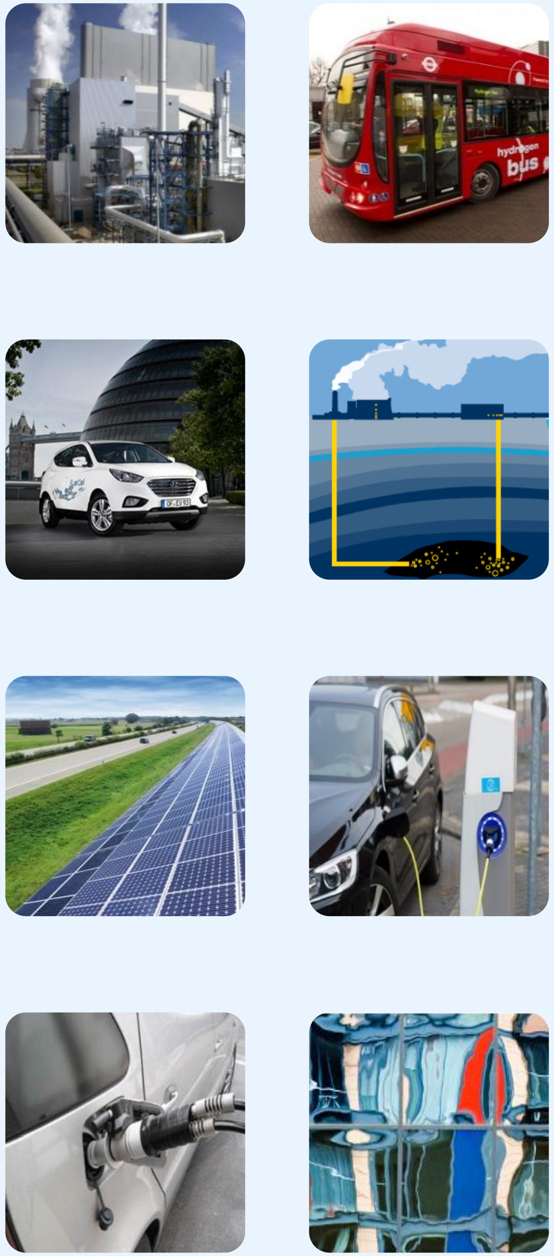

Work Packages 2 & 3: Battery replacement review and recycling cost modelling

BEUC – The European Consumer Organisation

Final Results

19th August 2021

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an ERM Group company

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BEUC TCO Extension Project: WP2 & WP3

Battery replacement review and recycling cost modelling

Result Pack Introduction

- Element Energy recently completed TCO results at an EU level and in 9 focus European markets for BEUC – the European Consumer Organisation
- Analysis included modelling CO_2 tailpipe emission for different uptake scenarios of battery electric vehicles (BEVs), from which conclusions were made for European manufacture emission targets
- Questions from readers of the report and at the BEUC launch event included the risk of battery replacement costs on BEV TCO savings over ICEVs and the additional residual value available at end-of-life from battery recycling
- This results pack, which addresses reader feedback, contains:
  - WP2: battery replacement & additional engine maintenance cost scenarios
  - WP3: battery recycling review

Agenda

WP2: battery replacement & additional engine maintenance cost scenarios

- Review of battery degradation
- Nissan Leaf case study
- Review of engine maintenance costs
- TCO implication & conclusions

WP3: battery recycling review

WP2 – battery replacement & additional engine maintenance cost scenarios

Summary of conclusions:

1

Consumers are very unlikely to require out of warranty battery replacements for current generation of BEVs

- **160,000km battery warranties have become industry standard**, which is close to ca. 200,000km average vehicle lifetime. Even after warranty, **BEVs with degraded batteries still meet the needs of many consumers**. Consumers are better off buying a new car rather than replacing the battery.
- Battery replacement **only a viable option for early generation BEVs**, e.g. Nissan Leaf 24kWh

2

Importance of State of Health and "right to repair" regulation

- Legislation allowing consumers to see the **State of Health of their battery in real time and maximum battery degradation criteria** could help boost consumer confidence in the longevity of their BEV, particularly for used owners when purchasing a BEV second or third hand
- **"Right to repair" regulation that ensures spare part availability** is important to increasing battery life and reducing maintenance costs being passed onto consumers

3

BEVs remain a cheaper option than ICEVs even in "very unlikely" cases of battery replacement

- High mileage scenarios representing a pessimistic case where battery replacements are used by consumers (which are baselined against additional "non-routine" maintenance costs) show that **BEVs continue to provide significant lifetime TCO savings even in the "worst case" scenario where a battery replacement is required**

WP2 – battery replacement & additional engine maintenance cost scenarios

Results pack contains the following sections:

1 Literature review of battery degradation

- Review of **“real world” battery degradation and implication for battery replacement**
- Overview of **battery warranties of leading BEV models**

2 Nissan Leaf case study

- Implication of early Nissan Leaf **battery degradation on additional charging stops** per year
- Review of **costs to replace batteries in first generation Nissan Leaf models**

3 Review of engine maintenance costs

- Overview of average additional costs from “non-routine” engine maintenance

4 TCO implications & conclusions

- **“Worst case scenario” where battery replacements are required for high mileage drivers**
- Deep dive into battery maintenance regulation that can protect consumers

Agenda

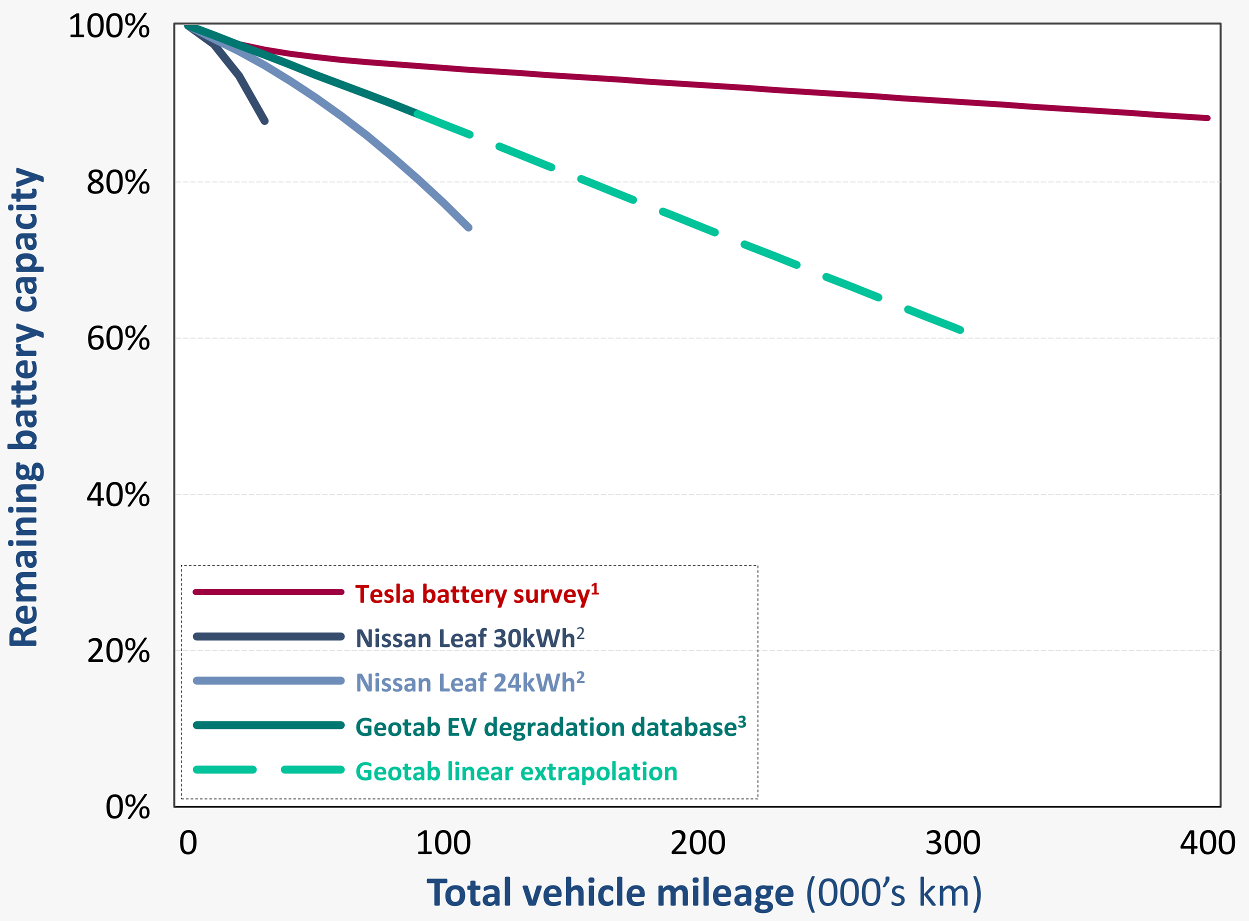
WP2: battery replacement & additional engine maintenance cost scenarios

- **Review of battery degradation**
- Nissan Leaf case study
- Review of engine maintenance costs
- TCO implication & conclusions

WP3: battery recycling review

EE Literature review of "real world" battery degradation

Real world EV battery degradation profiles



EE Conclusions

- "Real world" EV battery degradation data is becoming available and **indicates 150,000 km or more vehicle mileage before reaching 20% decrease in capacity**

- Early generation Nissan Leaf batteries were passively cooled, unlike Tesla packs which have active liquid cooling. **Active cooling is becoming the industry norm, reducing degradation, particularly during rapid charging**

- Tesla battery packs are also significantly larger than Nissan Leaf packs, meaning they have a lower depth of discharge and C rates – which reduces degradation. **Larger battery packs are becoming more common as prices decrease**

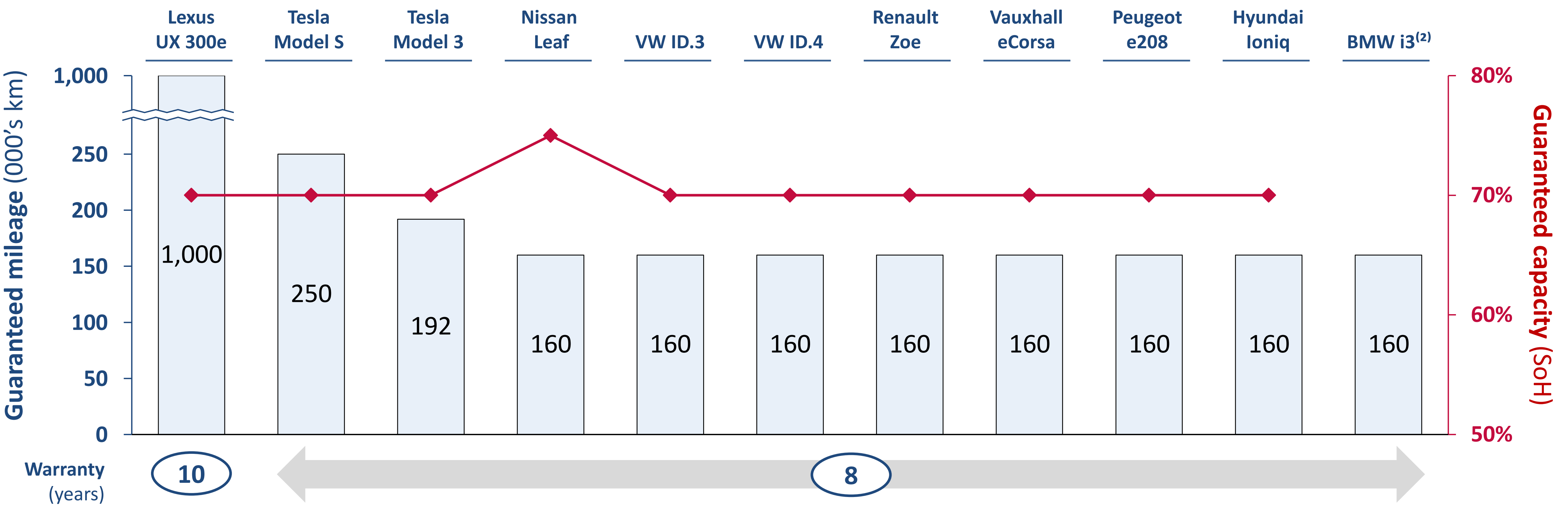
1 – Tesla Battery Survey (1,500 vehicles, global), 2020; 2 – Myall *et al.*, 2018 (283 vehicles, New Zealand). 3) Geotab (6,300 vehicles, USA), 2020. Apart from the Tesla battery survey, degradation was provided against age and converted to total vehicle mileage for comparison. Some high mileage Tesla's are known to have undergone a battery replacement (e.g. source).

Battery warranties of leading EV models

Current warranties close to total car lifetime mileage

160,000km "industry standard" warranty, which is close to ca. 200,000km average car lifetime mileage, across leading BEV models means that out-of-warranty battery replacements are very unlikely to be required by consumers; range after warranty[1] still sufficient for majority of consumers

Battery warranties of leading available BEV models (WLTP)



	Lexus UX 300e	Tesla Model S	Tesla Model 3	Nissan Leaf	VW ID.3	VW ID.4	Renault Zoe	Vauxhall eCorsa	Peugeot e208	Hyundai Ioniq	BMW i3[2]
Range after warranty (km, WLTP)	*220*	*437*	*394*	*202*	*247*	*350*	*269*	*236*	*246*	*279*	*156*

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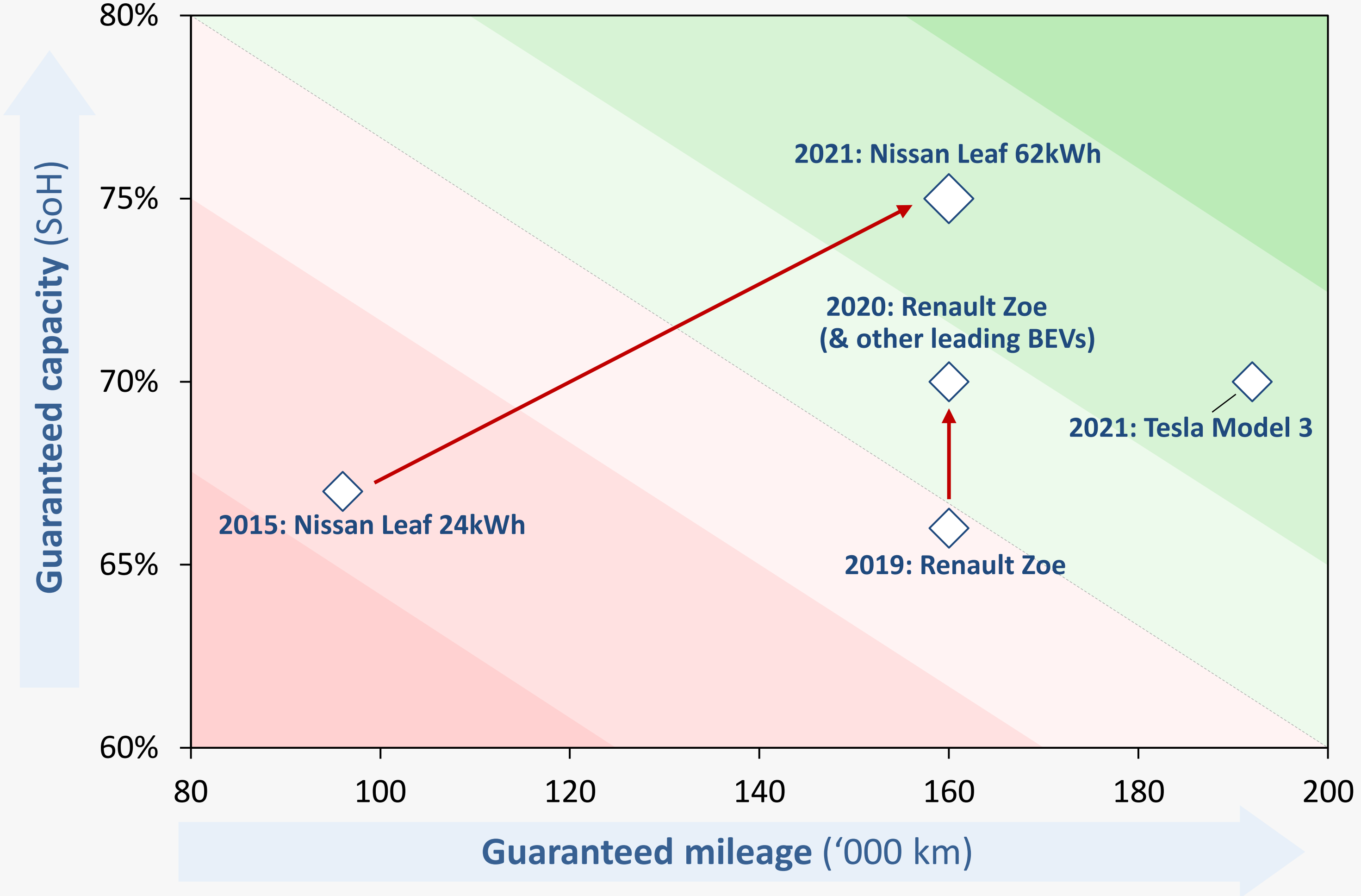
1 – Range after warranty calculated as: WLTP Range x guaranteed Soh; 2 – BMW i3 warranty does not provide a specific SoH guarantee, only against 'excessive' loss of capacity. Source graph: EE compilation of public statements, all SoH shown as guarantee at end of warranty. Acronyms: SoH = State of Health

Evolution of leading EV battery warranties over time

Historic vs. current EV battery warranties



EE Conclusions

i
- In the last decade, improved battery technology has given OEMs confidence to **guarantee greater battery mileages and capacities**

ii
- **Warranty mileage and guaranteed capacities are likely to continue to increase**, with Lexus giving consumers the option to extend to a "million km" warranty in 2021 for UX 300e model[1]

iii
- Batteries will last at least as long as the car itself and **battery replacements** (whether in or outside warranty) **are very unlikely to ever become necessary**

Source graph: EE compilation of public statements, all SoH shown as guarantee at end of warranty. Acronyms: SoH = State of Health;
1 – requires having an annual electric battery health check at a Lexis centre

Agenda

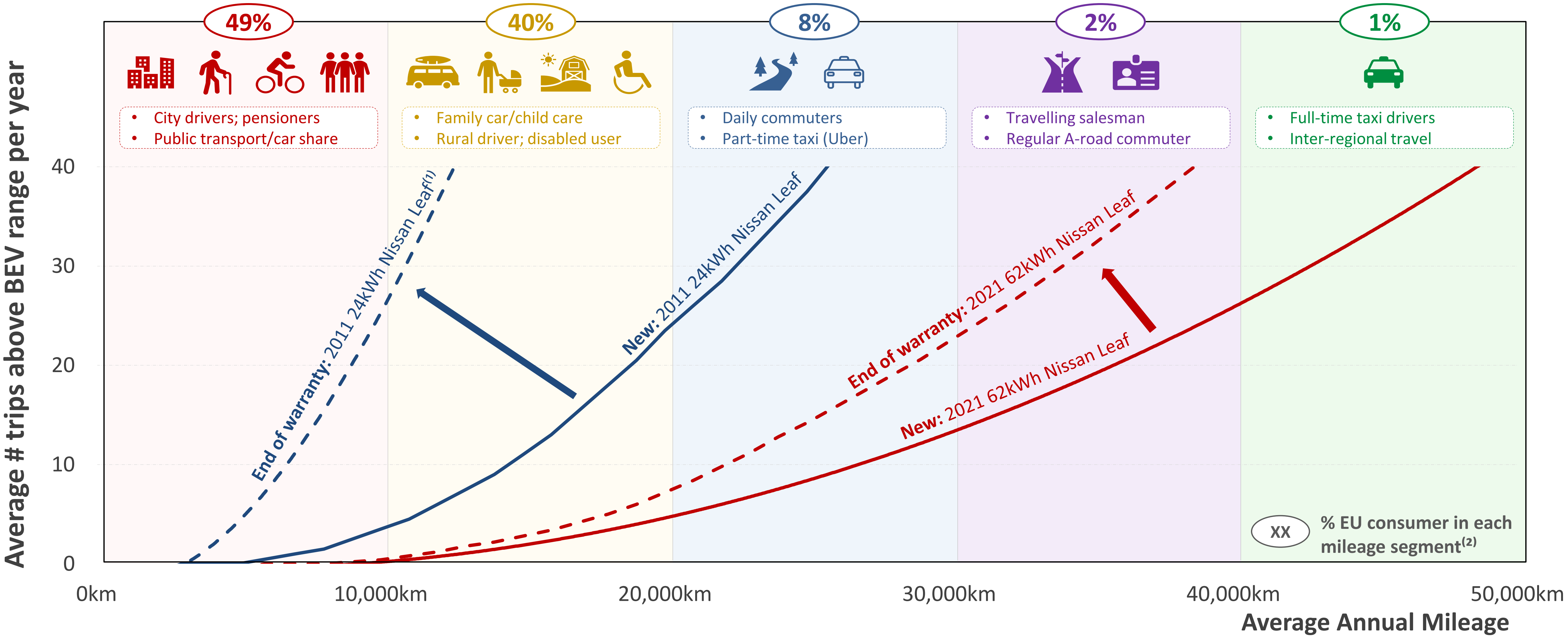
WP2: battery replacement & additional engine maintenance cost scenarios

- Review of battery degradation
- **Nissan Leaf case study**
- Review of engine maintenance costs
- TCO implication & conclusions

WP3: battery recycling review

2021 Nissan Leaf remains viable for majority of European consumers at end of warranty

A 15,000km annual mileage 62kWh Nissan Leaf driver would only need an additional 2 stops a year with a 70% degraded battery[1]



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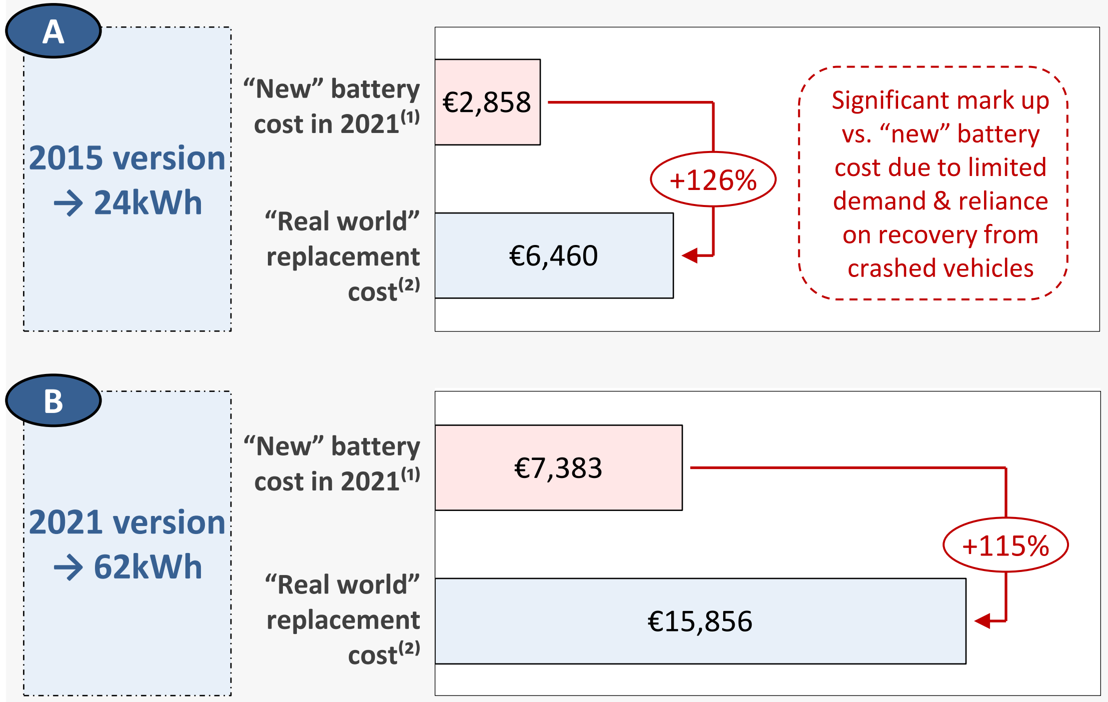
1 – End of warranty scenarios based on the maximum battery degradation allowed under the guarantied capacity (state of health). 2 – Ricardo-AEA (2014): Improvements to the definition of lifetime mileage of light duty vehicles Note that “real world” ranges have been estimated to be up to 25% lower than WLTP figures, which may increase yearly en-route charging stops required

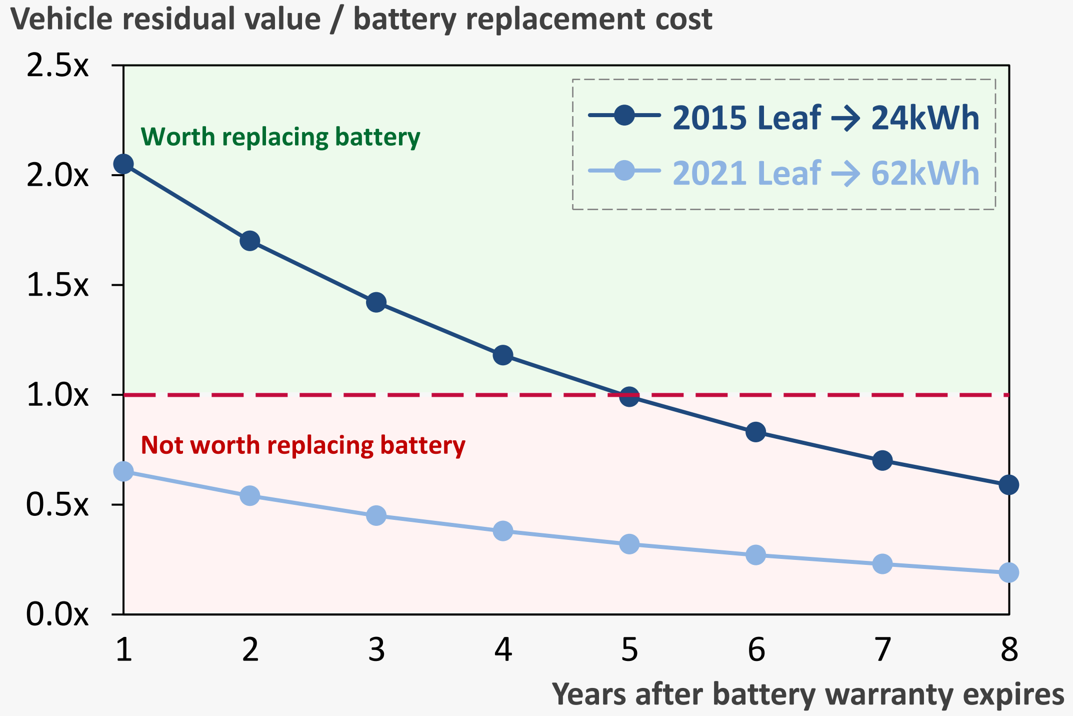
Nissan Leaf case study: battery replacement costs vs. warranty period

Nissan Leaf: battery replacement costs (incl. VAT)



Significant mark up vs. "new" battery cost due to limited demand & reliance on recovery from crashed vehicles

Battery replacement cost vs. car residual value[3]



- EE interviews conducted with companies that offer Nissan Leaf battery replacements which reported that **overwhelming majority of battery replacements are 2011 model**, with **replacement batteries sourced from crashed vehicles**

- **Current EV batteries**, such as 2021 62kWh Nissan Leaf (160,000km, 8-year warranty), **will never require a replacement** → with **battery replacement costs greater than the vehicle residual value**

1 – "New" battery cost represent the theoretical cost of a new battery for a specific capacity, EE C&P modelling based on BloombergNEF price forcasting; 2 – "real world" battery replacement using crashed vehicles Cleevely Electric Vehicles, 2021; 3 – 2015 version has a 5 year warranty, with 2021 version having an 8 year warranty; battery replacement cost based on EE collection "real world" prices available from crashed vehicles in 2021

Agenda

WP2: battery replacement & additional engine maintenance cost scenarios

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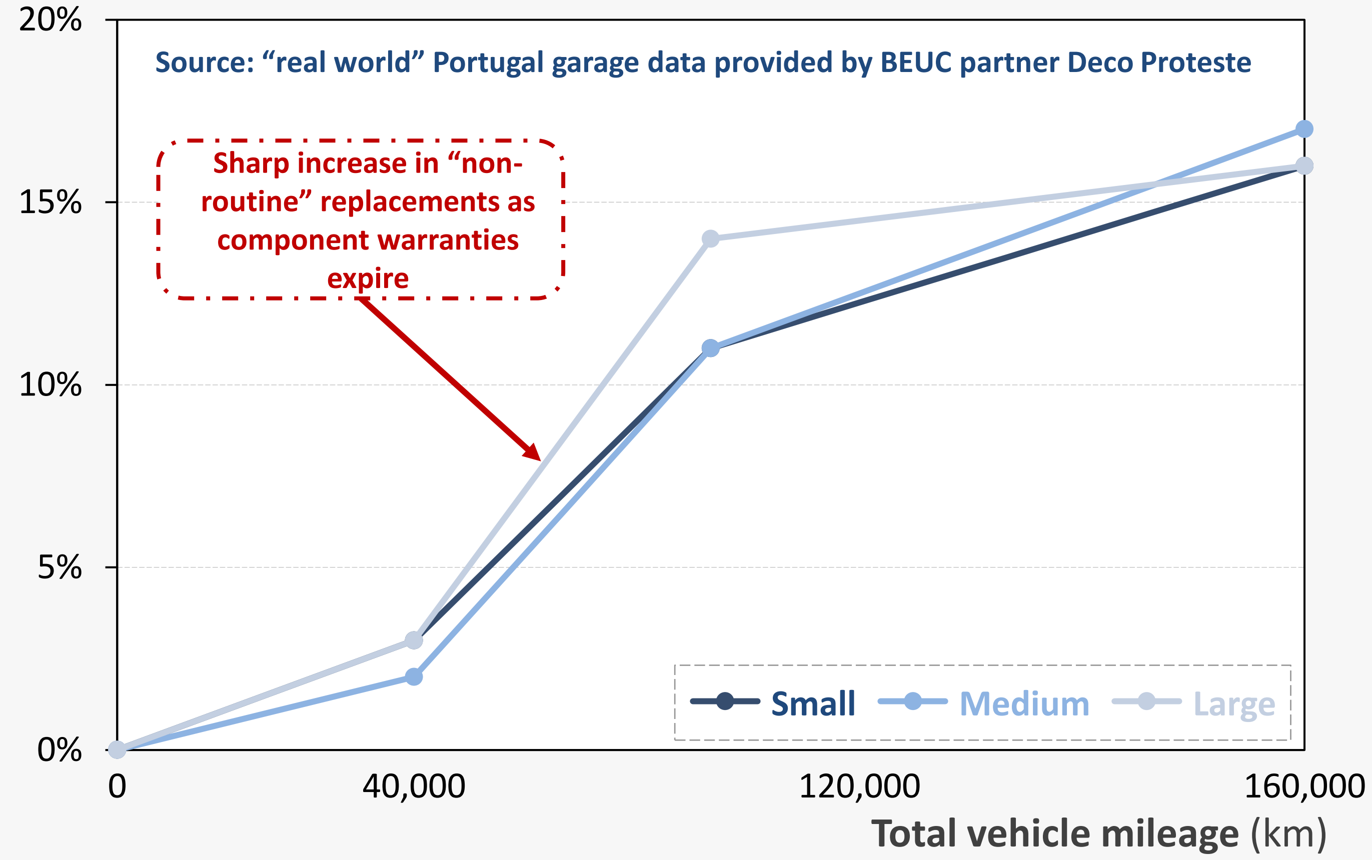
WP3: battery recycling review

EE review of “non-routine” combustion engine maintenance

“Routine” maintenance costs for a medium Petrol ICE (bought new in 2020) **is ca. €9k over its 16 year lifetime; “non-routine” maintenance costs** (which were largely discounted for the original BEUC TCO study) **add between 15-20% additional cost, ca. €1.5-2k**

% Petrol ICE maintenance cost in “non-routine” combustion replacements[1]



Source: “real world” Portugal garage data provided by BEUC partner Deco Proteste

Sharp increase in “non-routine” replacements as component warranties expire

EE Conclusions

- **Proportion of “non-routine” combustion component maintenance** of total maintenance costs **increases for ICEs with increased mileage, with a significant increase after component warranties expire,** typically 18-36 months[2], for combustion components

- **EE only included a minor proportion of “non-routine” engine maintenance in TCO study** to avoid accusations of bias towards BEVs

- However, **any discussion of battery maintenance / replacement costs** (for example, for vehicles that driver unusually high mileages) **must be put into context with additional “non-routine” engine maintenance cost**

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1 – “Non-routine” combustion maintenance includes replacement oil filter, cambelt, exhaust, clutch, fuel filter and particle filter; 2 – EE review of leading Petrol ICE models

Agenda

WP2: battery replacement & additional engine maintenance cost scenarios

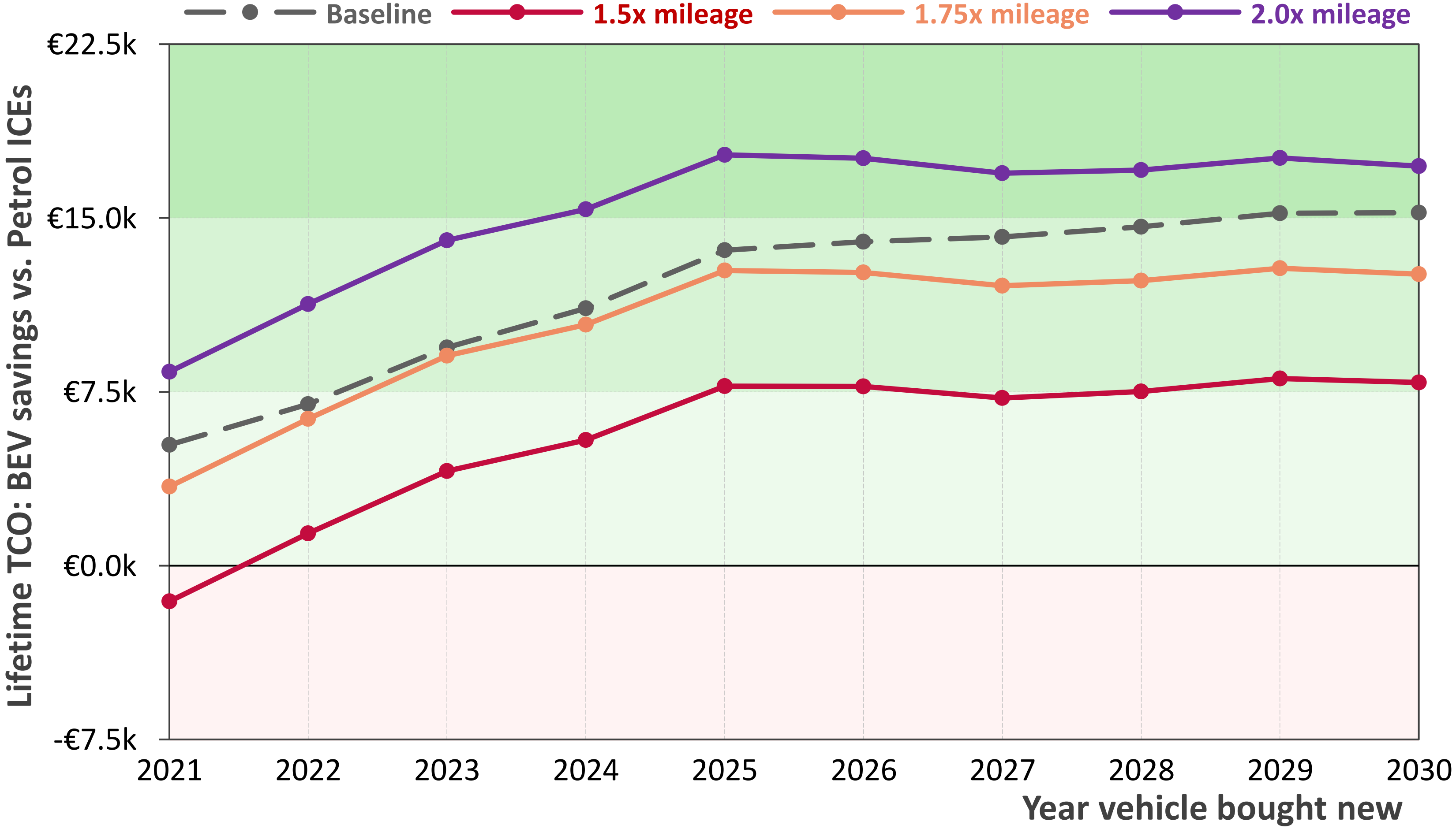
- Review of battery degradation
- Nissan Leaf case study
- Review of engine maintenance costs
- **TCO implication & conclusions**

WP3: battery recycling review

Case study: battery replacement for high lifetime mileage vehicles

Note: even for the "high mileage" scenarios modelled below, battery replacements do not represent a realistic prospect (as it is cheaper to replace the entire vehicle) & would only be used in practice by a very small minority of consumers

Including a battery replacement & "non-routine" engine maintenance(1)



- EE have modelled the TCO savings for BEVs vs Petrol ICE for different high lifetime mileage scenarios, if a battery replacement is required

- **BEVs remain the cheapest option under each high mileage scenario even with battery replacement** (and additional "non-routine" combustion maintenance)

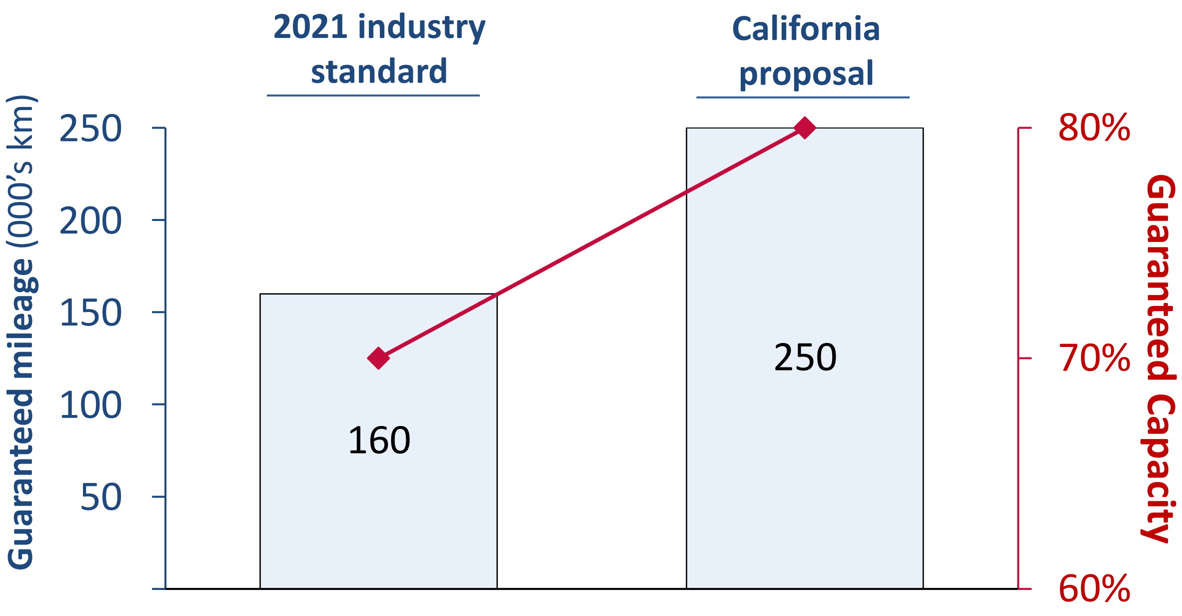
- Battery replacements (which although remain an unrealistic option) would pose a risk to consumer equity, with the cost potentially falling on used car owners

1 – battery replacement cost based on EE collection " real world" prices available from crashed vehicles in 2021. Note based on 16 year average vehicle life, baseline mileage case excludes batteries replacement & "non-routine" engine maintenance costs

Opportunity for EU regulation around battery State of Health (SoH)

California policy case study

- Californian government have proposed that from 2026 BEV **batteries must retain 80% of their certified range for 15 years or 240,000km** as part of their Advanced Clean Cars Framework[1]
- OEMs would be required to provide a **"readable state of health metric",** allowing consumers to **see the battery state in real-time**, without tools → **boosting consumer confidence**, especially for used car buyers



Although battery warranties have been steadily increasing, more can be done to boost consumer confidence – **especially for second hand buyers who may be uncertain at the State of Health of the battery** – in the longevity of their BEV

A

- **Regulation to ensuring increasing mileage and battery capacity guarantees**, with the aim of guarantees that match the total vehicle lifetime, and **allows consumers in "real time" to check the health of their battery**

B

Protecting the consumer's "right to repair":

- EU right to repair legislation currently requires manufactures of household appliances to supply spare parts for a minimum of ten years[2]
- Introduction of **similar legislation for BEV batteries would maximise battery lifetimes and reduce maintenance costs passed onto consumers**

1 – California proposes degradation limits, Green Car Reports, May 2021; 2 – EU brings in 'right to repair' rules for appliances, BBC News, October 2019

Agenda

WP2: battery replacement & additional engine maintenance cost scenarios

WP3: battery recycling review

- Results summary & implications
- Recycling process overview
- Profitability analysis
- Sensitivities

Battery recycling is forecast to be profitable in EU

Summary of conclusions:

1

Strong profitability forecast for battery recycling in Europe

- **Profits from battery recycling of up to €1,500 per battery pack in Europe by 2040**
- **Limited value will directly reach consumers**, and will most likely be absorbed by OEMs, recyclers and reducing cost of future cell material; important that **proportion of profit invested to decarbonise recycling**, including transition to organic leaching processes & "net zero" process fuel usage

2

EU based recycling competitive with China by 2040

- Despite forecast **higher profits for battery recycling in China than the EU**, modelling suggests the gap would not be significant by 2040
- However, the **profit gap between Europe and China remains uncertain** given the **dependence of any reduction in labour costs on how much automation is achieved**

3

Hydrometallurgical recycling provides the best value to consumers

- **Hydrometallurgical recycling processes are forecast to be significantly more profitable than pyrometallurgical recycling**, which also produced lower GHG emissions and is more easily and cheaply decarbonised
- EU legislated recovery rates would **encourage OEMs towards hydro processes to reach requirements**

4

Profitability highly dependant on long-term metal prices

- Recycling profit is inherently linked to **future metal prices which can fluctuate dramatically**
- Sensitivities suggest **metal prices are the difference between a profit or loss from pyro recycling in 2030**, and that hydro profits could be 98% higher if rare earth metal prices double by 2040

WP3 – Battery recycling value

Results pack contains the following sections:

1 Results summary & implications

- Review of **profits from battery recycling for “real world” BEVs in 2030 and 2040 for EU and China**
- Discussion of the **distribution of future system recycling value**

2 Recycling process overview

- Overview of key battery recycling processes
- Implications of relevant EU battery legislation

3 Profitability analysis

- **Cost and revenue breakdown & comparison for each process** in Europe and China in 2030 and 2040

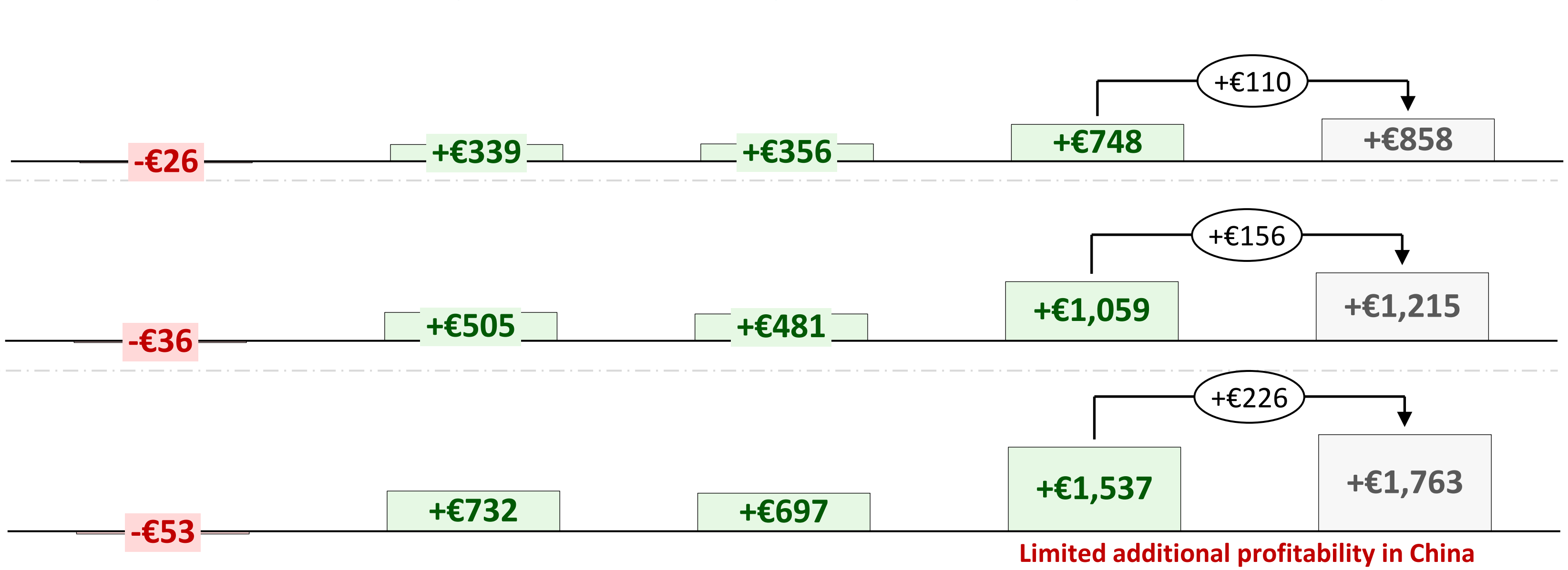
4 Sensitivities

- Analysis of the **impact of different metal price scenarios** on the profitability of battery recycling

Agenda

- WP2: battery replacement & additional engine maintenance cost scenarios
- **WP3: battery recycling review**
  - **Results summary & implications**
  - Recycling process overview
  - Profitability analysis
  - Sensitivities

Profitability of battery recycling in the EU in 2030 and 2040



Battery capacity	Demonstrative vehicle model[1]	EU based: recycling profit from battery pack				China comparison
		2030		2040		2040
		Pyro	Hydro	Pyro	Hydro	Hydro
36 kWh	NISSAN leaf	-€26	+€339	+€356	+€748	+€858
51 kWh	TESLA MODEL 3	-€36	+€505	+€481	+€1,059	+€1,215
74 kWh	iX3	-€53	+€732	+€697	+€1,537	+€1,763

Limited additional profitability in China

Key findings:

1. **Significant end-of-life value is identified in BEV battery packs** – up to €1,500 in Europe by 2040
2. **Hydro is expected to be the more profitable process** carrying substantial profits in both 2030 and 2040
3. **Europe and China could have similar profit levels** from hydro by 2040
4. A battery gate fee[2] would be required for pyro to be profitable in Europe in 2030

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1 – Note that analysis has covered NMC 811 batteries. The car models shown here do not have NMC 811 batteries, but have the shown battery size, to illustrate the type of car to which the forecast profit corresponds; 2 – 'Battery gate fee' refers to fees paid to the recycler for taking BEV batteries from car OEMs

Recycling value distribution between recycler, OEM or decarbonisation

A Profits benefits recyclers

- Car OEMs and battery recyclers could remain distinct entities
- Even if batteries are obtained at cost to recycler, **significant profits could still be available by selling recovered materials to battery manufacturers/car OEMs**

B Profits benefit car OEMs

- Car OEMs/battery manufacturers could develop **vertically integrated in-house recycling facilities**
- **Recovered materials may then fund lower raw material costs** for battery production
- **OEMs would likely retain the value from recycling** in the form of higher profit margins on new BEVs

C Profits go into decarbonisation

- Legislation that all cars must have net zero life cycle emissions could be introduced
- Decarbonising the hydro process in the EU in 2030 for a 70 kWh battery would cost ca. €470(1)
- **Value from battery recycling could cover decarbonisation costs and make an economical contribution to achieving a net zero car**

- **Limited opportunity for consumer to obtain value from battery recycling** – discussed further on next slide
- In practice, a mixture of all of the above is likely; **future developments in legislation** and the **nature of entities recycling BEV batteries will be essential in understanding how the identified value is distributed**

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1 – based on a “pessimistic” decarbonisation cost case outlined in WP1

Consumers unlikely to benefit from system value identified from battery recycling

In the current situation, there is no political or economic reason why significant value from battery recycling will reach the consumer. Battery recyclers and/or OEMs are most likely to retain the majority of profit

Opportunities for some "minimal" consumer benefit:

1 At end of life

- An end-of-life BEV owner may receive a slightly higher scrappage fee than for an ICE, however, **consumers will have limited bargaining power to gain much value in this way**
- **Marginal TCO reductions** could be foreseen for **third-hand owners who purchase their BEV at low cost**

2 Reduced upfront costs

- Battery recycling could lead to **decreased raw material costs** and **lower upfront costs to first-hand owners**
- However, a rapidly growing BEV market means that not enough batteries will be recycled in 2030/40 to significantly reduce raw material costs. Furthermore, while significant uncertainty remains, potentially up to 85% of BEV batteries leaving the market in 2030 will be repurposed for second life usages(1)
- Any **upfront cost reductions from one vehicle's battery would hence be diluted across several new vehicles**
- Additionally, by 2030/40, TCO analysis shows that BEVs will be significantly cheaper than ICEVS – hence diluted cost reductions from battery recycling are likely to have any **minimal impact on consumer powertrain choice**

1 - Batteries on Wheels, Element Energy, June 2019

Agenda

WP2: battery replacement & additional engine maintenance cost scenarios

WP3: battery recycling review

- Results summary & implications
- **Recycling process overview**
- Profitability analysis
- Sensitivities

Overview of key recycling processes and EE modelling methodology

Process	Description	Advantages	Limitations	Modelling Methodology
A **Pyrometallurgical recycling (pyro)**	Cells removed from battery pack to undergo pyrolysis and smelting	- Simple with existing equipment - Recycles all battery chemistries simultaneously	- **Fails to recover all materials, importantly lithium** - Carbon intensive	- EE **compared the profitability of hydro & pyro using the Argonne National Laboratories EverBatt model** as a foundation - Archetypal inputs defined for both recycling processes(2) in Europe and China for 2030 and 2040, with EU labour costs sourced from Eurostat(3) - A **key input is future metal prices, which are highly uncertain**. World Bank(4) forecasting has been used for the baseline scenario - Analysis **assumes a NMC 811 chemistry**, which is forecast to be the most common battery chemistry between 2030-40(5)
B **Hydrometallurgical recycling (hydro)**	Acids applied to shredded cells to leach out metals	- Recovers each rare earth metal with high recovery rates	- Newer technology yet to be widely deployed(1)	
C **Direct physical recycling**	Electrode materials directly recovered from battery cells via disassembly	- High recovery rates	- Still in R&D phase	- Due to this process still being in the R&D phase, it has not been included in the profitability analysis

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1 – New entrants into the recycling market such as Li-Cycle are starting to deploy hydro, however pyro remains the dominant method today; 2 - A facility throughput of 25,000 and 100,000 tonnes of battery has been assumed in 2030 and 2040 respectively which roughly corresponds to a gigafactory worth of battery by 2040; 3 -Hourly Labour Costs, Eurostat, March 2021; 4 – Commodity Markets Outlook, World Bank Group, April 2021; 5– Avicenne battery chemistry forecasting for Element Energy;

Hydrometallurgical battery recycling processes will be required to meet proposed EU legislation

Battery recycling policy in the EU(1)

	Current EU Battery Directive	Proposal → option 1	Proposal → option 2
Collection rate	No target – collection producers responsibility	Non-specific target for light transport vehicles	'Explicit' target for EV batteries
Recycling efficiency	No requirement	65% by 2025 for lithium-ion batteries	70% by 2030 for lithium-ion batteries
Material recovery rates	No requirement	90%, 90%, 35% and 90% for Co, Ni, Li and Cu respectively by 2025	95%, 95%, 70% and 95% for Co, Ni, Li and Cu respectively by 2030

Current situation of EU battery recycling market

- Currently, pyro is the most established process because the technology is simple to implement
- **Battery gate fees**(2) (due to an immature market), and **high quantities of cobalt** in older BEV batteries also helps make pyro profitable

Implications of anticipated EU policy for recycling market

- As pyro does not recover lithium, **hydro processes will need to be prevalent in the EU from 2030**, to **meet increasing lithium recovery rates in legislation**
- It is likely that **recyclers could employ both processes** to **meet recovery rates on average**
- The **transition will be supported** by the fact that **hydro is forecast to be more profitable than pyro by 2030**
- Additionally, **hydro recycling is significantly easier to decarbonise** (e.g. using organic leaching agents), relative to pyro which uses fossil-powered furnaces

Sources: 1 – Proposal for a regulation on batteries and waste batteries, European Commission, December 2020; "proposals" represent distinct options currently being considered by the Commission; 2 – 'Battery gate fees' refers to fees paid to the recycler for taking BEV batteries from car OEMs

Agenda

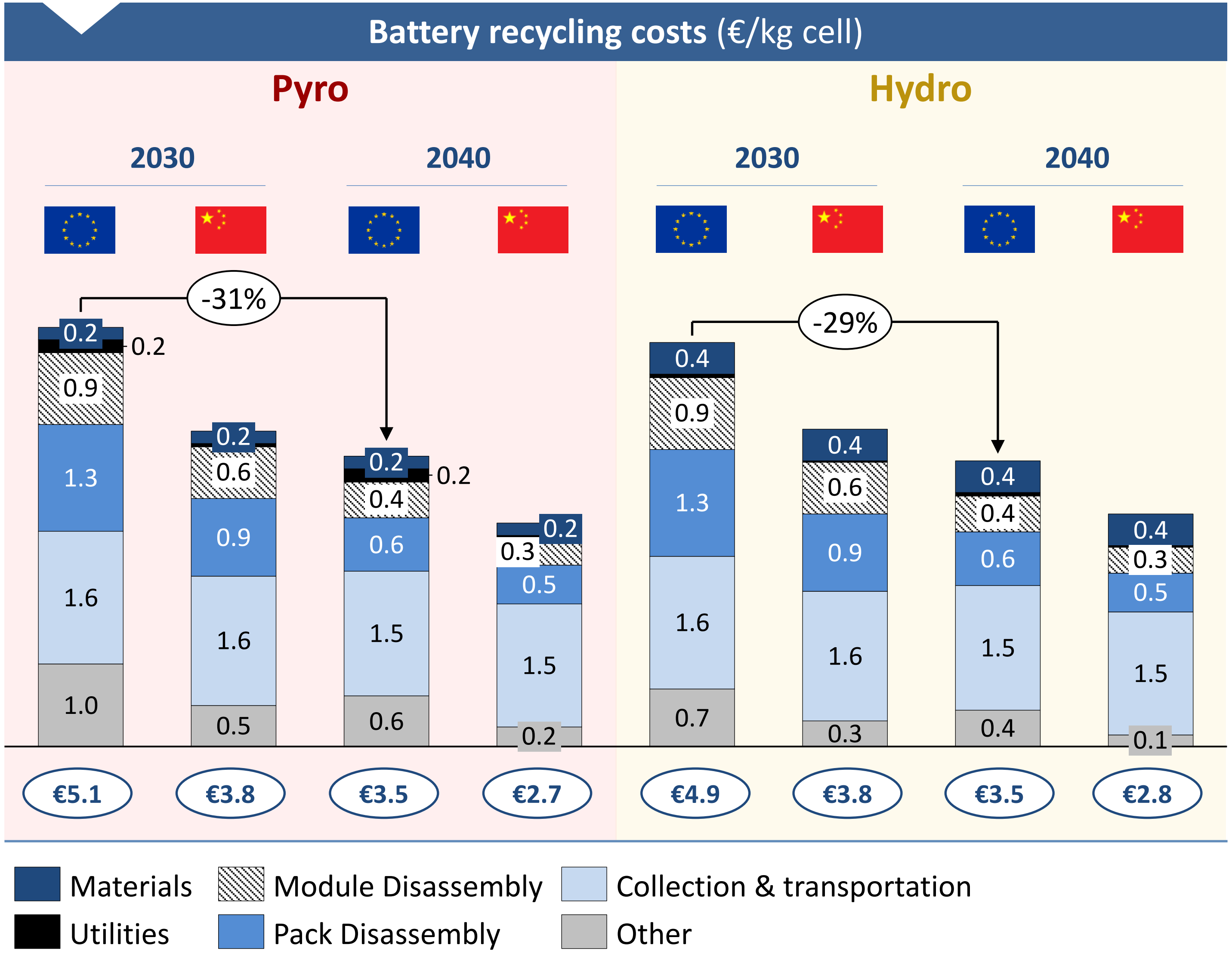
WP2: battery replacement & additional engine maintenance cost scenarios

WP3: battery recycling review

- Results summary & implications
- Recycling process overview
- **Profitability analysis**
- Sensitivities

Costs of NMC 811 battery recycling in EU and China in 2030 and 2040

Battery recycling costs (€/kg cell)



Key comparisons and cost drivers

Hydro is up to 4% cheaper than pyro in the EU → this is due to high utilities prices and other costs(1) used in pyro in the EU, while in China low utilities and materials costs make pyro cheaper

Recycling forecast up to 31% cheaper in 2040 vs. 2030 → this is driven by a decrease in labour costs from an assumed level of automation and increased labourer efficiency in pack and module disassembly

Recycling costs are 22% cheaper in China than the EU → this is mainly driven by lower labour and utilities costs in China. Any increased **automation in disassembly could reduce this difference significantly**

Costs are dominated by disassembly which are in turn driven by labour costs

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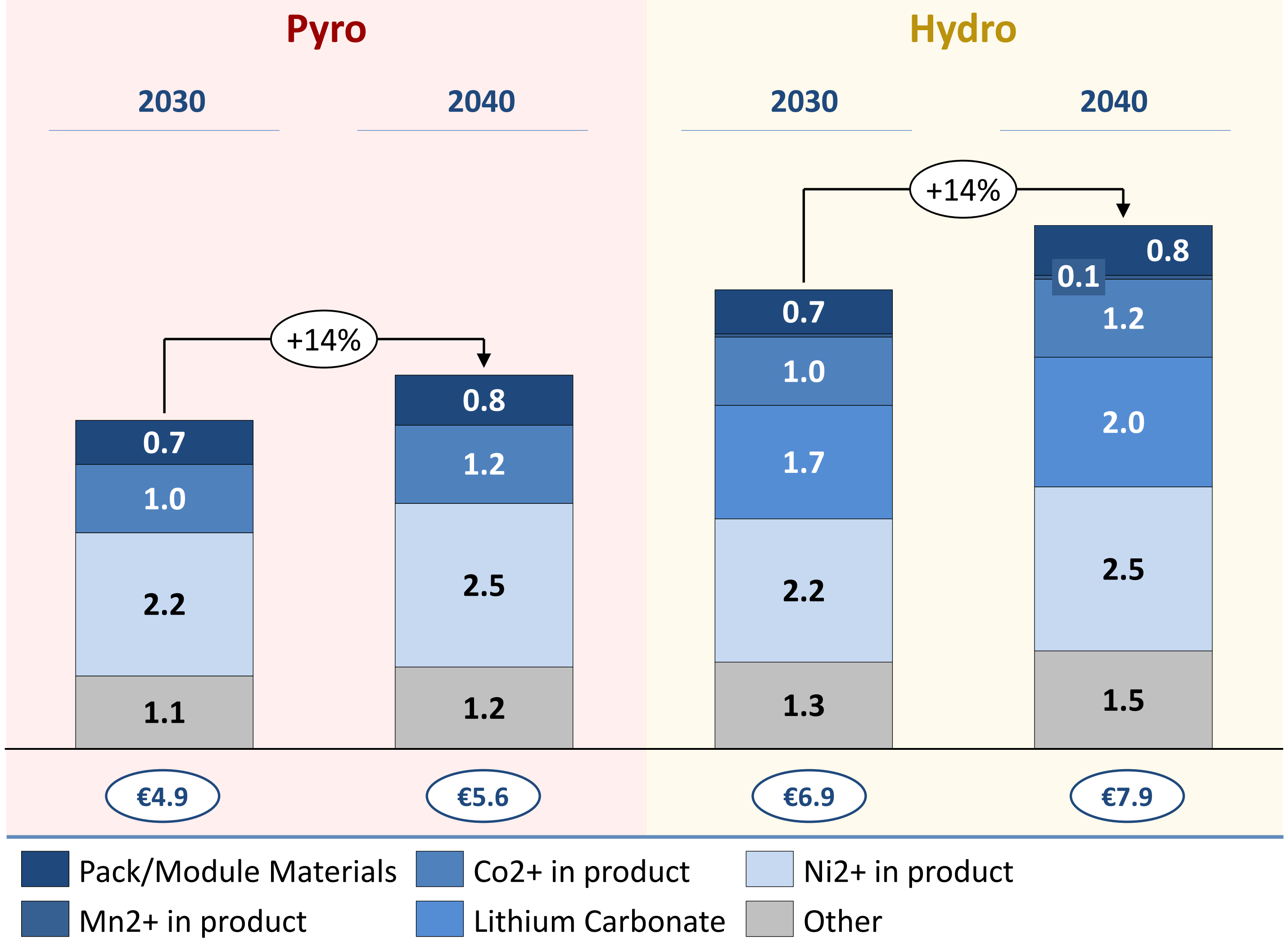
1 - These largely consist of maintenance, repair and equipment costs
Note that although costs are calculated per kg cell, the cost of module and pack disassembly has been allocated across all cells for completeness

Revenues of NMC 811 battery recycling in EU and China in 2030 and 2040

Battery recycling revenues (€/kg cell)



Key revenue sources and sensitivities

Revenues from hydro are 40% greater than pyro → this is because hydro successfully recovers materials which are lost through pyro

2040 revenues are 14% higher than 2030 → this is due to forecast increases in metal prices. However, **future prices of metals remain uncertain**

- Due to the sensitivity to these metal prices, different metal price scenarios have been analysed on a later slide

EU vs. China: no difference → due to assumed equal value of materials in China and Europe

Pack and module materials also make a contribution to revenue → this is mainly from the aluminium content in the battery shell and module cases[1]

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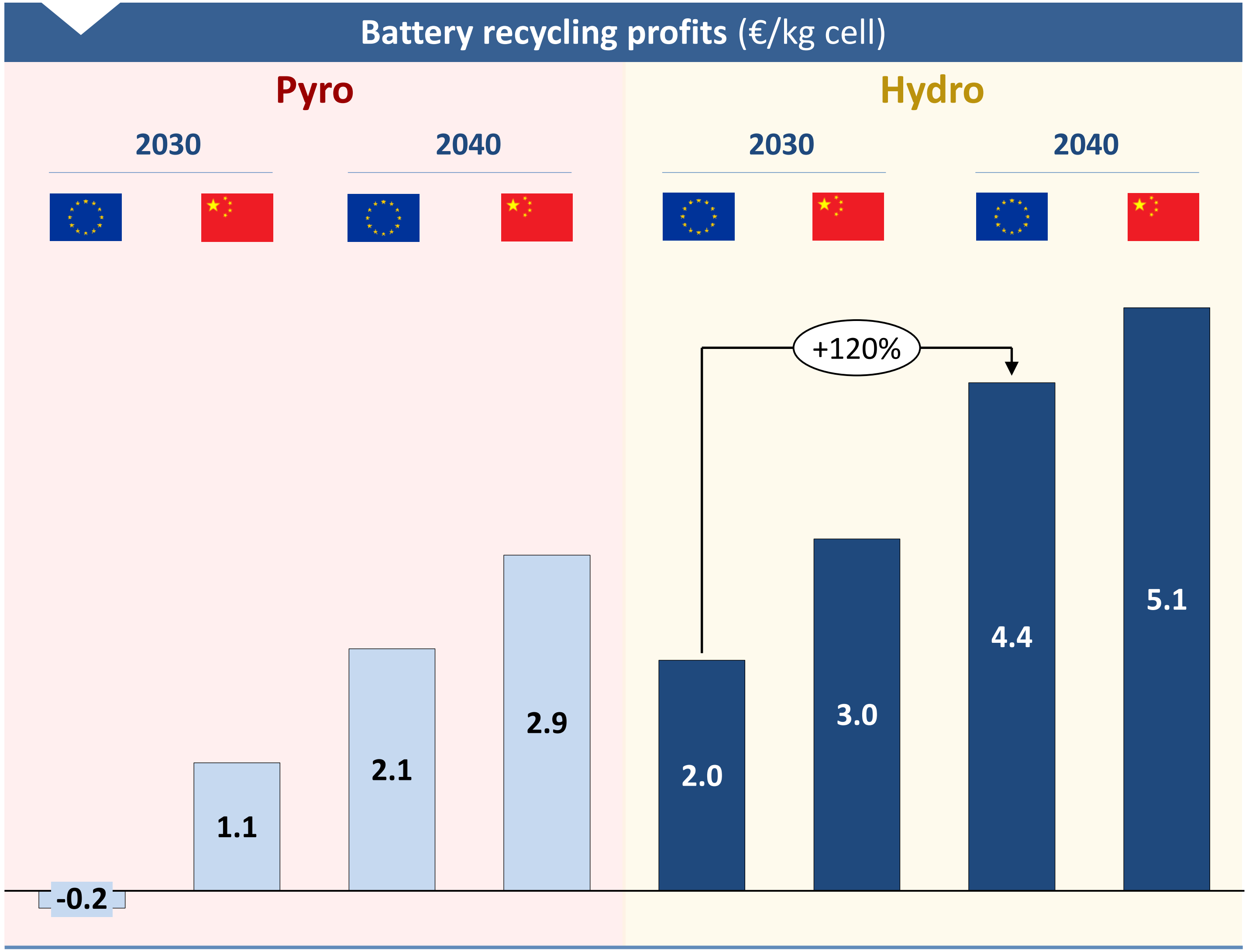
1 - Although revenue is calculated per kg cell, revenue from pack and module materials has been allocated across all cells for completeness
Note that 'Ni2+/CO2+/Mn2+ in product' refers to the nickel/cobalt/manganese content in the salt produced from the given recycling process

Profits of battery recycling in EU and China in 2030 and 2040



Profit summary and analysis

Hydro is up to 175% more profitable than pyro → this is due to hydro's recovery of additional materials. To 2030, pyro recycling is not profitable in the EU without the recycler receiving an additional fee for taking the batteries[1]

Battery recycling could be 120% more profitable in 2040 vs. 2030 → this is caused by declining costs and rising revenues driven by increasing metal prices.
As with revenue, the profit is highly sensitive to fluctuations in global metal prices

Recycling batteries in China is 15-53%[2] more profitable → this is down to lower labour and utilities costs in China. Accelerated automation of the disassembly process, or full shredding of the battery pack prior to material recovery could lower the labour requirement and thus reduce the profit-gap between the EU and China

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1 – For the purposes of this analysis, it is assumed that neither the recycler pays for the batteries, or receives a fee for recycling them
2 – Excludes the instance of pyro in 2030 where recycling in Europe is not profitable

Agenda

WP2: battery replacement & additional engine maintenance cost scenarios

WP3: battery recycling review

- Results summary & implications
- Recycling process overview
- Profitability analysis
- **Sensitivities**

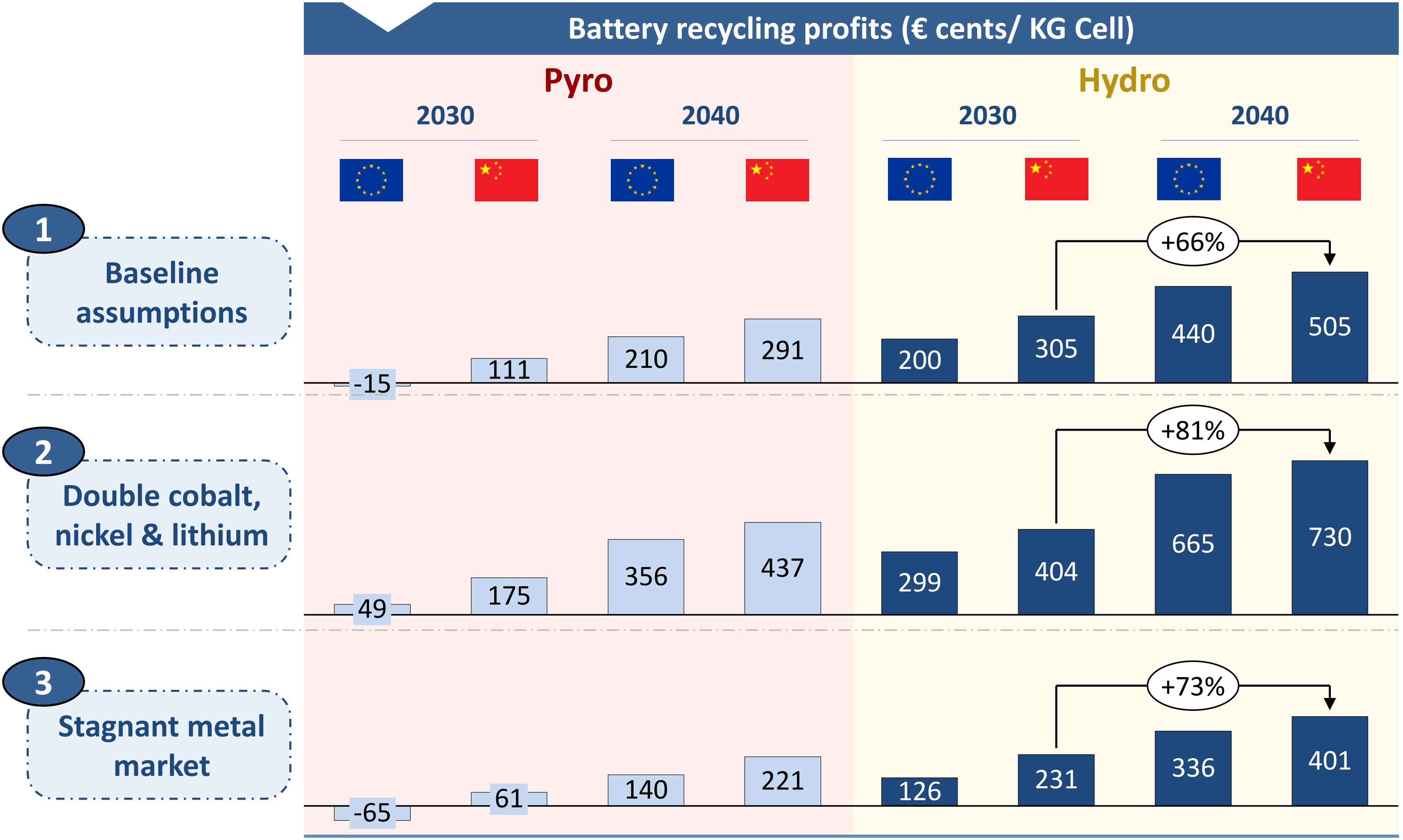
Sensitivities modelling scenarios

Modelling scenario	Metal price foresting assumptions
1 **Baseline assumptions**	• These are the figures shown previously • Uses forecasts for **metal price increases based on those of the World Bank**(1), such as a 25% increase in Nickel price by 2030
2 **Double cobalt, nickel & lithium price**	• Assumes that **by 2040 cobalt, nickel and lithium prices will double, and have increased by 50% by 2030** • These metals make up 64-71% of recycling revenue
3 **Stagnant metal market**	• Assumes **no change in metal prices in 2030 and 2040 relative to today** • Inflation of 1% year-on-year is included

- Note: that **costs not relating to metal prices, are kept constant in every scenario**

1 - Commodity Markets Outlook, World Bank Group, April 2021

Sensitivity modelling: fluctuations in metal prices has a significant impact on profitability


Battery recycling profits (€ cents/ KG Cell)

EE conclusions

- **Profitability is highly dependent on global metal prices**

- In each scenario, hydro recycling is profitable in the EU in 2030 and 2040
- However, **profit where Co/Ni/Li prices double is around 98% higher than the stagnant scenario by 2040**

- Pyro recycling is only profitable in the EU in 2030 where Co/Ni/Li prices have increased significantly