THE ROLE OF GASIFICATION

OPTIONS TO PRODUCE RENEWABLE FUELS FROM A WIDE RANGE OF FEEDSTOCKS

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Dr. S. Janbroers

WHO WE ARE

MORE THAN **4500** projects per year

WE WORK FOR MORE THAN **2400** companies

3200 Employees

856 patents

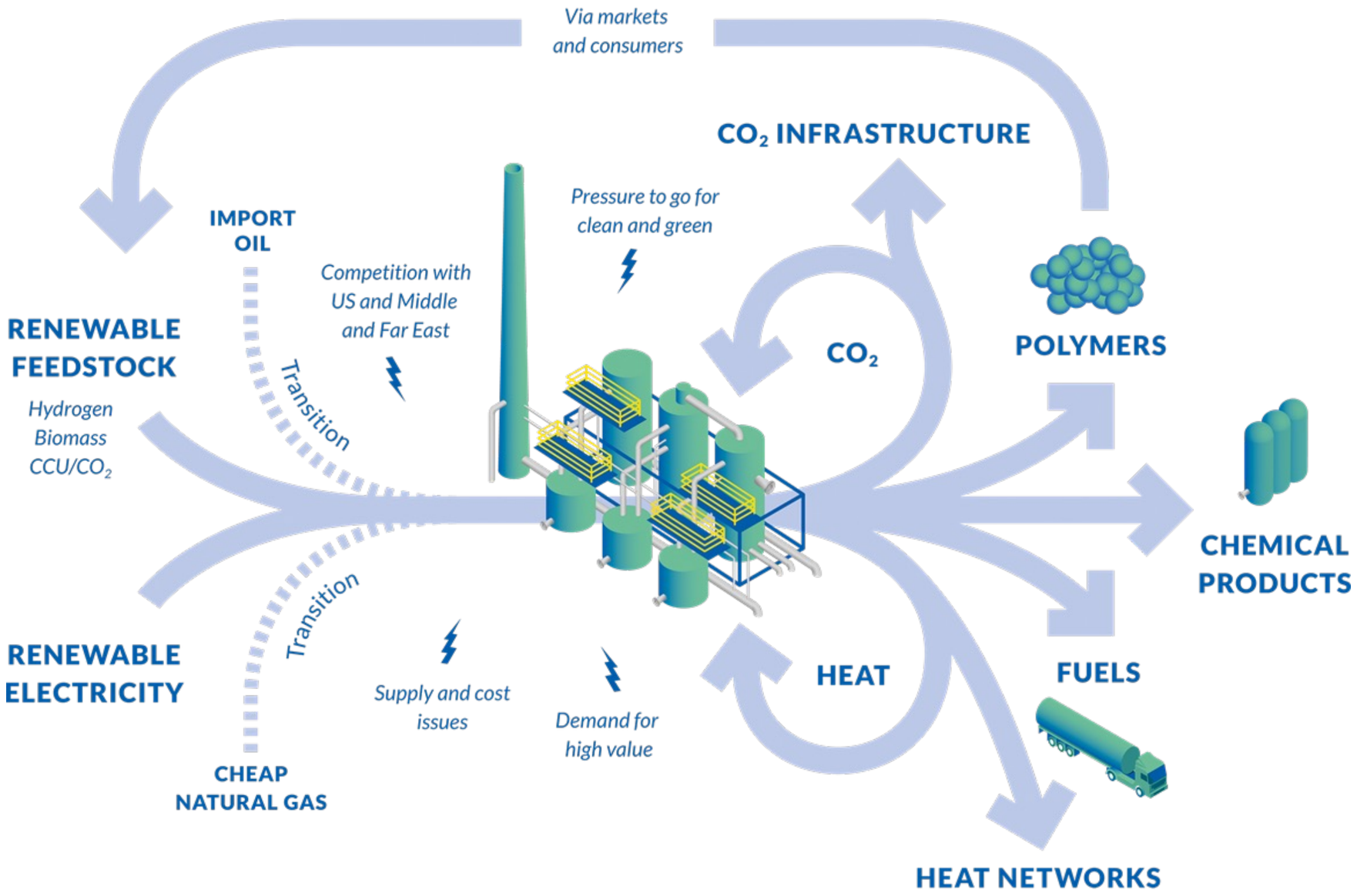
publications **2188**

47 professors

12 lecturers

"TNO connects people and knowledge to create innovations and sustainable solutions for The industry and the well-being of society in a sustainable way"
https://www.tno.nl/en/

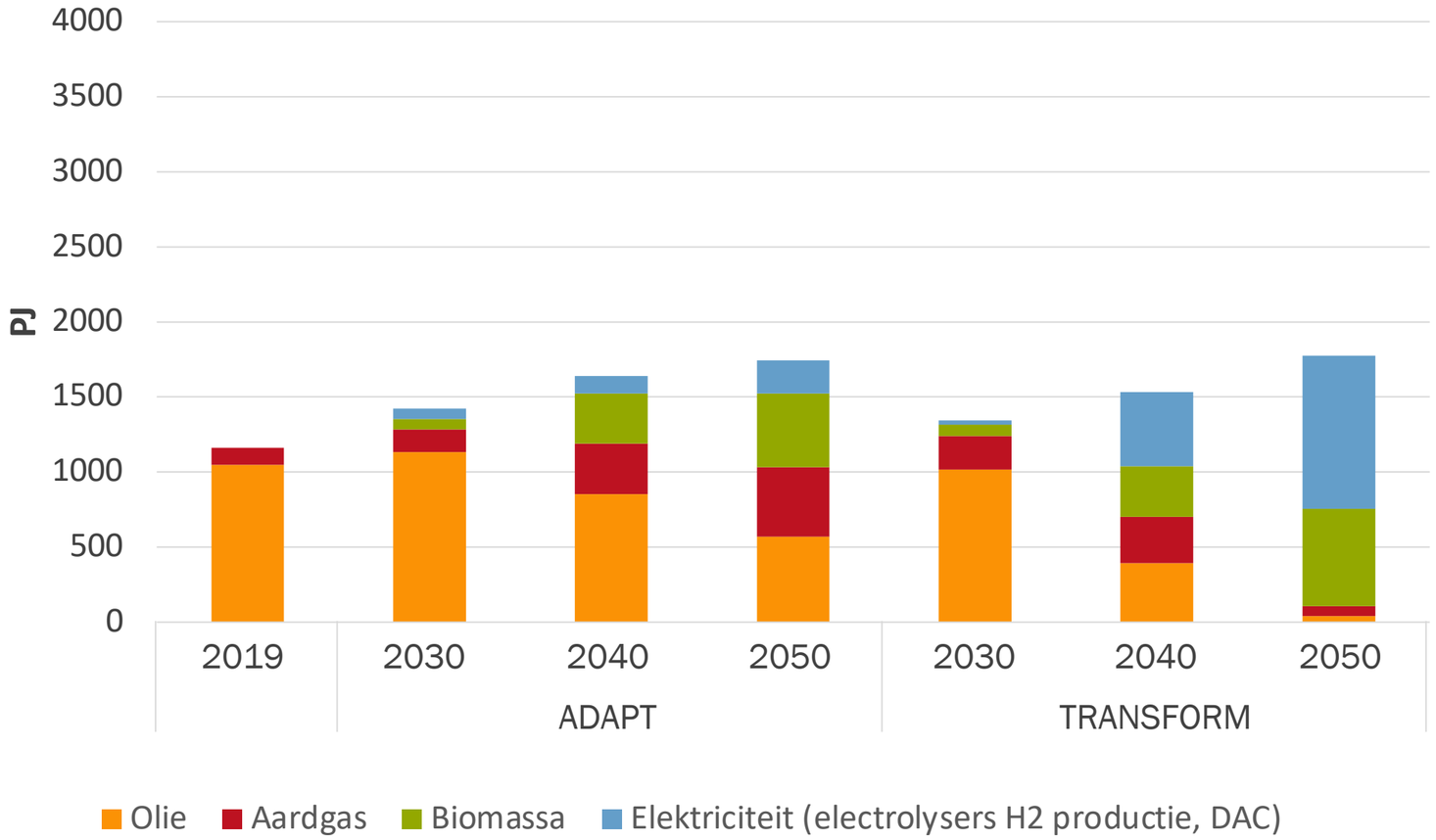
ENERGY TRANSITION



DUTCH SCENARIO STUDY ON FUELS

- Transition by biomass and electricity*

- **ADAPT:**
  - In 2050, 50% replaced by renewable sources;
  - 28% biobased.
- **TRANSFORM:**
  - In 2050, 100% replaced by renewable sources.
  - 37% biobased.



*https://repository.tno.nl/islandora/object/uuid%3A5c7f19fb-9e6d-4830-9ad6-1e83d1355ece

EU CHALLENGE

- Renewable Energy Directive II (RED II)
  - Target for renewable transport fuels
    - 14% in 2030, of which **3.5% advanced biofuels**
- This translates to 100 plants of 200 million liters per year capacity*

**Fuels Europe Statistical report 2018 and GAIN Report Number:NL1902 - EU Biofuels Annual 2019*

REFINERY OPERATIONS

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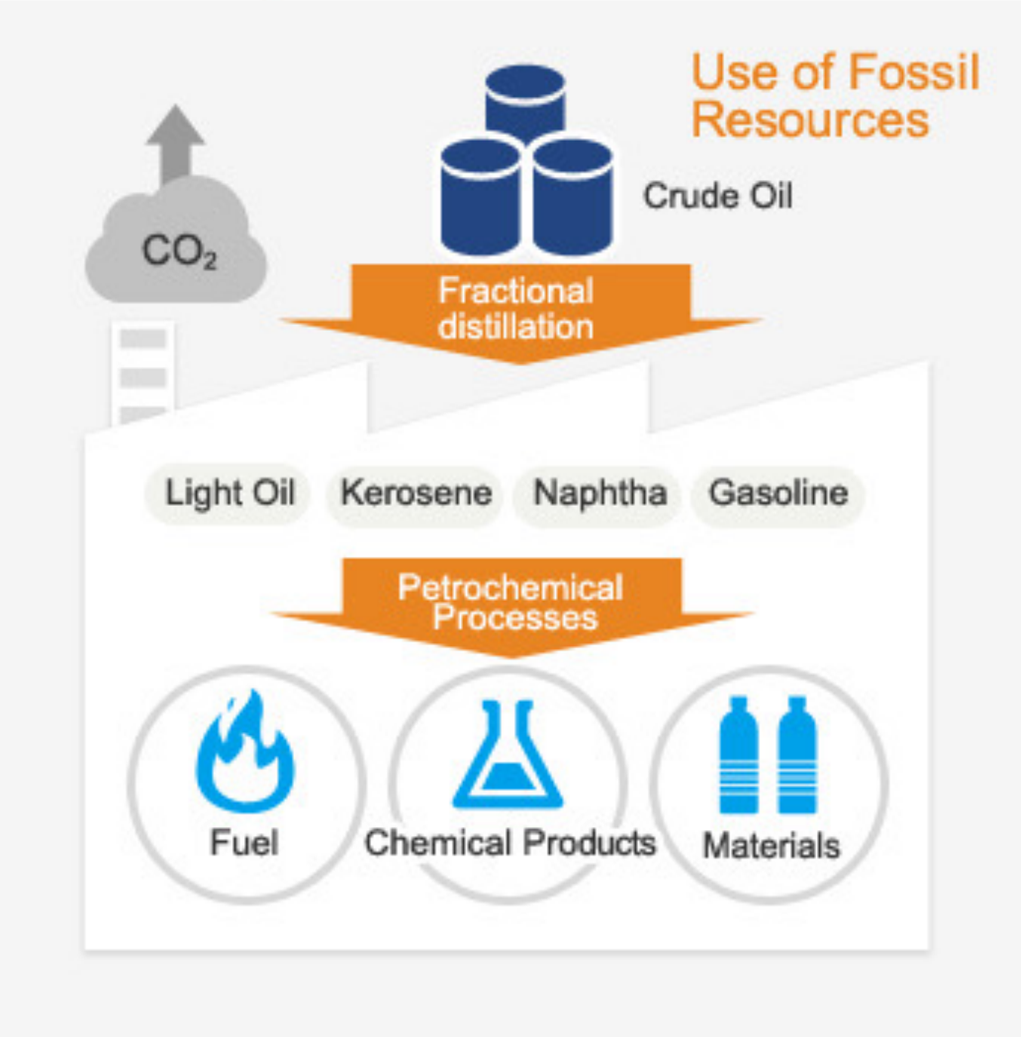
Oil Refinery



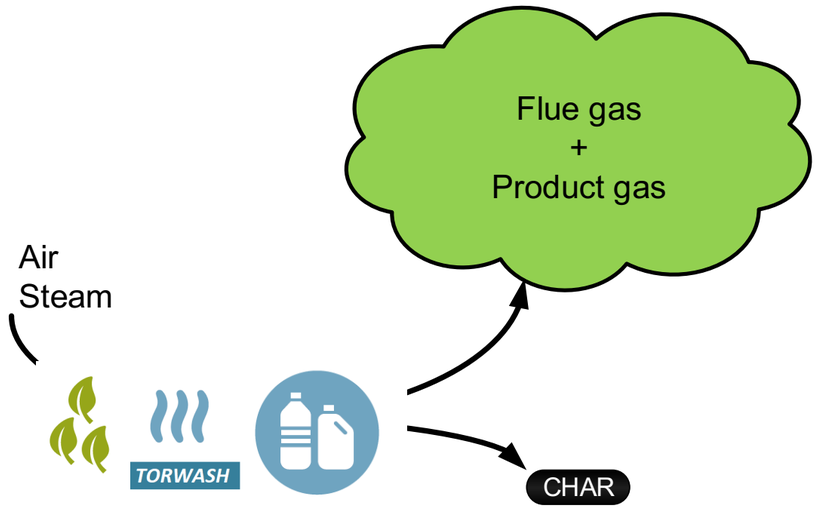
BIOMASS – A DIVERSE RAW MATERIAL

- Biomass = all organic material of non-fossil origin meant for energy or chemicals/materials production
- New, flexible technologies required
- Gasification is one of the options

waste | wood | (agricultural) residues | energy corps | aquatic biomass

GASIFICATION EXPLAINED

Direct gasification
typically for CO + H_2



Heat + Feedstock (s) → Product (g) + Char (s)

GASIFICATION DEVELOPMENTS

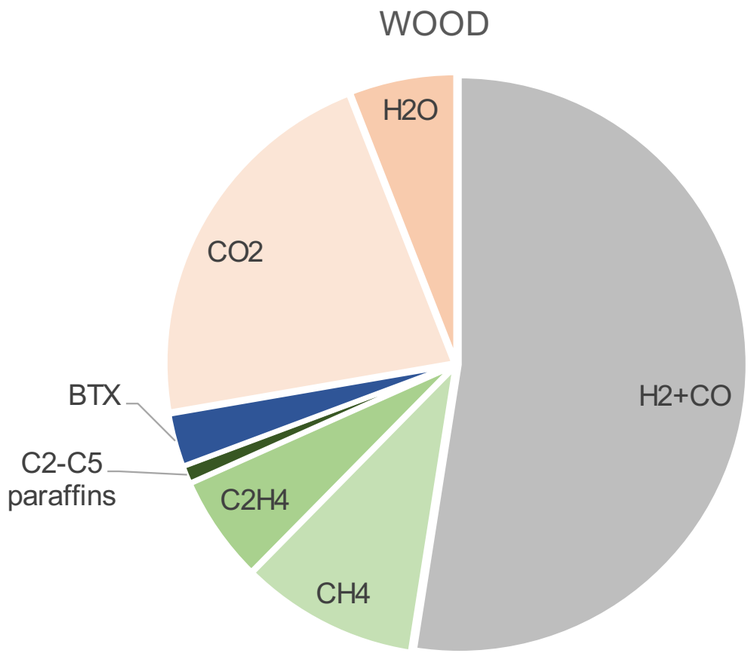
- Can be adapted to handle a variety of feedstocks
- Thermochemical process
  - High temperature
- Scalable

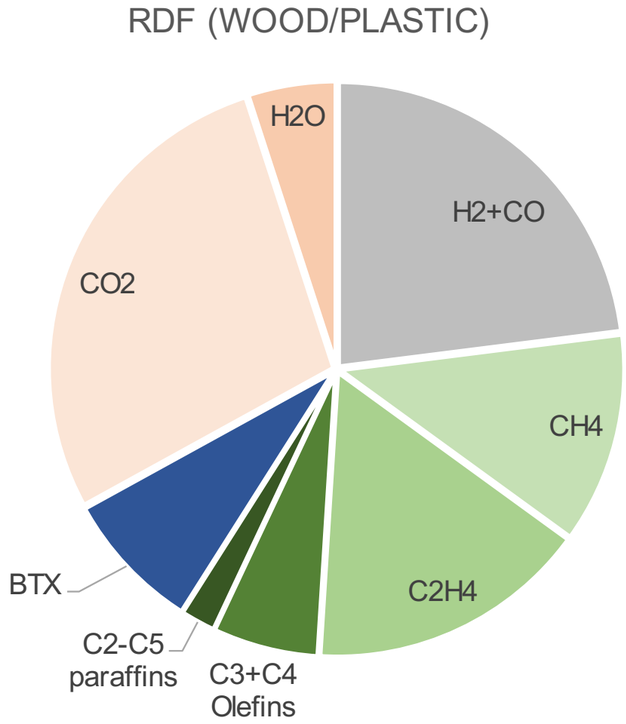
- Examples of developments in NL:
  - B.E.N.
    - Solid woody type of biomass
  - SCW systems
    - Wet residue streams (glycerol, manure)
  - Synova
    - Solid woody type, difficult waste mixtures (RDF, SRF), mixed plastics
  - Torrgas
    - Torrified biomass

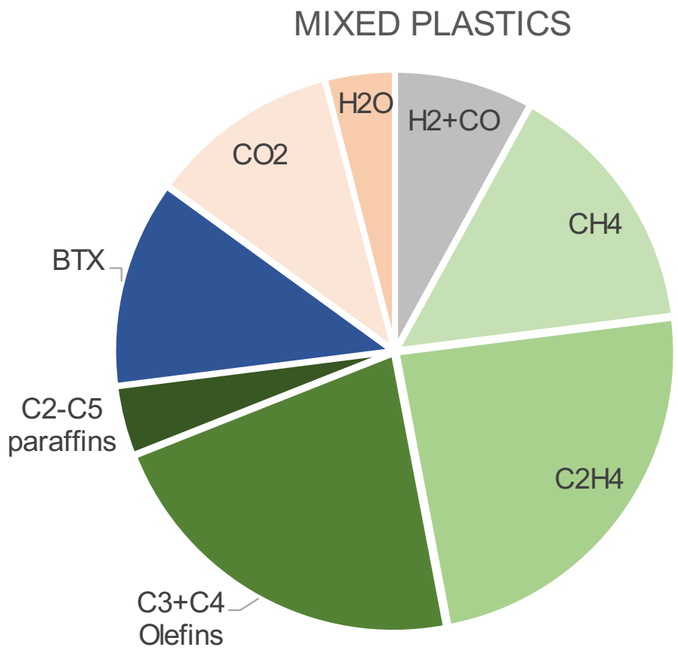
INDIRECT GASIFICATION

Market assessment

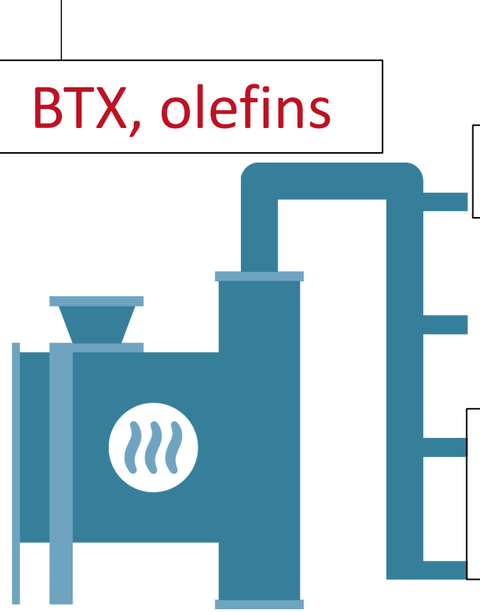
- Biomass to RNG (benefitting from high CH_4 content)
- Waste to chemicals (benefitting from high olefins and BTX content)
- Starting to look like a refinery







DOWNSTREAM OPTIONS



BTX, olefins

CH_4

Syngas
CO + H_2

Fischer-Tropsch

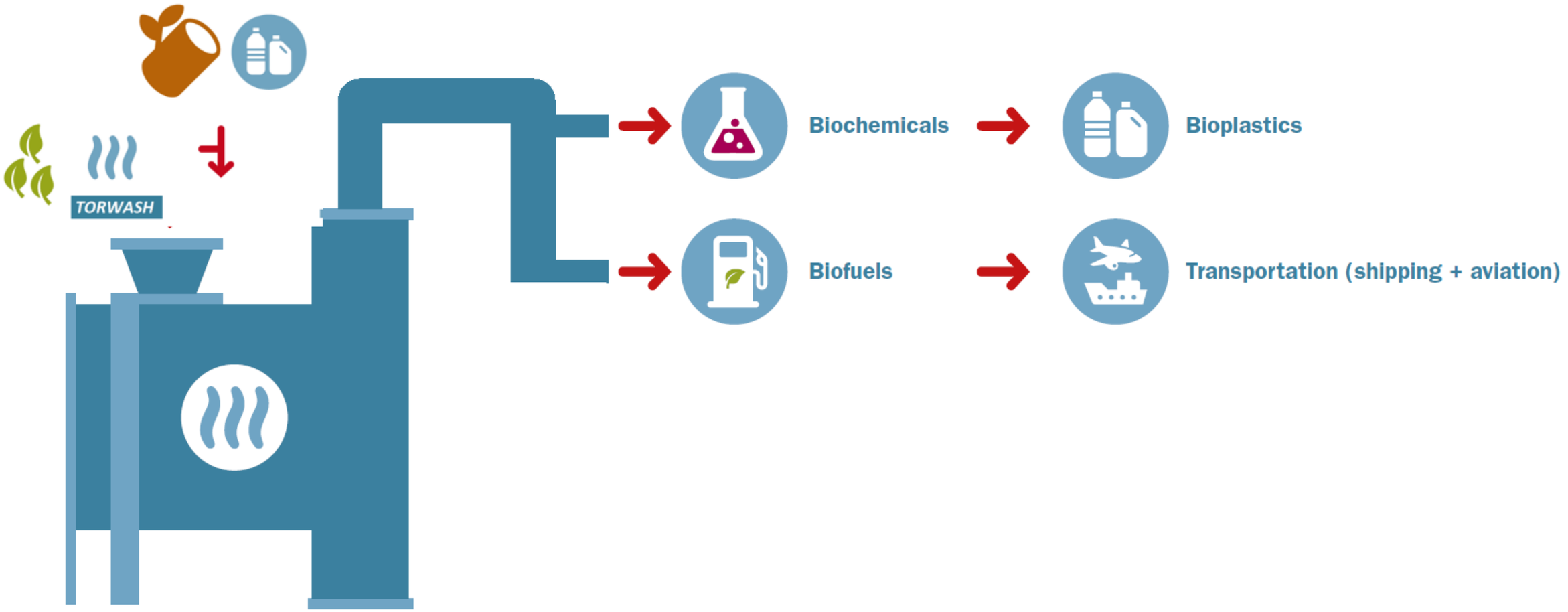
- LPG
- Gasoline
- Jet-fuel
- Diesel
- Waxes
- Olefins

Methanol

- Direct use
- DME
- Acetic acid
- Formaldehyde
- MTBE

- Aromatics
- Mixed Alcohols
- EtOH
- *i*-C4
- H_2 → Ammonia

DOWNSTREAM TECHNOLOGIES



FUTURE

- The EU and the NL have set goals for the introduction of sustainable fuels.
  - Target for renewable transport fuels is 14% in 2030, of which 3.5% advanced biofuels
- Today there are hardly any advanced fuels available

- Technologies need to be proven
  - Build demo's, cross the valley of death (proven difficult)

- For 3.5% fuel replacement we need ~100 plants of 200 million liters capacity*
  - Or 300-400 plants at 200Mwth capacity

- Once proven, there is a bright future!

**Fuels Europe Statistical report 2018 and GAIN Report Number:NL1902 - EU Biofuels Annual 2019*

THANK YOU FOR YOUR ATTENTION

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