# Introduction

- “the initiative will modify the Directive or a proposal for a new Regulation repealing the Directive will be prepared, to notably encompass end-of-life and sustainability requirements. (… Q4 2020)” 2020 CWP
- Information from
  - Studies and consultation underpinning the assessment and evaluation of the Directive,
  - Studies and consultation carried out in the context of the ‘eco-design’ process,
  - Extensive consultation processes during and following up to the Strategic Action Plan on Batteries,
  - Two specific studies,
    - *Feasibility of measures addressing shortcomings in the current EU batteries framework system,*
    - *Study addressing particular topics on batteries (legal statuses, restrictions, etc).*

# Proposed approaches and measures

- Taken from
  - EU institutions
  - Stakeholders' proposals
  - Technical and scientific publications
- Disclaimer

This document is part of a study which is being prepared for the European Commission. However, the information and views set out in this report are those of the authors and do not necessarily reflect the official opinion of the Commission. The Commission does not guarantee the accuracy of the data included in this initial presentation of results.

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# Batteries Directive 2006/66/EC

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## Initial results of the study in support of the assessment of the Batteries Directive

Measure 10: 2nd-life for Li-ion traction batteries from EV



# Measure 10

# 2nd-life for Li-ion traction batteries from EV

# 2nd-life for Li-ion traction batteries from EV

# 2nd life
# Problem Description: Current situation (1/5)

- Earlier studies and forecasts (i.e. < 5 years) overestimated Second-Life (SL) potential.
- Service lifetime of today's batteries for EV last longer than expected (possibly the entire life of the EV). In result SL batteries compete with newly manufactured batteries in stationary use of the 3rd or 4th generation.
- SL Business cases of repair and disassembly of modules or even cells are economical non-viable.
- Economical viable SL business cases require Input-Output-access via the battery management system. Information on parameters indicating status and history of potential SL batteries should be available and also control of the battery / module / cell in order to provide certain functions.
- For current business cases the OEMs grant I/O-access on a contractual base to innovators and SMEs. The basic motivation for OEMs is to test SL in pilot plants and for research and to assess if the returns of SL could cover the costs for recycling.

# 2nd life
# Problem Description: Current situation (2/5)

- Batteries with potential for 2nd-life are distributed
  - To brand authorized and free workshops as a result of replacement or after a road accident of the EV,
  - To authorized treatment facilities (ATFs according to ELV Directive) when the EV became an end-of-life vehicle.
- The car manufacturer is responsible for the recycling of end-of life batteries. According to ACEA, OEMs are also responsible for storage and transport to recyclers (although it is not clear that this is required by current legislation).
- Traction batteries that are waste and shall be shipped to remanufacturing (or to dismantling & recycling) must comply with the waste management regulations (e.g. Waste Shipment Regulation (WShipR) when crossing borders). This causes relevant administrative burdens and costs.
- The SL product needs homologation and CE approval.

# 2nd life
# Problem Description: Current situation (3/5)

- The use of EV traction batteries for SL, replacing the production of new stationary batteries shows considerable positive environmental impacts and encouraging the market for SL is the preferred option. At the moment the market is restricted by market access barriers (asymmetric information) and no stipulations are in place (e.g. by the Battery Directive).

- Currently the waste status of batteries from EV for SL is unclear. Hence remanufacturing for SL in legal terms is a '**re-use**' operation (non-waste) **or** a '**preparation for re-use**' operation (waste regime).
  - The status (waste / non Waste) has effects on the liabilities of OEMs and remanufacturers via the EPR scheme.
  - Within waste status extra burdens occur by handling of EoL-batteries under stricter waste regulation regime and by unclear regulations for end of waste (EoW) declaration for SL-batteries.

# 2nd life
# Problem Description: Current situation (4/5)

The problem is caused by the missing definition of the term ‘purpose’ as established by the WFD Art. 3 (13) on re-use. Two interpretations are currently possible:

1. Narrow Definition of the purpose:

- Either the ‘purpose’ of a 2nd-life battery is defined narrowly and restricted for usage in EV, hence a battery used for stationary power storage is **not used for the same purpose.**
  - It becomes waste after 1st life,
  - the treatment operation to remanufacture is a preparation-for-re-use operation (waste regime).
  - A new product approval for the SL product **is** necessary (e.g. CE homologation).

# 2nd life
# Problem Description: Current situation (5/5)

The problem is caused by the missing definition of the term ‘purpose’ as established by the WFD Art. 3 (13) on re-use. Two interpretations are currently possible:

2. Wide Definition of the purpose:

- Or the ‘purpose’ of the battery is broadly defined as charging, storing and discharging of power.
  - Insofar there is no change in the purpose between 1st and 2nd-life and hence the traction battery **does not become waste.**
  - The treatment operation to remanufacture the EoL battery for second life is a re-use operation.
  - A new product approval (e.g. CE homologation already approved) is **not** necessary, but the product must meet the regulations of the target market.

# 2nd-life for Li-ion traction batteries from EV

1 Problem Description

2 Alternative Options for Assessement

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5 Initial Conclusions

# 2nd life
# Alternative Options for Assessment (1/7)

**Baseline: Batteries are waste at the end of their first life**

- The traction battery becomes waste at the end of its first life and EPR obligations are shifted to new OEM of SL application / product

**Option 1: Batteries are waste at the end of their entire lifetime only**

- Batteries are waste when entering recycling and EPR for SL product / application remains with OEM.

**Option 2: Batteries become waste after 1st life; batteries for SL ceased to be waste**

- Establish a clear legal framework: (End-of)-Waste status and EPR-regime for SL with liabilities between OEMs and remanufacturers clearly defined

# 2nd life
# Alternative Options for Assessment (2/7)

**Baseline: Batteries are waste at the end of their first life**

- **Waste Status:**
  - At the end of the ‘first life’ the traction battery becomes waste if it is no longer used as traction battery (but for purposes others than the battery was originally designed, e.g. for stationary storage instead).
  - Re-use for the same purpose (e.g. traction battery in the same vehicle type) is still possible.
  - End of waste status: After remanufacturing  for stationary purposes the waste battery (EoL traction battery of EV) cease to be waste.

- **EPR status:**
  - Original EPR remains with the OEM for first life.
  - Shifting the EPR on the remanufacturer starts when the remanufacturer places the SL battery on the market (purposes others than the battery was originally designed).

# 2nd life
# Alternative Options for Assessment (3/7)

**Baseline: Batteries are waste at the end of their first life**

**Stakeholder reactions**

- **All (!)** stakeholders rejected the idea (and cost burden) that the traction battery is considered waste when it is shipped for reprocessing for second life.
  - The stakeholders do not see the need to apply the WShipR.
  - Instead application of ADR (UN rules for the transport of dangerous goods by road) which is anyhow to apply, should be sufficient.
  - The situation for batteries damaged by accidents is different, these must be anyhow safely stored and transported in much more costly manner.

# 2nd life
# Alternative Options for Assessment (4/7)

**Option 1: Batteries are waste at the end of their entire lifetime only**

- **Waste status:**
  - The industrial battery is, in legal terms, considered waste when entering recycling.
  - All remanufacturing activities are in legal terms ‘re-use’ (and not ‘preparation for reuse’ for not passing waste status) regardless if the battery, originally designed for traction batteries in EV, are remanufactured for traction batteries or stationary batteries.
- **EPR status:**
  - As the battery does not become waste before recycling, the EPR remains with the OEM, also for the SL service lifetime.

# 2nd life
# Alternative Options for Assessment (5/7)

**Option 1: Batteries are waste at the end of their entire lifetime only**

**Stakeholder reactions**

- **All (!)** stakeholders reject the idea that the EPR remains with the car manufacturer when the battery is placed on the market for a 2nd-life.
  - OEMs cannot be liable for processes they do not control
  - High and unsecure liabilities from EPR and insurances costs

# Dilemmata: Baseline and Option 1

**Recall the dilemma:**

**All (!)** stakeholders reject the idea that the traction battery is considered waste when it is shipped for reprocessing for second life (**Baseline**) as it would increase the management and shipment cost significantly.

and

**All (!)** stakeholders dealing with this issue reject the idea that the EPR remains with the car manufacturer when the battery is placed on the market for 2nd-life (**Option 1**).

**--> how to overcome ? --> see Option 2**

# 2nd life
# Alternative Options for Assessment (6/7)

**Option 2: Batteries become waste after 1st life; batteries for SL ceased to be waste**

**Waste status:**

- At the end of the ‘first life’ the traction battery becomes waste
- The waste battery is ceased to be waste if the following two conditions apply:
  - The traction battery is equipped with certificates on state of health and other information (to be defined in a delegated act) which guarantees the SL potential (preparation for re-use operation).
  - The PRO (or OEM) establishes a contract with a remanufacturer making Input-Output access to BMS available to the remanufacturer.
- Batteries meeting these conditions cease to be waste before shipment.

- **EPR status:**
  - As the battery does become waste, the EPR remains with the OEM for the first life.
  - An EPR scheme for SL need to be established or integrated in existing EPR schemes.

# 2nd life
# Alternative Options for Assessment (7/7)

**Option 2: Batteries become waste after 1st life; batteries for SL ceased to be waste**

**Stakeholder reactions**

- **Nearly All (!)** stakeholders rejected the idea that Input / Output – Accessibility should be regulated by legislation but instead should be incentivized
  - OEMs are very cautious for sensitive data and property rights infringements.
  - OEMs also point on sensitive personal data which could be interpreted from the batteries information stored (e.g. personal driving behavior).

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# 2nd life
# Qualitative Assessment of Options (1/4)

**Baseline:** Batteries are waste at the end of their first life.

- Once the traction battery becomes waste, it must be submitted to a treatment process, either recycling or preparation for re-use for which the EPR need to cover the costs for recycling.
- Cost for removing the battery from the vehicle, safe storage, shipment and treatment is covered by OEMs' EPR obligations.
  - Costs can be reduced if revenues are generated by the treatment operations including SL revenues.
- EPR obligations for SL batteries are shifted to SL remanufacturers. On a contractual base these liabilities can be shared between OEM and SL remanufacturer (current business cases).
- EPR obligations might be transferred to producer responsibility organisations (PROs).
- The market for SL is limited due to market restrictions (asymmetrical information)

# 2nd life
# Qualitative Assessment of Options (2/4)

**Option 1:** Batteries are waste at the end of their entire lifetime only.

- OEMs are exposed to risks from EPR which imply high costs for unsecure liabilities (e.g. insurances) would hamper the SL market.
- SL operations might be limited to restricted remanufacturers highly dependent to OEMs or even limited to in-house processes.
- OEMs might develop business models giving them tight control of the distribution of end of life batteries (e.g. leasing) as a reaction.
- Once the battery becomes waste, it must be submitted to a recycling process for which the EPR need to cover the costs.
- Cost for dismantling, safe storage, shipment and treatment is covered by OEMs' EPR obligations.
  - Costs can be reduced if revenues are generated by the treatment operations (including SL revenues).

# 2nd life
# Qualitative Impacts of Options (3/4)

**Option 2:** Batteries for SL are ceased to be waste

- Residual Value for SL batteries would increase due to granted information
- Market share for SL products would increase
- Incentives for OEMs to provide batteries for SL via reduced administrative burdens (e.g. waste regulation liabilities).
- Costs/liabilities of EPR could be clearly defined and split between OEM and remanufacturers for SL
- For EoL-batteries from EV (not used for SL) the stipulations of the baseline continues to apply

# 2nd life
# Qualitative Impacts of Options (4/4)

| IA Category | Baseline | Option 1: | Option 2: |
|---|---|---|---|
| Environmental Benefits | Limited impact from SL | More limited impact, smaller market as it is not attractive for OEMs offering EoL batteries for SL.<br>**-** | Bigger Impact, as incentive for OEMs by reduced EPR costs and higher residual value for EoL batteries enables market uptake.<br>**++** |
| Environmental burdens | n.a. | More recycling, less SL<br>**(+)** | n.a. |
| Additional savings (Euro) | **/** | Remanufacturing **(-)**<br>Recycling **(+)** | General system costs of EPR scheme is reduced<br>Remanufacturing **(+)**<br>Recycling **(-)** |
| Additional costs (Euro) | Liabilities from EPR for OEMs and remanufacturers | OEMs' risk from EPR<br>**+** | n.a. |
| Administrative burden (yearly) | OEMs' EPR burdens (e.g. for waste handling) | (+) OEM EPR burdens<br>! High uncertainties from EPR liabilities | (-) OEMs' EPR burdens<br>(+) Remanufacturing SL EPR burdens |
| One-time administrative burden | Product approval burden | / | Remanufacturing EoW status<br>-<br>Product approval burden |

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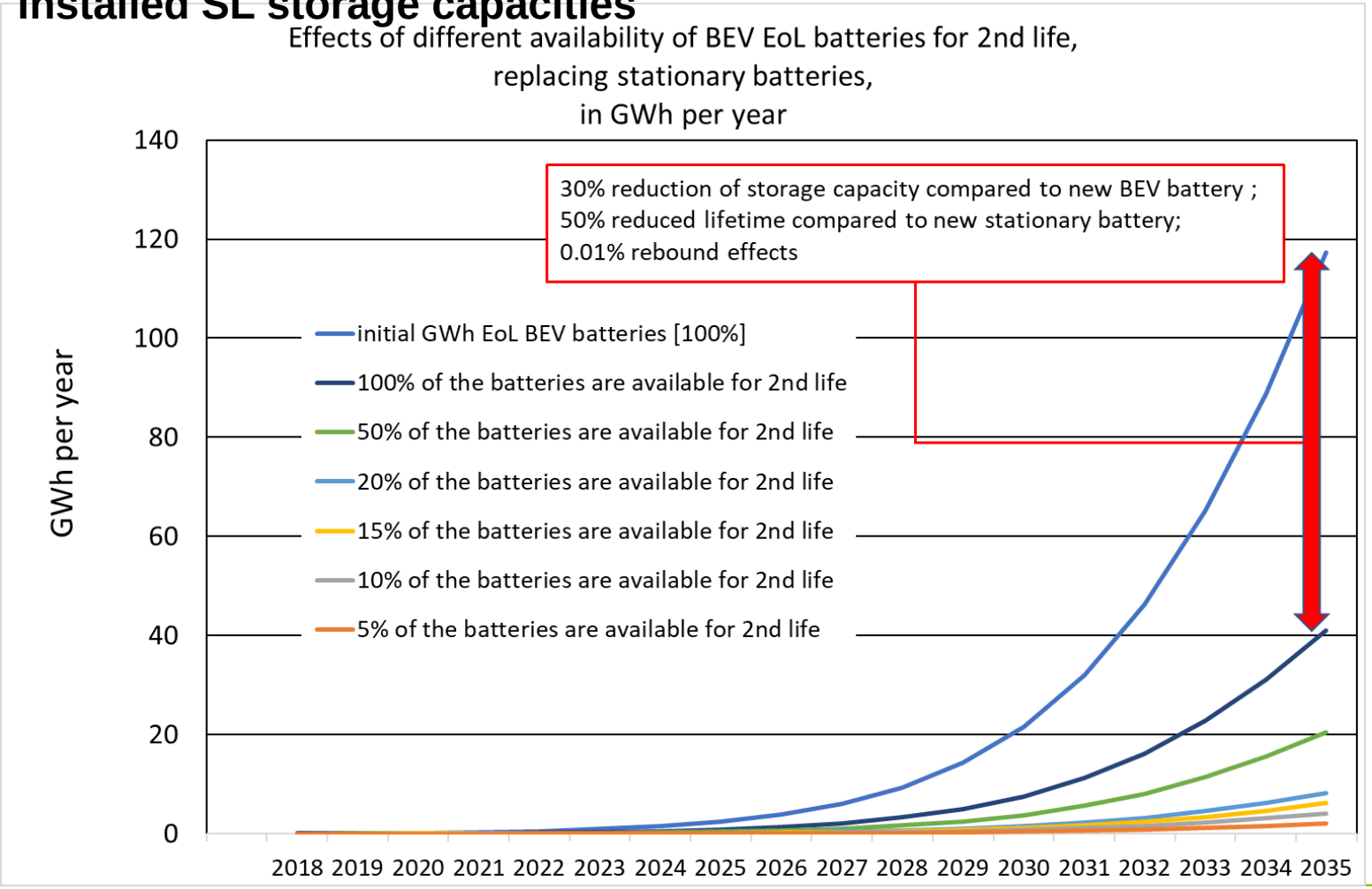
# Quantitative Impacts of Options (1/6)

**Assumptions for the quantitative assessment model**

- SL Potential: Batteries are used after second hand car usage and SoC will be on 70 %.
- SL will have ½ the life service time of a new stationary battery.
- For SL remanufacturing additional expenses are incurred.
- The battery chemistry replaced in stationary appliances is LFP.
- Market prices for batteries in SL applications are 200 € per kWh in 2017 and the price will decline to 65% (130 € per kWh) until 2035.
- 55% of the cost of remanufacturing are labour cost.
- FTE average cost according to Eurostat (low / high skilled).

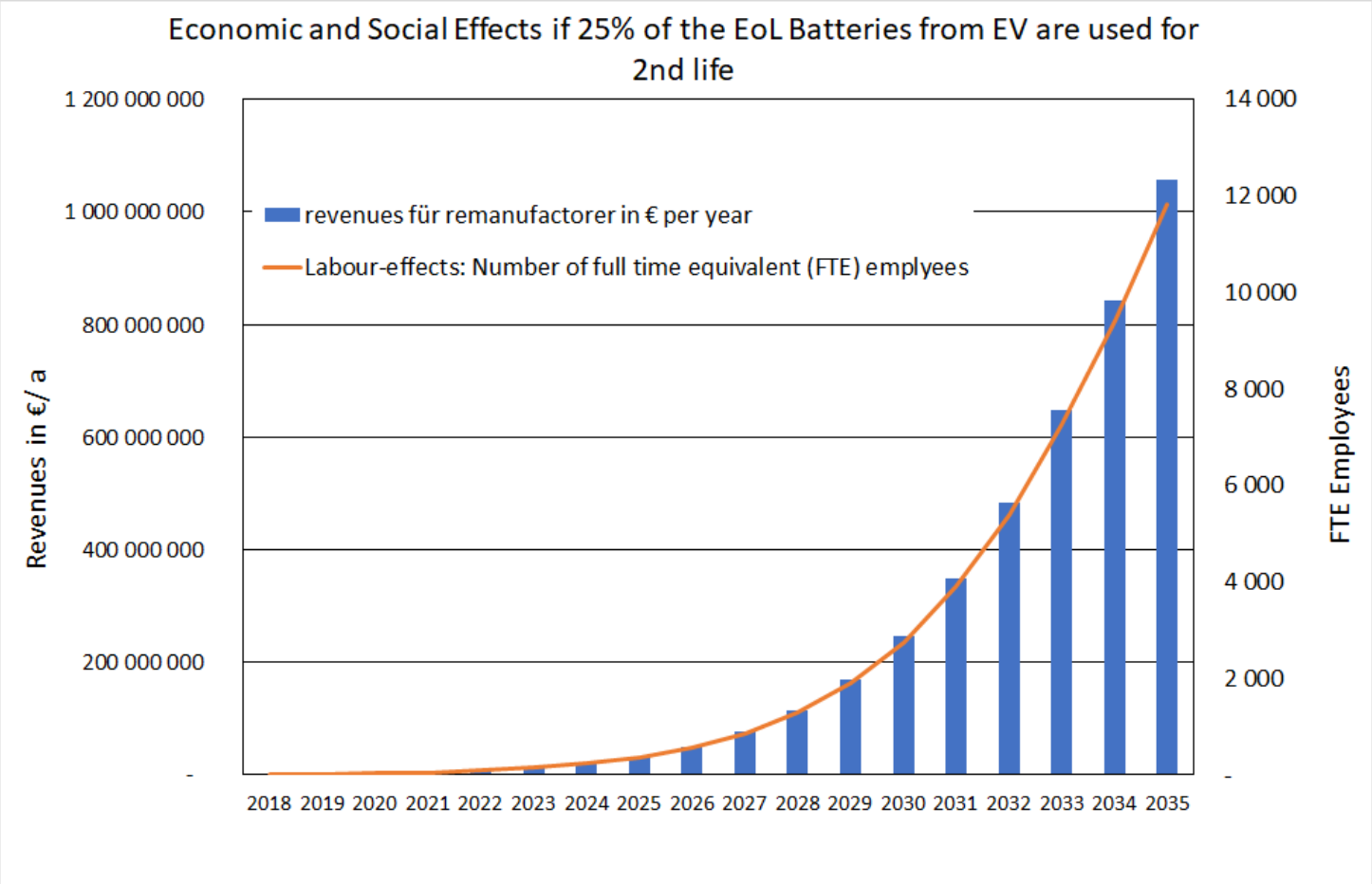
# 2nd life
# Quantitative Impacts of Options (2/6)

## Installed SL storage capacities



# 2nd life
# Quantitative Impacts of Options (3/6)

## Economic and Social Impacts



# 2nd life
# Quantitative Impacts of Options (4/6)

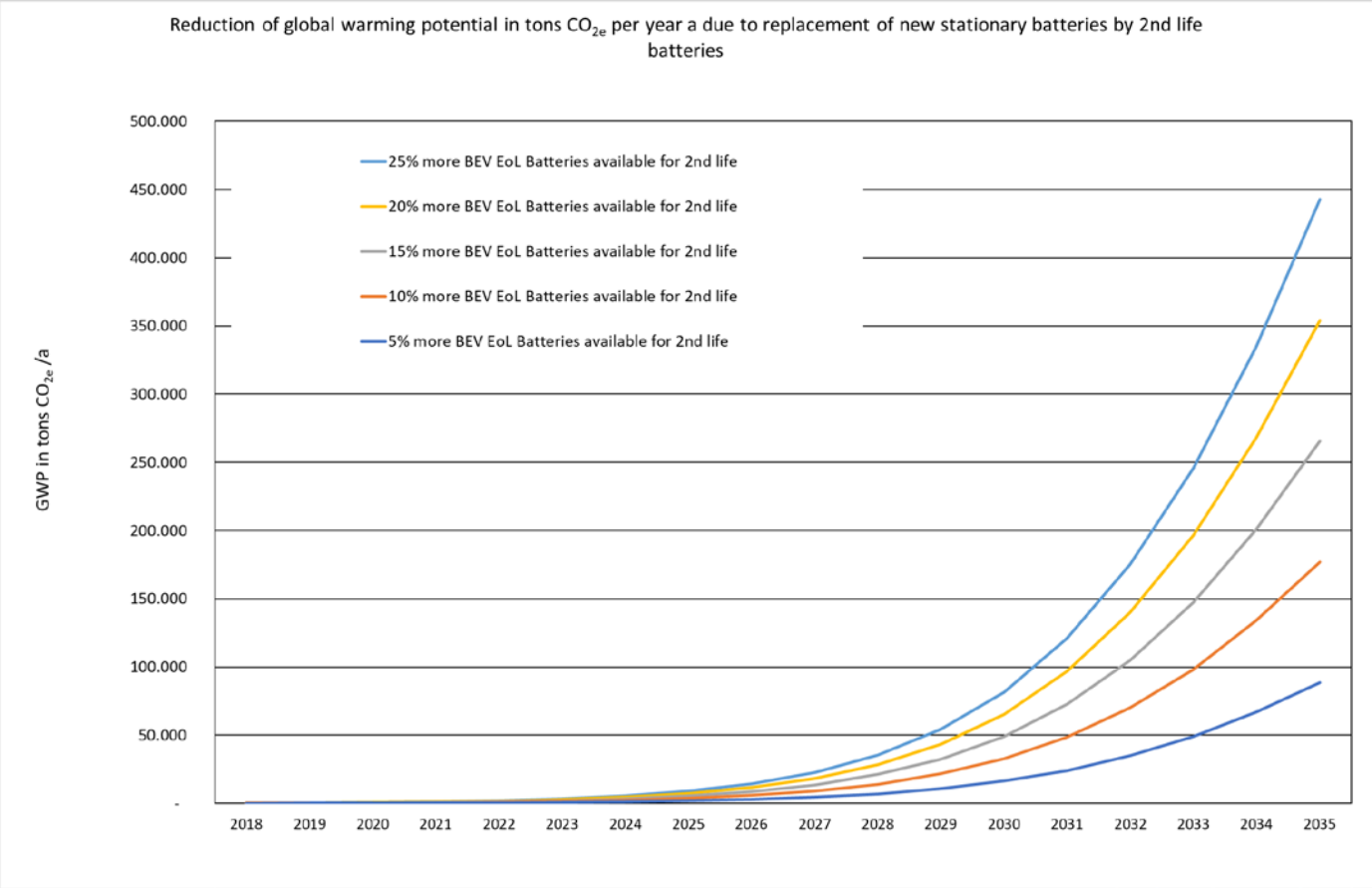
**Findings from the quantitative assessment (1/2)**

- If 50% of the available EoL traction batteries are transferred to 2nd life this would replace a yearly storage capacity of 20 GWh/a in 2035.
- If 25% of the available EoL traction batteries are transferred to 2nd life this would replace a yearly storage capacity of 10 GWh/a in 2035.
- If 10% of the available EoL traction batteries are transferred to 2nd life this would replace a yearly storage capacity of 4 GWh/a in 2035.

- If 25% of the available EoL traction batteries are transferred to 2nd life this would generate in 2035
  - a revenue for the remanufacturers of 1 000 Million Euro per year
  - 12 000 Full time equivalent employees in EU

# 2nd life
# Quantitative Impacts of Options (5/6)

## Environmental impacts: Global Warming Potential




- Other relevant effects for Acidification and Eutrophication etc.

# 2nd life
# Quantitative Impacts of Options (6/6)

**Findings from the quantitative assessment (2/2)**

- If 25% of the available EoL traction batteries are transferred to 2nd life this would avoid a Global Warming Potential of 450 000 tons $CO_{2e}$ per year in 2035.
- If 10% of the available EoL traction batteries are transferred to 2nd life this would avoid a Global Warming Potential of 180 000 tons $CO_{2e}$ per year in 2035.
- If 5% of the available EoL traction batteries are transferred to 2nd life this would avoid a Global Warming Potential of 90 000 tons $CO_{2e}$ per year in 2035.

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# 2nd life
# Initial Conclusions

- SL business cases will be fully developed not before +/- 2030 as the volume of EV Batteries for second life is to small for a fully developed market across Europe before 2030. In the years before it will be a niche product
- The **Baseline** (Batteries are waste at the end of their first life) and **Option 1** (Batteries are waste at the end of their entire lifetime only) are rejected by effectively all stakeholders.
- **Option 2** (Batteries are waste and batteries for SL ceased to be waste) lift market barriers and additional impacts could be raised by additional regulations regarding certificate for SL batteries.
- For each 10% more usage of SL batteries 300 000 tons CO2-eq can be avoided per year in 2035.
- A new reporting obligation for EV and/or industrial batteries is proposed to be established (see measure on a collection target for industrial batteries). A monitoring / reporting on how much of the traction batteries are directed to 2nd life and how much is directed to recycling should be included.