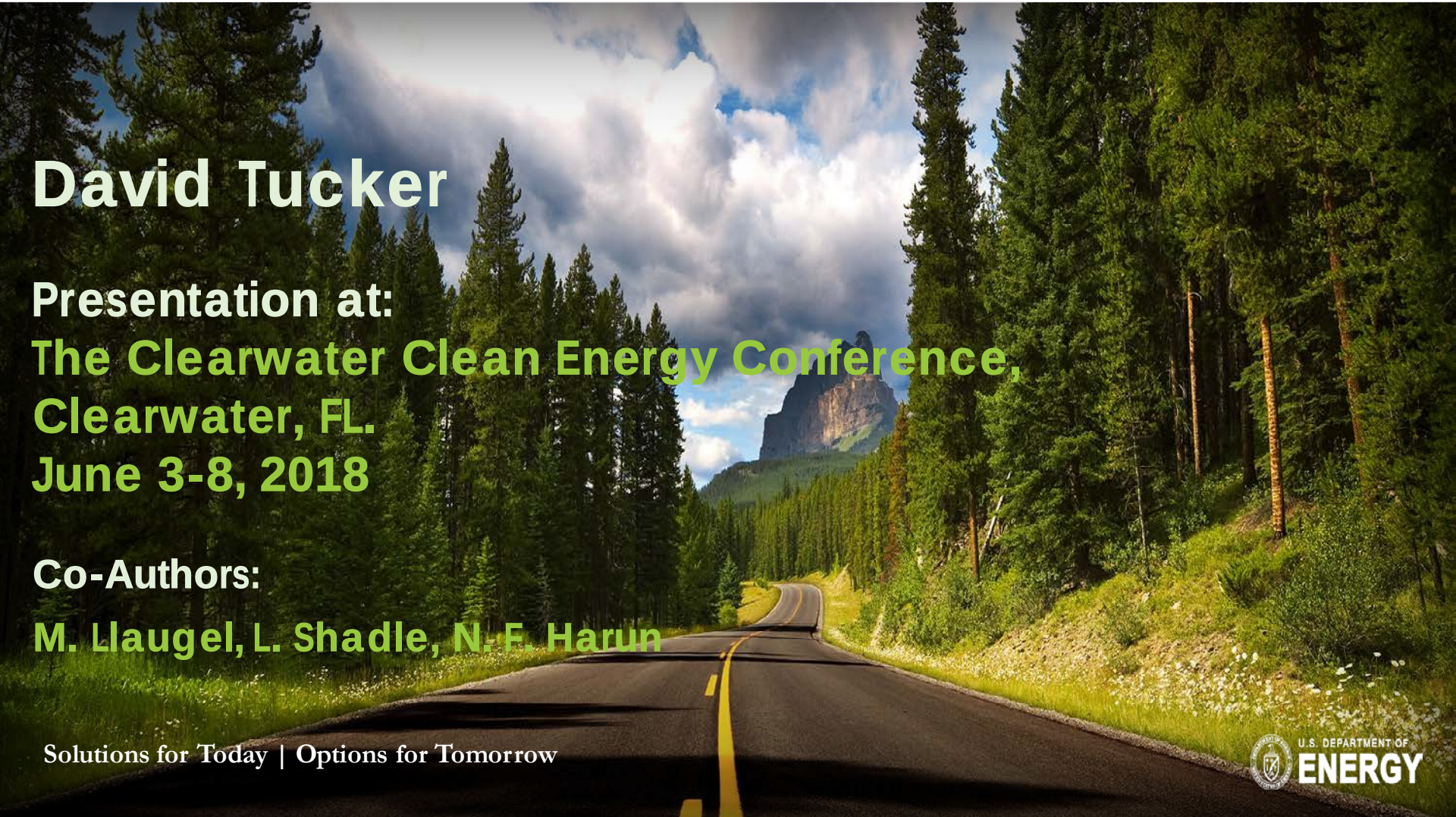
Solid Oxide Fuel Cell-Gas Turbine Hybrid Power Systems: Load Following Capability for Microgrid Applications

NATIONAL ENERGY TECHNOLOGY LABORATORY



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Solutions for Today | Options for Tomorrow

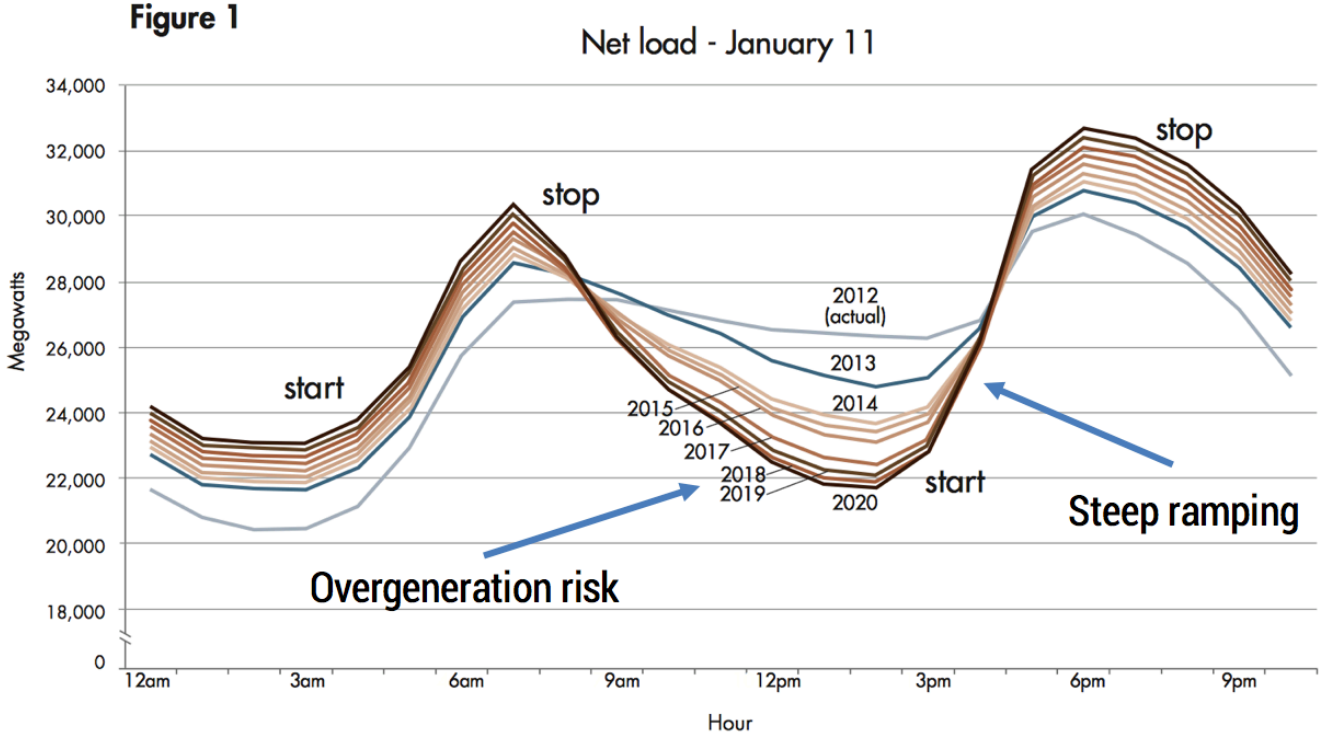
U.S. DEPARTMENT OF ENERGY

PROBLEM

SOFC/GT hybrid system: load following capability for microgrid applications

DUCK CURVE

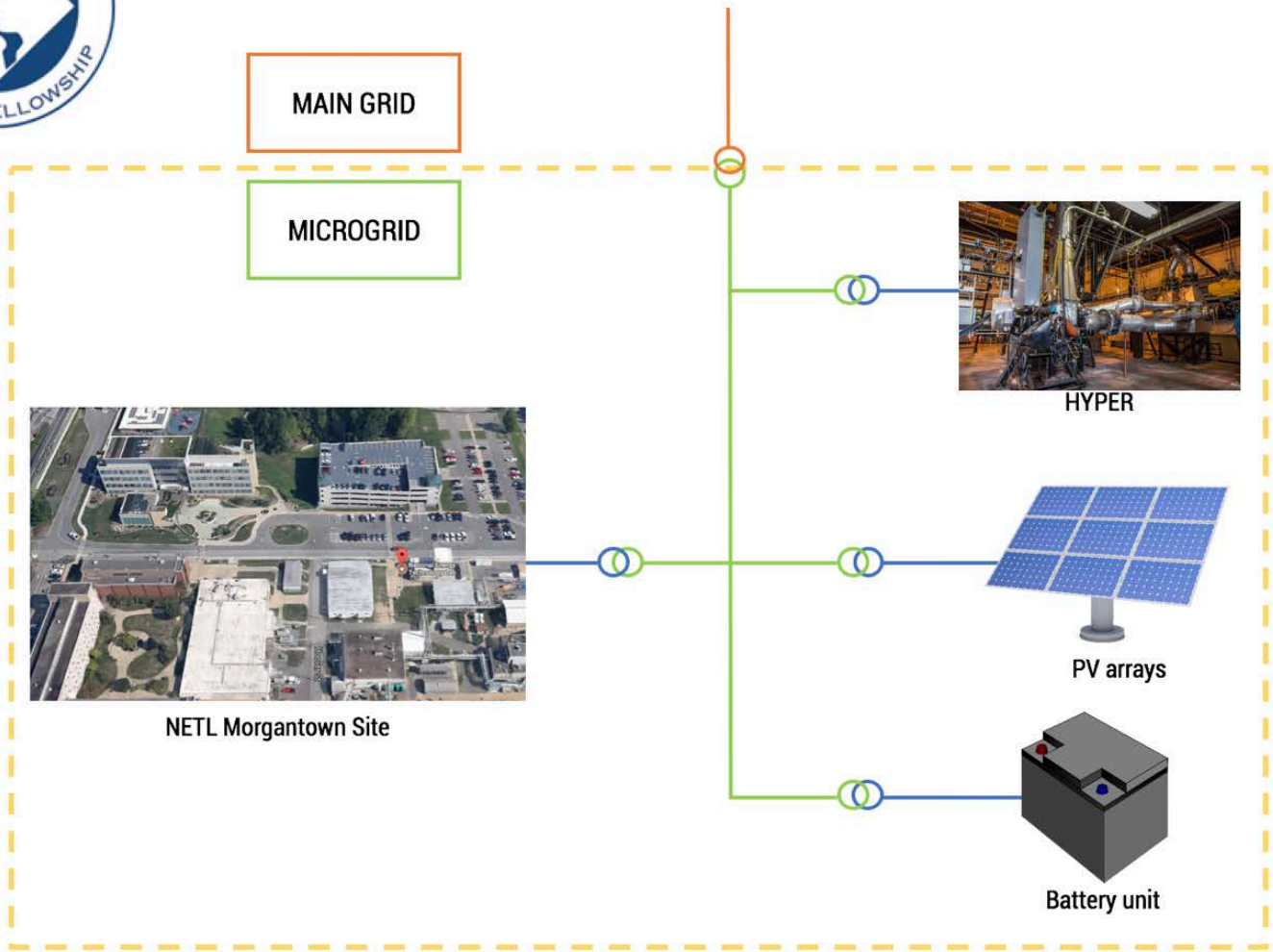
Figure 1



Source: California Independent System Operator

PROBLEM

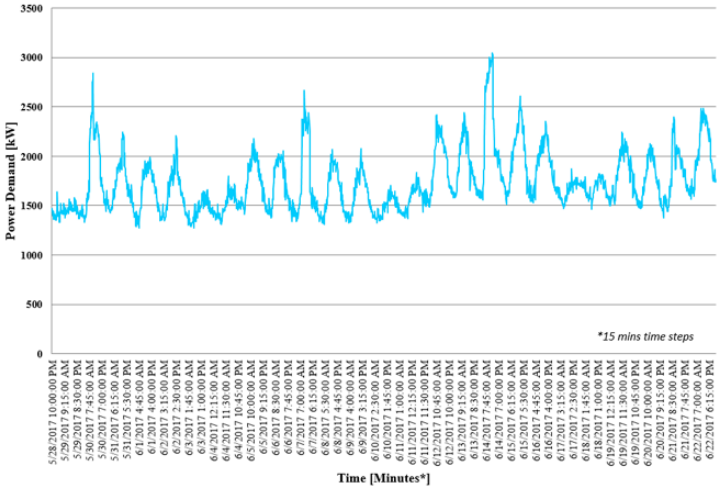
SOFC/GT hybrid system: load following capability for microgrid applications

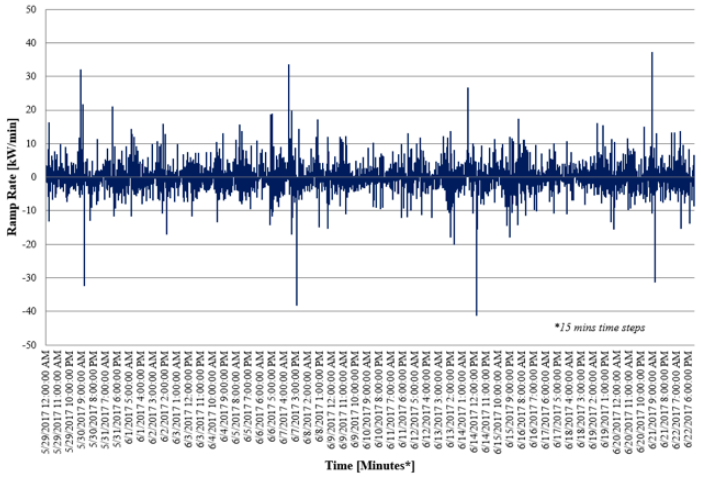


LOAD PROFILES

SOFC/GT hybrid system: load following capability for microgrid applications

NETL POWER LOAD DEMAND & RAMP RATE





Minimum load:
1,277 kW

Peak load:
3,044 kW

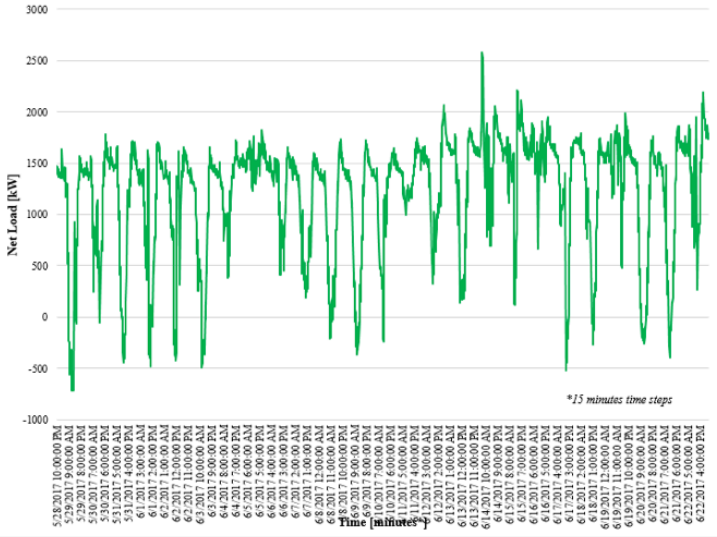
Ramp up:
37.3 kW/min

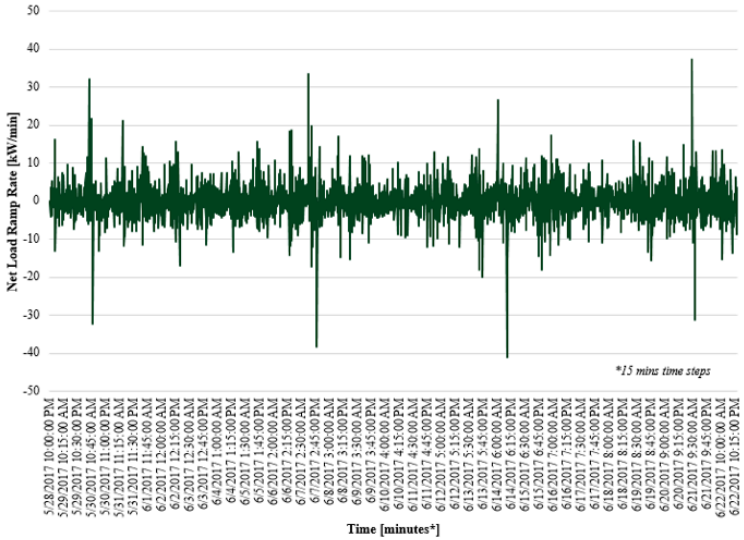
Ramp down:
41.2 kW/min

LOAD PROFILES

SOFC/GT hybrid system: load following capability for microgrid applications

NETL NET LOAD CURVE





Minimum load:
721.5 kW

Peak load:
2,580.3 kW

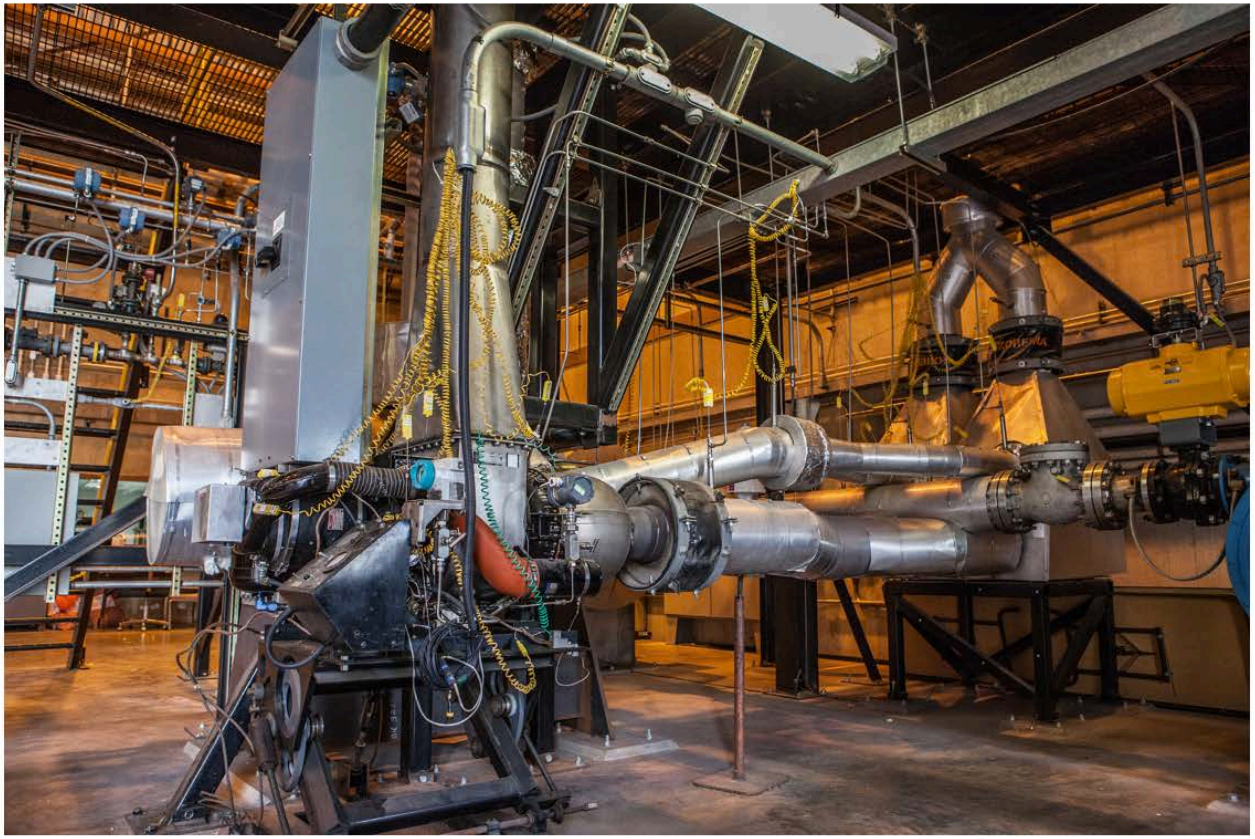
Ramp up:
105.4 kW/min

Ramp down:
128 kW/min

EXPERIMENT

SOFC/GT hybrid system: load following capability for microgrid applications

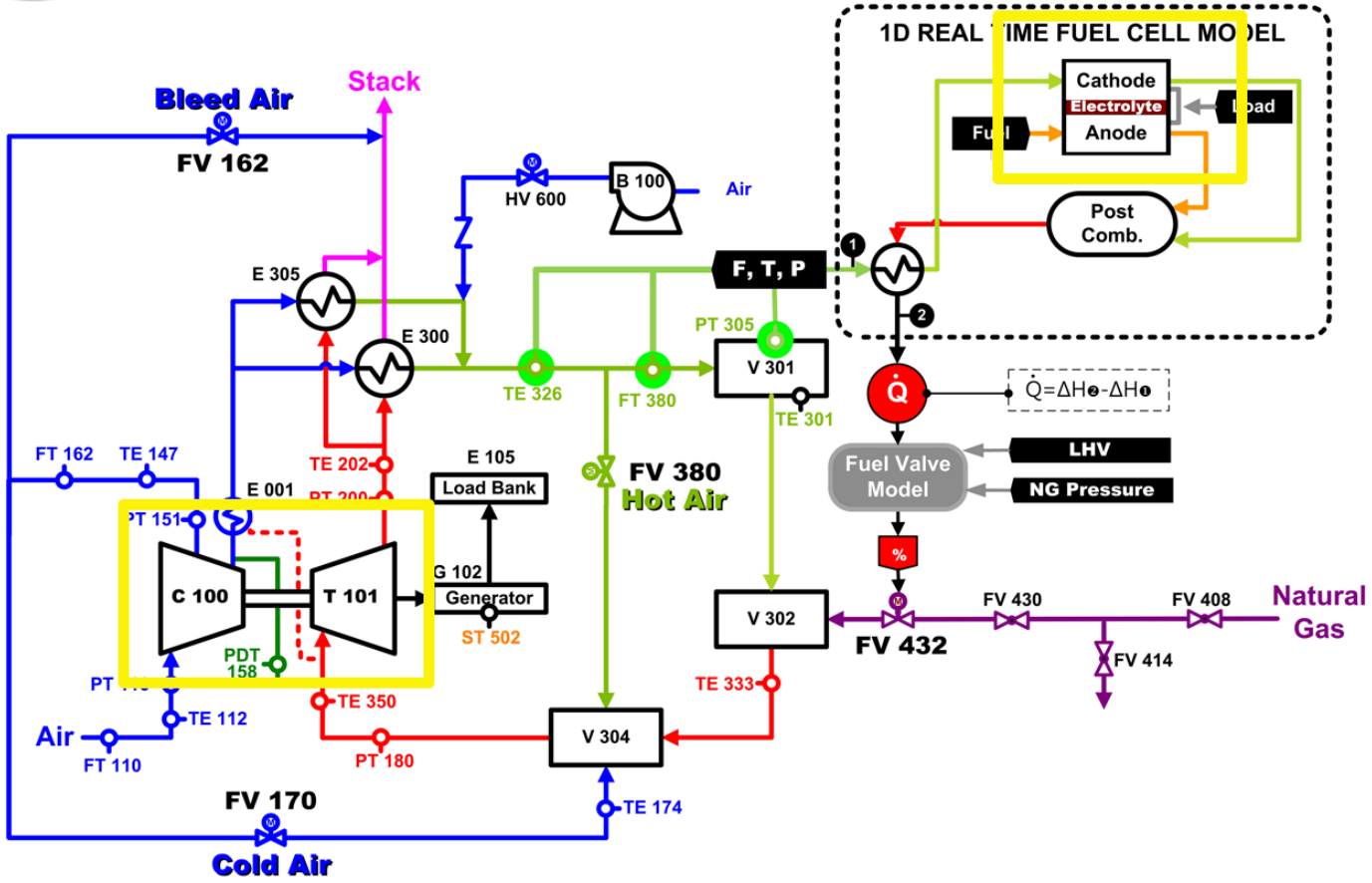
HYBRID PERFORMANCE FACILITY



HYPER FACILITY AT NETL

SOFC/GT hybrid system: load following capability for microgrid applications

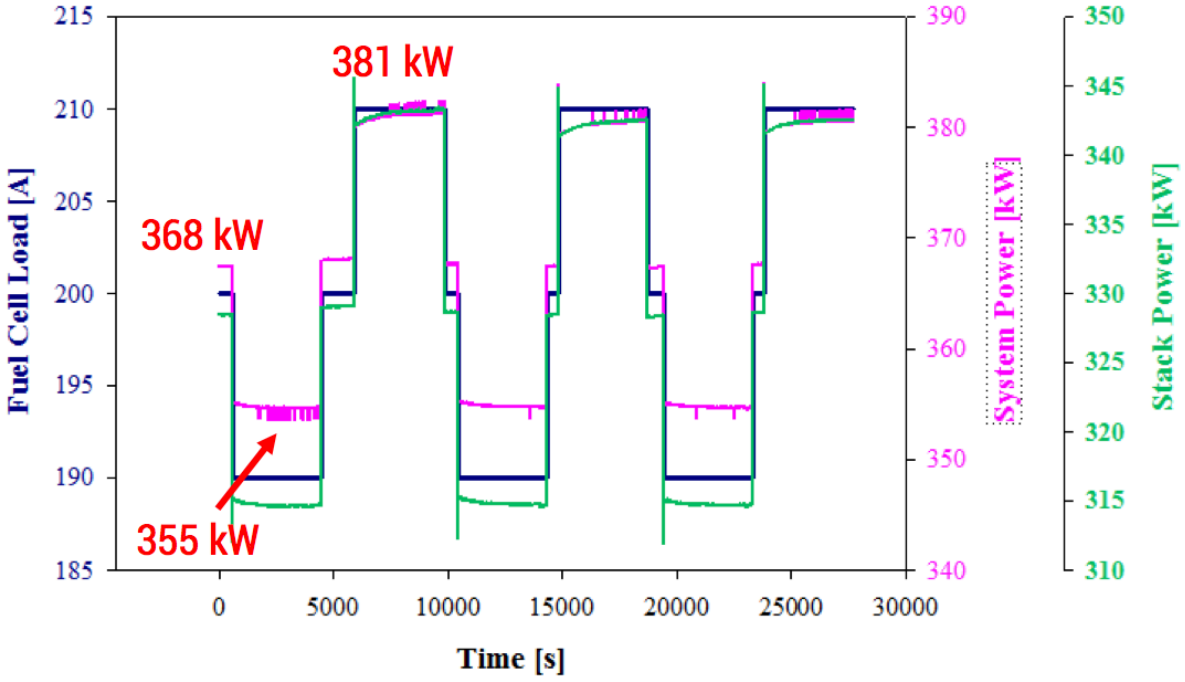
HYBRID PERFORMANCE FACILITY



RESULTS

SOFC/GT hybrid system: load following capability for microgrid applications

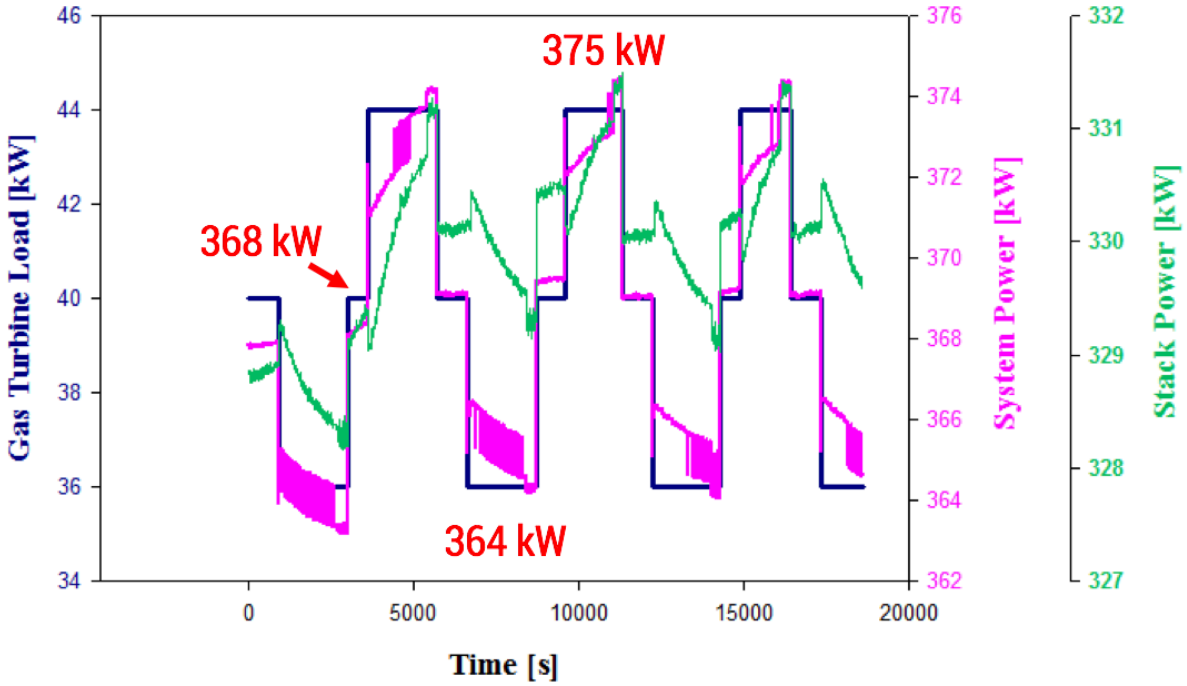
FUEL CELL LOAD STEP CHANGES: 5% CHANGE



RESULTS

SOFC/GT hybrid system: load following capability for microgrid applications

GAS TURBINE LOAD STEP CHANGES: 10% CHANGE



RESULTS

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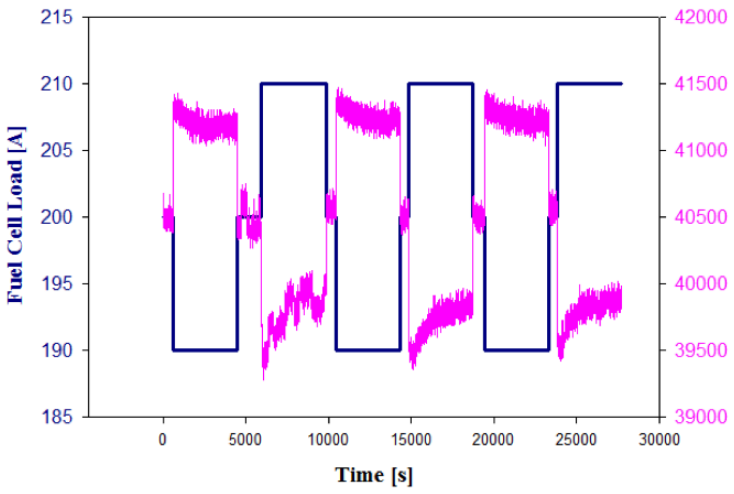
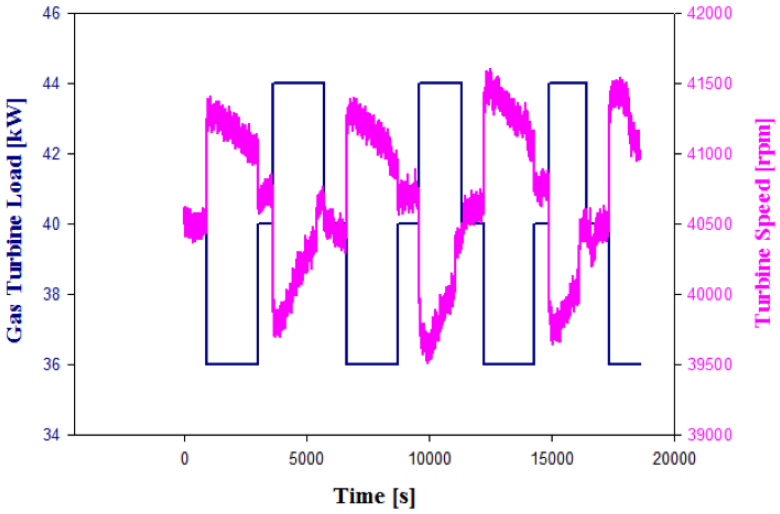
FUEL CELL



GAS TURBINE



FUTURE WORK

- Evaluation of the system capacity to generate power similar to the ramp rates of typical load profiles
- Evaluation of the impacts on fuel degradation
- Development of control strategies for turbine speed
- Evaluation of operating envelop and flexibility