The role of catalytic reforming in the production of synthesis gas from biomass and waste

Ilkka Hiltunen, Sanna Tuomi, Esa Kurkela
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VTT – beyond the obvious

VTT – *beyond the obvious*

VTT is a visionary research, development and innovation partner for companies and the society.

We bring together people, business, science and technology to solve the biggest challenges of our time. This is how we create sustainable growth, jobs and wellbeing and bring exponential hope.

244 M€
turnover and other operating income

2,129
employees

45%
of the net turnover from abroad

32.5%
a doctorate or a licentiate's degree

Established in
1942

Owned by Ministry of Economic Affairs and Employment

Biomass gasification for biofuels and bio-chemicals

- Long experience of medium-to-large scale synthesis gas technologies

VTT

PEAT AMMONIA PLANT
OULU, FINLAND, 1991

NSE BIOFUELS DEMO, VARKAUS, FINLAND, 2011

PILOT PLANT AT VTT BIORUUKKI, ESPOO, 2022

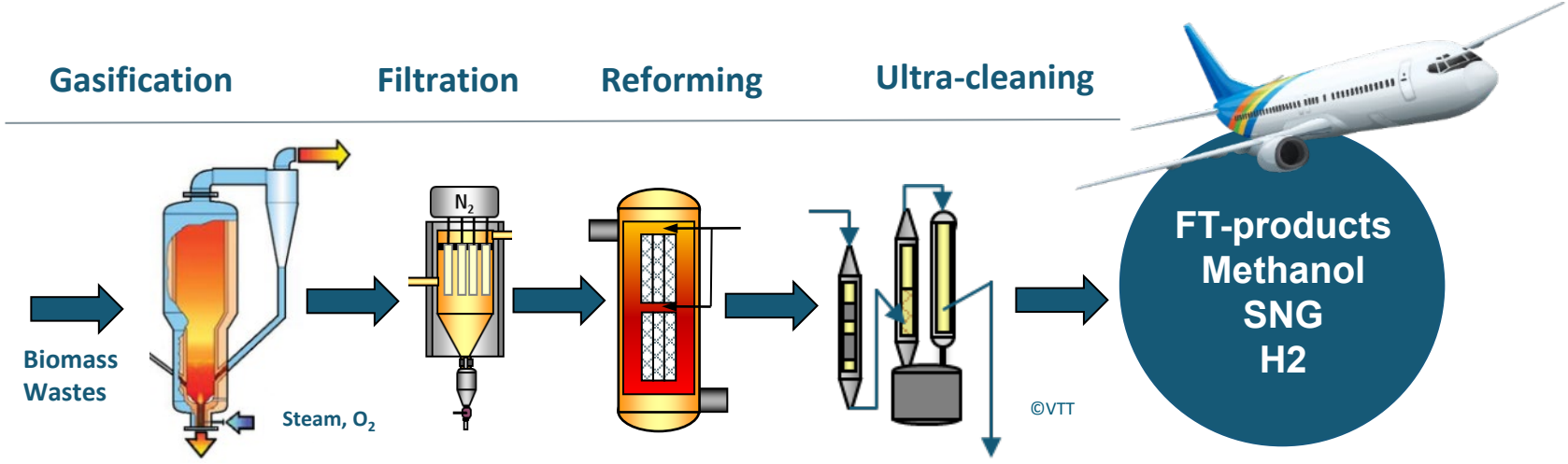
1985 | 1995 | 2000 | 2005 | 2010 | 2015 | 2020 | 2025 | 2030

COAL GASIFIER APPLIED FOR PEAT AND WOOD

LARGE-SCALE GASIFICATION SPECIALLY DEVELOPED FOR WOOD FEEDSTOCKS

PROCESS DEVELOPMENT FOR LOWER CAPEX, HIGHER CARBON UTILIZATION AND WASTES

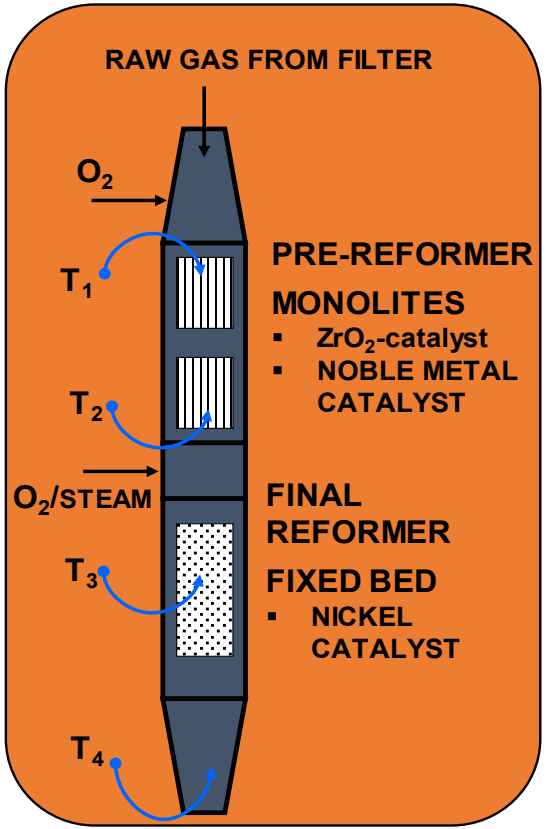
Key steps in the gasification-synfuels process of VTT



Technological basis – TRL7

- Air-blown CFB gasifier commercial, steam/O_2-blown demonstrated at 12 MW
- Filtration demonstrated at 5 MW scale, commercial in air-blown gasification
- **Reforming demonstrated at 5 MW scale**
- Final gas cleaning commercial (similar to coal gasification)

Key Process Step in Syngas Process
Tar Reforming – VTT's Core Technology



The process for syngas cleaning patented by VTT EP2542654 A1

- Heavy tars and C_2-hydrocarbons are decomposed in the **Pre-Reformer**
- Total tar reforming and partial reforming of methane (60-90 %) in the **Final Reformer**
- No soot formation in the reformer and stable pressure drop
- Developed and demonstrated during 5000 hours of operation at VTT's pilots
- Verified also at industrial demo plants, technology licensing to industrial partners
- Different designs for different applications

Pressurized O2/steam CFB gasification pilot plant

O,5 MW UCG PILOT

5-10 m³n/h SLIP-STREAM

GUARD BEDS

WATER SCRUBBING

ADSORPTION

ACID WASH

H_2 ADDITION

FT SYNTHESIS (MOBSU)

OFF-GASES (C1-C5)

FT OIL (C5-C18)

FT WAX (C18+)

MOBILE FT SYNTHESIS

BIOMASS WASTE

O2/steam CFB

GAS COOLER

GAS FILTER

CATALYTIC REFORMER

CO_2 ADDITION

FT synthesis

FT product sampling

TO DISTRICT HEAT BOILER

Varkaus SFW 12 MW_{th} O_2-H_2O Gasifier and 5 MW_{th} slip stream

Demonstration of O_2/steam-blown gasification using different types of biomass

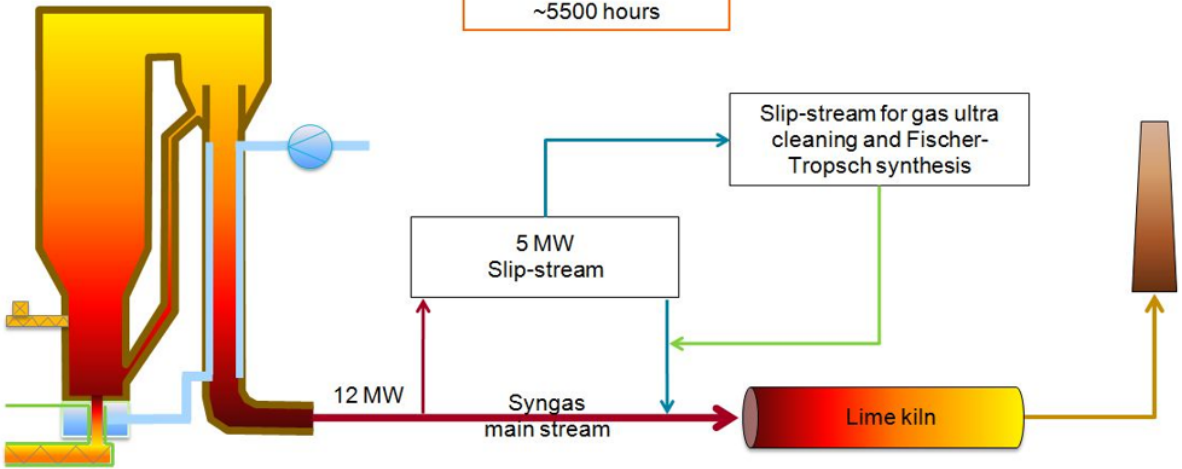
Demonstrated successfully in atmospheric pressure

~9000 hours

Demonstration of product gas treatment: cooling, cleaning and tar reforming

Demonstrated successfully in atmospheric pressure

~5500 hours



Complete cycle from wood based biomass to FT primary wax was demonstrated => technically feasible

Sumitomo SHI FW

Phase 2 / NSE Biofuels Oy – Test Plant Varkaus, Finland

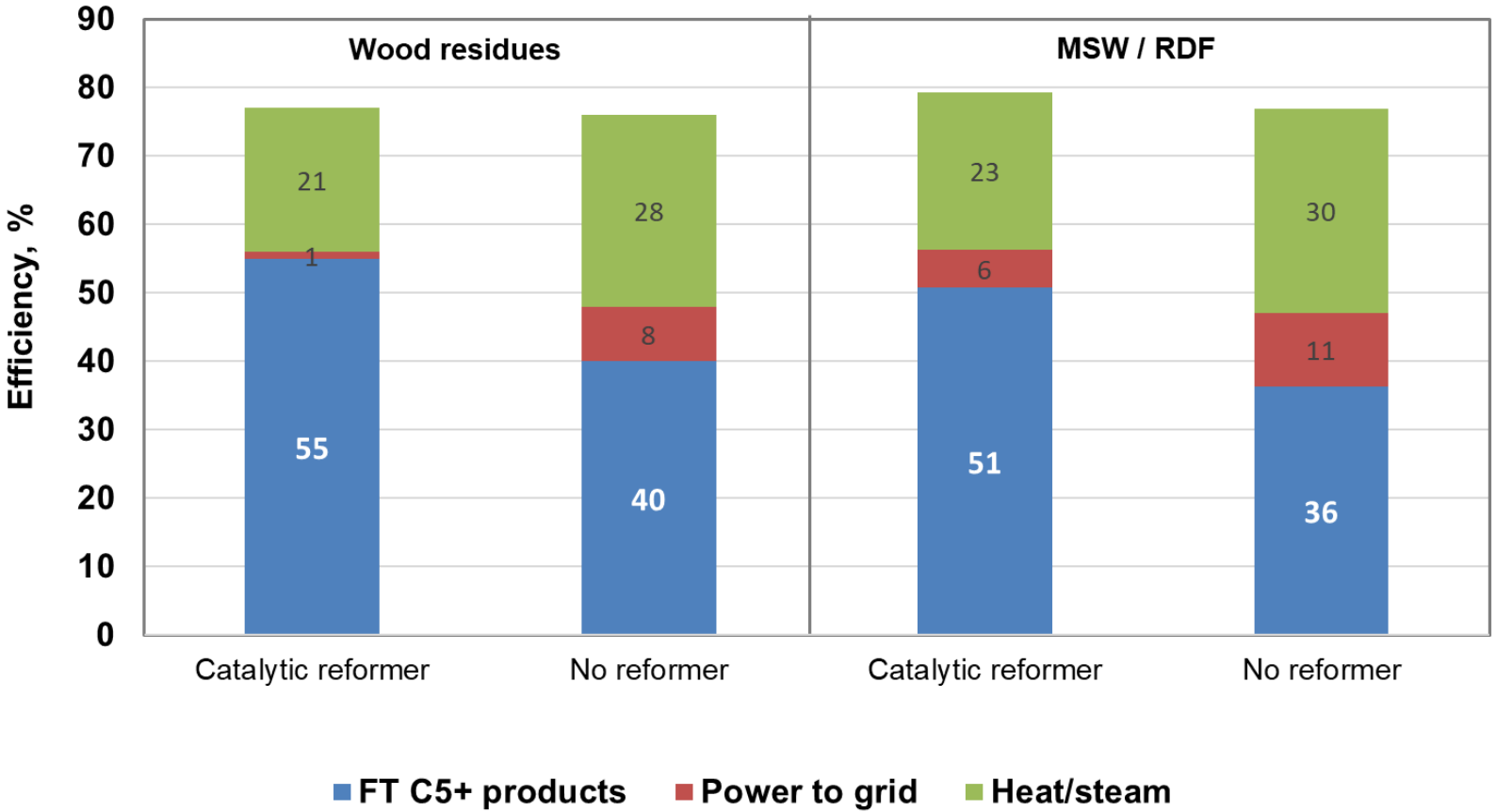
SFW 12 MWth gasifier and 5 MWth slip stream

[Photo: NSE Biofuels Oy]

Sumitomo SHI FW

Estimated conversion efficiencies with woody biomass residues and SRF to FT-crude (LHV based)

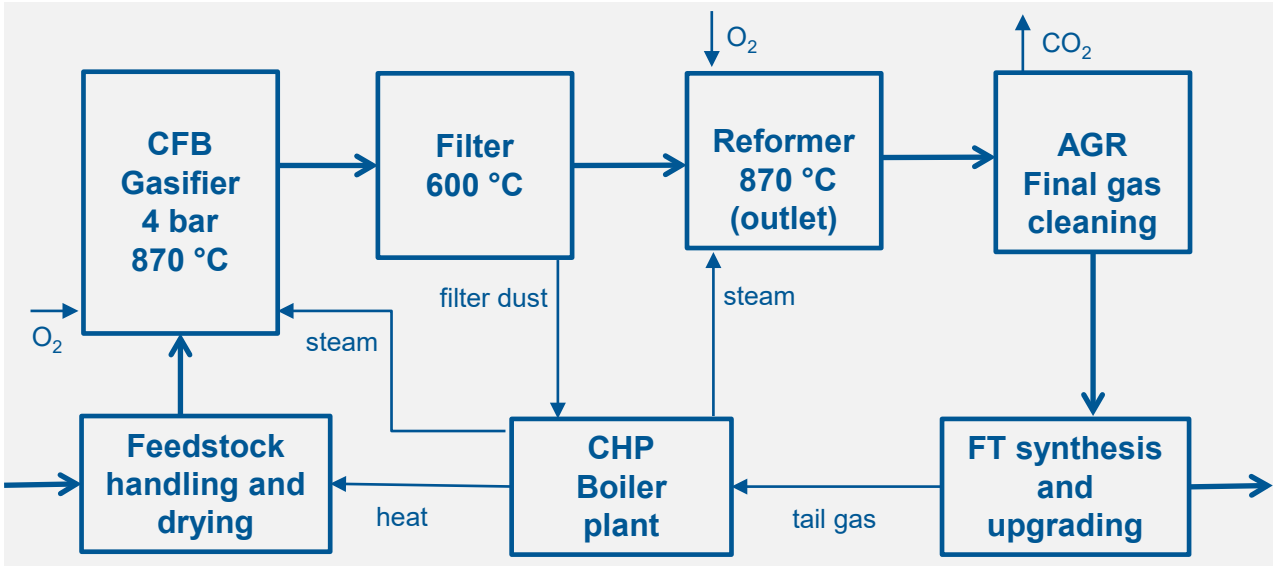
VTT's concept with reformer vs. FB gasifier without reformer



Capital cost and performance estimates for biomass to FT plant

ESTIMATED SYNFUEL YIELD
78 kton/a
ESTIMATED CAPEX
400 M€
ESTIMATED PRODUCTION COST
1400 €/toe

MAIN ASSUMPTIONS
payback time 15 a
WACC 8 %
feedstock 24 €/MWh



FOREST RESIDUE
200 MWth
50% MOISTURE
670 kton/a

SYNFUEL
110 MWth
EFFICIENCY 55%

beyond

the obvious

Ilkka Hiltunen
ilkka.hiltunen@vtt.fi
+358 400 22 6730

@VTTFinland
www.vttresearch.com/en/ourservices/thermochemical-conversion

www.vtt.fi