

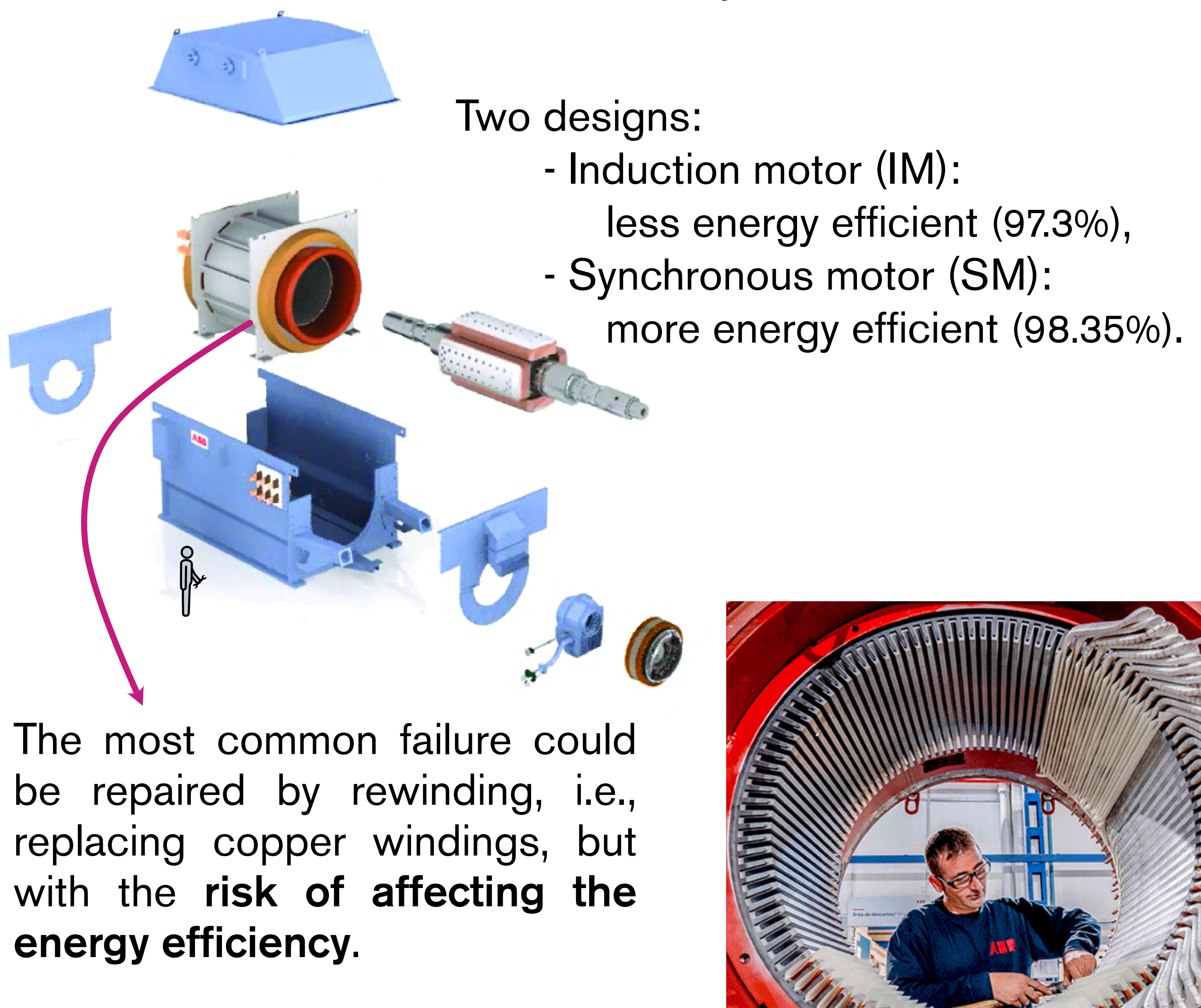
When is repair environmentally beneficial?

The case of high-voltage electric motors

① Context

One **energy-intensive product**: high voltage electric motors used in industry (e.g., pumps and compressors in chemical and metal industries)

- 30 tons of steel, copper and plastics,
- In operation for 50 weeks/year in Sweden,
- Output power of 16 MW,
- Used until failure, lifetime above 20 years.



③ Results - Resource depletion

Legend

(IM): induction motor, used for 20 years

(SM): synchronous motor, used for 20 years

(+20): SM repaired and used for 20 additional years

(+20↓): (+20) with an efficiency reduction of 0.6%

Motor recycling

Electricity losses during use

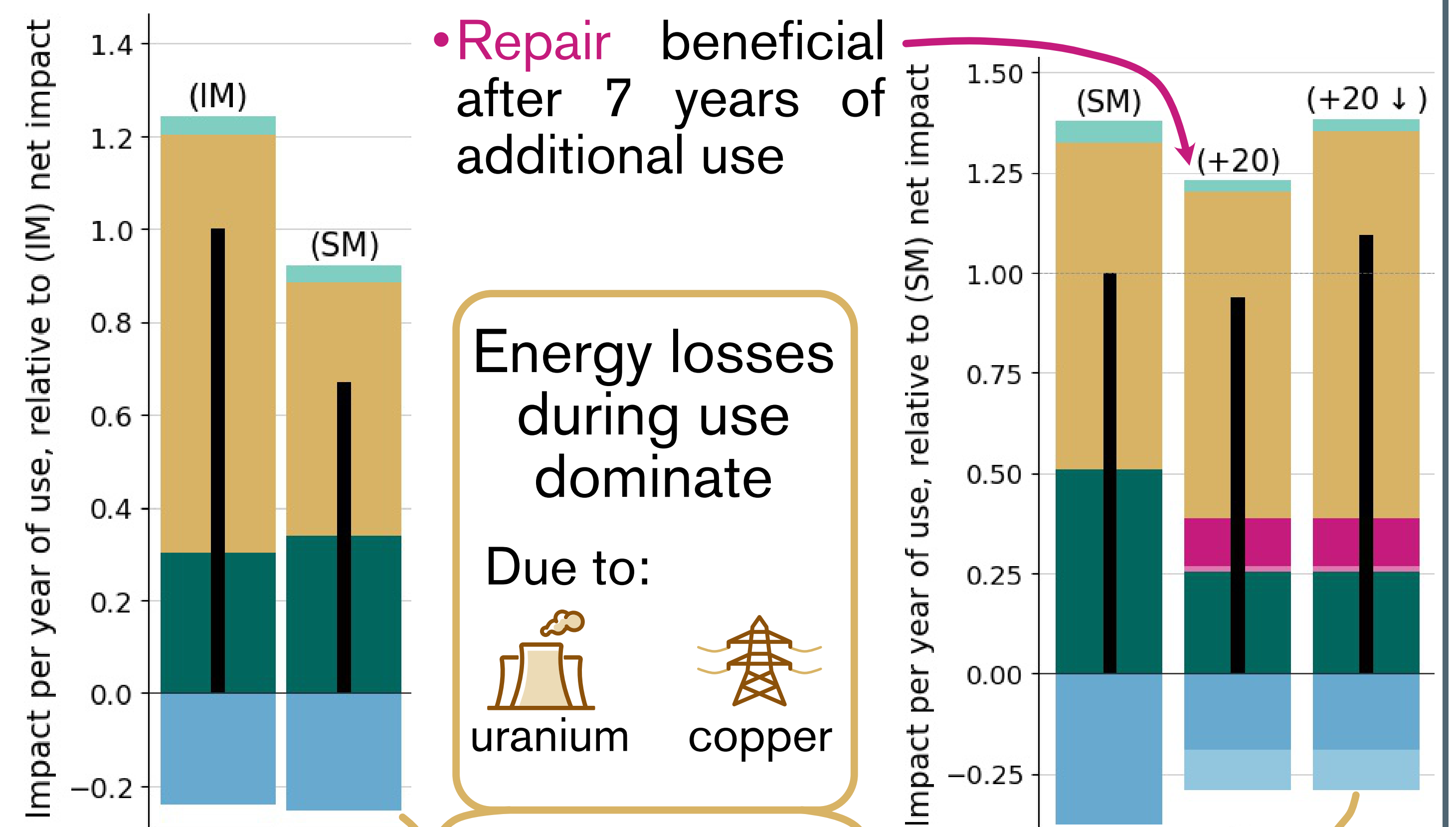
Motor production

Credits from motor recycling

Rewinding

Old windings recycling

Credits from windings recycling



- The more efficient SM results in lower impact than the IM.

- A small efficiency reduction ($>0.4\%$) offsets the benefit of repair.

The impact reduction from SM's better efficiency outweighs its **higher impact from extraction and production** (more copper in the motor).

② Results - Global warming

Legend

(IM): induction motor, used for 20 years

(+20): SM repaired and used for 20 additional years

(SM): synchronous motor, used for 20 years

(+20↓): (+20) with an efficiency reduction of 0.6%

Motor recycling

Electricity losses during use

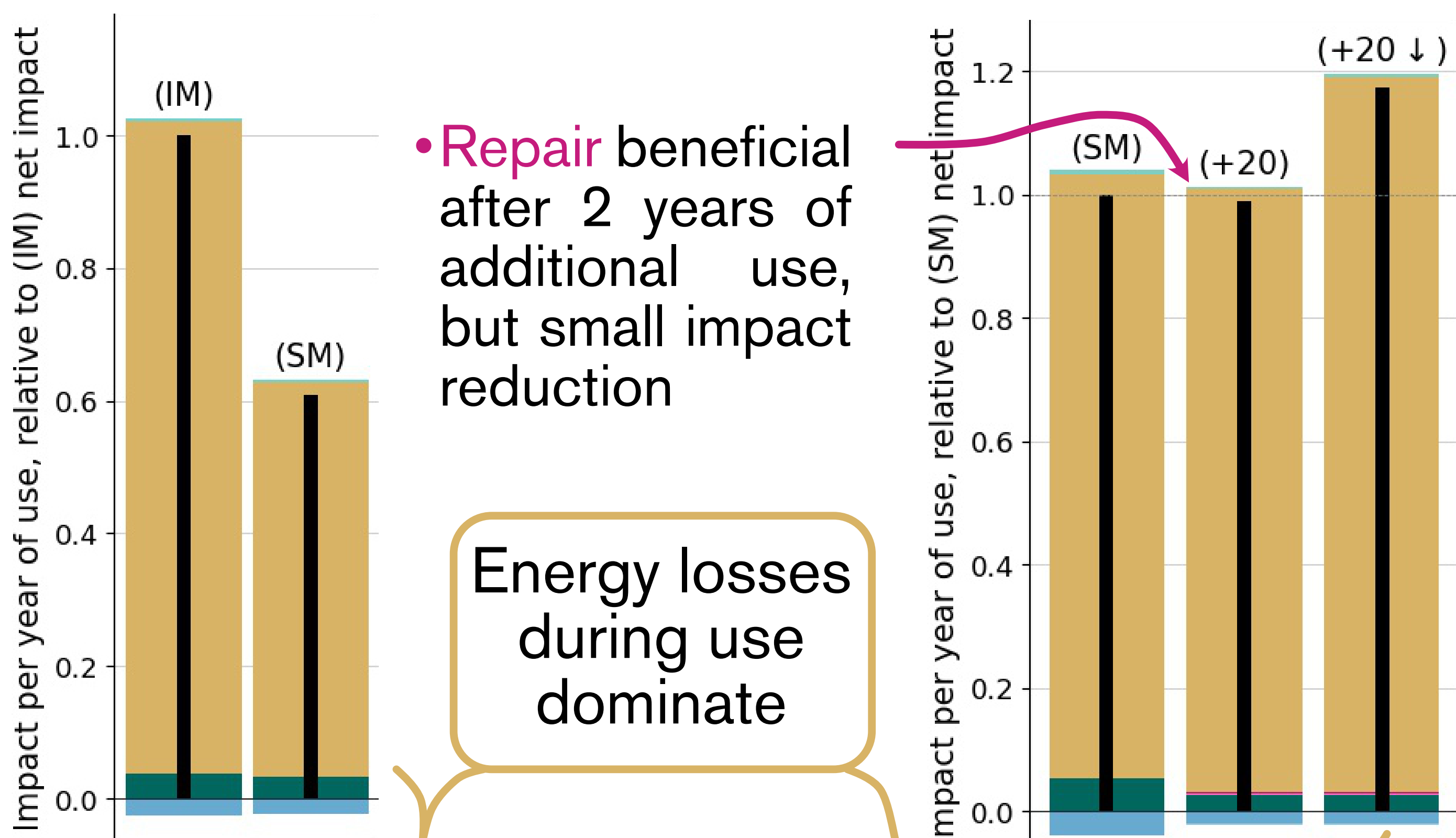
Motor production

Credits from motor recycling

Rewinding

Old windings recycling

Credits from windings recycling



- The more efficient SM results in lower impact than the IM.

- A small efficiency reduction ($>0.05\%$) offsets the benefit of repair.

④ Sensitivity analysis

Changing the electricity mix:

- Baseline: mix of nuclear, hydro, bio and wind (Swedish mix)
- Low-carbon: hydroelectricity only
- High-carbon: oil-based only

Conclusions are not changed

Conclusions

After a minimum additional use only (2-7 years), repair is beneficial, but less than choosing a more energy-efficient design, and a small energy efficiency reduction outweighs the benefits of repair.

➡ For LCAs of use extension of energy-using products: include resource use from electricity production and transmission.

➡ For motor manufacturers and users: focus on high energy efficiency rather than repairability.

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