La risposta di GE alle attuali esigenze del mercato elettrico

Tecnologie per aumentare rendimento e flessibilita' di impianti esistenti

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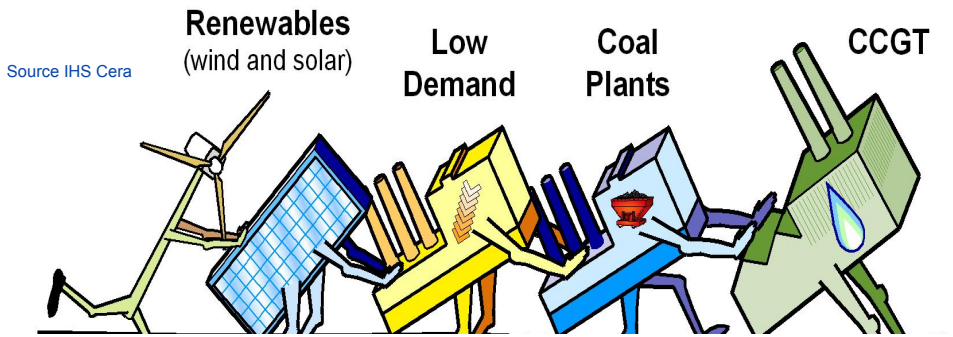
Mercato Elettrico



MGP (Day Ahead)

MSD

Regolazione di Frequenza secondaria …

Principali Richieste

- Efficienza
- Specialmente a carichi parziali
- Ottimizzazione dei costi variabili
- Riduzione del minimo tecnico

- Riduzione tempi di avviamento “Fast Start “
- Aumento delle rampe di carico “Fast Ramp”
- Flessibilita’ operativa FFH / FS
- Aumentare Delta Pmax- Pmin

Nel rispetto delle emissioni 30 mg NOx, 30 mg CO, 0 mg SOx

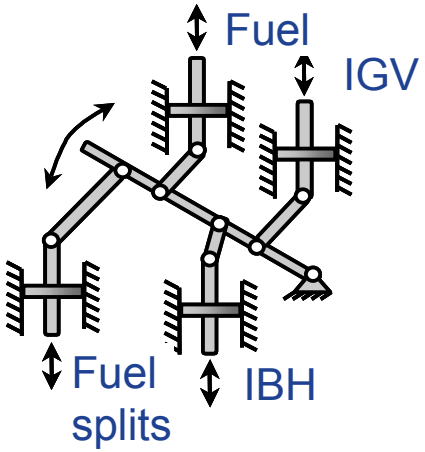
FlexEfficiency Solutions for 9F and 9E units

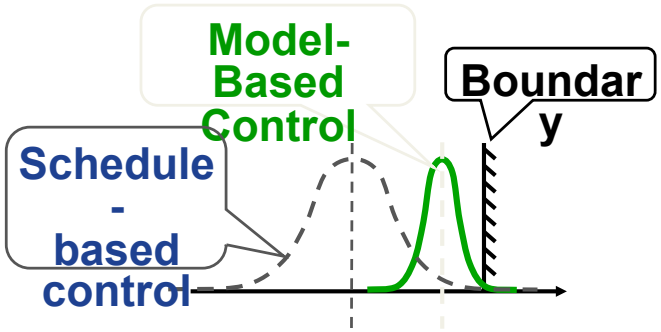
Tech	Size	Installed in Italy	FlexEfficiency Solutions
9 F	400 MW (109) 800 MW (209)	28 units ~ 15% Programmable Capacity	OpFlex Platform 9F Advance Gas Path Partial Load Efficiency Fast Start
9 E	127 MW SC	24 units ~ 5% Programmable Capacity	DLN1 Extend 9E Advance Gas Path

OpFlex Platform
MBC - New control methodology

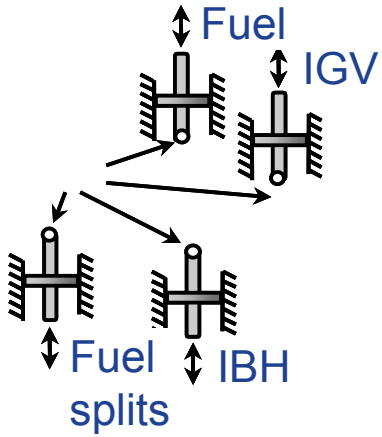
9F

Schedule Based Control





Model Based Control



Off-line, static model
- Traditional gas turbine control approach

Indirect boundary protection
- Dependent actions … effectors tied together

Inflexibility
- Margins applied for worst-case conditions

On-line, real-time model
- GE aircraft engines control approach

Direct boundary protection
- Independent actions … individual boundaries

Flexibility
- Unit-specific performance / operability entitlement

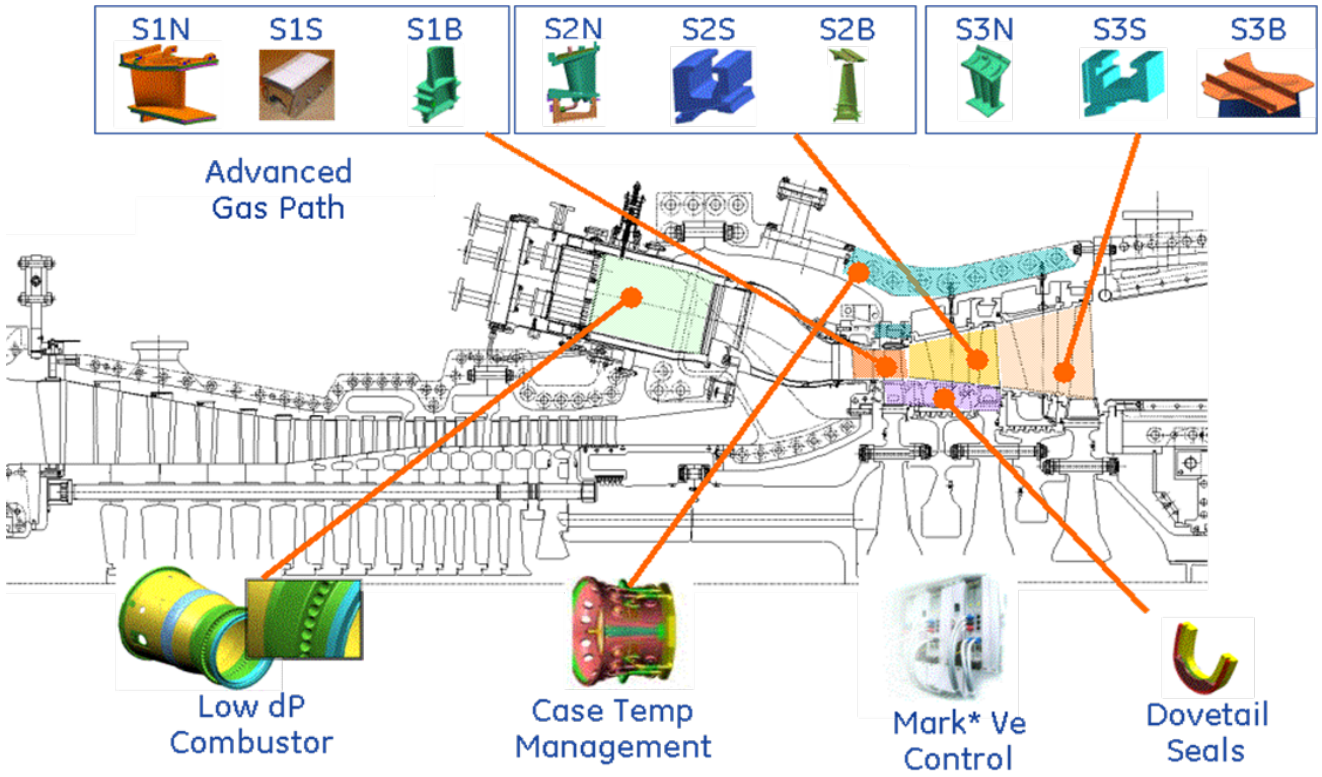
OpFlex Platform

9F

	Description and Benefits
ETS (Basis)	During grid stability event … rapid load change • Fuel to air ratio must remain within the operability limits of the combustor • Control detection and response have different delays … fuel, air, exhaust Solution: Coordinated Air to Fuel (CAF) with feed forward control for IGV angle
Autotune (Basis)	• No need for combustion re-tuning • Reliable operation up to +/- 10% variation in MWI • Automated firing temperature correction
Cold Day Performance	• Dynamics control enables removal of firing temperature suppression below 15°C • ~ + 3% GT output @ Tamb <15C
Variable IBH	Heat Rate improvements all loads (up to -1.2% @ part load in CC 109)
Extend Turndown	Up to 35% GT Load
Fast Ramp	From 21 MW/min to 50MW/min including advanced control on the Attemperation. Maintenance Factor to apply … under development.
Peak Load	• Peak Firing +30F above the base-load value (30 mg/Nm^3 NOx and 20 mg/Nm^3 CO) • Up to 2.2% increase in GT output … Up to 1.5% increase in CC output • Maintenance Factor to apply

9F Advance Gas Path

9F



- Aerodynamic scale of the 7FA.04 advanced gas path which uses FB technology
- Reduced cooling and sealing flows and tighter clearances for reduced leakage flows
- Design enhancements to address known 9FA.03 hot gas path distress modes
- Firing temperature increase (+20F)
- **Benefits**
  1. Heat Rate (BTU / KWh) at all loads: **1.6% - 2.1% in CC (109)**
  2. Power (MW): **~ 5% in CC (109)**
  3. Repair Interval: **32K FFH / 900 (1200) FS**

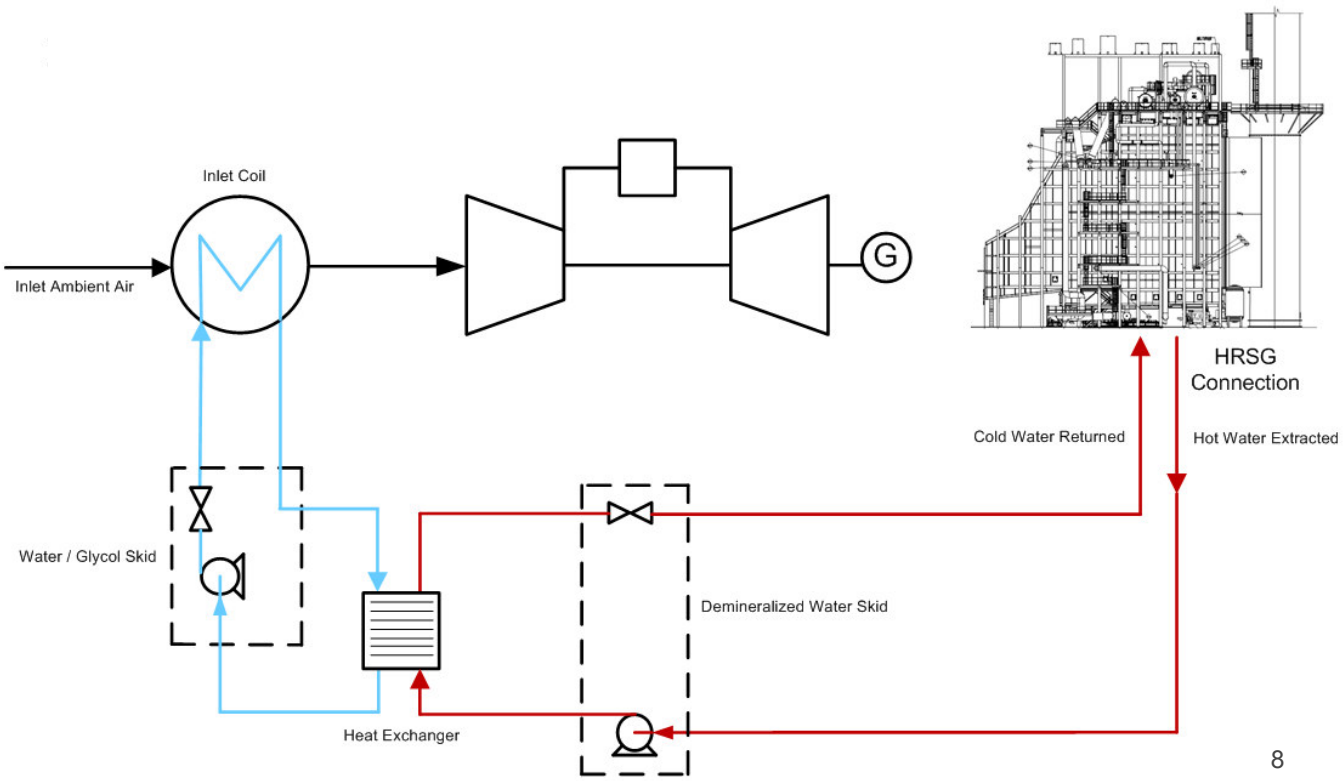
PLE (Partial Load Efficiency)

9F

- Based on DLN2.6+
- Uses low level energy from the bottoming cycle to heat the gas turbine inlet air during part load operations. Operates the compressor at more efficient point

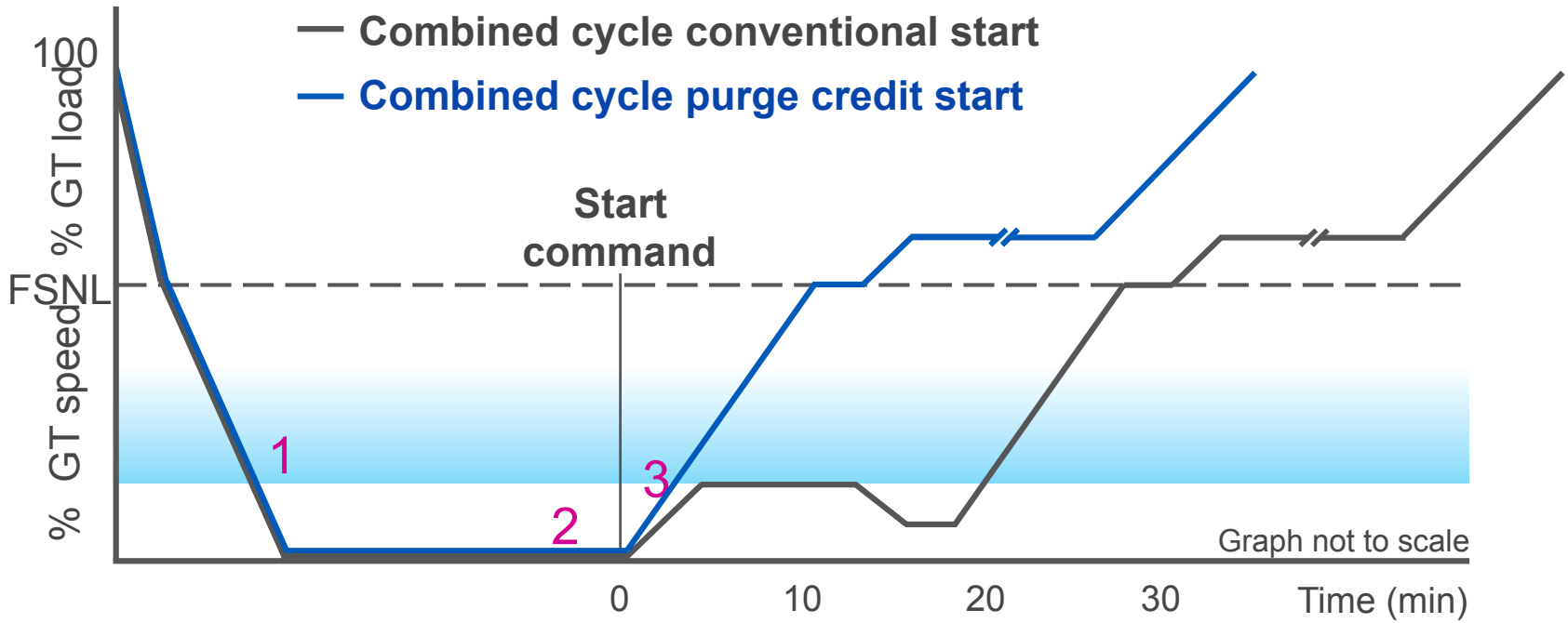
Benefits

- Min turndown up to 30% GT Load
- Heat rate improvement especially at min load Up to -2% Combined Cycle
- Requires feasibility study



Fast Start (Purge Credit)

9F



Features

1. Purge credit: GT purge performed during normal shutdown

2. Pre-start checks: automated check sequences

3. Fire on the fly: ignition during acceleration and warm-up removal

Benefits:

- Reduction of Start Up Time = Purge Credit time

9E Advanced Gas Path
Features and benefits

9E

Stage	Part	Improvement	Benefit
1st	Nozzle	Improved sealing Advanced cooling	Clearances Durability/Perf
	Bucket	Turbulators Dovetail sealing	Durability/Perf Clearances
	Shroud	Abradable shroud	Clearances
2nd	Nozzle	Advanced cooling GTD*262 Alloy	Durability and performance
	Bucket	Advanced Cooling Dovetail sealing	Durability/Perf Clearances
	Shroud	Abradable honeycomb	Clearances
3rd	Nozzle	3D aero	Performance
	Bucket	3D aero	Performance
	Shroud	Abradable honeycomb	Clearances

Performances	Output	Heat rate	Exhaust energy
vs 2007 Unit	+4.2%	-2.5%	+0.3%

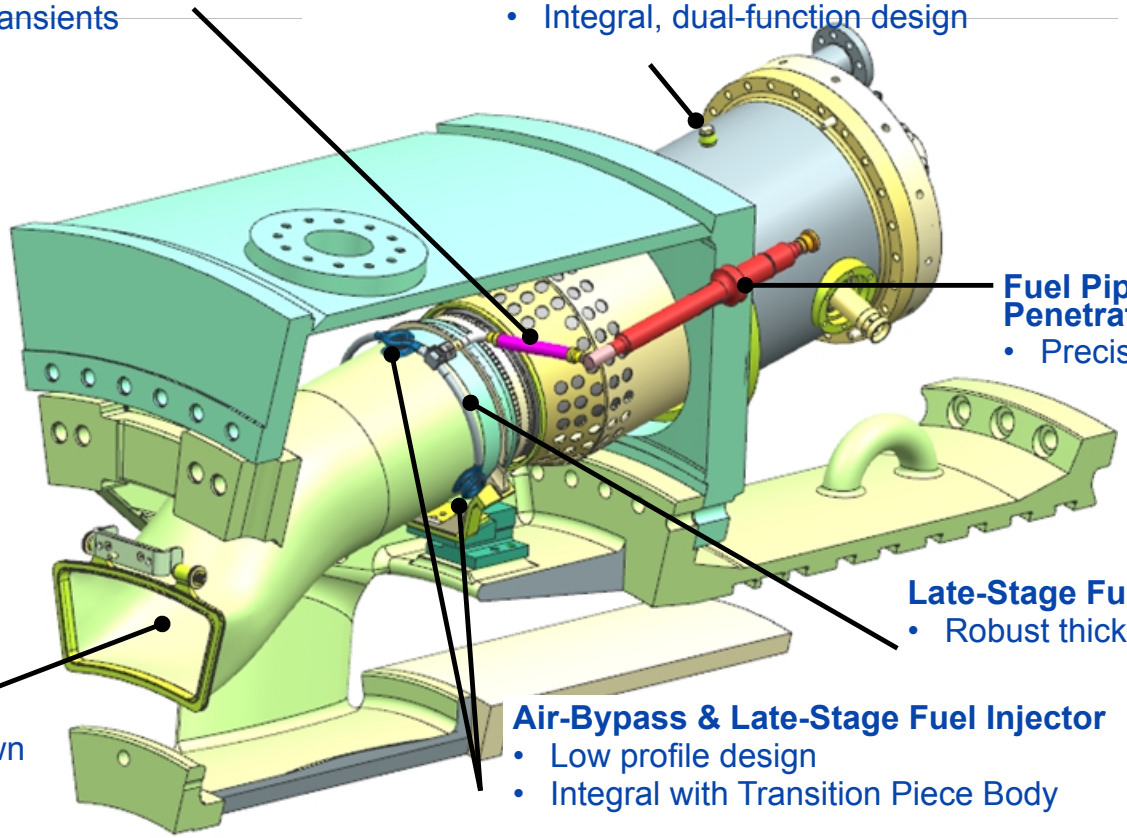
	Inspection Intervals (FFH)	Replace intervals (FFH)
9E STD HGP	24,000	72,000
9E AGP	32,000	96,000

9E Dry Low NOx Extend

9E

Fuel Delivery Flexhose:
- Compliant design for thermal transients

Combustion Dynamics and gas sampling for leak analysis:
- Existing dynamics probe port
- Integral, dual-function design



Fuel Piping Vessel Penetration:
- Precision on-site machined

Late-Stage Fuel Manifold:
- Robust thick-wall tubing

Dilution Holes:
- Additional Air-Bypass
- Optimized for turndown

Air-Bypass & Late-Stage Fuel Injector
- Low profile design
- Integral with Transition Piece Body

Benefits

- **Extended CO compliant turndown** – From 60%-**35%** of peak load (IBH installed)
- **Additional Output** : up to 100°F T^{fire} increase with no increase in current NO_x levels
- **Part-Load simple cycle efficiency** – up to 2% fuel burn reduction (higher Air / Pressure ratio
- **Repair Interval**: 32K FFH/1300 FS
- **Faster Normal Start:** from 32 min to 10 min

Principali Richieste

	9E	9F
• Efficienza	AGP	AGP
• Specialmente a carichi parziali		Variable IBH PLE
• Ottimizzazione dei costi variabili	32K FFH / 1200 FS	32K FFH / 1200 FS
• Riduzione del minimo tecnico		Extended Turndown PLE
• Riduzione tempi di avviamento “Fast Start “	DLN1 Extend	Purge Credit
• Aumento delle rampe di carico “Fast Ramp”		Ramp rate Advance Attemperation
• Flessibilita’ operativa FFH / FS		
• Aumentare Delta Pmax- Pmin	AGP	Peak Fire Cold Day Performance AGP

Energia Pulita / Miglior Qualita' dell'Aria

- **Senza aumentare i costi dell' Energia**
- **Garantendo la flessibilita' del Sistema Elettrico**
- **Rispettando i limiti di emissioni piu' stringenti**

ESISTE LA TECNOLOGIA PER FLEX-EFFICIENTARE GLI IMPIANTI

ESTENDERE I WHITE PAPER (TEE) AGLI IMPIANTI DI PRODUZIONE ENERGIA

INCENTIVARE I CONSUMI ELETTRICI

- **Autotrazione**
- **Riscaldamento**

RIFORMATTAZIONE DELLA TARIFFA ELETTRICA

GRAZIE!