Benefits of Aero-derivative Technology in Supporting Renewable Power Generation

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Changing Global Energy Market

- Volatile market due to:
  - Environmental Legislation driving to lowering of emissions and GHG output
  - Energy Efficiency Regulations
  - Retirement of capacity
  - Renewable Energy Drive
  - Developing Markets and Global Competition for Fuels

- These changes are driving the way we generate and trade electricity
Aeroderivative Gas Turbines

- Key attributes derived from aero heritage
  - High Power Density
  - Simple Cycle Efficiency
  - Operational Flexibility
    - Fast Start
    - Flexible Combined Cycle
    - Cycling
  - Availability
  - Construction

Assumptions for CCGT; Based on Trent 60 DLE ISI generating set; Once Through Steam Generator Boilers with Dearating Condenser; Typical pipeline quality natural gas fuel; Standard CC installation Losses at sea level with maximum wet bulb < 32°C; Supplementary Firing (<600°C) as required; Site Net Performance includes typical Auxiliary Power and Site Transformer Losses
Plant Configuration for Load Duration Curve

**Peak load**
- Peaking Plants
- Low CAPEX
- Fast Start
- Gas Turbines in Simple Cycle

**Base load**
- Mid-Merit Cycling Plant
- Trade-off between Capex and Efficiency
- Daily start/stop
- Gas Turbines in Flexible CCGT

**Aero-derivative Technology Fit**
- High Power Density
- Simple Cycle
- Operational Flexibility
- Availability
- Construction

- High Merit Plant
- High Capex
- High Efficiency
- Frame CCGT
- Nuclear
- Coal
- Steam Lead CHP

- Plant Operating Hours in a Year
- Electricity Selling Price COE $/MWh

Rolls-Royce proprietary information
Electricity Distribution Systems

- Example of renewable (wind) distributed power generation
- Challenge for a Grid Operator is to keep a system in balance in real time with the volatile generation supply and forward energy contracts for electricity supply
- This creates the need for fast start up, flexible and reliable forms of power generation to cope with the system dynamics
Renewable Generation on Distribution Grid
Example of one 24 hour Trading Period

Wind Generation displaces overnight secure generators required for daytime load ramps. The large potential imbalance swings require fast flexible aero CCGT.

DEMAND RISING
+375 MWe/hr

DEMAND RISING
+75 MWe/hr

Diverging Wind Generation vs Demand – Gap can be filled by fast flexible generation.

WIND Energy
-120 MWe/hr
Summary

- Changing market dynamics is driving changes in the way we generate and trade electricity
- Aero-derivative gas turbine flexibility is very complimentary to renewable generation
- Continuous improvements.....
  - Power output
  - Efficiency
  - Operational Flexibility
  - Environmental
Thank You