Siemens Energy

Gasturbiner som grön balanskraft

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Globalization

Urbanization

Demographic change

Climate change

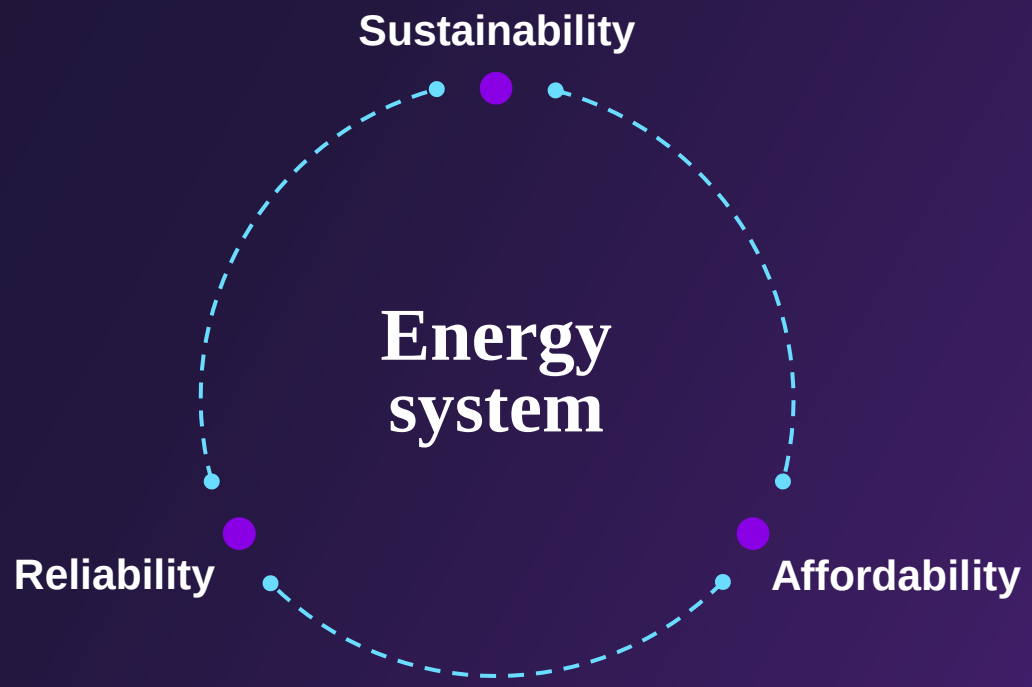
Digitalization

are drastically changing our environment.

At the same time,
we expect a 25% increase
in global energy demand by 2040.

This will present
enormous challenges
for the environment.

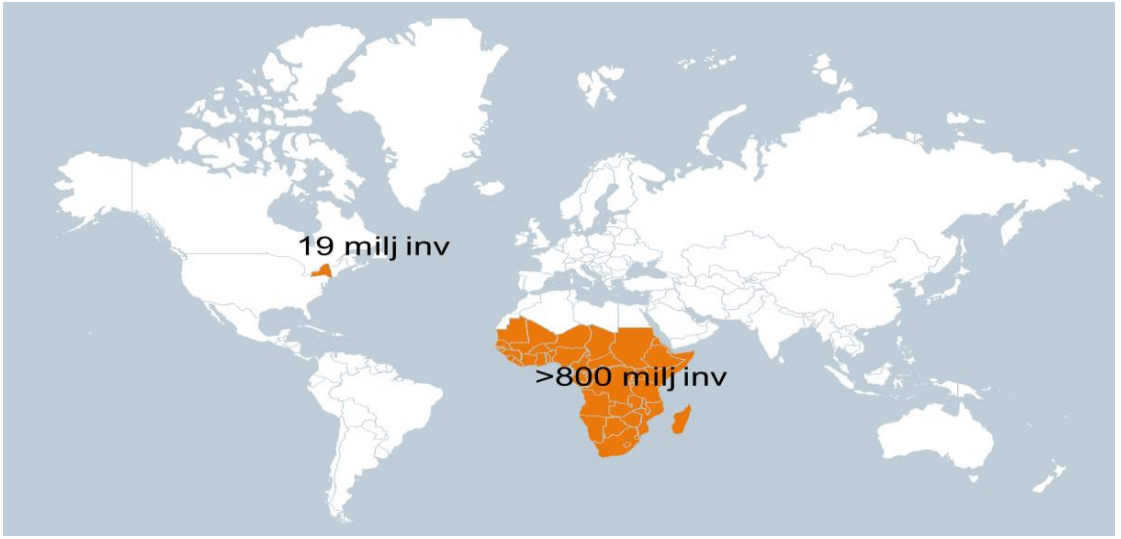
In this challenging environment, the world needs sustainable, affordable and reliable energy – and we are the ones who can provide solutions.



Brist på el är direkt sammankopplat med fattigdom

El är viktigt ur många perspektiv

- Rent vatten och sanitär utrustning
- Säkerhet, trygghet och jämlikhet
- Utbildning – både på skoltid och för läxläsning
- Matlagning, uppvärmning av bostäder
- Arbete och inkomster
- Minskad miljöbelastning

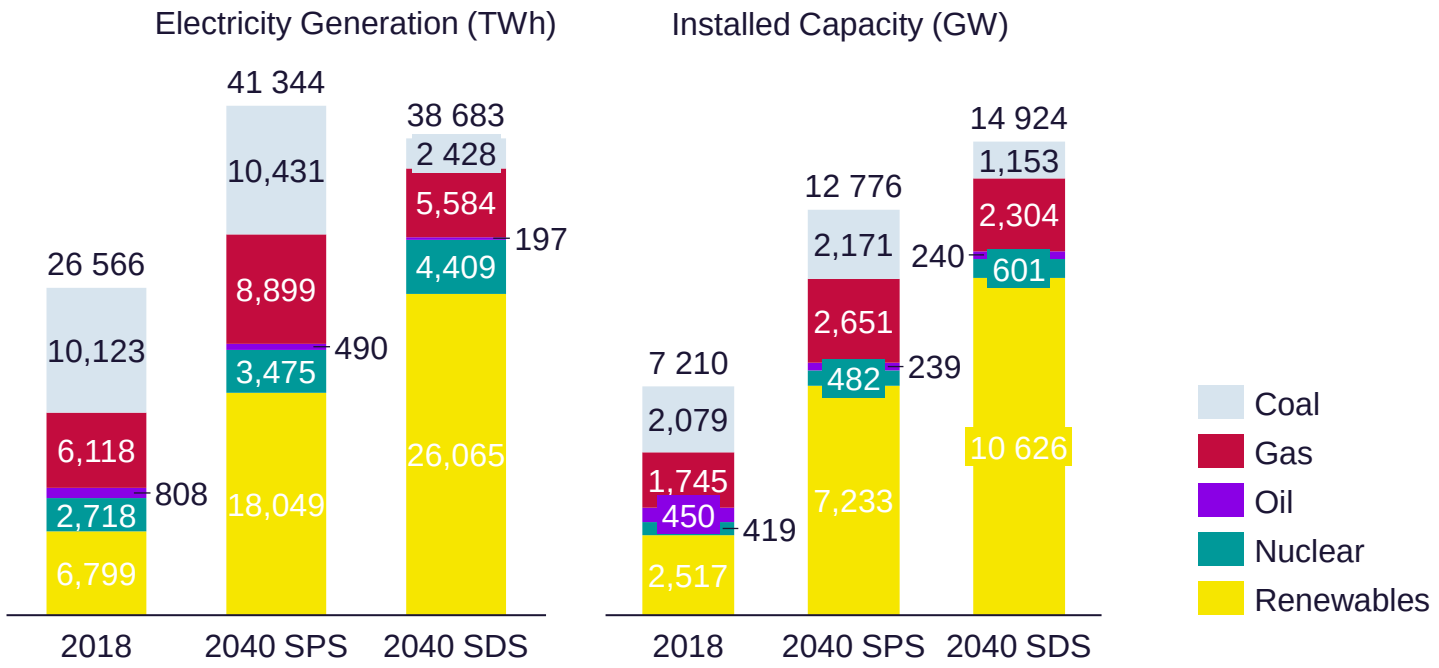


Afrikas energikonsumtion söder om Sahara motsvarar den i New York State

- 7 av 10 saknar tillgång till el
- 30% av vårdcentralerna och mer än en tredjedel av skolorna saknar el
- 8 av 10 invånare värmer sina hus och lagar sin mat över öppen eld

Afrika är dock rikt på energiresurser, inte minst naturgas
Stora investeringar görs för att elektrifiera Afrika

Electricity generation today and in the future



The **Stated Policies Scenario(SPS)** (previously called New Policies Scenario) provides a measured assessment of where today's policy frameworks and ambitions, together with the continued evolution of known technologies, might take the energy sector in the coming decades
The **Sustainable Development Scenario (SDS)** is fully aligned with the Paris Agreement's goal of holding the increase in the global average temperature to "well below 2 °C". It also includes the goal to achieve universal access to modern energy by 2030, and to dramatically reduce the premature deaths due to energy-related air pollution.

Source: IEA World Energy Outlook 2019

The road ahead for CO2 reduction in gas turbines

Siemens Energy prepare technical solutions

- Efficiency upgrades
- Flexibility
- Technical solutions for green fuels

Co-operation with Customers for references and implementation

AGENDA 2030

New regulations by policy makers

Government policies will shape the long-term future for energy

Subsidies for green fuels & CO_2 reduction

Acceleration of the supply of green fuels

Switching from coal to gas

- Coal-to-gas switching reduces Greenhouse Gas Emissions by 50% on the average when producing electricity (including combustion and indirect emissions).[1]
- In the U.S., the transition from coal to natural gas has been the major source of decrease of CO_2 the last 10 years. The contribution has been 50% more than Solar and Wind together.[2]
- Switching from coal to gas will also make a significant contribution to improved air quality (nitrogen oxides, sulphur dioxide and particles).
- IEA estimates that up to 1.2 gigatonnes of CO_2 could be abated in the short term by switching from coal to existing gas-fired plants, if relative prices and regulation are supportive. Doing so would bring down global power sector emissions by close to 10%.

2 x SGT-800 Combined Cycle Plant supplying electricity and heat for City of Holland, U.S.A, replacing an old coal fired plant

- 50% CO_2 reduction
- Radical emission reductions of nitrogen oxides, sulphur dioxide and particles

Coal-to-gas switching reduces Greenhouse Gas emissions by 50% on the average, and can make a significant contribution to reaching the emission targets

1) Emissions from production, processing and transportation (incl. Methane) . Source: IEA, the Role of Gas in Today's Energy Transitions, p.4
2) Carbon Brief 3) IEA WEO p.490, Center for Liquified Natrual Gas

Sweden
-Agile and early adopter in the Energy Sector

- High level of innovation and investments currently underway
  - Wind & PV Solar (complementing Hydro &Nuclear)
  - Forest based Biofuels (Sweden is the second largest exporter in the world of pulp, paper and sawn wood)
  - Hydrogen, push to decarbonize industries, e.g. Steel Mills (“Hybrit”)
- Climate Neutral by 2045

Nytt bolag bildat
Börsintro Frankfurt 1/10

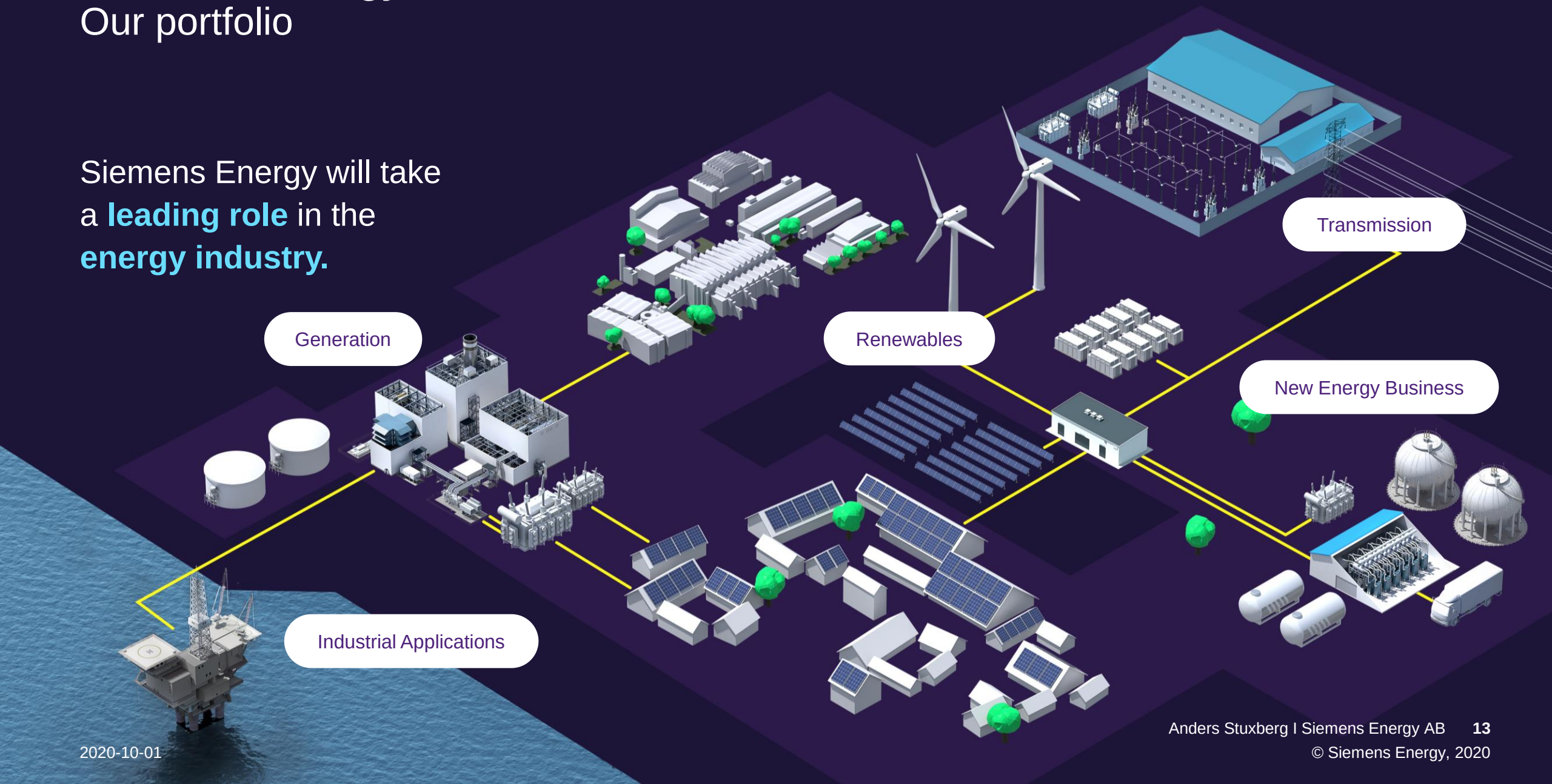
SIEMENS energy

- Split från Siemens AG
- Tydlig inriktning på energisektor
- Global närvaro
- Ca 90 000 anställda

Daily life is different

The entire energy value chain
Our portfolio

Siemens Energy will take a **leading role** in the **energy industry.**



The world needs sustainable, affordable and reliable energy

We meet this need

- with major location in Finspong
- 52 100 Shop floor area (m^2)
- 200 tons crane capacity
- 3 Engine test bays
- 5 string test beds
- 45 min to export port - purpose made road

- 2700 Siemens Energy employees of which
  - 75 different nationalities
  - 78% Male/ 22% Female
  - 33% with University degree
    - majority holds a Master
  - 300 R&D resources
    - 200 in IGT & 100 in Service

1000

With over 100 years experience

- ~ 1,000 gas turbines
- ~ 2,300 steam turbines
- ~ 50 power plants
- ~ 50 delivered heat pumps

70%

of service relevant fleet with customer agreements worldwide for up to ~25 years

10 BSEK

- 10 BSEK in revenue
- 90% exported to 115 countries
  - whereof 60-90% outside EU
  - 1-2 % of Swedish Export outside EU

Broad range of global applications

CO_2 reduction

Holland Park
Coal to Gas transition

Johan Castberg
Compression - FPSO

Estrella del Mar III
Clean energy to 1Mio. residentials

Heat & Power

Sochinskaya TES
Heat & Power for winter Olympics

DOW Stade
Process steam for Chemical Industry

Amata B.Grimm
Primary Energy Savings

Stability & Peak

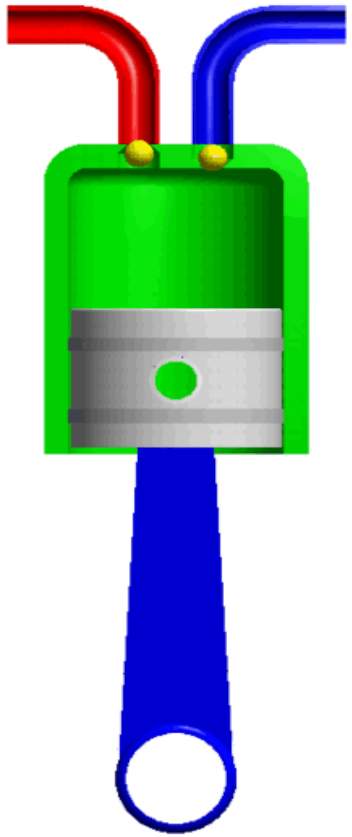
Ubungo
Providing sustainable, affordable and reliable energy

Brestanica
Fast start back-up for Nuclear plant

Hassi R'mel
Combined Cycle of natural gas and solar power

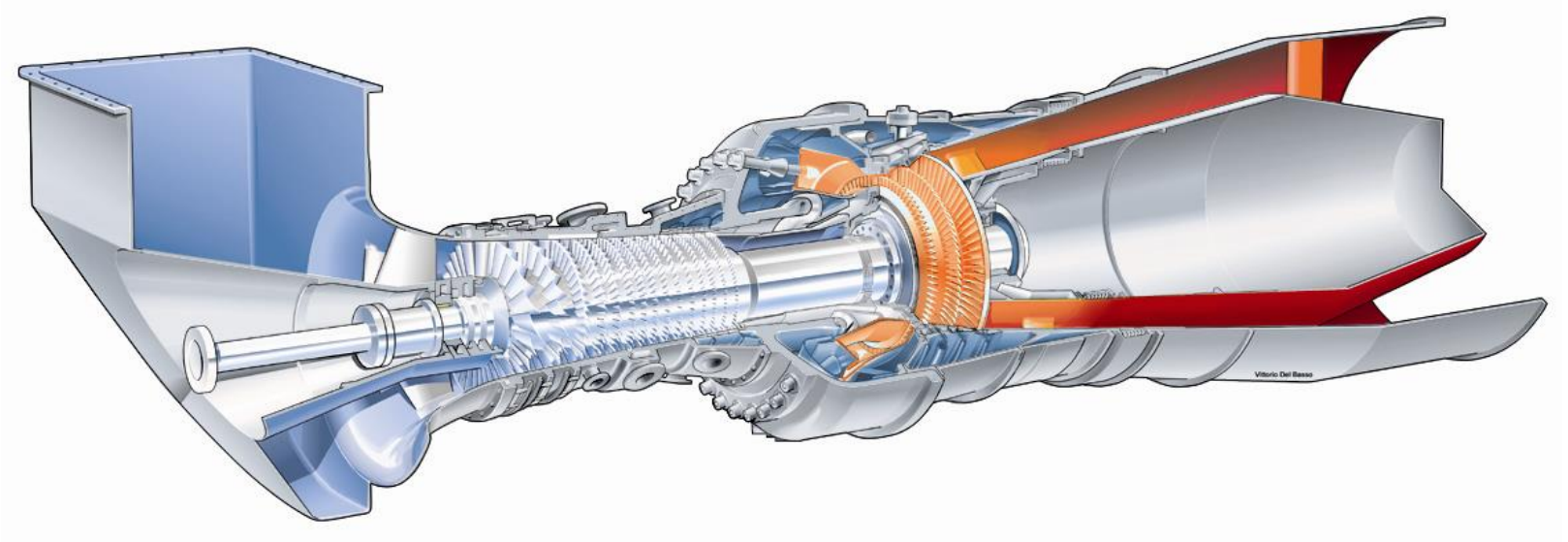
Combustion Engine principle

- Air intake
- Compress
- Burn
- Expand
- Reject exhaust



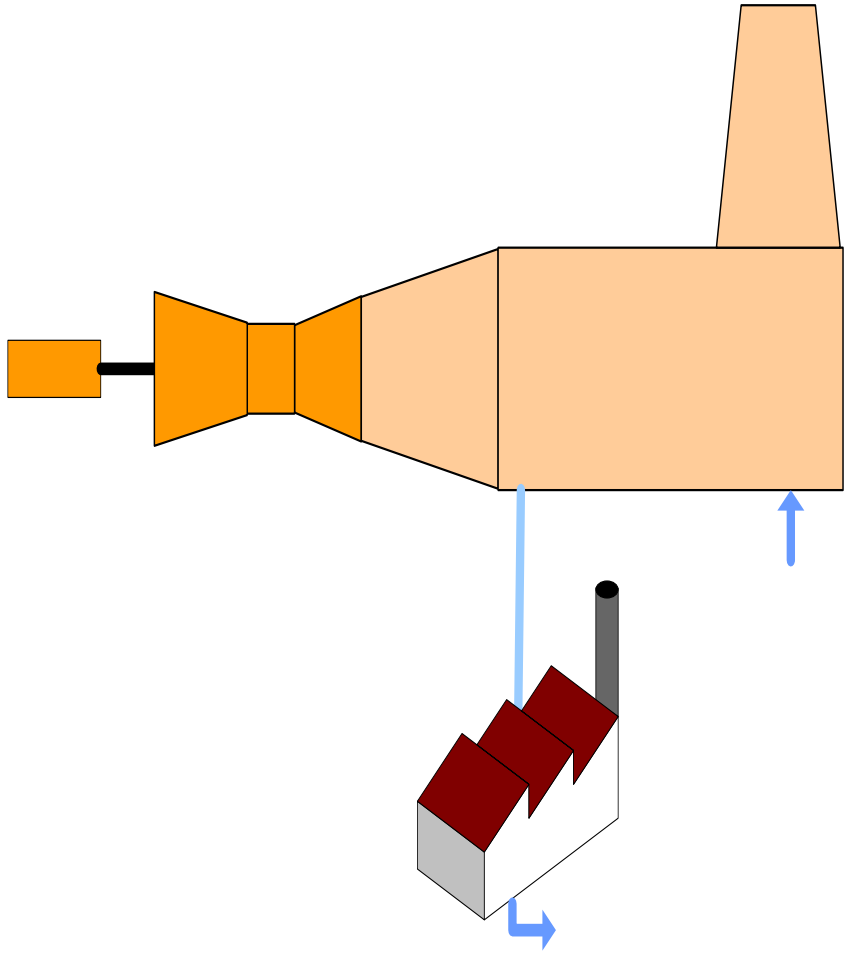
Gas Turbine principle (Brayton cycle)

- Working media = combustion air = GAS
- High temperature level for added and rejected heat
- High specific power (both volume and cost-vise)
- Efficiency 40%



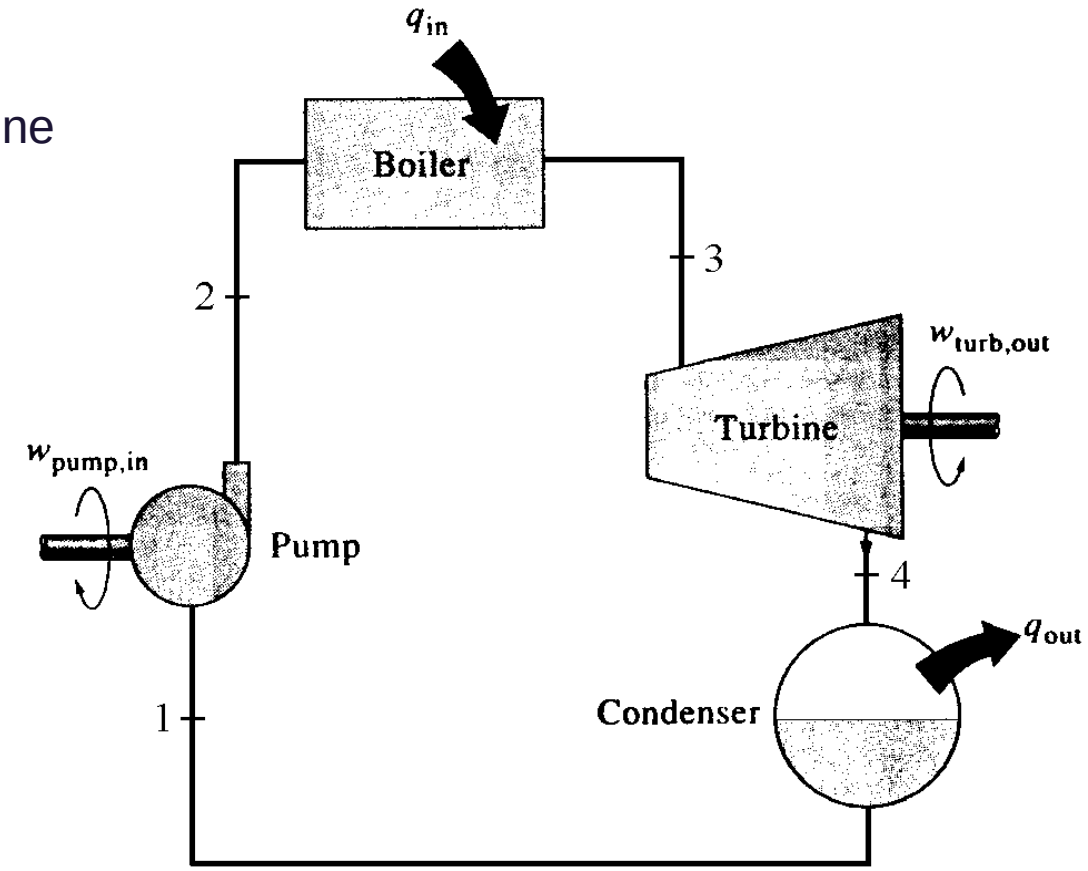
Industrial Power Plant Solutions
Plant configurations – SSC-X00 Cogen

- COGEN / CHP (Combined Heat and Power)
- El + processånga eller hetolja / hetvatten
- Högt bränsleutnyttjande, totalverkningsgrad 85 – 90%
- Vid små anläggningar eller anpassning till begränsat elbehov och stort värmebehov



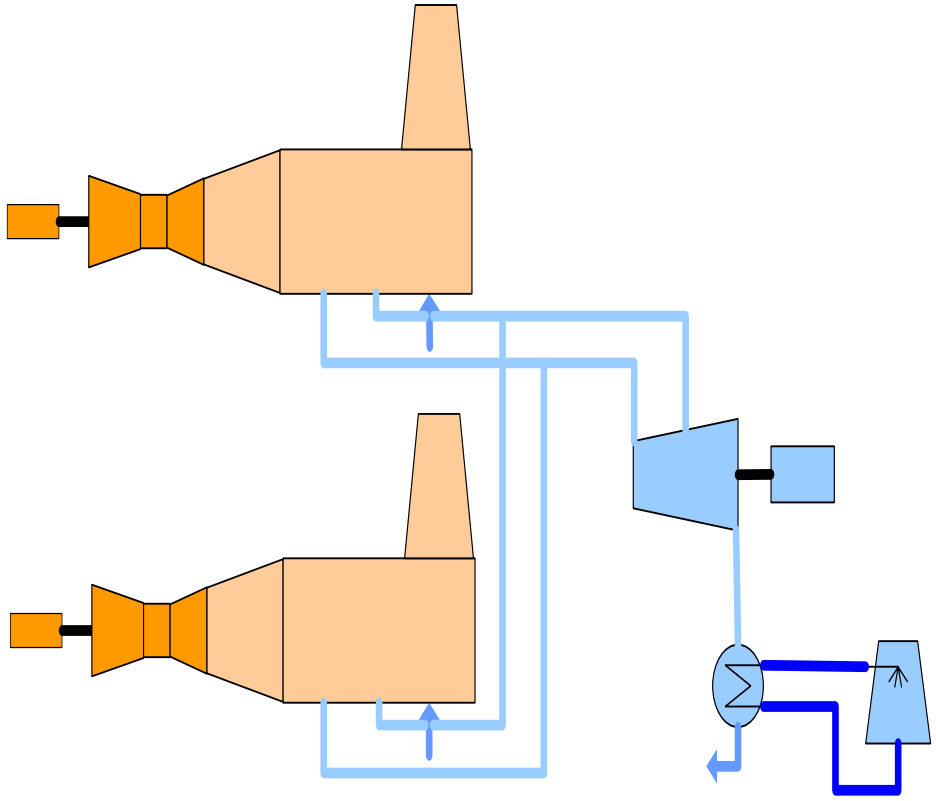
Steam Cycle (Rankine Cycle)

- Uses phase change to provide working media to turbine
- Limited working temperature, due to transfer of heat through material
- Large spec. volume & cost
- Efficiency 30%



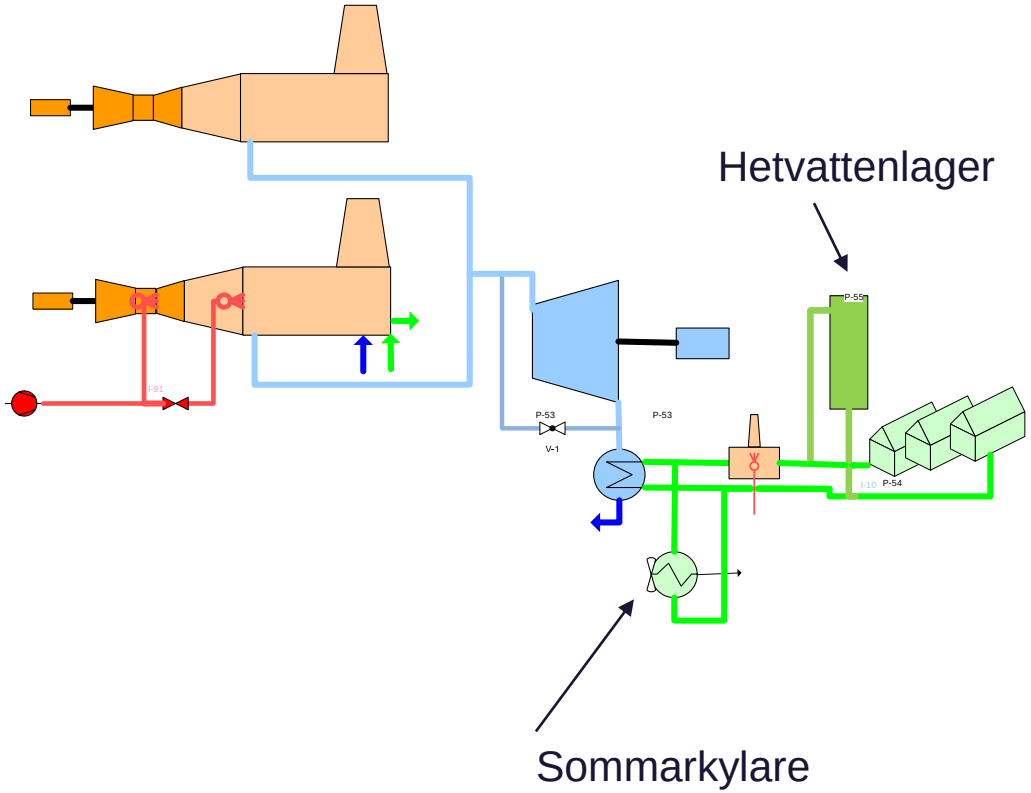
Condensing Combined Cycle
2x1 C

- Elverkningsgrad upp till 60%
- Traditionellt baslast men kan göras mkt flexibel
- Ofta stora anläggningar för skalfördel
- Fördel att begränsa storlek på största generator → multishaft
- Ny tendens – “distributed generation”



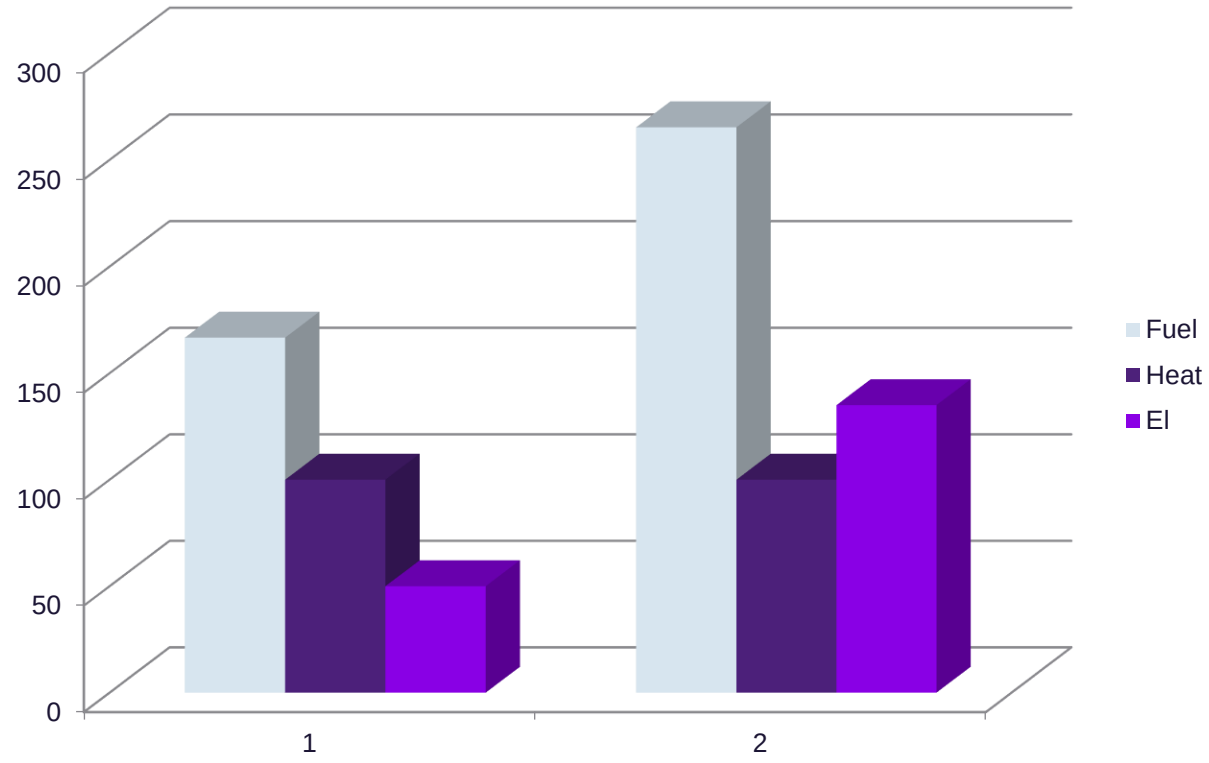
Combi-COGEN / CHP / mottryck

- Industriell eller fjärrvärme
- Både hög elverkningsgrad och hög totalverkningsgrad
- Ger > 100% mer el per givet värmeunderlag än enkel COGEN “alfa-värde” > 1
- Normal lösning om anläggning stor nog och det finns avsättning för el
- Frikoppla el och värmeproduktion med:
  - Avtappningar + kall kondensor
  - “Sommarkylare”
  - Ackumulatortank
  - Spetspanna



Alternative Math
Why efficiency is so important in cogen plants

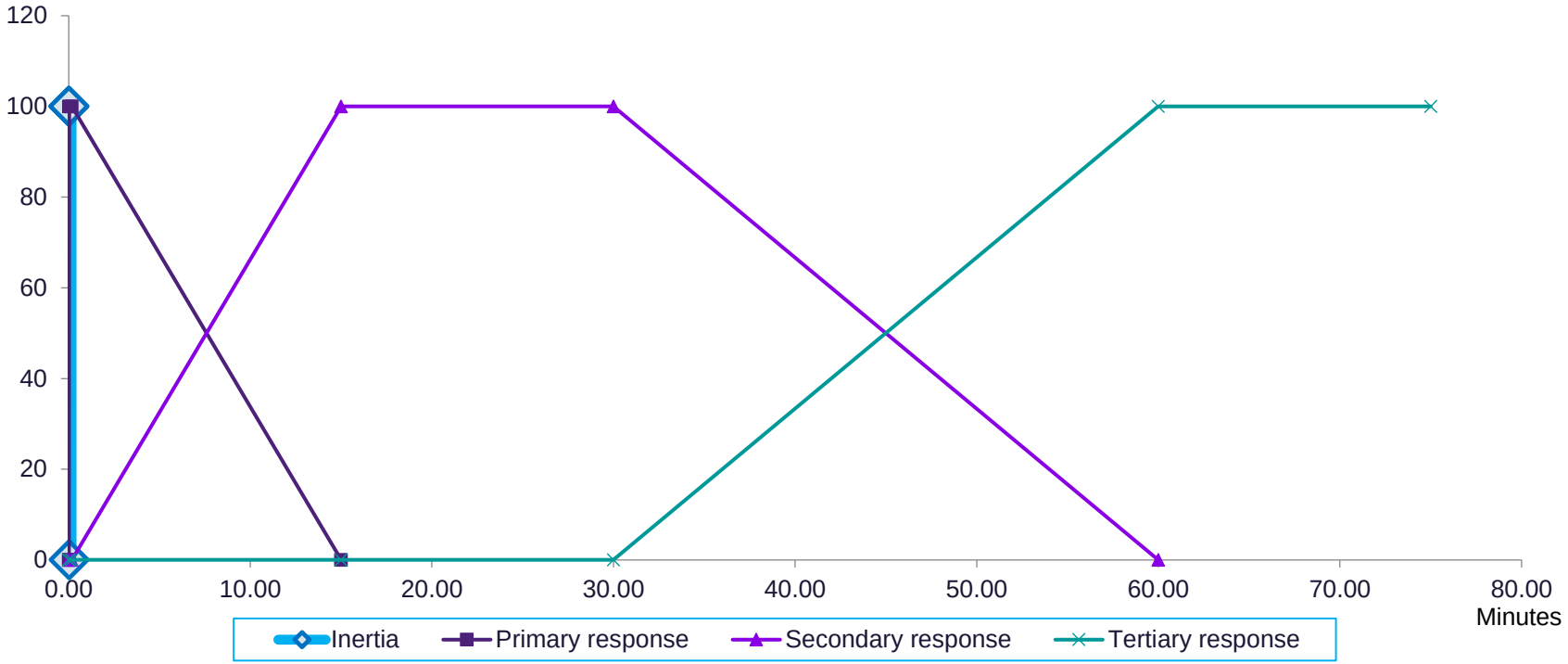
- 30% to 51% = +170%
- Electric efficiency 86%
- High dispatch from cogen
- Electric efficiency thus much more important in cogen than in condensing plants



167 MW fuel
100 MW heat
50 MW El

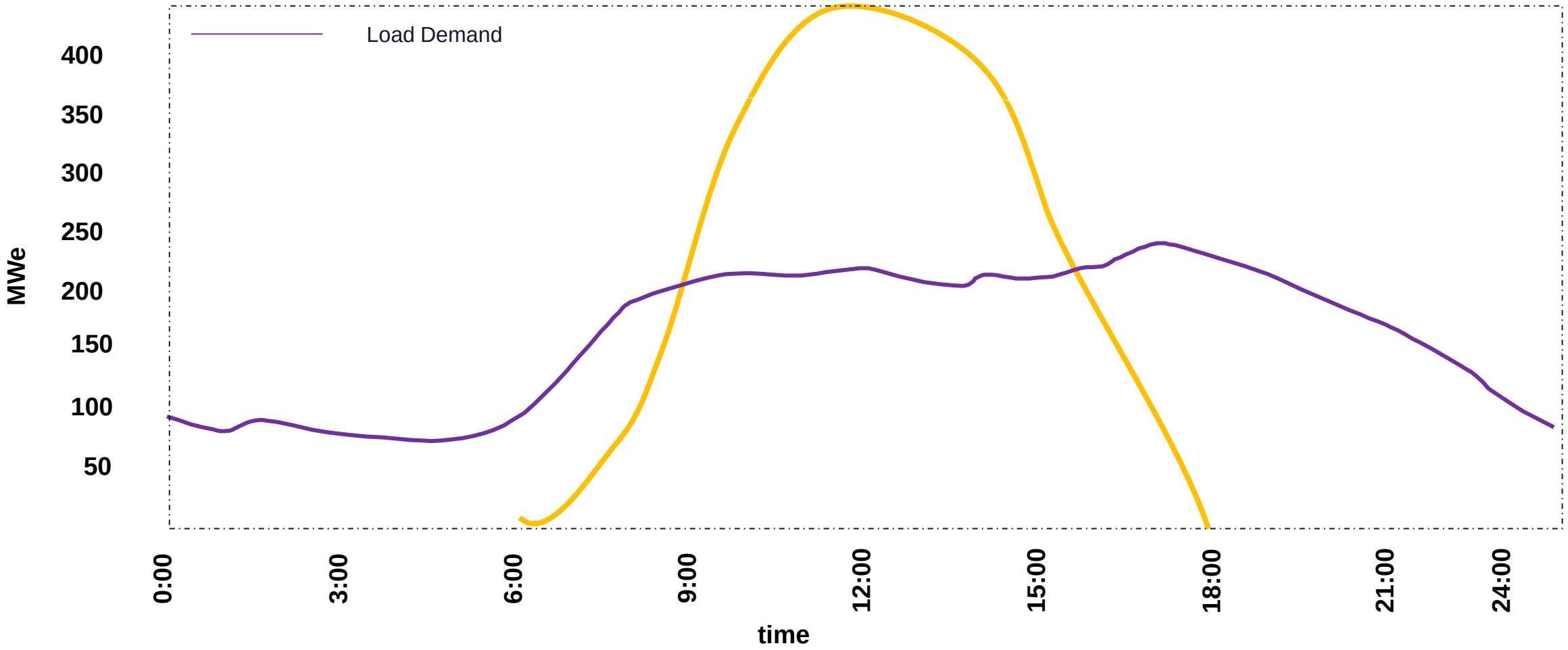
265 MW fuel
100 MW heat
135 MW El

Typical requirements for grid balancing
Power balancing is divided in time frames

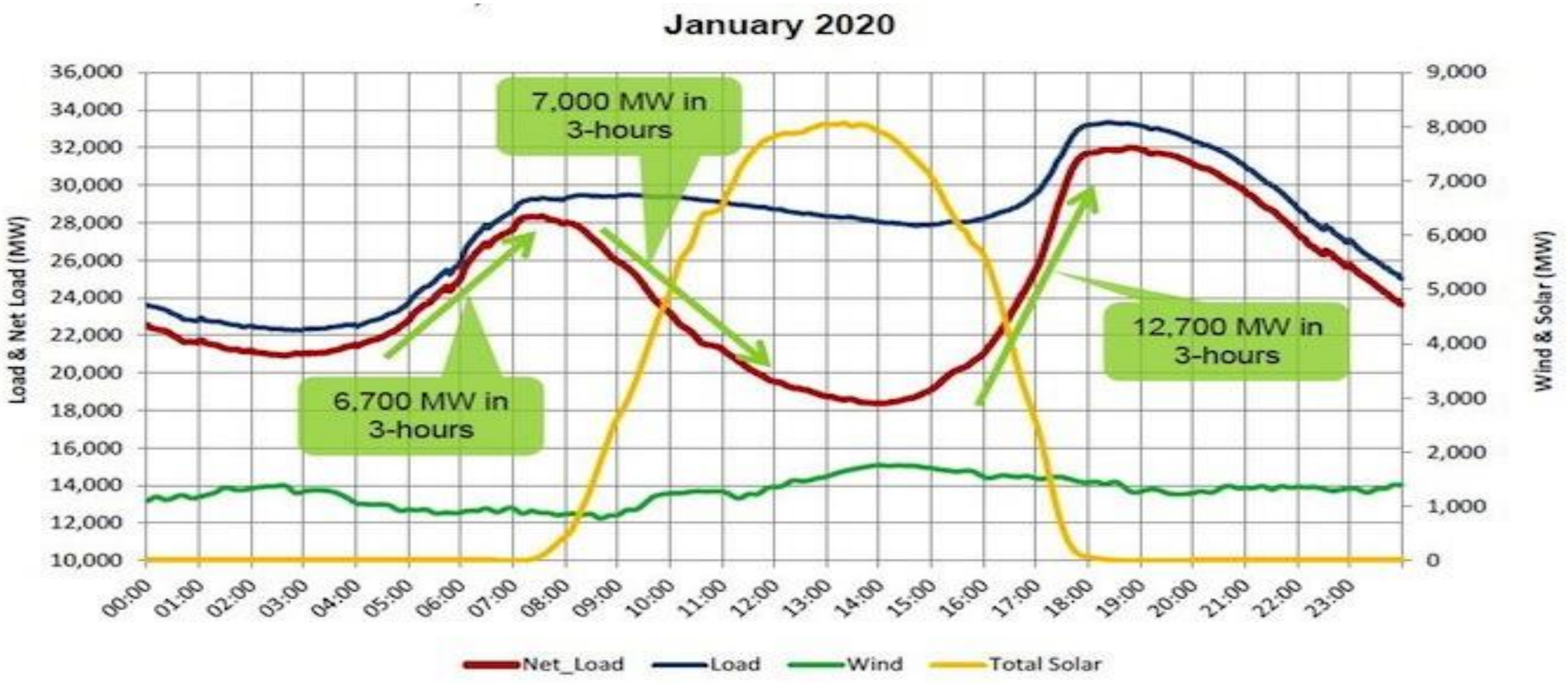


- The electric grid only transfers power and provides no energy buffering in itself.
- At mismatch between production and consumption grid frequency drifts away.
- Different resources used to match production to consumption across all time instances

Typical Load Demand vs. PV Supply



Resulting Firm Generation Load Profile



Balancing of the electric grid - Gas Turbines ensures grid resilience

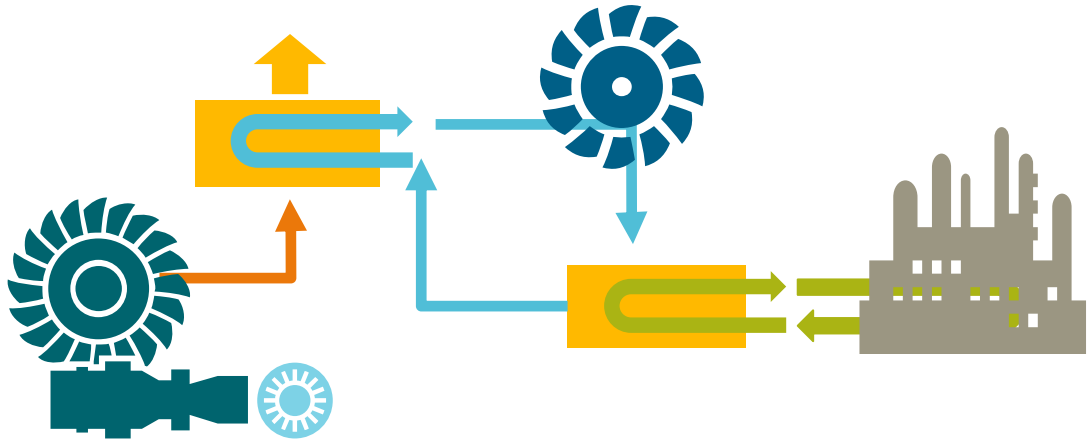
- Storage solutions and demand response can solve day-scale variations economically.
- Thermal backup required for limited annual hours
- Gas Turbines as thermal backup gives lowest investment.
- High efficiency, combined cycle at 60%
- Fast and flexible

Required Gas Turbines operating profile

- Dispatch by Gas Turbines when storages are emptied or when storage power is insufficient.
- Gas Turbines operation continuously for many weeks must be possible.
- Gas Turbines in standstill, ready standby for many weeks will occur.
- Daily cycling will occur.
- Fast start required at occasions.

CHP - a large grid balancing potential

- Heat needed anyway → 85% marginal e-efficiency.
- Thermal storage discouples demand.
- Hot water storage cheap.
- Flex operation → increase capacity.
- Heat pumps → use cheap electricity & increase CHP total efficiency
- Industrial CHP made flexible



Future renewable fuels for GasTurbine- operation

Biogas

- limited resources - wet waste streams

Bio-methanol

- large potential but distributed production near dry waste stream, sustainable forestry

Ethanol

- cheap but poor CO_2 footprint
- competes with food

Renewable diesel

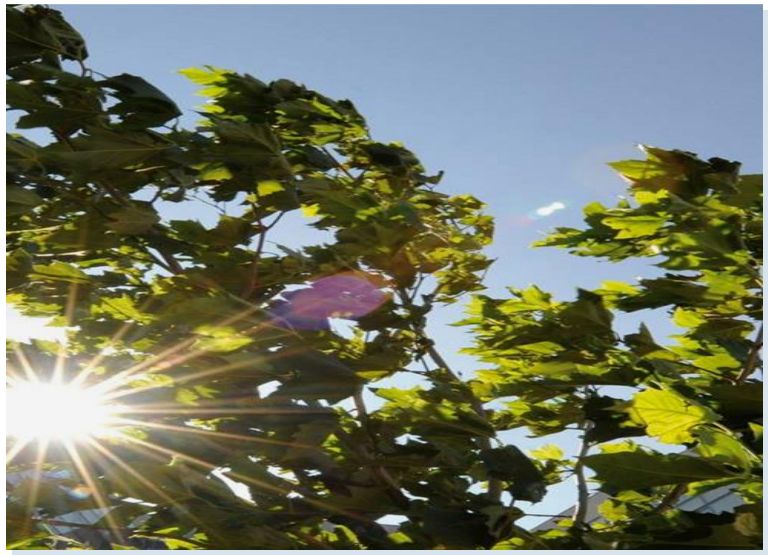
- limited resource if HVO, else expensive

Hydrogen

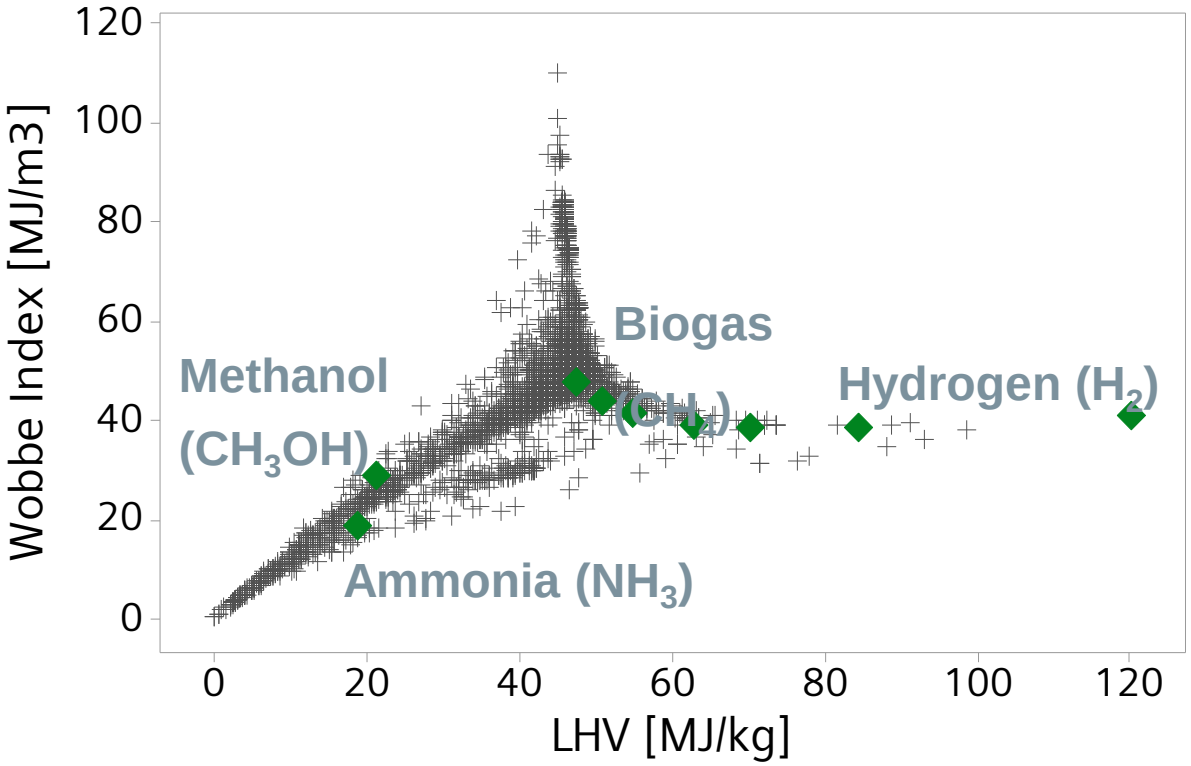
- expensive , large volumes, cryo at large effort

Power-to-X

- e-methanol, Ammonia
- added cost and energy loss from hydrogen base



Green fuels are suitable for gas turbines



Green fuels are within normal gas compositions!

- Co-fire with natural gas
- Change to 100% Green fuels can be made with no or some modifications

→ **a Siemens gas turbine is a future proof investment**

Benefits

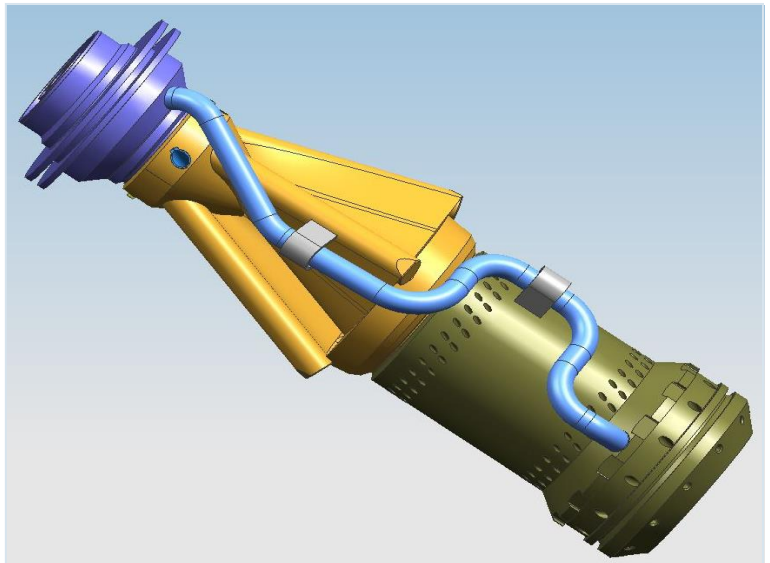
- **Reduction of CO_2 emissions** while keeping emissions such as **NO_X low**

Possibility to

- utilize certain by-products from industries
- store energy produced by renewables as gas (power-to-gas)

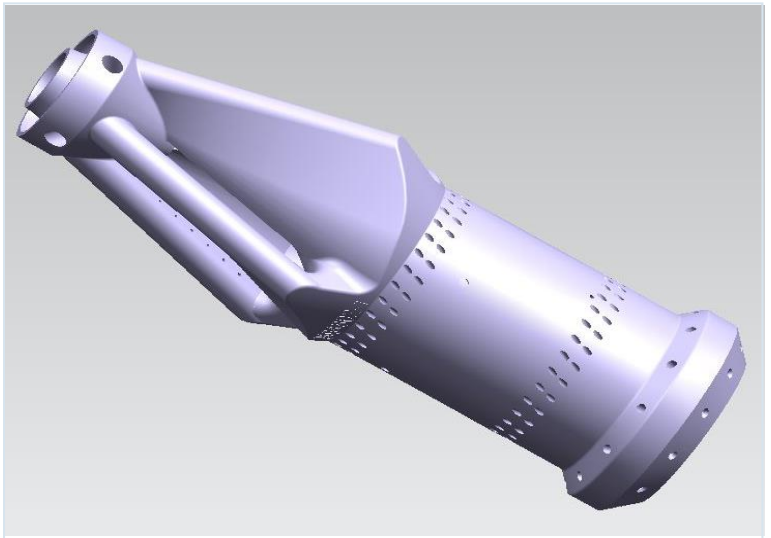
Graph: Illustration of different gas compositions that have been of interest for a customer, 2019-08-28

Additive manufacturing (AM) of burners
Rapid prototyping speeds up development



Traditionally manufactured burner

- 13 machined parts, assembled by 18 welds
- External pilot gas feed pipe
- Weight: 4.5 kg



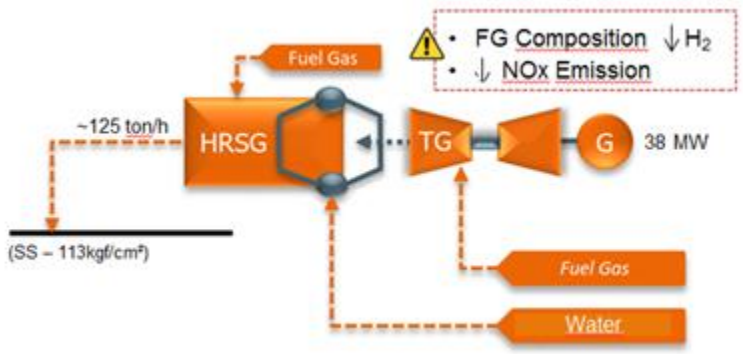
Additive Manufacturing burner

- 1 single part
- Pilot gas feed integrated in structure
- Weight: 3.6 kg
- **Lead time reduction of 75%**

- Rapid development for modifications
- Burner front with adjustments for H_2 are printed in AM
- AM burner experience > 10 000 EOH SGT-700 (fuel: natural gas)

Reference Project Braskem
Two SGT-600 to operate on high levels of Hydrogen

Braskem is a Brazilian petrochemical company headquartered in São Paulo. The company is the **largest petro-chemical company in Latin America** and has become a major player in the international petrochemical market.



Guascor Scope

Braskem main drivers

- Reduce NG consumption, **make use of fuel gas**
- Reduce Grid Energy consumption
- Power plant availability and reliability

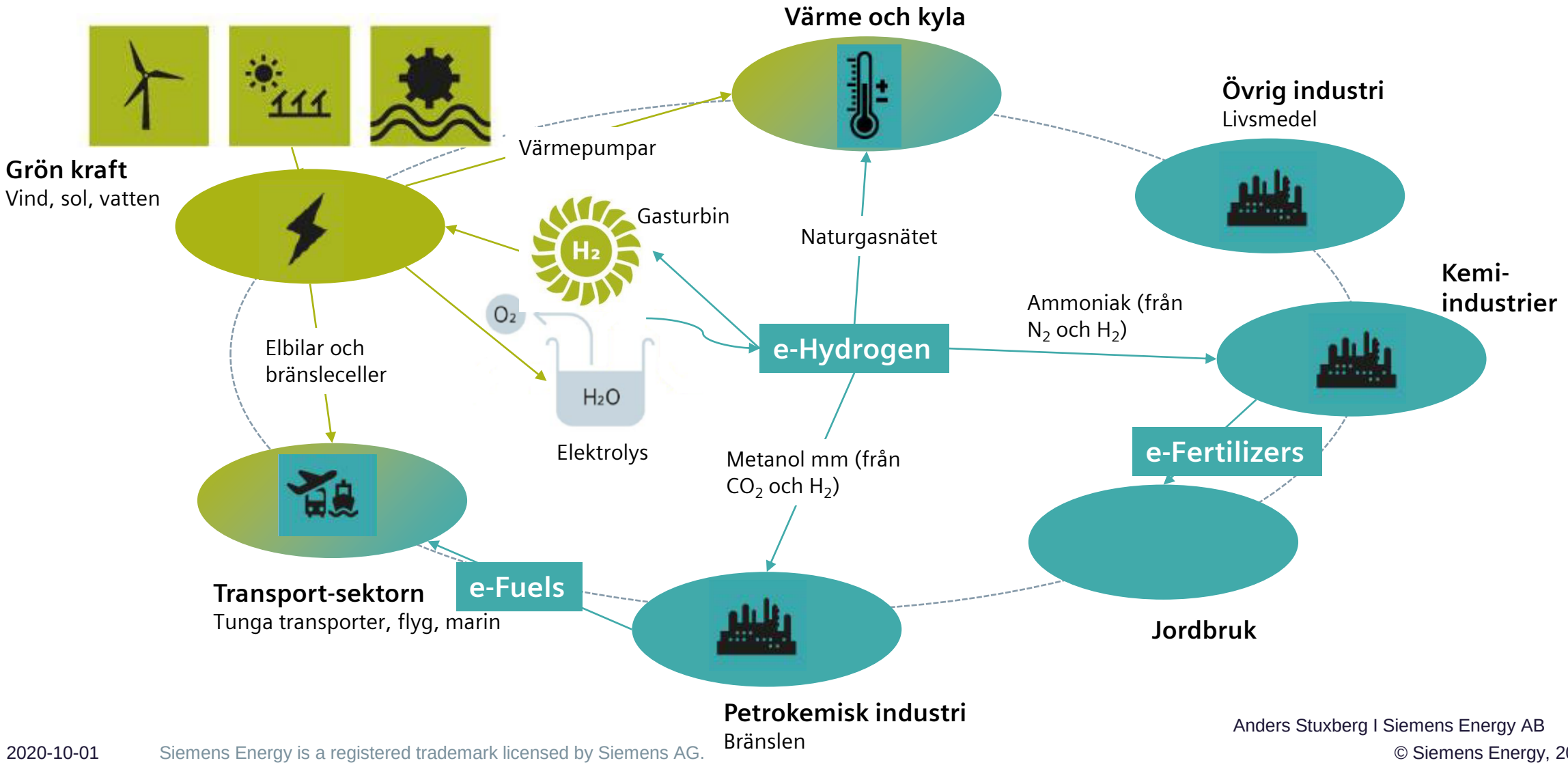
Guascor: is a 100% Siemens own company (part of DR), who will build, own & operate the CHP. HRSG and gas compressor are in their scope.

Will sell electricity and steam to end customer

Gas turbine summary

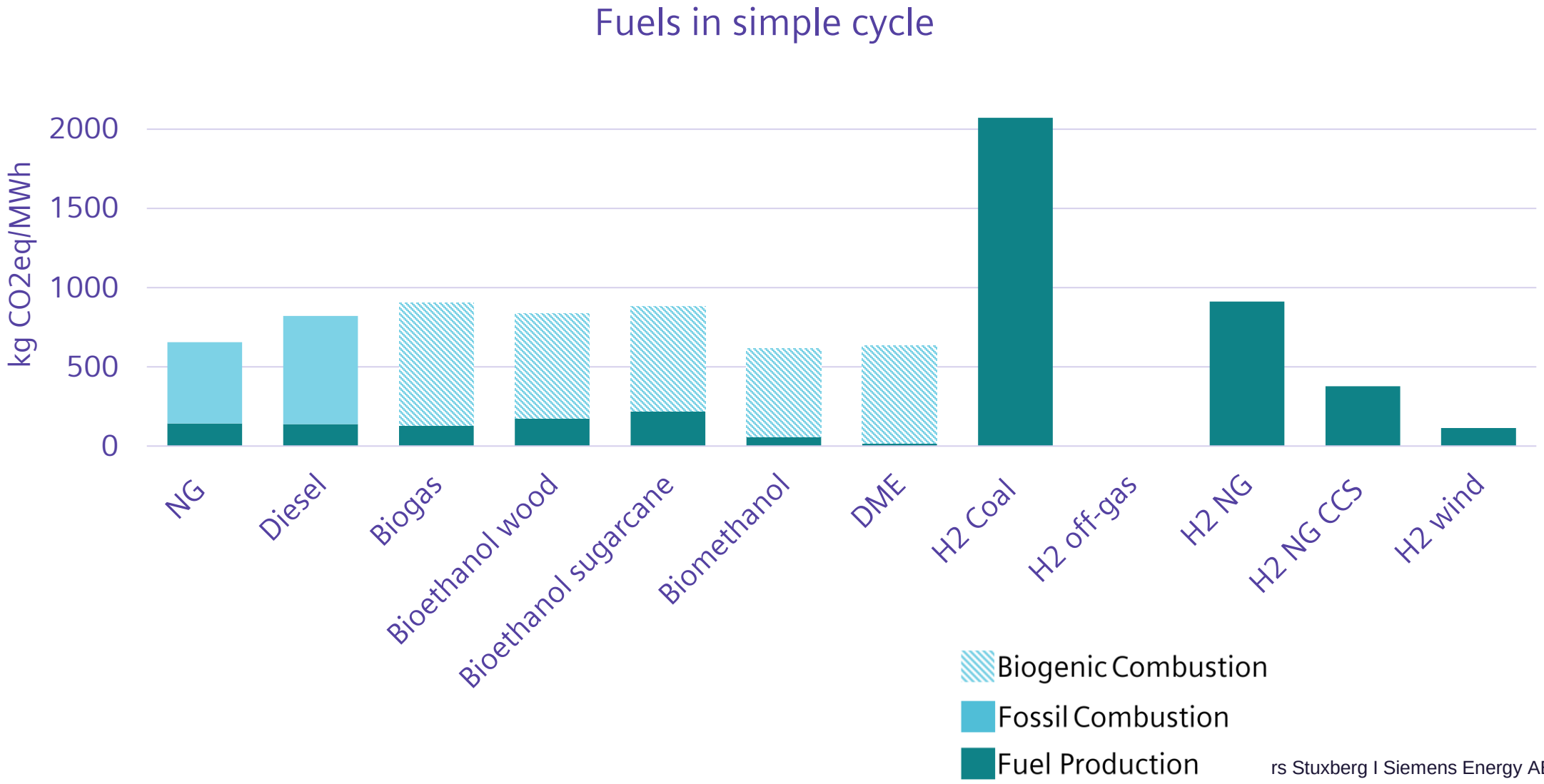
- **Type:** 2x SGT-600
- **Fuel:** **Fuel Gas with H2 up to 60% and Natural Gas**
- **ExWorks:** 11 Dec & 18 Dec 2019

Vätesamhället



Results from recent LCC analysis

By Moa Mellberg, Hanna Sundin



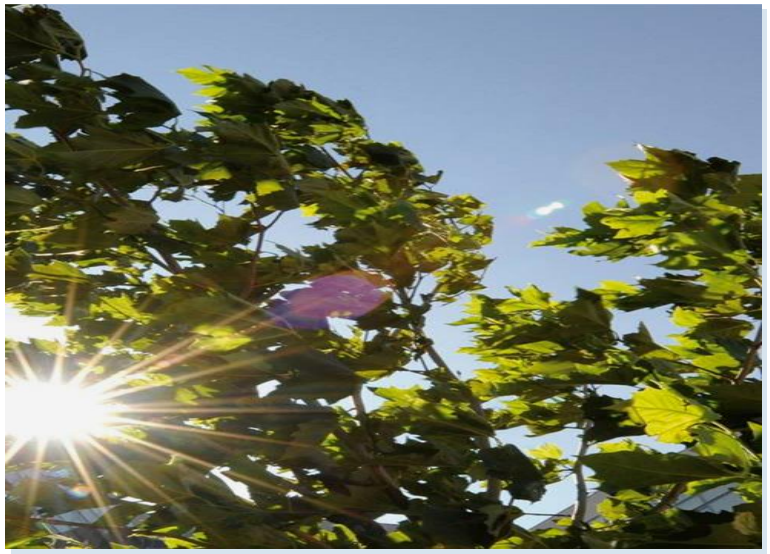
Future cost of renewable fuels ?

- Biogas 80 Euro/MWh
- Bio-methanol, ethanol, ren diesel 80 Euro/MWh
- Hydrogen 114 Euro/MWh
- Power-to-X : e-methanol 170 Euro/MWh, Ammonia 150 Euro/MWh

Cost of production = (purchase of feedstock + transport + conversion) / efficiency

E.g. green hydrogen, on-site
(40 + 0 + 40)/0.7 =
114 Euro/MWh

- Market price subject to many factors
- Importance of domestic fuel production

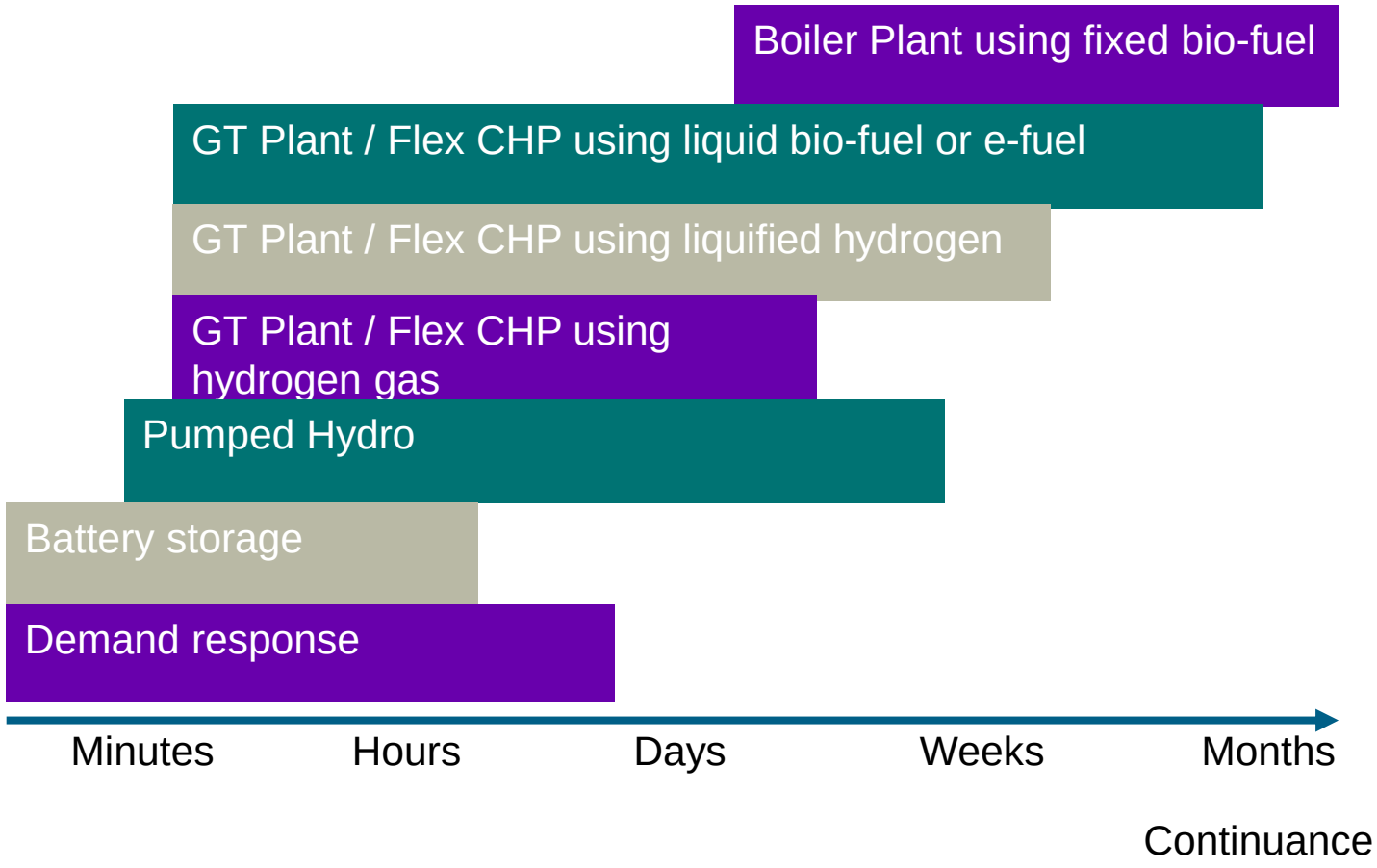


Future Renewable Fuels
Storage properties

	Boiling point ° C	Storage pressure bar	Storage temperature ° C	Storage volume m3
Hydrogen compressed	-253	70	amb	100000
Hydrogen liquid	-253	amb	-253	8900
e-methanol	64.7	amb	amb	4800
Ammonia	-33.34	amb	-33.34	5600
Bio-gas	-162	350	amb	5900
Bio-methanol	64.7	amb	amb	4800
Ethanol	78.24	amb	amb	3300
Renewable diesel HVO	>180	amb	amb	2200

Storage volume assumes one 50 MW GT, one week operation

Continuance for dispatch



- A Gas Turbine plant can compete for different time slots by shifting fuel.
- Liquid fuel much cheaper to store than gaseous fuels. Methanol will thus have a logic position even if hydrogen does get down to lower energy cost.

Our purpose

Contact page

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