Fast starting & flexible combined cycles for industrial applications

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Cogen = 90% marginal electric efficiency
Trad Cogen – Heat is main product
Combined Cycle Cogen - Electric is main product
Future Cogen = Flexible operation, flexible fuel use, grid services

Decarbonization of industry

Credit r/pix / Earthmoonsune

Continuous provision of heat and power @ baseload.

Electrification desired but non continuous supply.

COGEN decarbonized by shift to renewable fuel

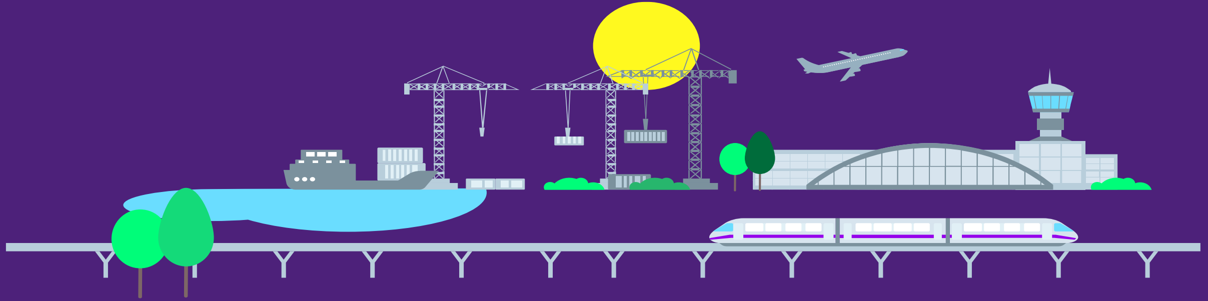
Step 1 : switching between electrified and COGEN.

challenge for grid capacity but doable through demand response.

Step 2 : Use of energy storages to buffer renewable power.

Large expansion of grid + storage capacity + cycle cost.
COGEN still needed as storage duration limited, or accept stoppages.

Industrial COGEN



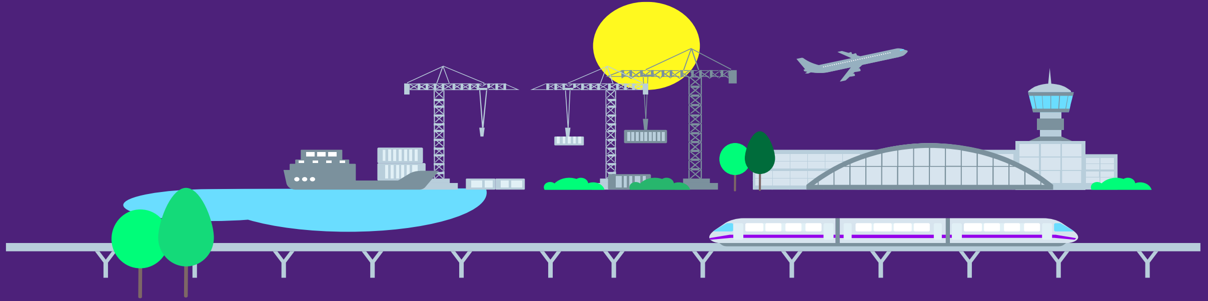
Distributed, <u>dispatchable</u> generation = high value for grid operator

- Less transmission capacity needed (reduced losses, reduced investment)
- More transmission capacity enabled by Firm voltage control
- Continuous frequency response requested but not possible by single tech in heat driven application

Addition of electrification to a CHP enables 2* frequency response

- Switch between electrified and CHP = large stepwise adaption
- Mixed-mode: Electrified + CHP @ partload → continuous strong response

Industrial COGEN
Flex features



- Cold condenser + duct firing = Cheap power-capacity
- ST bypass to reduce electric power (GT then also has to back off).
- Fast start adaptions.
- Green idling = spin GT at no power using green hydrogen. Waste heat recovered replaces other electrified heat supply partly.

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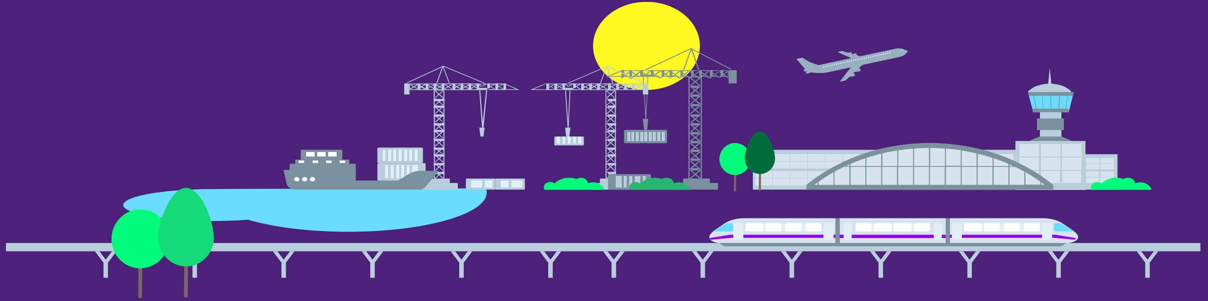
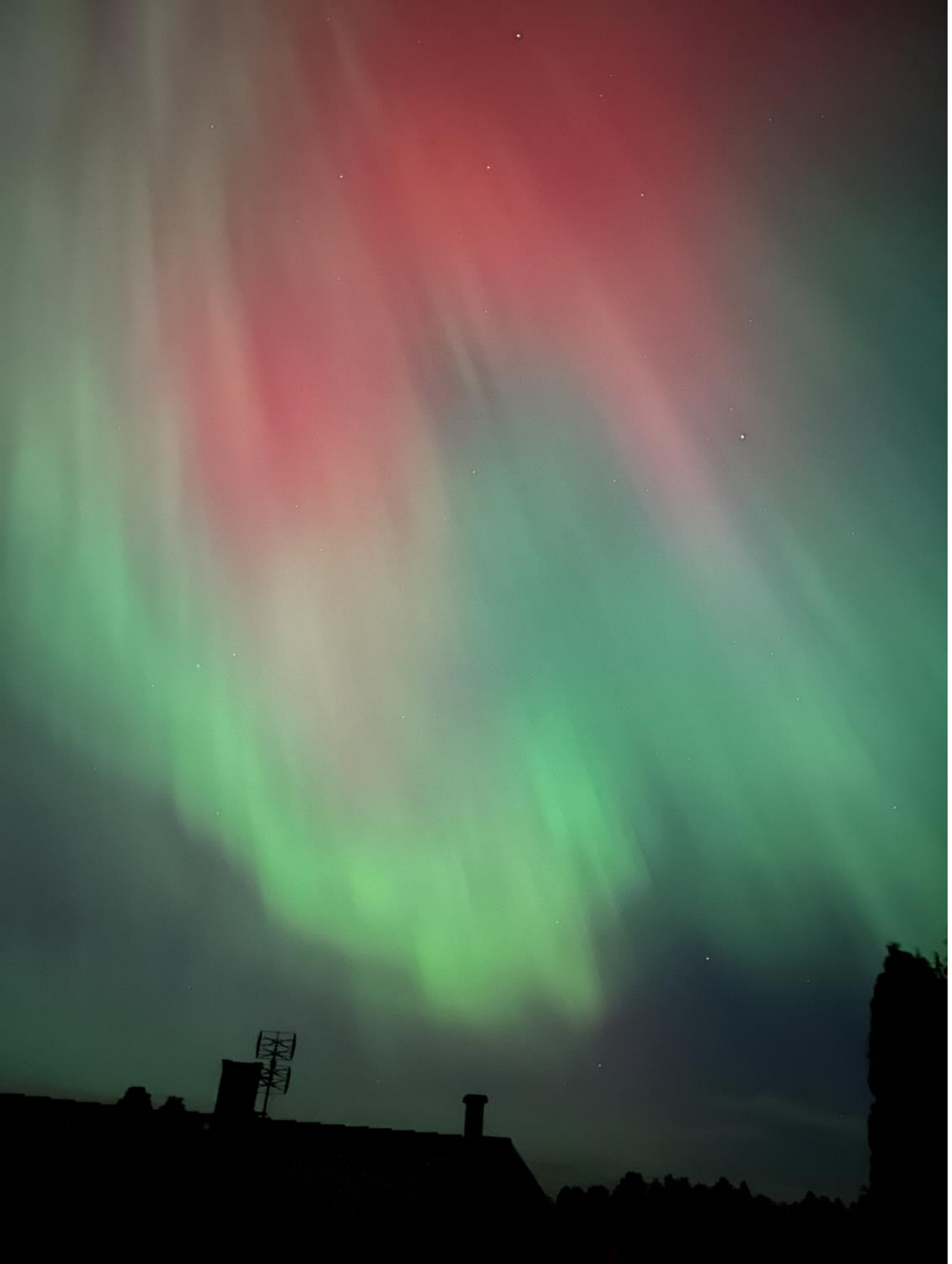
Industrial Flex COGEN
Future fuels



- **Flexibility by H2 supply:**
  - 1 – 4 day scale if dedicated storage.
  - few weeks if central gas network storage.
  - green idling mode

- **Flexibility by biogas supply:**
  - Prioritize biogas to power plants as easier to store than H2
  - Reduced Cogen dispatch means biogas demand approaches supply

- **Flexibility by liquid fuel storage.**
  - shift to liquid when H2 is emptied, many weeks duration.
  - adapt to availability: bio-methanol, e-methanol, ethanol, HVO, FAME, Ammonia



Delivered by Siemens Energy AB

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