



Keynote: UiA

automated disassembly
Martin Choux



TRCM – AA Battery Recycling

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LIBRES – NFR supported Lithium-Ion Battery Recycling Project

Project facts

- Hydro is project owner
- Main goal
 - Develop a design basis for a LIB recycling pilot plant in Norway
 - The pilot plant shall be large enough to handle commercial volumes in 2024
- Budget
 - 22 MNOK over 4 years (2018-2022)
- Partners
 - Commercial: Hydro ASA, Batteriretur AS, Glencore Nikkelverk AS, Keliber OY
 - R&D: IME RWTH Aachen, Elkem Technology, NTNU, UiA Grimstad



BatteriRetur



A Bluestar Company



A GLENCORE COMPANY



NCE EYDE
Norwegian Center of Expertise
Sustainable Process Industry

Hydro Volt AS

Hydro bygger fabrikk for resirkulering av elbilbatterier i Fredrikstad

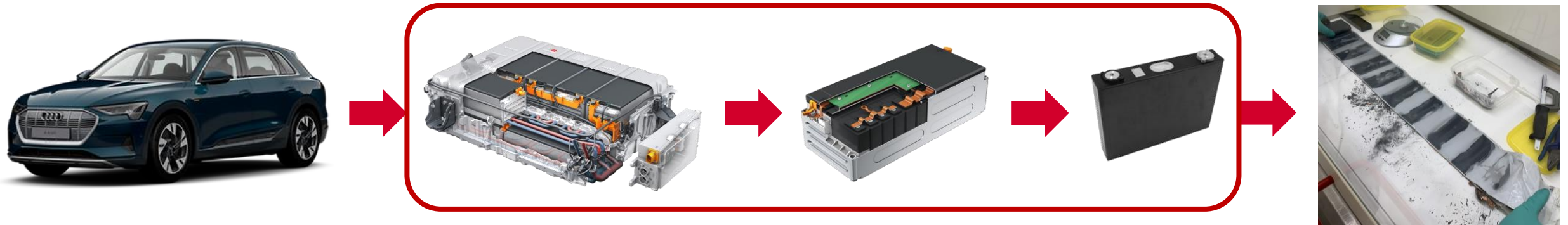
Sammen med Northvolt skal Hydro bygge et anlegg for resirkulering av elbilbatterier i Norge. – Dette er veldig viktig, sier statsminister Erna Solberg (H).



Arvid Moss, direktør for Energi i Hydro, viser statsminister Erna Solberg (H) en elbil med batteri om den planlagte fabrikken kan resirkulere. (Foto: NTB Scanpix)

Goals

Developing a **robotic dismantling process** from a battery pack to cell level components
LIBRES WP1



Robotic system that will deal with a **large variety of battery systems**



Challenges

- Large variations in battery pack/module/cell designs
- Dirty battery packs – recognition challenges



- Recognition of different components (e.g. flexible cables)
- Dismantling process with a minimum number of tool changes
- Safety issues with regards to high voltages and chemicals

Recent Increase of Popularity in Battery Disassembly

(Outside UIA)

DeMoBat in Germany

13 Millionen Euro für Batterierecycling

Das Forschungsprojekt DeMoBat beschäftigt sich im Rahmen des Strategiedialogs Automobilwirtschaft BW damit, wie Batterien und Antriebe für E-Autos robotergestützt demontiert und damit besser recycelt werden können.

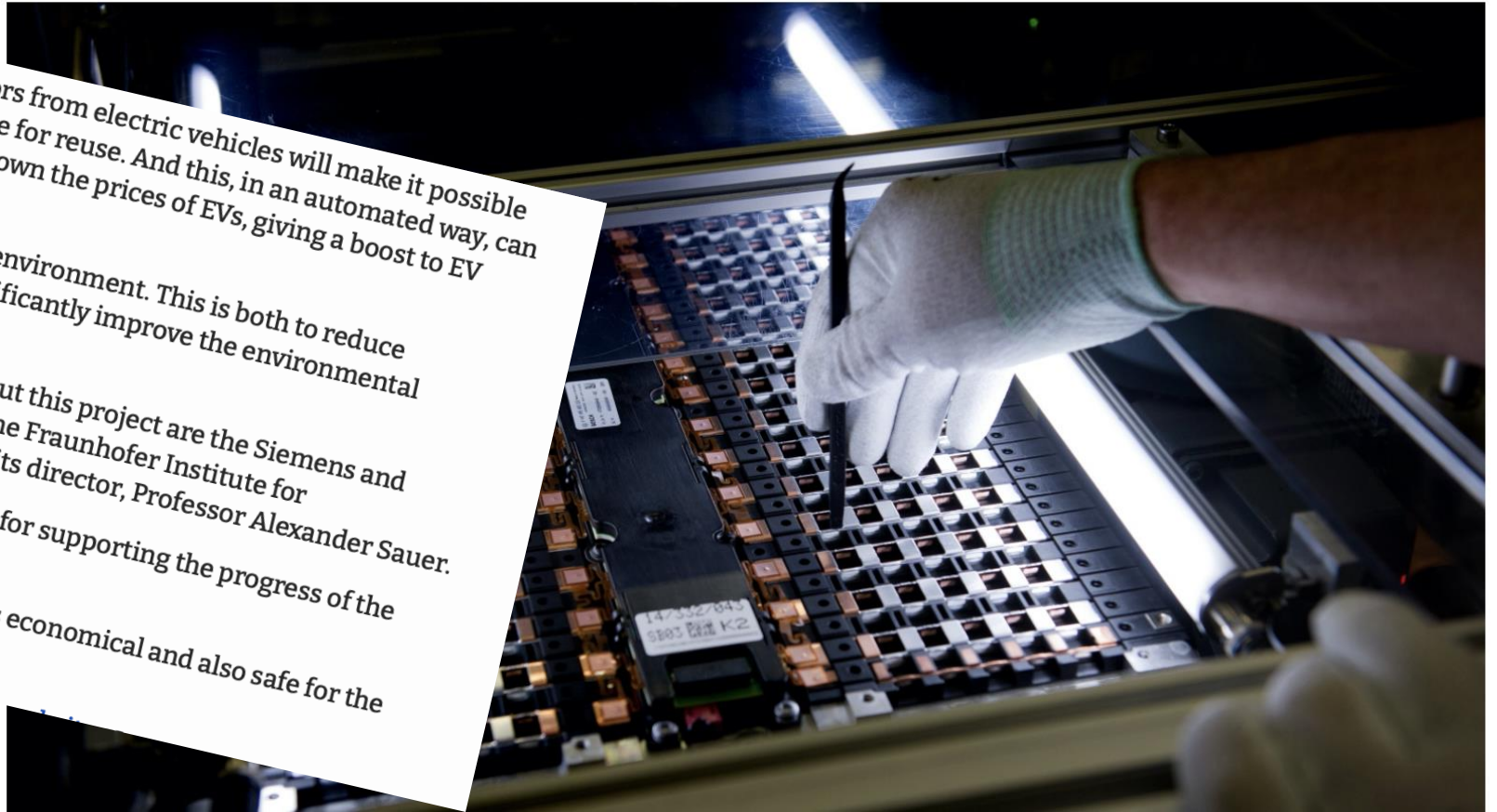
The robot-assisted dismantling of batteries and motors from electric vehicles will make it possible to recover materials such as cobalt, nickel and graphite for reuse. And this, in an automated way, can bring the cost of new batteries down, hence bringing down the prices of EVs, giving a boost to EV adoption.

The processes at work for this must be respectful of the environment. This is both to reduce dependence on imports of raw materials, but also to significantly improve the environmental impact of electric vehicles throughout their life cycle.

Among the 13 university and industrial partners carrying out this project are the Siemens and Mercedes-Benz groups. The consortium is coordinated by the Fraunhofer Institute for Manufacturing Engineering and Automation (IPA), through its director, Professor Alexander Sauer.

A center of excellence created specifically will be responsible for supporting the progress of the program on the technological and economic levels.

"It is important for us to verify whether the dismantling plant is economical and also safe for the environment," said German Minister Franz Untersteller.



Revolt by Northvolt

Northvolt is establishing a complete ecosystem for battery recycling:

- Distributed smart recovery infrastructure
- Automated dismantling & crushing
- State-of-the-art hydromet technologies to recover elemental metals and refine them to the highest quality

Revolt solutions will be demonstrated at a pilot recycling plant being established at Northvolt Labs in Västerås, Sweden.

A full-scale recycling plant will be built at Northvolt Ett to secure a goal of 50% recycled material in new cells by 2030. The recycling plant's first block will be operational in 2022 with capability to recycle approximately 25.000 tons of battery cells per year.



Northvolt to commercialise new lithium-ion recovery methods to support 2030 recycling targets

InnoEnergy, with the support of the [EIT](#) and the European Union, has announced its €5.8 million investment into [Northvolt's](#) “Revolt” programme. The programme, which will implement the latest discoveries in efficient materials recovery methods, will see the construction of a pilot battery recycling plant, followed by a full-scale version at Northvolt's site in Skellefteå in 2022. EIT InnoEnergy's investment supports Northvolt's target of using 50% recycled materials in all its new battery cells by 2030.

Faraday Institute ReLib

The installation of the industrial robots in a collaborative array of robots at [Tyseley Energy Park](#), which will be used to demonstrate automated disassembly operations on EV batteries, was also completed in July and will be ready for development work in August.



In an initiative lead by Newcastle-based ReLib Faraday Institution Research Fellow, Mohammad Rajaeifar, *Resources, Conservation and Recycling* is preparing a Special Issue *Sustainable supply and value chains of electric vehicle batteries*. Papers are due October 30th. We would encourage submissions.

Other

ENERGY STORAGE

REVIEW | [Free Access](#) |

**Battery pack recycling challenges for the year 2030:
Recommended solutions based on intelligent robotics for safe
and efficient disassembly, residual energy detection, and
secondary utilization**

Lin Zhou, Akhil Garg, Jun Zheng, Liang Gao✉, Ki-Yong Oh

First published: 28 June 2020 | <https://doi.org/10.1002/est2.190>

Results so far

(Inside UiA)

Approach

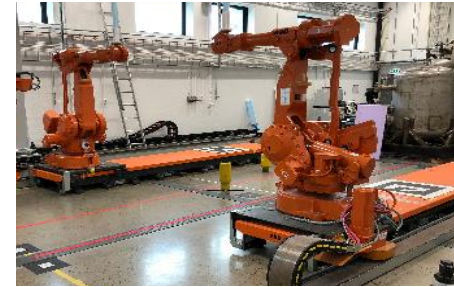
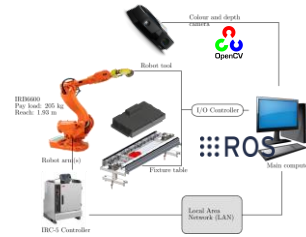
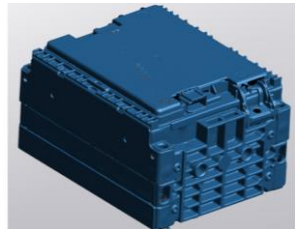
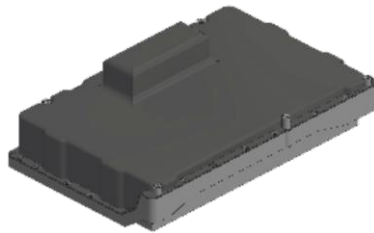
Battery Models

Disassembly plan / process

Connections

Robot Integration

Testing Cognitive Algorithms



Battery
Models

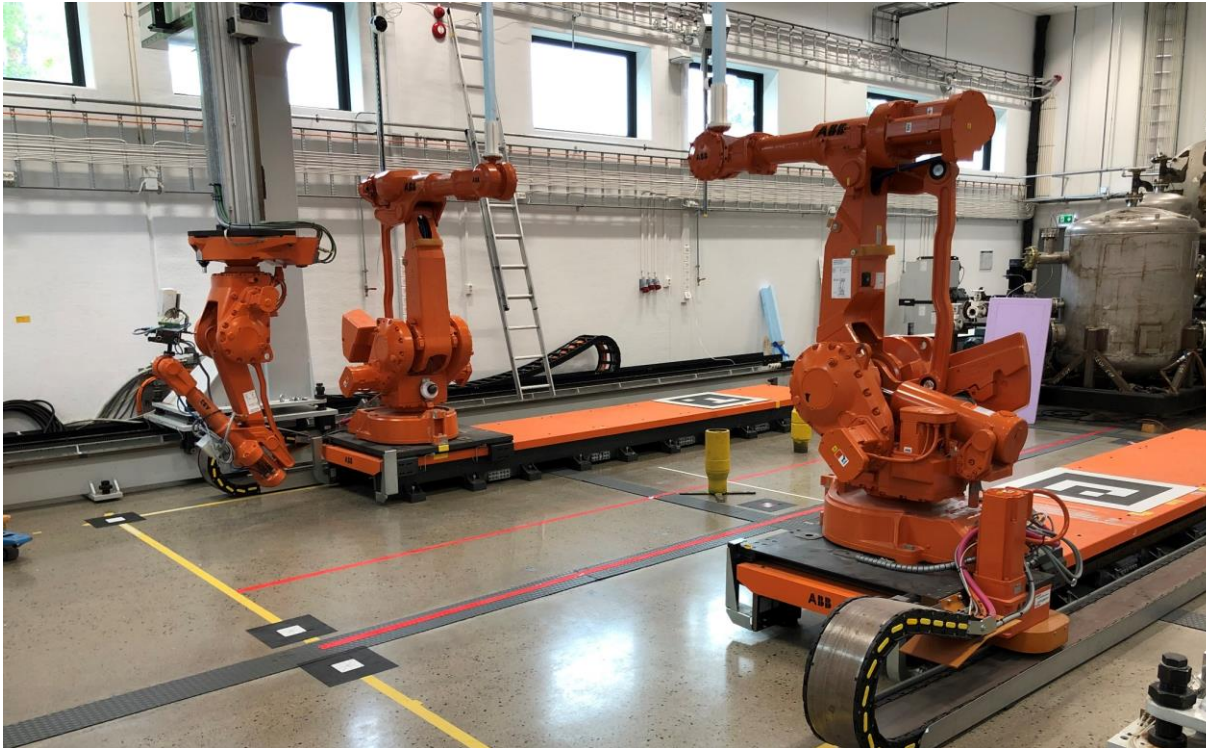
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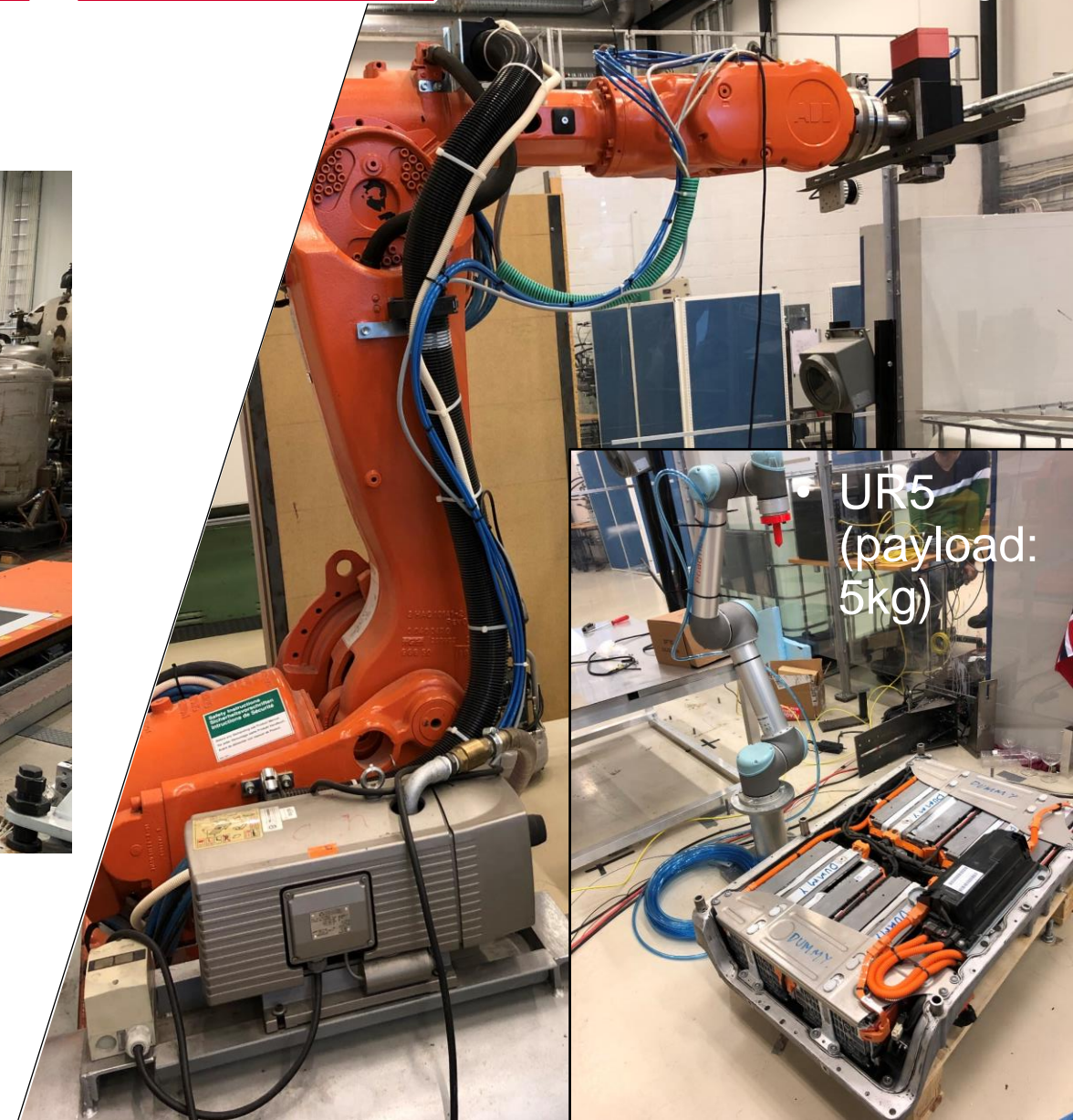
Robot
Integration

- Mechatronic lab:
 - IRB 6600
(payload: 250 kg)

Lab space allocated for dismantling at UiA



- Robot Lab
 - 2xIRB 4400 (payload: 60 kg)
 - IRB 2400 (payload: 7-20 kg)



- UR5
(payload:
5kg)

Battery
Models

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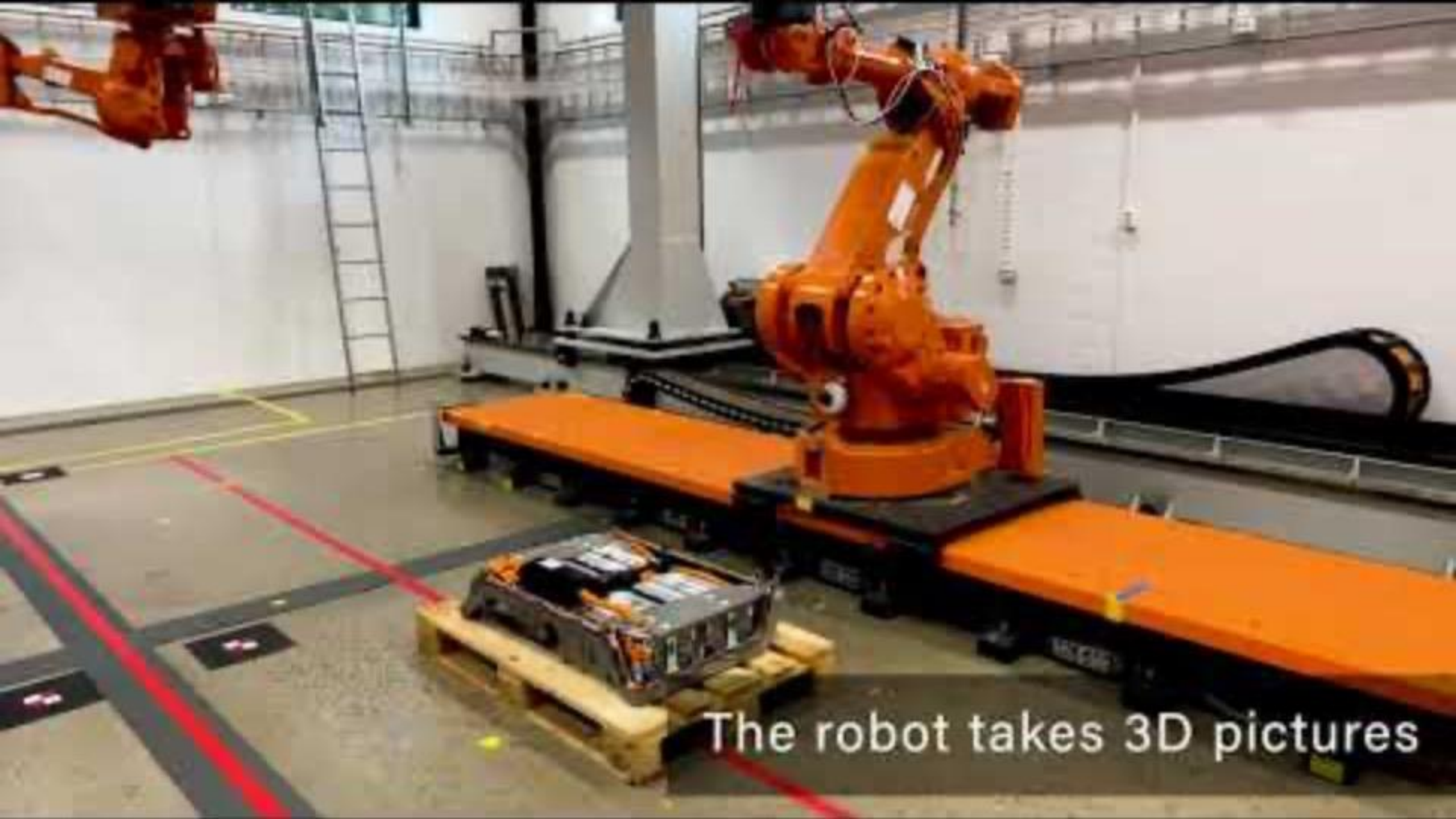
Robot
Integration

Testing
Cognitive
Algorithms

Cognitive Robotic Agent

- Image Capturing
- Object detection (2D Image analysis)
- Pose estimation (3D Point cloud and depth image)
- Decision making
- Robot communication and path planning (using ROS and MoveIt!)





The robot takes 3D pictures

Keynote: BatteriRetur

requirements for second use
Dag Albertsen



BatteriRetur

Three compliance organizations owned by importers and producers.
One protected brand.

AS Batteriretur

- SLI & Industrial

Rebatt AS

- Portable/household

Batteriretur Høyenergi AS

- Electric vehicles/High voltage batteries

Battery Operations Norway AS

- European collection and service provider
- Workshop
- Training and course center



Batteriretur dept. Sandefjord

- Est. in 2013
- Main focus on electrical and hybrid car batteries
- Also work with high voltage marine and industrial batteries
- Collecting, testing and dismantling HV batteries from the Norwegian market
- Evaluation, packaging and transport
- Several research and development projects
- Training partners from the industry, with special focus on safety





R&D Second life set-up at Kortbølgen Fredrikstad

- Solar system powering Batteriretur HQ in Fredrikstad.
- Battery modules charged from the solar systems store the energy to shave peaks off the grid.
- Energy can be sold back to the power grid or be stored in our internal smart grid system combined with used EV batteries.
- The project shows that it is possible to use battery modules from different batteries of the same type in such plants. Co2 friendly and cost saving.



Possibilities with Second Use

Big cost saving opportunities for OEM's who accept we re-use modules

- Up to 50% in 2019 and increasing

Batteriretur has agreements with companies for re-use of modules

- Modules are measured and health status & rest capacity is checked and certified by us
- The purchasing partner is invoiced a price pr kg
 - Quarterly payback or decreased invoice to importer or supplier
- The purchasing partner pays a fee pr kg to Batteriretur for securing the future cost of recycling

The above mentioned will only be done with acceptance from the producer/importer



Challenges with Second Use

Legislation is not clear on who carries producer responsibility.

- Therefore we have agreements to secure that the OEM/importer has no responsibility for the re-used modules

Money flow

- Modules from a private imported battery being re-used. Who will have the quarterly payback of saved costs?

Acceptance from OEM's to re-use

- No clear policy on re-use in some OEM organizations



Requirements for Second Use in Norway

- They must have a written contract with Batteriretur
- They must make a deal to set aside for future recycling expenses
- They must take on the producer responsibility for the battery modules and the new product that the modules will be used in
- They must have sufficient knowledge to be able to build a quality product
- They must implement sufficient safety measures into the product such as BMS, temperature control, balancing, limit values for load and charging, etc
- They must adapt the product to the user group it is intended with concern of safety
- They must remove any product marking from original producers



Requirements for Second Use in Norway

Batteriretur

- Batteriretur must have approval from the relevant car producers to use the battery modules for the planned purpose
- Batteriretur must recommend using battery modules suited for the planned purpose/use
- Batteriretur must select battery modules without measurable deviation in the battery cells and sufficient state of health (SOH)
- Batteriretur will normally balance the cells inside of the battery modules that are going to be used together in/for the energy storage system (ESS)

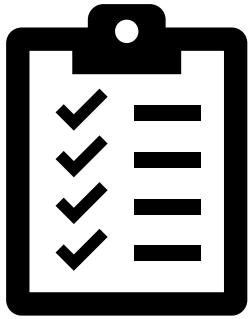


Thank you for your attention!

Panel Discussion

involve me and I will understand

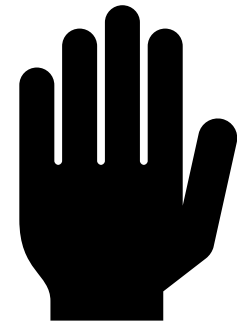
Panel Discussion



Questions
will be
answered



For questions
use **Q/A tool**



Or use **Hand**
if you want
to talk



battery.uia.no