华能清洁能源研究院
HUANENG CLEAN ENERGY RESEARCH INSTITUTE

Component Test Facility Project in China

Jianzhong Jiang

Deputy Director of
Department of Coal Clean and Efficient Utilization
Huaneng Clean Energy Institute, Beijing, China

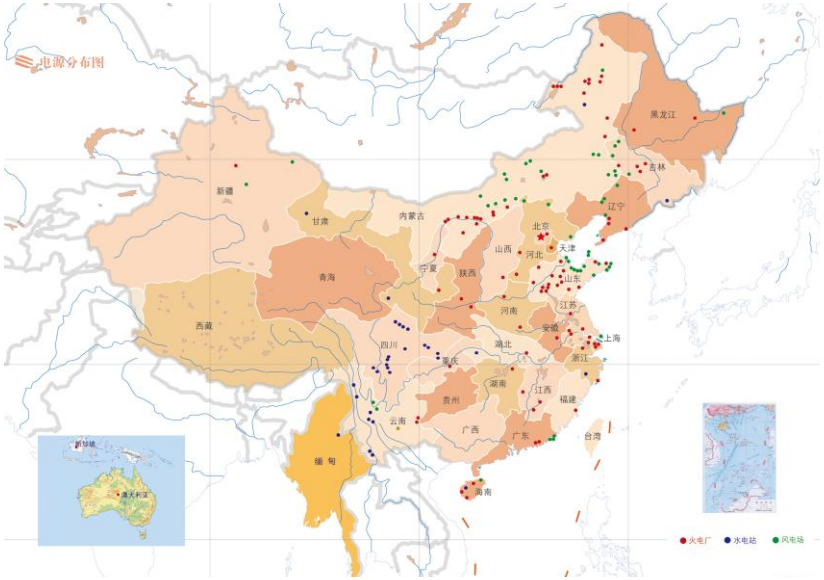
OUTLINE

- **Introduction to CERI**
- **Component Test Facility in the World**
- **Component Test Facility (CTF-700) in China**
- **Conclusion**

华能清洁能源研究院
HUANENG CLEAN ENERGY RESEARCH INSTITUTE

Introduction to China Huaneng Group

China Huaneng Group



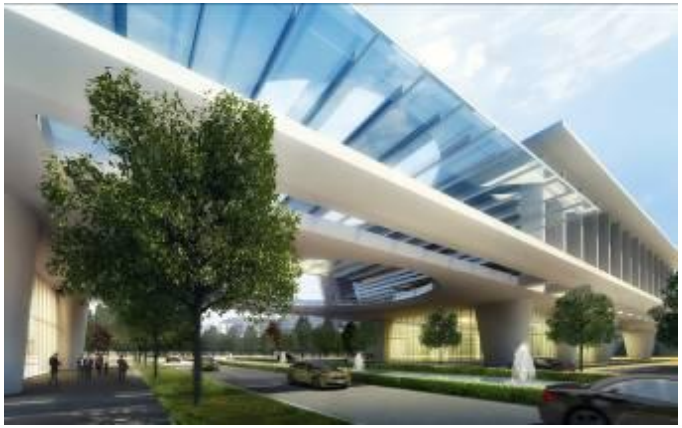
- Key state-owned company established with the approval of the State Council.
- The largest power generation company in Asia, the 2nd in the world.
- By the end of 2011, the Company had total installed capacity of 125.37GW, with assets distributed in 30 provinces (municipalities, and autonomous regions) of China and overseas.
- The first Chinese power producer to join the ranks of Fortune 500 Companies, ranking 275th in 2011.

华能清洁能源研究院
HUANENG CLEAN ENERGY RESEARCH INSTITUTE

Introduction to CERI

Huaneng Clean Energy Research Institute (CERI)

- **Institution focused on the frontier technology research and development of clean energy.**
- Mainly focuses on research of the following aspects:
  - Nearly zero emission for coal-fired power generation;
  - Coal gasification and clean coal-based energy conversion;
  - Capture, utilization and storage of CO_2;
  - Large–scale circulating fluidized bed boiler;
  - Low-quality coal utilization;
  - Renewable energy power generation;
  - Design and optimization of energy system.

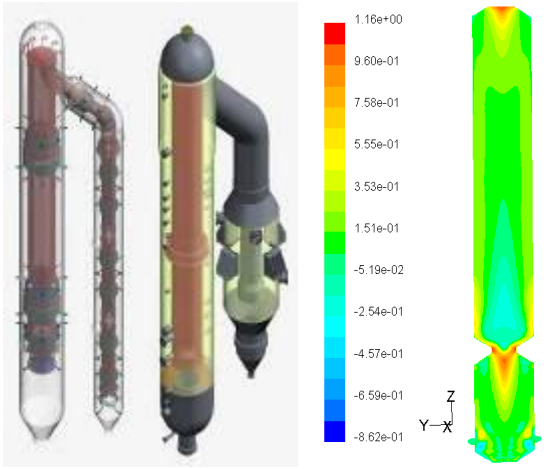


华能清洁能源研究院
HUANENG CLEAN ENERGY RESEARCH INSTITUTE

Introduction to CERI

CERI *is*

- National Energy Technology R&D Center of Clean and Low-carbon Coal-fired Power Generation Technology
- National Energy Technology R&D Center of Efficient Hydro-power Utilization and Dam Safety
- State Key Laboratory of Coal-based Clean Energy
- Beijing Engineering Research Center of Qualify and Clean Efficient Utilization of Poor Fuel
- Beijing Key Laboratory of CO_2 Capture and



3000t/d two-stage dry pulverized coal gasifier (used in Huaneng GreenGen Project inTianjin)

Largest CO_2 capturing facility in the world (120000t/y)

4MW circulating fluidized bed test device (largest in the word)

First Independent innovative 330MW CFB in China

华能清洁能源研究院
HUANENG CLEAN ENERGY RESEARCH INSTITUTE

Introduction to CERI

National key research projects

Undertaken:

- "Twelfth Five-Year Plan" National 863 Program "CO_2 capture system development based on IGCC"
- "Twelfth Five-Year Plan" National 863 Program "CCUS system design based on IGCC"
- NEA "**R & D and demonstration of 700℃ USC coal-fired power key equipment**"
- NEA "Key technology and equipment R & D and demonstration of CCUS in coal-based power generation and conversion process"

Completed:

- National 863 Program "250MW IGCC experiment and demonstration"
- National 863 Program "IGCC polygeneration system operation and control technology"
- National 863 Program "2000 t/d dry coal gasification technology development"
- National 863 Program "Coal gasification-based polygeneration demonstration"
- National 863 Program "Absorption of carbon dioxide capture technology"
- National 863 Program "250MW IGCC gas sensible heat recovery technology development and demonstration"

Component Test Facility in the World

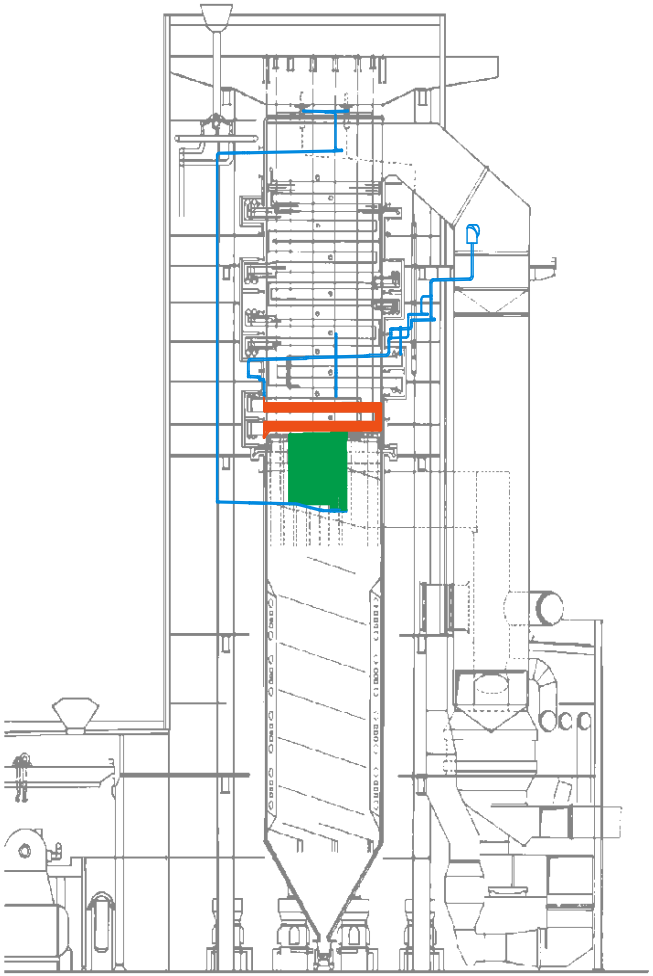
- Component test facilities are needed to provide experience in fabricating and erecting components and limit the cost and risk of building a commercial-scale demonstration plant.

Some well-known component test facilities in the world

Project	Host site	Mass flow rate (kg/s)	Steam temperature (℃)	Steam pressure (bar)	Duration
KOMET 650	Westfalen power plant, Unit B	1	650	190	2003-2008
Esbjerg	Esbjerg unit 3	unknown	720	270	2004-2010
COMTES 700	Scholven power plant, unit F	12	705	226	2004-2011
725 HWT GKM I	GKM power plant, unit 6	0.32	725	167	2008-2015
HWT II	GKM power plant, unit 6	unknown	725	167	2011-2014
ENCIO	Andrea Palladio Power Station	5	700	177	2011-2018
Weisweiler	PS Weisweiler Unit G	Unknown	650-720	160 (180)	1998-~2004
Vestkraft	PS Vestkraft Unit 3	Unknown	527-620	251	1995-unknown

Component Test Facility in the World

- **Component Test Facility in Europe**



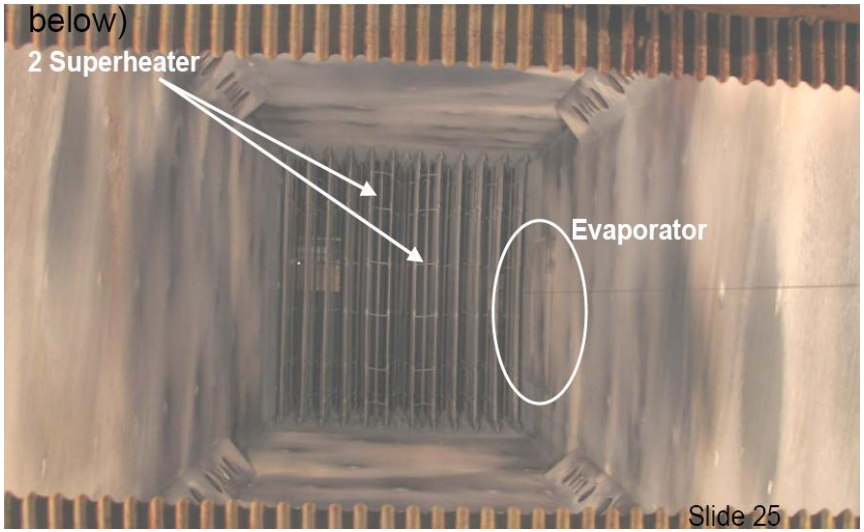
COMTES 700 test rig

Parameters of the units selected for test rig installation

- **Boiler type:** Tower boiler
- **Production capacity:** 676 MW
- **SH steam temperature:** 540℃
- **SH steam pressure :** 220bar

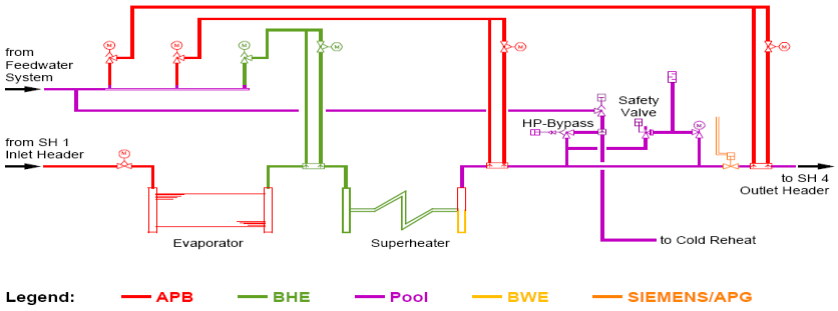
Parameters of test rig

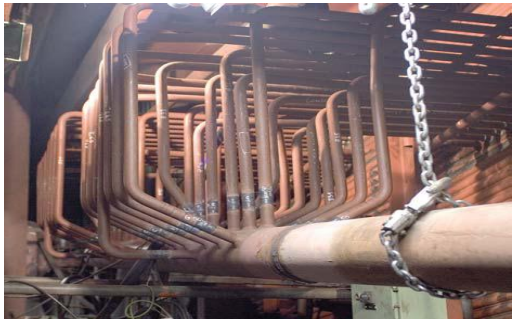
- **Test temperature:** 705 ℃
- **Steam flow:** 12 kg/s

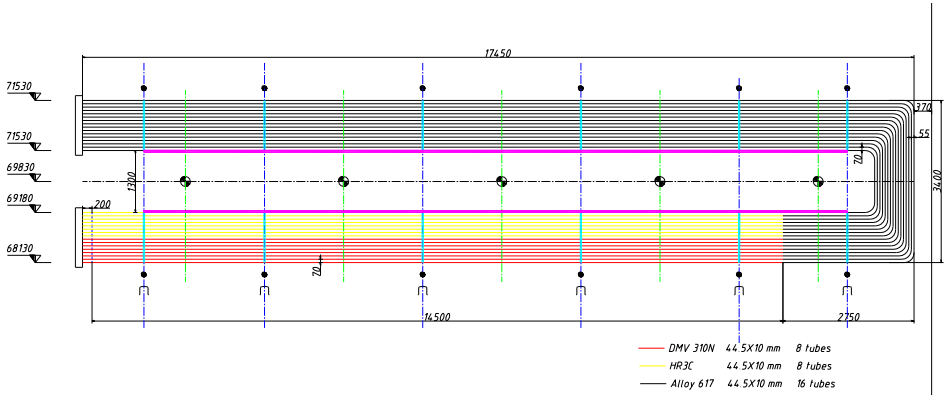


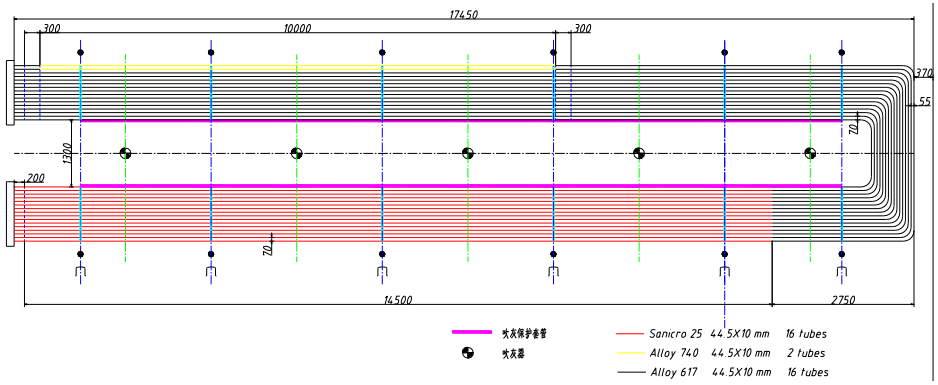
Component Test Facility in the World

- ## Component Test Facility in Europe





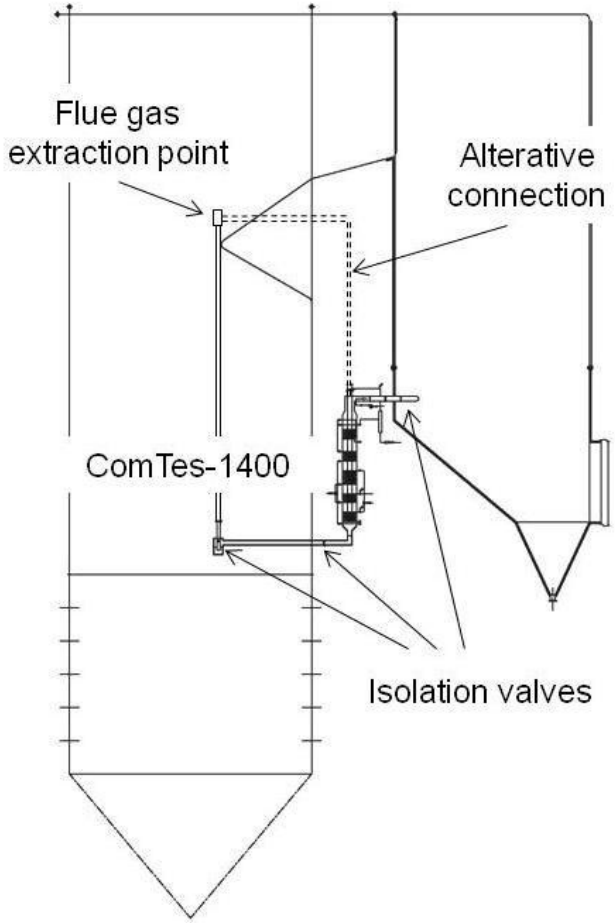




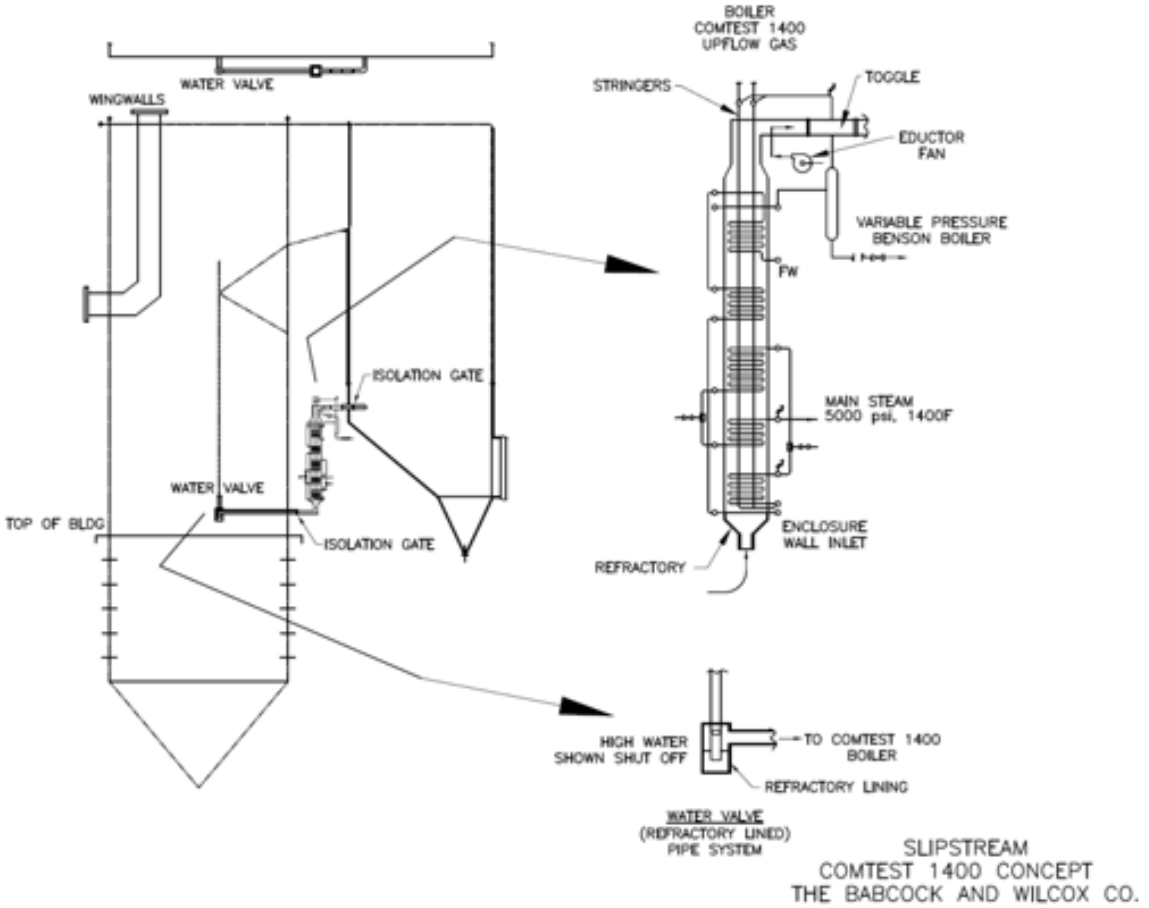
COMTES 700 test rig

Component Test Facility in the World

- **Component Test Facility in US**



A Slipstream Design



A Hybrid Design

华能清洁能源研究院
HUANENG CLEAN ENERGY RESEARCH INSTITUTE

Component Test Facility (CTF-700) in China

A state key energy-related project ***"R & D and demonstration of 700℃ USC coal-fired power key equipment"*** was set up by China Energy Bureau in 2011.

- **Project contents:**

- Overall scheme design of A-USC power plant
- Material research
- Boiler research
- Turbine research
- Building and operation of CTF-700
- Feasibility research for demonstrating project

CERI *undertakes one of the subprojects –* ***"Building and operation of CTF-700".***

华能清洁能源研究院
HUANENG CLEAN ENERGY RESEARCH INSTITUTE

cpecc 中国电力工程顾问集团
CHINA POWER ENGINEERING CONSULTING GROUP CORPORATION

TPRI 西安热工研究院有限公司
Xi'an Thermal Power Research Institute Co., Ltd.

DEC 中国东方电气集团有限公司
DONGFANG ELECTRIC CORPORATION

上海电气
SHANGHAI ELECTRIC

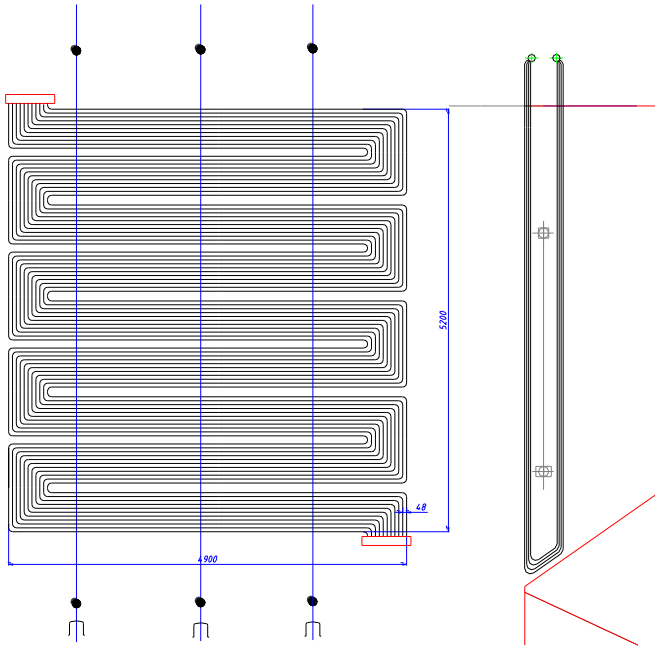
哈尔滨电气集团公司
HARBIN ELECTRIC CORPORATION

华能清洁能源研究院
HUANENG CLEAN ENERGY RESEARCH INSTITUTE

Component Test Facility (CTF-700) in China

- **Components in-service test on CTF-700**

1. Evaporative panel
2. Superheat section
3. Boiler header, large diameter pipe and accessories (tubes, valves, etc)



- **Parameters of CTF-700**

1. Steam temperature: 725 ℃
2. Steam flow rate : 3 kg/s
3. Steam pressure:

Step 1: *equal to the host plant*
Step 2: *equal to the Demo plant in future with a separate pumped circuit.*

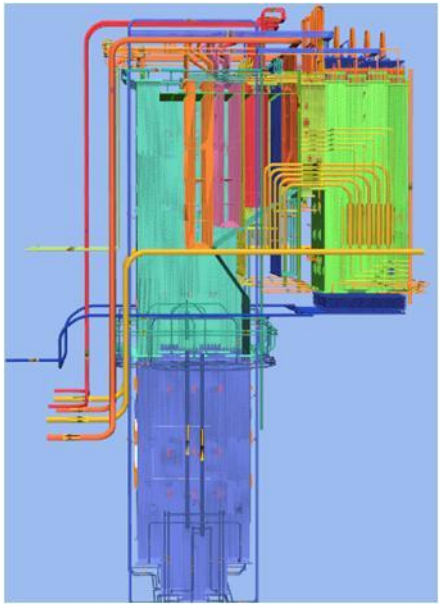
Component Test Facility (CTF-700) in China

Objectives

- Establish a test rig for components closer to commercial designs at host site.
- Test the performance and reliability of high-temperature materials and accessories through long-period running.
- Obtain the operating experience of high-temperature materials and limit the risk of demo plant.

Component Test Facility (CTF-700) in China

Design of CTF-700:



----Similar to the design of COMTES 700

----Differences:

1. Boiler type: ***Two pass boiler***
2. Location of the tested sections
3. Mass flow rate of the facility: ***3 kg/s***
4. Steam parameters: ***higher inlet pressure and outlet temperature***

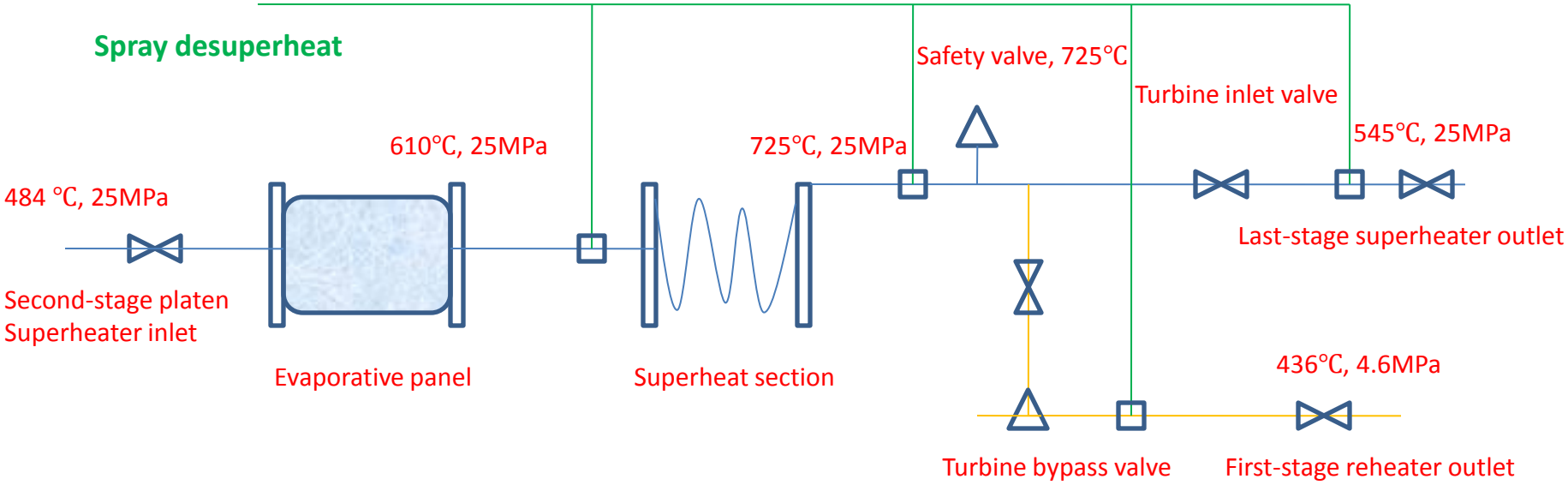
----Further consideration:

Increase the steam pressure to be equal to the demo plant.

华能清洁能源研究院
HUANENG CLEAN ENERGY RESEARCH INSTITUTE

Component Test Facility (CTF-700) in China

Steam flowchart



华能清洁能源研究院
HUANENG CLEAN ENERGY RESEARCH INSTITUTE

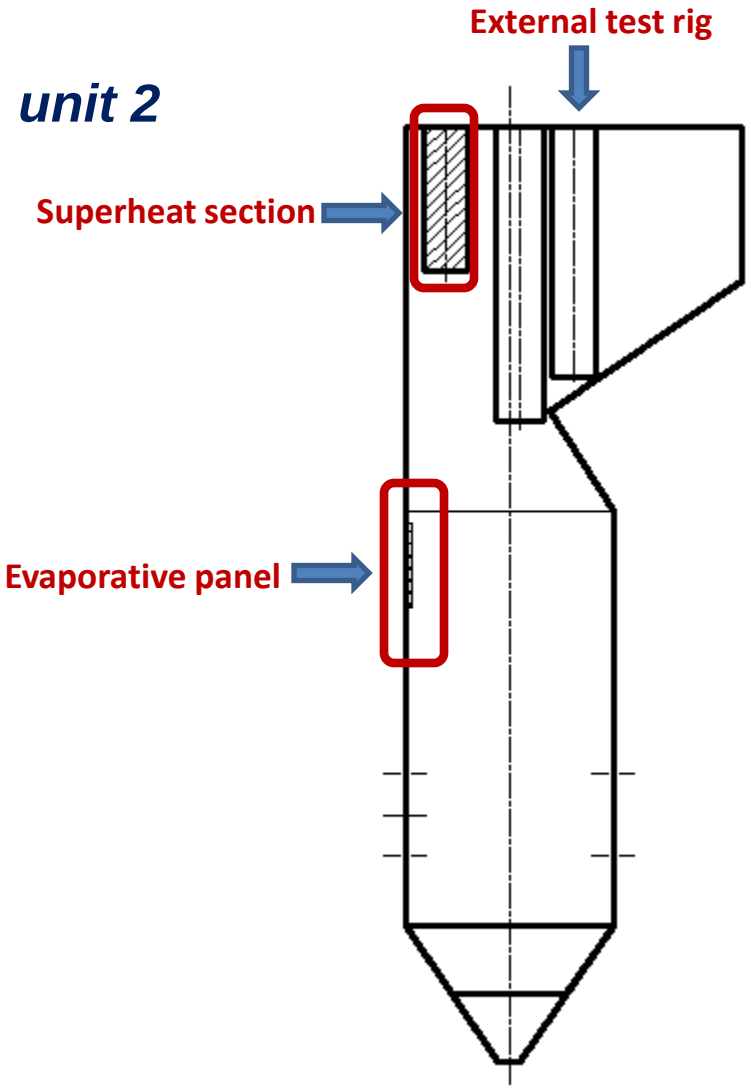
Component Test Facility (CTF-700) in China

Host site:

Huaneng Nanjing thermal power plant, unit 2

- **Boiler type:** *two pass boiler*
- **Steam capacity:** *1000 t/h*
- **Production capacity:** *320 MWe*
- **Burner type:** *wall fired System*
- **Fuel:** *bituminous coal*

- **SH steam temperature:** *540° C*
- **SH steam pressure:** *25 MPa*



Component Test Facility (CTF-700) in China

•Operation and experiment

- Test rig experiment
  - ✓ Monitor temperatures, pressures, creep strain, etc in boiler and test rig
  - ✓ Steam temperature control (STC) experiment
  - ✓ Component experiment

Component Test Facility (CTF-700) in China

- Component experiment

  Performance of new material

  1. Creep strength
  2. Rupture strength
  3. Rupture ductility

  Manufacture and processing of components

  1. Cold & hot working and machine processing
  2. Dissimilar steel welding
  3. Heat treatment

  Performance of high-temperature valves

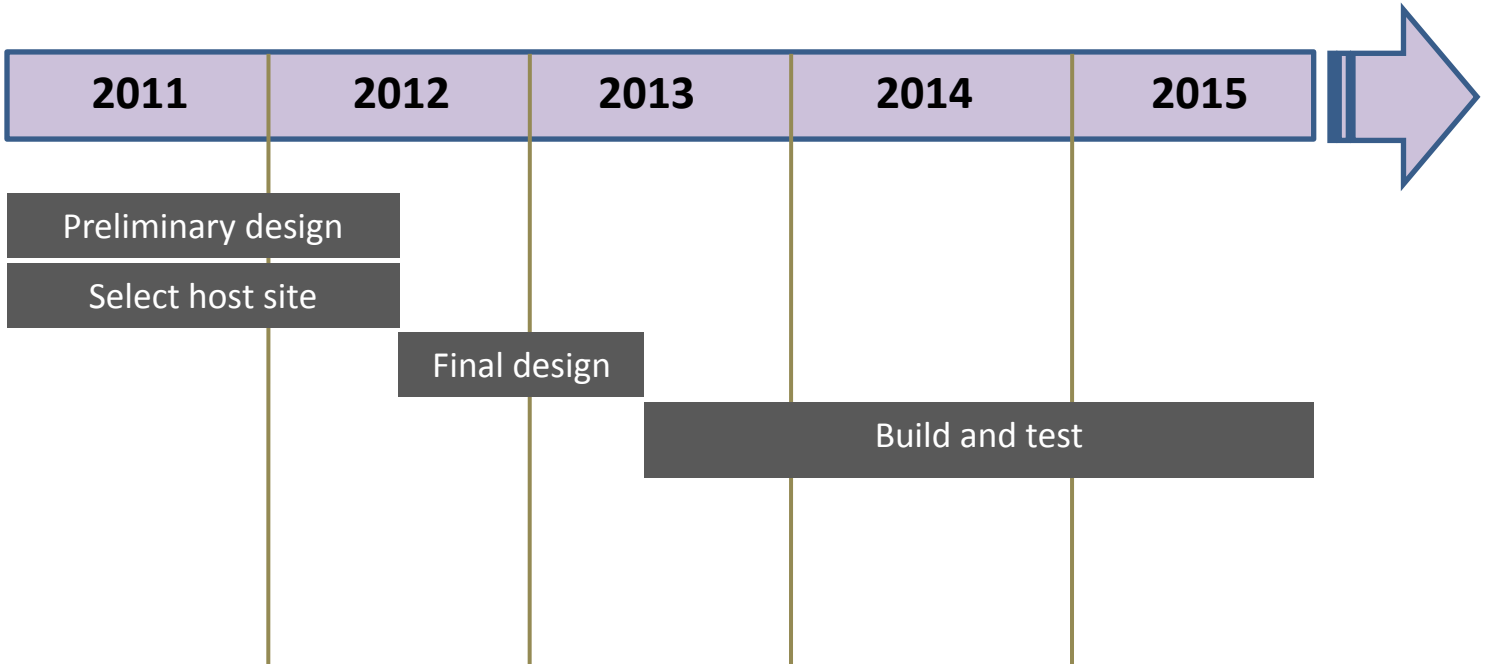
  1. Turbine inlet valves and bypass valves
  2. Control characteristics of valves

  Lifetime evaluation for components and other nondestructive test

  Lab examination (take samples if necessary)

Component Test Facility (CTF-700) in China

- **Time table**



Need tests for >100,000 hrs

Present:

- Designs without an extra HP piston pump have been finished.
- The host power plant has been determined.

Conclusion

✓Component test facility is essential before building a commercial-scale 700℃-class demo plant.

✓Components and materials tested on CTF-700 have been determined.

✓Steam parameters of CFT-700 have been determined.

✓Host site for CTF-700 has been determined.

Thanks!
… and question?