电力规划设计总院
Electric Power Planning & Engineering Institute

Development of 700℃ USC Coal-Fired Power Generation Technology in China

Sep 19-20, 2012

Vienna, Austria

Content

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1. Electric Power Development Situation of China

2. Introduction of the National 700℃ USC Consortium

3. R&D Proposal of the National 700℃ USC Technology

4. Progress of the Research Project

5. Follow-up R&D work

Content

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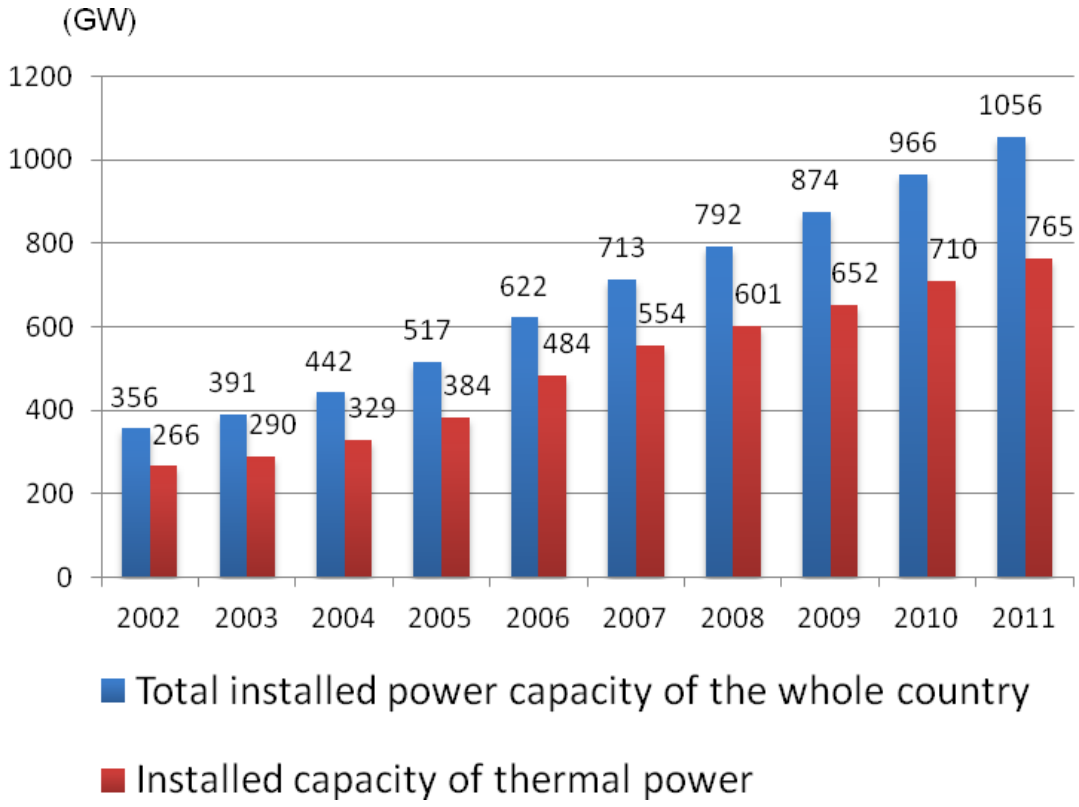
Electric Power Development Situation of China

Ⅰ. Installed Capacity and Structure of Electric Power

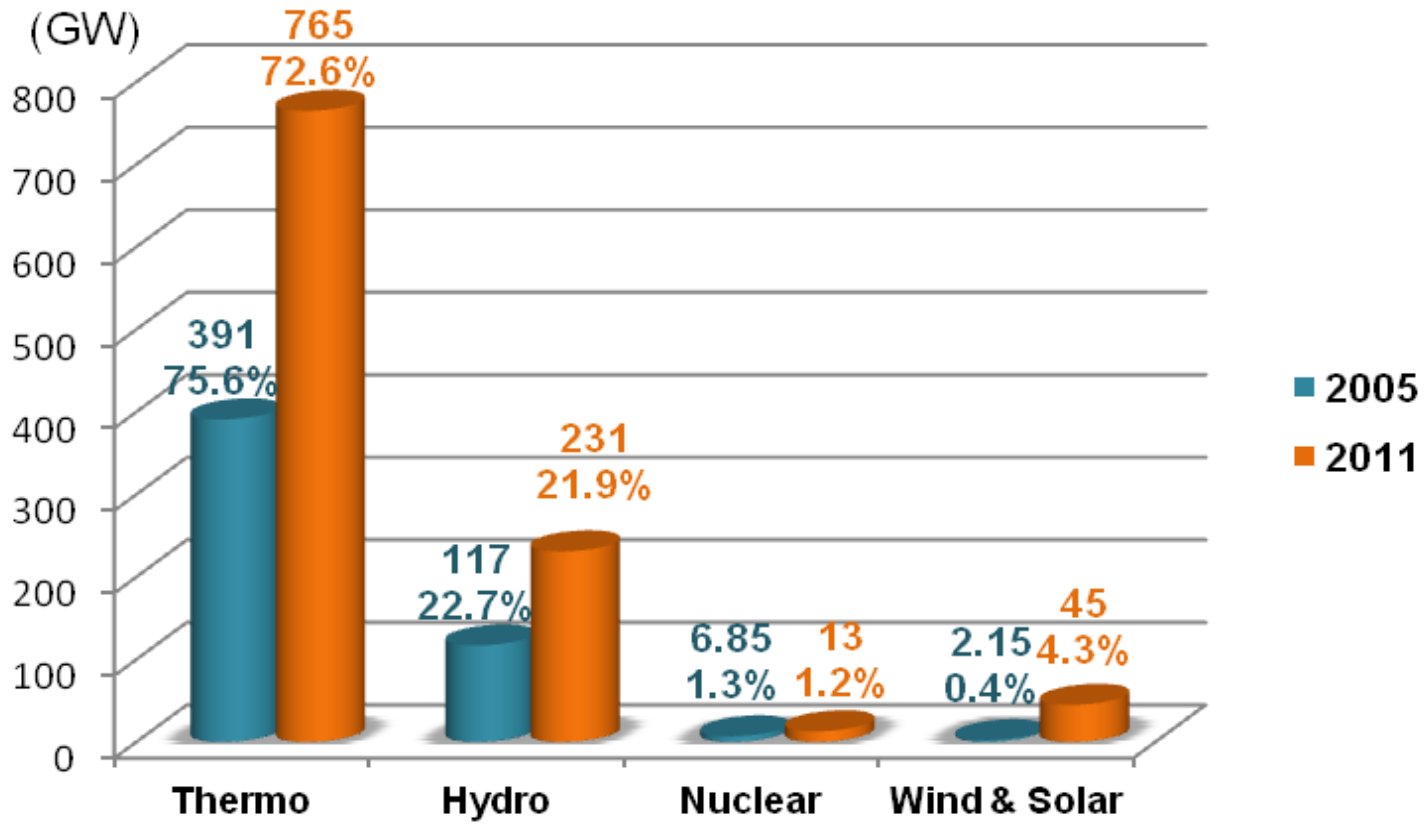


By the end of 2011, the installed capacity of thermo power has reached 765GW

The trend of 2002-2011 China's installed power generation capacity

Electric Power Development Situation of China

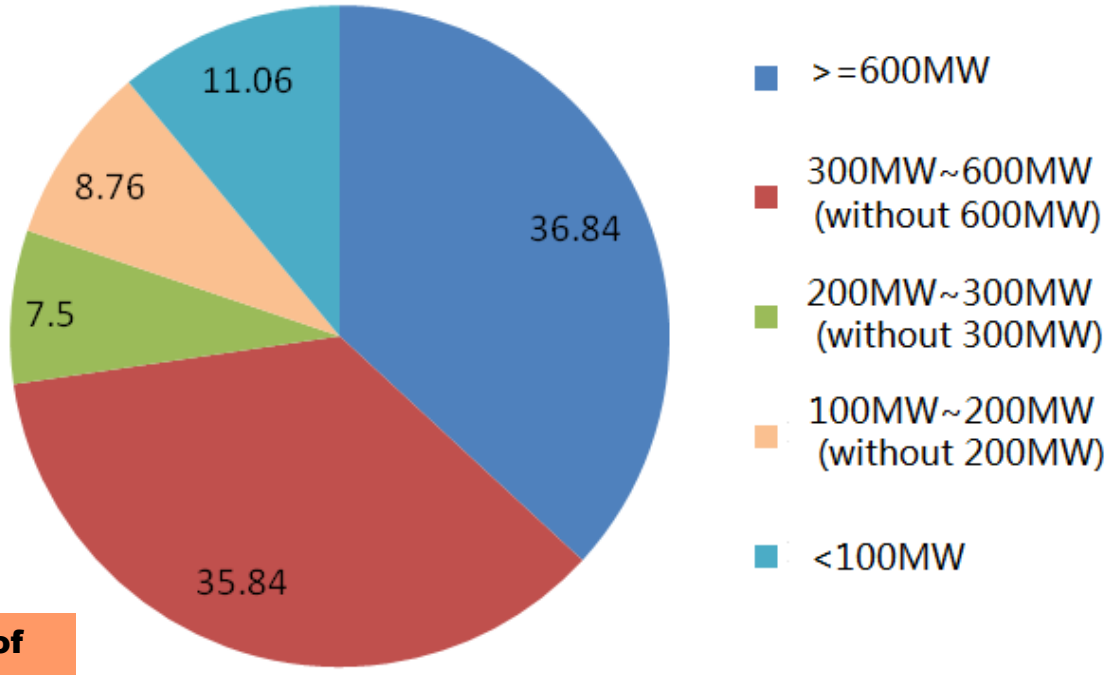
Ⅰ. Installed Capacity and Structure of Electric Power



2005 & 2011 China's installed power generation capacity and its structure

Electric Power Development Situation of China

Ⅱ. The Share of Different Capacity Level of Thermal Power Units

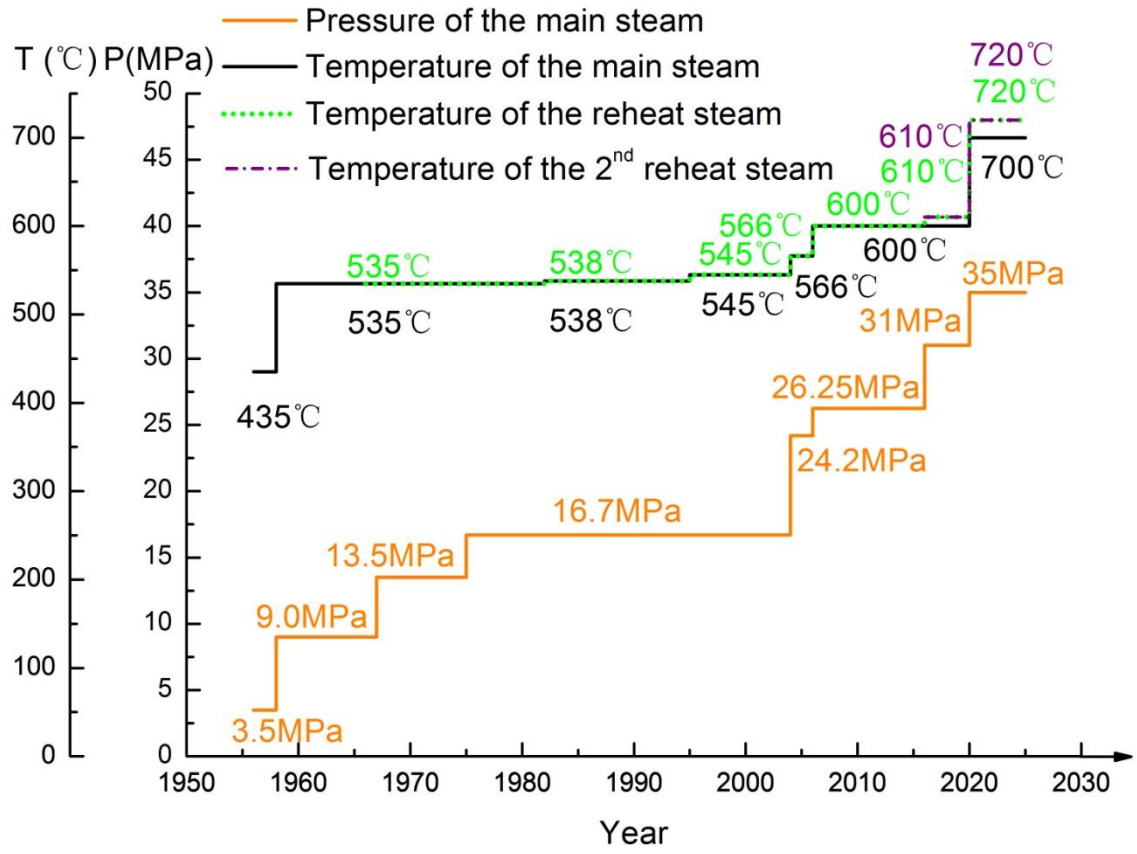


There are more than 70% of thermal power units larger than 300 MW in China

The share of different capacity level of 2010 thermal power units (%)

Electric Power Development Situation of China

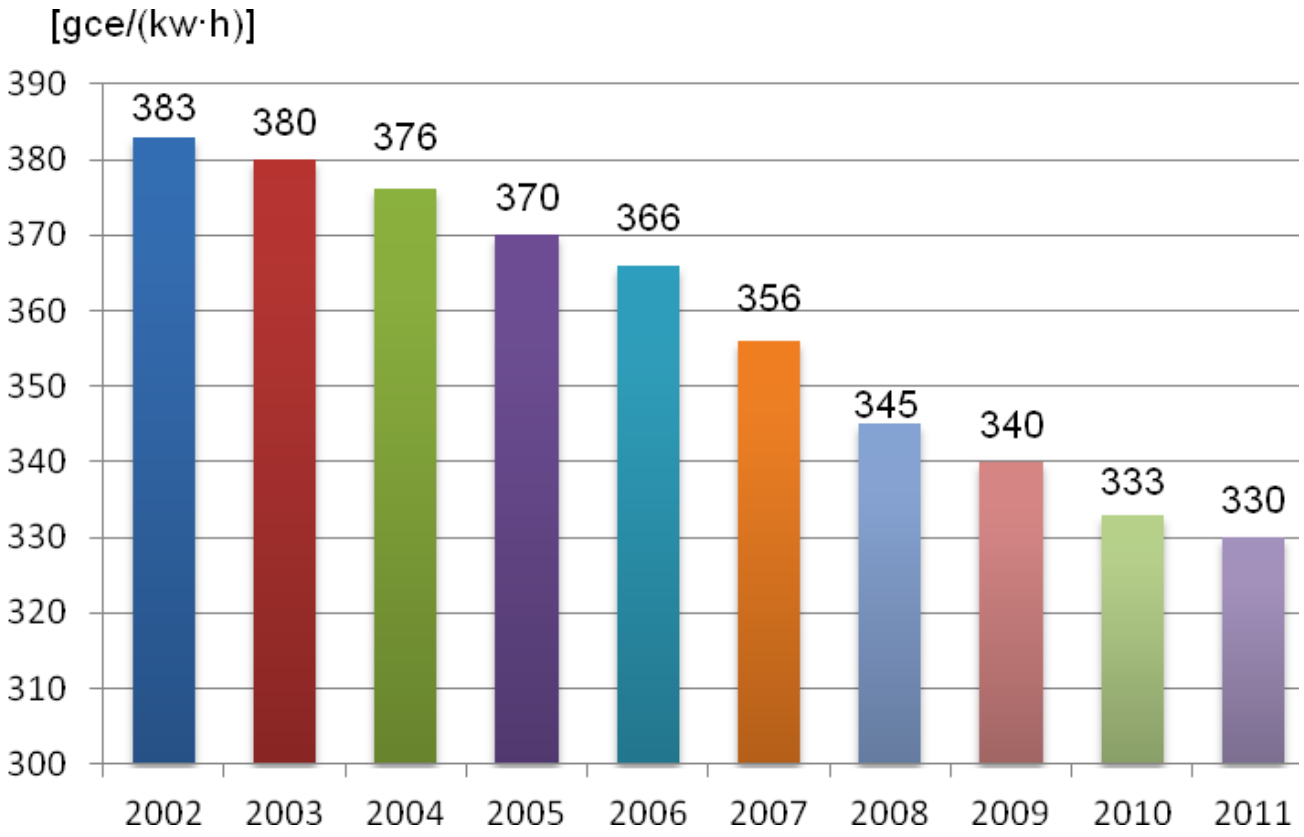
Ⅲ. Technology level of the thermal power units



Initial parameters schematic of China's coal-fired units

Electric Power Development Situation of China

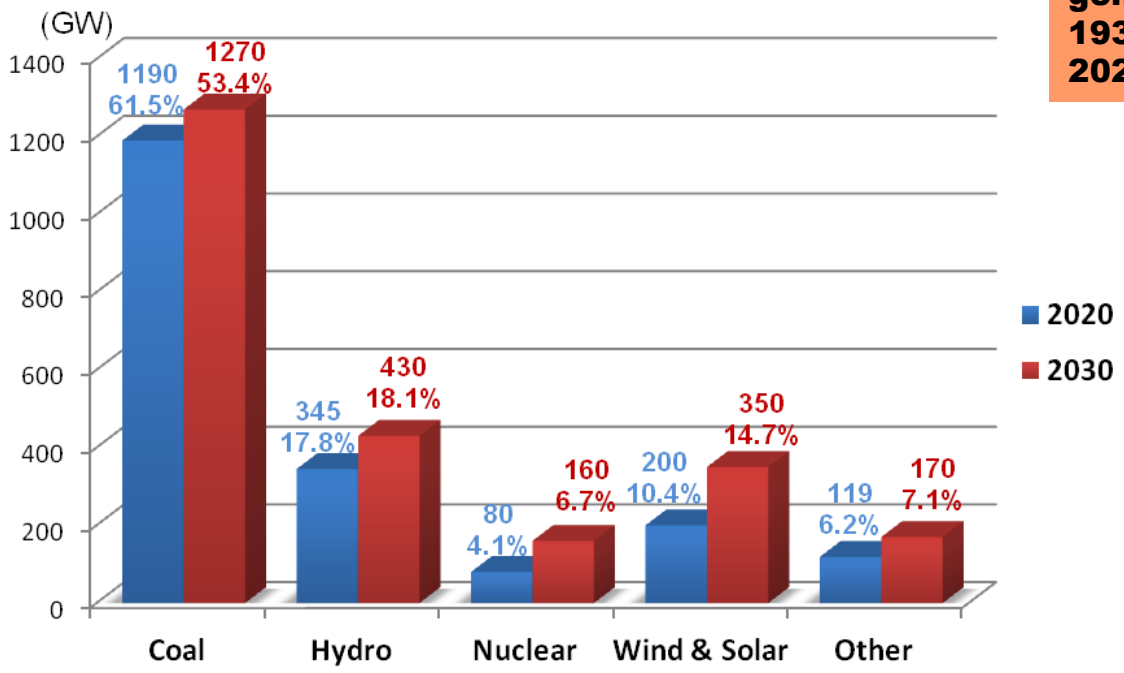
Ⅲ. Technology level of the thermal power units



Annual average coal consumption of power supply of China's coal-fired units

Electric Power Development Situation of China

Ⅳ. Forecast of China's Electric power development



China's installed power generation capacity will be 1934 GW and 2380 GW in 2020 and 2030, respectively

Forecast of China's installed power generation capacity in 2020 and 2030

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Introduction of the National 700℃ USC Consortium

Ⅰ. Members of the Consortium

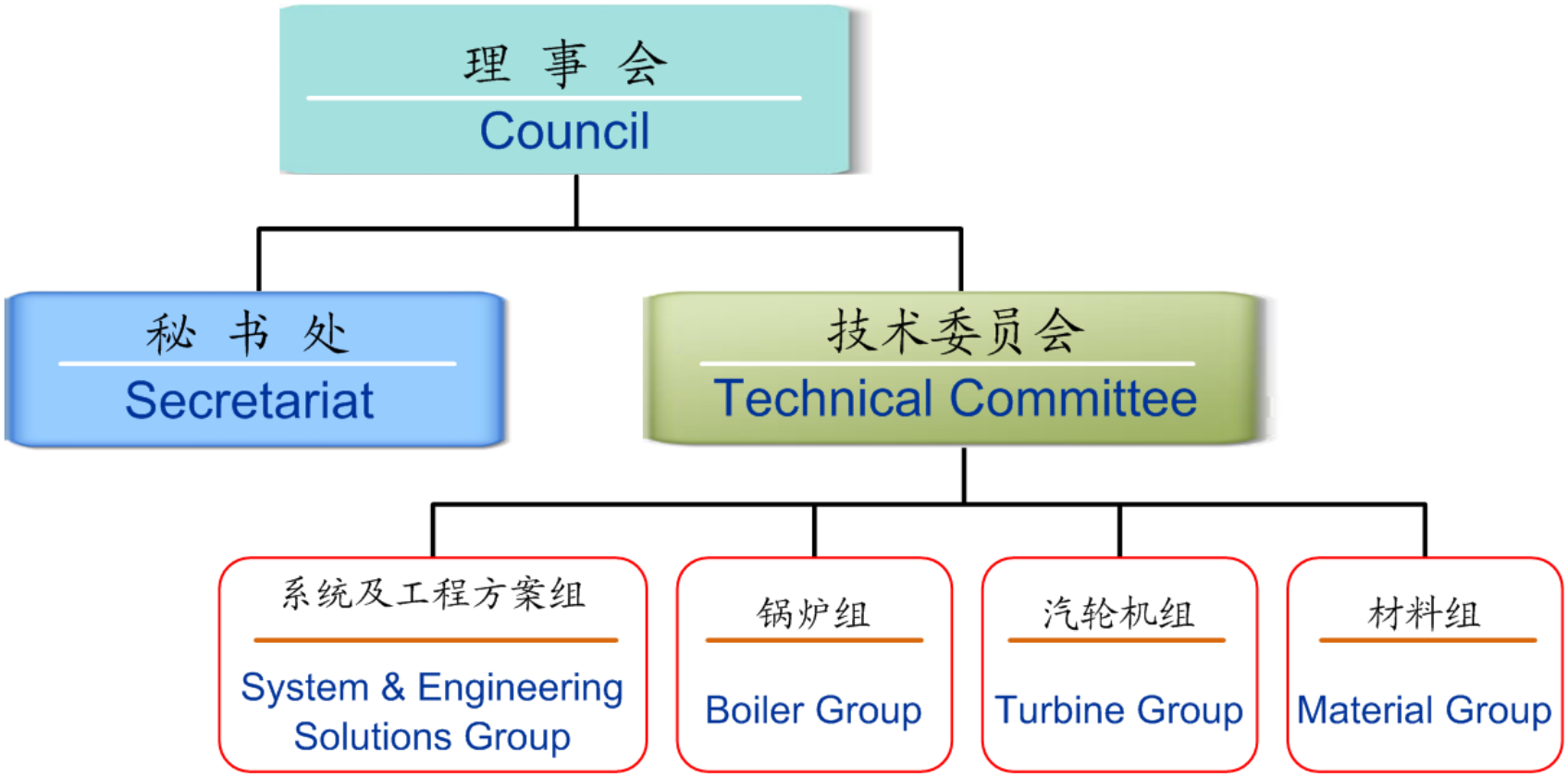
On July 23, 2010, the launching ceremony of the National 700℃ USC Coal-Fired Power Generation Technology Innovation Consortium was held in Beijing Great Hall by National Energy Administration (NEA).

Introduction of the National 700℃ USC Consortium

Ⅰ. Members of the Consortium

Introduction of the National 700℃ USC Consortium

Ⅱ. Organizational Structure of the Consortium



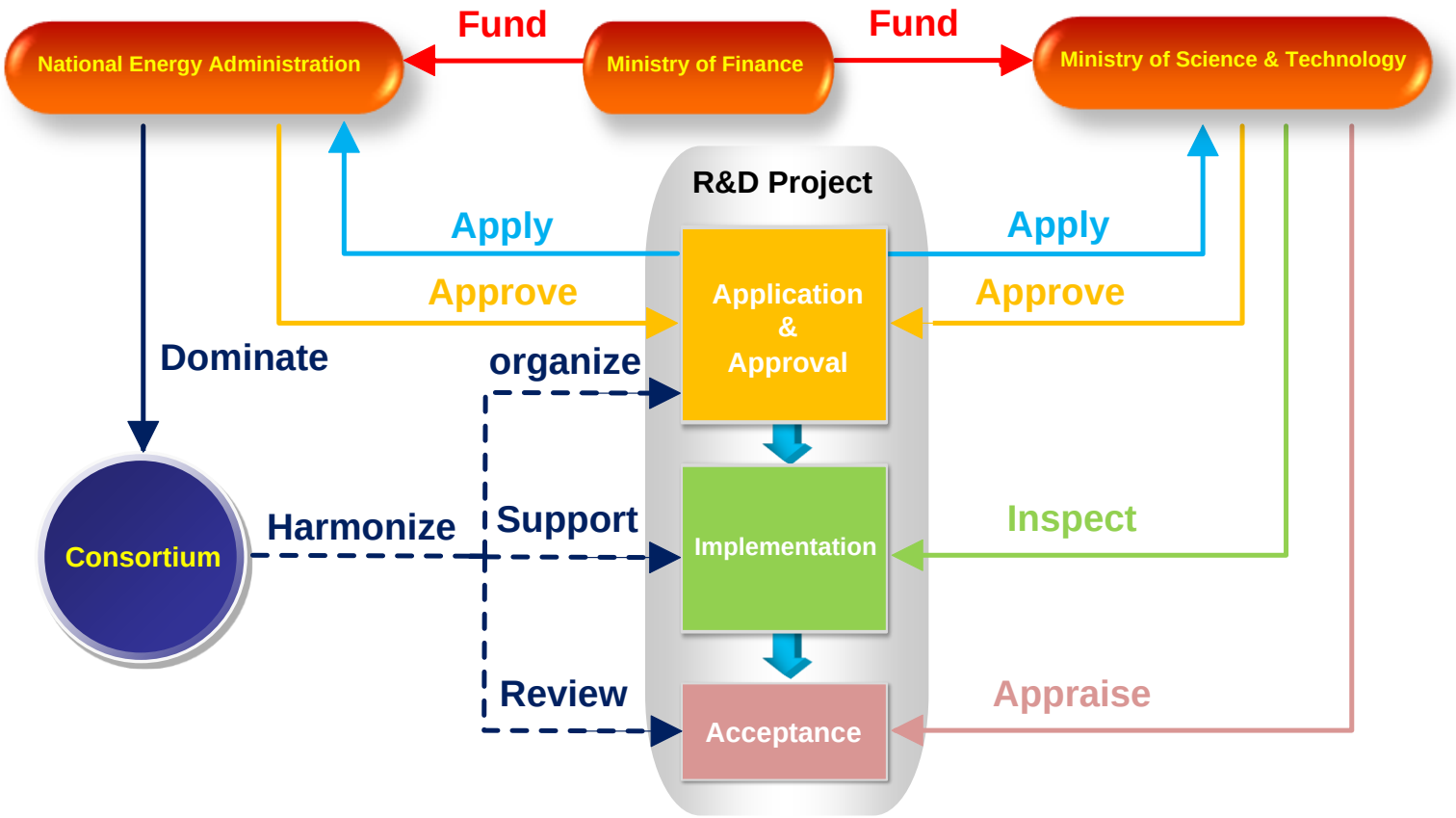
Introduction of the National 700℃ USC Consortium

Ⅲ. Working pattern of the Consortium

- **The Council** meets once a year to make decisions for the significant matters of National 700℃ Consortium.
- **The Secretariat** implements the system of office conference meeting once a quarter, responsible for the daily operations.
- **The Technical Committee** holds workshop every six months, making decisions of major technical issues.
- **The special working groups** are under the unified leadership of the Technical Committee, responsible for treating major technical issues, developing the technical roadmap and R&D plan of their respective fields, organizing research, guiding work progress and reviewing research achievements of each stage.

Introduction of the National 700℃ USC Consortium

Ⅲ. Working pattern of the Consortium



Flow chart of Chinese 700℃ USC R&D project

Content

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R&D Plan of the National 700℃ USC Technology

Ⅰ. R&D Technical Route

Based on Chinese R&D application of 600℃ USC units, the R&D platform of Chinese 700℃ USC power generation technology is constructed, taking the experience of other countries on developing 700℃ USC unit for reference:

R&D Plan of the National 700℃ USC Technology

Ⅰ. R&D Technical Route

- Researching and proposing the overall technical proposal and key equipment design proposal of 700℃ USC unit;
- Selecting, developing, assessing and optimizing the materials used in high temperature components, to determine the series of heat-resistant materials for Chinese 700℃ USC unit;
- Developing the production technology of key ultra high temperature materials and the manufacturing technology of key components;
- Constructing the high temperature component test platform, to take performance verification test for critical components;
- Constructing the demonstration projects of 700℃ USC unit, and comprehensively mastering the core technology of 700℃ USC coal-fired power generation technology.

R&D Plan of the National 700℃ USC Technology

Ⅱ. R&D Proposal

NO.	CONTENT	11	12	13	14	15	16	17	18	19	20	21
1	overall program design proposal											
2	Filtering, developing, optimizing and assessing of heat resistant materials											
3	key components of main equipments and high temperature pipes											
	1)Boiler's tubes											
	2)Boiler's key components											
	3)Turbine's Large Forgings											
	4)Turbine's key Components											
	5)High temperature pipes and fittings											
	6)High temperature and high pressure valves											
4	Test platform construction and test											
	1)Design and construction of test platform											
	2)Test of boiler's key components and valves											
5	Demonstration projects											
	1)Preparation											
	2)Construction of the project											
	3)Operation and summary											

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Progress of the Research Project

Ⅰ. Progress of the Research Projected by National Energy Administration

"National 700℃ USC Coal-fired Power Generation Technology and Equipment R&D as well as application demonstration", research and engineering demonstration project, has been launched by NEA, including 6 sub-topics.

Progress of the Research Project

Ⅰ. Progress of the Research Projected by National Energy Administration

➢ Sub-topic 1: Research on Overall Design Proposal

In this sub-topic, the overall design research of 700℃ USC coal-fired units will be conducted, including initial parameters, capacity, thermal system and layout scheme.

The capacity is chosen as 600MW-level and the initial parameter as 35MPa/700℃/720℃. Research work is carried out in accordance with two options, single reheat and double reheats, respectively. The power efficiency is expected to be higher than 50%.

Progress of the Research Project

Ⅰ. Progress of the Research Projected by National Energy Administration

➢ Sub-topic 2: Research on key materials

This sub-topic will accomplish material characteristics tests, master the technologies of welding and non-destructive testing in order to select, develop, evaluate and optimize the material in this 700℃ plan, by developing the domestic materials while actively seeking international cooperation.

At present, experiments are ongoing, relative to foreign materials of 617M、740、740H high temperature alloys and T24 ferrite steel boiler tubes, etc.

Progress of the Research Project

Ⅰ. Progress of the Research Projected by National Energy Administration

➢ Sub-topic 3: Research Proposal on key technology of boiler

This sub-topic will do research in engineering design and manufacturing programs of domestic-manufactured 700℃ USC boiler and will have the capability of design, manufacturing, technological and ancillary equipment of 700℃ USC boiler.

Draft of 700℃ boiler general proposal has been completed, with research ongoing including programs specifics, performance calculation, boiler grid layout, frame design, process design of steam/water/flue gas/air, expansion system, piping thrust, heating surface arrangement of all levels, De-NOx system selection, preheater selection and flue gas/air duct design, etc.

Progress of the Research Project

Ⅰ. Progress of the Research Projected by National Energy Administration

➢ Sub-topic 4: Research on turbine key technology

This sub-topic is aimed at developing general proposals for 700℃ turbine and master the key technologies of its design, materials and manufacturing, to develop 700℃ USC turbine with better economics and high reliability.

Draft of 700℃ turbine general proposal is ongoing, along with thermodynamic system calculation, research and optimization, and development of relevant processing technologies.

Progress of the Research Project

Ⅰ. Progress of the Research Projected by National Energy Administration

➢ Sub-topic 5: Construction and operation of test platform for key components

This sub-topic will do field testing of 700℃ USC key high temperature alloy materials and components, by constructing a test platform with main steam temperature of 700℃,based on an active 300MW-level supercritical unit, to test domestic high temperature materials and high temperature components and explore the feasibility of testing foreign materials.

The preliminary proposal of test platform has completed and technical proposal are being further specified with economic analysis and pre-construction preparation work.

Progress of the Research Project

Ⅰ. Progress of the Research Projected by National Energy Administration

- **Sub-topic 6: Feasibility study on constructing a demonstration power plant**

In this sub-topic, the research of choosing a suitable site for a demonstration power plant and the proposal of installed capacity will be conducted and technical conditions of the main equipment will be put forward, including an overall design proposal for the demonstration power plant and general layout proposal of the plant, fulfilling the design of the process systems (such as thermal system and combustion system) and layout proposal of each machine shop. Besides, it is also aimed at estimating the investment of the project, analyzing the cost comparatively and reaching an economic evaluation, etc.

Progress of the Research Project

Ⅱ. Progress of Research Projected by the Ministry of Science and Technology

The Ministry of Science and Technology has set up a project, "Research on Advanced Boiler's Key Pipes of USC Thermal Power Units", among the projects of Core Technology on High Quality Special Steel (Stage I), belonging to the "863 High Science -Technology Plan" on new material.

China Iron & Steel Research Institute Group is the leader member of the project, along with 9 partners. It consists of 3 sub-topics.

Progress of the Research Project

Ⅱ. Progress of Research Projected by the Ministry of Science and Technology

- **Sub-topic 1: Manufacturing the boiler's key pipes of 600-700℃ USC unit**

This sub-topic focuses on selecting material for the 600-700℃ USC demonstration power plants. 6 boiler's key pipe materials (P92, P122, G115/G112, CCA617, Inconel740H) are under study now, which are all candidate materials for Chinese 700℃ USC demonstration projects.

Progress of the Research Project

Ⅱ. Progress of Research Projected by the Ministry of Science and Technology

- **Sub-topic 2: Research on alloy “GH2984” and its technology process used in 700℃ USC thermal power units**

This sub-topic’s task is optimizing the constituents of iron-nickel based alloy “GH2984”, manufactured in China earlier, and testing materials for boiler’s pipe and its welding materials.

Progress of the Research Project

Ⅱ. Progress of Research Projected by the Ministry of Science and Technology

- **Sub-topic 3: Research on new-type austenitic high temperature steel used in 650℃ USC thermal power units**

According to the steam conditions in 650℃, this sub-topic needs to design several kinds of new-type austenitic high temperature steel and put them into experiment and qualification tests.

The project is announced start by all the project members on Jun. 1st, 2012, in Beijing. The specifics of trial-manufacturing materials in industry are being explored, with its earlier research in laboratory basically finished. Their plan is to finish the trial-manufacturing and present a sample pipe in full-size by the end of 2013.

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Follow-up R&D work

There are nine more topics preparing to apply for support from national scientific research funds, which are as follows:

- **1: Research on the boiler's water wall technique for 700℃ USC unit**
- **2: Research on the components of boiler's superheater and reheater for 700℃ USC unit**
- **3: Research on boiler's header of 700℃ USC unit**
- **4: Research on high temperature steam pipes and fittings of 700℃ USC unit**
- **5: Research on manufacturing technology of turbine's HP-IP rotor of 700℃ USC unit**
- **6: Research on manufacturing technology of high temperature cylinder valve housing**
- **7: Research on turbine's high temperature blades and fasteners, valve core's wear-resisting parts of 700℃ USC unit**
- **8: Research on turbine's high temperature forgings of 700℃ USC unit**
- **9: Research on turbine's high temperature castings of 700℃ USC unit**

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Thanks for your attention!