turboreflex
power plant technology upgrades

ETN Webinar Series
FLEXIBLE POWER GENERATION
March 2nd, 2021, 12pm-1pm CET

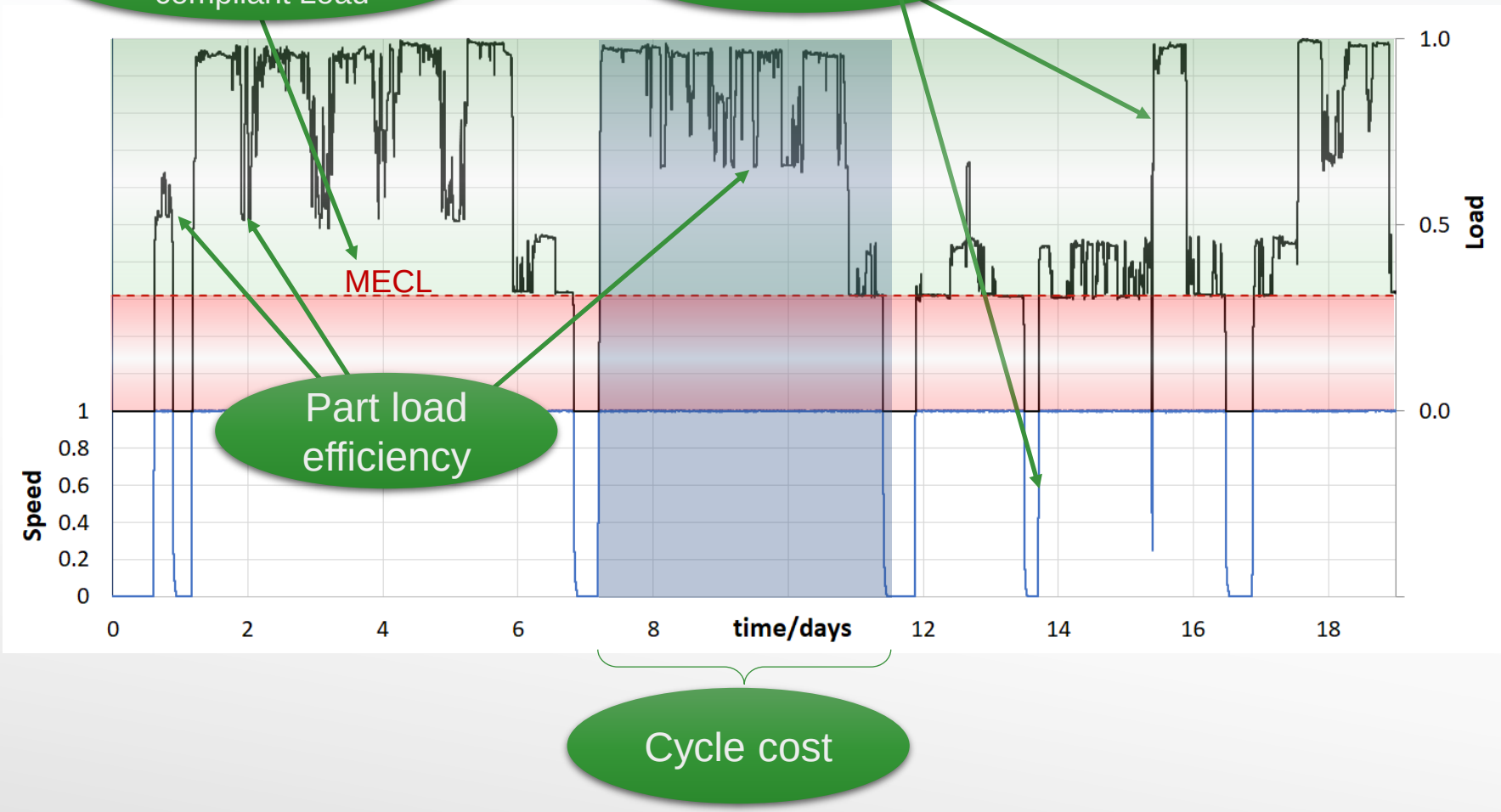
Assessing the impact of component innovations and improvements at plant level - Wolfgang Mohr, GE Switzerland

“TURBO-REFLEX. TURBOmachinery REtrofits enabling FLEXible back-up capacity for the transition of the European energy system”

Intermittent use of CCGT/Conventional power plants

- Definitions of four KPIs:

Example:
F-class CCGT



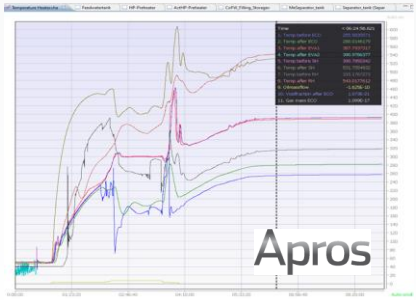
TurboReflex: Preliminary classification of technologies per KPI

- Service application (TRL>4)
  - Retrofits
  - Upgrades (Components/Control)

Reference power plants
- F-class CCGT
- 500MW conventional

ID	Project	Description	Minimal load	Ramp rate	Part load efficiency	Cycle cost	System	Effect on PP performance
1	T1.1(GE)	Compressor end wall design for larger operability	✓		✓		GT	YES
2	T1.2 (AEN)	Compressor blow off extraction design	✓				GT	NO
3	T1.3 (MH-UK)	Compressor performance and operability during charging	✓				GT	YES
4	T2.1 (SIE)	Gas turbine combustor with enhanced load flexibility	✓	✓			GT	YES
5	T2.2 (MH-UK)	Combustor stability during charging and discharging	✓	✓			GT	YES
6	T2.3 (AES)	Advanced turbine cooling schemes		✓	✓	✓	GT	YES
7	T3.1 (MAN)	Robust mechanical design (burst speed, LCF, …)	✓			✓	GT	NO
8	T3.2 (DSPW)	Steam turbine – blade vibrations	✓				ST	NO
9	T3.3 (DSPW)	Steam turbine – thermal loading		✓			ST	NO
10	T3.3 (SIE)	Exploitation of stretched design limits for flexible and cost-effective plant operation	✓				ST	NO
11	T4.1 (MAN)	Condition and efficiency monitoring system		✓		✓	PP(GT)	NO
12	T4.2 (DSPW)	Steam turbine monitoring system	✓	✓		✓	ST	YES
13	T4.3 (GECH)	Power generation analytics	✓	✓	✓	✓	PP	YES
14	T4.4 (SIE)	Machine learning on large heterogeneous data sources for optimized operation		✓		✓	PP	NO

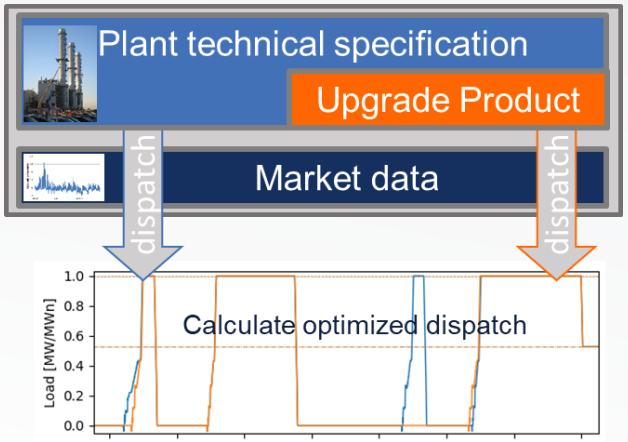
WP5: Assessing technology impact



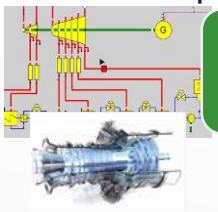
WP5.3
Closed loop plant model
(components & control)

Performance improvements on plant level

Productization (Example)



Thermal model of components

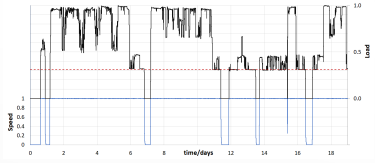


Performance improvement on component level

Thermo-economic Assessment

Minute-resolved/full-year Dispatch Optimizer

Objective: Maximum income
Validation: Historic plant commitments



TurboReflex Methodology

Technology Development

Project Work
in WP1 to WP4
→ Validated results

KPI definition

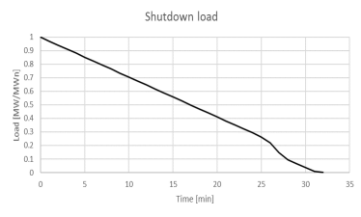
Product Value

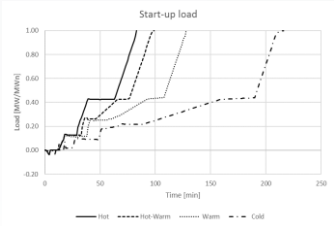
WP5.4
Development Scenarios
Risk of Investment
(required deprecation time)

Example: Subtask 4.3.1 WSC preservation

- **Plant technical specification**

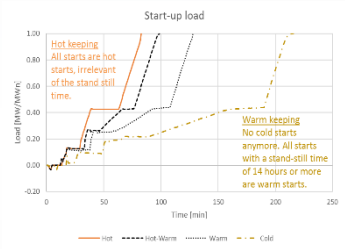
  - Reference plant: F-class CCGT
    - Start-ups & shutdowns
    - Maintenance cost
    - Operation cost





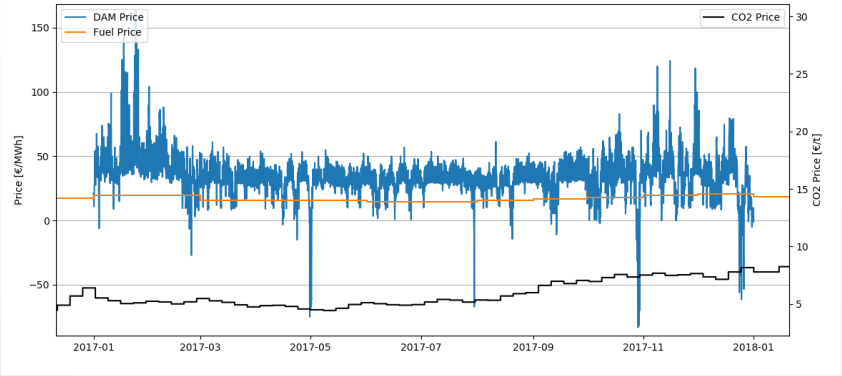
Upgrade Products enabled by technology

  - Warm keeping of ST
  - Hot keeping of ST



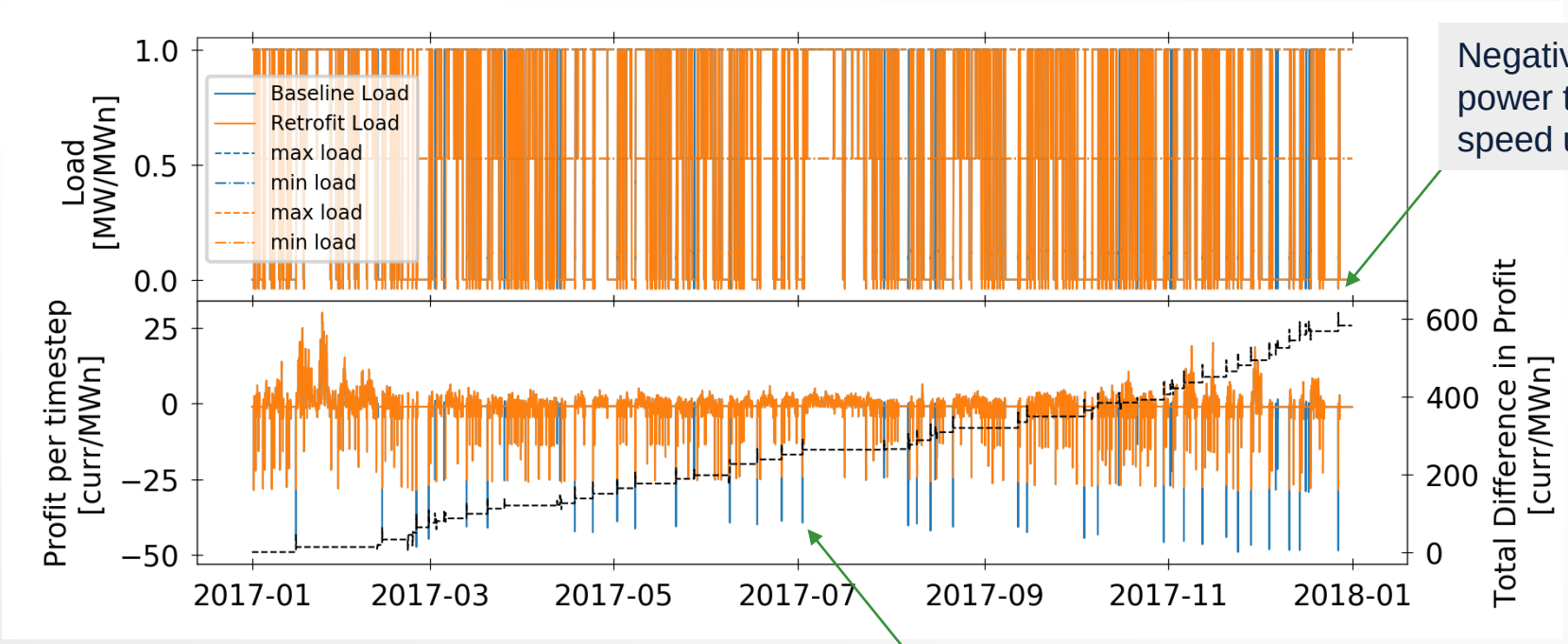
- **Market data**

Market	Name	Resolution	Period
Electricity	Day ahead market (DAM)	1 hour	2017
Fuel	Natural Gas Prices Europe	Monthly	2017
Emissions	EUA	Weekly	2017



Example: Subtask 4.3.1 WSC preservation

- Result of an optimized dispatch
  - Orange: Retrofitted power plant
  - Blue: Baseline power plant



Example: Assessment results in 2017 markets

 Germany	Increase in profit [€/MWn/a]	Capacity factor [%]	Hot	Hot-warm	Warm	Cold	Low load
Baseline	0	49.1%	109	38	49	33	61
WSC Warm Keeping	582	48.6%	104	32	80	0	59
WSC Hot Keeping	1'633	48.0%	234	0	0	0	49

 UK	Increase in profit [€/MWn/a]	Capacity factor [%]	Hot	Hot-warm	Warm	Cold	Low load
Baseline	0	94.7%	47	4	1	0	96
WSC Warm Keeping	0	94.7%	47	4	1	0	96
WSC Hot Keeping	34	94.7%	53	0	0	0	95

- Both products reduce the start-up costs, saving fuel and O&M costs
- Upgraded power plants are sometimes operated, while it is not beneficial to start the baseline power plants, due to higher start-up costs
- Low load events of the baseline plant, are partially removed by start-stop cycles.
- More flexible operation due to shortened start-up time.

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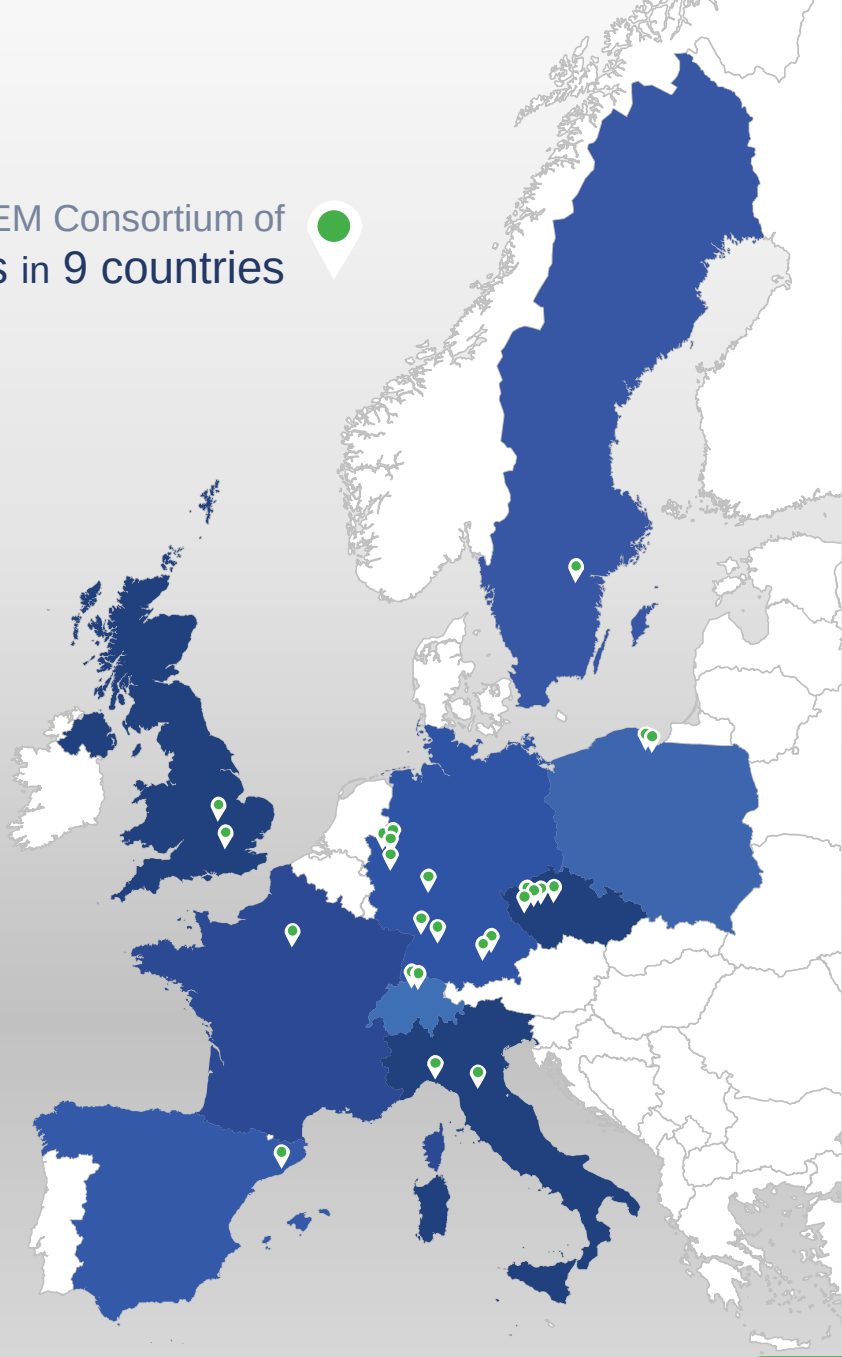
An OEM Consortium of
26 partners in 9 countries



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