HTW®2.0 Gasification: A proven path towards Advanced Biofuels

Presenter: Elyas Moghaddam, PhD

GIDARA® ENERGY

Who we are

HTW® Technology

Simulation & Experiment for HTW®2.0 Design

Advanced Methanol Amsterdam Plant

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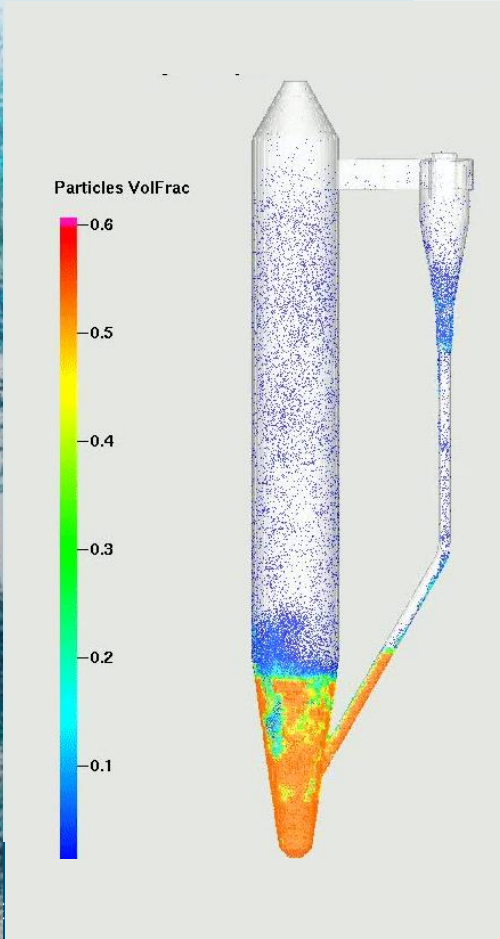


GIDARA is jointly founded by **Ara Partners**, US private equity firm, and **G.I. Dynamics**, Dutch engineering and project development firm, for the sole purpose of taking on today's waste and climate challenges

G.I.DYNAMICS

Ara Partners

GIDARA® ENERGY

Investment Partner

Ara Partners

Employees

88

HTW® Technology

+91%

average availability in 10 years

HTW® Development

+500 Mio Euro

investment

Advanced Methanol Facilities

Amsterdam

Rotterdam

Production capability

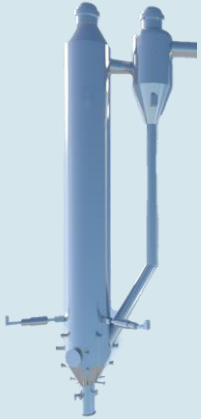
180KTA

advanced methanol

Our drivers: de-carbonization

Producing
Advanced Biofuels from
non-recyclable
(biomass) waste

Utilizing only
Commercially
Proven & Applied
Technologies



Patented HTW®
Gasification
Technology

- **Over 40 years of experience** in fluidized bed
- **+500 Mio Euro investment** in development
- **3 commercial facilities** successfully built and operated
- **+12 years** operational time of a single plant.
- **+91% average availability** in 10 years
- Existing active **testing facility**

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Growth inevitably generates waste

Ability to Convert Wide Range of Feedstock into High Value Products

Material Feedstock Flexibility

Wood Waste

Sewage Sludge

Municipal Solid Waste

Non-Recyclable Plastics

Waste Paper

Agricultural Residue

Construction & Demolition Waste

Adaptable and Cost-Effective Gasification Technology

GIDARA Energy's process and highly flexible HTW®2.0 technology plus adapted purification design allow a broad range of feedstocks (with minor to no incremental CAPEX)

Multiple End Product Applications

Road Transport Fuels

- Green Gasoline
- Biomethanol
- Renewable Diesel
- Green Hydrogen
- Renewable Natural Gas (CNG, LNG)
- Bio-mmtpa

Marine Fuels

- Biomethanol
- Bio-Ammonia
- Bio-DME
- Renewable Natural Gas (CNG, LNG)

Sustainable Aviation Fuels

High Growth End Markets (e.g. Chemicals)

Technology proven and applied for more then 10 yrs and with mixed feedstock

- ✓ **+500 Mio Euro:** - Investment in development of HTW
- ✓ **3 commercial facilities:** - Successfully built and operated
- ✓ **+10 years:** - Operational time of a single plant.
- ✓ **+91% Availability:** - Average availability in 10 year
- ✓ **+5% Extra availability:** - Can be increased by process improvements
- ✓ **Existing Testing facility:** - Recent successful test on all mixtures of RDF and biomass waste

1970s

Rheinbraun & ThyssenKrupp developed the pressurized version of the gasifier known as the High Temperature Winkler (HTW) process

Key reference plant

1986 - 1997

Commercial plant
at Berrenrath, Germany

Input → **Output** Methanol

Purpose/learnings of the plant
- ✓ Methanol production from syngas
- ✓ Long-term use of RDF + plastic sources, feedstock flexibility
- ✓ Pressure range 10-15 bar

1988 - 1994

Commercial plant
at Oulu, Finland

Input → **Output** Ammonia

Purpose/learnings of the plant
- ✓ Produce ammonia from syngas
- ✓ Utilisation of peat and waste wood as feedstock, feedstock flexibility
- ✓ Pressure range 10-15 bar

1989 - 1992

High pressure plant
at Wesseling, Germany

Input → **Output** Syngas

Purpose/learnings of the plant
- ✓ Sustainable HTW gasification operations under 25 bar

1999 - 2002

Demonstration plant
at Niihama, Japan

Input → **Output** Syngas

Purpose/learnings of the plant
- ✓ Utilizing direct municipal solid waste as feedstock to produce syngas

Key reference plant

2020 - current

Demonstration plant
at TU Darmstadt, Germany

Input → **Output** Syngas

Purpose/learnings of the plant
- ✓ Feedstock testing and continuous research and development on HTW technology
- ✓ Full production including methanol

Today

Proven track record of multiple HTW projects, strong market demand and regulatory tailwinds make HTW technology an economically viable option for biofuels

- Fossil fuels (coal, lignite)
- Biomass (incl. waste wood)
- Waste

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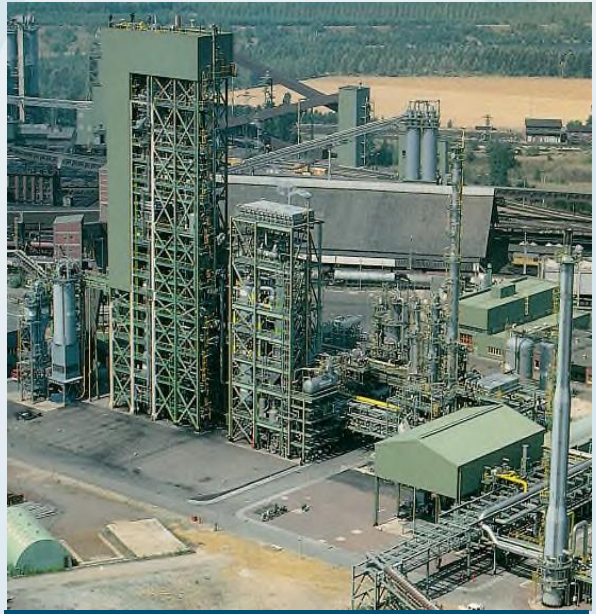
Experience from Key Reference Plant

HTW™-to-Methanol Plant (10 bar, 720 tpd) – HTW™ Section

Feed:	30 t/h
Operating pressure:	10 bar
Syngas ($CO+H_2$) production:	38,000 Nm3/h
Cold gas efficiency:	85 %
Carbon conversion:	95 %
In operation:	1986 - 1998
Methanol Production:	300 tpd
Total operation:	67,000 h
RDF*:	15,195 h
Type of feedstock used:	lignite, DSD-plastic residue, sewage sludge, SRF, Waste Wood, Dioxin /furan-loaded cokes from waste incineration

*Excluding other waste combinations such as sewage sludge, wood, peat, etc.



HTW Demonstration Plant Berrenrath

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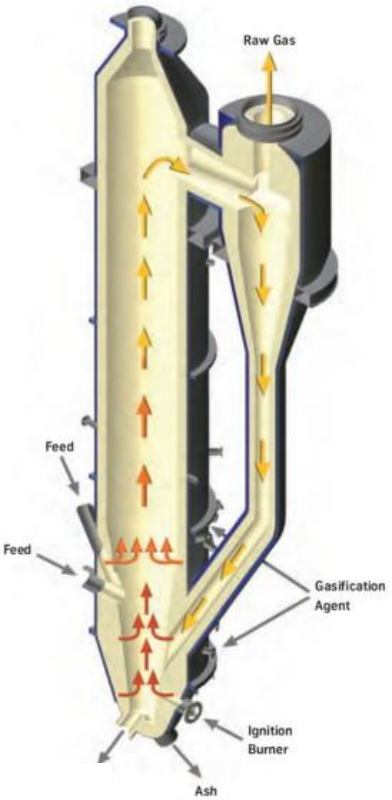
The HTW™2.0 Fluidized Bed Technology

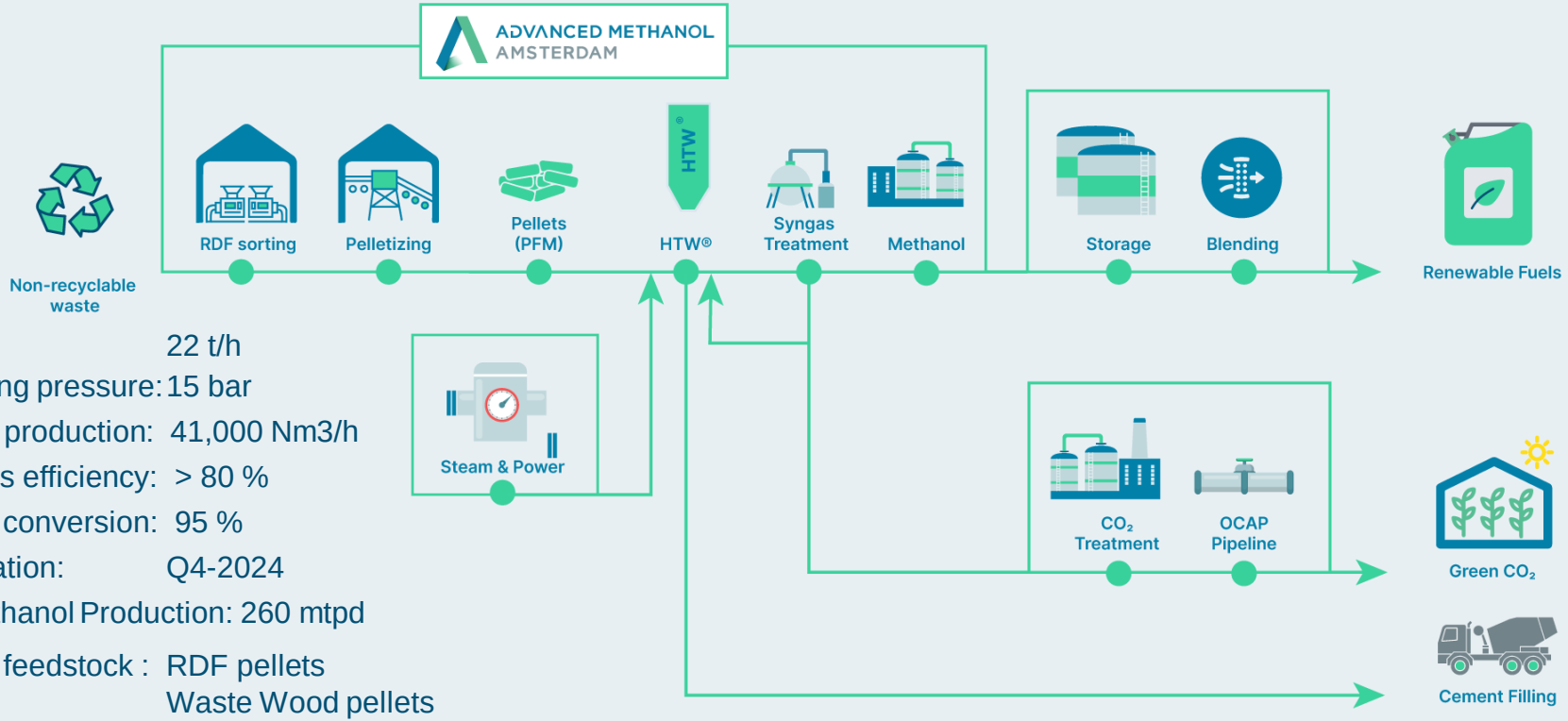
The HTW™2.0 Gasifier Today

- Low oxygen consumption due to moderate temperatures;
- Optional use of air or pure oxygen as an oxidant;
- Simple feedstock preparation;
- Good partial load behavior over a wide range of operating conditions;
- Simple start-up and shut-down procedures;
- High operational availability;
- No by-products in the syngas, such as tars, phenols and liquid hydrocarbons; low waste-water discharge, easy to treat
- Proven and robust sub-systems such as: dry dust removal and Waste heat recovery;
- High cold gas efficiency (over 85 %);
- Great variety of feedstock (lignite, coal, peat, biomass, MSW, RDF etc)



Flagship Facility "Advanced Methanol Amsterdam (AMA)"

HTW™2.0-to-BioMethanol Plant: Process Flow Diagram



Feed: 22 t/h

Operating pressure: 15 bar

Syngas production: 41,000 Nm3/h

Cold gas efficiency: > 80 %

Carbon conversion: 95 %

In operation: Q4-2024

Bio-Methanol Production: 260 mtpd

Type of feedstock : RDF pellets
Waste Wood pellets

Twin facilities

Amsterdam

ADVANCED METHANOL

Rotterdam

Future for GIDARA Energy

- **Future-Proof Technology**
  - **Road Transport fuels**
  - **Marine fuels**
  - **Aviation fuels**
  - **Chemicals**

- **Roll out of multiple facilities in Europe, UK and USA**

Thank you

We make sure
our waste isn’t wasted

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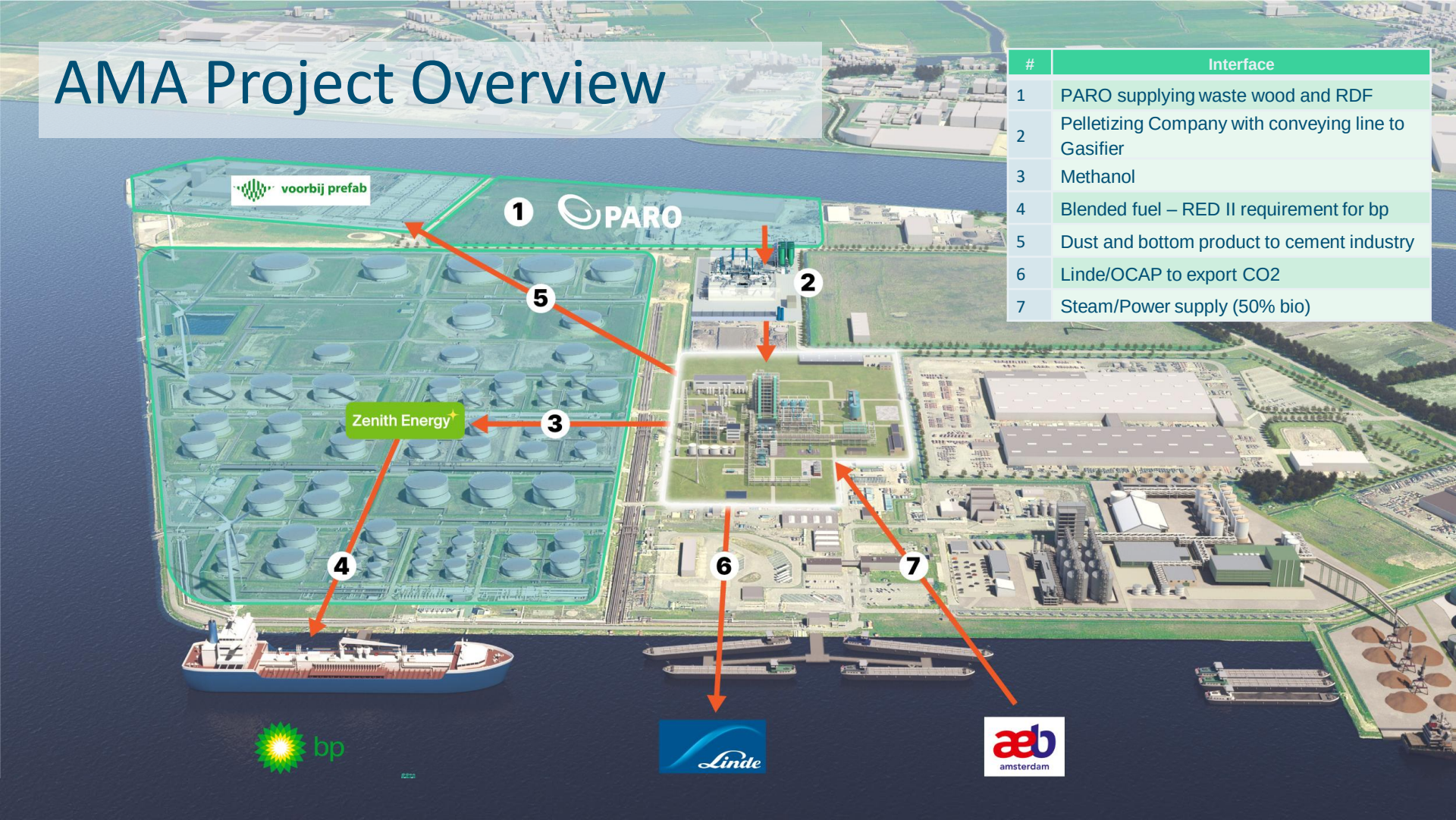
AMA Project Overview



#	Interface
1	PARO supplying waste wood and RDF
2	Pelletizing Company with conveying line to Gasifier
3	Methanol
4	Blended fuel – RED II requirement for bp
5	Dust and bottom product to cement industry
6	Linde/OCAP to export CO2
7	Steam/Power supply (50% bio)

Waste To Chemical Innovation Center

New state-of-the-art HTW Pilot Plant in operation since 2017

Key operating parameters

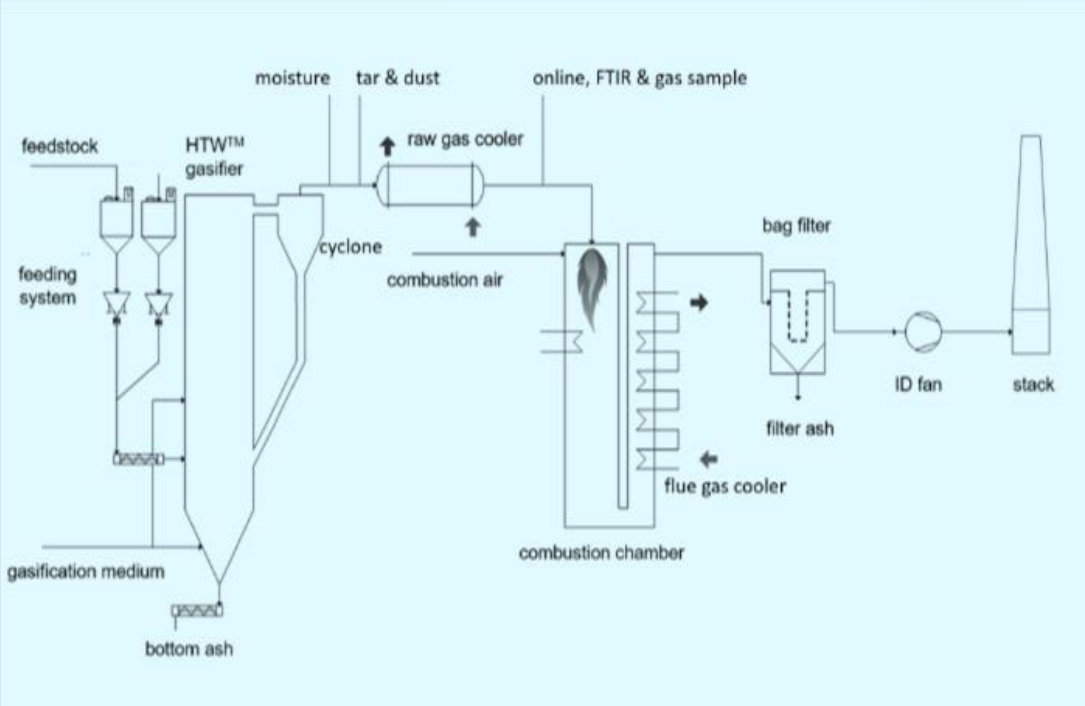
Thermal Input: 500 kWth

Gasification temperatures:

- Fluidized bed: 700 - 900 C
- Free board: 800 - 1200 C

Gasifier dimensions:

- Height: 12 m
- Diameter: 1 m



Waste To Chemical Innovation Center

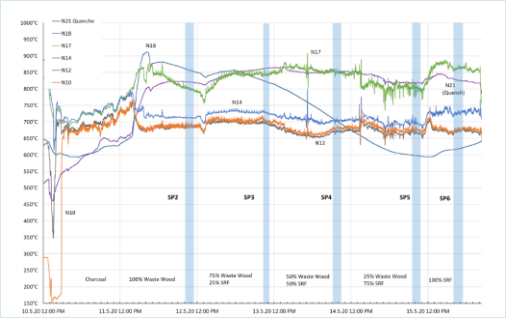
HTW™ Further Development

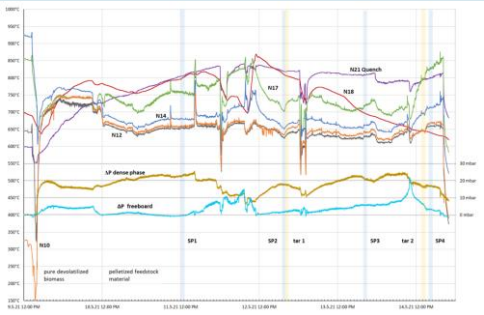
April 27th, 2020 → May 8th, 2021 → Q3, 2022

100% WW pellets
100% RDF pellets } Mixing

PFM: 75% RDF – 25% WW

Planned test for:
80% WW pellets
20% RDF pellets } Mixing { 90% WW pellets
10% RDF pellets



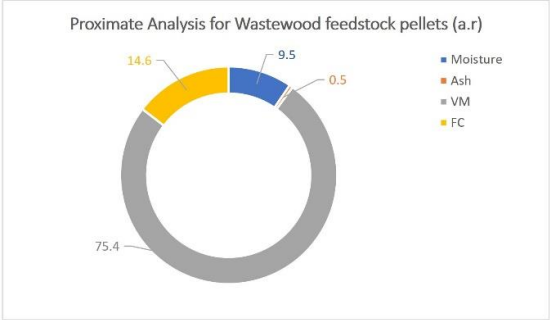


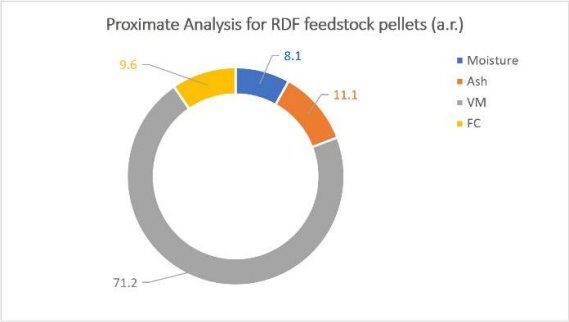
Waste To Chemical Innovation Center

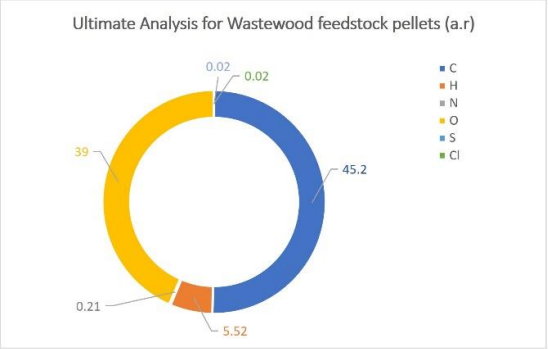
Results of Pilot gasification test (April 2020)

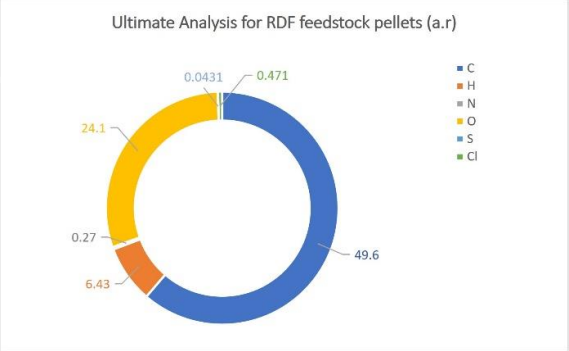
- Feedstock pellets

b-WW pellets
RDF pellets } Mixing



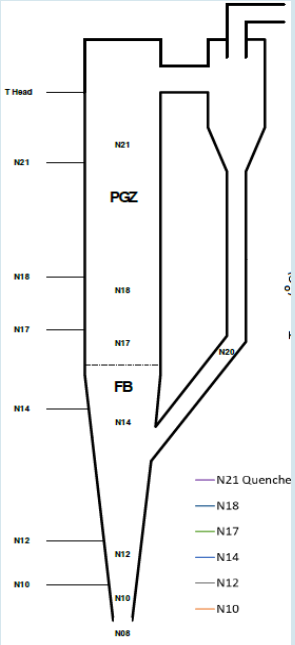


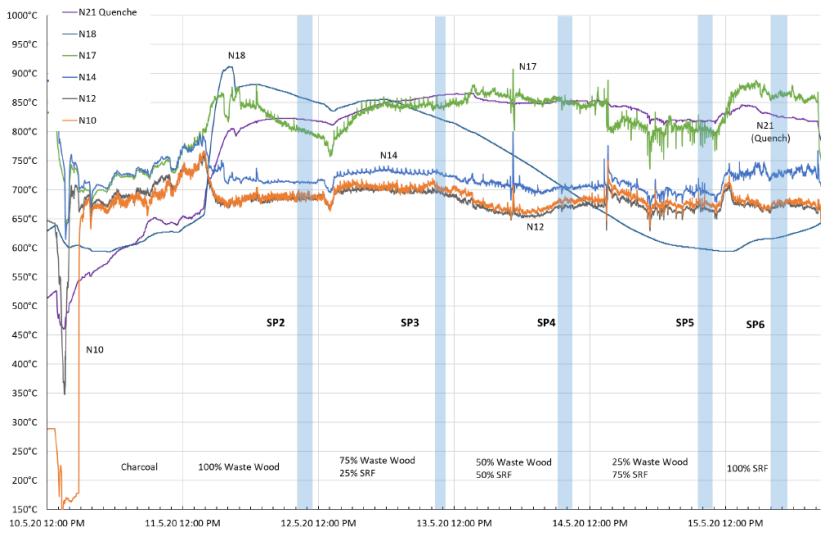


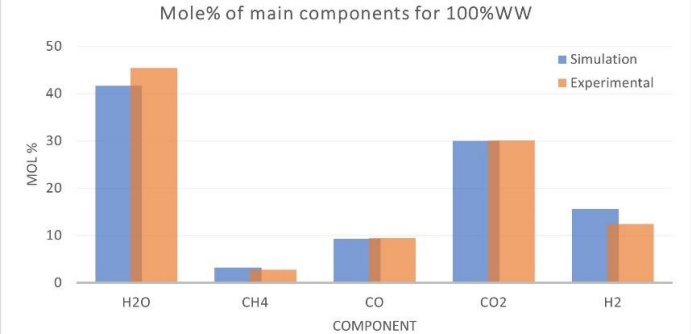


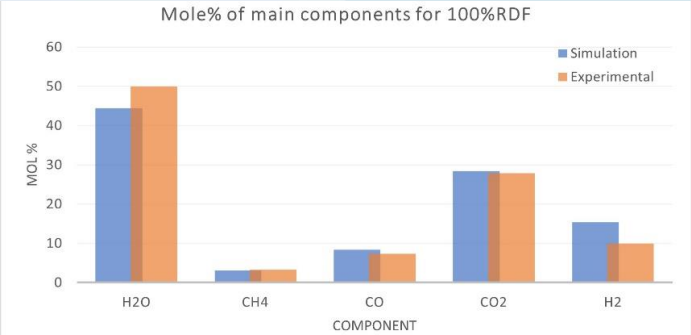
Waste To Chemical Innovation Center

- Temp. profile
- Syngas composition









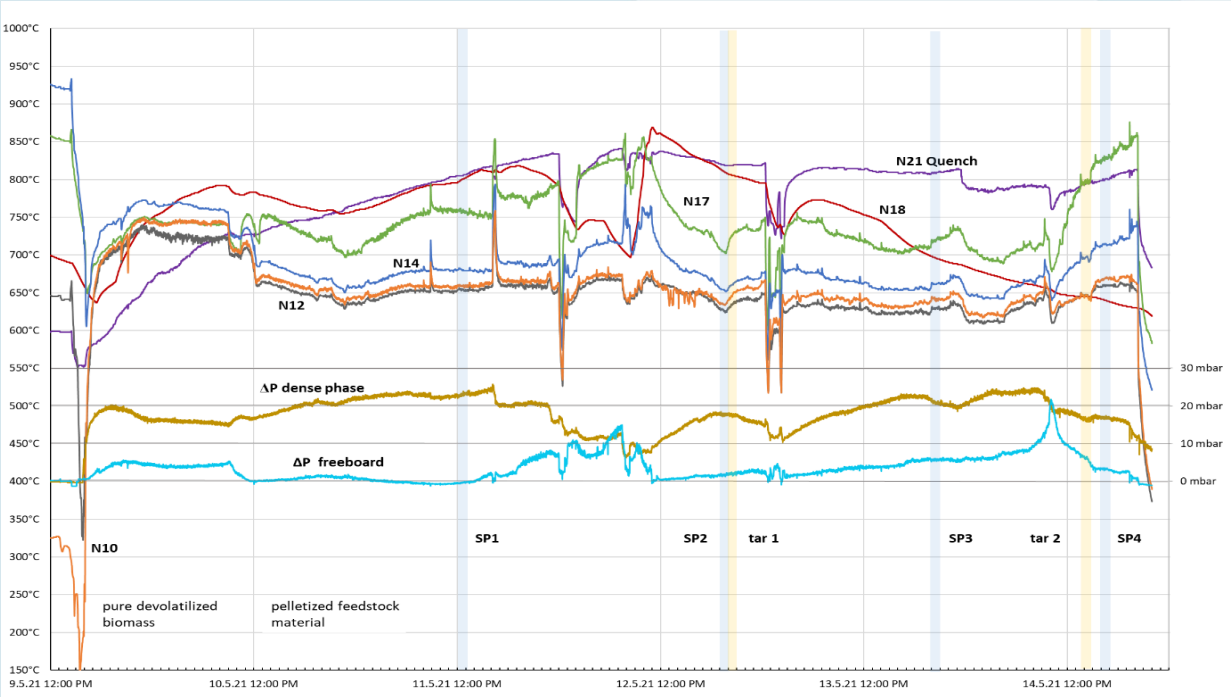
Waste To Chemical Innovation Center

The HTW™ Further Development

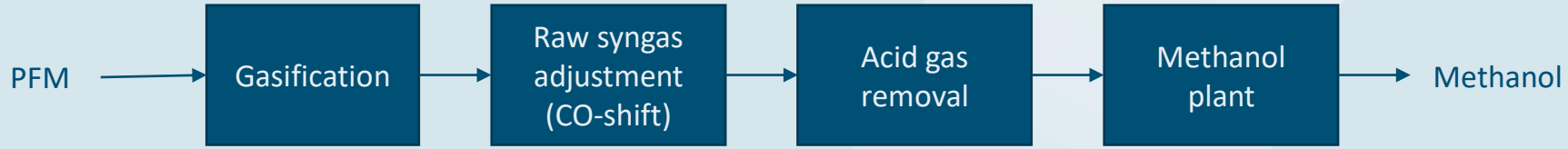
Results of Pilot test (May 2021)

PFM:

75% RDF – 25% WW



- The effective syngas is H_2 and CO. The amount of effective syngas is the main driver towards the methanol yield. And to ensure the capacity and ratio in which the effective syngas is produced following measures are taken.



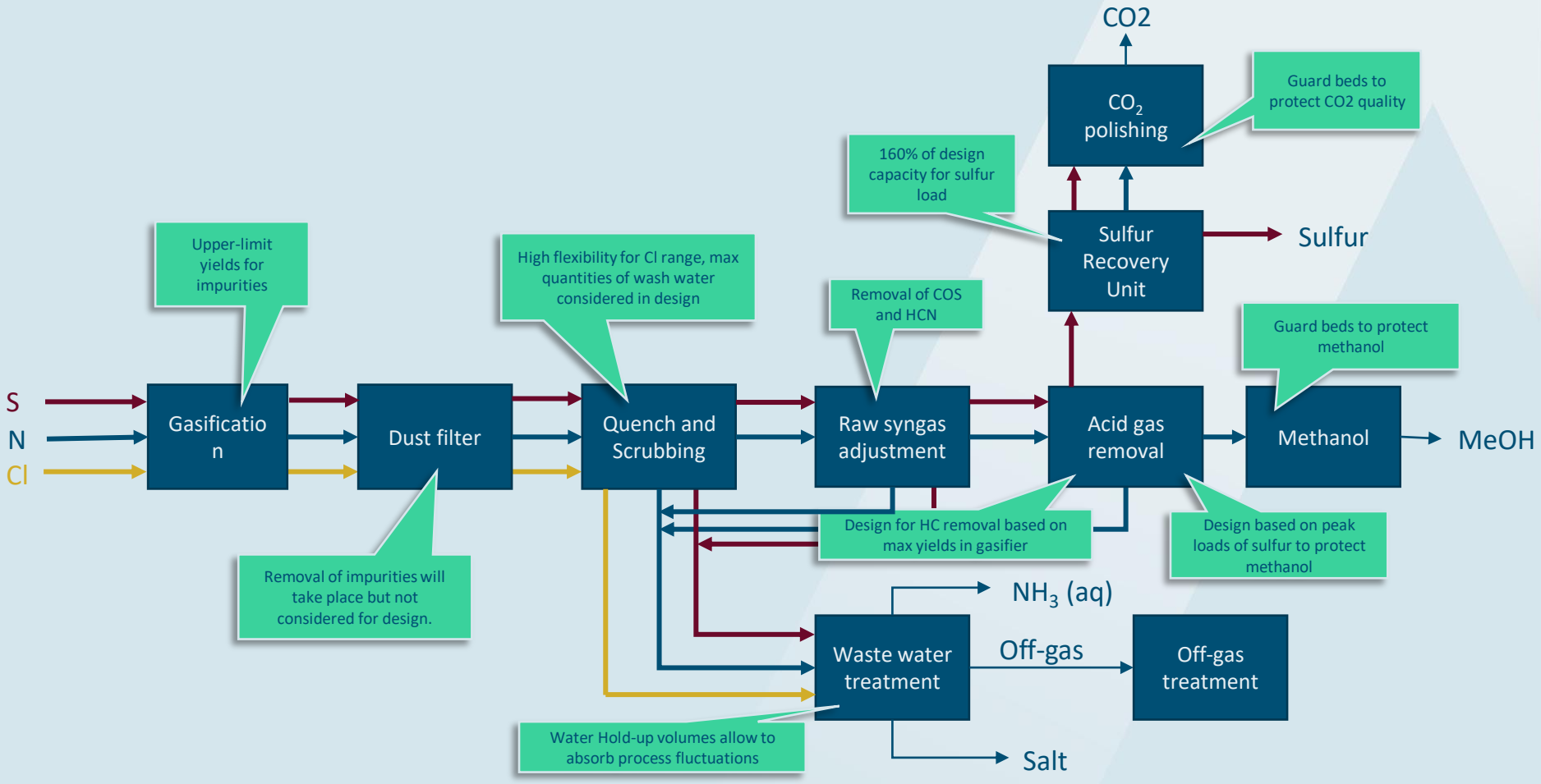
- Feedstock composition control

- Feeding rate
- Gasification conditions

- Ratio control between CO and H_2
- Adjustable bypass

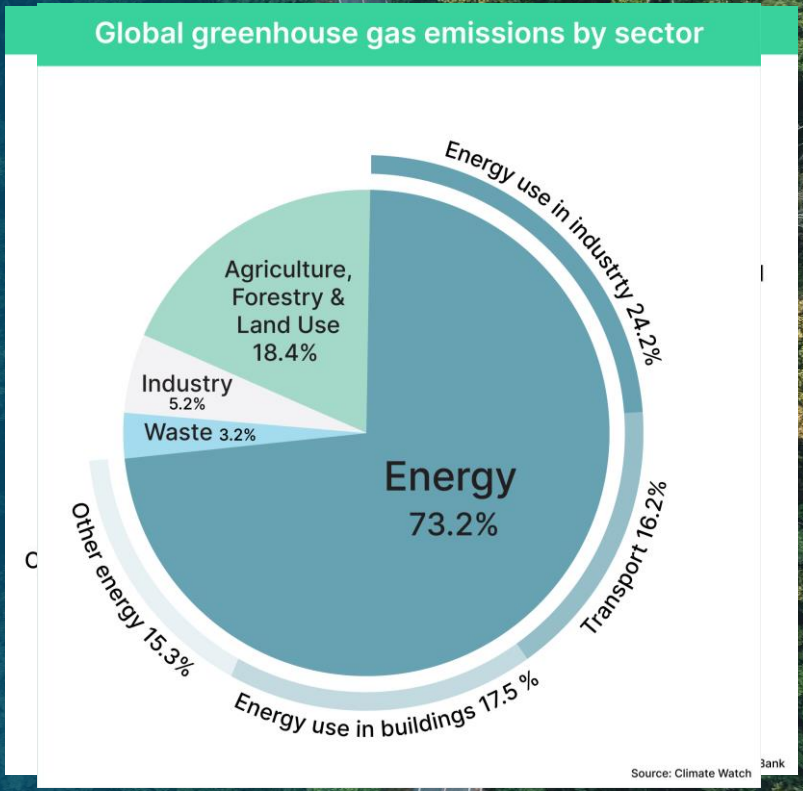
- Recovery of 99.5% of $CO+H_2$

- Control on syngas composition from Autothermal reformer (ATR)


CO2
CO_2 polishing
Guard beds to protect CO2 quality
160% of design capacity for sulfur load
Sulfur Recovery Unit
Sulfur
Upper-limit yields for impurities
High flexibility for Cl range, max quantities of wash water considered in design
Removal of COS and HCN
Guard beds to protect methanol
S
N
Cl
Gasification
Dust filter
Quench and Scrubbing
Raw syngas adjustment
Acid gas removal
Methanol
MeOH
Design for HC removal based on max yields in gasifier
Design based on peak loads of sulfur to protect methanol
Removal of impurities will take place but not considered for design.
NH_3 (aq)
Waste water treatment
Off-gas
Off-gas treatment
Water Hold-up volumes allow to absorb process fluctuations
Salt

Global challenges

- Waste generation and waste disposal
- Climate change challenges



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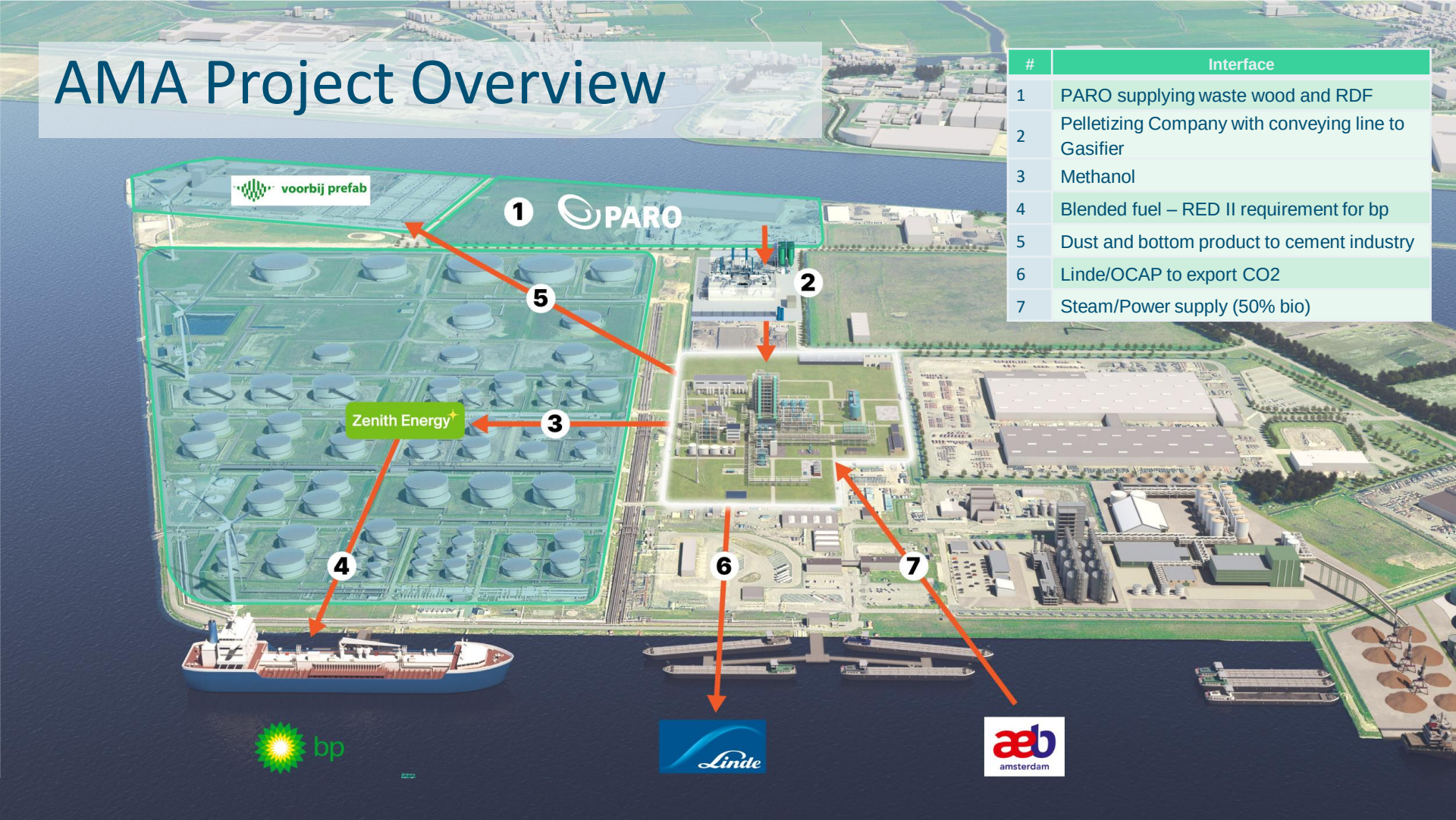
AMA Project Overview



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