IEA Bioenergy

Country report Finland

November 2019

Photo: Lahti Energia KYVO II plant in operation

Juhani Isaksson Valmet technologies (presenter)

Jarno Haapakoski – Volter

Esa Kurkela – VTT

Juha Palonen – Sumitomo SHI FW Energia

Jean Taillon - Andritz

Content

Large scale operational plants in Finland

Suppliers and technology development activities

Large scale operational plants

1. Joutseno

Metsä Fibre, 48 MW
Lime kiln

2. Lahti

Lahti Energia
Kymijärvi I, 70 MW
Kymijärvi II, 2* 80 MW
Power Generation

3.Varkaus

Stora Enso
Lime Kiln, 12 MW
Corenso, 50 MW
Power Generation

4.Vaasa

Vaskiluodon Voima, 140 MW
Power generation

5.Äänekoski

Metsä Fibre, 85 MW
Lime kiln

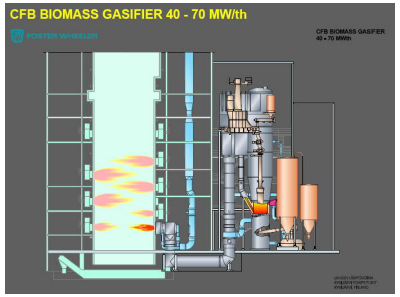
IEA Bioenergy

www.ieabioenergy.com

Large scale Operational Plants

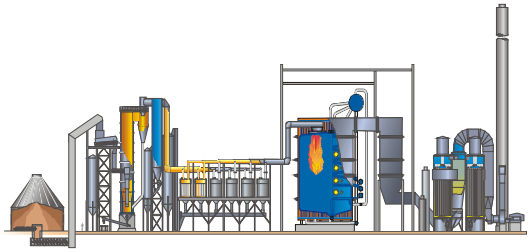
Kymijärvi I /Lahti Energia

- CFB Gasifier (SFW)
- Biofuels, 70 MW, gas to PC boiler
- PC and the gasifier was shut down spring 2019 after 20 years of commercial operation



Kymijärvi II/Lahti Energia

- Start up 2012
- 2 CFB gasifiers (Valmet) 160 MW (= 2*80) fuel
- RDF, different contaminated waste wood fractions
- 7 years of commercial operation, ongoing



Large scale Operational Plants

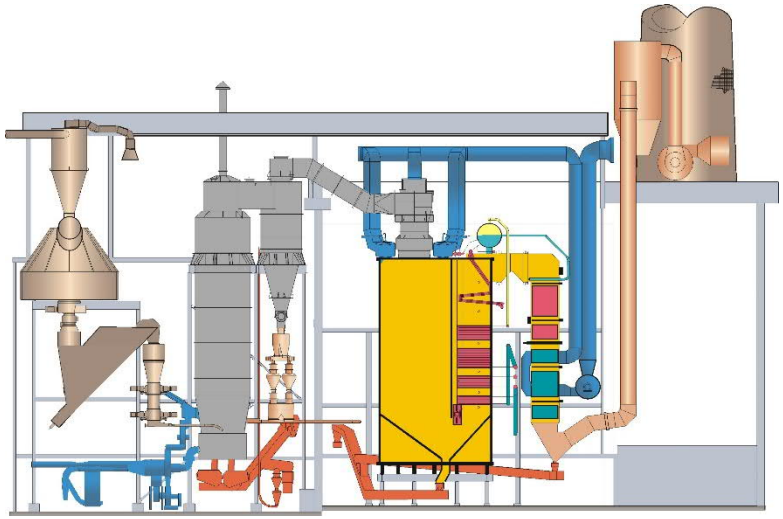
Corenso Gasifier / Varkaus, Finland

In commercial operation since 2001

50 MW BFB Gasifier (SFW)

Complete recycling of liquid cartoons (milk and juice packaging)

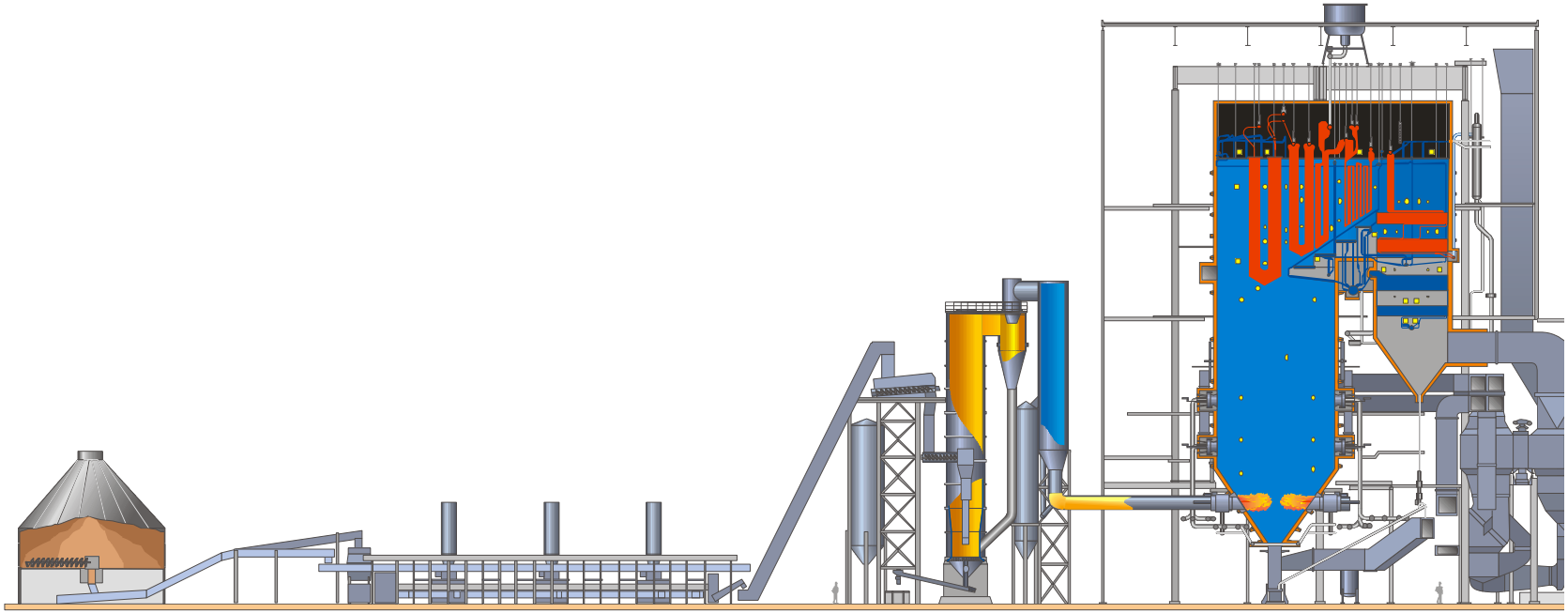
- Fibres separated and recycled back to (core)board manufacturing
- Gasification ofaluminiumcontaining plastic (PE) reject
- Metallic aluminium separated from the gas stream and recycled back to industry
- Gas substituting heavy fuel oil in the power plant



Large scale Operational Plants

Vaskiluoto

- In Commercial operation since 2013, ongoing
- 140 MW CFB gasifier (Valmet) , wood, bark, forest residues, stumps etc. and peat
- Hot gas delivered directly to one through PC boiler
- Replacing annually round 40 % of coal



Large scale Operational Plants

Lime kiln gasifiers substituting oil/gas in pulp mill lime kilns

Varkaus (Stora Enso / SFW)

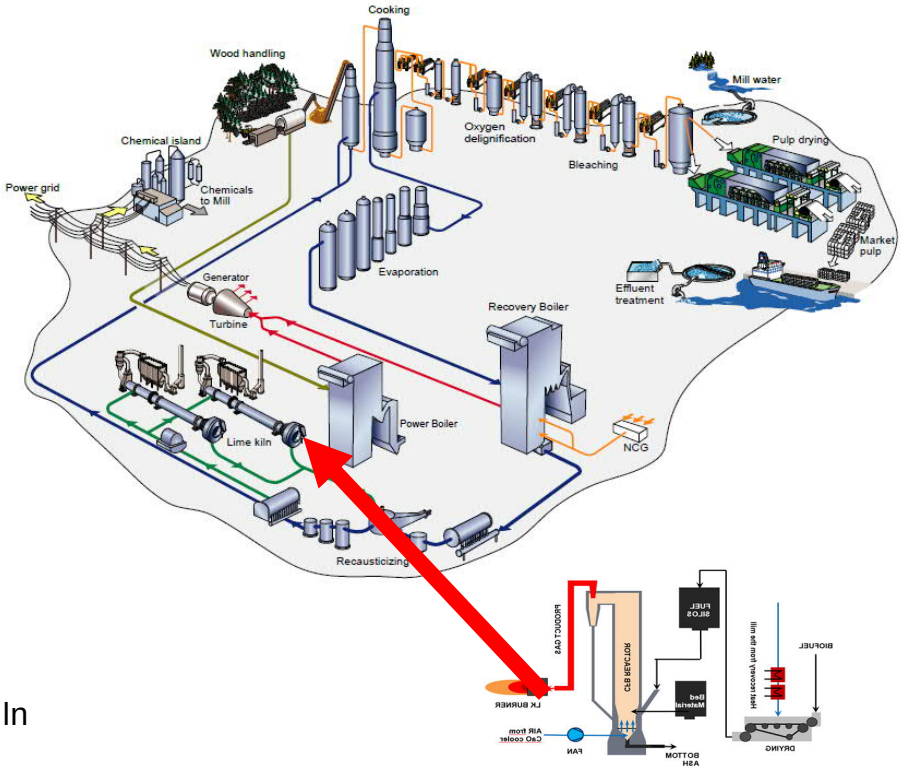
In operation since 2009 (also used as a FT test plant)
12 MW
Bark, wood residues
Replacing heavy fuel in the kiln

Joutseno (Metsä Fibre / Andritz)

In operation since 2012
48 MW
Bark, wood residues
100 % replacement of NG in the kiln

Äänekoski /(Metsä Fibre/ Valmet)

In operation since 2017
85 MW
Bark, wood residue
100% replacement of bio/heavy fuel oil in the kiln



IEA Bioenergy

www.ieabioenergy.com

Suppliers and technology development activities: ANDRITZ

THE ANDRITZ GROUP

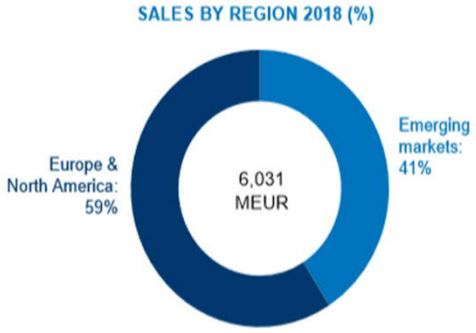
ANDRITZ is a globally leading supplier of plants, equipment, systems and services for hydropower stations, the pulp and paper industry, the metalworking and steel industries, and solid/liquid separation in the municipal and industrial sectors as well as for animal feed and biomass pelleting.

Global presence

Headquarters in Graz, Austria; over 280 production sites and service/sales companies worldwide

KEY FINANCIAL FIGURES:

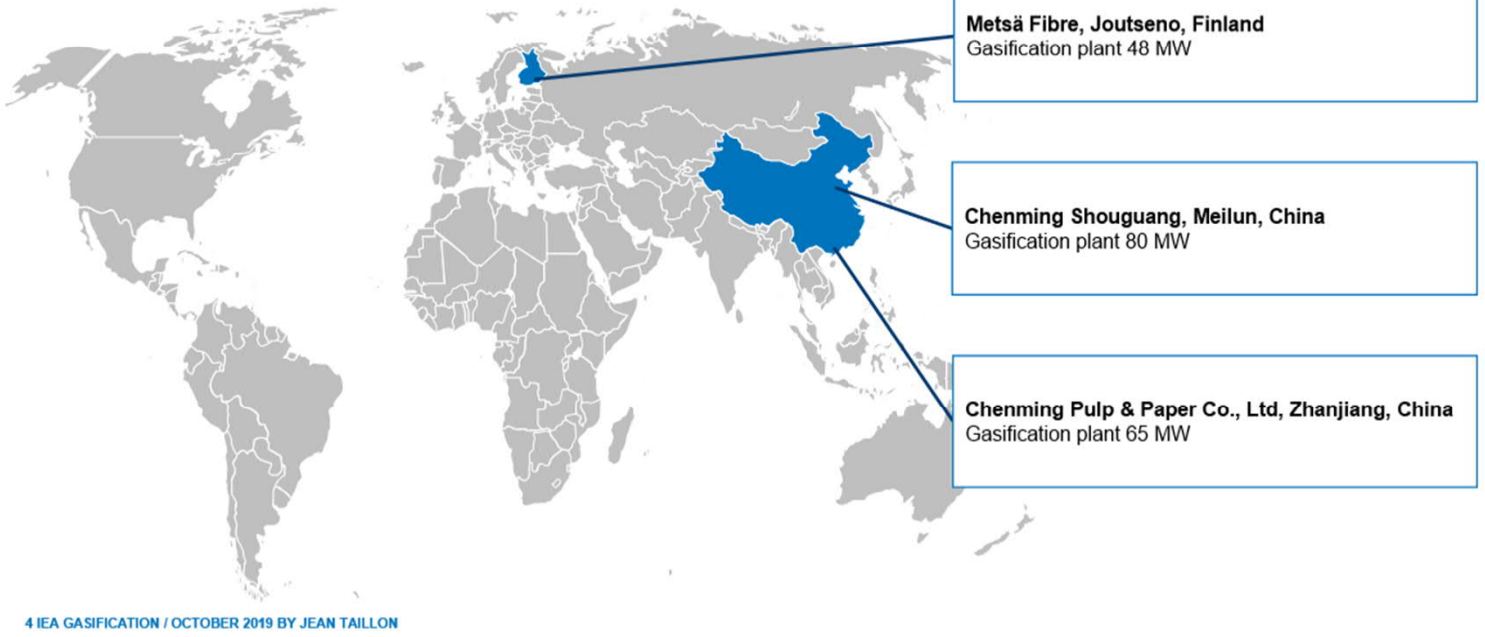
	UNIT	2018	2017
Order intake	MEUR	6,646.2	5,579.5
Order backlog (as of end of period)	MEUR	7,084.3	6,383.0
Sales	MEUR	6,031.5	5,889.1
Net income (including non-controlling interests)	MEUR	219.7	265.6
Employees (as of end of period; without apprentices)	-	29,096	25,566



2 IEA GASIFICATION / OCTOBER 2019 BY JEAN TAILLON

Suppliers and technology development activities: ANDRITZ

RECENT CIRCULATING FLUIDIZED BED (CFB) GASIFIER PROJECTS



4 IEA GASIFICATION / OCTOBER 2019 BY JEAN TAILLON

Suppliers and technology development activities : ANDRITZ

FOSSIL FUEL REPLACEMENT IN PULP MILL LIME KILNS

CFB biomass gasification technology

- **Technology**
  CFB gasification plant, belt dryer, biomass and ash handling equipment, multi-fuel lime kiln burner and auxiliaries.

- **References**

Metsä-Fibre Joutseno:	48MW, 100% replace NG, 600 t/d lime kiln, nordic HW & SW barks, start 2012.
Chenming Zhanjiang:	65MW, 100% replace HFO, 800 t/d lime kiln, eucalyptus chips screening fines and bark, start 2015.
Chenming Meilun:	80MW, 1200 t/d lime kiln, eucalyptus chips screening fines, start 2019.

- **Experiences**
  Despite variations in fuel properties (moisture, heating values), CFB plant provides a steady heat supply to lime kiln.
  Burnt lime quality is satisfactory with no accumulation of NPEs and reaction with burnt lime.
  Satisfactory payback.

- Contact
  For further information, please contact: Mr. Jean Taillon at ANDRITZ.

5 IEA GASIFICATION / OCTOBER 2019 BY JEAN TAILLON

Suppliers and technology development activities:Sumitomo SFW

Sumitomo SFW Fluidized Bed Gasification

Juha Palonen
SUMITOMO SHI FW Energia Oy

Sumitomo SHI FW

Suppliers and technology development activities:Sumitomo SFW

Sumitomo SHI FW Gasification Status

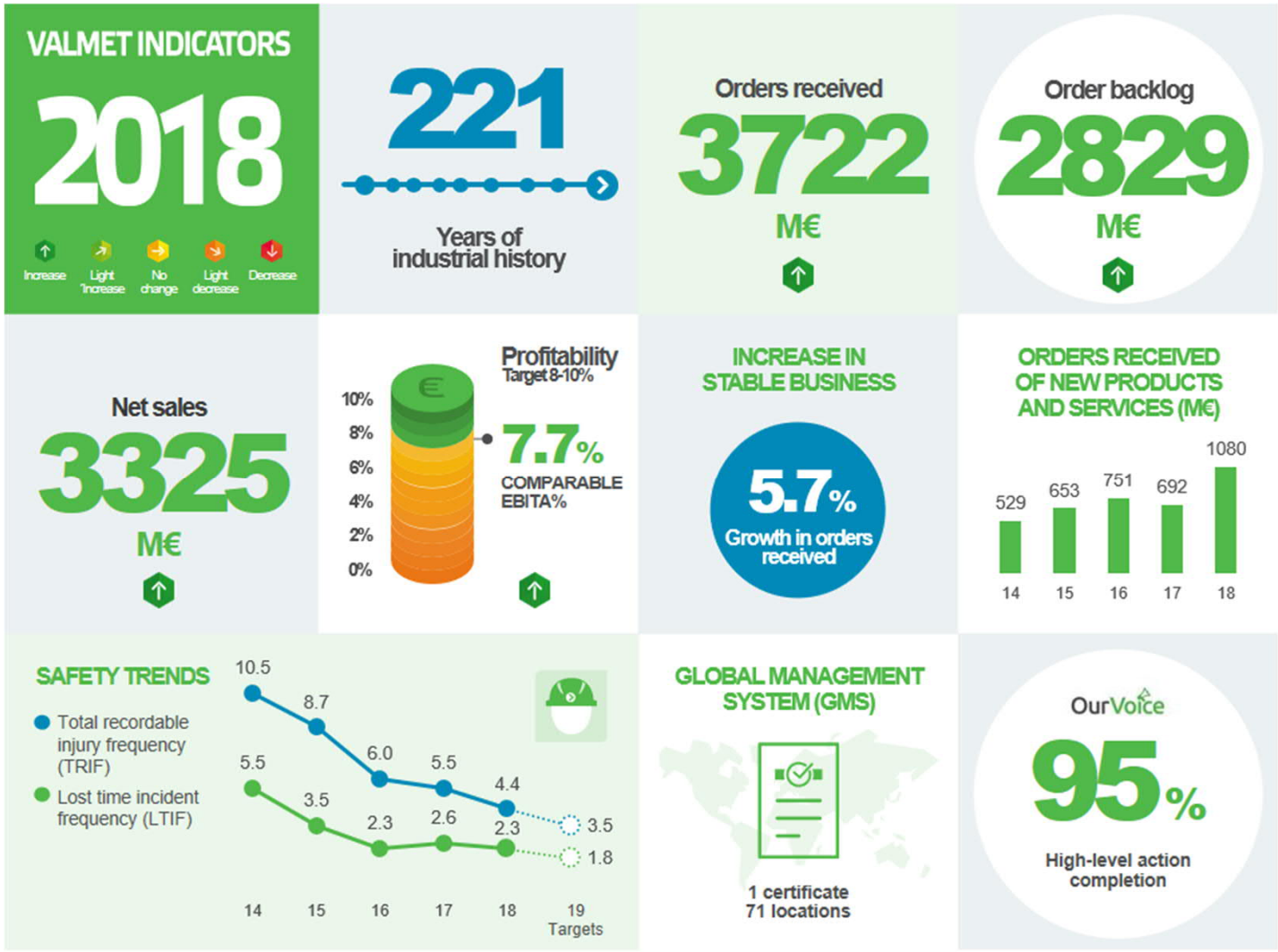
Commercial scale applications / Daily business

- In addition to normal daily business
  - Service activities and process development/modifications on customer plants
- Further scale up in MWs
- Design development for more challenging fuels and for different fluidizing media (O2 enrichment, etc)

Development work / Future applications

- Main focus at the moment
  - Target on transportation sector fuels and biochemicals
- Development projects going on
  - Pilot tests and model development
  - Different gasification processes for different scopes
  - Expanding of fuel range

Suppliers and technology development activities: Valmet



IEA Bioenergy

www.ieabioenergy.com

Suppliers and technology development activities:Valmet

Valmet CFB Gasifier

Product gas for industrial kilns

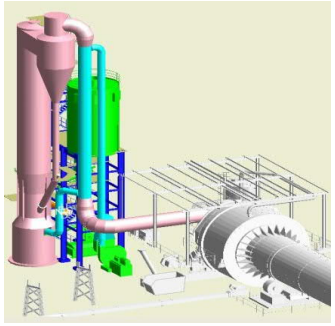
- Woody biomass, bark, peat and waste
- 20 – 110 MW_{fuel} units
- Typically includes a dryer
- Dusty product gas
- References for Limekilns
  - OKI, Indonesia 2 * 110 MW
  - Äänekoski, Finland 87 MW
  - Huangang, China 50 MW
  - Confidential, Brazil 2*87 MW

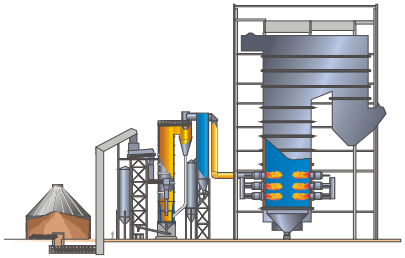
Product gas for power boilers

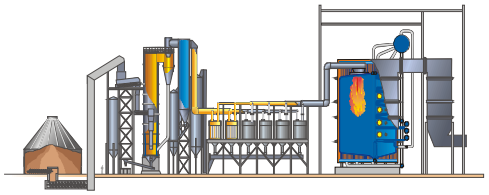
- Woody biomass, bark, peat and waste
- Superior electrical efficiency
- **Existing boilers**
- 50 –300 MW_{fuel} units
- If needed, can include a dryer and gas cleaning
  - Vaskiluodon Voima, Finland 140 MW

Product gas from waste for power production

- Waste-derived fuel
- 50 – 150 MW_{fuel}
- High electrical efficiency
- Typically a new gas boiler (existing boiler is also an option)
- Gas cleaning included
  - Lahti Energia, 160 MW







Suppliers and technology development activities:Volter

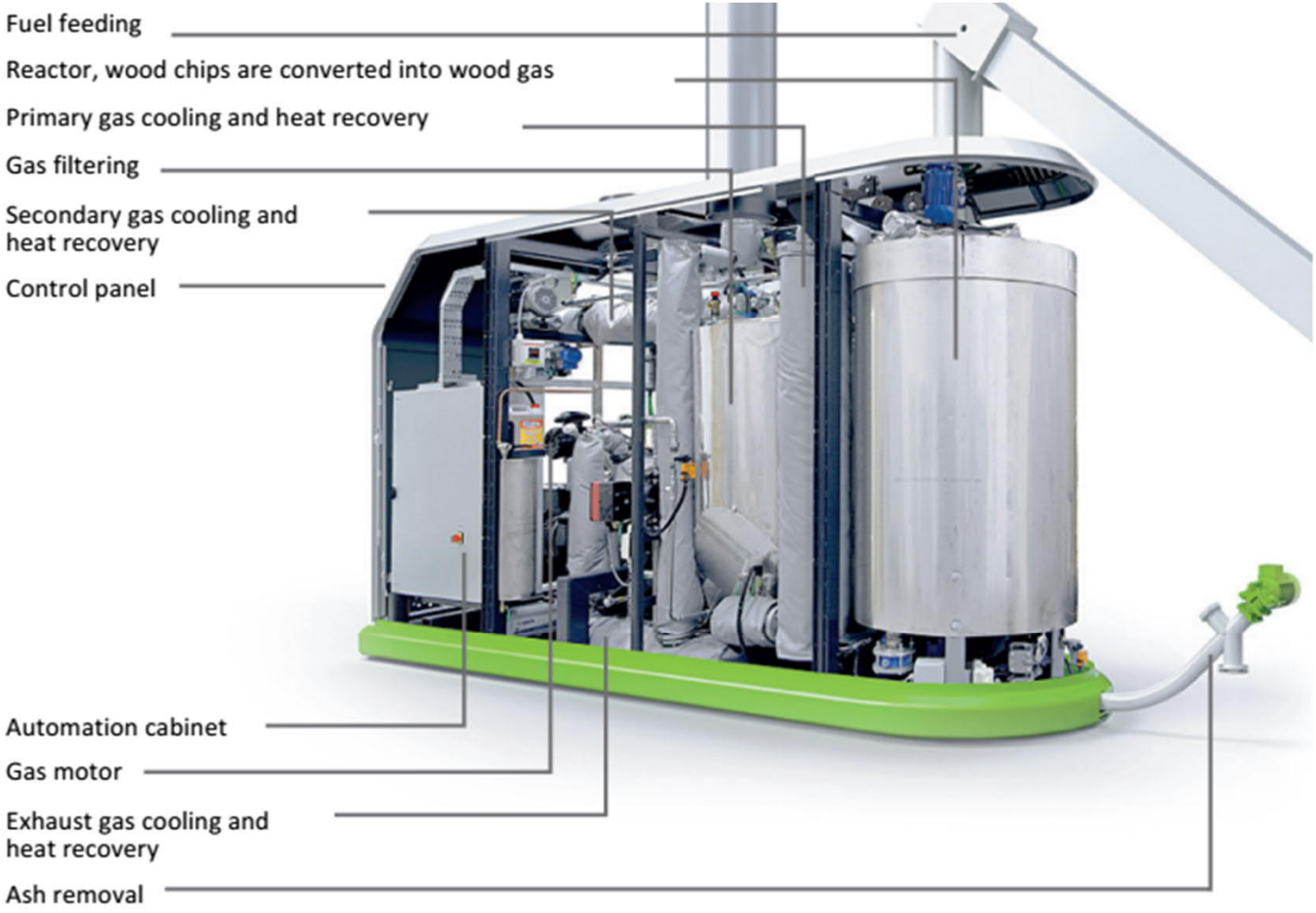
Suppliers and technology development activities:Volter

Manufacturer of small wood fuelled combined heat and power plants. We enable our customers to increase their energy independency and to create new business from renewable energy sales. Volter power plants provide both heat and electricity all-year-around regardless of weather conditions.

Founded in 1997 by Finland´s current prime minister Juha Sipilä. Company was later sold to it´s employees and has focused in the current field since 2009.

Currently all sales come from outside of Finland where the units are manufactured. Key market areas are UK, Italy, Japan and North-America. Our target for turnover in 2020 is 39M€.

Suppliers and technology development activities:Volter



IEA Bioenergy

www.ieabioenergy.com

Suppliers and technology development activities:Volter

VOLTER

Market

-Units delivered to more that 10 different countries

-Several multi unit installations

-110+ units sold to date

Suppliers and technology development activities:Volter

VOLTER

Our young and energetic group is filled with different personalities, which together form a strong team. By exploring our products you can feel the passion we share for uncompromised quality and functionality.

Our Values: Passion, Bravery and Care

Suppliers and technology development activities:VTT

BtL2030
https://www.vtt.fi/sites/BTL2030/en

COMSYN
https://www.comsynproject.eu/

FLEXCHX
http://www.flexchx.eu/

Transportation fuels from biomass via gasification route

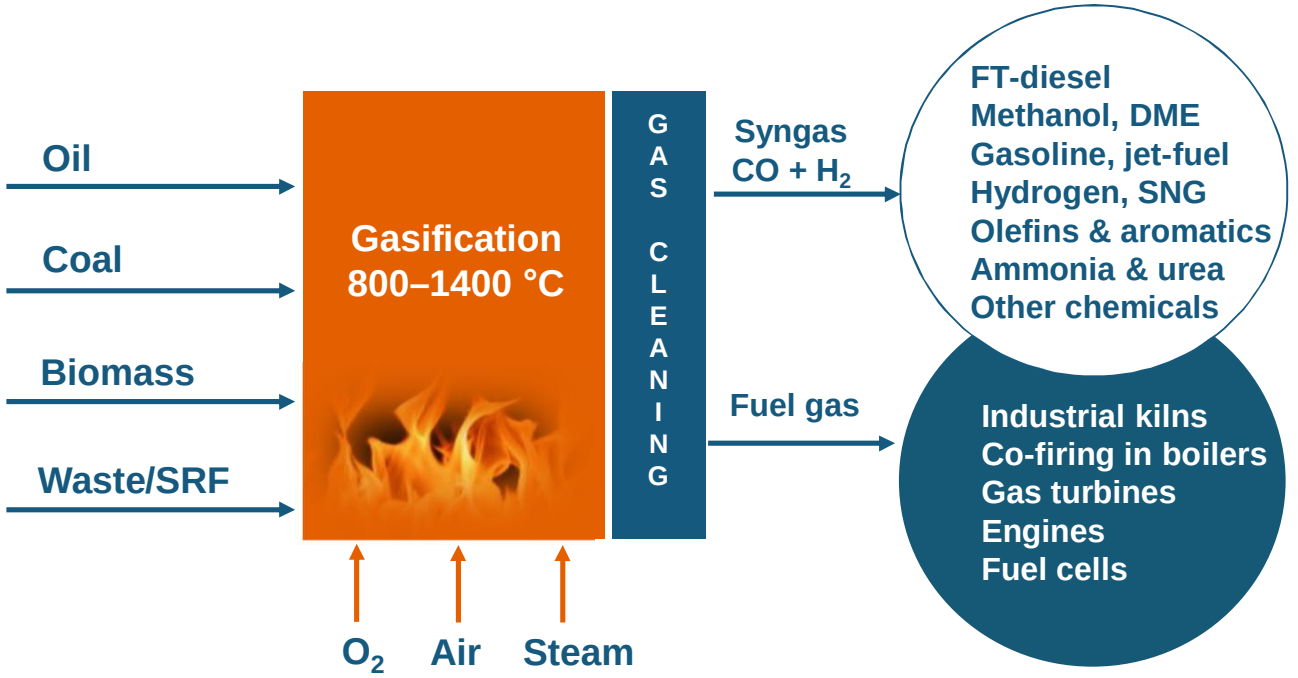
Esa Kurkela
VTT Technical Research Centre of Finland Ltd
Espoo

January 2019

19

Suppliers and technology development activities:VTT

Conversion of low-grade feedstock to valuable Products



Wide feedstock basis

High-Quality Final Products

Suppliers and technology development activities:VTT

Biomass and waste gasification for boilers and kilns

- Industrial experience in Finland since 1980's

LIME-KILN GASIFIERS

BIOMASS/WASTE GASIFIERS FOR POWER

REPLACEMENT OF FOSSIL FUELS IN BOILERS AND KILNS
- o wood, agrobiomass
- o 10 - 200 MW fuel

NOVEL WASTE CONVERSION PLANTS
- o high electric efficiency
- o recovery of metals and phosphorus

1985 1995 2000 2005 2010 2015 2020 2025 2030

GASIFIER DEVELOPMENT

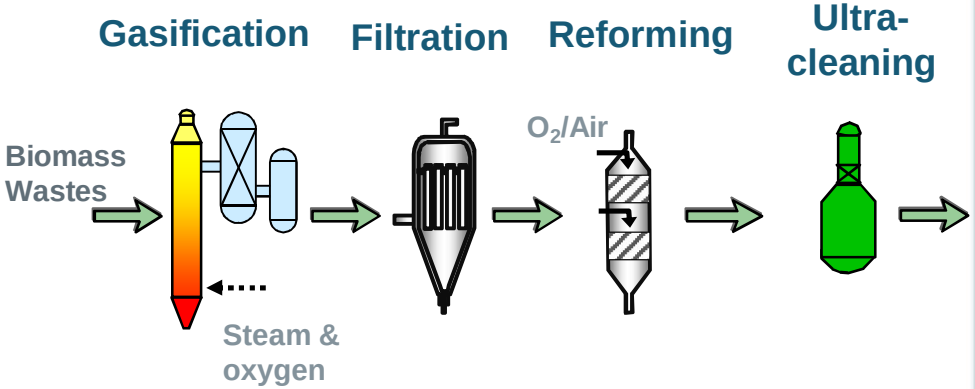
R&D AND PILOTING AT VTT

IEA Bioenergy

www.ieabioenergy.com

Suppliers and technology development activities:VTT

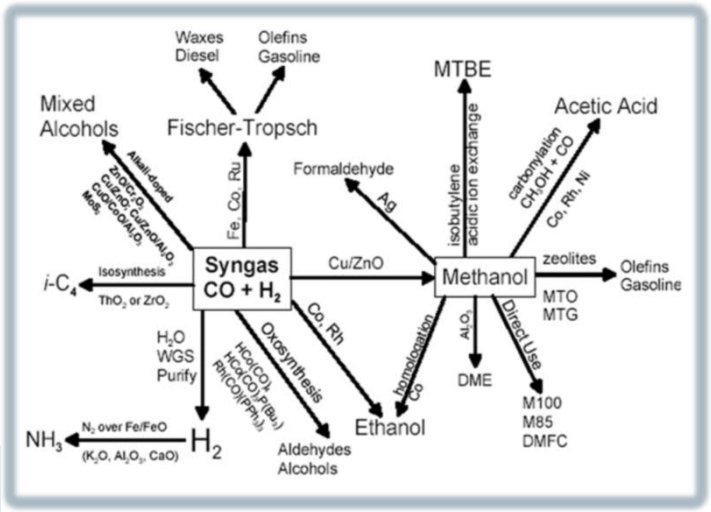
Key steps in gasification based synfuels process



Selection of the optimal Gasifier depend on target scale

- Pressurized O_2-blown CFB for > 150 MW input
- Dual Fluidized-Bed steam gasification for 70 – 150 MW
- Pressurized Staged Fixed-Bed gasifier for 10 – 70 MW

Syngas toolbox

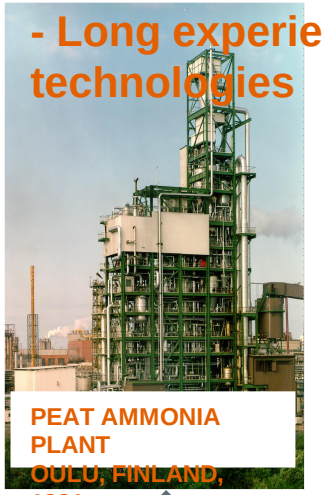


IEA Bioenergy www.ieabioenergy.com

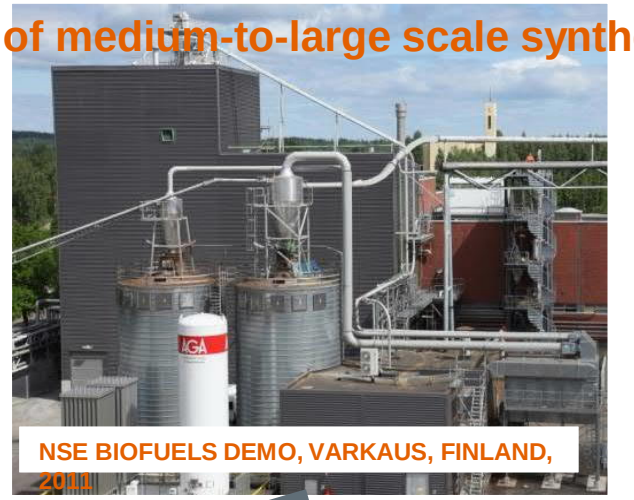
Suppliers and technology development activities:VTT

Biomass gasification for biofuels and bio-chemicals

- Long experience of medium-to-large scale synth technologies



PEAT AMMONIA PLANT
OULU, FINLAND, 1991



NSE BIOFUELS DEMO, VARKAUS, FINLAND, 2011

PILOT PLANT AT VTT BIORUUKKI, ESPOO, 2016

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

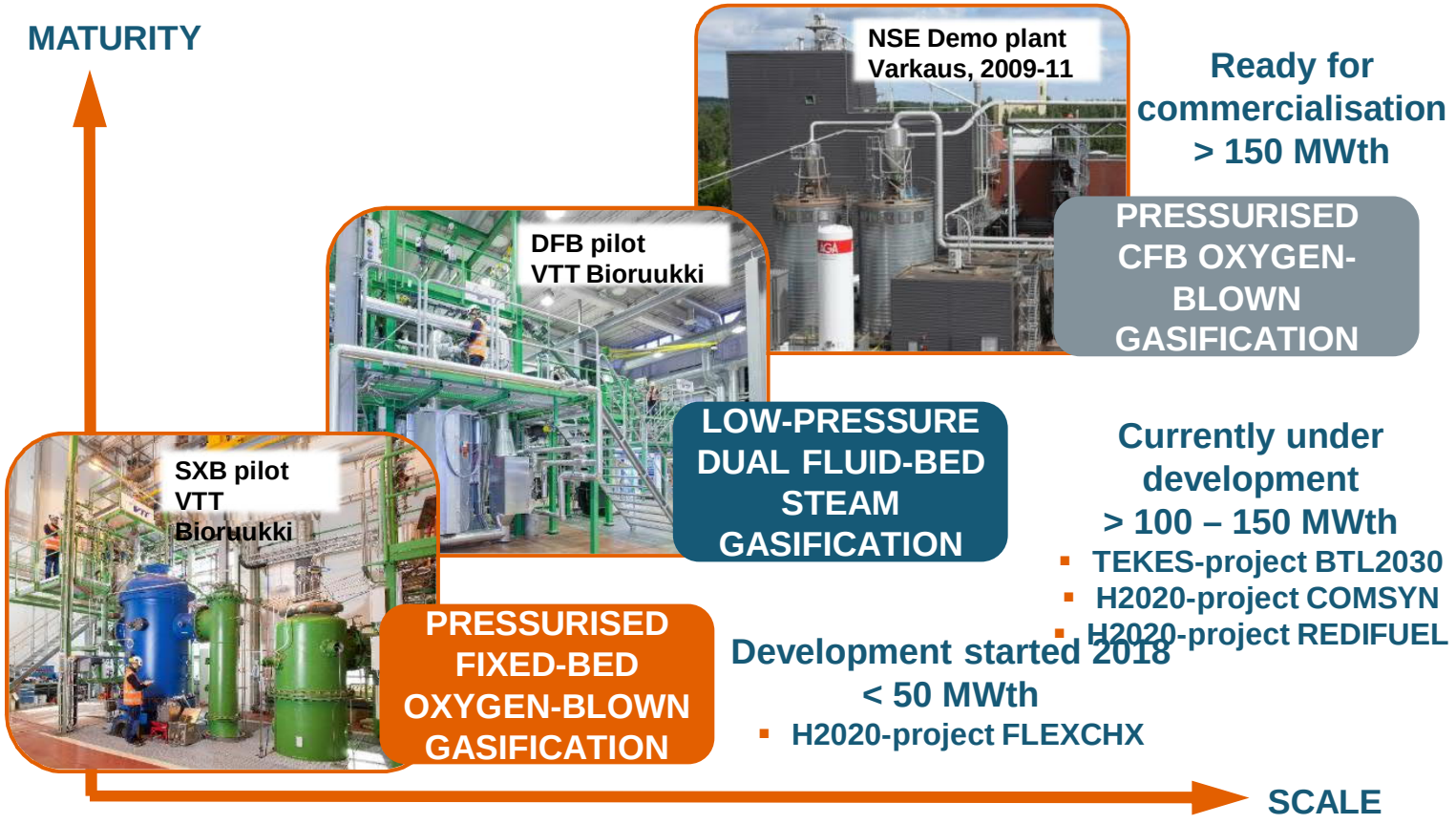
COAL GASIFIER APPLIED FOR PEAT AND WOOD

LARGE-SCALE GASIFICATION SPECIALLY DEVELOPED FOR WOOD FEEDSTOCKS

NEW PROCESS FOR SMALLER SCALE AND WITH LOWER CAPEX

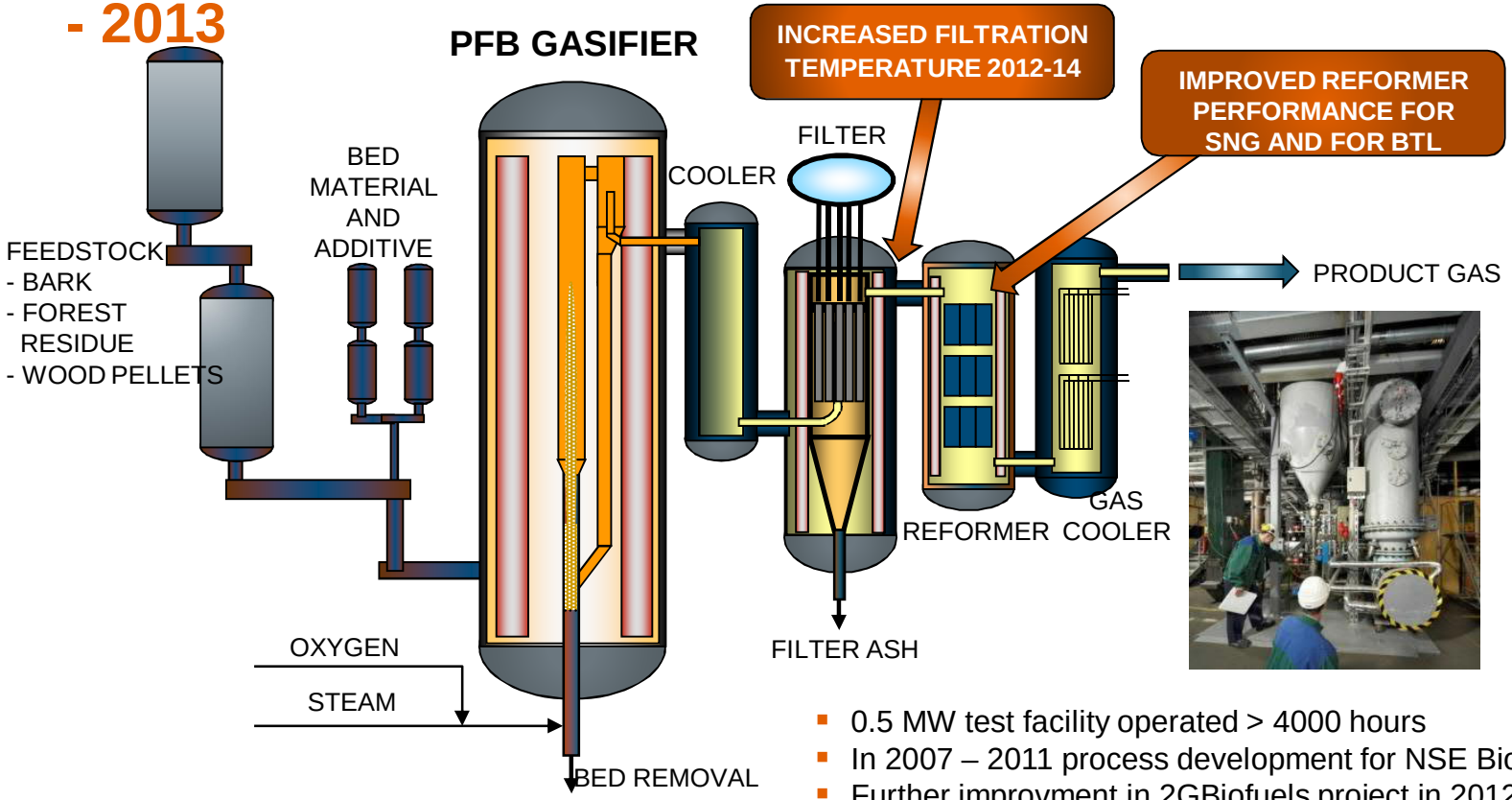
Suppliers and technology development activities:VTT

Synthesis gas production at different scale



Suppliers and technology development activities:VTT

O_2-Blown CFB Gasification – PDU at VTT in 2007 - 2013



- 0.5 MW test facility operated > 4000 hours
- In 2007 – 2011 process development for NSE Biofuels
- Further improvment in 2GBiofuels project in 2012-13

Suppliers and technology development activities:VTT

Why commercial gasification and synthesis plants are not yet under construction?

Economic challenges of first-of-a-kind (FOAK) plants

- Investment typically 50% higher than for mature plants
- Large > 100 ktoe/a plants require 500 -1000 M€ investment
- Financing of FOAK carries significant risk component

Significant political uncertainties

- Binding targets for renewable fuels missing
- Long-term support for large-scale flag ship projects too expensive
- Complex sustainability issues

HVO and first generation biofuels have so far satisfied the

Smaller plant size and simplified processes needed!

- Reducing CapEx a key
- Maximise integration benefits – biomass logistics, heat integration
- Use local residues and wastes to ensure sustainability

Suppliers and technology development activities:VTT

Integrating production of fuels and chemicals from biomass and residues to existing industries to improve competitiveness

Several local sites with CHP integration

- Forest and agricultural residues
- Industrial and municipal wastes
- Integration to district heating, forest, chemical or metal industries

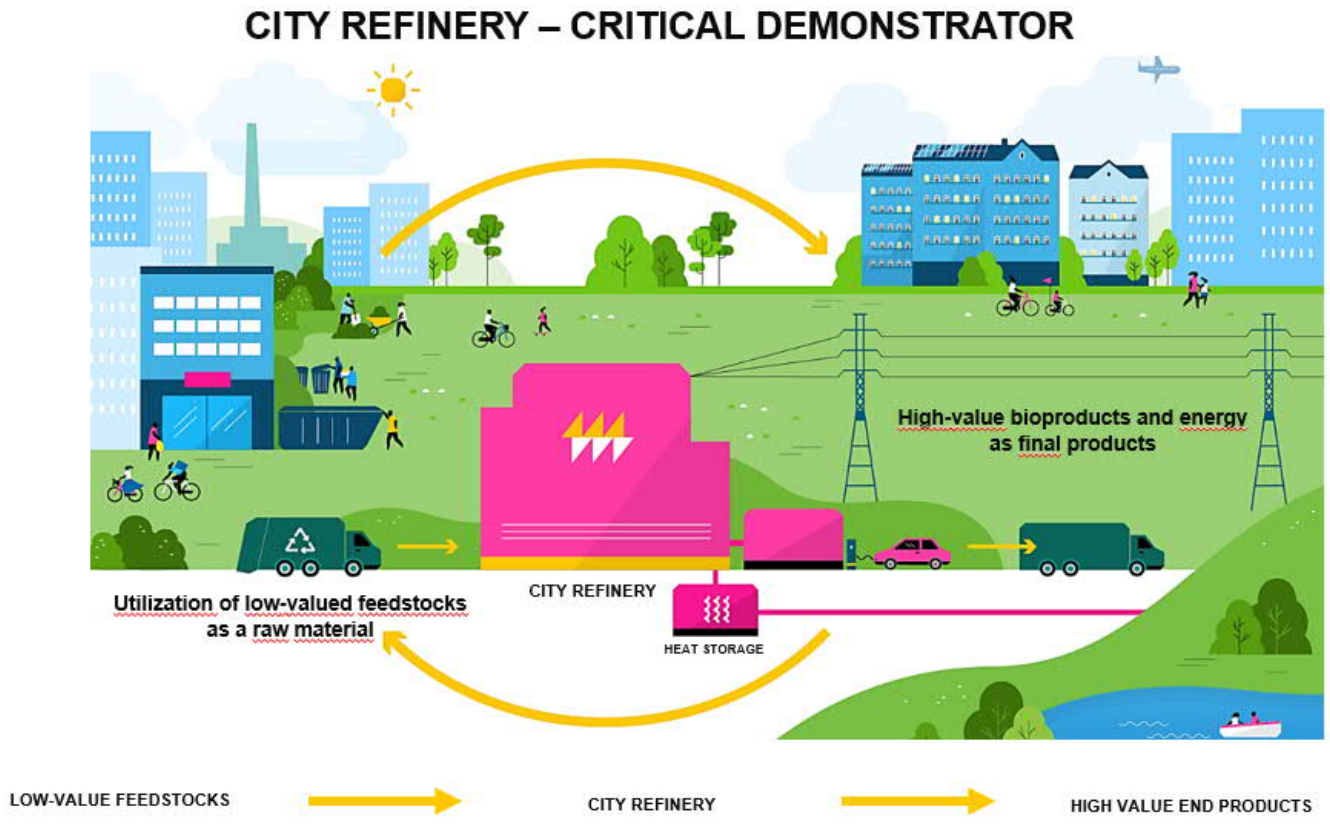
Transport of intermediate products

- Pyrolysis oil
- Methanol
- Synthetic hydrocarbons (FT)
- Synthetic methane (SNG)

Large-scale refineries or chemical industries

- Co-refining
- Drop-in transportation fuels
- Olefins for renewable packaging materials
- Basic chemicals, fertilisers
- Aromatics

Suppliers and technology development activities:VTT



HELEN

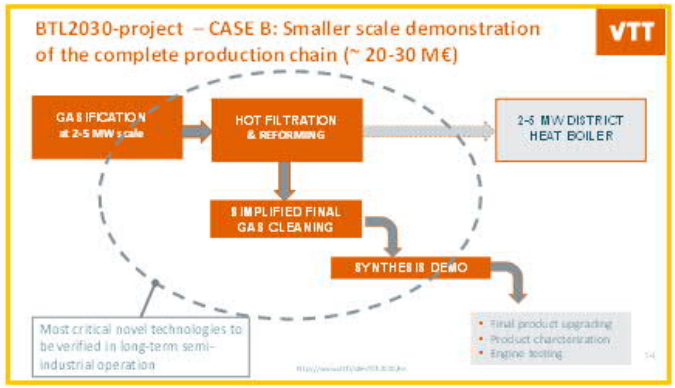
IEA Bioenergy

www.ieabioenergy.com

Suppliers and technology development activities:VTT

DEMONSTRATION FOR ENTERING INTO FLAGSHIP

- Objectives
  - To lower the technical risks related to key enabling technologies
  - To gain long-term experience on process performance with different feedstock
  - To test effects of new process developments and to define an optimal process concept

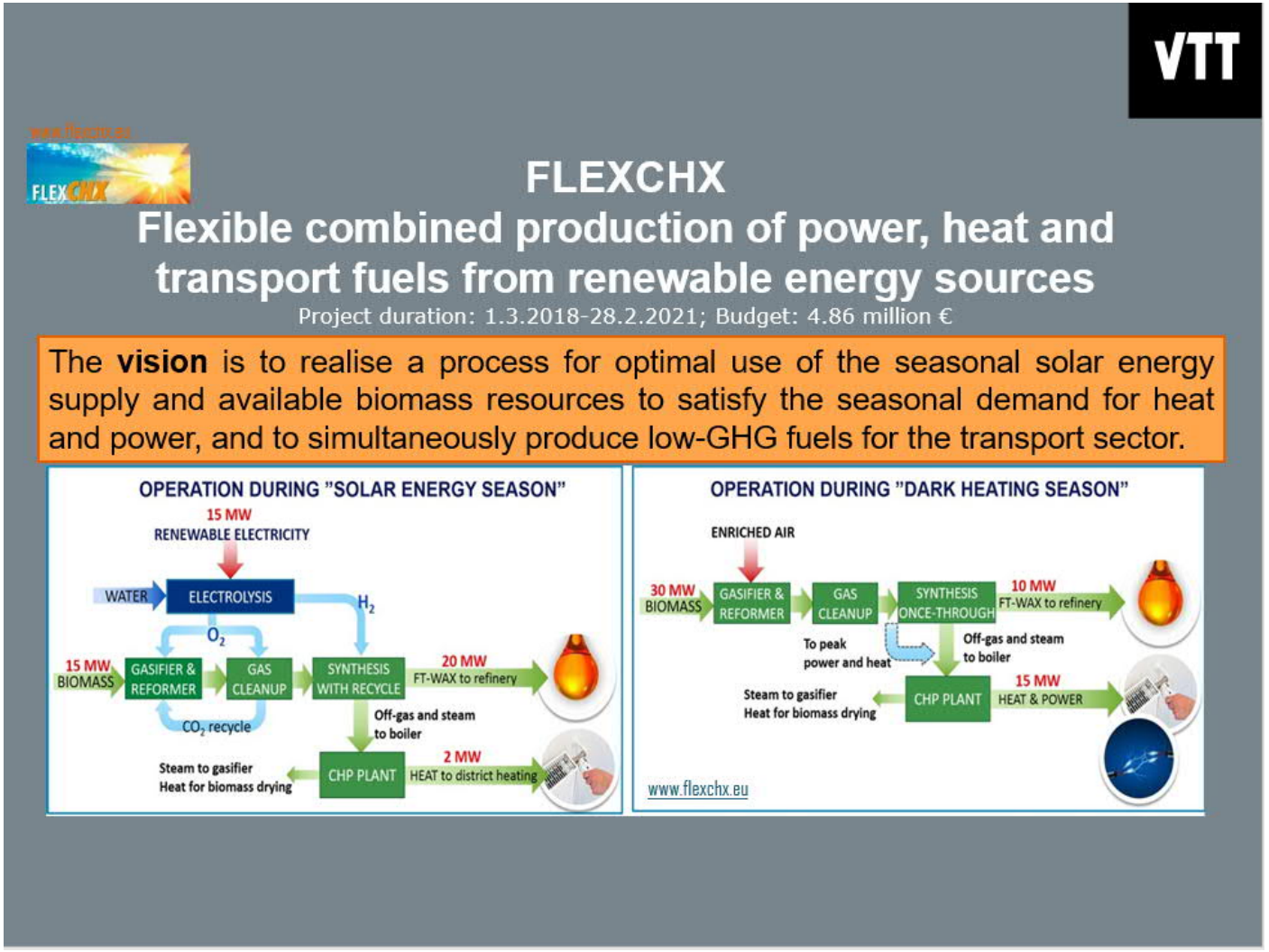


HELEN

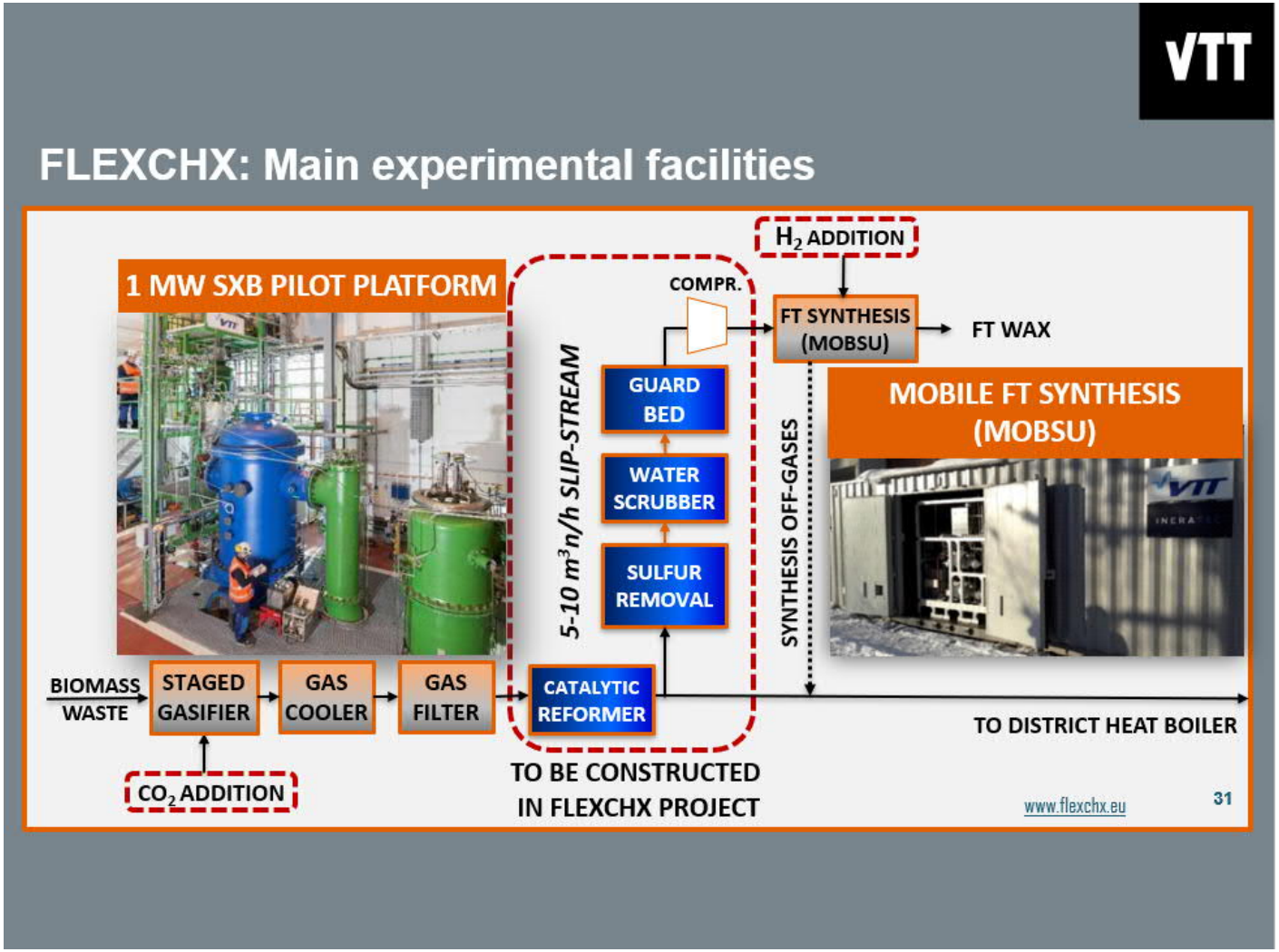
IEA Bioenergy

www.ieabioenergy.com

Suppliers and technology development activities:VTT



Suppliers and technology development activities:VTT



IEA Bioenergy

iea Energy Technology Network

Contact Details