NRW.Zirkulär: Implementation Study for Circular Plastics via Pyrolysis Processes in NRW

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Project: NRW.Zirkulär
Wissenschaft trifft Wirtschaft
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Project target of NRW.Zirkulär

Status Quo

- In NRW, **input materials** are in principle **available**
- Technical **foundations** of plastic pyrolysis **exist**
- A reasonable **climate-related perspective** is emerging for chemical recycling

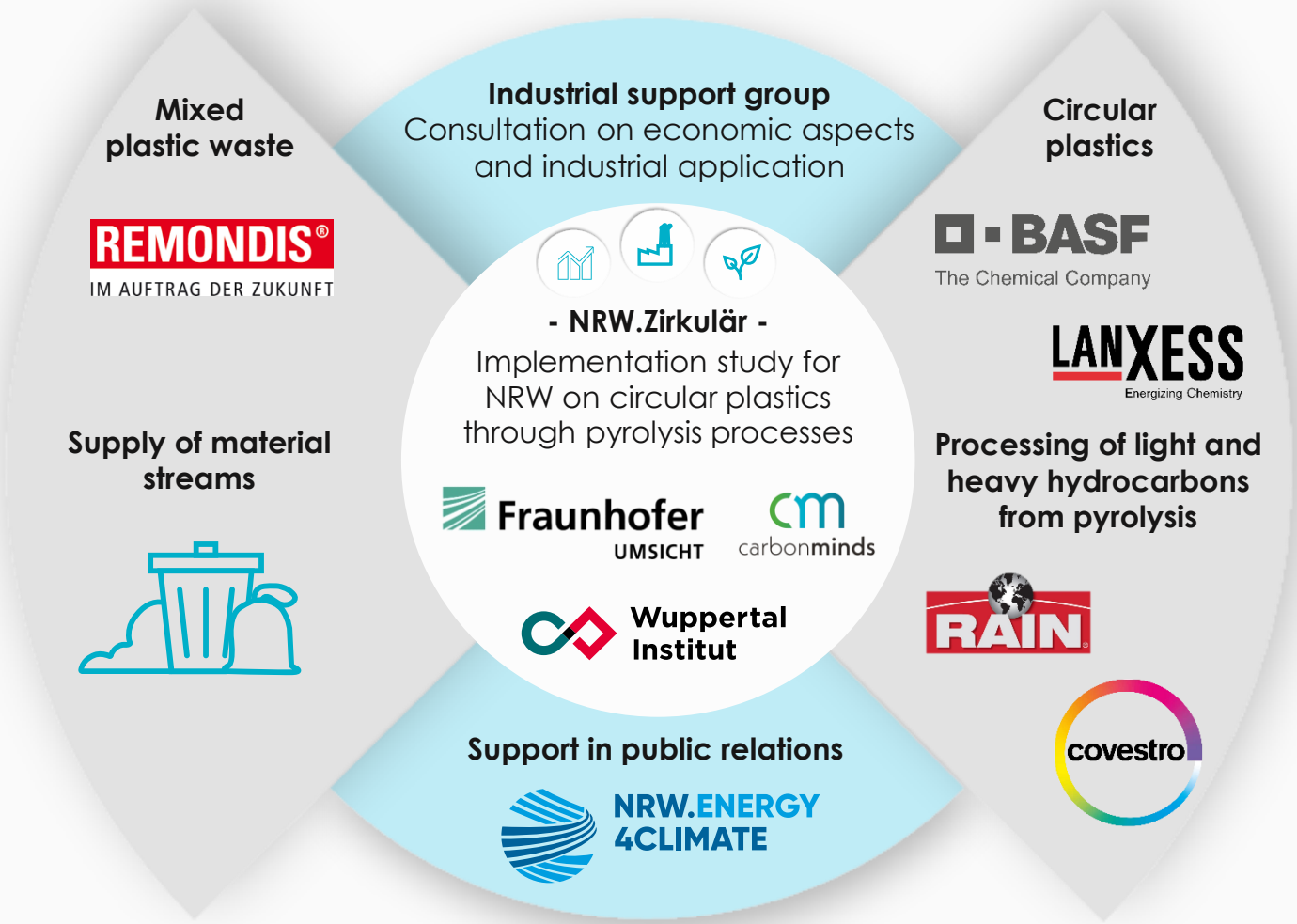
Open Questions for NRW.Zirkulär

- What are the **long-term climate and resource-related benefits** of pyrolysis for NRW?
- Will there be **sufficient raw materials** for pyrolysis **in NRW** in the future?
- **Cost-competitiveness** with alternative **in the long-term** depending on local parameters?

Target

- Technical parameters of possible pyrolysis processes
- Economical and ecological evaluation of plastic pyrolysis regarding current and future scenarios in NRW
- **Preparation and decision support to build a pilot scale pyrolysis pilot plant in NRW**

Partners of NRW.Zirkulär



Die Landesregierung Nordrhein-Westfalen

The overall objective is the evaluation of a larger follow-up project for the construction of a pilot plant/industrial plant in NRW

Projektträger Jülich Forschungszentrum Jülich

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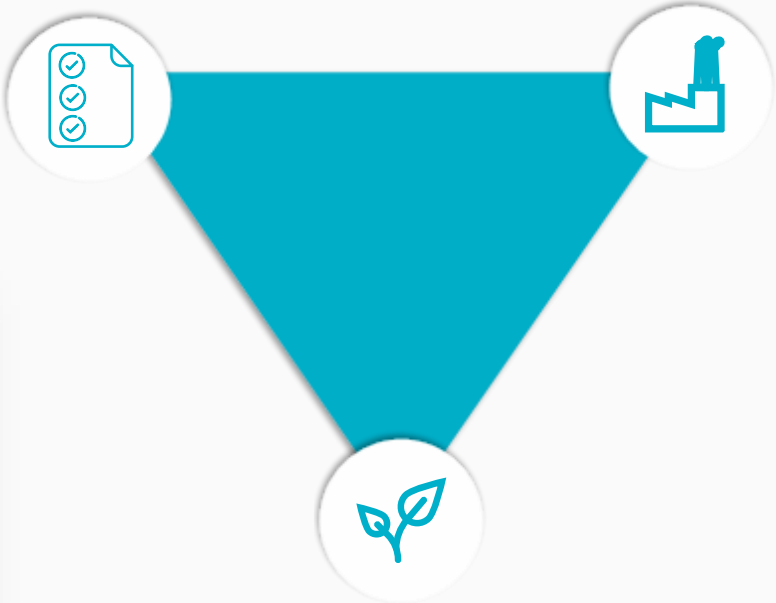
The focus areas of the project team

Economical and infrastructural evaluation

Wuppertal Institut

- **International think tank** for impact and application-oriented sustainability research.
- Focus on shaping transformation processes towards a climate-friendly and resource-efficient world.



Technical evaluation

Fraunhofer UMSICHT

- **Research institute** in the areas of climate-neutral energy systems, resource-efficient processes and circular products.
- Development and implementation of innovative technologies, services and products for the circular economy.

Environmental evaluation

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- **Company** addressing the evidence-based transition to a sustainable chemical industry.
- Provider of data and services for the assessment, monitoring and reduction of environmental impacts of chemicals and plastics.

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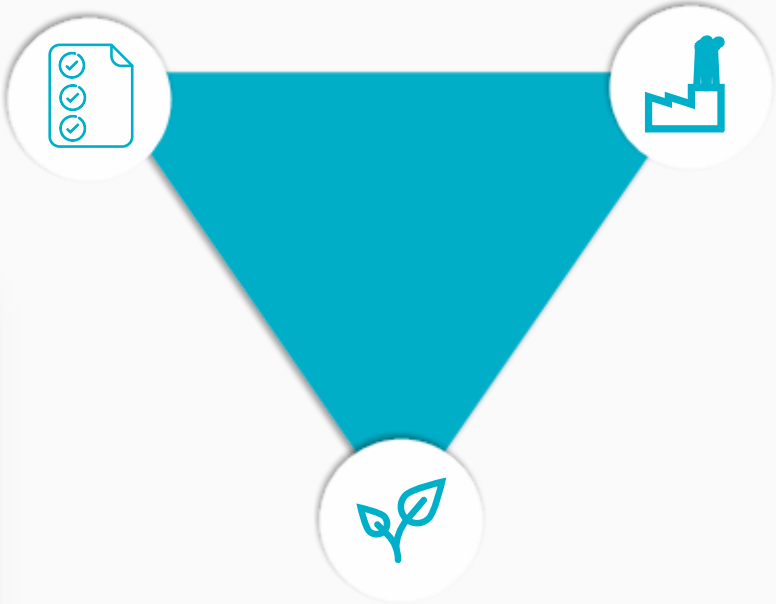

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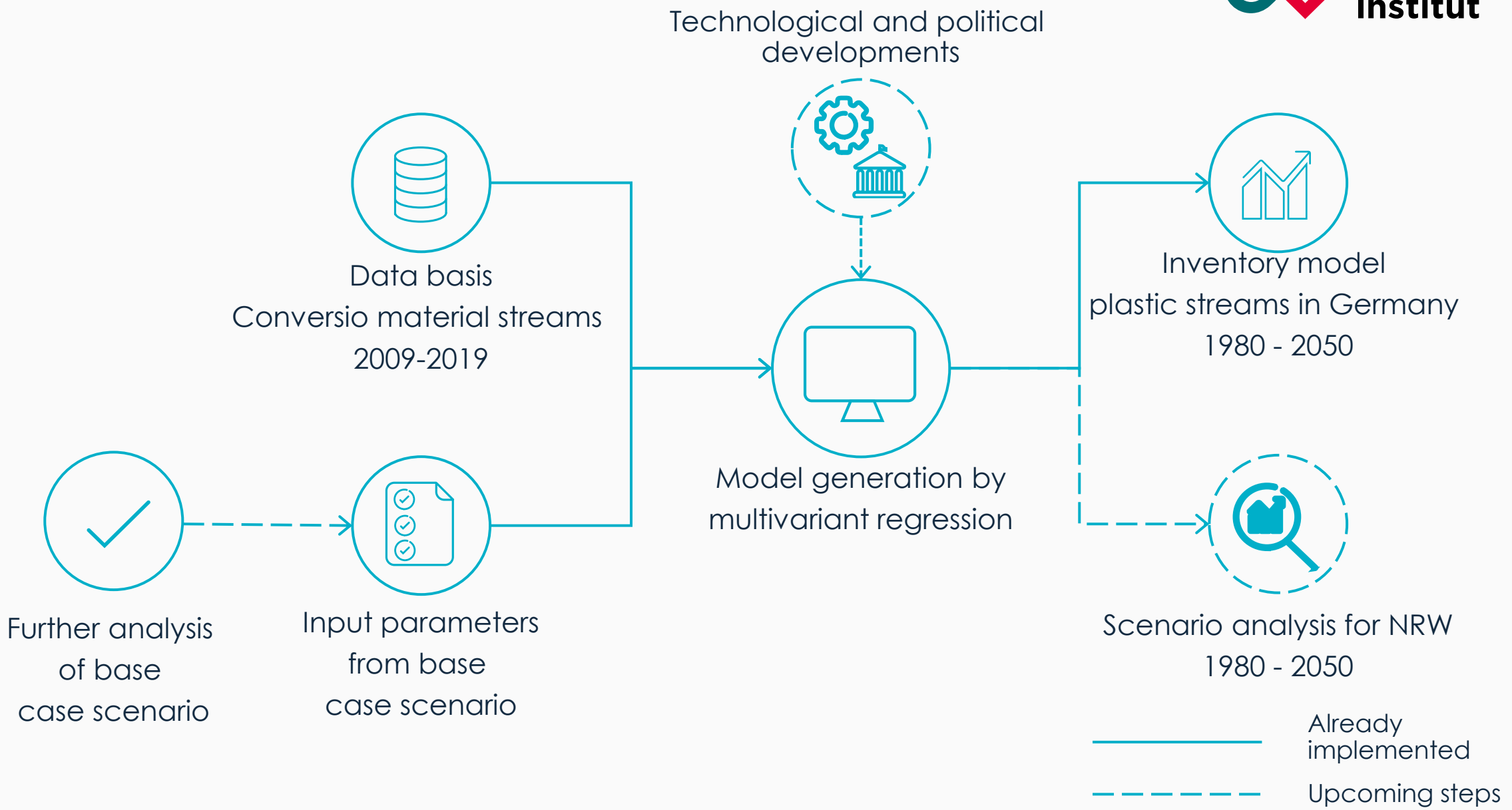
Modeling of plastic material streams



Annual plastic waste volume in Germany by sector

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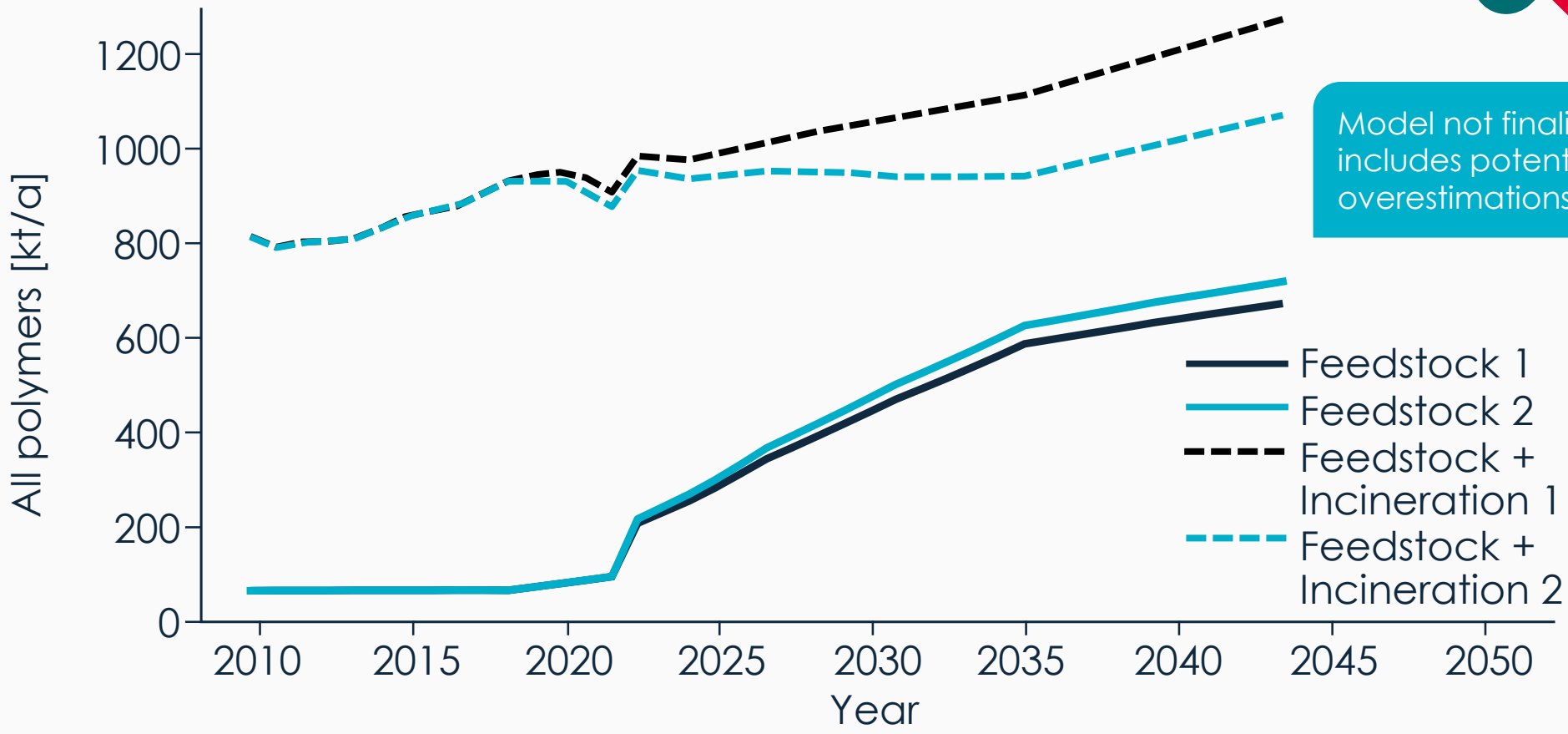

Model not finalized and includes potential overestimations.

Average contribution sorted plastic waste					
PE (LD/HD)	PP	PET	PVC	PS	other
49%	21%	14%	8%	2%	6%

Potential available amount of plastic waste

- **2025 890 - 940 kt / a**
  2050 880 - 1060 kt / a

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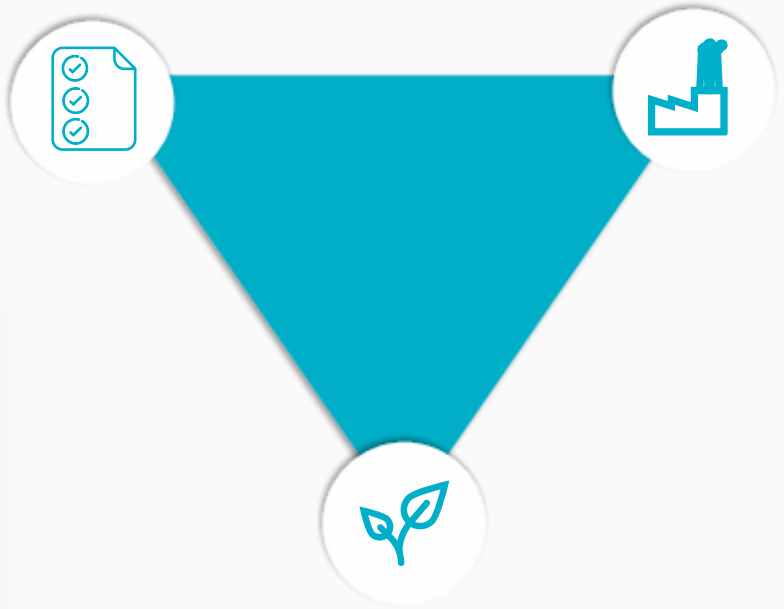

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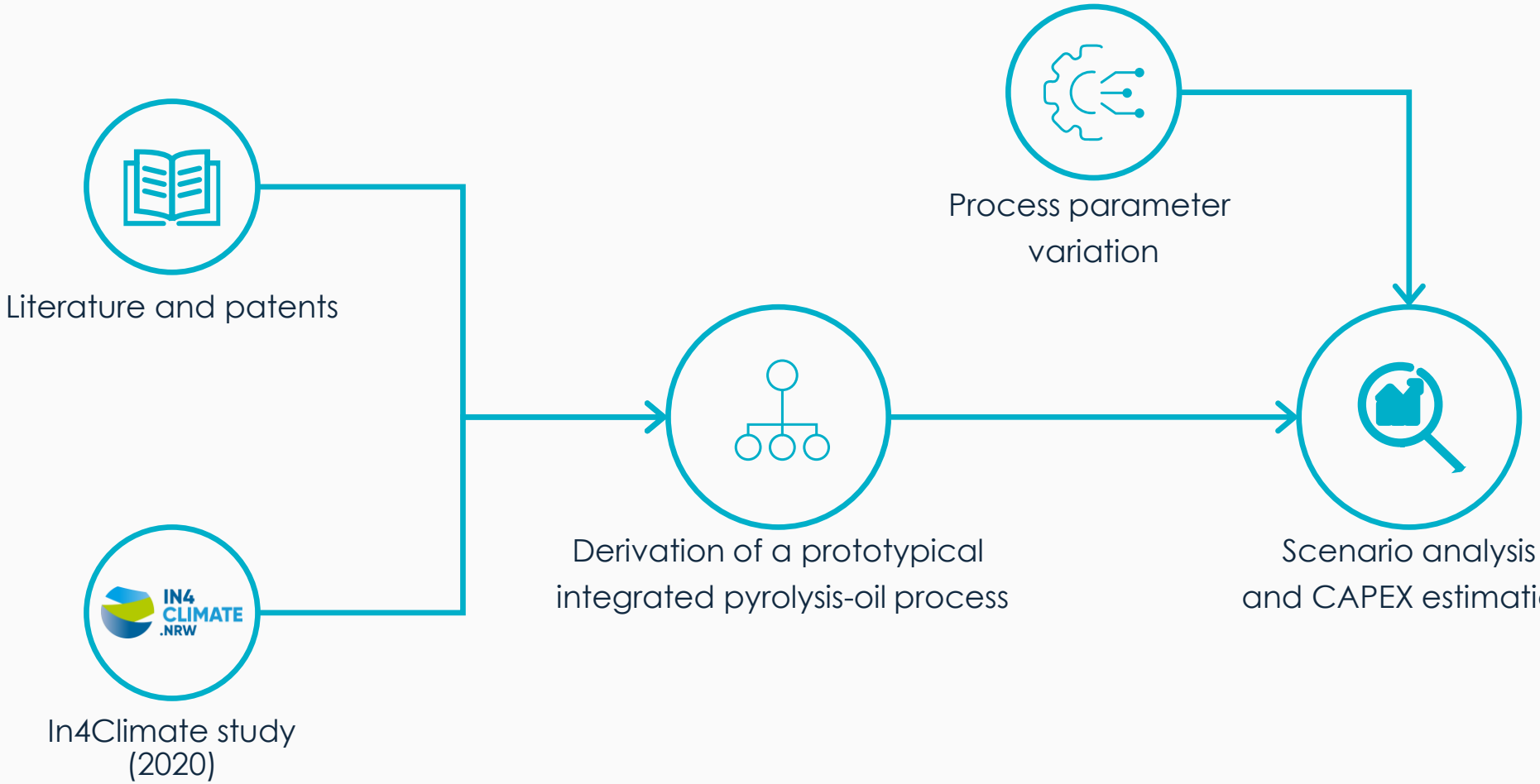
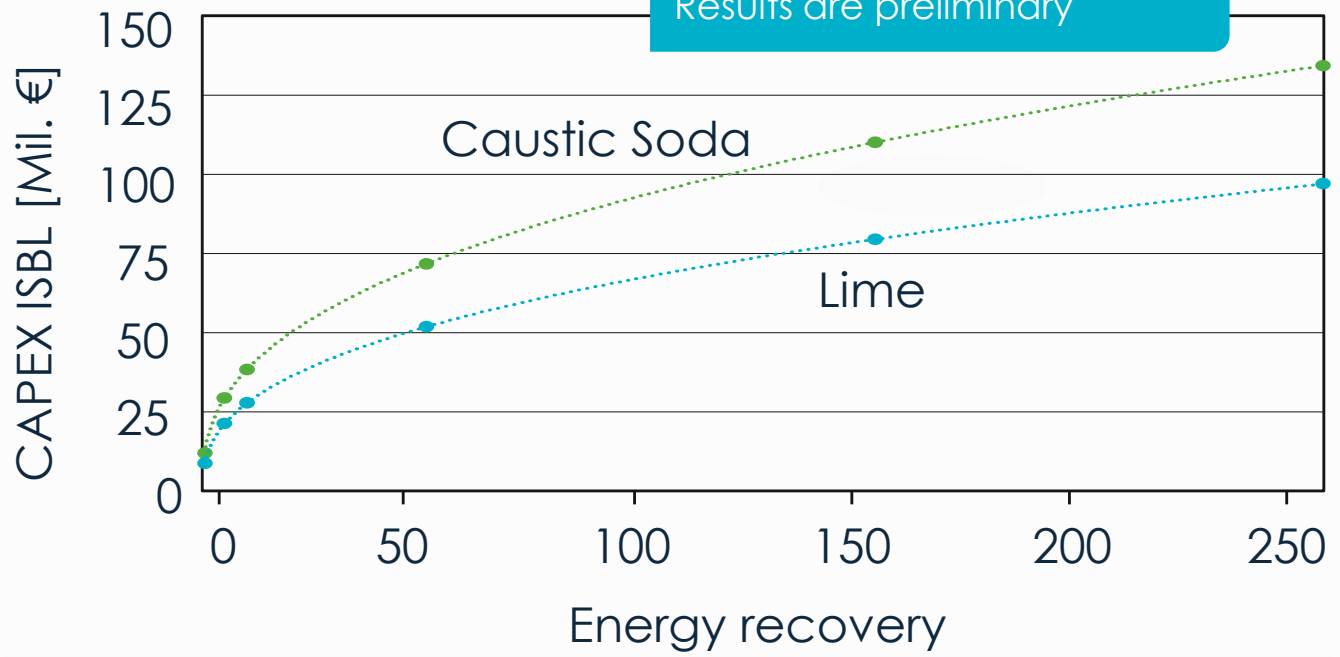
Prototypical pyrolysis-oil process for CAPEX estimation



CAPEX estimation for caustic soda

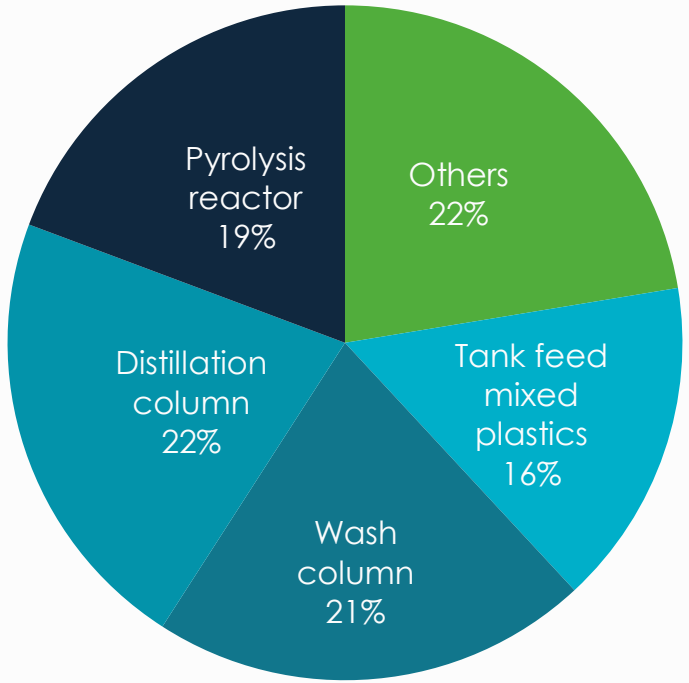
The CAPEX of a plant (ISBL= Inside Battery Limits) is related to its capacity and to a complexity index expressing process and chemistry complexity.



→ The larger the plant, the lower the specific costs per kt:

Pyrolysis process with Caustic Soda:
~0.3 – 250 kt/a 32,492 – 537€/(t/a)
Pyrolysis process with Lime:
~0.3 – 250 kt/a 23,439 - 387€/(t/a)

Share of CAPEX by unit step: lime process example



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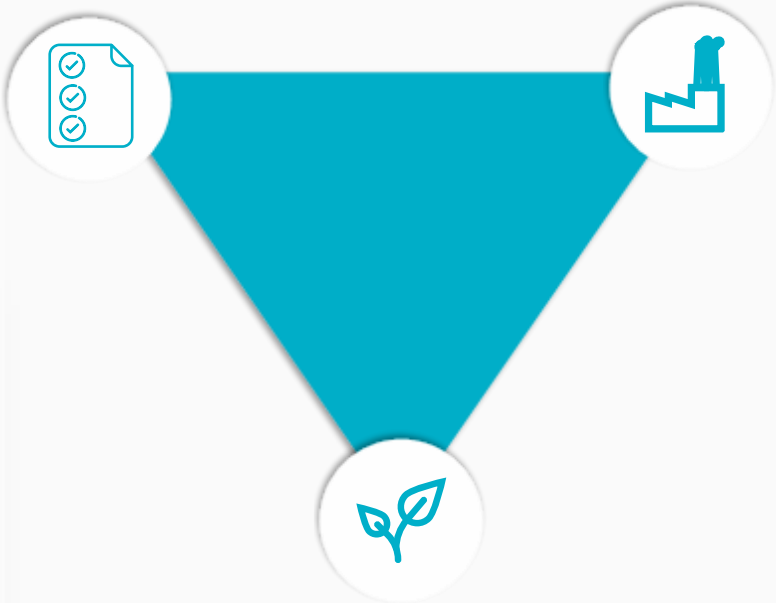

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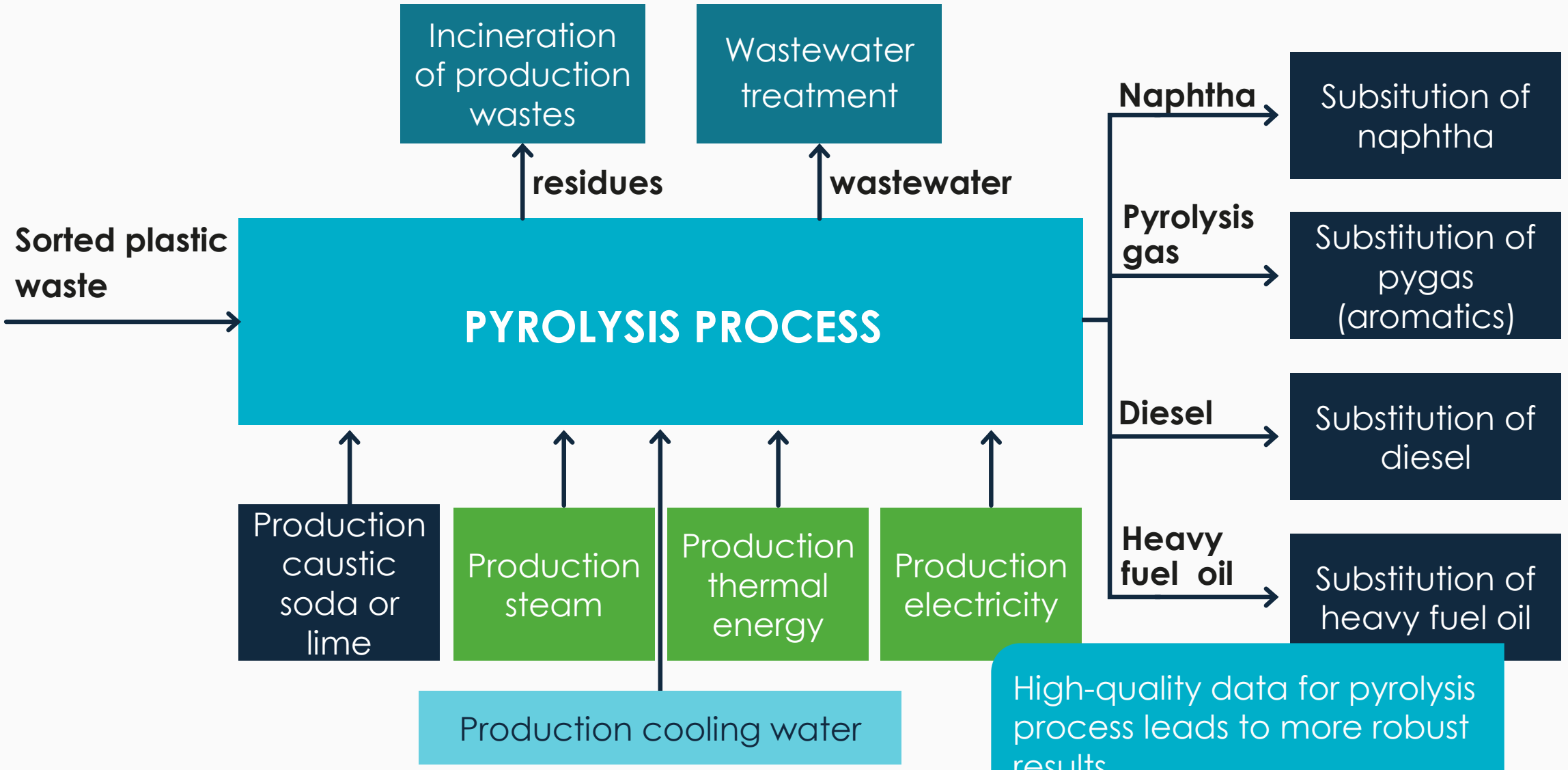
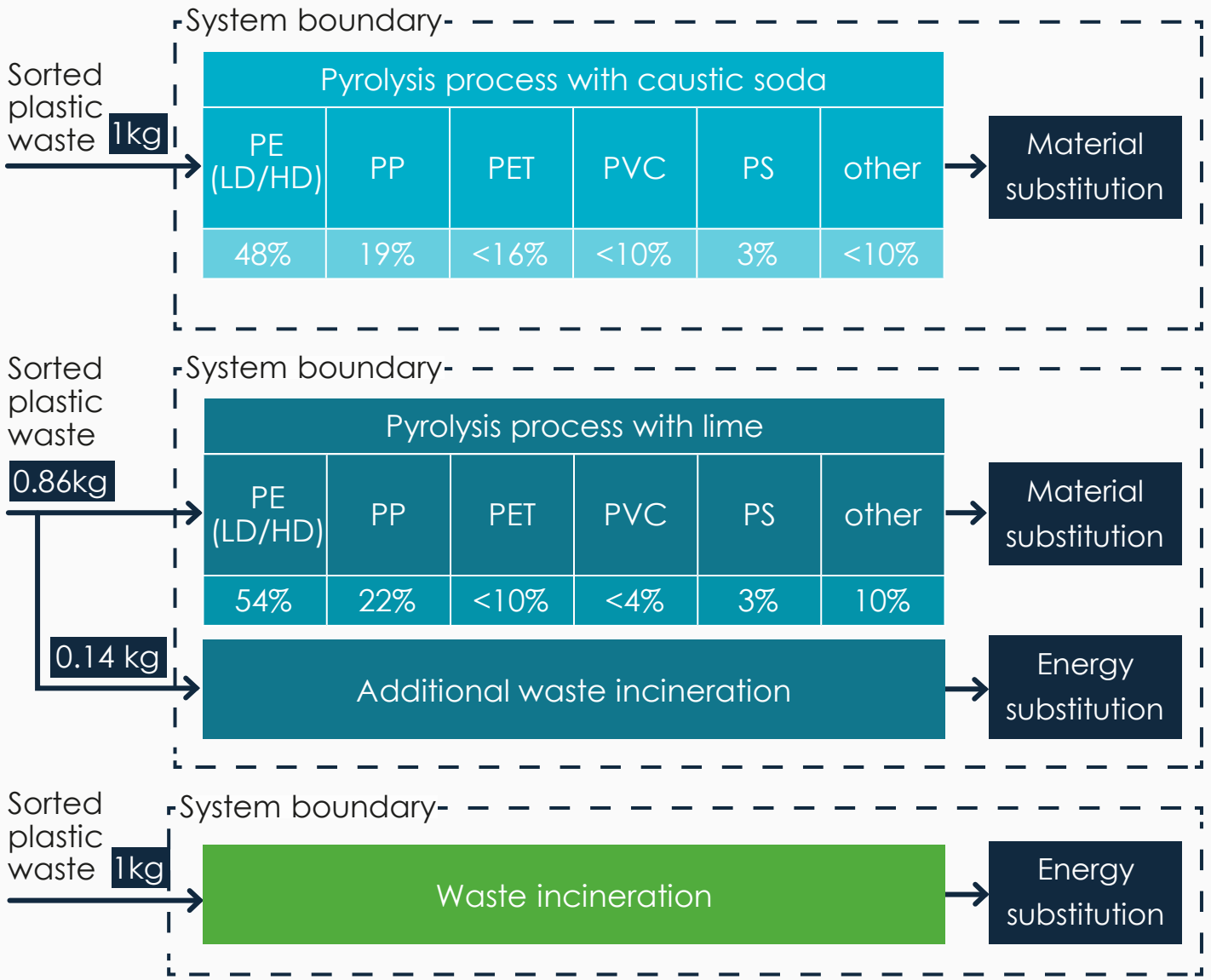
Detail assessment of pyrolysis process based profound data



High-quality data for pyrolysis process leads to more robust results

Functional unit, product systems and system boundaries



Functional unit:

1 kg of sorted mixed plastic waste

Product systems:

Lime process

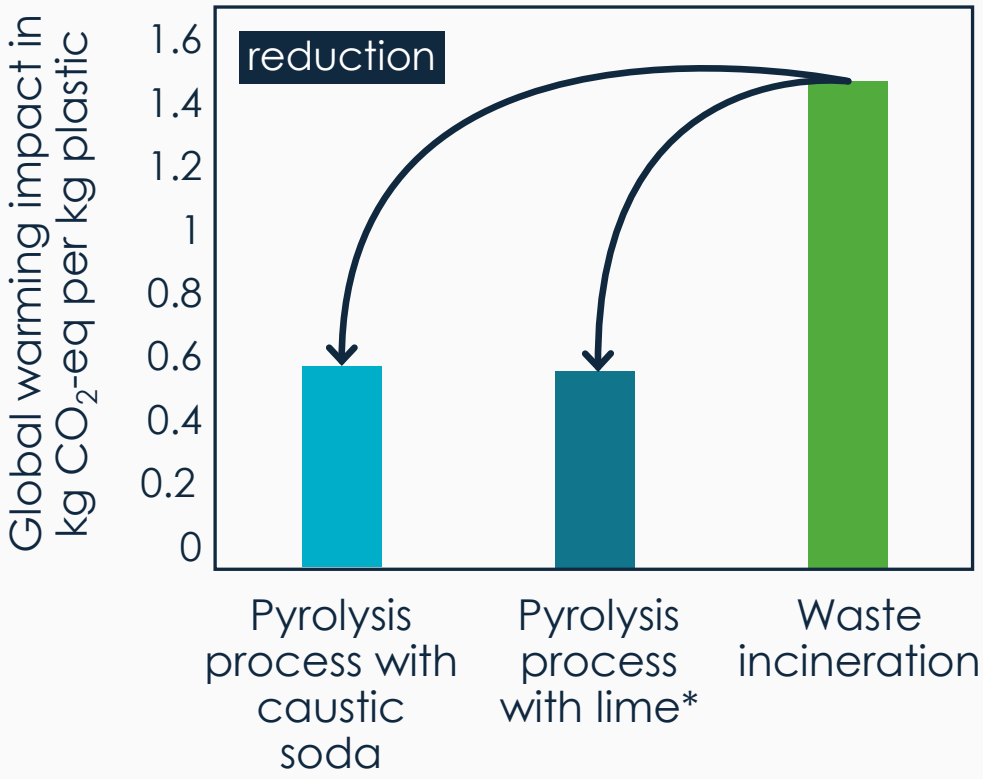
Caustic soda process

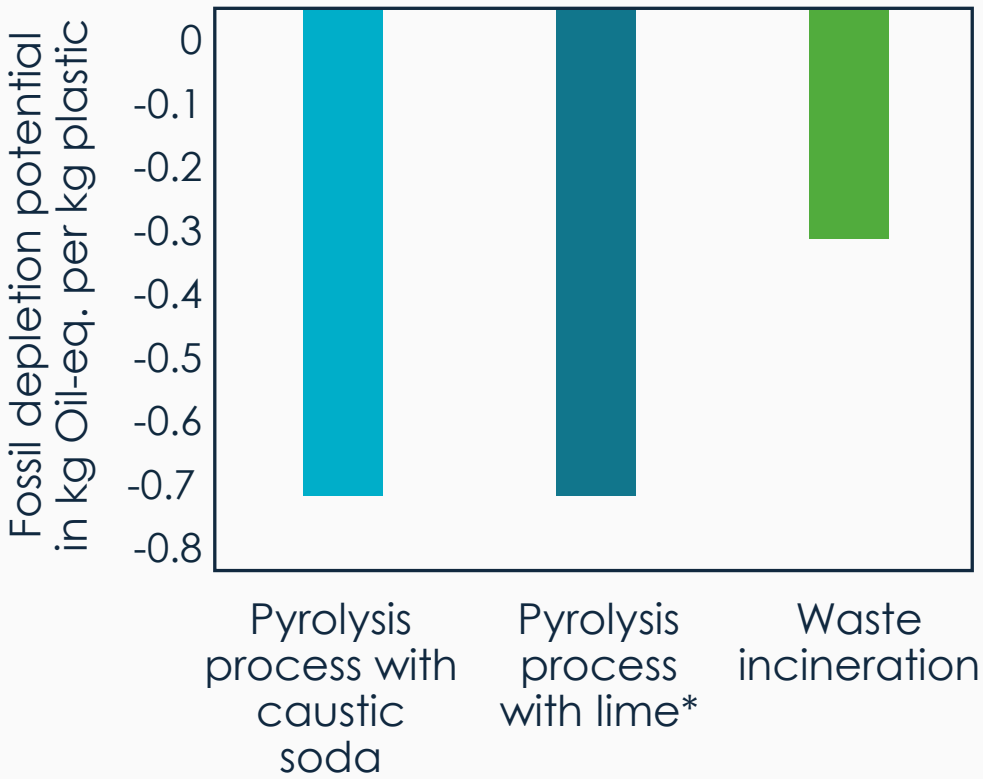
Energy recovery

System boundary:

Gate-to-grave

Comparison of pyrolysis processes to energy-recovery





Pyrolysis process are able to reduce environmental impacts compared to waste incineration with energy recovery by up to 62% (Global warming impact) and 111% (Fossil depletion potential).

*in the LCA results of the pyrolsis process with lime the additional waste incineration is included.

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Summary and next steps for NRW.Zirkulär

Summary

Economical and infrastructural

- Potential available amount of plastic waste suffices for medium and large-scale pyrolysis plants

Technical evaluation

- Lime- and caustic soda-based production technologies are available and can be build

Environmental evaluation

- Compared to energy recovery pyrolysis reduces greenhouse gas emissions by 62% and fossil resource depletion by 111%

Next steps

Economical and infrastructural

- Calculation production cost based on OPEX and raw material cost evaluation

Technical evaluation

- Review with industrial support group of cost estimation

Environmental evaluation

- Comparison of pyrolysis with future production pathway for plastics, e.g., bio-based and CO_2-based plastic production

Thank you!

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