Business from technology

Finnish Country Highlights – Biomass Gasification in 2014

IEA Task 33 meeting, KIT Nov2014

Ilkka Hannula

Metsä-Botnia, Joutseno gasification plant for lime kiln

Metso's Gasification Projects

Vaskiluodon Voima – Substituting Coal for Biomass in a PC boiler

- 140 MW_{th} gasifier adjoined to the existing 560 MW coal-fired power plant
- PC boiler in operation since 1982
- Coal consumption 400,000 – 500,000 t/a
- Enables to replace up to 40 percent of coal
- Production capacity
  - electricity 230 MW
  - district heating 170 MW
- Vaskiluodon Voima's total investment ~40 MEUR

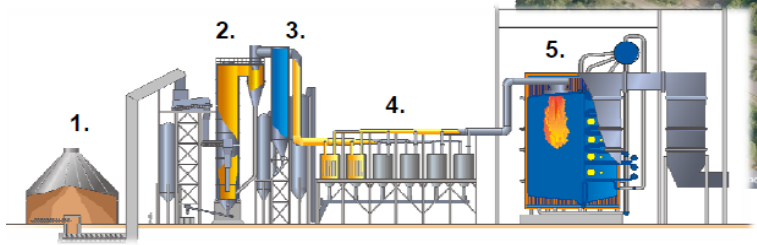
CARBONA AND © Metso metso

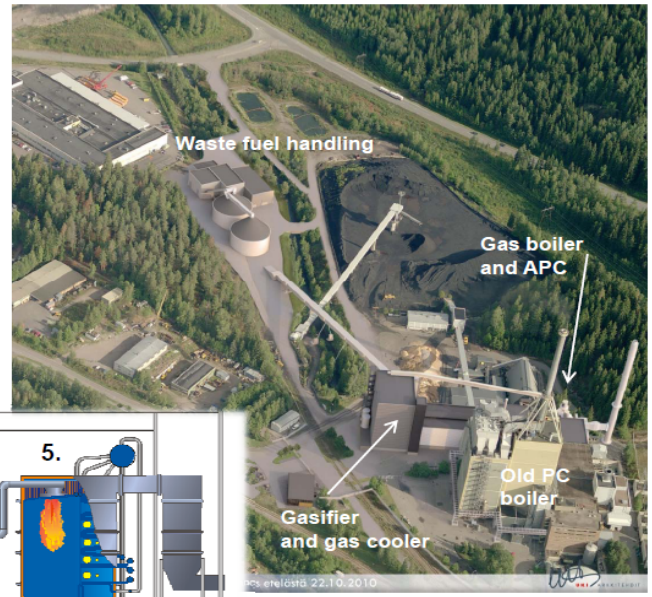
Lahti Energia – Gasification Power Plant

2 x 80 MW_{th} gasifiers
Waste-derived fuel
50 MW_e & 90 MW_{heat}

1. Fuel handling
2. Gasifier
3. Gas cooling
4. Gas filter
5. Gas boiler and flue gas cleaning

Start-up April 2012
Total investment 157 M€



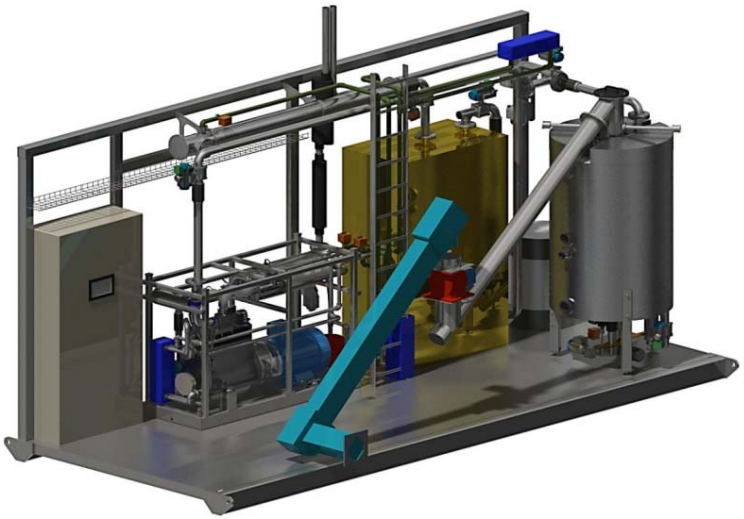


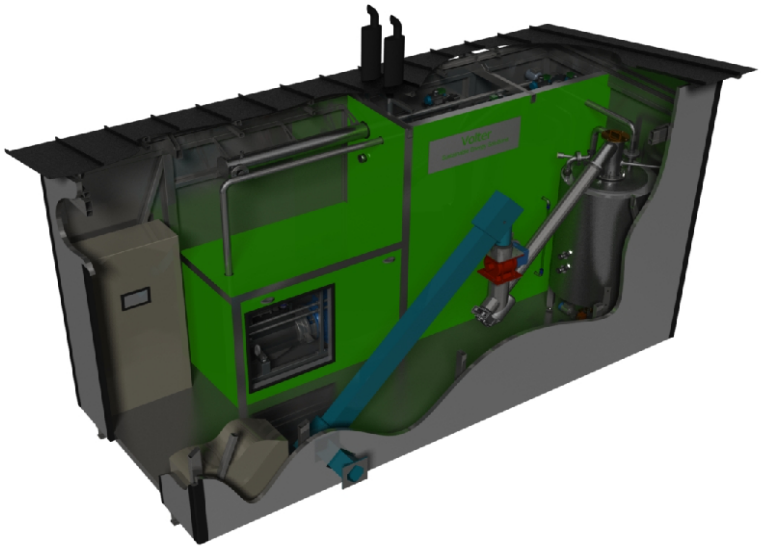
Architecture study of the plant

RECENT PROJECTS:
Biomass and waste gasification for boilers and kilns

metso

VOLTER
I HAVE A CHOICE





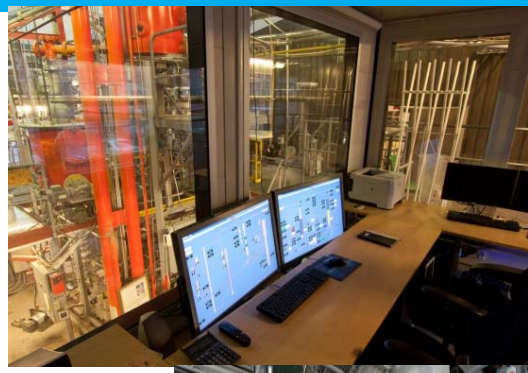
Model:	Volter 30 (40)
Fuel:	Wood chips (birch, spruce, pine, aspen)
Fuel moisture:	<18%
Particle size:	8mm ≤ P ≤ 50mm, fine particles (<3,15mm) <1%, all <63mm
Plant structure:	Steel frame, Insulated with paroc (or similar) panels
Color:	As per agreement
Fuel supply:	Spring agitator, auger, rotating feeder
Generator:	Agco Sisu Power 4,9L, 4-cyl. (8,4L, 6-cyl.)
Output:	Generator output 30kW (40kW), thermal 80kW (100kW)
Plant usage (e):	ca. 1,5-2,5kW
Fuel consumption:	ca. 3,5 m3 (4,5 m3) of chips/24h at 100% power level
Automation:	Schneider electric PLC, GSM –alarms, remote internet control
Connections:	Electricity cable, Heat channel, water line, broadband, GSM-connection
Installation:	Asphalt or concrete base
Ash removal:	Automatic ash removal
Max. o.t./a:	7000h
Maint. interval:	once a week
Other:	

SMALL-SCALE COMBINED HEAT AND POWER

R&D Partners: University of Eastern Finland

- Volter 30
- Installed inside an existing building

RES-Infra: Gasification and Pyrolysis



- VTT will move it's Gasification and Pyrolysis test facilities to an industrial area in Kivenlahti, Espoo
- New pilot plants will also be constructed
- Start-up at new site in Q4/2014-Q1/2015
- Efficient development from laboratory to industrial realization

Horizon 2020-projects, 2015-2020
- Biofuels for transport sector, renewable chemicals
- Fuel gas & pyrolysis oil for CHP and industrial applications
- Waste-to-Energy with material recovery

VTT RES-Infra Investment
New R&D Platform
2013-2015

Industrial projects
- Pyrolysis and gasification R&D
- Testing and piloting services
- Platform for new pilot plants

2G Biofuels R&D and Piloting project
7.2 M€: 2012-14, 2nd phase planned for 2015-16

Pilot/PDU-scale Gasification Test facilities

Intermediate pressure CFB gasification pilot plant (existing test rig)

- Pressure 2-6 bar, fuel capacity max. 0.5 MW, gas flow rate 200 m3n/h
- CFB-gasifier, fluidisation by air/O_2/steam/recycle gas
- High-temperature filter, tar and methane reforming, gas cooling
- Slip stream or full stream testing of final gas clean-up and synthesis processes
- Large-scale synthesis gas applications

Dual fluidised-bed gasification pilot plant DFB (present plant will be modified)

- Fuel capacity max. 300 kW, Air gasification with single gasifier reactor (mainly waste gasification)
- Dual-Bed steam gasification High-temperature filter, tar and methane reforming, gas cooling
- Smaller size syngas applications 50 .. 150 MW to be integrated to forest industries and CHP

Bench-scale gasification and gas cleaning facilities

- Atmospheric-pressure BFB gasifier with hot filtration and catalytic reforming (syngas & fuel gas) - *New*
- Atmospheric-pressure CFB gasifier with hot filtration (fuel gas applications)
- Pressurized BFB gasification reactor for fuel and bed material characterization - *New*
- Pressurized filtration and reforming test facilities (operation with slip streams or with synthetic gas)
- Catalytic conversion R&D laboratory, Fuel reactivity and ash sintering R&D laboratory (at Otaniemi)

High-Pressure BFB gasification PDU (new test facility, to be built in 2015)

- Bubbling Fluidised-Bed gasification, fluidisation by air/O_2/steam/recycle gas
- max. pressure 25 bar, thermal capacity max. 0.5 MW, gas flow rate ca. 200 m3n/h
- High-temperature filter, tar and methane reforming, gas cooling
- Slip stream or full stream testing of final gas clean-up and synthesis processes

Auxiliary equipment

- Gas boiler with two-way connection to DH network of Espoo
- Fuel pretreatment unit, steam generators, compressors, sampling and analytical systems

Pyrolysis Test facilities at Kiviruukki

Fast Pyrolysis CFB Pilot Plant (current PDU to be scaled-up and modified)

- Bio fuel oil test production – fuel for boilers and ovens
- Catalytic fast pyrolysis – feed for hydro-treatment of co-feed to a refinery
- Capacity 350 kg of bio fuel oil or 150 kg of catalytic bio-oil a day, about 100 kW of feed biomass

Fast Pyrolysis BFB Bench-Scale Unit (current bench-unit to be modified)

- Characterization of biomass for fast pyrolysis – base data for mass & energy balances for techno-economic evaluations
- Both inert (Al_2O_3) and catalytic (zeolites) operation – fuel oils and co-feeds for refineries
- Capacity 1 kg/h feed

Batch Unit for Slow Pyrolysis

- Indirect heating of samples
- Volume 100 liter, maximum temperature of heating oven 1100 ºC
- Amount of sample 6 kg, maximum temperature reactor about 550 ºC
- Computer controlled, sampling for solids, liquids and gases

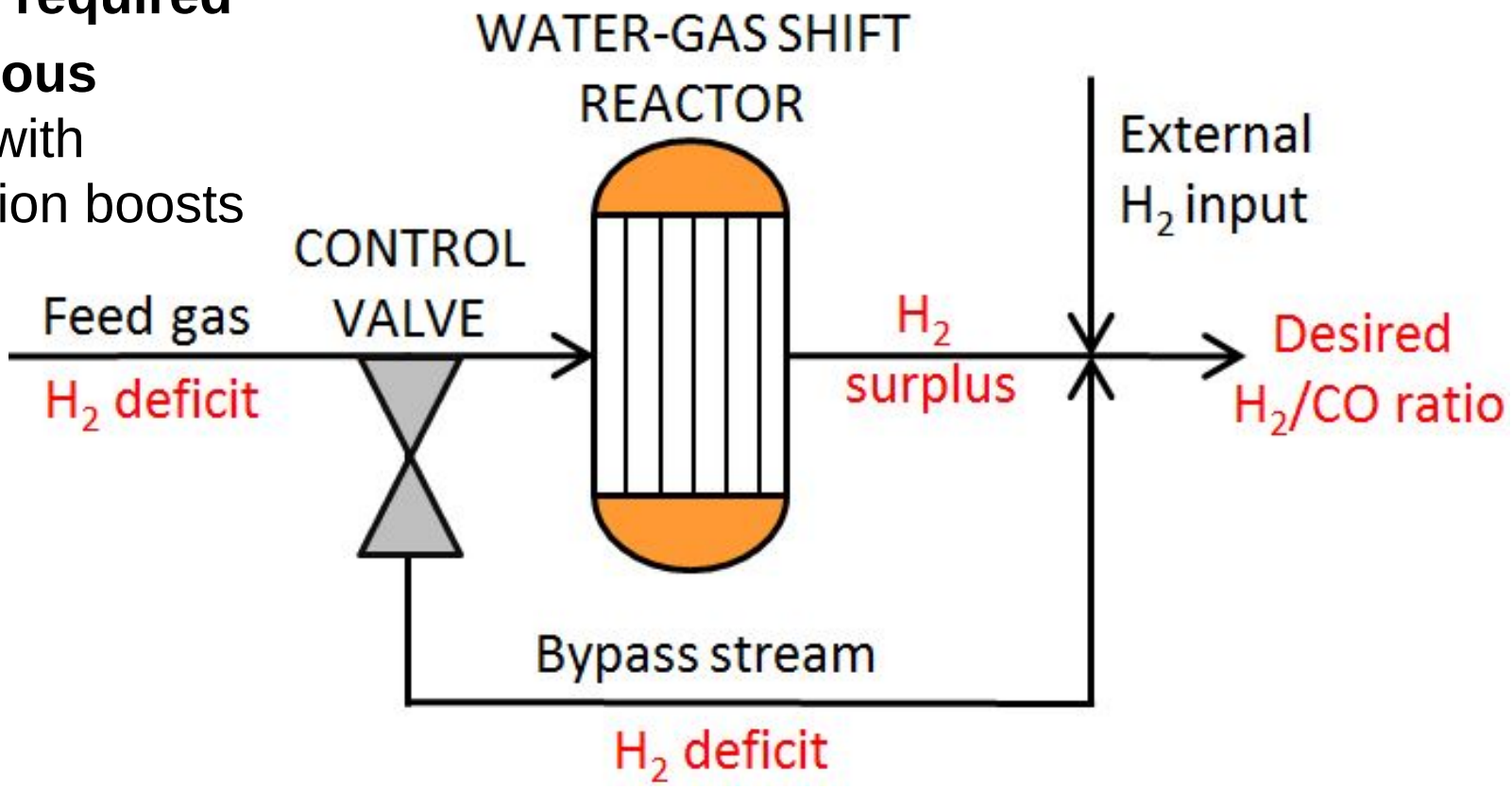
Pyrolysis Bio-Oil Test Rig

- Development of filtration, pumping, heating, homogenization, and for material testing in pilot-scale
- Feed vessel 1 m3, volume flow up to 2 m^3/h

Electrolyser enhanced Biomass to fuels

- Method for **integrating** RE with synthetic biofuels production via electrolytic hydrogen
- Implementation based on commercial components, **no new technologies required**
- Combines **continuous** biofuel production with **periodical** production boosts from RE

Fig1. Configuration suitable for regulating syngas stoichiometry with a combination of water-gas shift and external hydrogen input



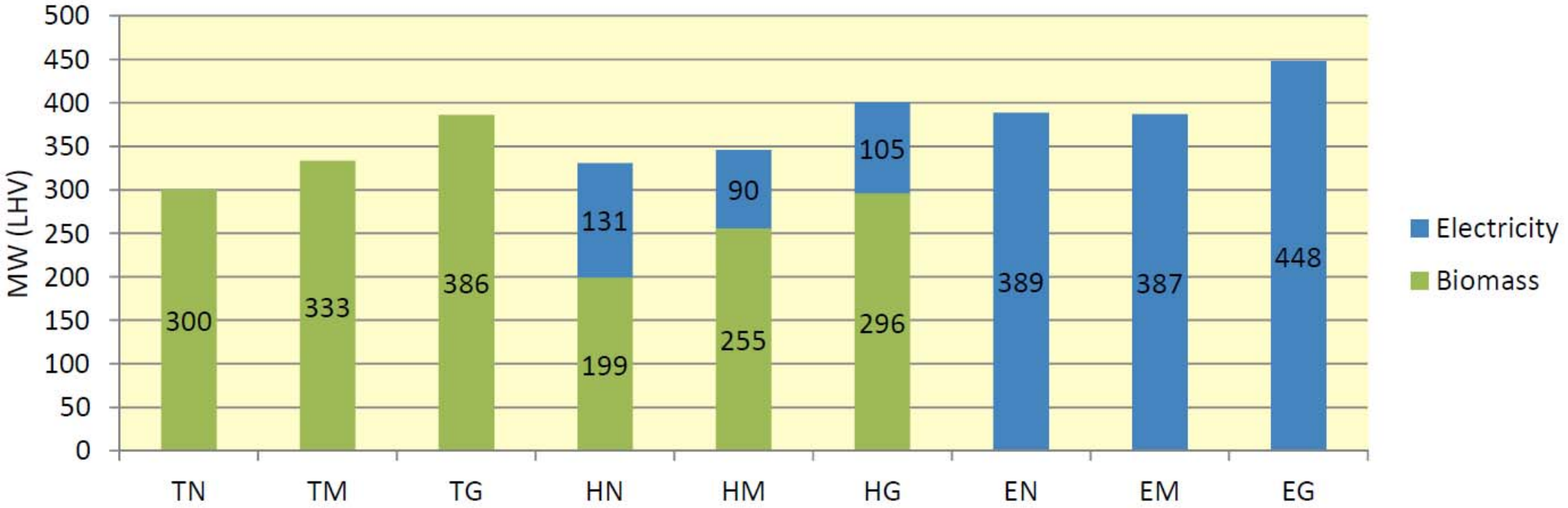


Fig 2. Feedstock requirements for a plant producing 200 MW of synthetic fuel: T=thermochem, E=electrochem. H=hybrid, N=natgas, M=MeOH, G=gasoline

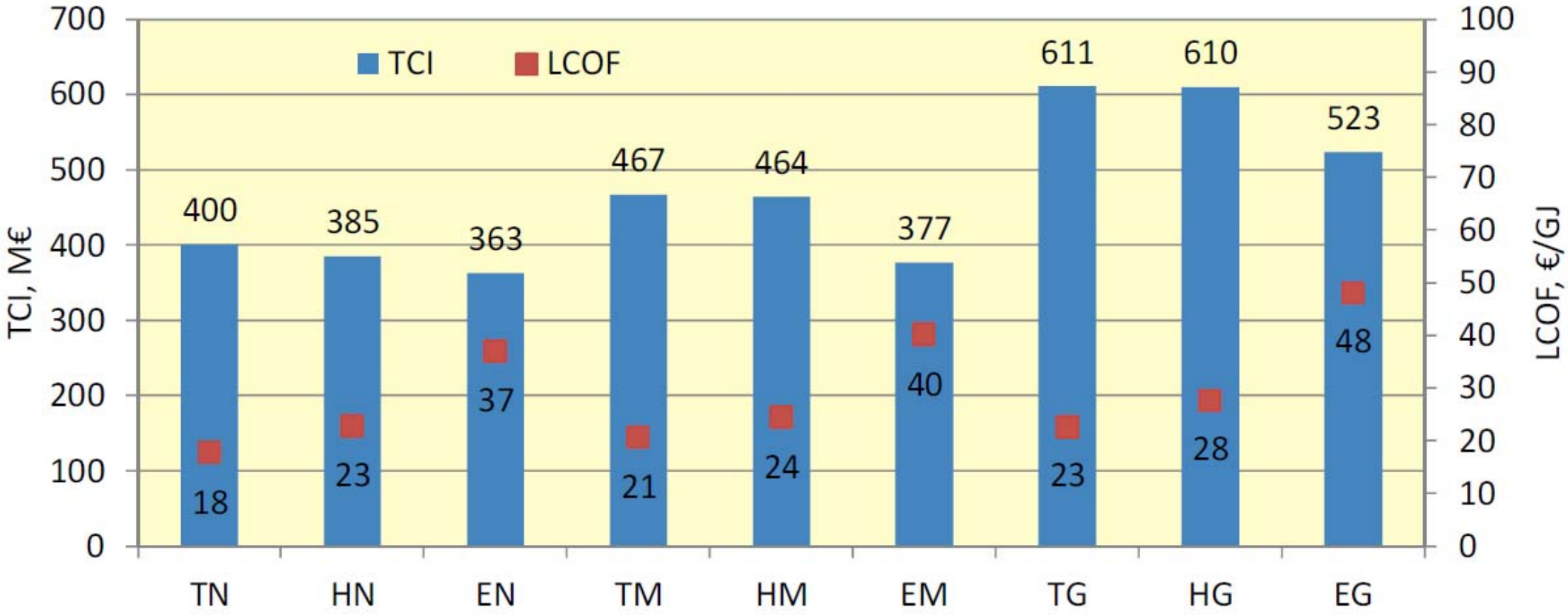


Fig 3. Investment estimate and lev. production cost for a plant producing 200 MW of synthetic fuel: T=thermochem, E=electrochem. H=hybrid, N=natgas, M=MeOH, G=gasoline

Thanks – Kiitos!

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