



The European Association
for Electromobility

AVERE Webinar

Raw Materials Supply Chain for Batteries

9 April 2020

Webinar Info

- This webinar is recorded.
- Participants receive the link, inclusive the presentations.
- Q&A : please post your questions.
- Questions can be up voted.
- We limit the Q&A to 15 minutes or 15 questions.
- Participation in the polls is anonymous.

History

AVERE – Passion to electrify since 1978

Vision

AVERE's electromobility vision for Europe is:

- A strong electromobility industry;
- Clean, quiet and healthy cities;
- Energy efficient transport;
- Independence of fossil fuels.



Agenda of the webinar

- Introduction to CRM4EV
- ...
- Questions and answers

Speakers

- Philippe Vangeel
- Bert Witkamp

HEV TCP Task 40 CRM4EV

Critical Raw Material for Electric Vehicles

Electric vehicles – Batteries – Raw Materials

Current - 2030

Bert Witkamp – Operating Agent Task 40

Disclaimer

- *The IEA HEV TCP is part of a network of autonomous collaborative partnerships focused on a wide range of energy technologies known as Technology Collaboration Programmes or TCPs. The TCPs are organised under the auspices of the International Energy Agency (IEA), but the TCPs are functionally and legally autonomous. Views, findings and publications of the HEV TCP do not necessarily represent the views or policies of the IEA Secretariat or its individual member countries.*
- *Views, findings and publications of the Task 40 CRM4EV (HEV TCP) do not necessarily represent the views or policies of the HEV Secretariat, HEV TCP or its individual member countries. Nor does it necessarily represent the individual Task 40 participants.*

The IEA HEV-TCP

The International Energy Agency Hybrid & Electric Vehicle Technology Cooperation Programme
An independent multi country initiative started in 1993

- 18 member countries:



Austria



Germany



South Korea



Belgium



Ireland



Sweden



Canada



Italy



Switzerland



Denmark



Netherlands



Turkey



Finland



UK



France



Spain



USA



Norway



The IEA HEV has started Task 40 CRM4EV in April 2018

Participating IEA HEV countries and organisations

Japan is represented by JOGMEC and Western Australia by MRIWA



IEA HEV Task 40 CRM4EV: Mission

Connecting the raw material industry with electromobility

- To supply objective information the **Task 40 participants** & to governmental policy makers and agencies, industry decision makers and research institutes
- To facilitate international collaboration involving shared resources from multiple countries and organisations



EVs and Critical Raw Materials:

Can raw material issues slow down the EV transition?

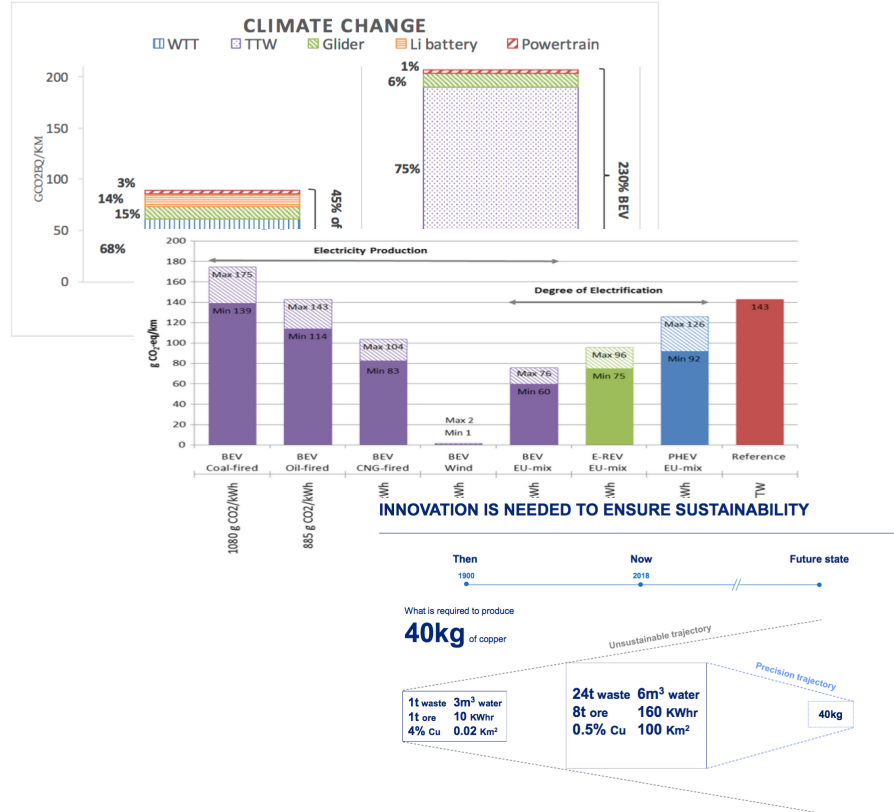
(Critical) Raw Materials - Supply

- Supply risks at short and long term
- Environmental impacts - LCA
- Social impacts
- Recycling and the circular economy
- Li – Ni – Co – Cu – Graphite – Rare Earths

Electric Vehicles - Demand

- How many, when, which type
- When and to what extent will mass deployment happen
- How EV technologies evolve: impact the type and quantity of CRMs required (per unit)

Reducing the Life Cycle impacts of EV batteries



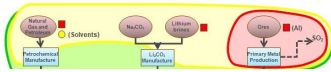
- Entire EV lifecycle, raw materials key
- Focus GWP & primary energy demand
- Leveraging existing LCA studies and expertise of Task partners
- Harmonization of methodologies in existing CRM-LCA studies
- Current / future battery chemistries to consider in LCA

Recycling in task 40 CRM4EV

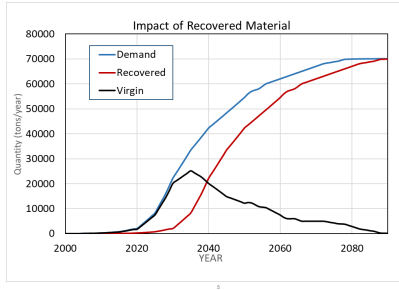
2017 INTERNATIONAL LIB TRADE FLOWS

SOME MAJOR ASSUMPTIONS

LI-ION RECYCLING PROCESSES DISPLACE MATERIALS AT DIFFERENT PRODUCTION STAGES



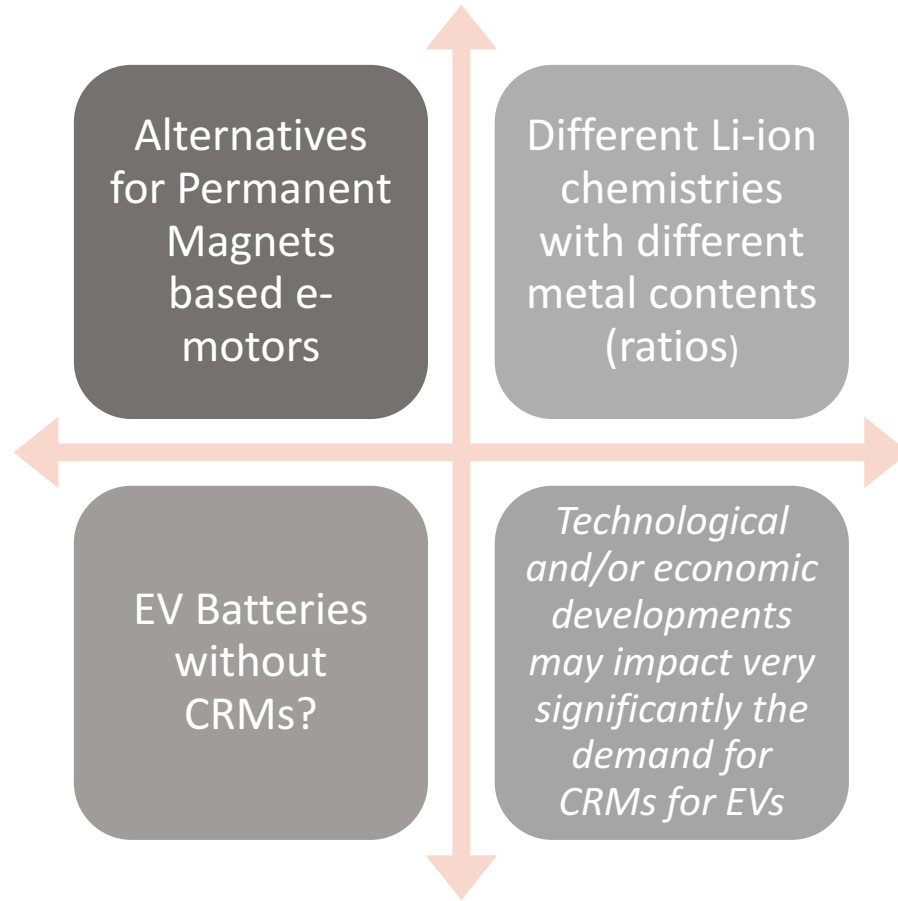
RECYCLING CAN REDUCE MATERIAL DEMAND... EVENTUALLY



- Recycling as future source of raw materials (mass flow model, economics)
- Environmental impacts of recycling (input to Task 40 LCA model) versus use of virgin raw materials
- Evaluation of existing and future recycling processes (material yields, energy efficiency)

Also in scope:

Alternatives for Critical Raw Materials (applications)



Workshop 3 on recycling and LCA of Li-ion batteries – Shanghai

hosted by IPE CAS, SSPU, WEEE, Botree



External guest speakers:

- AIKAR « next generation EV platform »
- Innovation centre for WEEE recycling « recycling of anode materials »
- Huayou Cobalt « recycling of Li-ion batteries »
- CATL « life cycle system for the sustainable development of traction batteries »
- Botree « recycling of cathode materials »



Antaiko NiCo Industry forum Task 40 presentation

国际能源署 Bert Witkamp 作报告



Task 40 in China November 2019

CATL site visit & discussions



AIWAYS site visit & discussions



Bert Witkamp - Task 40 - Confidential

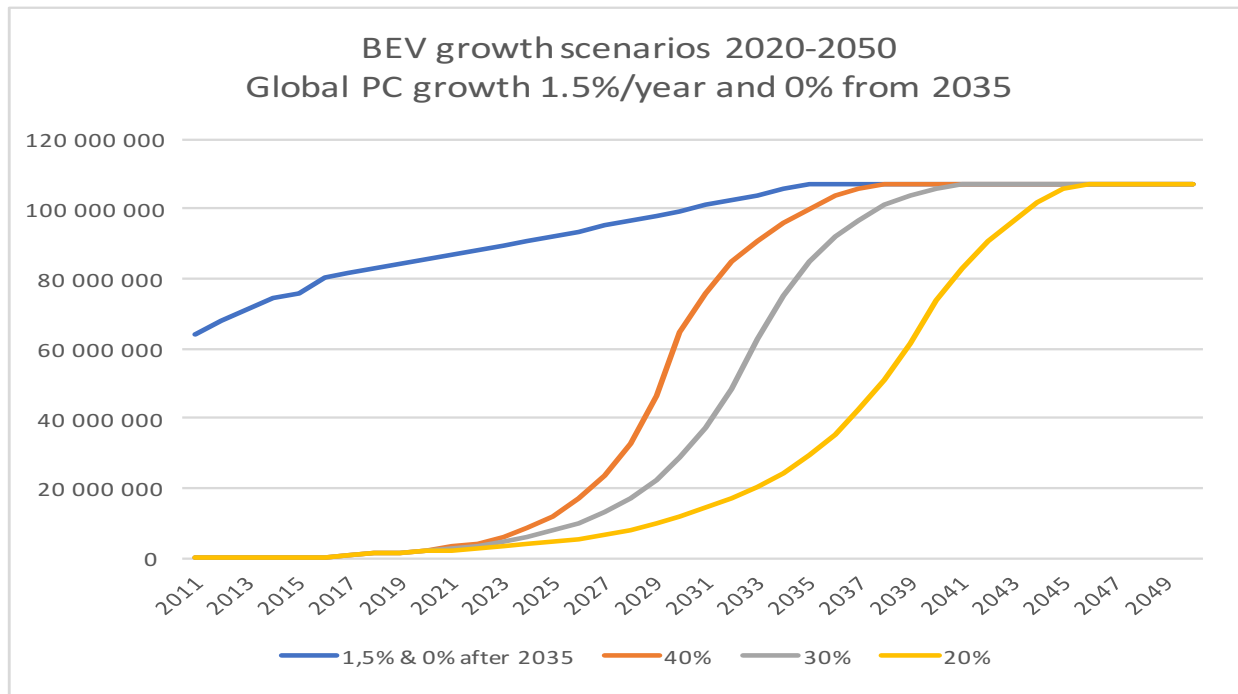


Huayou site visit & discussions

Electric vehicles (road) 2018 - 2030

Task 40 CRM4EV passenger car market: modest growth only

BEV: 3 growth scenarios



- Historic PC growth about 4%/year
- Historic BEV growth 50%/year (2008-2018)
- After 2035 impact shared cars, autonomous cars, other transport solutions?

Two global scenarios from multi-stakeholder initiatives

EV30@30: multi-country driven and GBA: industry driven



CEM Campaign

EV30@30 INCREASING
UPTAKE OF ELECTRIC VEHICLES
A CAMPAIGN OF THE CLEAN ENERGY MINISTERIAL

EV30@30 Campaign

A campaign launched under the Electric Vehicle Initiative (EVI)

Goals

The EV30@30 Campaign sets a collective aspirational goal to speed up deployment and reach a 30% sales share for electric vehicles by 2030 among the participating countries.

The campaign supports the market for electric passenger cars, light commercial vans, buses and trucks (including battery-electric, plug-in hybrid, and fuel cell vehicle types). It also works towards the deployment of charging infrastructure to supply sufficient power to the vehicles deployed.



Insight Report



A Vision for a Sustainable Battery Value Chain in 2030 Unlocking the Full Potential to Power Sustainable Development and Climate Change Mitigation

September 2019

Global, EU and national NEV/ZEV (car) ambitions

IEA HEV Task 40 CRM4EV - Impact of NEV/ZEV targets on BEV penetration

	NEV / ZEV Targets passenger cars	Required NEV/ZEV growth YoY %	2030 NEV market share %	2030 ZEV market share %	2030 BEV car sales (millions)
COP 21	1.5°C target - 100% ZEV fleet in 2050 - 100% ZEV sales in 2035 - 75% ZEV in 2030 (all transport)	40%		75%	63
WEF GBA Base case	WEF - Global Battery Alliance	27%			22
WEF GBA Target case					
EV 30@30 midpoint	CEM-EVI scenario	30%			34
Task 40 CRM4EV	30% year on year growth for BEV cars	30%	29%		29
EU	Proposal 11 MS for ICE ban 2030 (= 5years faster than EU Green Deal!)	47%		100%	16
China	Strategic plan 50% NEV in 2030	26%	50%		12
Germany	Climate package (10 mio PEV fleet 2030)	45%	90%		2,5
Germany	Climate package (7 mio PEV fleet in 2030)	40%	60%		2,5
Italy	National target EV - 6.5 EV in 2030	60%	100%		1,9
Netherlands	Green deal	27%		100%	0,5
UK	100% ZEV in 2032 (proposal)	43%		85%	1,2
UK	100% ZEV in 2040	28%		36%	0,2

NEV: New Energy Vehicles = PEV = BEV + PHEV ; ZEV: Zero Emission Vehicles = BEV (FCEV assumed 0)

Market share: if assumptions on total market are available

Scenarios: WEF GBA: 2019, EV30@30: 2017, Task 40: 2019, China: 2017, Countries: 2019

- What do these ambitions imply for BEV annual sales (growth) and fleet?
- What are the impacts on battery demands?
- Recent years ambitions have been increased by advancing 100% ZEV years or increased targets.
- China is currently reviewing its NEV strategy, in draft 25% NEV sales in 2025.

2018 global vehicle market and 2030 scenario

EV market: 2019 data

2030 market based on scenarios GBA, EV30@30, Task 40 CRM4EV 30% growth

Vehicle category	2018 market	2030 market	
	Sales (thousands)	battery size (kWh)	Sales (thousands)
Light Duty Vehicles:			
Passenger cars	83 000		100 000
Light Commercial Vehicles	8 300		10 000
PC/LCV Electrified:			
BEV	1 600	65	32 000
PHEV	630	15	6 400
Hybrid	3 500	2	10 000
Medium & Heavy Duty Vehicles			
Trucks	3 000		3 900
Buses	500		600
Vocational	500		
MDV/HDV Electrified:			
e-Buses	100	300	420
e-Trucks	5	500	390

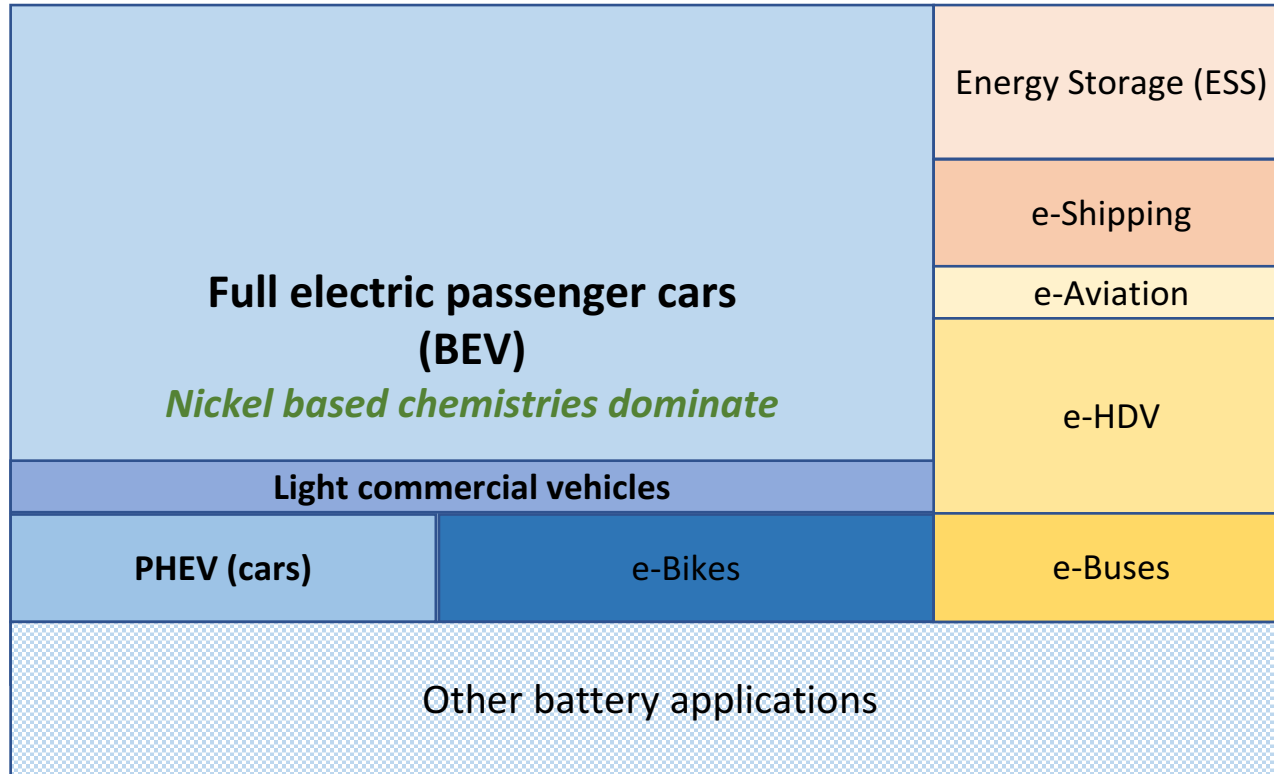
Passenger cars: this includes the 12 Mio USA « Light Duty Trucks »

Sources: OICA, DOE, Interact Analysis, BNEF, GBA, IEA, EVI, Fraunhofer/VITO, CRM4EV

- 2030 sales targets from scenarios / ambitions
- HDV: e-buses 70% share in 2030, based on BNEF scenario – in many situations e-buses already have lowest TCO
- MDV/HDV: e-trucks 10% share in 2030, today 1%
- Lowest TCO expected for many e-truck applications (200-300 km/day), share could be much higher in 2030

Lithium-ion batteries

Applications for Li-ion batteries



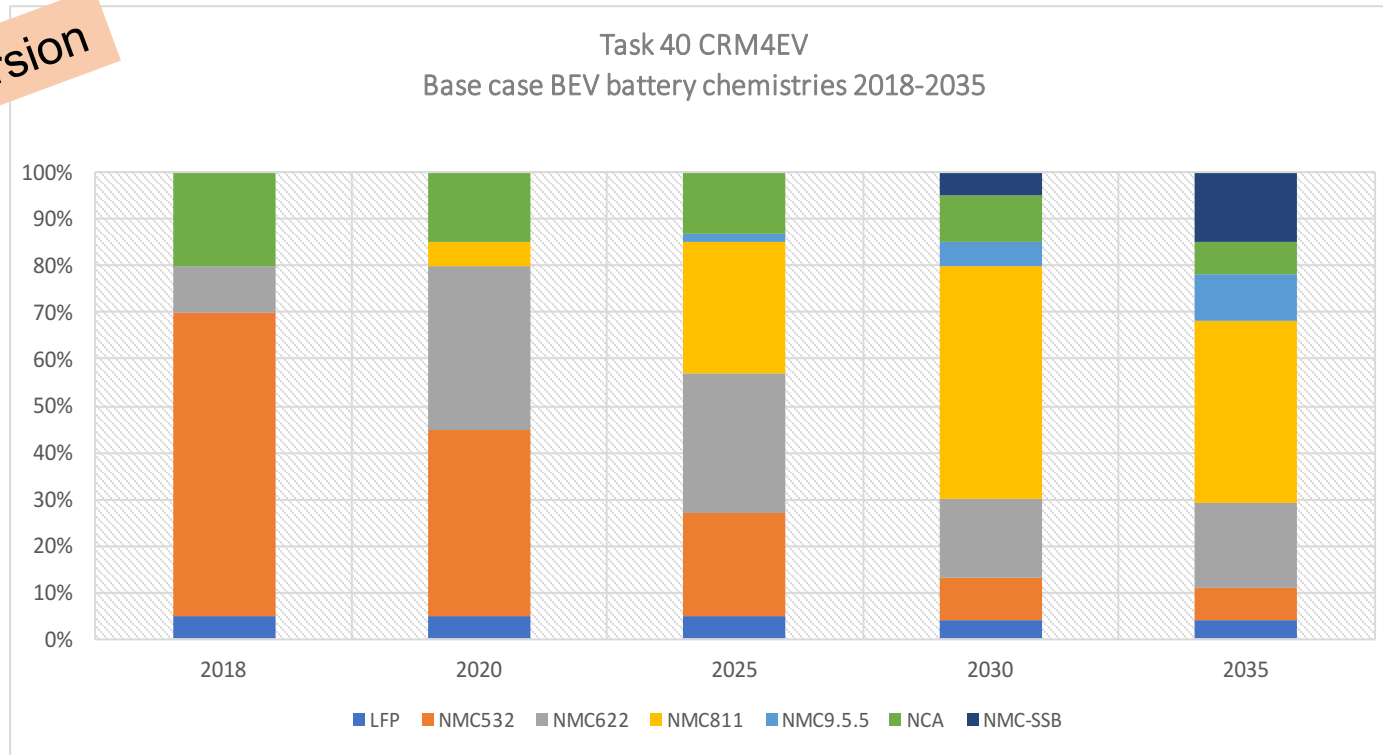
Battery chemistries for different vehicle types

- Cars / LCV (BEV)
 - NiCo based mainly (high nickel); possibly high Mn introduced as of 2025
 - CRM4EV scenarios 2019-2025-2030-2035
 - Development of chemistries without NiCo
 - Utilization of LFP in small amounts
 - LCV = 10% of cars
 - 65 kWh/car 2030
- Cars (PHEV): 11 kWh/car going to 15 kWh/car in 2030;
 - 2030: PHEV = 20% of BEV market (currently: 30%, trend: declining)
 - Cars (Hybrid): 1.5 kWh/car, several chemistries (NiMH, Li-ion): @15% market share 2030: 1% of BEV battery demand
- HDV:
 - Currently almost only LFP (China), developments in Europe/USA based on NiCo
 - Alternatives not based on NiCo expected to be able to cover significant part (market mechanism)
 - Buses (city): 300 kWh
 - Trucks: 500 kWh
- LEV and e-bikes: different technologies (lead-acid, LFP, NMC)
- Other transport (shipping, aviation,...): very small markets

Battery technology mix (market shares) for passenger cars: « base case »

based on current technology roadmap insights

Draft version



Li-ion battery market: global forecasts & scenarios 2030				
GWh demand	30% growth CRM4EV	GBA base	GBA target	EV30@30 midpoint
Light Duty Vehicles:				
<i>Passenger Cars and</i>		1597	2304	
<i>Light Commercial Vehicles</i>		160	230	
BEV	2080			2015
PHEV	96			169
Hybrid	15			
Commercial Vehicles				
(Medium & Heavy Duty Vehicles)				
HDV/MDV		475	755	
e-Buses	125			250
e-Trucks	350			117
e-Vocational				
2/3 Wheelers	100	100	100	100
Transport total	2766	2332	3389	2651
ESS - stationary storage	220	220	220	220
Consumer electronics	70	70	70	70
Total GWh	3056	2622	3679	2941
%LDV	71	61	63	74
%transport	91	89	92	90

- The GBA (Global Battery Alliance) base case scenario foresees a 14-fold increase for lithium-ion batteries in 2030 from 2018 (in GWh/year).
- For the transport battery demand this is in line with the EV30@30 (midpoint) scenario and it corresponds with the Task 40 CRM4EV 30% growth per year (midpoint scenario).
- Consumer applications (GBA): demand will grow with 5% per year from 38 GWh in 2018 to 69 GWh in 2030. The market share for this application will be reduced from 21% to 2.6%. The lifetime of batteries in consumer applications is a few years.
- Stationary energy storage (GBA): demand (for Li-ion batteries!) will grow with 38% per year from 4 GWh in 2018 to 221 GWh in 2030. This is for lithium-ion batteries only. Market share will be 8% in 2030.

Key raw materials for Li-ion batteries

Raw material requirements EVs

- **How many EVs, which categories?**
 - 3 scenarios for BEV growth (20, 30, 40% year on year)
 - Scenarios for other vehicle types
 - Till full transition is reached
- **Which battery materials?**
 - 3 scenarios for battery chemistries development
 - **Base case (« high Ni »)**
 - High Mn chemistry
 - High Mn + Zero NiCo chemistries
- **Raw material requirements**
 - a. **For new EVs**
 - b. Contained in BEV car fleet and other fleets (cumulative)
 - c. Available from end of life of car – how much, when
 - d. Net RM requirements (a-c) for BEV cars and other EVs

Impact of EV targets on 2030 Li-Co-Ni : current battery roadmap

IEA HEV Task 40 CRM4EV - Impact of NEV/ZEV targets on EV penetration and Li-ion battery demand				Metals for batteries for transport		
	NEV / ZEV Targets passenger cars	2030 BEV car sales (millions)	Li-ion for transport (GWh)	Lithium (kton)	Cobalt (kton)	Nickel (kton)
COP 21	1.5°C target - 100% ZEV fleet in 2050 - 100% ZEV sales in 2035 - 75% ZEV in 2030 (all transport)	63				
WEF GBA Base case	WEF - Global Battery Alliance	22	2 332	225	140	1 080
WEF GBA Target case			3 389	340	215	1 650
EV 30@30 midpoint	CEM-EVI scenario	34	2 651	325	360	1 800
Task 40 CRM4EV	30% year on year growth for BEV cars	29	2 767	250	260	1 320

Lithium: 2018 production 53 kton, increase needed 540-850% by 2030

Cobalt: 2018 production 125 kton, increase needed 100-275% by 2030

Nickel: 2018 production 2250 kton, increase needed 45-80% by 2030

NEV: New Energy Vehicles = PEV = BEV + PHEV ; ZEV: Zero Emission Vehicles = BEV (FCEV assumed 0)

Market share: if assumptions on total market are available

Scenarios: WEF GBA: 2019, EV30@30: 2017, Task 40: 2019, China: 2017, Countries: 2019

This is based on the currently expected battery « roadmap » of the just starting battery development era – expect this to change significantly even if we do not know how exactly

The future of batteries is bright

- « 1 million mile » batteries for BEVS announced by Tesla, GM (and informally by others)
 - Presume a 100 kWh battery, $0.20 \text{ kWh/km} = 3,200 \text{ cycles}$
 - This is 100 years battery life @ 16.000 km / year.....
- EOL BEV batteries: second life or recycling
 - Both options are proven and can be attractive
 - At 30% growth per year, full recycling will provide +/- 1% of metals in 2030
- LCA impact future batteries:
 - Less materials (solid state = -50%)
 - Use of renewable energy for manufacturing of battery (materials)
 - Longer life time in vehicles + longer lifetime « second use » + recycling

Development of batteries (and EVs) is only just starting!

We should expect « faster than forecasted » developments in performance, cost, material use

But often we project long term based on today's technology.....

Task 40 CRM4EV: interested to learn more or join?

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9 April 2020

Bert Witkamp - Task 40 - AVERE webinar



Q/A

Please submit your questions through the attendee
chat



Join our upcoming webinars

22/04 – 10am CET: Insights of the SEEV4-City project: 6 pilots that pave the way for smart electric mobility solutions.

6/05 – 10am CET: Vehicle-to-grid(V2G) and Smart Charging: the future symbiosis between emission-free transport and sustainable energy infrastructure

20/05 – 10am CET: Policy Learning from SEEV4-City pilots: what policies do we need for the future?

