HITACHI

Standardized Combined Cycle Power Plant for Gas Turbine H-80

22.04. – 23.04.2013
GT Conference Bucharest 2013
1. Standardized Combined Cycle Power Plant with GT H-80

2. Performance Figures

3. Steam Turbine

4. Arrangement Planning
Standardized Combined Cycle Power Plant H-80
Motivation and Requirements

Motivation to develop a new standardized CCPP:

• New available gas turbine H-80 with radial exhaust (Hot-End-Drive) within the Hitachi Power Segment

• Lack of available Combined Cycle Power Plants in the 150 MW-class with 1 GT resp. 300 MW-class with 2 GT

Requirements to the new CCPP-Concepts:

• Compact and less consuming area demand plant design

• Optimized for decentralized combined production of district heat and-/or process steam extraction and electricity

• Optimal economic efficiency for both power- and heat oriented operation ➔ plant concept without reheat!
Combined Cycle Plant Concepts for new GT H-80 Solutions

N1/S1: 1x GT type H-80 with HRSG, 1x ST (Single-Shaft-Arrangement)

N1: North Europe

Gas Turbine -> HRSG vertical 2-pressure -> Large LSB Steam Turbine single Casing -> Condenser -> Cooling Tower

S1: South Europe

Gas Turbine -> HRSG horizontal 2-pressure -> small LSB Steam Turbine single Casing -> ACC

District Heater and/or Steam Extraction

if applicable only
Combined Cycle Plant Concepts for new GT H-80 Solutions

N2/S2: 2x GT type H-80 with HRSG, 1x ST (Multi-Shaft-Arrangement)

N2: North Europe
- Gas Turbine
- HRSG (vertical 2-pressure)
- Steam Turbine
- Condenser
- Cooling Tower

S2: South Europe
- Gas Turbine
- HRSG (horizontal 2-pressure)
- Steam Turbine
- ACC
- District Heater and/or Steam Extraction

if applicable only
1. Standardized Combined Cycle Power Plant with GT H-80
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N1 CCPP Concept with one Gas Turbine H-80
Condensing Operation with Single-Shaft-Arrangement

Performance Data at ISO-Condition: $T_{amb} = 15^\circ$ C; $\varphi_{amb} = 60\%$; $P_{amb} = 1013$ mbar

Hitachi Power Europe GmbH
N2 CCPP Concept with two Gas Turbines H-80
Condensing Operation with Multi-Shaft-Arrangement

Performance Data at ISO-Condition: \( T_{\text{amb}} = 15^\circ \text{C} ; \phi_{\text{amb}} = 60\% ; P_{\text{amb}} = 1013\text{mbar} \)
S1 CCPP Concept with one Gas Turbine H-80
Condensing Operation with Single- Shaft- Arrangement

Performance Data at ISO-Condition: \( T_{\text{amb}} = 15^\circ \text{C} ; \varphi_{\text{amb}} = 60\% ; P_{\text{amb}} = 1013\text{mbar} \)

- **Generator Output**: 138.7 MW
- **Net Power Output**: 136.0 MW
- **District Heating**: 0.0 MJ/s
- **Net Fuel Utilisation**: 51.36 %
- **Fuel Consumption**: 264.7 MJ/s
- **Power to Heat Ratio**: -

<table>
<thead>
<tr>
<th>Component</th>
<th>P – bar(a)</th>
<th>T – ° C</th>
<th>M – kg/s</th>
<th>V – m³/s</th>
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<tr>
<td>Natural Gas</td>
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<td>Air</td>
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<td>1.013 P 15.0 T</td>
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<td><strong>H-80 Gas Turbine</strong></td>
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<td><strong>Two-Pressure HRSG</strong></td>
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<td><strong>Steam Turbine</strong></td>
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<td>Feed Water Tank</td>
<td>0.096 P 42.8 M 584 V</td>
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<td>Air Cooled Condenser (ACC)</td>
<td>0.096 P 42.8 M 584 V</td>
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<td>Make-Up 20.0 T</td>
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<td><strong>Feed Water Tanks</strong></td>
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<td>104.8 T</td>
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<td>48.2 M</td>
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<td>60.0 T</td>
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<td>Flue Gas</td>
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<td>7.5 M</td>
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<td>LP-Drum</td>
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<td>35.3 M</td>
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<td>526.7 T 35.3 M 7.5 M</td>
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<td>80.0 P 8.5 P 105 T</td>
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S2 CCPP Concept with two Gas Turbines H-80
Condensing Operation with Multi-Shaft-Arrangement

Performance Data at ISO-Condition: $T_{\text{amb}} = 15^\circ \text{C}$; $\varphi_{\text{amb}} = 60\%$; $P_{\text{amb}} = 1013\text{mbar}$
N1 CCPP Concept with one Gas Turbine H-80
Net Plant Efficiency vs. Gross Power Output

Performance Data at ISO-Condition: $T_{\text{amb}} = 15^\circ \text{C}$; $\varphi_{\text{amb}} = 60\%$; $P_{\text{amb}} = 1013\text{mbar}$

- Gas Turbine at Part Load with Inlet Bleed Heating (IBH)
- 6,3 m² Last Stage Blades
- District Heating Operation:
  - 60 °C return temperature
  - 110 °C supply temperature

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Jürgen Klebes, GT-Conference Bucharest 2013
Hitachi Power Europe GmbH
N1 CCPP Concept with one Gas Turbine H-80

Net Power Output vs. District Heat Output

Performance Data at ISO-Condition: \( T_{\text{amb}} = 15^\circ \text{C} \); \( \varphi_{\text{amb}} = 60\% \); \( P_{\text{amb}} = 1013\text{mbar} \)
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Performance Data at ISO-Condition: $T_{\text{amb}} = 15^\circ \text{C}$; $\varphi_{\text{amb}} = 60\%$; $P_{\text{amb}} = 1013\text{mbar}$
N2 CCPP Concept with two Gas Turbines H-80
Comparison of specific Power Generation Cost

Performance Data at ISO-Condition: \( T_{\text{amb}} = 15^\circ C \); \( \phi_{\text{amb}} = 60\% \); \( P_{\text{amb}} = 1013\text{mbar} \)

Load Regime:
- 5000 operation hours per year
- 100 MJ/s average district heat extraction
- 2200 operation hours minimum GT-Load per year
- without CO2-emission cost
- without subsidies from CHP law
N2 CCPP Concept with two Gas Turbines H-80
Comparison with CCPP of 400 MW-Class

Performance Data at ISO-Condition:

\[ T_{\text{amb}} = 15^\circ \text{C}; \varphi_{\text{amb}} = 60\%; P_{\text{amb}} = 1013\text{mbar} \]
N2 CCPP Concept with two Gas Turbines H-80
Net Power Output vs. District Heat Output

Performance Data at ISO-Condition: $T_{amb} = 15^\circ$ C; $\varphi_{amb} = 60\%$; $P_{amb} = 1013\text{mbar}$

District Heating Operation: 60 °C return temperature
110 °C supply temperature

- 100%-Load of GT 1 & 2 with District Heating and Supplementary Firing
- 100%-Load of GT 1 & 2 with District Heating
- Part Load of GT 1 & 2
- 25%-Load of GT 1 & 2
- 25%-Load of GT 1 with District Heating and GT 2 out of Operation
- 25%-Load of GT 1 & 2
- 25%-Load of GT 1
N2 CCPP Concept with two Gas Turbines H-80
Start-Up Diagram for Hot Start-Up (< 8 h )

![Start-Up Diagram](image)

- **LPT Speed**
- **HPT Speed**
- **GT Load**
- **ST Speed**
- **ST Load**

**Preliminary!**

- Ignition
- GT Synchronisation
- ST Synchronisation

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Picture of Steam Turbine during Assembly
N2 CCPP Concept with two Gas Turbines H-80
Picture of Steam Turbine Rotor before Assembly
N2 CCPP Concept with two Gas Turbines H-80
Cross Sectional Drawing of Steam Turbine with adjustable Guide Vanes at Extraction
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N1 CCPP Concept with one Gas Turbine H-80
Arrangement Plan / Field Dimensions

~ 67 m
~ 105 m (with cooling tower)
~ 100 m
N2 CCPP Concept with two Gas Turbine H-80
Arrangement Plan / Field Dimensions

~ 175 m (with cooling tower)

~ 136 m

~ 113 m
N2 CCPP Concept with two Gas Turbines H-80
View of the Power Plant
N2 CCPP Concept with two Gas Turbines H-80
View of the Power Plant
N2 CCPP Concept with two Gas Turbines H-80
View of the Power Plant
CCPP Concept with Gas Turbine H-80
View to Gas Turbine
CCPP Concept with Gas Turbine H-80
View to Gas Turbine
N2 CCPP Concept with two Gas Turbines H-80
View of the Machine House / Steam Turbine
Thank you for your attention