

Pyrolysis oil as bioliquid for balancing the grid

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Major trends

- Growth of renewable energy
- Decentralisation of energy production
- Energy efficiency: utilisation of heat
- Circular economy / blue economy
- Energy storage
- Interconnectivity
- Power to the people

Situation

- Wind & solar creates imbalance of the grid
- Existing grids not fit for significant share of renewable energy
- Bioliquids can provide energy on demand
- Power and/or heat (storage for both needed)
- Rebalancing saves costs
- Small scale/local & large scale

Options with bioliquids

- 1G bioliquids
- 2G bioliquids
- Pyrolysis oil (PO) taken as 2G bioliquids

Commercial scale demonstration of fast pyrolysis technology





Options with pyrolysis oil

- For peak load and/or base load; heat and/or power
- (Partial) replacement of natural gas in a natural gas fired boiler (FrieslandCampina case). Up to 70% replacement; 30 MWth.
- (Partial) replacement in a medium scale gas turbine; 50 MWe
- Small scale gas turbines: (1,9 MWe/4,5 MWth); 100% on pyrolysis oil
- Diesel on 100% crude pyrolysis oil; MWe-scale

Examples of storage

- Small example: WakaWaka (Light/Base10)
- Tesla battery
- NEDAP PowerRouter
- Hydrogen
- Water
- Pyrolysis oil
- Etc.

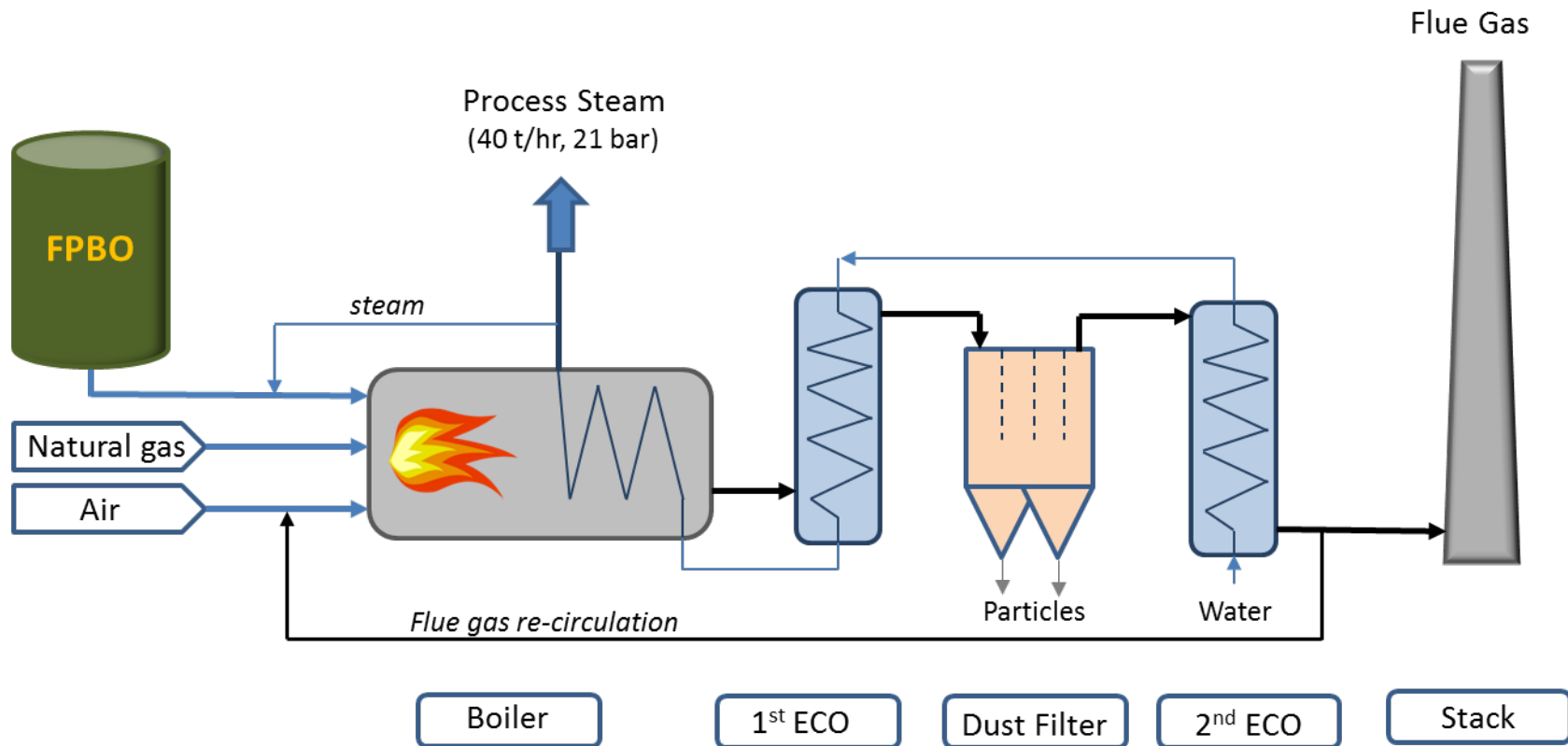
Pyrolysis oil for industrial heat (base load)

- ☐ Pyrolysis oil will be co-fired with natural gas producing process steam.
- ☐ New natural gas fired steam boiler has been designed suitable to co-fire pyrolysis oil (Stork Industrial Services & Kaisec);



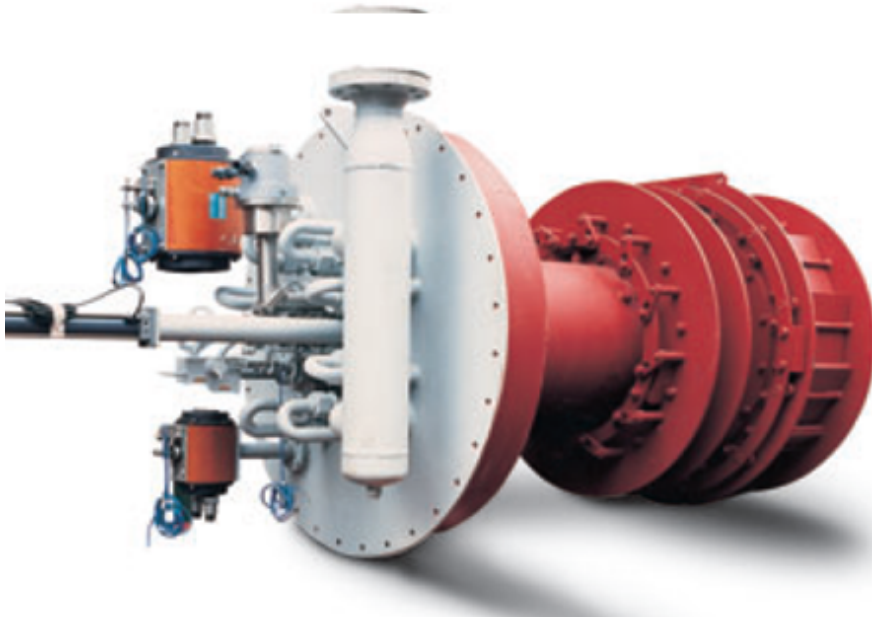
- Global dairy company
 - Major launching customer for pyrolysis oil
 - Process steam used in milk powder process
- ☐ Pyrolysis oil off-take agreement concluded for a period of 12 years (equivalent to ~ 200 million litres)
- ☐ Annual saving of 10 million m³ of natural gas
- ☐ Up to 70% replacement of natural gas
- ☐ Always 100% back-up possible with natural gas (= guaranteed steam supply)

Pyrolysis oil for industrial heat



Schematic drawing of Process Steam Boiler at FrieslandCampina (NL)

Commercially available burners for PO

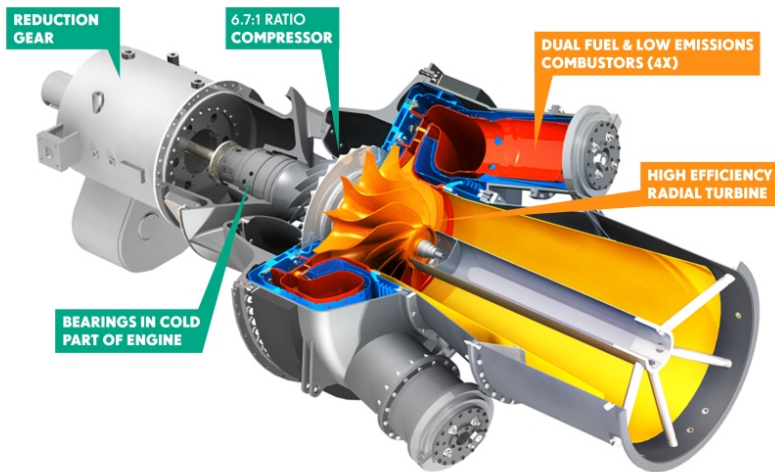


Double register burner of Stork



» Dreizler, hollow flame burner

Small scale gas turbines for PO



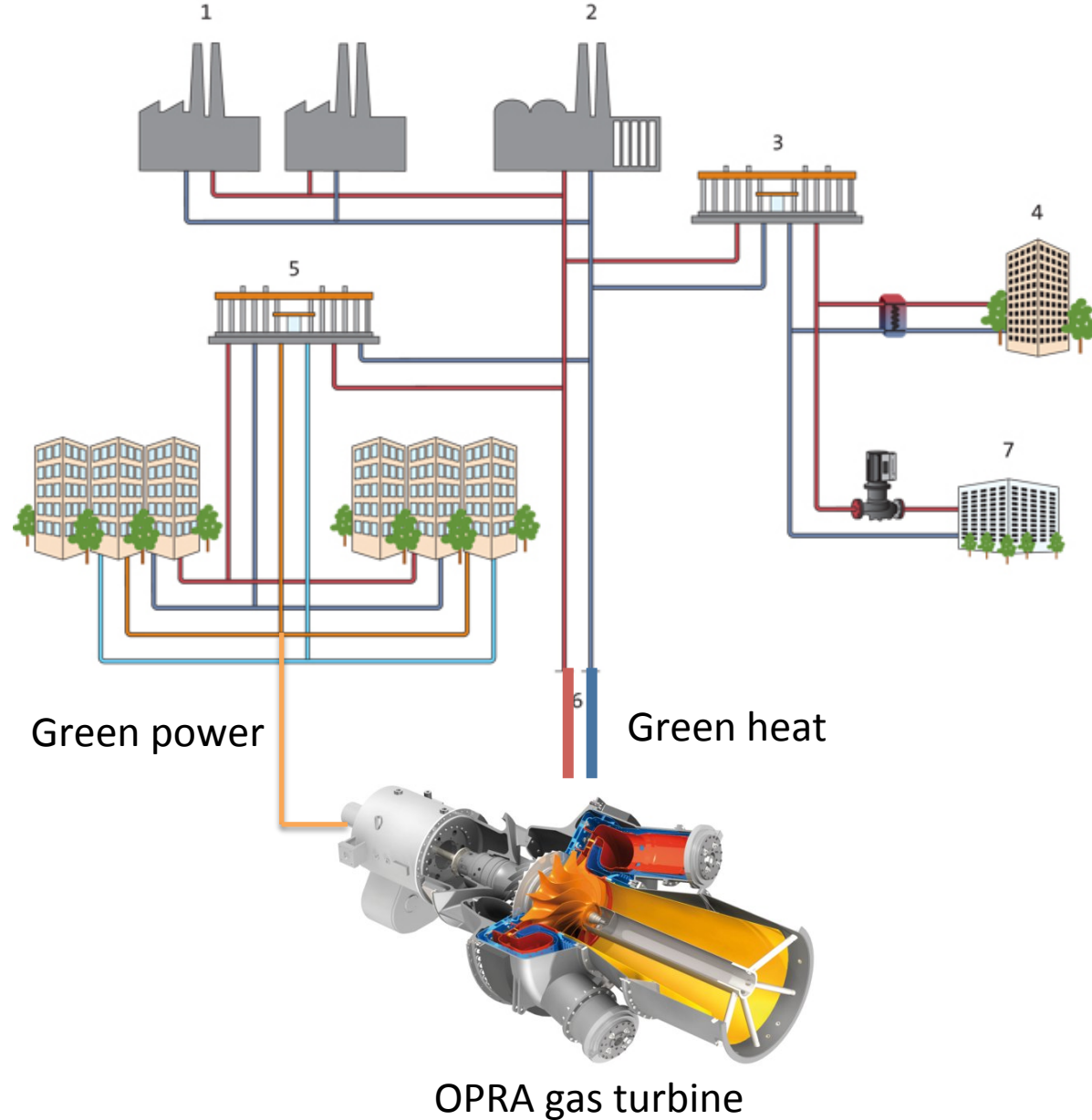
1.9MW OP16 GAS TURBINE ENGINE

Commercially available small scale gas turbine for PO

Potential off-takers for gas turbines include district heating grids.

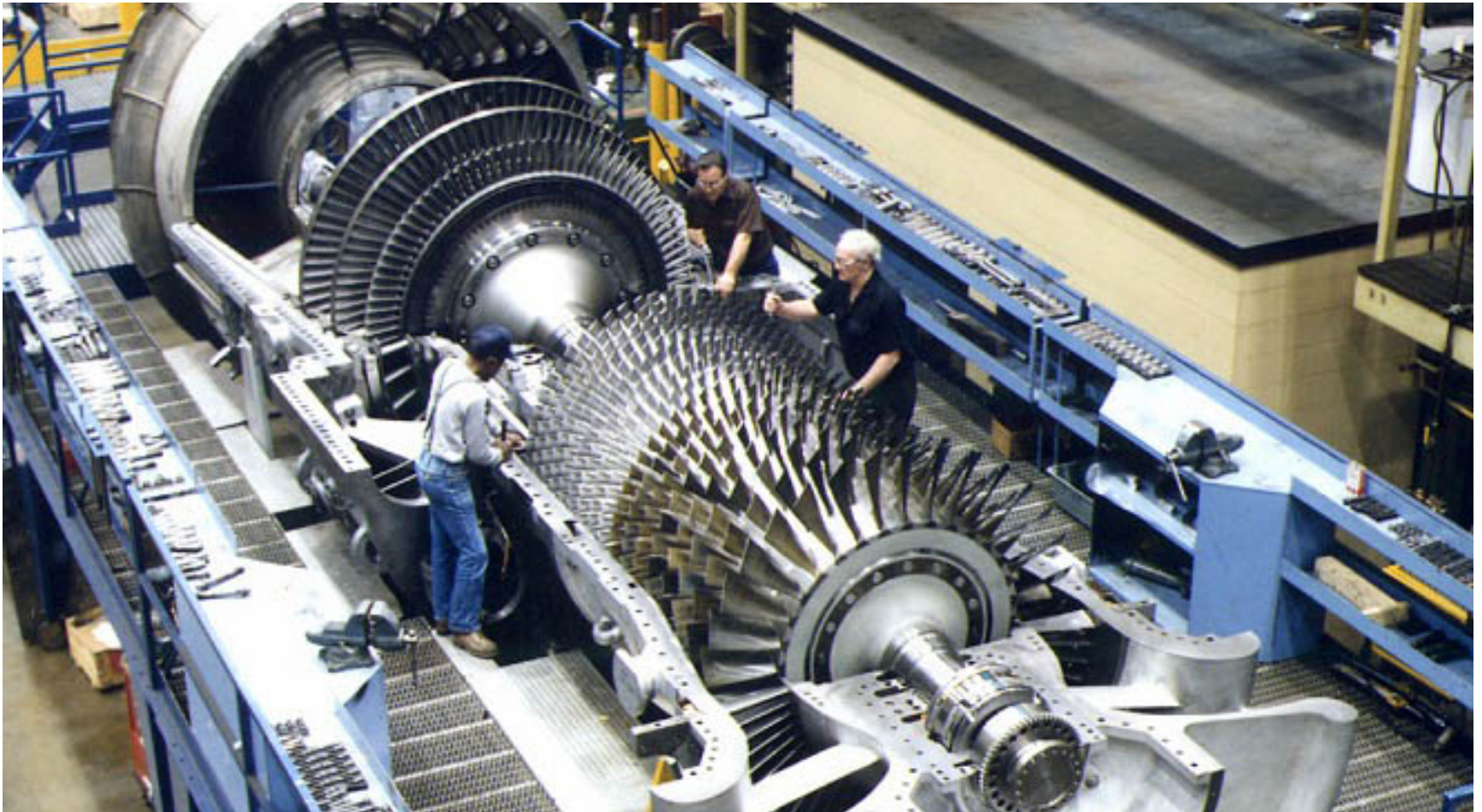
The business case for two turbines must then be based on selling to the district heating/power grid:

27.200 MWh electric power
+ 68.000 MWh heat

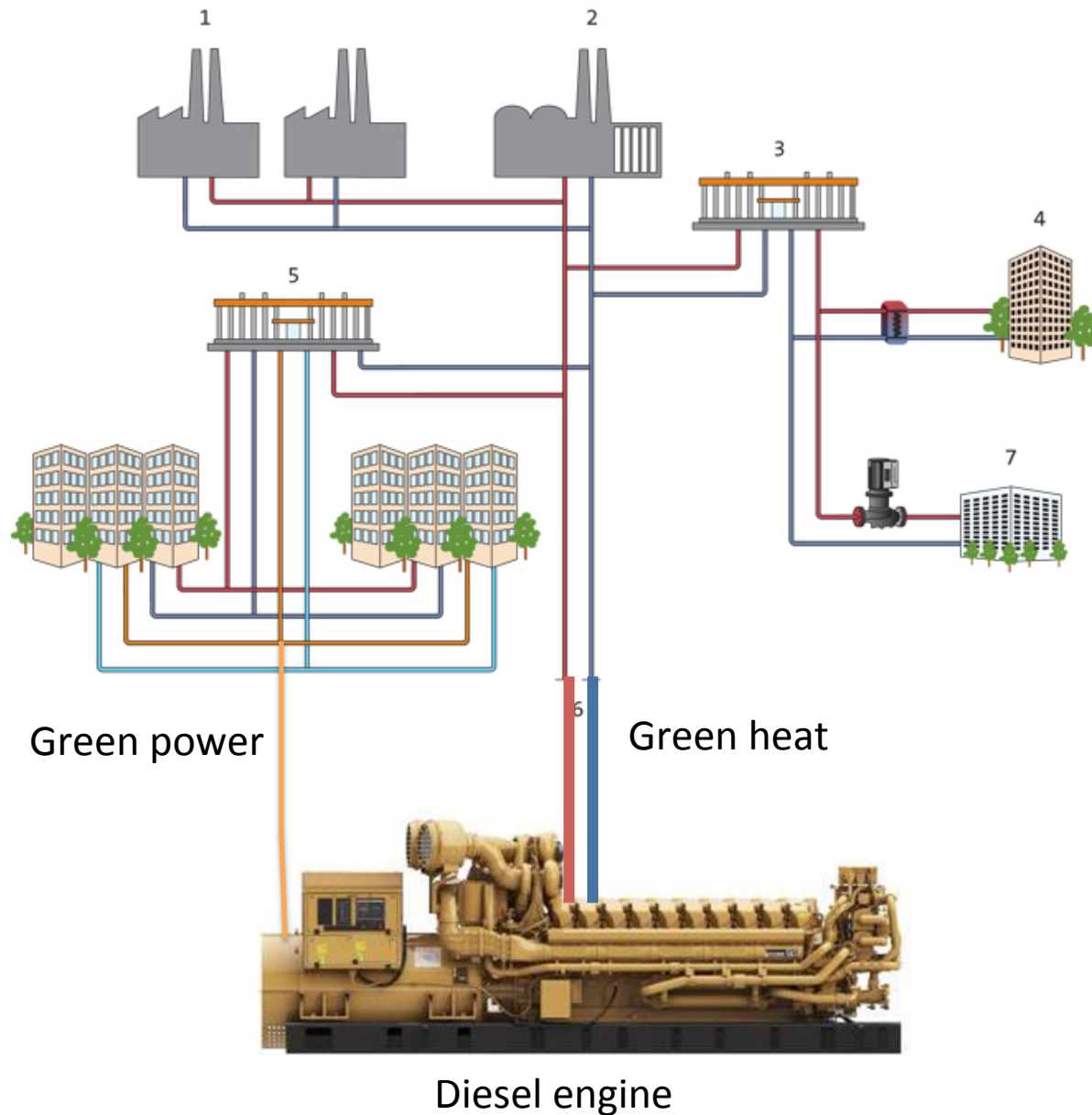


Medium scale gas turbines

(to be adapted for pyrolysis oil)



Diesel engines for PO (under development)



Diesel engine for PO (RTD last 4 yrs at BTG)

Basis: JIANG DONG Engine

Model	ZH1130
	1-cylinder
Piston displacement:	1,592 ml
Compression ratio:	17,6
Output:	23,5 kW (2,200 rpm)
Injection pressure:	200 – 250 bar
Fuel consumption:	240g/kW _e (diesel)
Generator output:	Max. 10 kW _e



Next phase: 4 cylinder diesel engine for PO (small scale; under development at BTG)

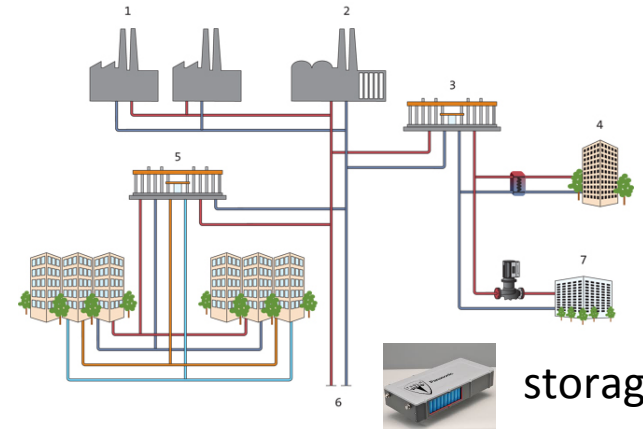
- System under construction
- Max power output = 48 kWe
- Turbo-charged
- 1,500 rpm
- Compression ratio = 18



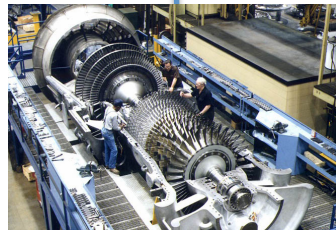
Balancing the system



storage

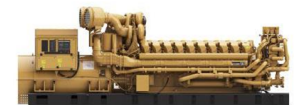


storage



medium scale

peak capacity



small scale



storage of pyrolysis oil



Future programme(s)

- Solar & wind & BioCHP & storage & smart grid
- Pilot project(s): step by step
- Experience to be built up
- Both small scale and large scale (consumers, SMEs, industry)
- Right ecosystem(s) to be developed
- SMEs, civilians and local governments will push forward and implement; established powers may provide resistance as it will take time to adapt and refocus