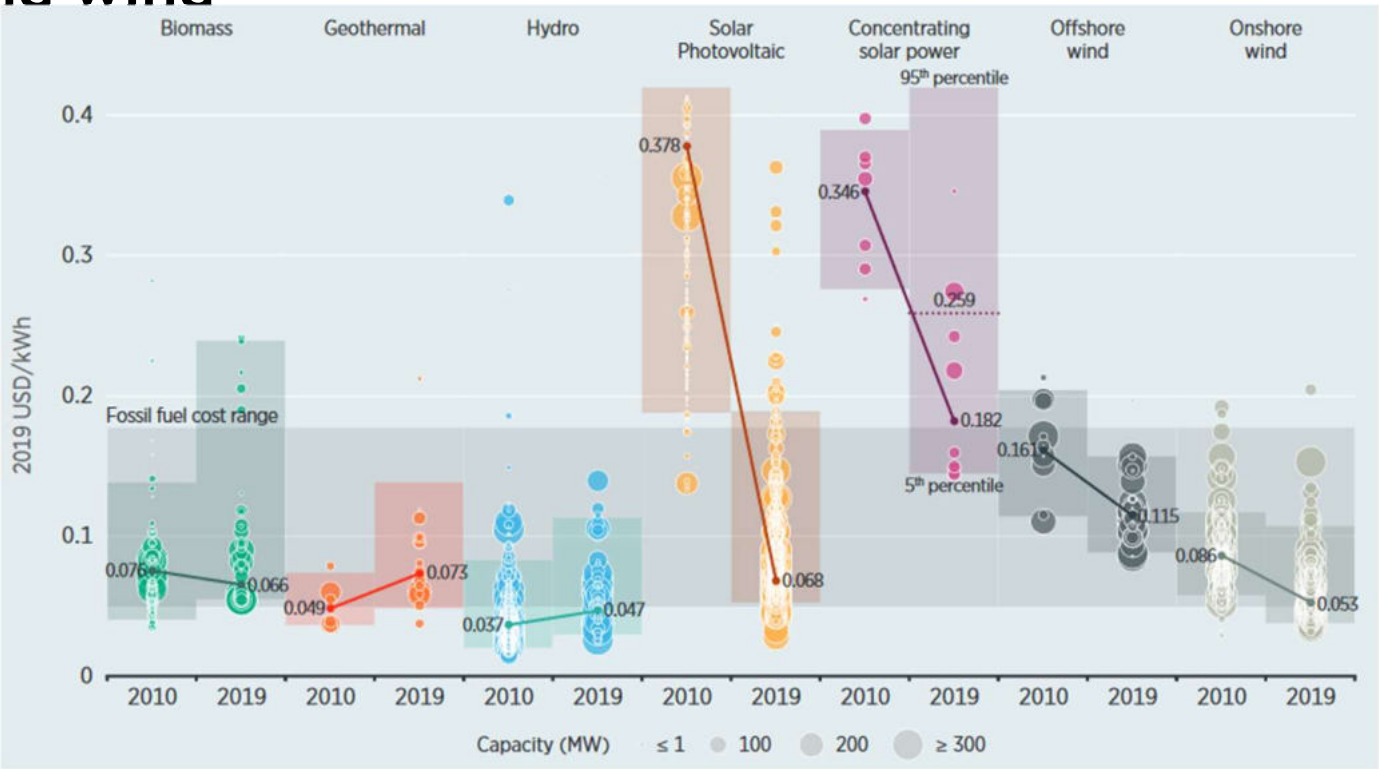
Source: EPG, based on Eurostat

While fossil fuel upstream investments have suffered in 2020, RE invest remained relatively robust



Source: IEA

But: not all renewable technologies' cost have declined as much as solar PV and wind



Source: IRENA Renewable Cost Database

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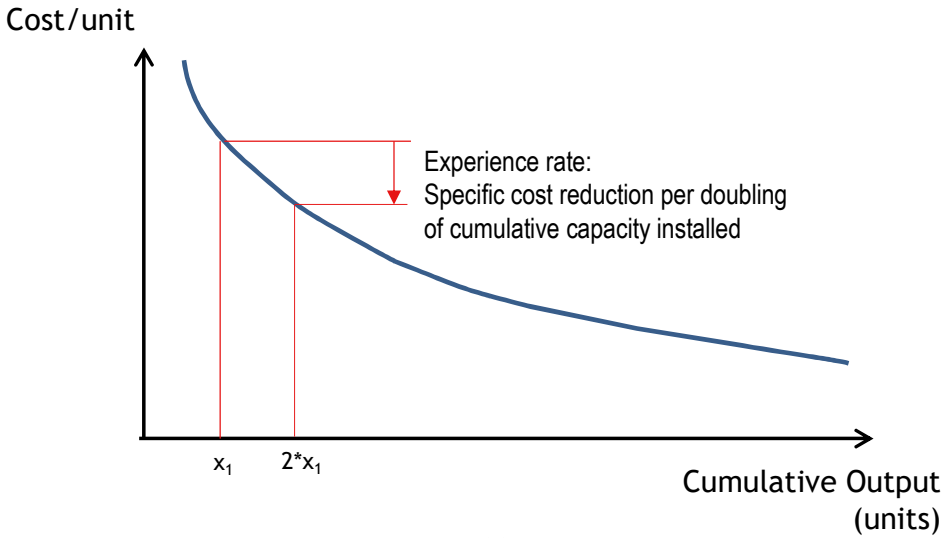
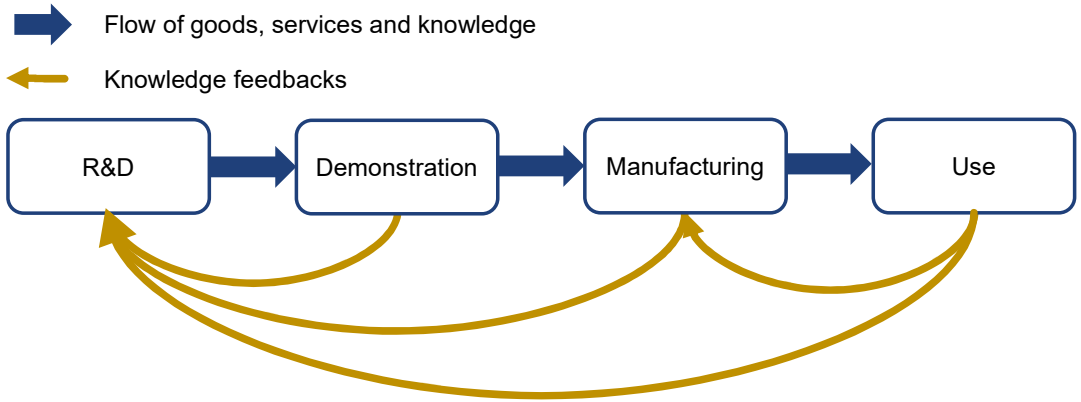
What is behind these cost reductions? Explaining the experience curve

Wright's law of the experience curve



- Experience effects
- Scale effects
- Income -> slack

Experience effects

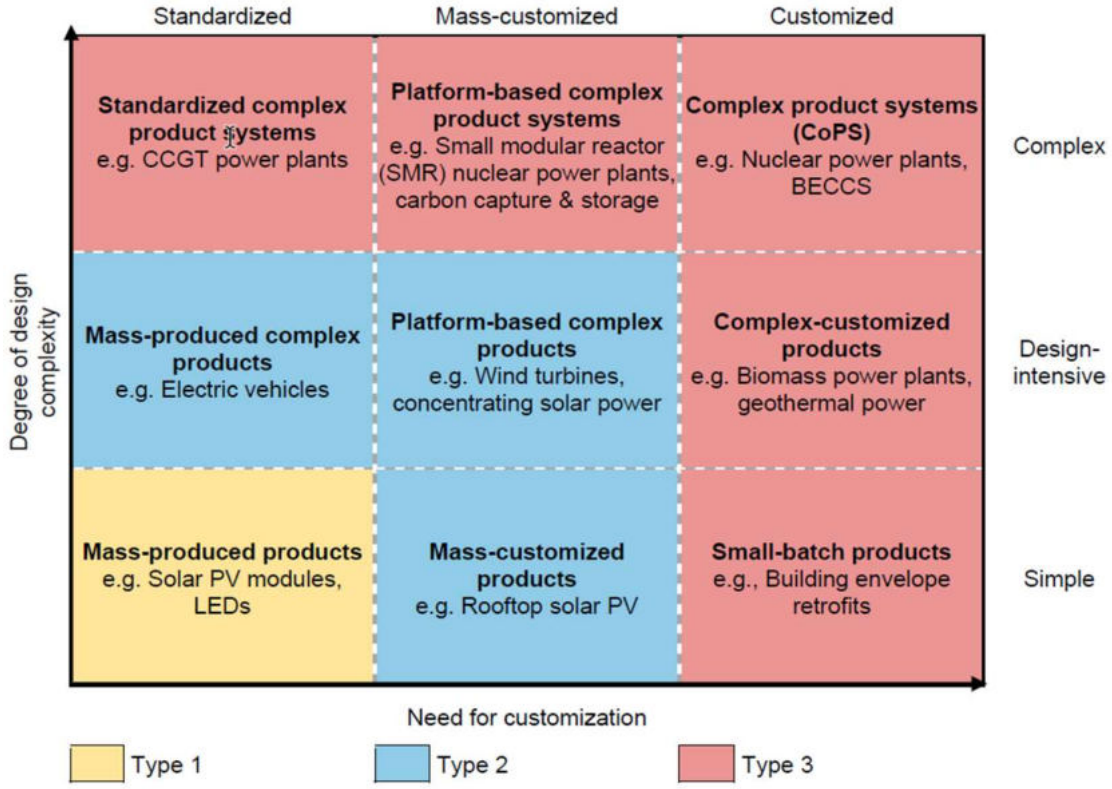


Knowledge feedbacks from learning by doing, using, and interacting

Source: EPG, ETH Zurich

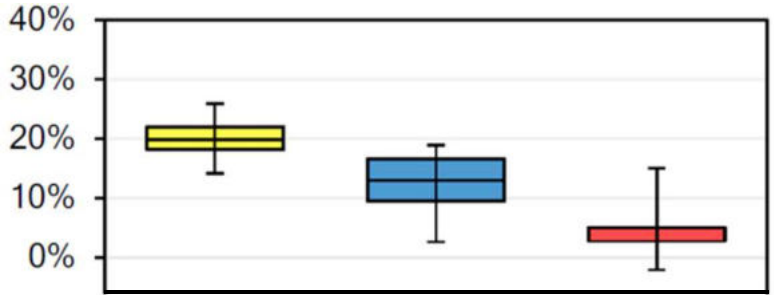
Drivers of global experience rates* of clean energy technologies

Method: Synthesis of literature, review of local and global learning rates



* Specific cost reduction per doubling of cumulative output

Ranges of global experience rates* of technologies by type



The lower and upper box boundaries represent the 25th and 75th percentiles, respectively. The line inside the box represents the median, and the lower and upper error lines depict the minimum and maximum of all the data, respectively.

Source: Malhotra & Schmidt (2020), ***Joule***

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Energy policy makers have identified the significance of energy storage

Ernest Moniz (Former US Secretary of Energy, under Obama's 2nd term)
"Energy storage is the holy grail of energy policy"

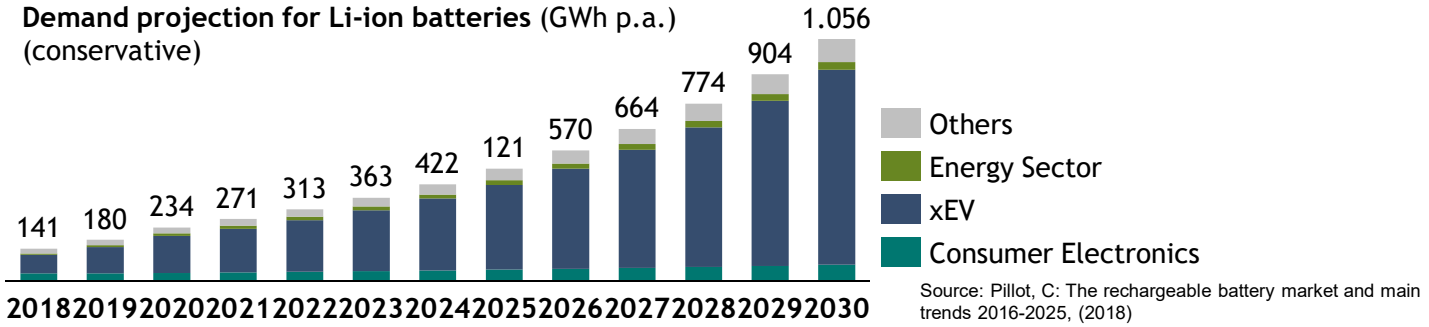
In 2012, the U.S. Department of Energy called for revolutionary new technologies to store electricity that could become competitive with existing pumped hydro storage. (or even cheaper)

⇒ Which technologies will succeed?
⇒ How to intervene?

Using experience curves to project the competition and thus cost between stationary electricity storage technologies

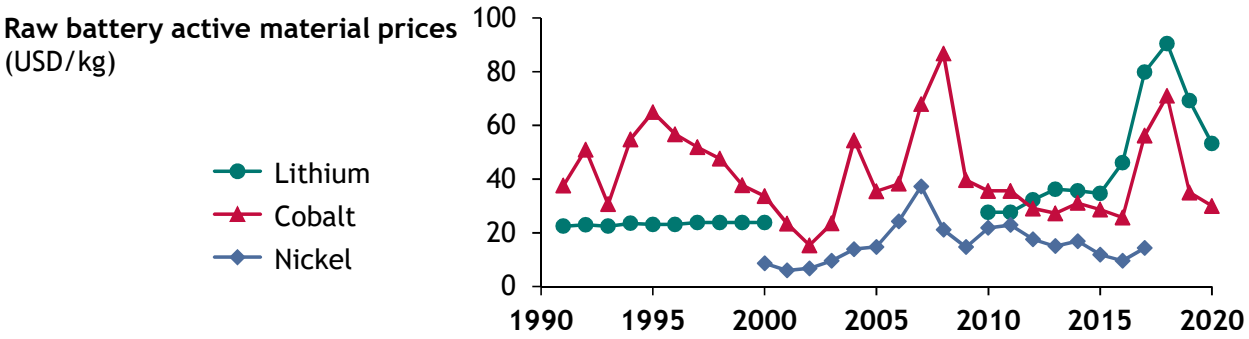
2 Complications:

1. Storage technologies are multi-purpose (= they can serve in multiple markets within and beyond the electricity sector)



Source: Pillot, C: The rechargeable battery market and main trends 2016-2025, (2018)

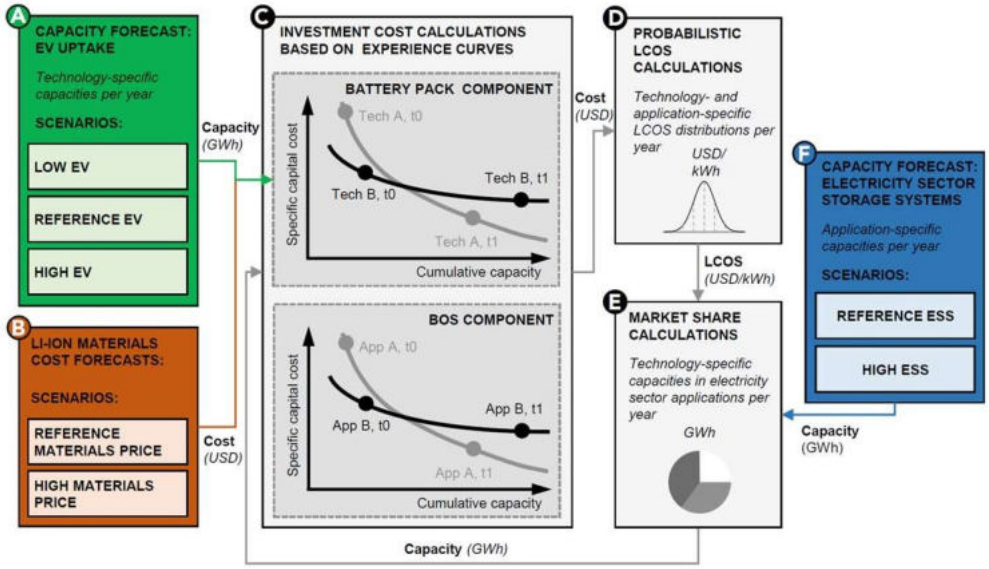
2. Raw battery active material prices are volatile and make-up an increasing share of battery cost



Source: Beuse, Steffen Schmidt (2020), ***Joule***

We built a system dynamic model, using component-based experience curves and analyzed 3 cases

Structure of system dynamic model projecting market shares and LCOS



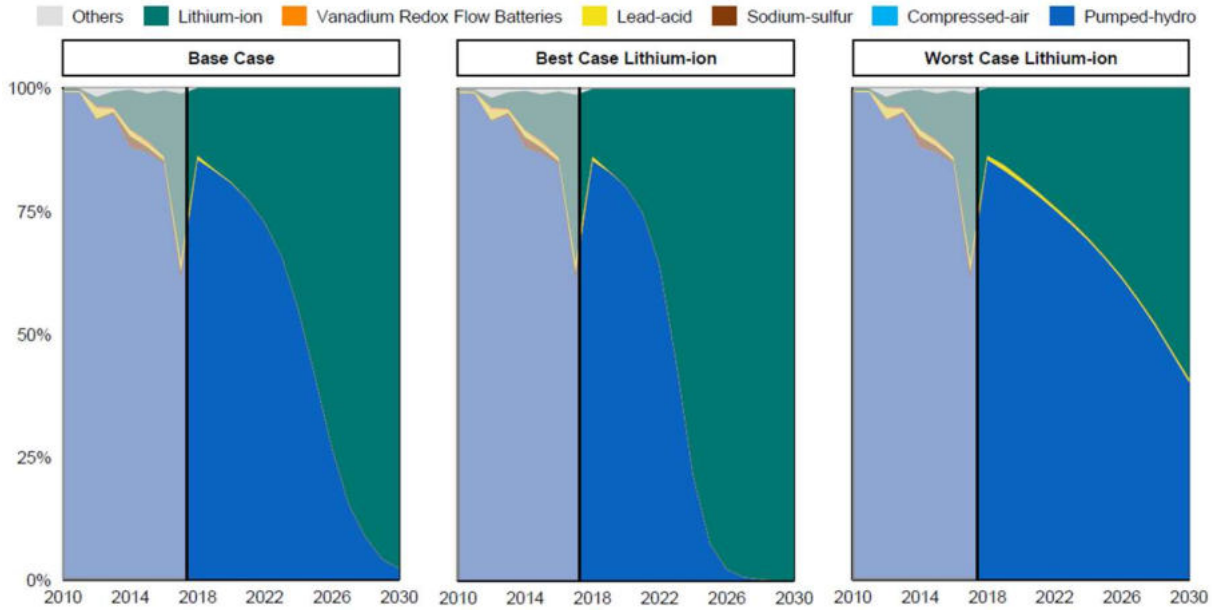
3 most distinctive cases modeled

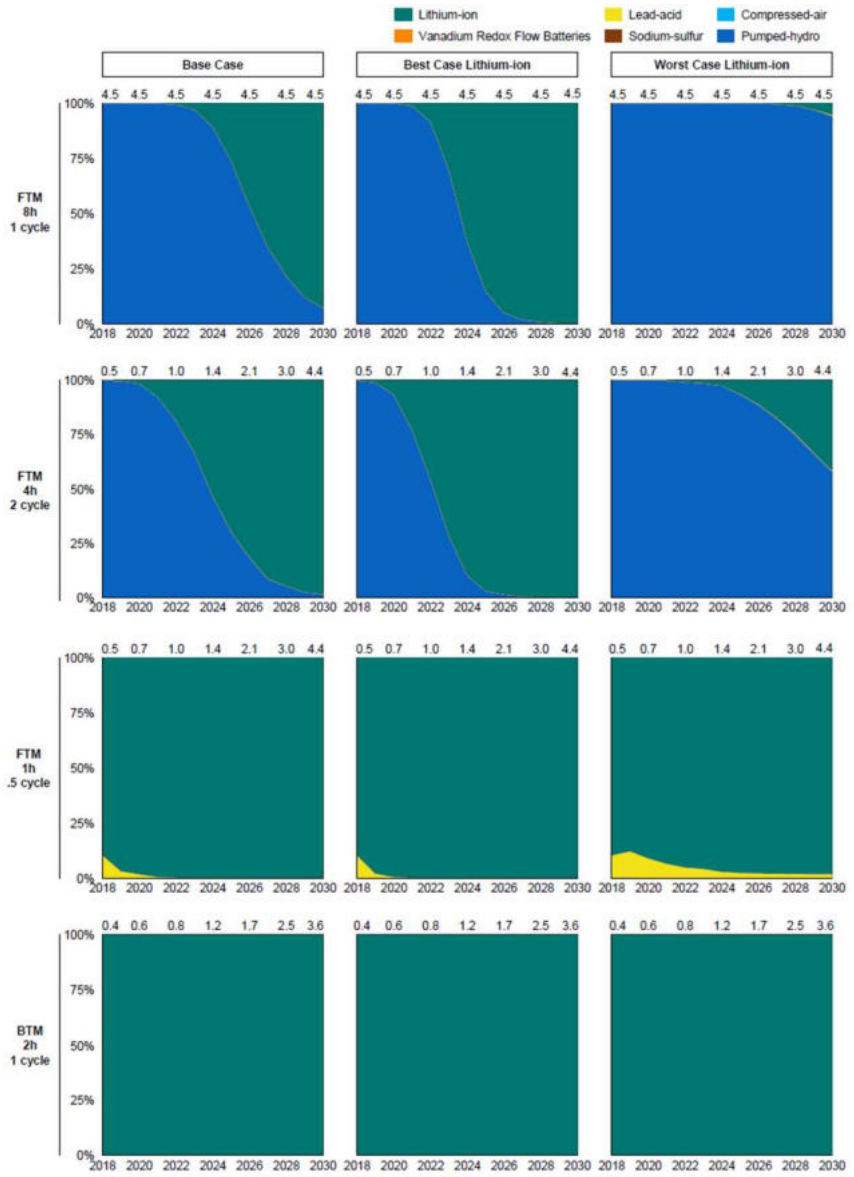
	Base case	Best case LiB	Worst case LiB
EV uptake	• Ref	• high	• low
LiB material prices	• Ref	• Ref	• High
LiB Pack ER*	• 20.8%	• 25.8%	• 15.8%
Other techs' ER*	• Medium	• Low	• High

* ER= experience rate (specific cost reduction per doubling of cumulative capacity installed)

Source: Beuse, Steffen Schmidt (2020), ***Joule***

Projected market shares for new storage capacity indicate a strong likelihood for Lithium-ion battery dominance

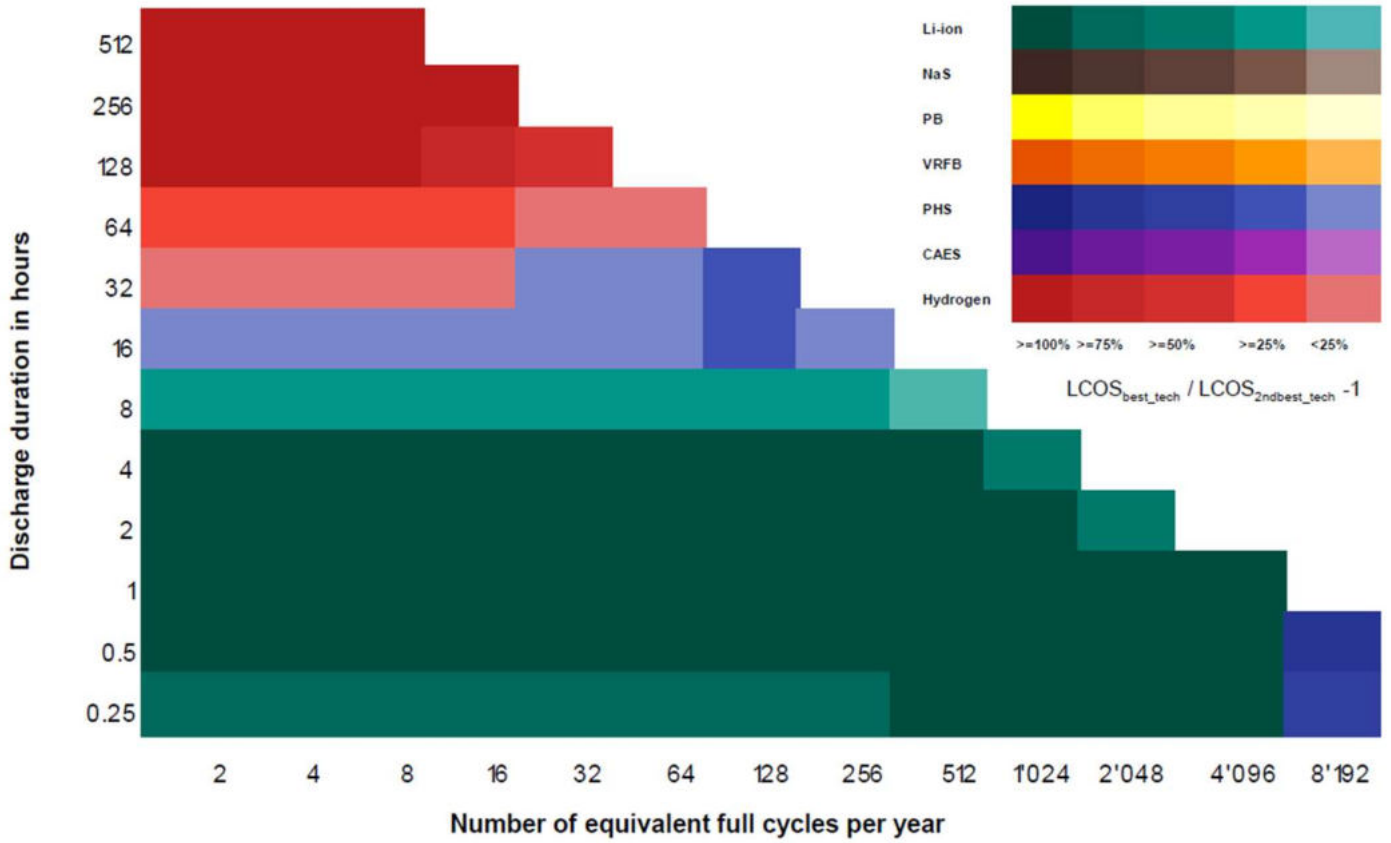




Source: Beuse, Steffen Schmidt (2020), ***Joule***

Non-LiB storage techs are competitive in applications with >8h duration

Most likely cost and performance values – long-duration perspective incl. Hydrogen

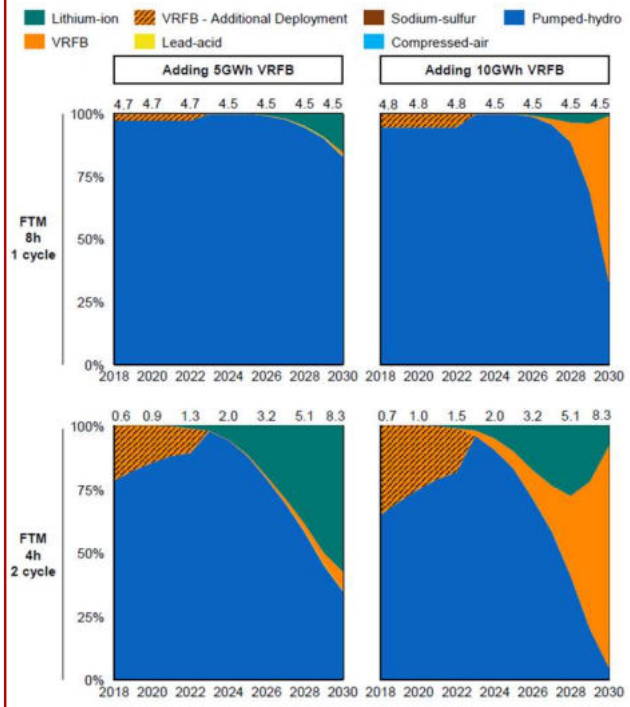


11/2/2020

Source: Beuse, Steffen Schmidt, 2020, ***Joule***

To address LiB dominance, we analyze 3 policy strategies

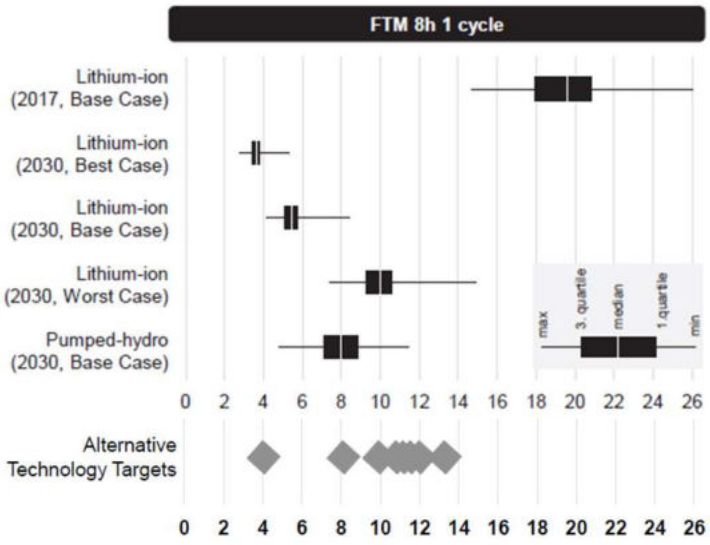
1. Support deployment of existing rival technology (VRFB)



Market shares of annual, additional electricity-storage deployment (new-built) in GW split by applications and across scenarios for additional deployment of VRFB

Can work in certain applications, but potentially very expensive

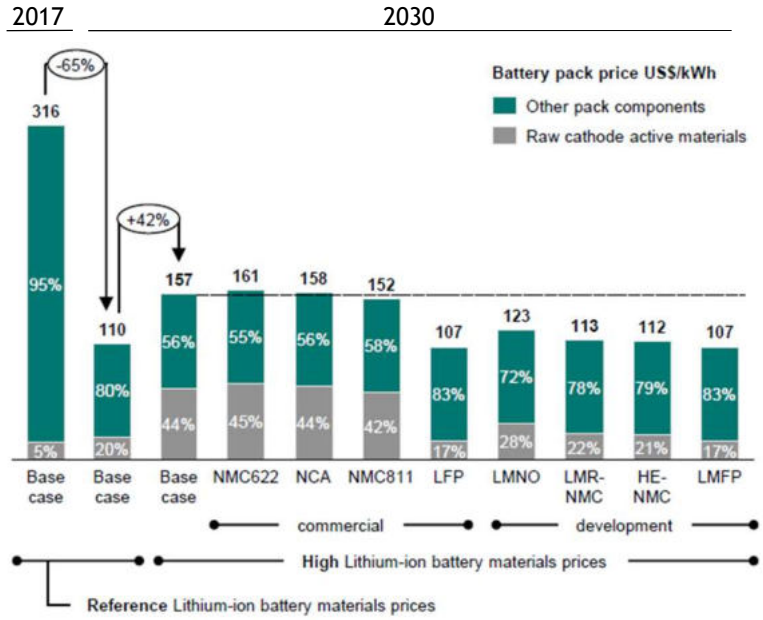
2. RD&D support for novel technologies



Projected levelized cost of storing electricity in application with 8 hours duration and 1 full charge and discharge cycle per day (in US$ct/kWh)

Only support techs with aggressive targets and for *long* duration applications

3. Foster variance within LIB technology family



Lithium-Ion Battery Capital Cost in US$ per kWh for Chemistries with Different Cathode-Active Materials (base case is the average of NMC622 and NMC811 materials prices).

Seems to be the most cost effective strategy for *short/medium* duration applications

Source: Beuse, Steffen Schmidt, 2020, ***Joule***

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How can Europe catch up in the Lithium-ion battery race?

"Brussels wants Airbus-style consortium to lead battery revolution"

POLICY FORUM

INDUSTRIAL POLICY

Science

A "technology-smart" battery policy strategy for Europe

Batteries' inherent characteristics should inform policies

What are elements of a technology-smart catching up strategy?

1. Make cell production in Europe and partnerships with European firms attractive to East-Asian industry leaders
2. Create a large and predictable home market (EV targets; more stringent caps of fleet emission standards)
3. Only if enough learning and catching-up has taken place, create incentive for a "European cell"

Source: Beuse, Schmidt, Wood, ***Science*** (2018);
Picture/quote: EP, ft.com

3 take home messages

1. Clean energy technologies have very different inherent characteristics (e.g., design complexity), resulting in different experience rates
2. This affects the long-term competitiveness of technologies, with Lithium-ion batteries likely to become very dominant in short-/medium duration applications
3. Policy makers should:
    - Provide R&D support only to very aggressive technologies and for long-duration applications
    - Observe and potentially intervene to uphold variance within the LiB family
    - Design support policies in a “technology smart” way (considering the inherent characteristics of the targeted technology/ies)

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2

MELCHIOR FAURE

Intro „Airbus“ der Batterien

3

JULIEN FREY & MICHAELA STENG

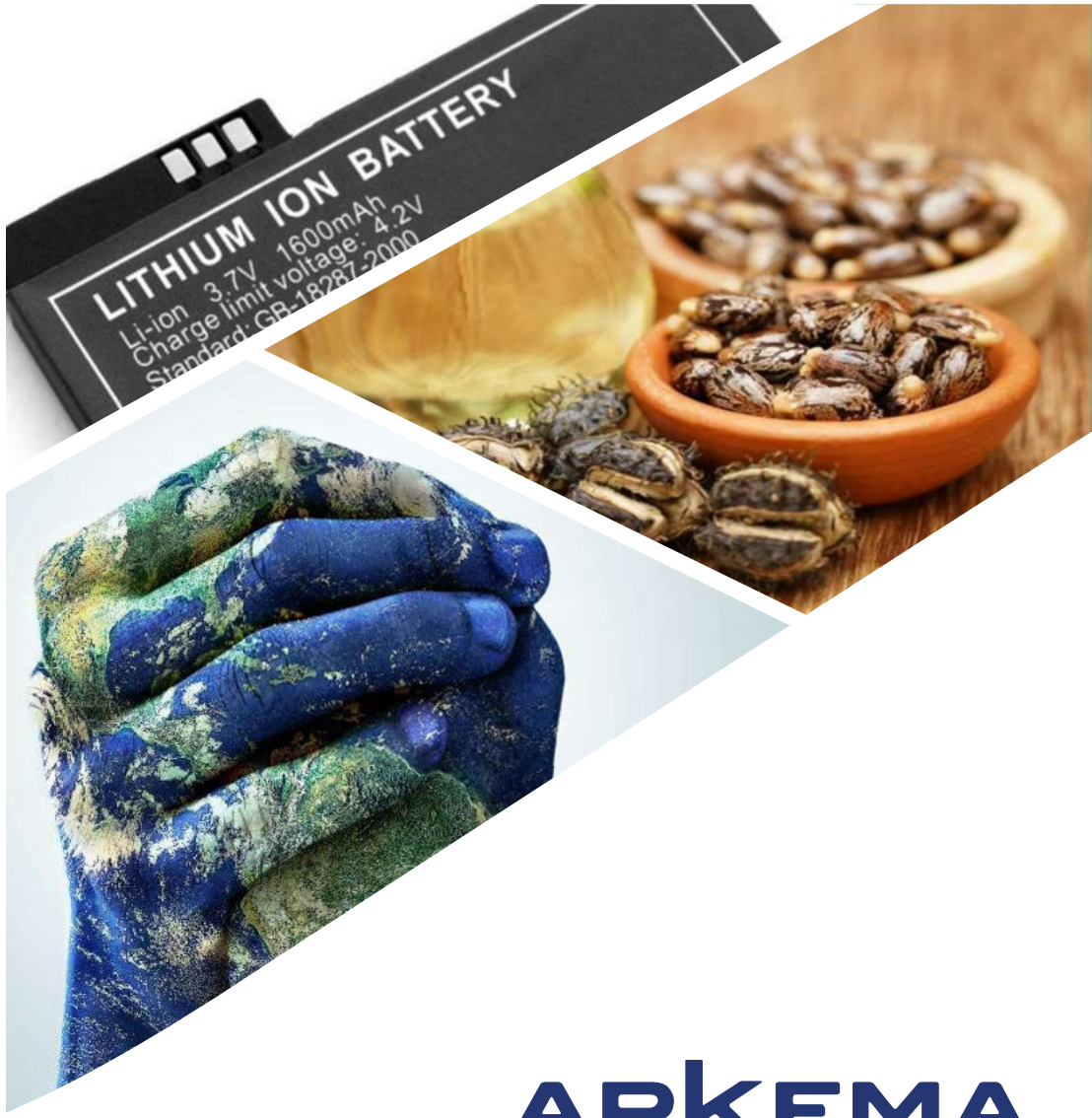
Materialien für eine nachhaltige Batterien-Wertkette

SPECIALTY MATERIALS FOR SUSTAINABLE BATTERIES

"FUTURE OF ENERGY" WEBINAR - NOVEMBER 03, 2020
ADVANTAGEAUSTRIA

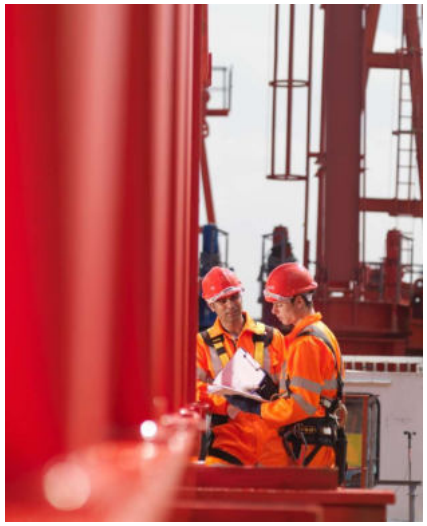
JULIEN FREY, PhD
SCIENTIFIC DIRECTOR - ENERGY MATERIALS
RESEARCH & DEVELOPMENT DIVISION

MICHAELA STENG, PhD
DIRECTOR - GLOBAL BUSINESS
DEVELOPMENT BATTERY, BOSTIK



ARKEMA
INNOVATIVE CHEMISTRY

OUR WORLD IS CHANGING FAST, ACCELERATING DEMAND FOR NEW MATERIALS



Future of mobility	Urbanization	Environment	Industry 4.0	Consumer demand
Lightweighting	Insulation	Wind, solar, hydrogen	3D printing	Personalized designs
Durability	Energy efficiency	Water treatment	Miniaturization	Performance
Batteries	Modular construction	Renewable resources	Smart devices	Sustainability

OUR UNIQUE MATERIALS FOR SUSTAINABLE FUTURE

THE PROMISE OF BATTERY TECHNOLOGIES

- Batteries are a key technology to meet the Paris Agreement* while sustaining developments goals as defined by the United Nations…

**Less than 2.0 degrees Celcius temperature increase*

… Which means climate neutrality by 2050

Addressable UN Sustainable Development Goals

- **~850M people**
  lack access to electricity worldwide

- Battery industry:
  ~$40B created
  in economic value in 2018

- **~2M people employed**
  in the battery value chain in 2018

Partnerships, such as the Global Battery Alliance, help drive the sustainable expansion of the battery value chain to achieve the UN Sustainable Development Goals.

ARKEMA AND THE BATTERY VALUE CHAIN

- Arkema presence all along the value chain (“inside and outside the cell”)

HOW ARKEMA CONTRIBUTES TO SUSTAINABLE BATTERIES

Specialty Materials
from Renewable Resources

Materials with
Low Emissions

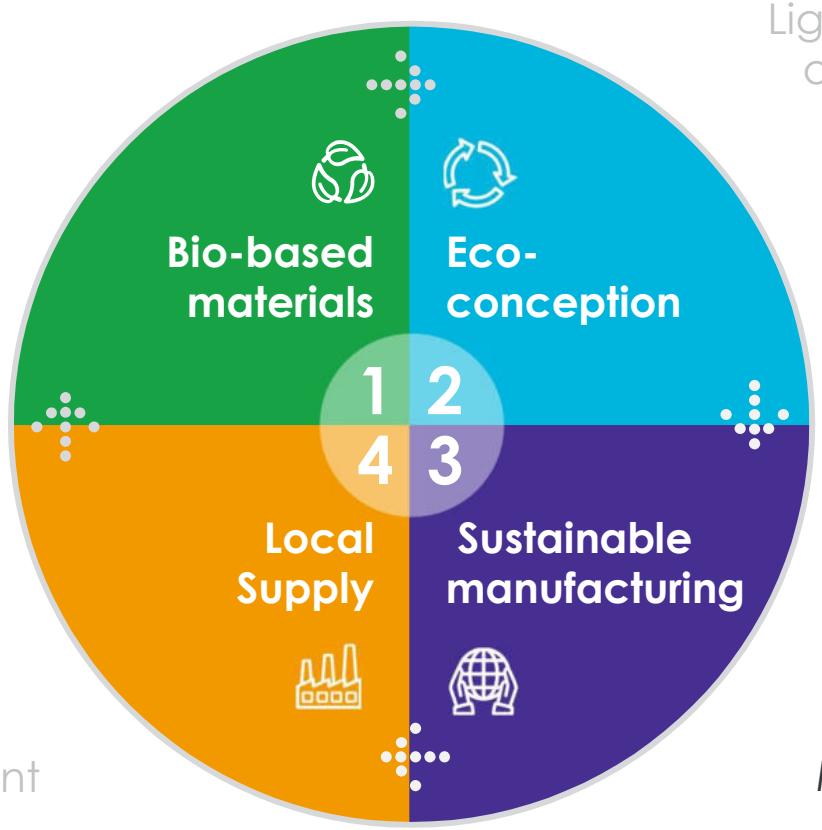
Manufacturing Footprint
Close to Customers

Lightweight Design
of Battery Packs

Advanced Technologies
for Battery Cells

Recyclability
of Battery Systems

Advanced
Manufacturing Technologies



BIO-BASED MATERIALS

RILSAN® POLYAMIDE 11. A BIO-BASED EXTREME MATERIAL

100% Bio-based PA 11

World leader in specialty
biobased polyamides derived from Castor Oil

100% RECYCLABLE

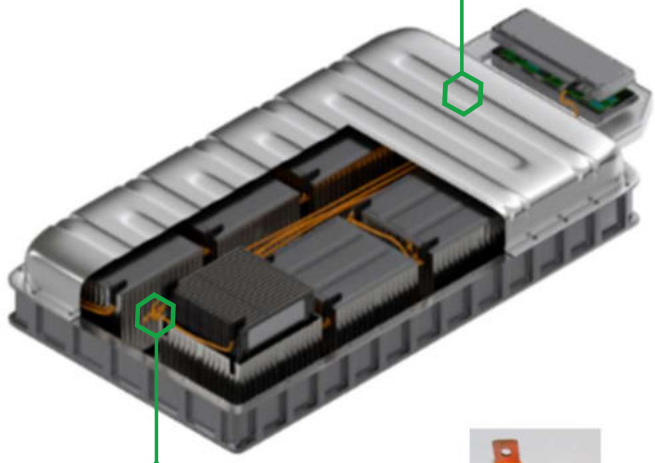
LOW GLOBAL WARMING POTENTIAL

Key Properties

- Low density (1.0)
- Toughness
- Dimensional stability
- Easy Processing
- Abrasion Resistance
- Flexible
- Chemical Resistance
- Bio-based

Applications In Batteries

Casing
(metal replacement)



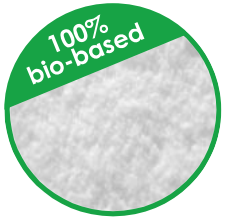
Bus Bar Protection

RILSAN® POLYAMIDE 11. 100% FROM CASTOR OIL

Castor plant

Castor seeds

Castor oil



Amino 11

Polymerization

RILSAN® BY ARKEMA

PA 11

100%

Renewable Content (ASTM D6866)

A UNIQUE & INTEGRATED BIO-BASED SUPPLY CHAIN

Arkema has announced a major PA11 investment in Singapore - moving closer to the Castor Supply and closer to the customers.

- No Food Competition
- From Semi-arid to sub-tropical
- Sustainable Farming
- No Deforestation
- Non GMO

ECO-CONCEPTION

ADHESIVES & SEALANTS FOR ECO-DESIGNED BATTERY SYSTEMS

Bostik smart adhesives

Technologies

Hot melt -

With leading position in Specialty hot melts

Silyl Modified Polymer

Rubber based

Web and Film

Polyurethane

Water Based

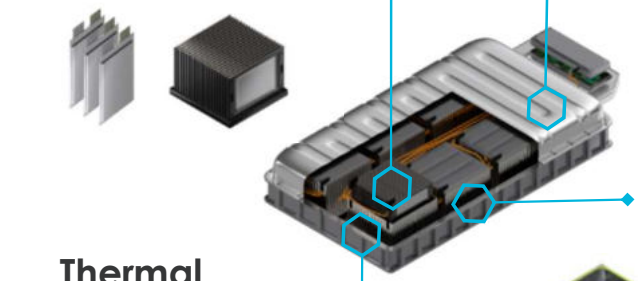
Acrylic

Film – Web – Powders – Foam Gaskets

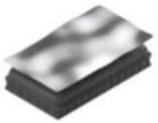
Applications in batteries

Cell to Module Assembly

Cell to Cell bonding



Lamination for EMI Shielding



Battery Pack Assembly

Thermal Management

Gapfiller

Sealing &Gasketing

Structural bonding

Contributions

Light weight

Design for disassembly

Increased lifetime – smaller pack size

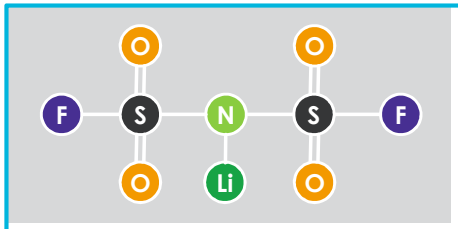
Low emission chemistry

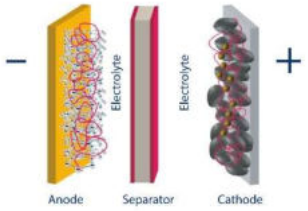
Clean processing

LiFSI. AN ECO-DESIGNED LITHIUM SALT

FORANEXT BY ARKEMA

Less critical materials use





High purity LiFSI for battery electrolytes

LiFSI process using **no Phosphorus** and **60% less Fluorine** than classic electrolyte salts

Some elements are **scarce** or **geopolitically important** - Cobalt, Lithium, Rare Earths -

Higher performance

Compatible with Co-Free Cathodes

Allow high voltage battery (power)

Allow fast charge

Recovery & reuse

Improving Battery second life performance

Recovery of LiFSI *via* environmentally friendly process

SUSTAINABLE MANUFACTURING

SUSTAINABLE MANUFACTURING WITH KYNAR®

Cathode Manufacturing Process

Mixing → Coating → Drying → Calendaring

Current Processes

NMP* (harmful organic solvent) used for cathode manufacturing

« Greener » Processes

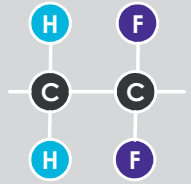
- Switch from NMP to water
- Switch to Dry Process

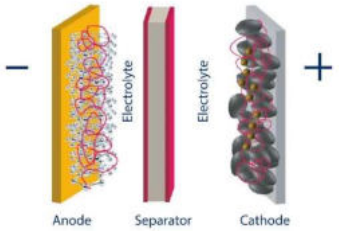
- **Binder plays a key role in manufacturing process**
- **New greener processes to make electrodes means need of new tailored-made binders**

*N-Methyl-2-pyrolidone

SUSTAINABLE MANUFACTURING WITH KYNAR®

PVDF binder

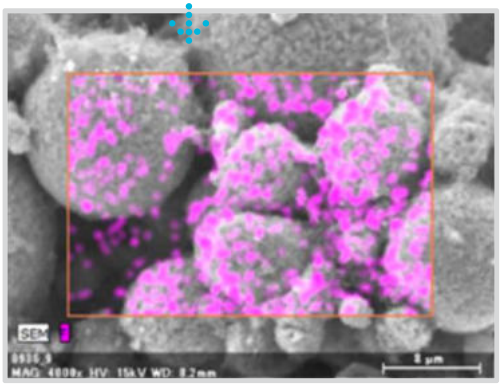




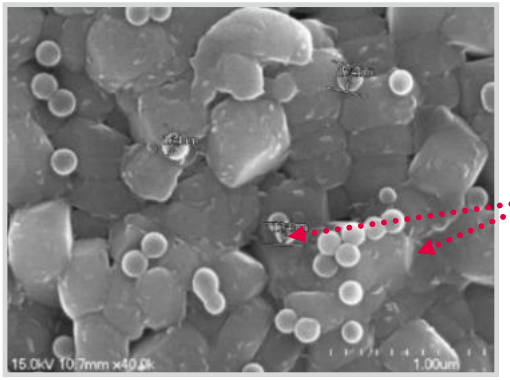
- Reliable **legacy in battery**: 1st ton sold in 1996
- Excellent **adhesion** properties
- **Electrochemical stability** up to 5V
- Reference material for NMP-based cathode

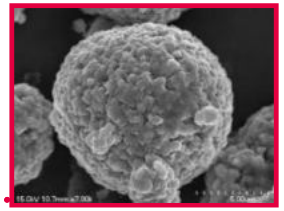
ARKEMA **UNIQUE PROPRIETARY EMULSION PROCESS** ALSO ENABLES TO MAKE **BINDERS FOR NEW GREENER PROCESSES**

Aqueous Kynar® PVDF latex for **water-based cathodes**



Super fine powder of Kynar® PVDF for **dry process**

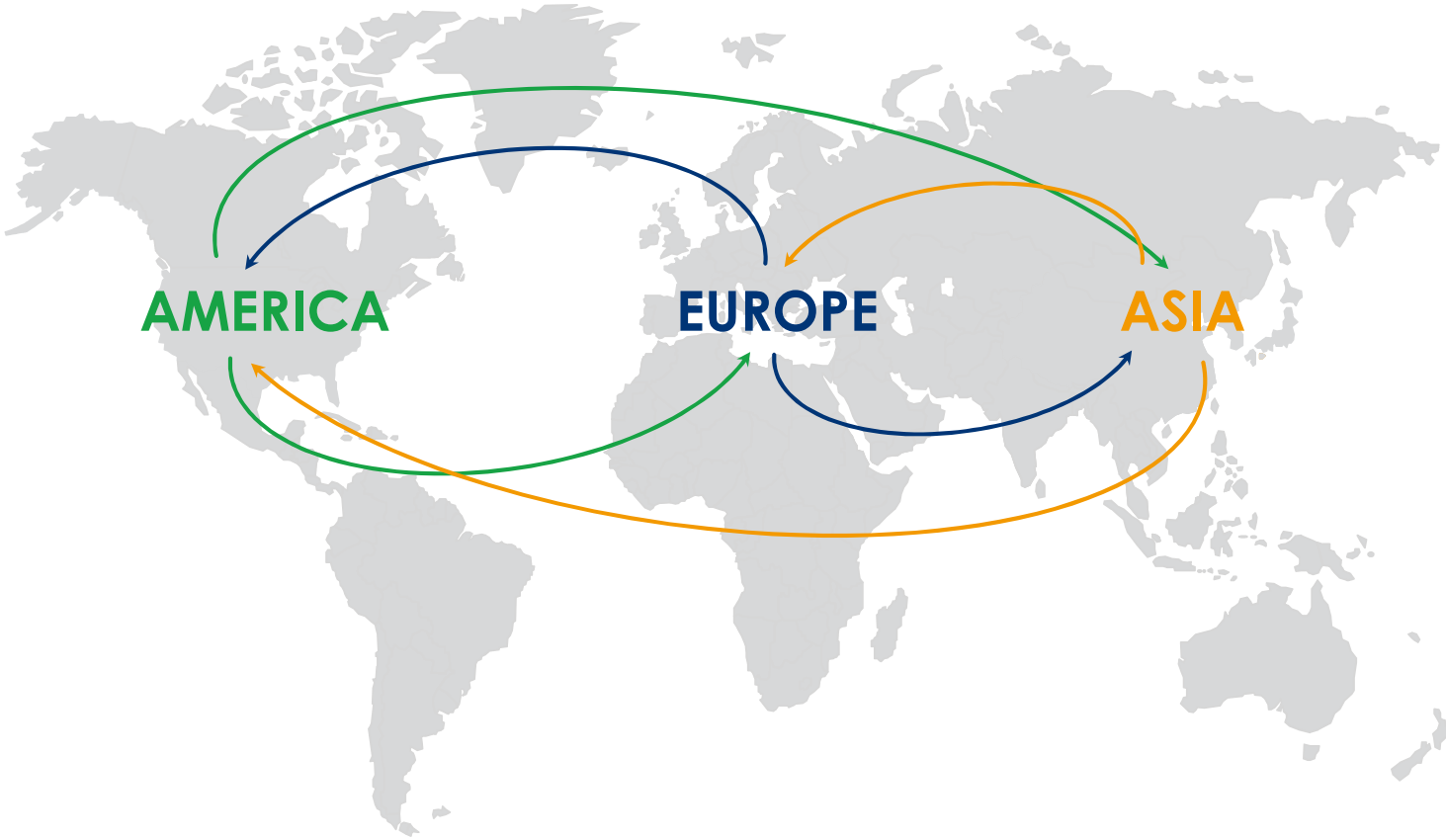




Primary particle size of PVDF < 200 nm

LOCAL SUPPLY

OUR GLOBAL PRESENCE



20,500
talents

11,200
in Europe

4,075
in North America

4,320 in Asia

Over
10,000
customers

Collaborations
with the leading
global brands

~2,000
new hires
every year

Presence in
55 countries

144 plants

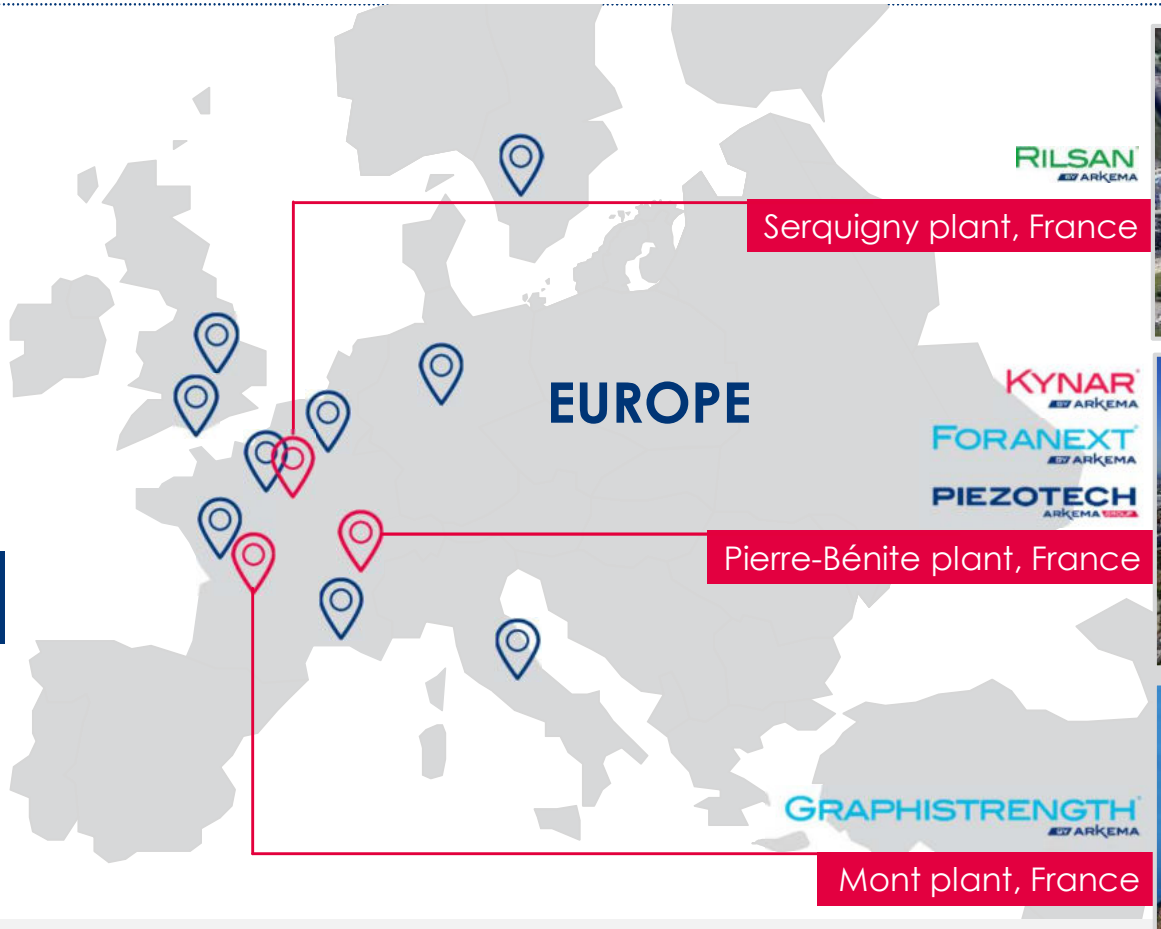
15 R&D centers

EUROPEAN SUPPLY OF BATTERY MATERIALS

Bostik plants in Europe

Bostik smart adhesives

Wide spread industrial footprint all over Europe



RILSAN ARKEMA

Serquigny plant, France

KYNAR ARKEMA

FORANEXT ARKEMA

PIEZOTECH ARKEMA

Pierre-Bénite plant, France

GRAPHISTRENGTH ARKEMA

Mont plant, France

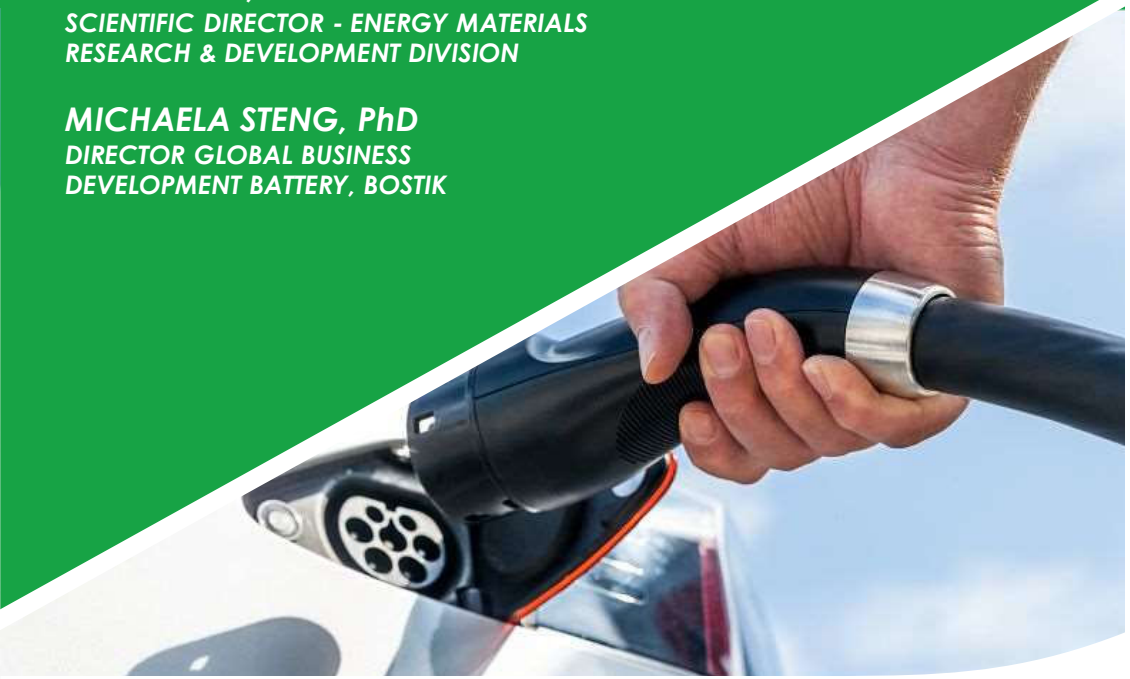
Reduce Carbon footprint serving the region from the region

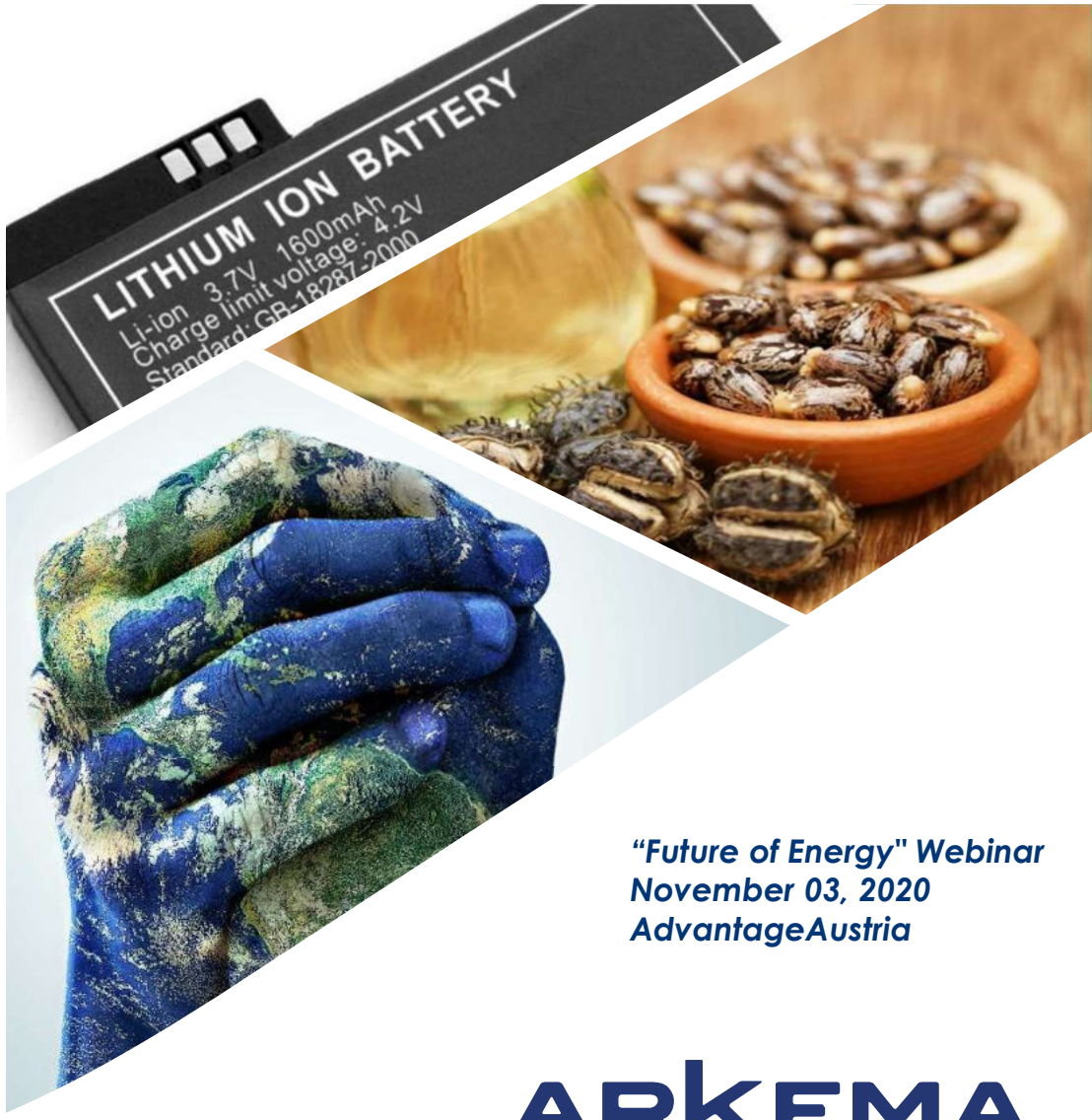
HOW ARKEMA CONTRIBUTES TO SUSTAINABLE BATTERIES

THANK YOU FOR YOUR ATTENTION!

JULIEN FREY, PhD
SCIENTIFIC DIRECTOR - ENERGY MATERIALS
RESEARCH & DEVELOPMENT DIVISION

MICHAELA STENG, PhD
DIRECTOR GLOBAL BUSINESS
DEVELOPMENT BATTERY, BOSTIK





"Future of Energy" Webinar
November 03, 2020
AdvantageAustria

ARKEMA
INNOVATIVE CHEMISTRY

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Q&A

WKO
AUSSENWIRTSCHAFT AUSTRIA

Danke für Ihre Aufmerksamkeit

Weitere Fragen?

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