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Hybrid Gas Turbine (GT) mech drive from BHGE

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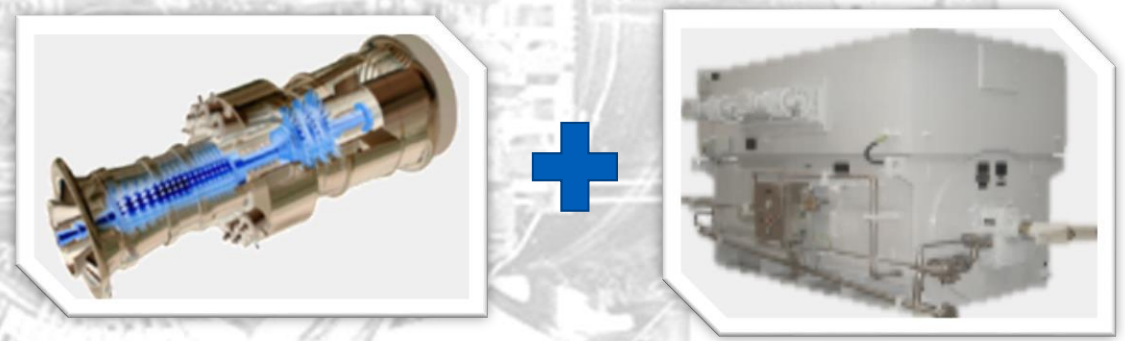
The Future of Gas Turbine Technology

- **Emissions reduction**
- **Production flexibility and operation reliability**
- **Renewables & Energy Storage**
- **Maintenance cost reduction**



Synergy between Gas Turbines and VFD Electric Motors

The best way to design the future is to invent it

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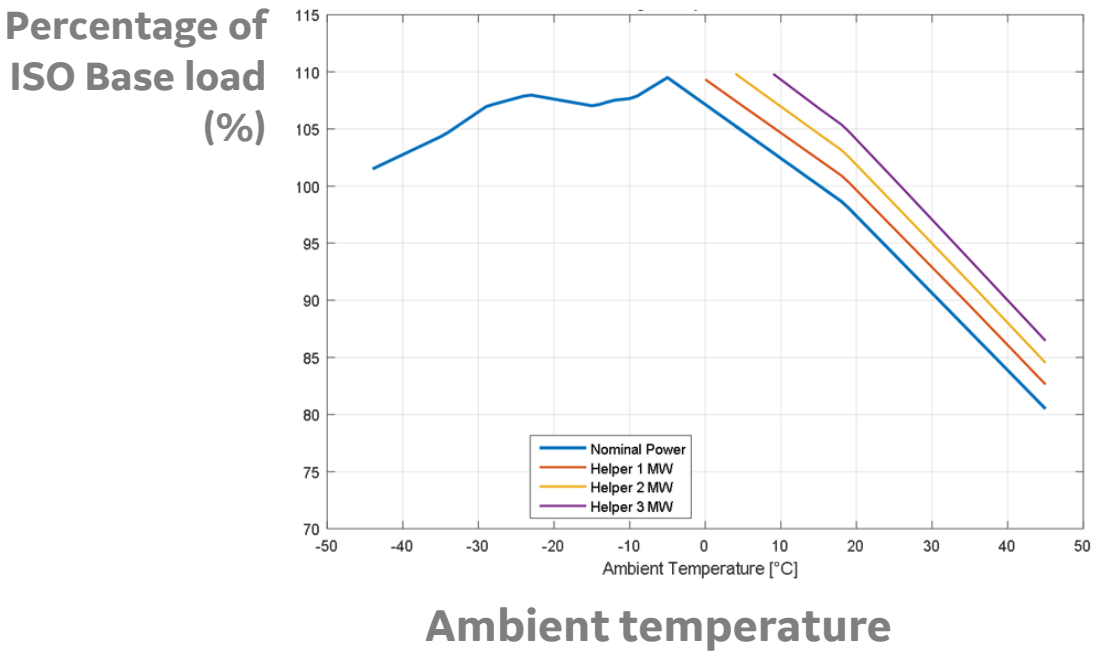
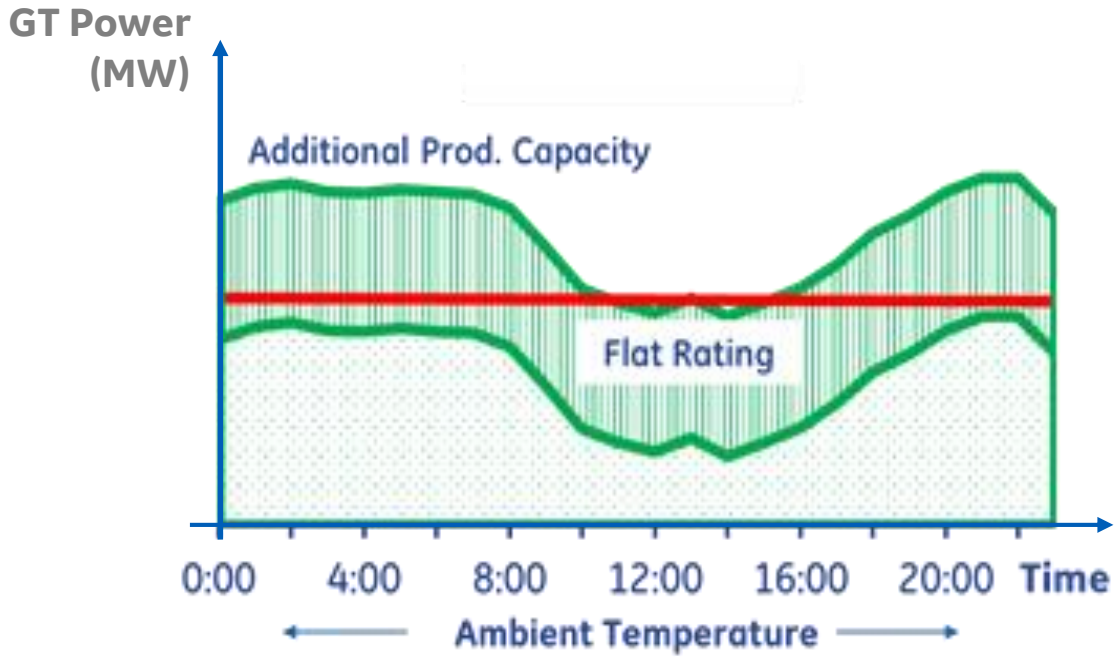
Gas Turbine performances

Gas turbines power is affected by ambient temperature and emissions are affected by power output

Power output vs ambient temperature



Power output vs time



VFD Electrical Machine is a flexible solution to improve a Gas Turbine emission profile and provide additional power to the Gas Turbine driver as needed (e.g. hot days) and recover excess power during cold days

Use electric power to boost Gas Turbine performance

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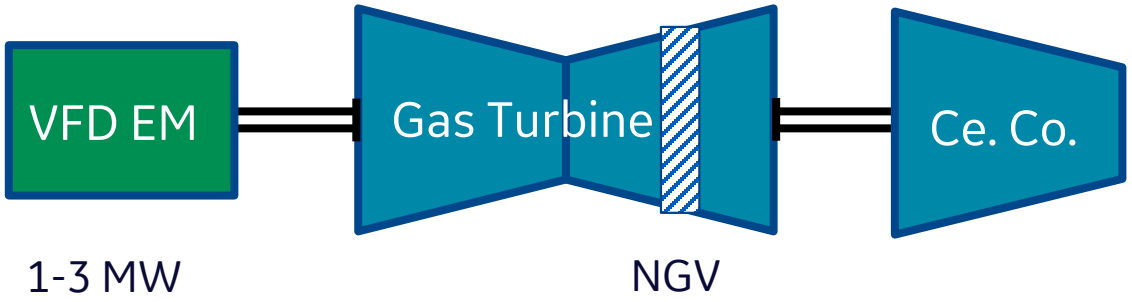
Hybrid GT configuration n#1

Patented

Electrical machine coupled directly on high pressure gas turbine shaft. Not applicable for Aeroderivative GTs

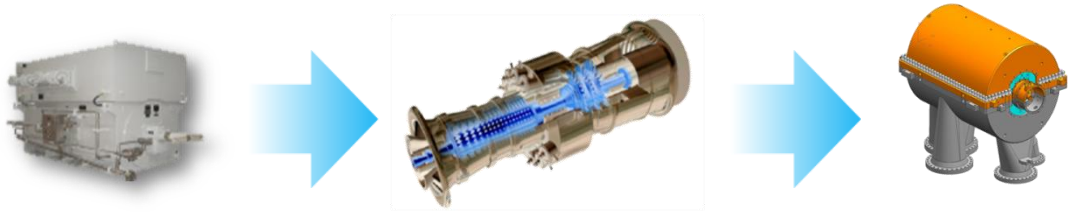


Value proposition

- Production increase
- OPEX reduction
- Gas turbine life extension
- Operation flexibility
- Reduce fuel and emissions
- Electrical grid indipendence

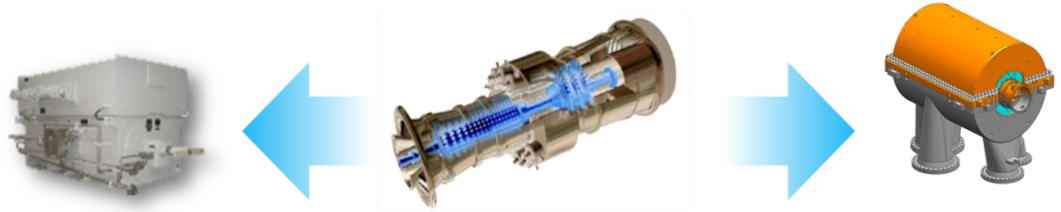
Starter/Helper mode

2 MW → 30MW → 32 MW



Starter/Generator mode

2 MW → 30MW → 28MW



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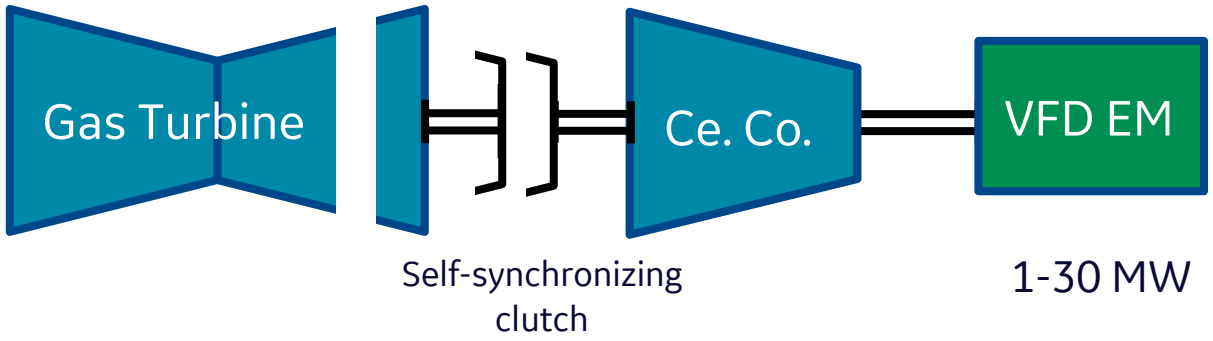
Hybrid GT configuration n#2

Patented

Electrical machine coupled on gas turbine low pressure shaft with a self-synchronizing clutch between GT and load compressor for a full electric mode operation while GT is in shutdown (*2)

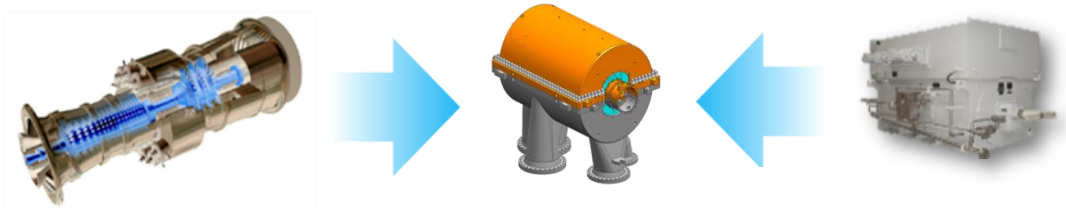


Value proposition

- Production increase
- OPEX reduction
- Gas turbine life extension
- Operation flexibility
- Reduce fuel and emissions
- Electrical grid indipendence

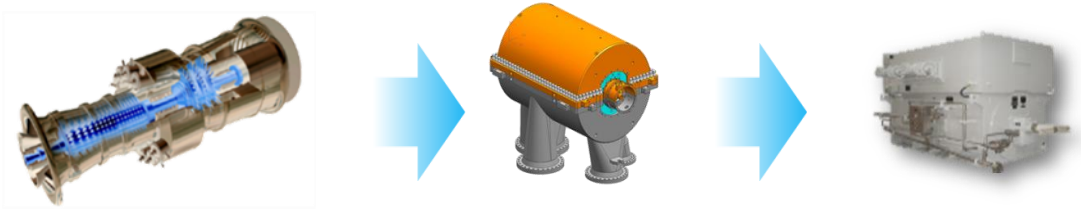
Helper mode (*1) /Full electric mode (*2)

(*1)	30 MW	60MW	30 MW
(*2)	0 MW	30MW	30 MW



Generator mode

30 MW 15MW 15MW



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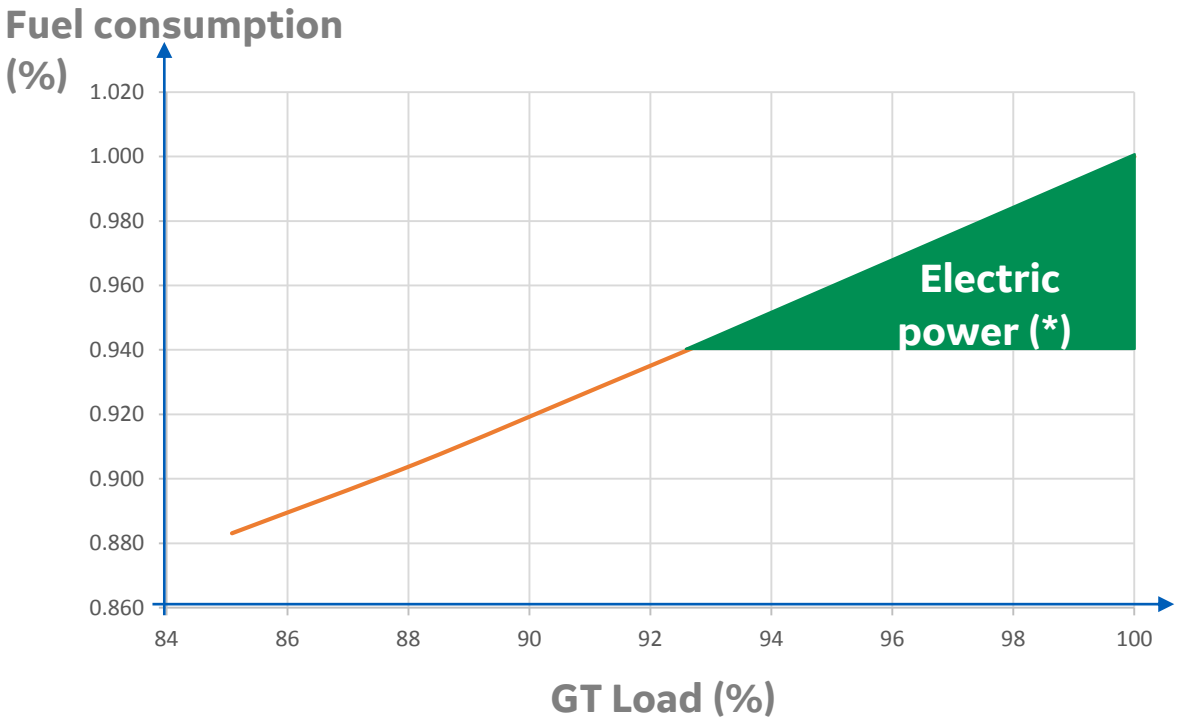
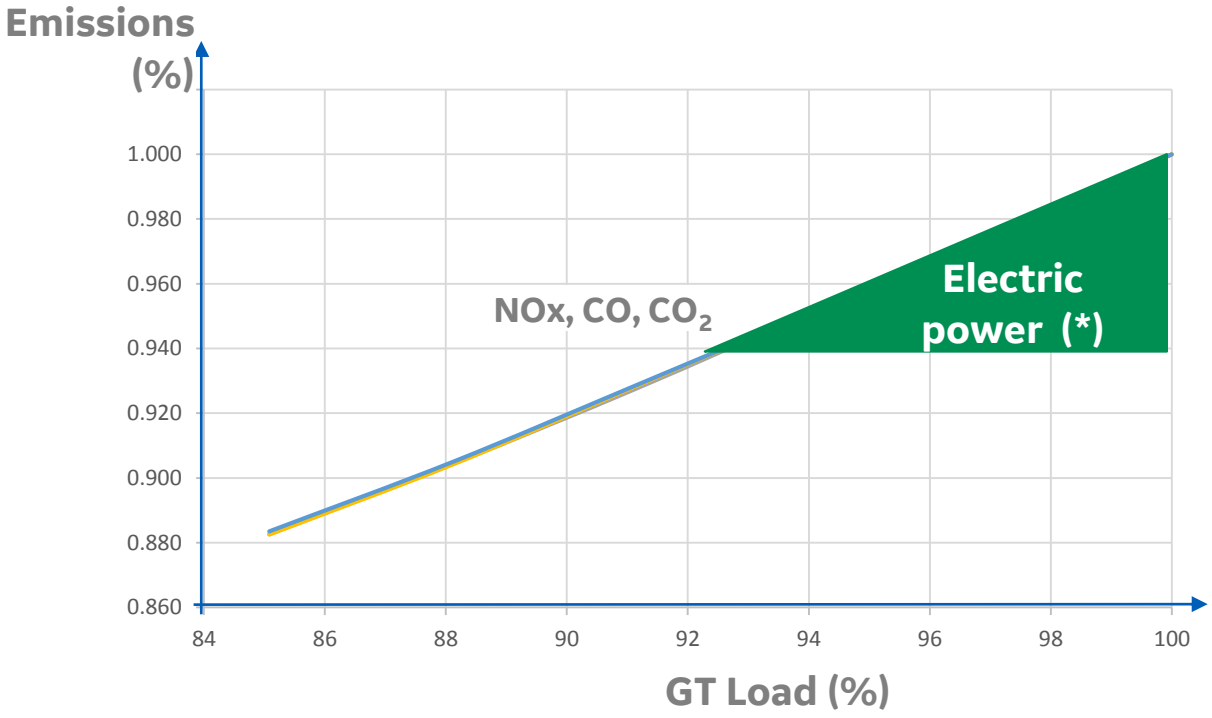
Environmental impact





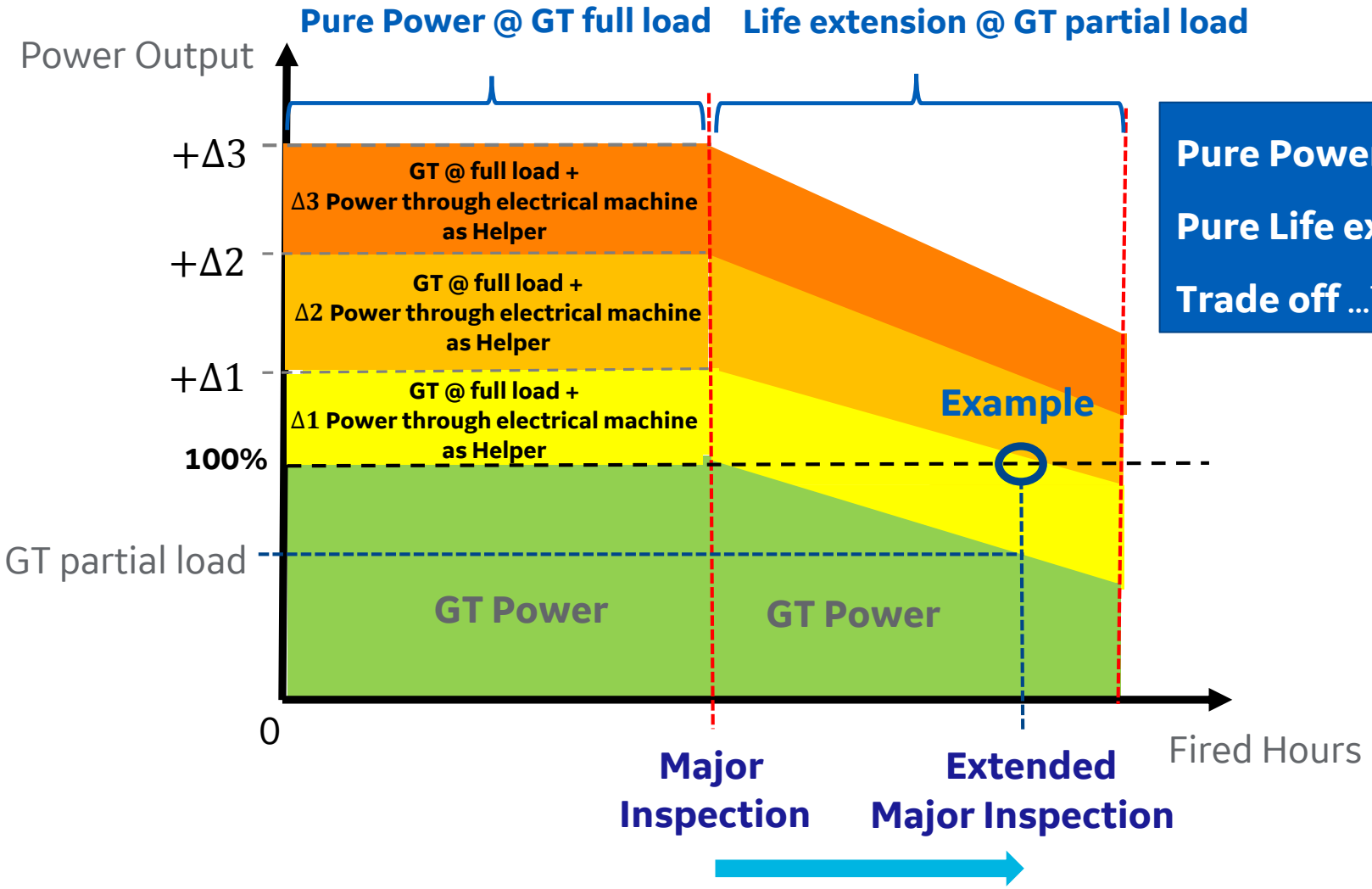
Helper mode (*) Fuel saving and NOx, CO and CO2 emission reduction. Renewable integration and energy storage

Production and availability increase.

Generator mode GT efficiency increase and NOx emission optimization according to the DLE technology.

On site power generation

Power augmentation & life extension sinergy

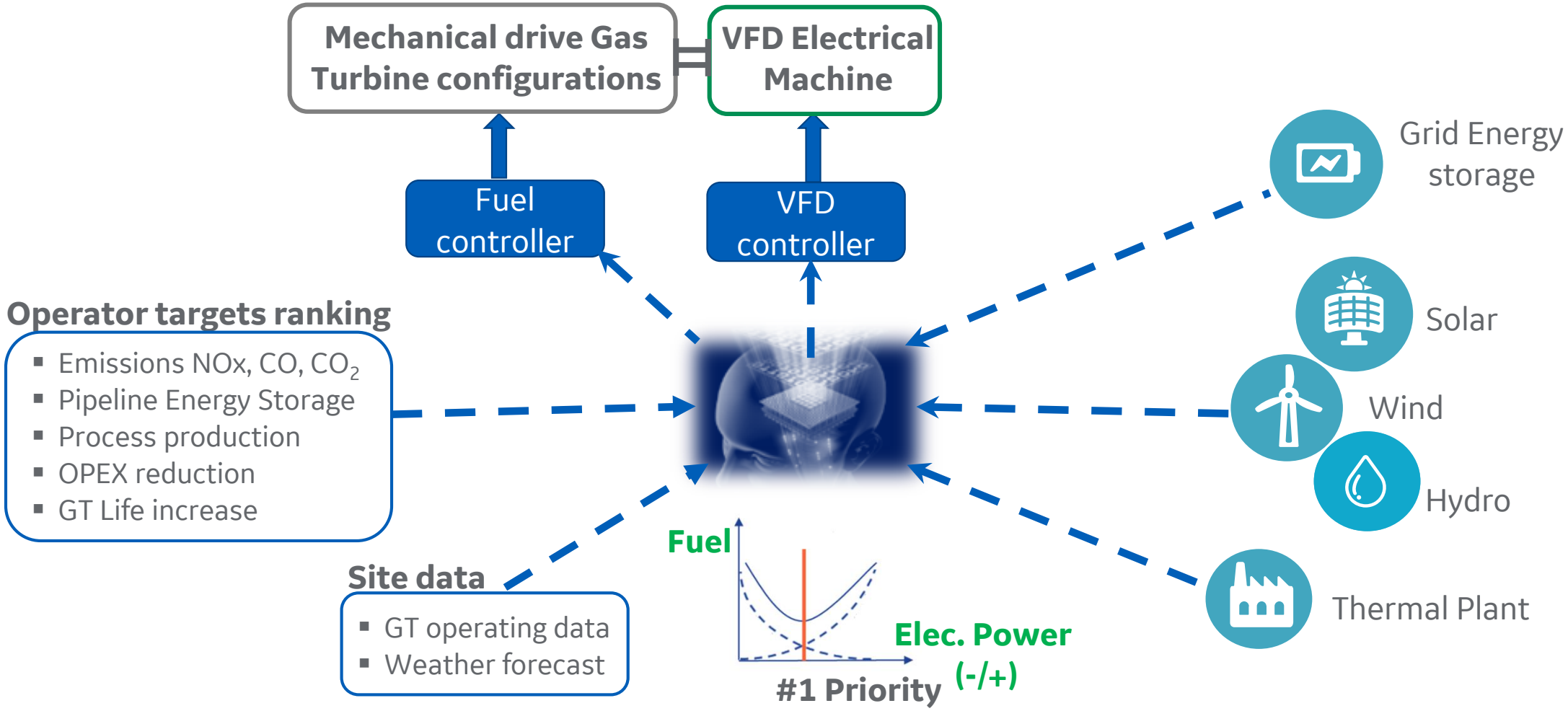


Pure Power …increase production

Pure Life extension …longer maintenance cycle

Trade off …Tailored on dynamic operators needs

Smart Energy Balance



Decision curve allow to achieve dynamic operators targets

Conclusions

- Solution effectively integrate Oil & Gas and Renewables Energy Sources
- Hybrid configurations boost GT performance without impact GT flange to flange
- Increase power plant efficiency and reduce OPEX

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