

**BtL2030**[www.vtt.fi/sites/BTL2030/en](http://www.vtt.fi/sites/BTL2030/en)**COMSYN**[www.comsynproject.eu](http://www.comsynproject.eu)[www.flexchx.eu](http://www.flexchx.eu)

# Transportation fuels from biomass via gasification route

## From R&D to demonstration and flag ship plant

BTL2030 project

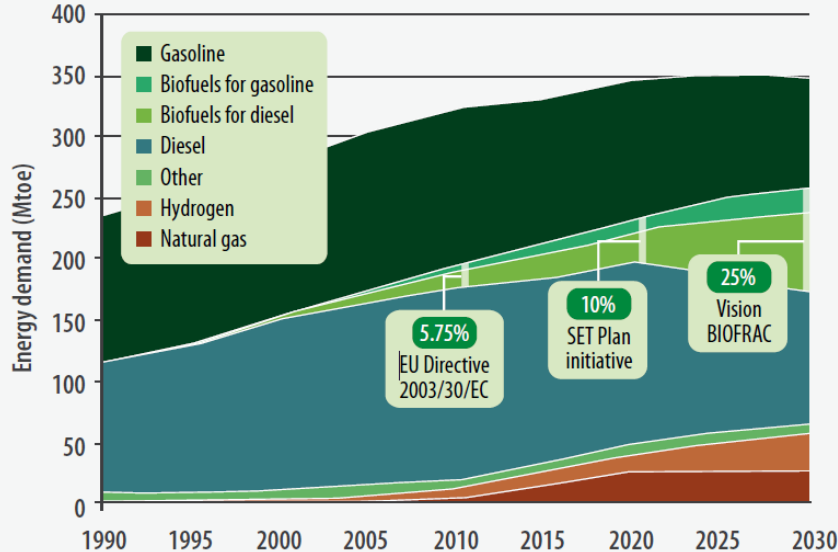
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# Huge EU market after 2030

## - How Can Be Satisfied – 5

%?



Source: European Biofuels Technology Platform, SRA Jan. 2008



## What would mean e.g. 5 % of EU market?

- 15 Mtoe/a in road transport
- 300 gasification-synthesis plants of 150 MW feed
- e.g. 25 plants/year after 2030  
=> 5 B€/year investment

## Aviation fuels: 4 % target

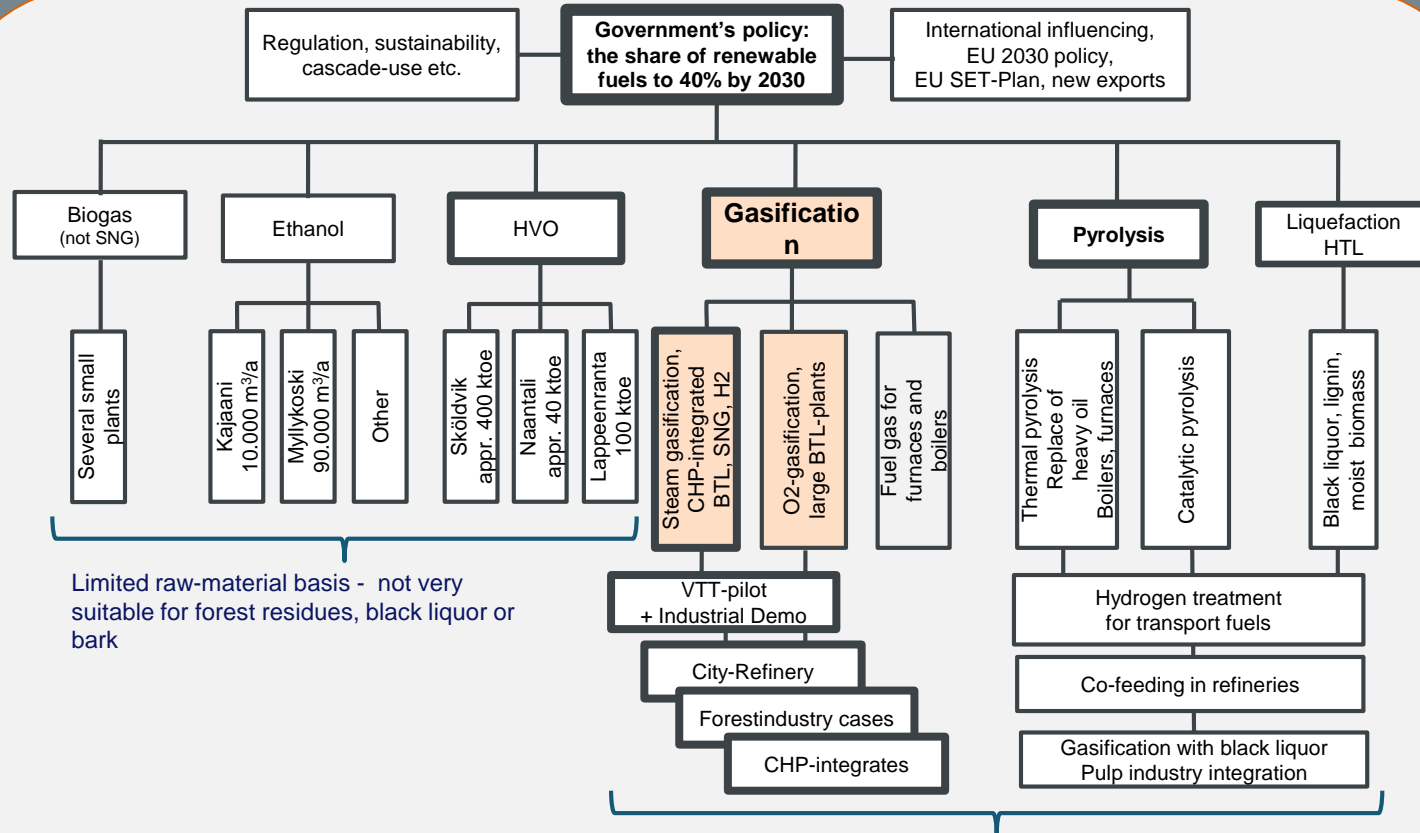
- 2 Mtoe/a
- 40 gasification-synthesis plants

## Sustainability and ILUC

- GHG reduction > 60 %  
(Gasification-BTL > 80 %)
- Residues are the main feedstocks of gasification BTL

# Solutions for biofuel production from domestic feedstocks in Finland

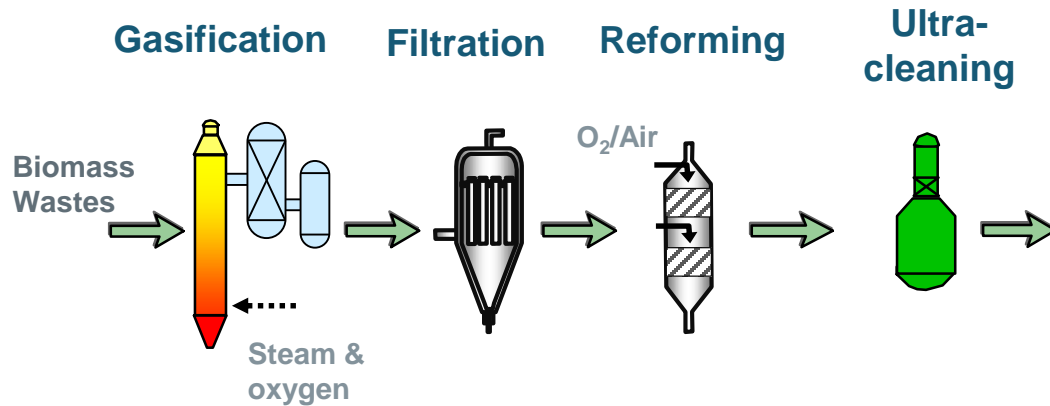
Target for renewable energy use of 40 % by 2030



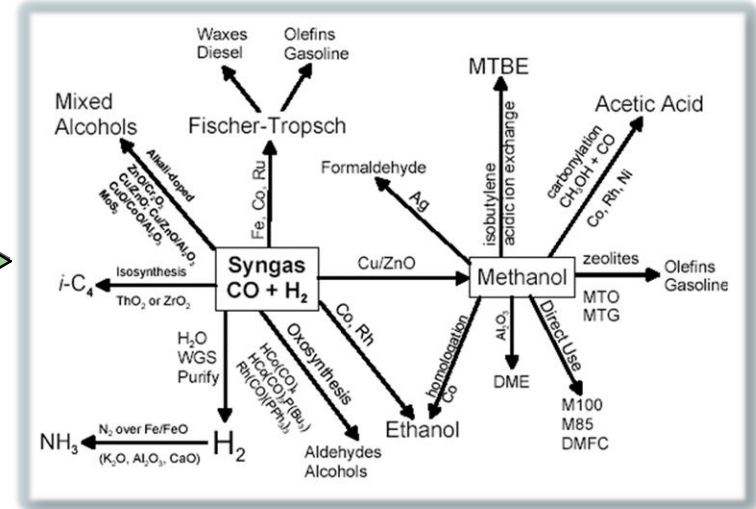
Limited raw-material basis - not very suitable for forest residues, black liquor or bark

Suitable for wide range of domestic woody raw material, Additional production capacity of 600-900 ktoe/a by 2030

# Key steps in gasification based syngas process



## Syngas toolbox



Input/output    Biomass and wastes  
100 MW

price    5-20 €/MWh

Renewable heat  
30 MW

30-50 €/MWh

Renewable fuel/chemicals  
55 MW

80-130 €/MWh

# Biomass gasification for biofuels and bio-chemicals

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



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

# 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 market**

## Smaller plant size and simplified processes needed!

- Reducing CapEx and introducing smaller first-of-a-kind plants
- Maximise integration benefits – biomass logistics, heat integration
- Use local residues and wastes to ensure sustainability

# 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



- 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

# City Refinery Concept: "Vuosaari Gas Hub"

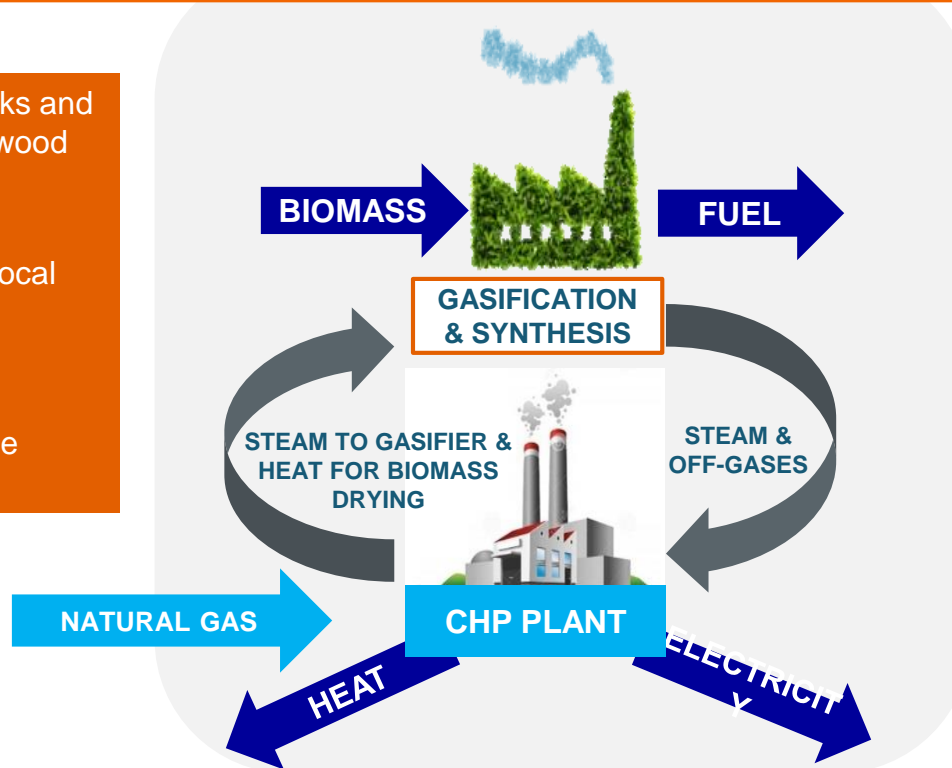
An example of integration alternatives studies in the BTL2030 project

INNOVATIVE SOURCING OF URBAN RESIDUES AND WASTES

CONVERSION UNIT INTEGRATED TO CHP PLANT

FINAL REFINING TO VALUE-ADDED PRODUCTS

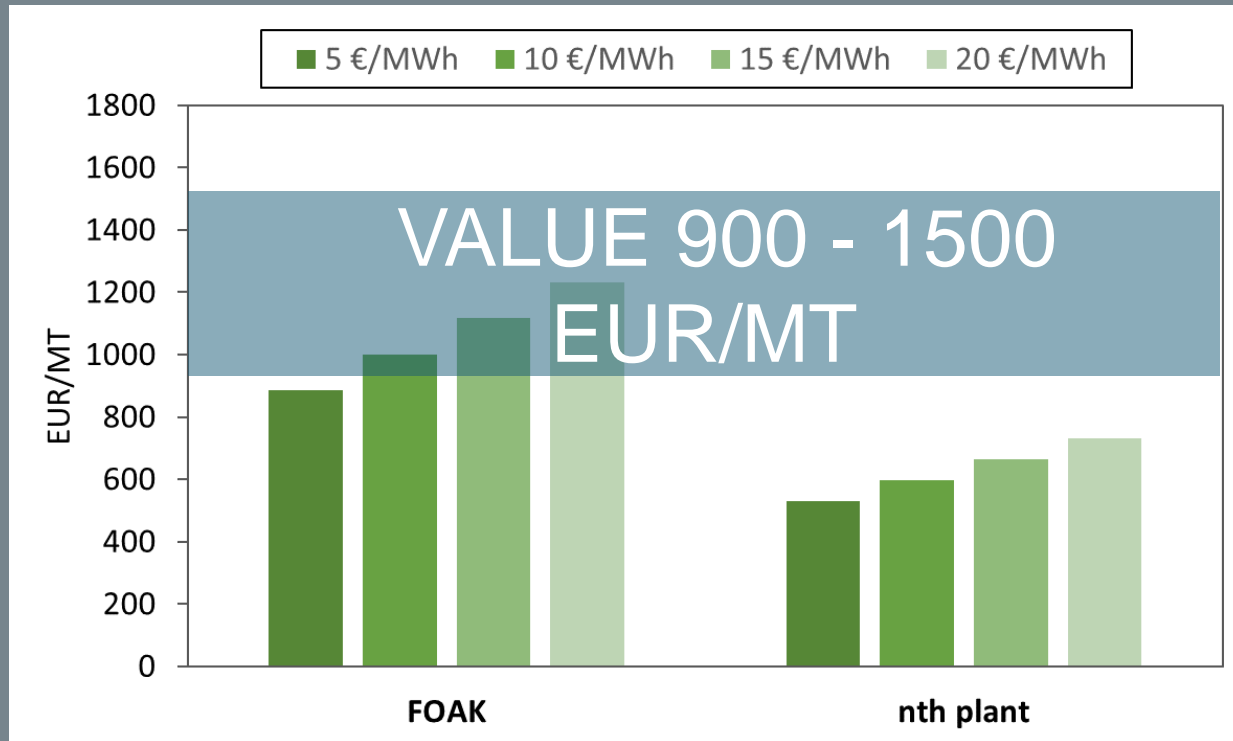
- Residues from parks and horticulture, used wood
- Used packaging materials
- By-products from local industries
- Source-separated household wastes
- Sludges from waste water treatment



- Sustainable fuels for air, maritime and heavy duty road transport
- Renewable plastics: ABS for boats, lego etc. and olefins for packaging materials
- High-value products: biopanol, aromatics
- Biofertilizers
- Recovered metals



# Production cost estimate for FT liquids: Sensitivity to feedstock price



## ASSUMPTIONS

- **First-of-a-kind** plant or **nth plant**
- Scale: 1000 bpd (**150 MW<sub>BIOMASS</sub>**)
- Availability: 8000 h/yr
- WACC: 8%
- Plant economic life: 20a
- Fixed O&M: 4% of TCI/a
- Electricity: 60 €/MWh
- Heat: 40 €/MWh

CAPEX, M€

300

200

# Heat-integrated medium-scale BTL process via piloting and demonstration to industrial use

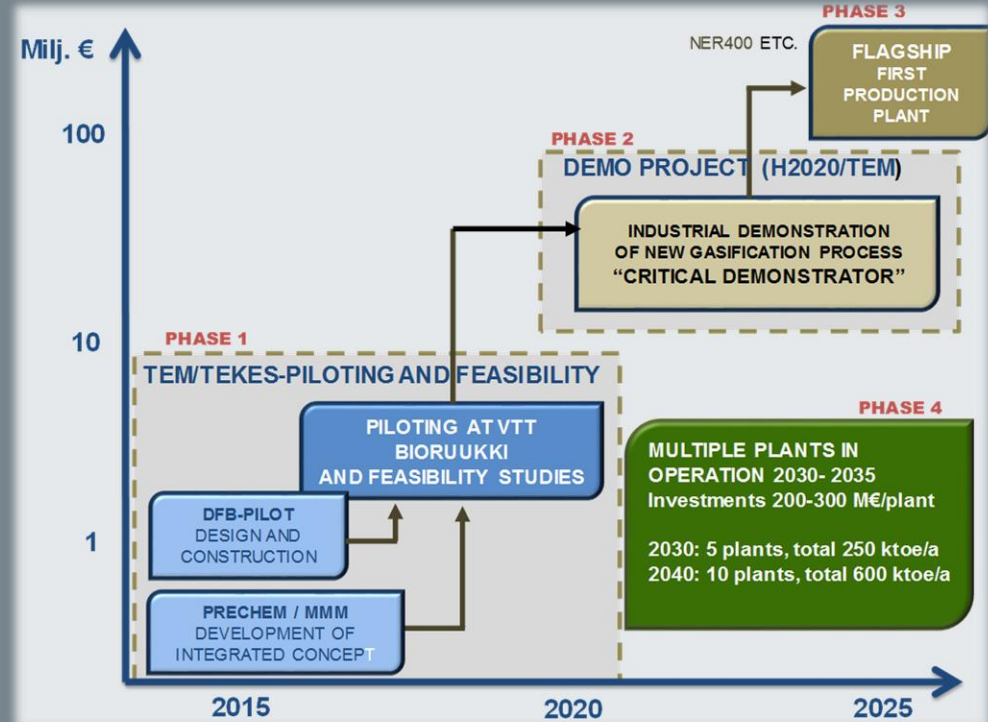
**P0:** Concept development – PRECHEM-Kokkolan Biorefinery project (2015)

**P1:** Piloting at VTT Bioruukki and system studies 2016-18, 2.7 M€

**P2:** Demonstration at power plant site or at VTT Bioruukki, 2019-22, 20-50 M€

**P3:** First production plant, 200 M€  
Capacity 30 ktoe/a, Investment decision 2022, construction 2022-24 operational 2025 =>

**P4:** Several plants in operation after 2030, investments 250 M€/plant  
2030: 5 plants, total 250 ktoe/a  
2040: 10 plants, total 600 ktoe/a



Phase 1: Piloting and evaluation project, on-going as national project and two EU H2020 projects

Phase 2: Demonstration project, will be planned together with industrial partners – possible realization 2019-2022

Phase 3: Industrial Flagship project

# Alternatives of the intermediate demonstration before entering into Flag ship project

## 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

## Rationale

- To test the processes at as small-scale as technically possible in order to minimize costs
- To involve a group of companies representing the whole value chain which could later on make profit from industrial follow-on projects
- To carry out this critical and not economically profitable stage with strong public support

## Main alternatives

- A. Slip-stream gas cleaning and fuel synthesis demonstration connected to an industrial gasification plant (similar idea to the NSE demo plant as operated in Varkaus in 2009-11)
- B. To build and operate a small pilot-scale (1-3 MW input) demonstration plant at VTT Bioruukki demonstrating the whole chain from biomass gasification to fuel synthesis

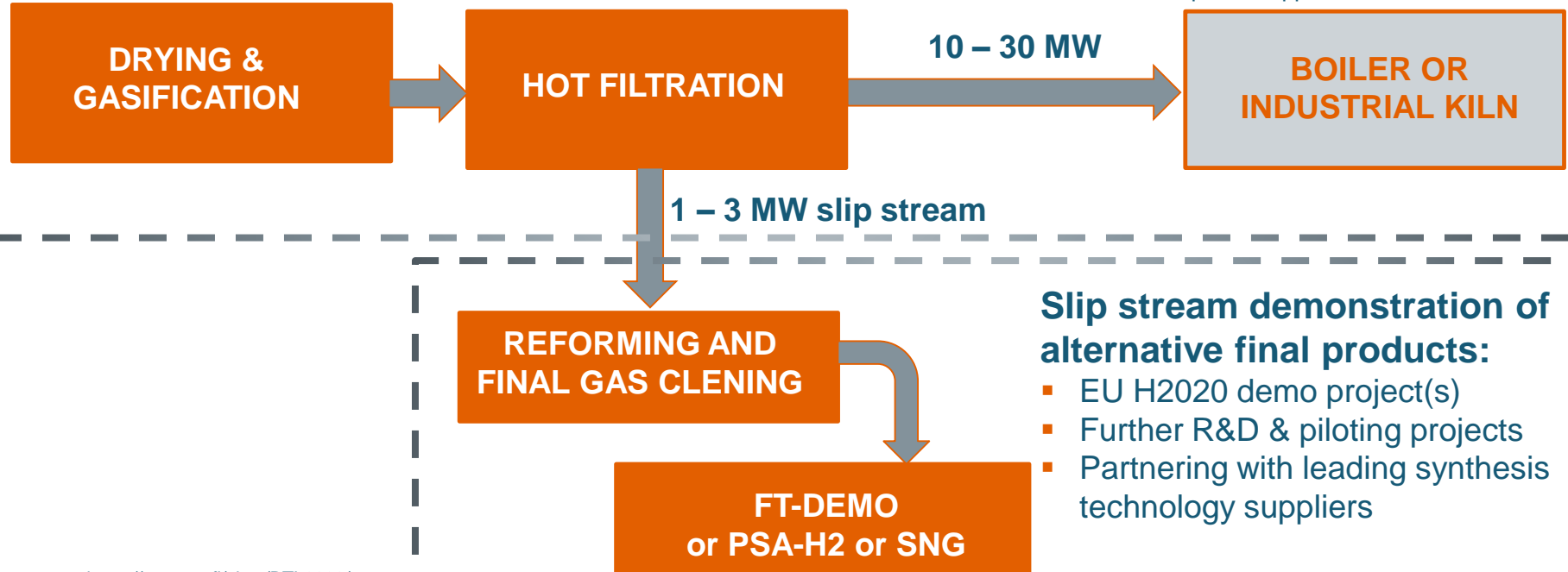
# BTL2030-project – Case A: Industrial slip stream demo

(required budget 50-60 M€ - part of which would be commercial fuel gas investment)

## ”Critical demonstrator” in an industrial environment

Low risks: CFB/air-blown gasifier modified to a DFB process

Energy production covers costs after public support for the investment



### Slip stream demonstration of alternative final products:

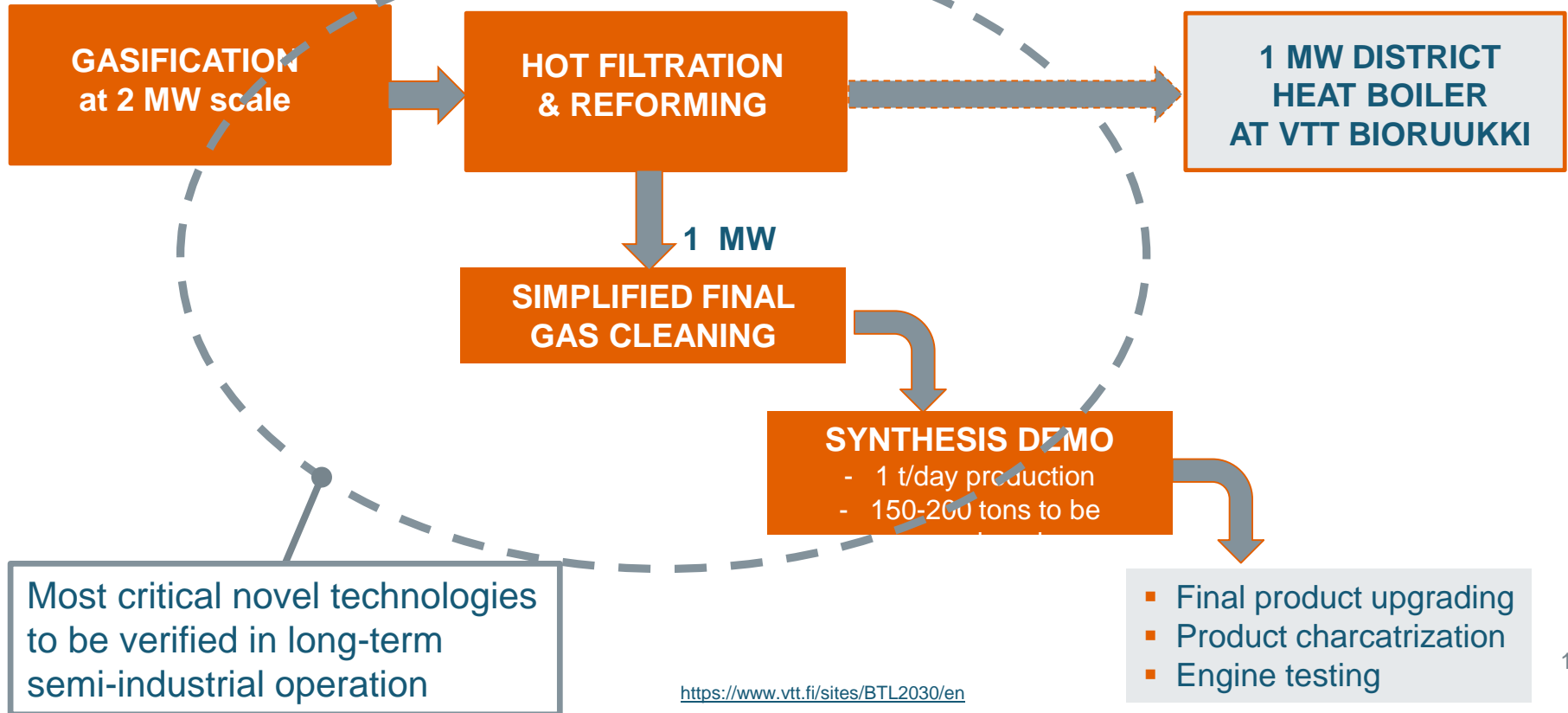
- EU H2020 demo project(s)
- Further R&D & piloting projects
- Partnering with leading synthesis technology suppliers

# How to realize alternative A: industrial slip stream demo

- Main principles of this alternative
  - Industrial fuel gas production pays back part of the investment and enables continuous operation
  - The costs of slip-stream testing of gas cleaning and synthesis technology are reasonable to reduce the risks before entering into flag ship project
  - Different public financing instruments and sources can be applied simultaneously
- Requirements
  - The investor of the primary fuel gas plant exists and has interests also on BTL
  - Other parts of the BTL value chain are also represented by companies who are willing to invest on the project and can foresee profitable business from BTL
- This is most suitable for a large national effort realized by a group of Finland-based companies – on the road in fulfilling national strategy
  - 10-15 M€ investment support (TEM) + 10-15 € from Business Finland or H2020
- Main challenges
  - The interests of the fuel gas investment and BTL demonstration may be controversial thus limiting the scope of demonstration
  - The main investor should also be and important part of the future value chain of BTL

# BTL2030-project – CASE B: Pilot-scale demonstration

## of the complete production chain at VTT (~ 15-25 M€)



# How to realize alternative B: Pilot-scale demo at VTT

- Main ground-braking ideas of this alternative
  - The whole production chain is demonstrated at the smallest realistic scale, which enables continuous operation
  - Small-scale results in reasonable costs (15-25 M€) and enables process optimization and modifications without major economic risks
  - Various feedstock can be tested and a total of 200 tons of products would be produced for final refining tests
- Requirements
  - A suitable group of industrial companies are committed to the project and can foresee profitable business from follow-on industrial BTL projects
  - National funding for a 15 M€ project can be found with 50 % industrial share (in this case the consortium could consist mainly of Finnish companies)
  - EU-IA financing is an alternative way for realizing this alternative with 20 M€ (in this case and European consortium with a max- of 3-5 Finnish partners is needed)
- Main challenges
  - Long continuous operation at VTT Bioruukki would require also external personnel
  - After this project there would still be some risks related to scaling up the processes