How can the End of Life of automotive polymers be considered in Life Cycle Assessment?

A scenario based evaluation of the current End of Life situation

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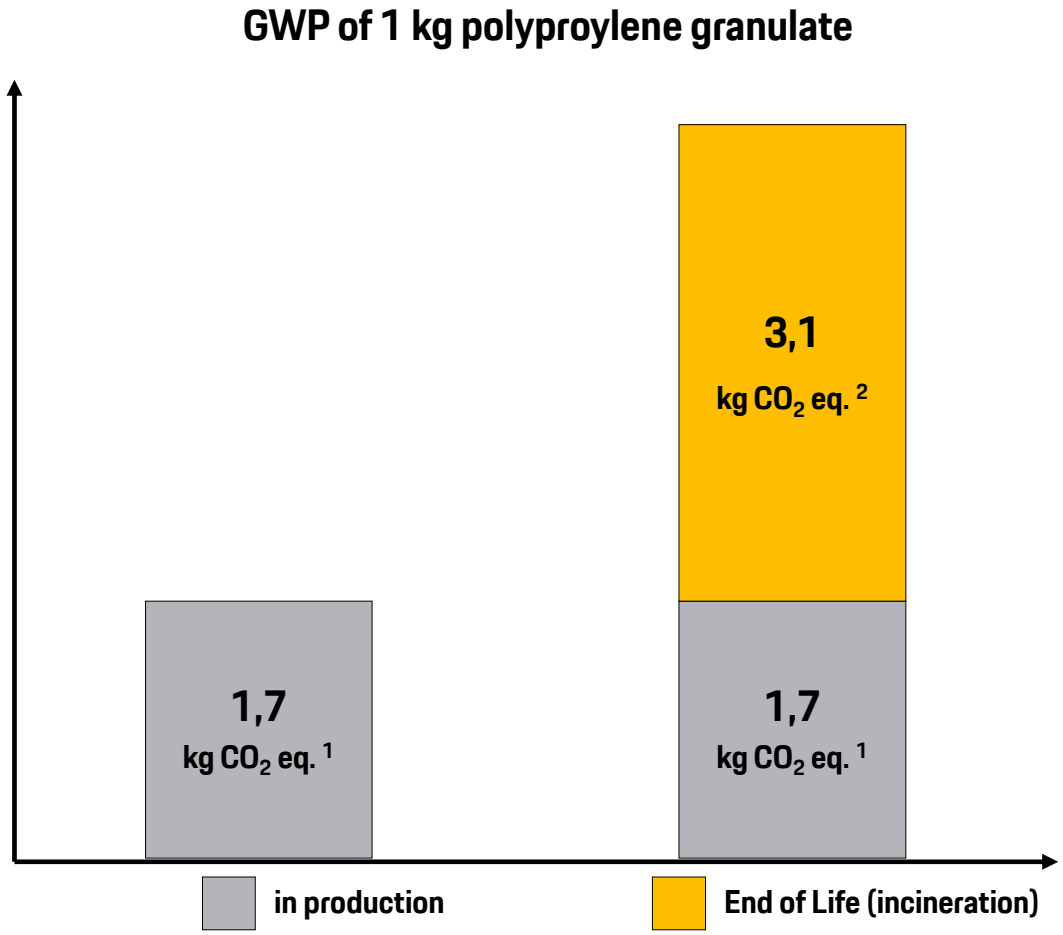
Why is the End of Life important for polymer's LCAs?



Data sets from GaBi Professional database (SP39): [1] DE: Polypropylene granulate (PP) mix | [2] DE: Polypropylene (PP) in waste incineration plant

- Incineration is a possible waste treatment procedure for the End of Life of automotive polymers.
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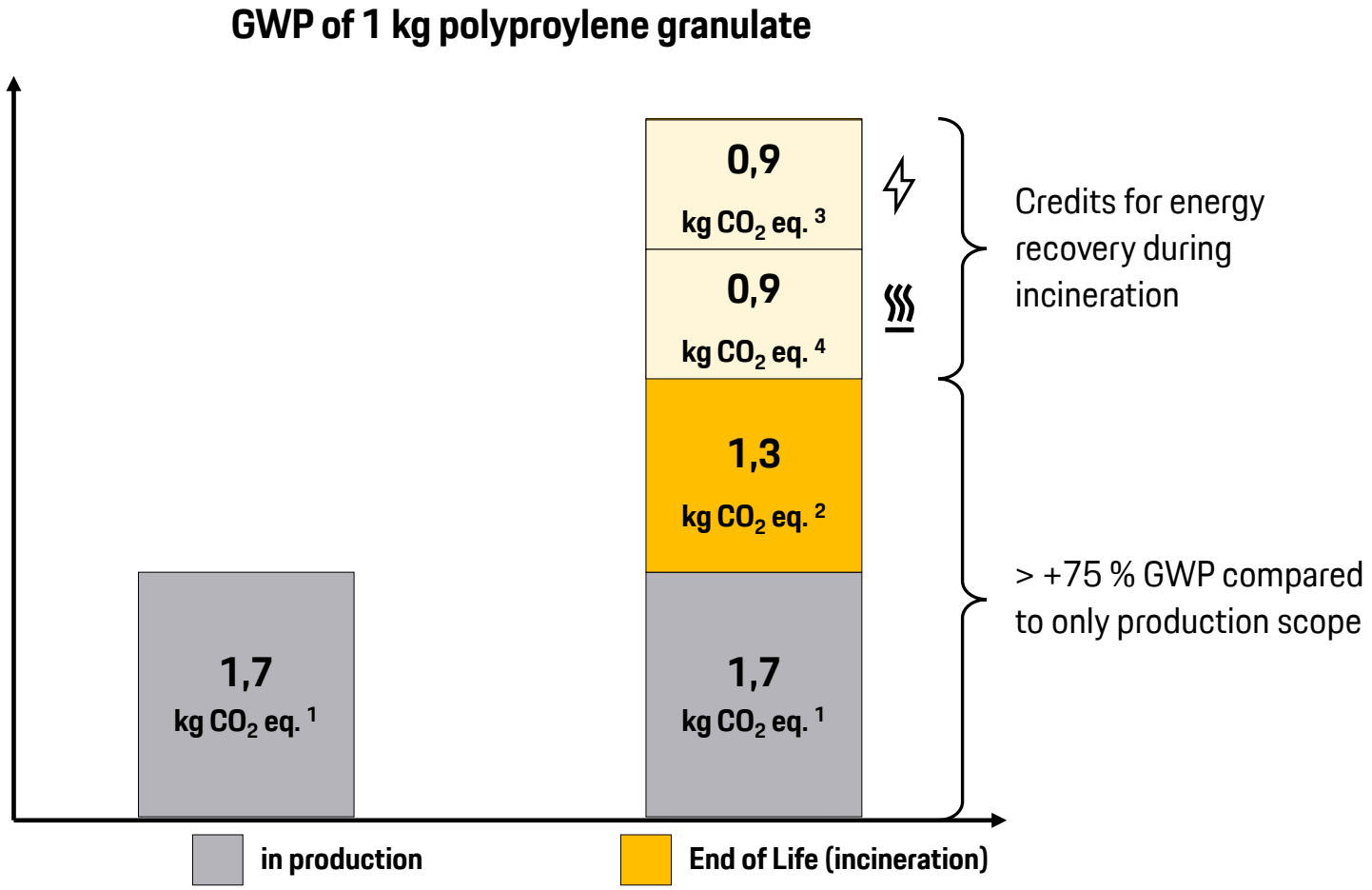

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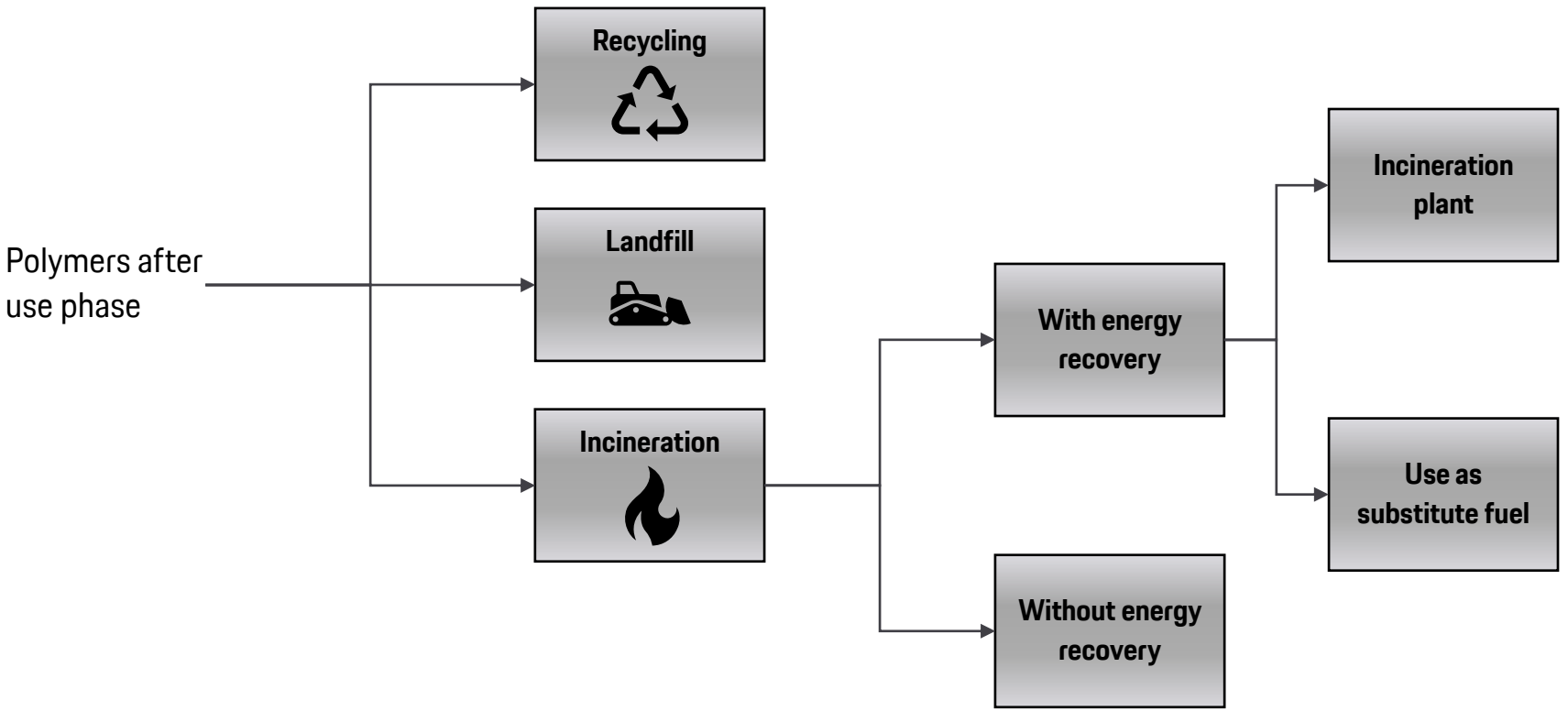
- The emissions that occur during the incineration can have a significant impact on the GWP of the polymer.
- Even with the recovery of thermal energy, a significant increase in GWP of polymers compared to the production phase is possible.

Data sets from GaBi Professional database (SP39): [1] DE: Polypropylene granulate (PP) mix | [2] DE: Polypropylene (PP) in waste incineration plant | [3] DE: Electricity grid mix | [4] DE: Thermal energy from natural gas

Different waste treatment options for automotive polymers



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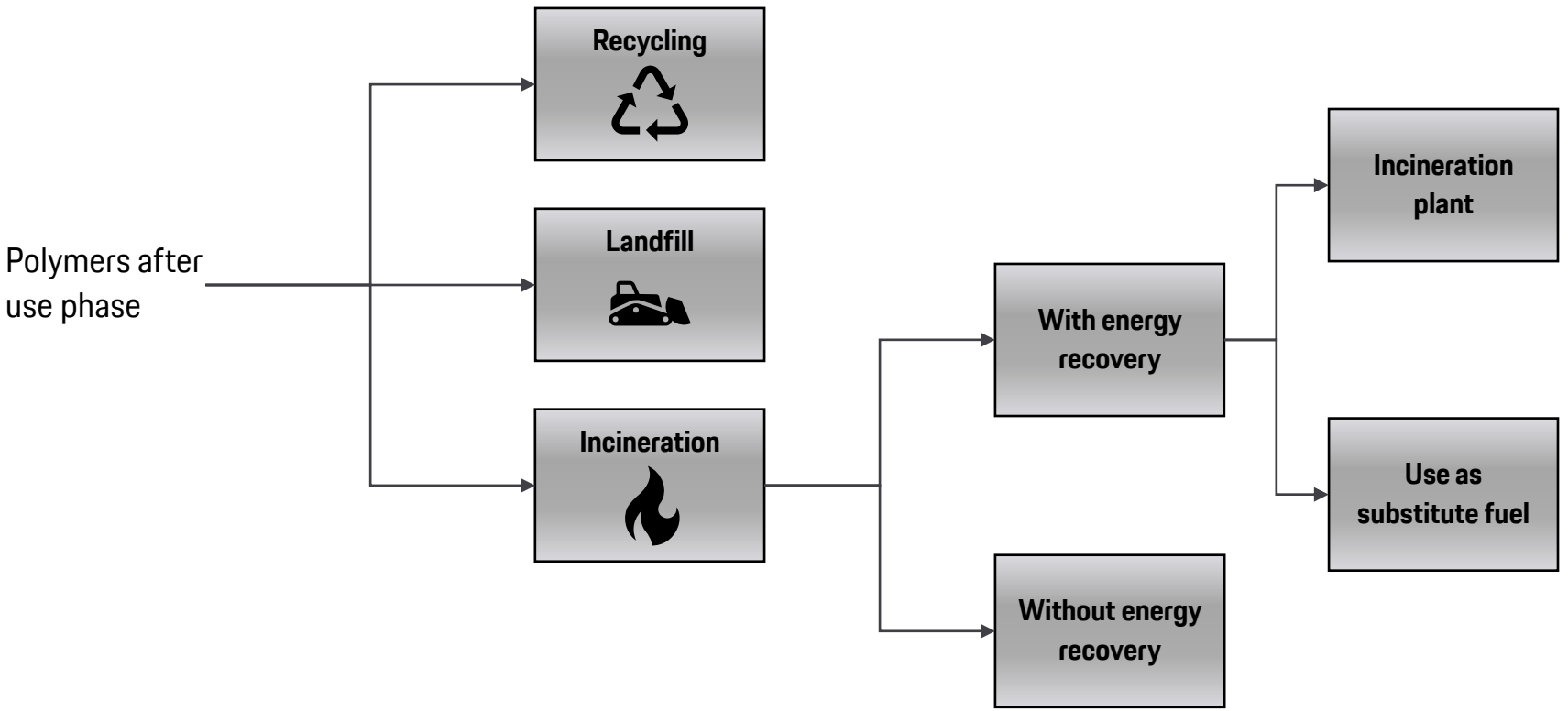
Different waste treatment options for automotive polymers



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Approaches in literature:

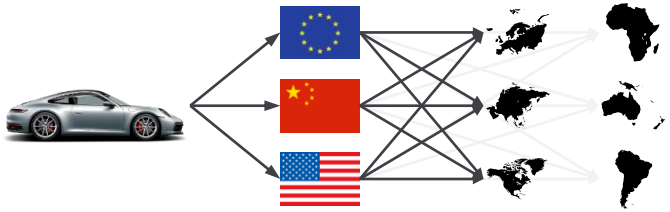
Scenarios based on local conditions

Scenarios based on assumptions

A global scenario based on data for the End of Life for automotive polymers is missing.

Main questions to be answered

Where do the automotive polymer‘s life cycles end?



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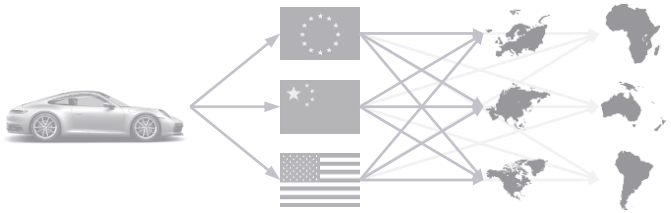

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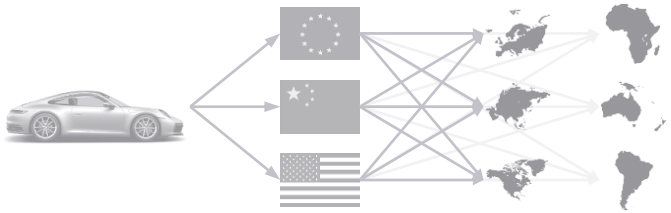

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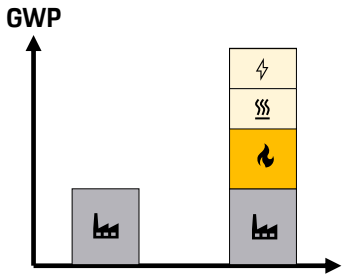
What is the environmental impact (GWP) of those waste treatment technologies?



GWP: Global Warming Potential

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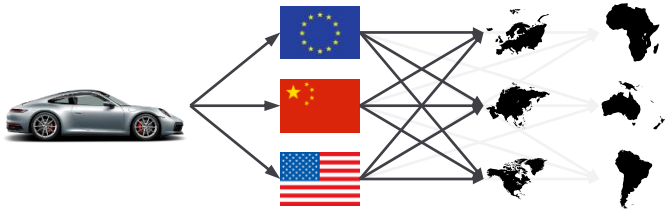

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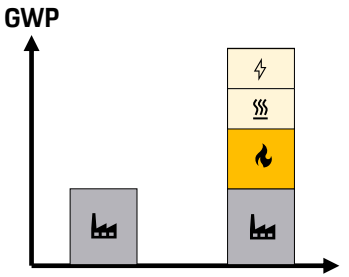

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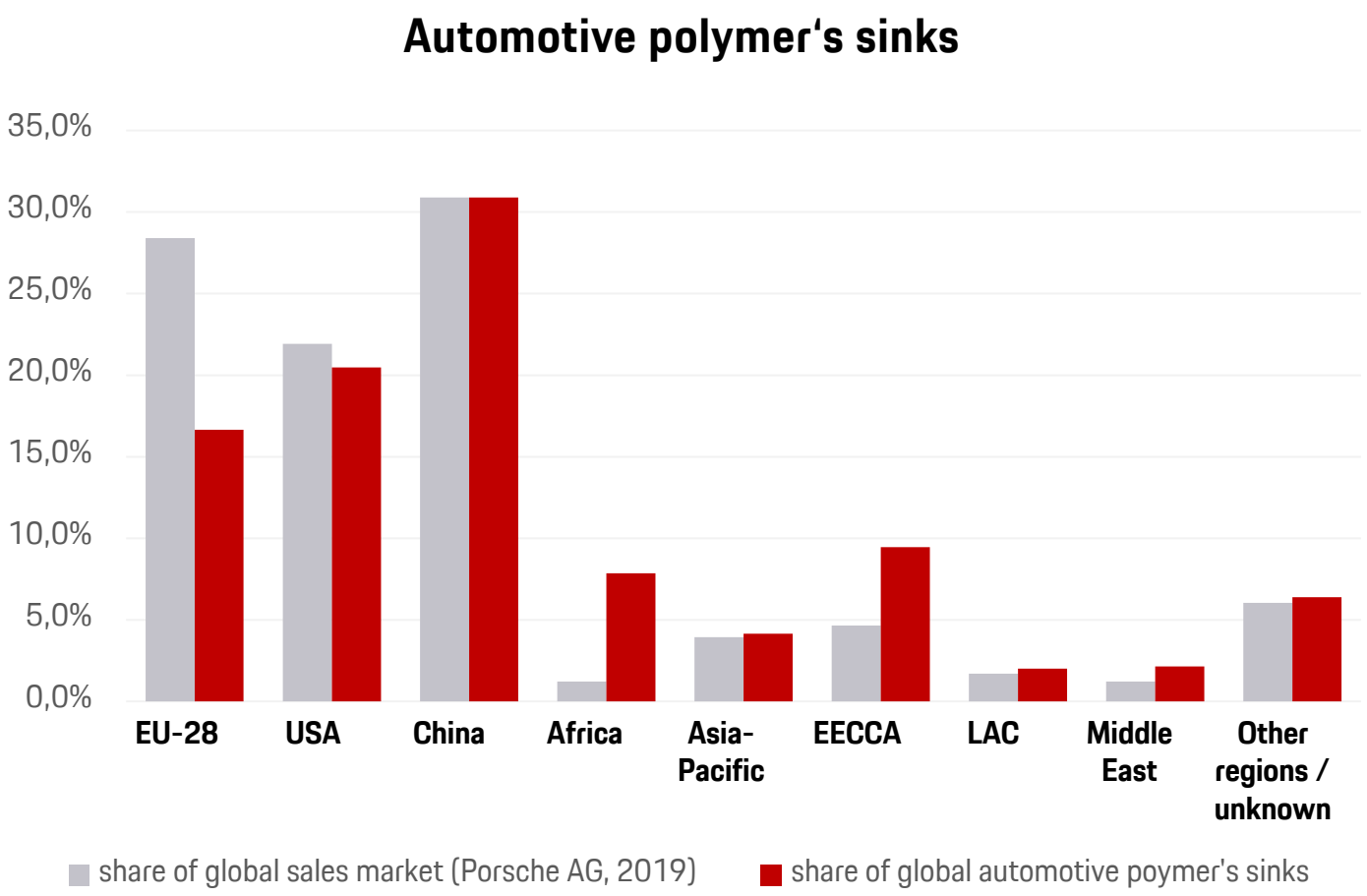

EU-28: European Union (2013-2020) | USA: United Stated of America | EECCA: Eastern Europe, Caucasus and Central Asia | LAC: Latin America and the Caribbean

- Sales markets of Porsche AG were linked with information about import/export of End of Life vehicles (ELVs) in the respective markets.
- Simplifications and assumptions were made to fill data gaps (e.g. the number of vehicles that change the market more than once were assumed to be negligible)

What are the local conditions of waste treatment in the respective regions?

	EU-28	USA	China	Africa	Asia-Pacific	EECCA	LAC	Middle East	Other regions / unknown
Recycling	13%	0%	0%	0%	0%	0%	0%	0%	0%
Incineration without energy recovery	0%	0%	0%	50%	0%	0%	0%	50%	50%
Incineration with energy recovery	87%	0%	0%	0%	0%	5%	0%	0%	0%
→ Incineration plant	12%	-	-	-	-	100%	-	-	-
→ Use as substitute fuel	85%	-	-	-	-	-	-	-	-
→ Other	4%	-	-	-	-	-	-	-	-
Landfill	0%	100%	100%	50%	100%	95%	100%	50%	50%

- Based on quantitative or qualitative literature data
- Based on literature data for single, representative country in market
- No data available or high uncertainties, assumption based, important for sensitivity analysis

- Large data gaps lead to the necessity for assumptions.
- Single countries were assumed to be representative for a larger region as an assumption.
- For regions without reliable data, a default scenario of 50% landfill and 50% incineration without energy recovery was set.

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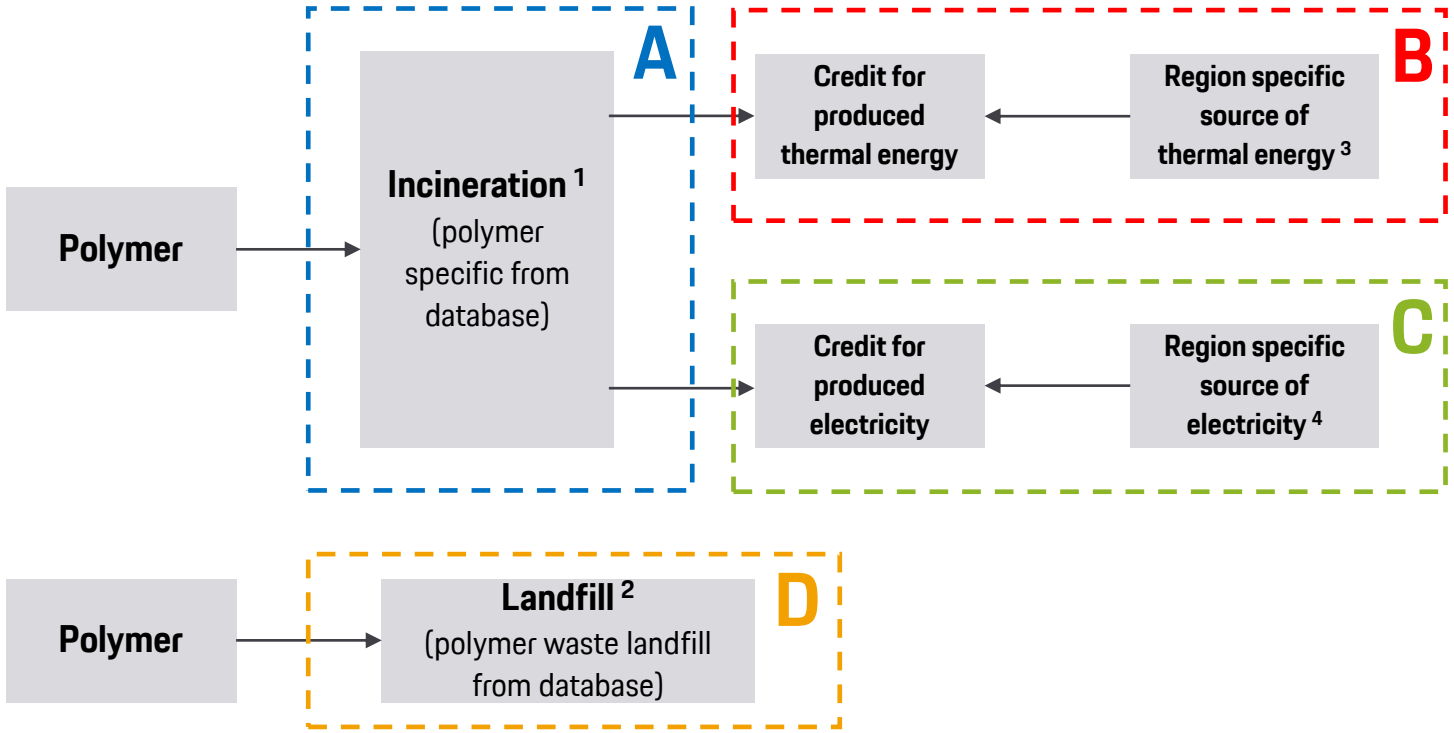
Architecture of LCI models for waste treatment

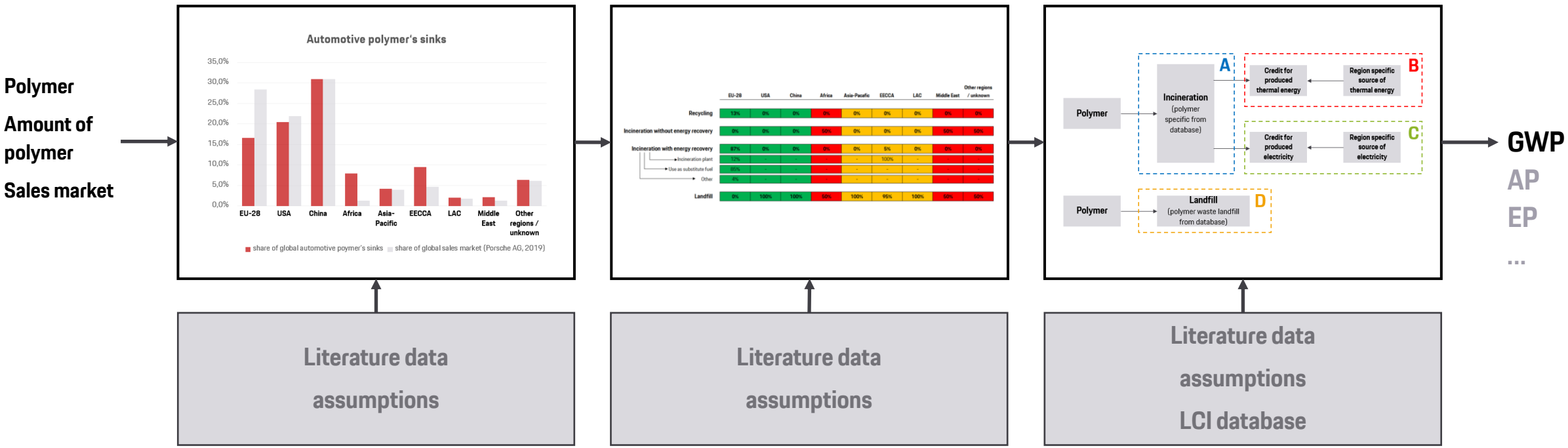


- Emissions for all incineration options are assessed with datasets for EU-28 incineration plants.
- Dependent from the waste treatment different parts of the LCI model are used:

Incineration without energy recovery	A
Incineration for use as subtitution fuel	A+B
Incineration in incineration plant	A+B+C
Landfill	D
Recycling (Cut-Off allocation)	/

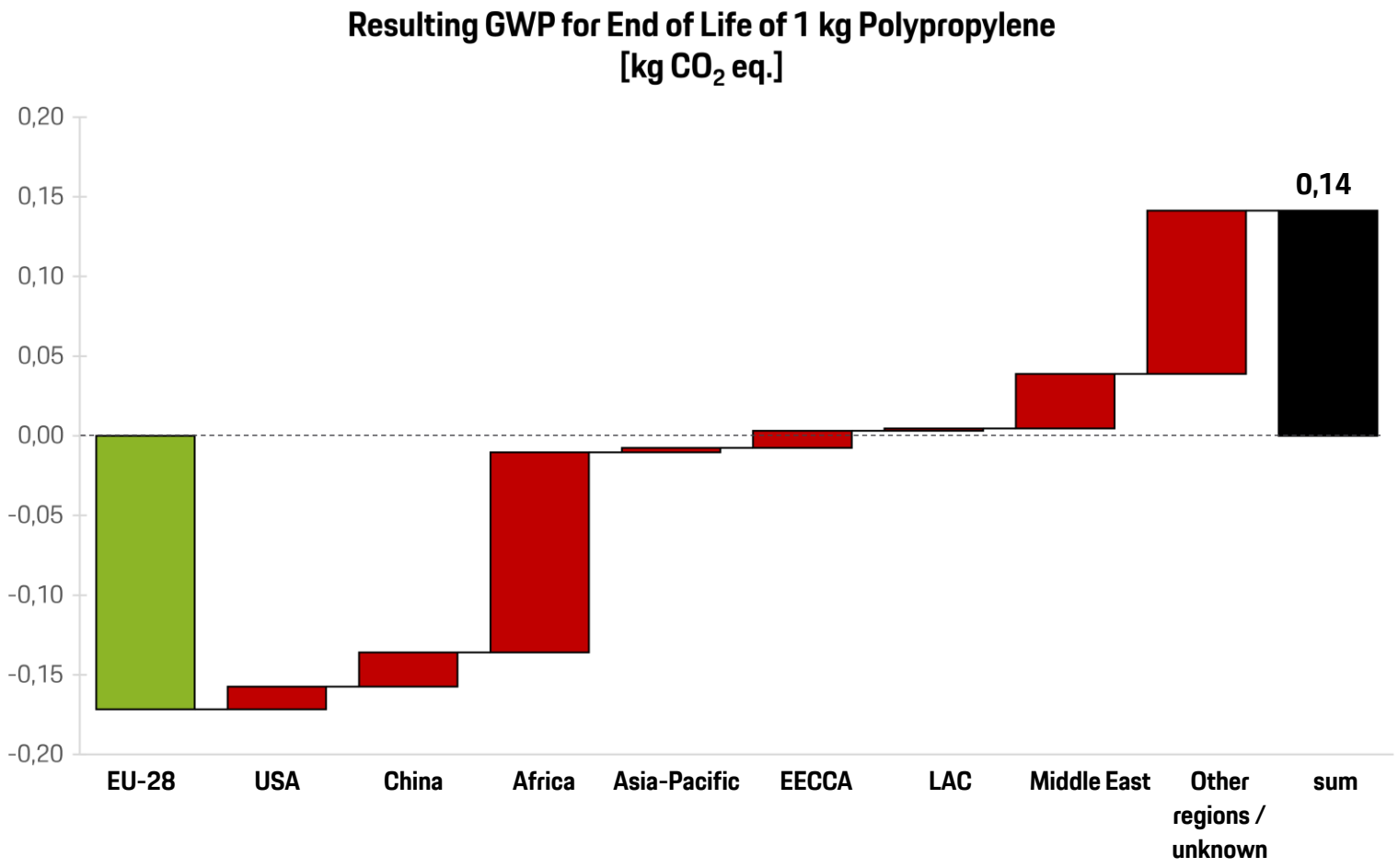
GWP: Global Warming Potential | Data sets from GaBi Professional database (SP39): [1] DE: XX in waste incineration plant | [2] EU-28: Plastic waste on landfill| [3] XX: Thermal energy from hard coal or thermal energy from natural gas | [4] XX: Electricity grid mix

Combination of information to build up an LCA-framework



GWP: Global Warming Potential | AP: Acidification Potential | EP: Eutrophication Potential

Results for chosen default scenario



- Credits for the EU-28 are due to the incineration as substitution fuel (substituted fuel has a higher GWP per calorific value than PP).
- Hotspots are regions where assumptions had to be made.
- High sensitivity for share of incineration without energy recovery

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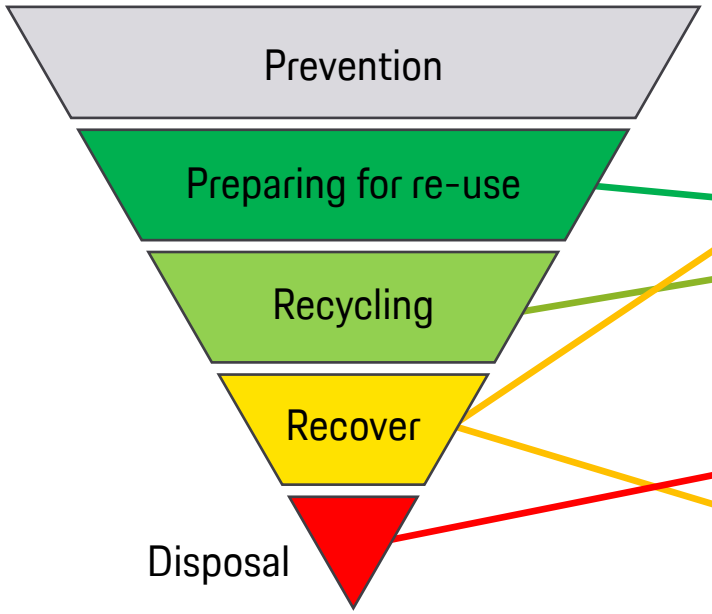
Contradictions between CO_2-reduction and circular economy

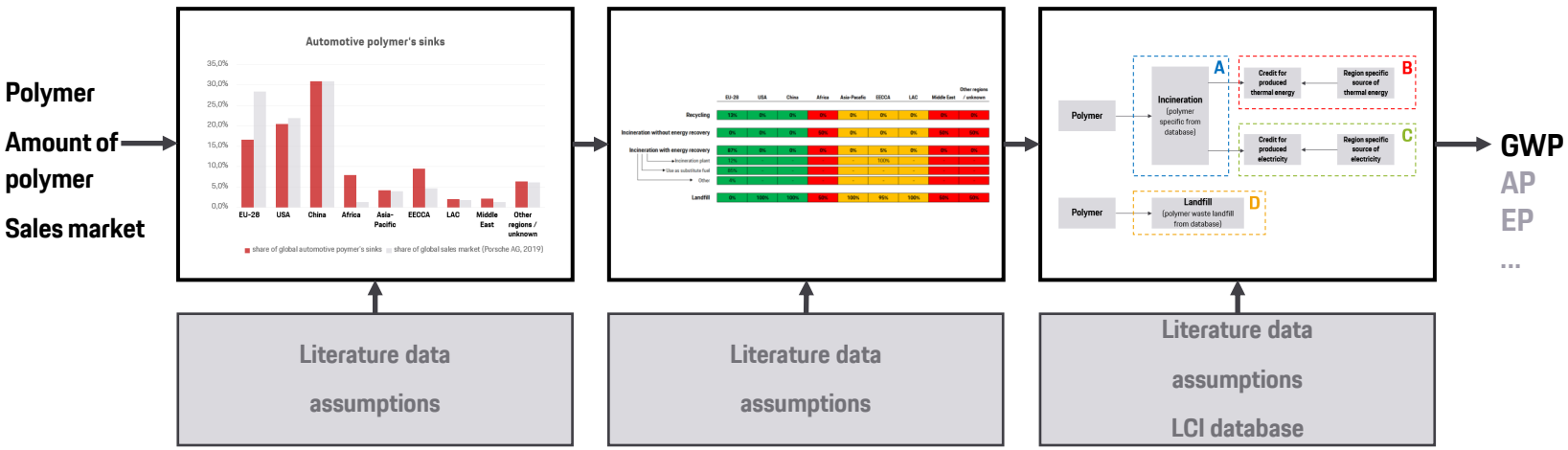
Waste hierarchy of European Commission



„CO_2-ranking“ under given system boundaries and allocation rules

1. Incineration with energy recovery (use as substitute fuel)
2. Recycling and re-use
3. Landfill
4. Incineration with energy recovery (incineration plant)

Conclusion



- LCA-framework allows to assess the environmental impact (GWP) of automotive polymers in the End of Life based on background information and little input information.
- Data gaps limit the resilience of the results.

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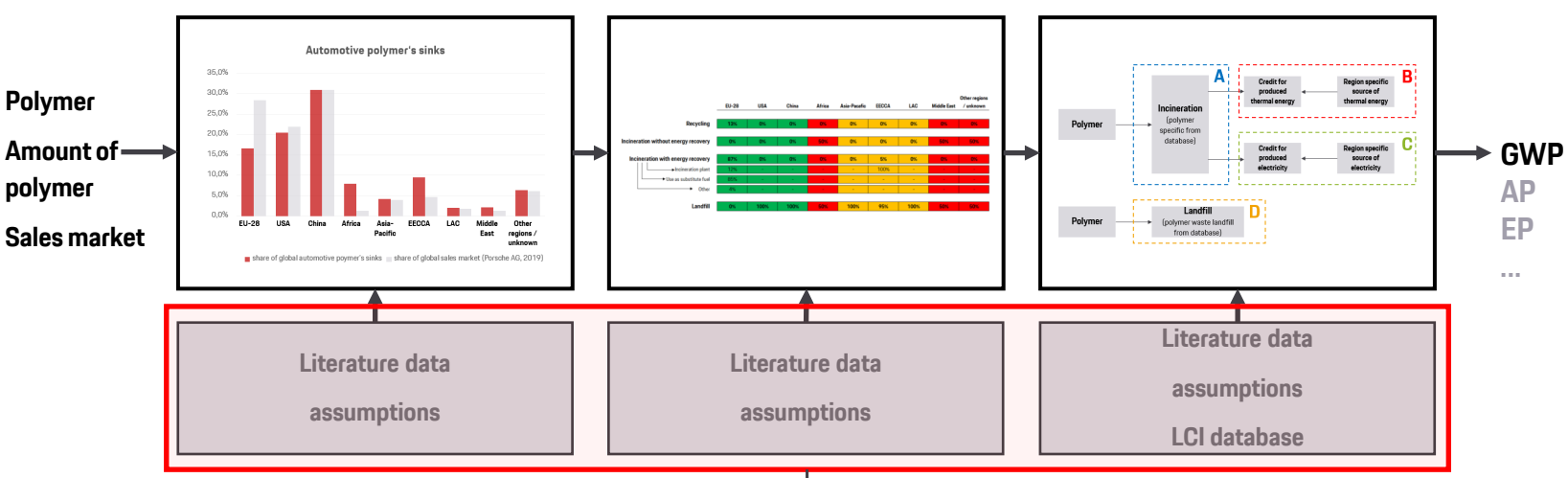

- LCA-framework allows to assess the environmental impact (GWP) of automotive polymers in the End of Life based on background information and little input information.
- Data gaps limit the resilience of the results.
- Further optimization regarding background information is necessary and possible.

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