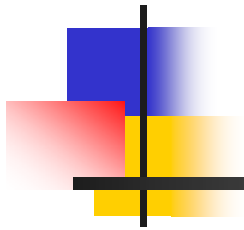


IGCC and Co-Production in China



Prof. XIAO, Yunhan

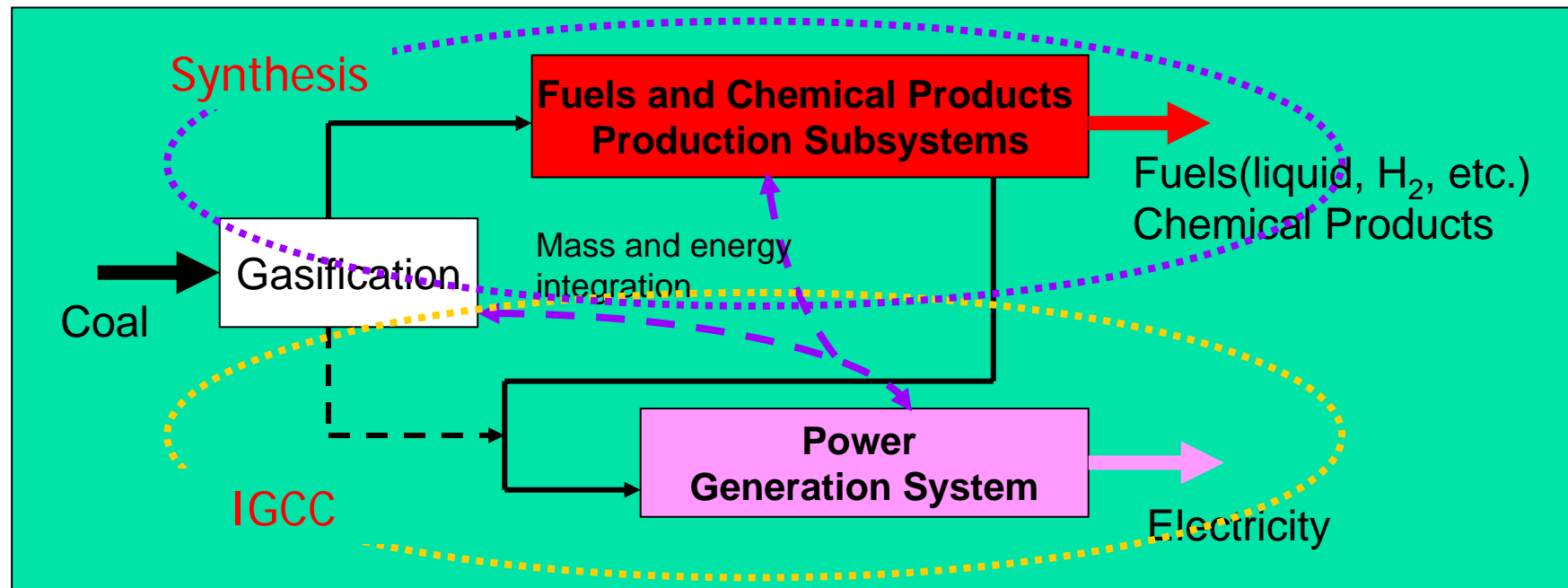
The National Joint Expert Group for IGCC and Co-
Production Demonstration Engineering

2007' International Workshop on IGCC & Co-Production
and CO₂ Capture & Storage

May 23, 2007

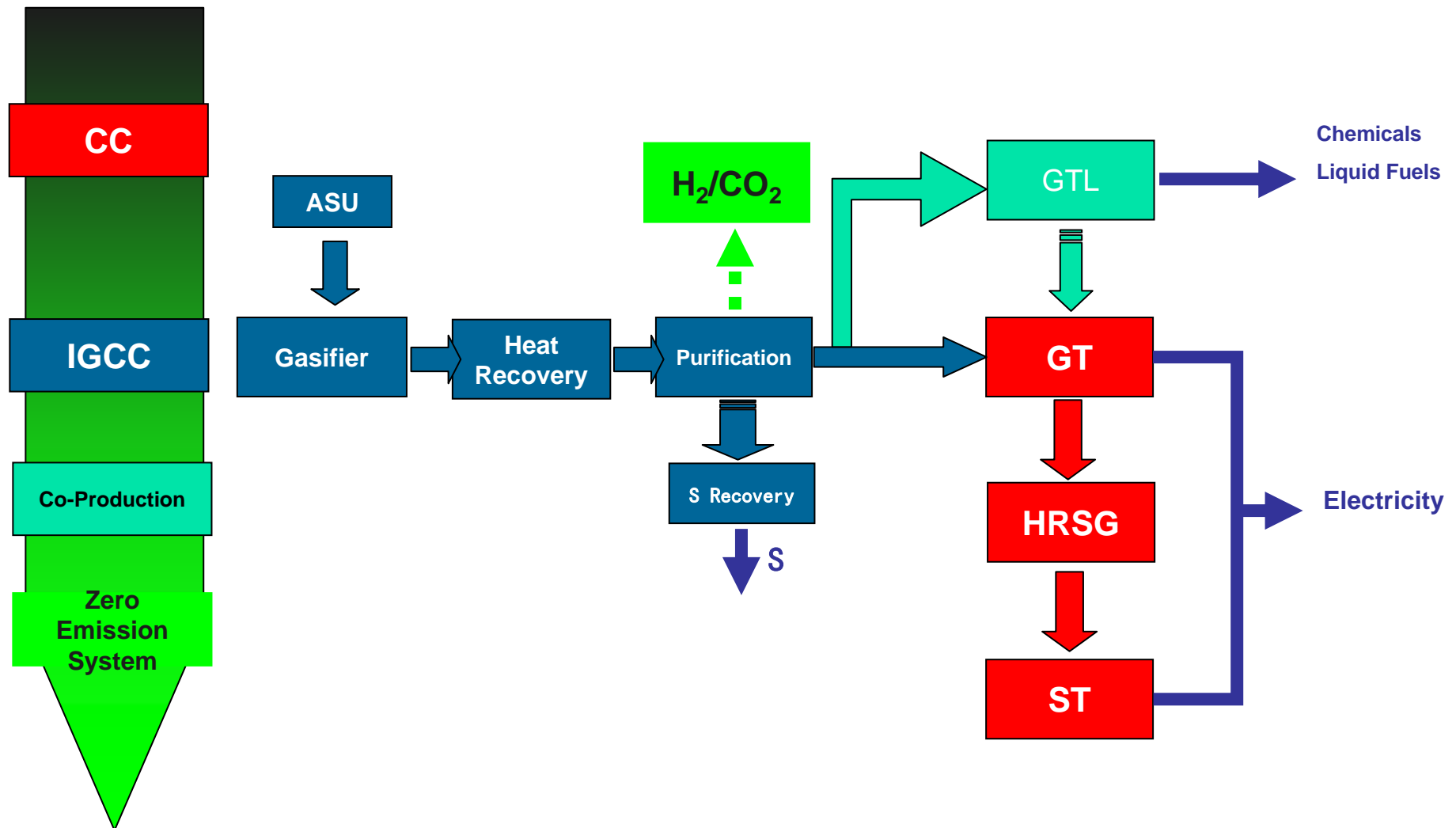
Beijing, China

IGCC/Co-production

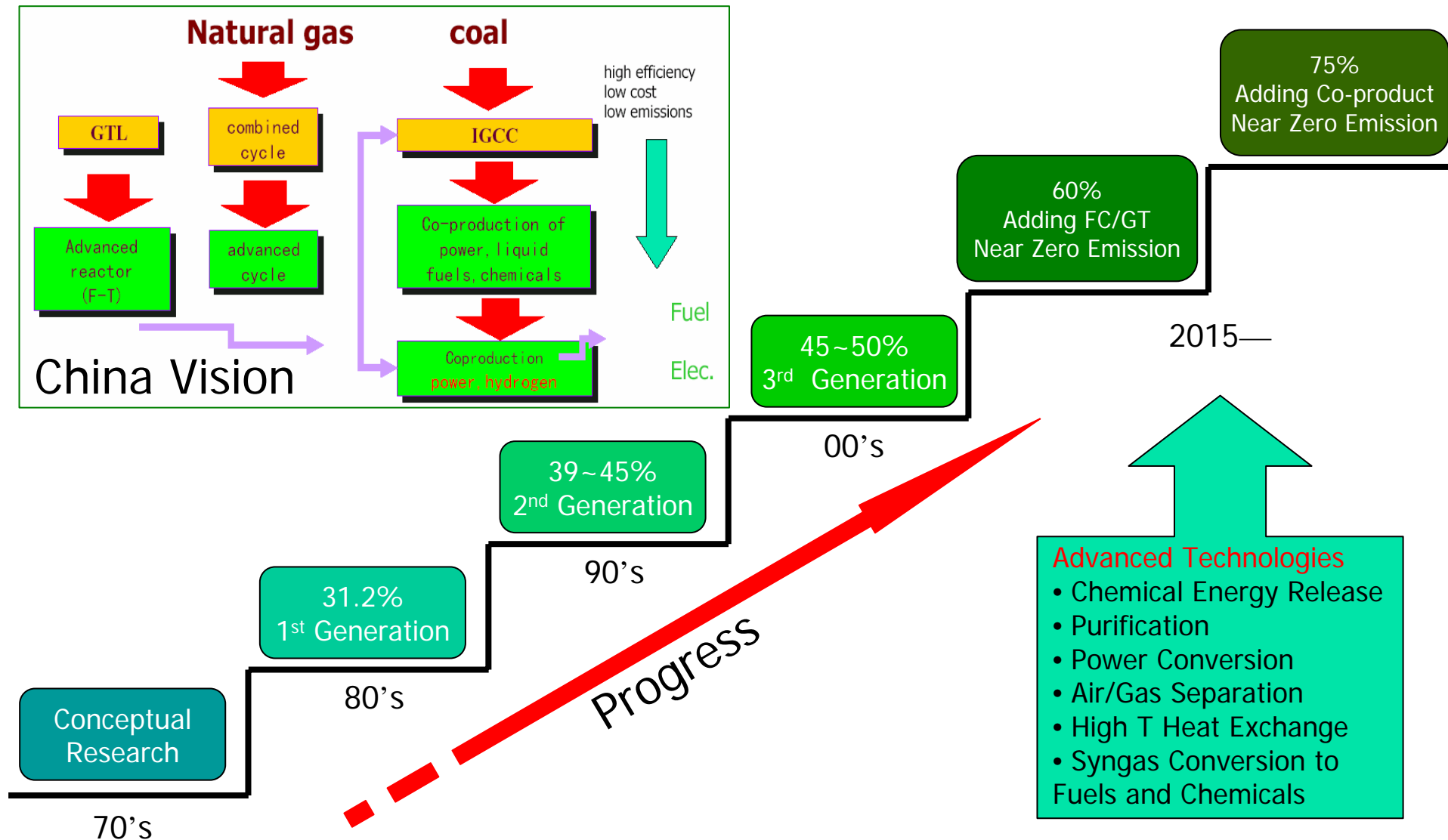


- **Solution to the issues with of coal, power, and oil**
 - Clean and efficient power generation from coal
 - Ultra-clean fuels and chemicals from coal
 - Fuel and product flexible
- **Consistent with hydrogen economy, CCS**
- **To build a stable, economic, clean and secure Energy supply system**

IGCC/Co-production



IGCC/Co-production

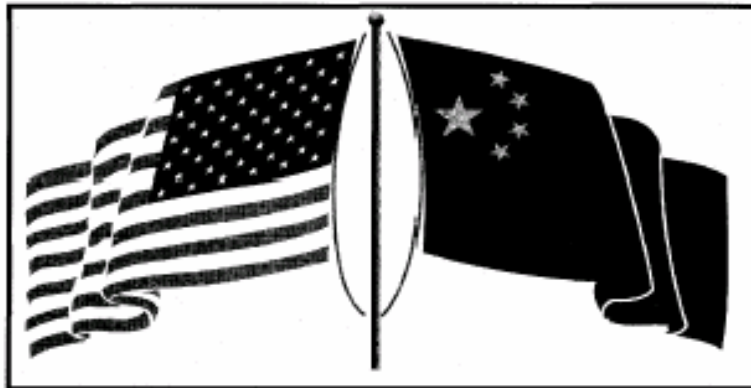


The Course and Evolution of IGCC and Co-production in China

- 1970's, Suzhou IGCC pilot plant — Abortion
 - Platform
- 1990's, Yantai 300~400MW IGCC demonstration plant — not start construction yet
 - Dependent on imported technologies
 - High capital cost
 - High COE

The Course and Evolution of IGCC and Co-production in China

The United States of America
and the
People's Republic of China
Experts Report on
**Integrated Gasification
Combined - Cycle Technology
(IGCC)**
December 1996



Commissioned by
Office of Coal and Power Import and Export, U.S. DOE
Energy Division, State Service and Technology Commission, PRC

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Tulane University, USA

MASTER

US-PRC IGCC EXPERT REPORT

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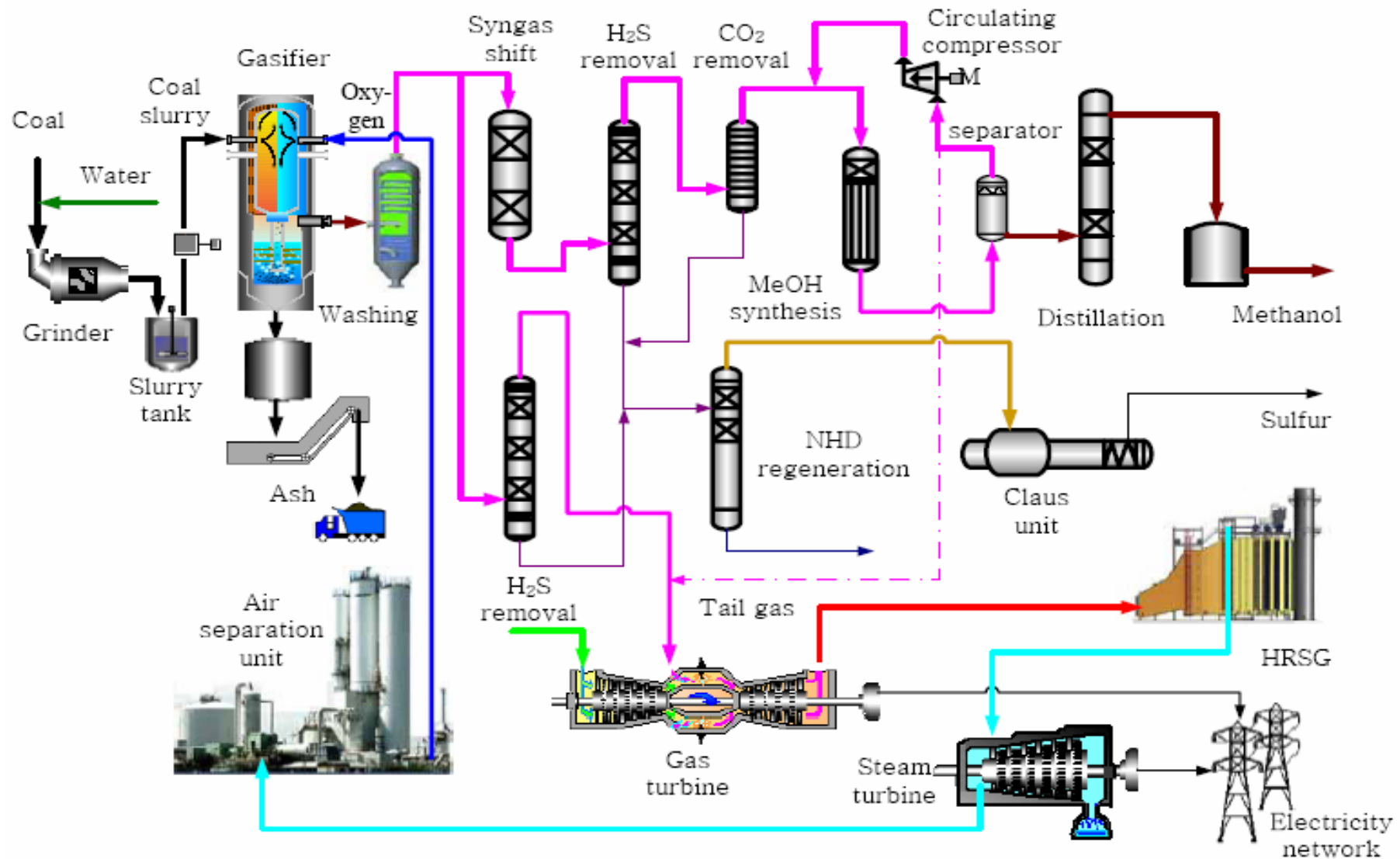
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The Course and Evolution of IGCC and Co-production in China

- 863 Project——High-Tech Research and Development Program of China (2001 ~ 2005)
 - Yankuang 240,000 t/a methanol and 60MWe Co-production demonstration
 - 1000 TPD coal slurry feed gasification

IGCC & Co-Production Development in China

—Yankuang 240,000 t/a methanol and 60MWe Co-Production Demo Plant



IGCC & Co-Production Development in China

——Yankuang 240,000t/a methanol and 76MWe Co-Production Demo Plant



- ❑ New type slurry feed gasifier: $1150 \text{ TPD} \times 2$
- ❑ Investment 1.58 billion RMB
- ❑ Financial investment recovery in 8.1 years (construction period included)
- ❑ Operating, totally >6000 hours achieved by now

Commercial Operation since Apr. 2006

Gasification

- new-style coal-water slurry gasification
 - scale: 1150 tons/day
 - operation times up to 5130 hours
- dry pulverized coal pressurized gasification (1)
 - scale: 24 tons/day
 - operation times up to 2100 hours
- dry pulverized coal pressurized gasification (2)
 - scale: 45 tons/day



Synthesis

- 750 tons per year pilot plant of CTL
 - 7 operation experiments
 - In 2004, operation with full load 1500 hours
 - sufficient operation experience and engineering data through 5000 hours run of the plant
- 5000 tons per year pilot plant of CTL
 - operation for 6068 hours
 - full load operation times up to 4706 hours



IGCC & Co-Production Development in China

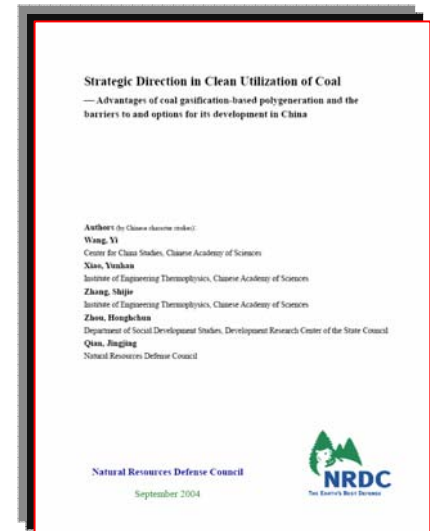
—Advantages, Barriers and Strategies Research

■ Barriers Recognized

- Policy barriers
 - No special policies
 - Lack of market measures or incentives
 - Environmental policies and standards need further improvement
- Institutional/organizational barriers
 - Unfavorable sectoral structure and division
 - Low investment
 - lack of market mechanism and effective government supervision
- Technical barriers
 - Key Technologies
 - System integration & design
- Financial barriers

■ Breakthrough Needed

- High-Tech
 - Gasification & Syngas Preparation
 - Syngas Gas Turbine
 - Fuels and Chemical Synthesis
 - Hydrogen Production and CCS
- Industrial Reform
 - Power Utility
 - Coal Chemical Industry
 - Technology providers, engineering design, equipment manufacturing
- Cooperation Mechanism
 - Government
 - Industry
 - Institute
 - University



IGCC & Co-Production Development in China

——Coal Co-production Technology Roadmap

- Goals: provides a blueprint for the coordinated, long-term, efforts required
 - Develop unified roadmap
 - Maintain high-level approach
- Supported by
 - Ministry of Science and Technology, China
 - China Academy of Sciences
 - NRDC
- Implementation by
 - IET, CAS
 - 863 Clean Coal Technology Experts Group



IGCC & Co-Production Development in China

——Coal Co-production Technology Roadmap

- Energy System Innovation Integration
- Step-by-step Strategy
 - Mature Individual Technologies Integration
 - Key Technologies Breakthrough
 - Near Zero Emission Technologies
- Combined Strategy
 - State Guide and Enterprises Voluntary Participate
 - Industrial Development and Technological innovation
 - International Cooperation and Self Creation

Technology Development Strategies

—Roadmap Goals

■ Overall Goal

- Form the clusters of the Clean Coal Technologies, support the development of China's energy manufacturing industry, achieve the efficient, clean, and affordable of coal

■ Stage Goal

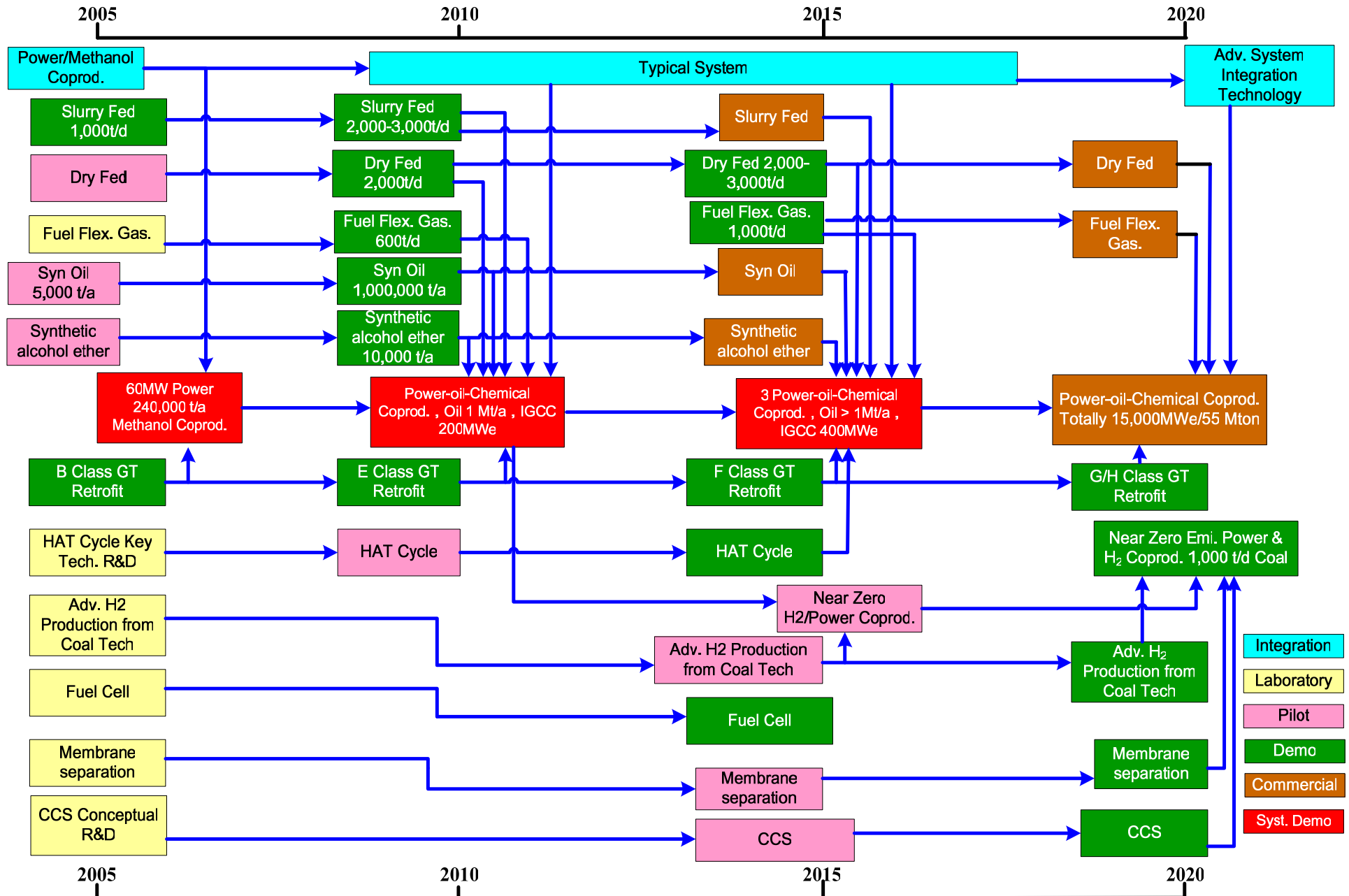
■ 2010

- commercial demonstration power plant
- coal gasification based co-production of oils and power system

■ 2020

- Installed capacity of IGCC to reach 20,000MWe
- Synthetic oil and chemical products to substitute 50 million tons of crude oil on annual basis
- Conversion of coal into hydrogen and electricity, and near-zero emission of CO₂

IGCC & Co-Production Roadmap in China

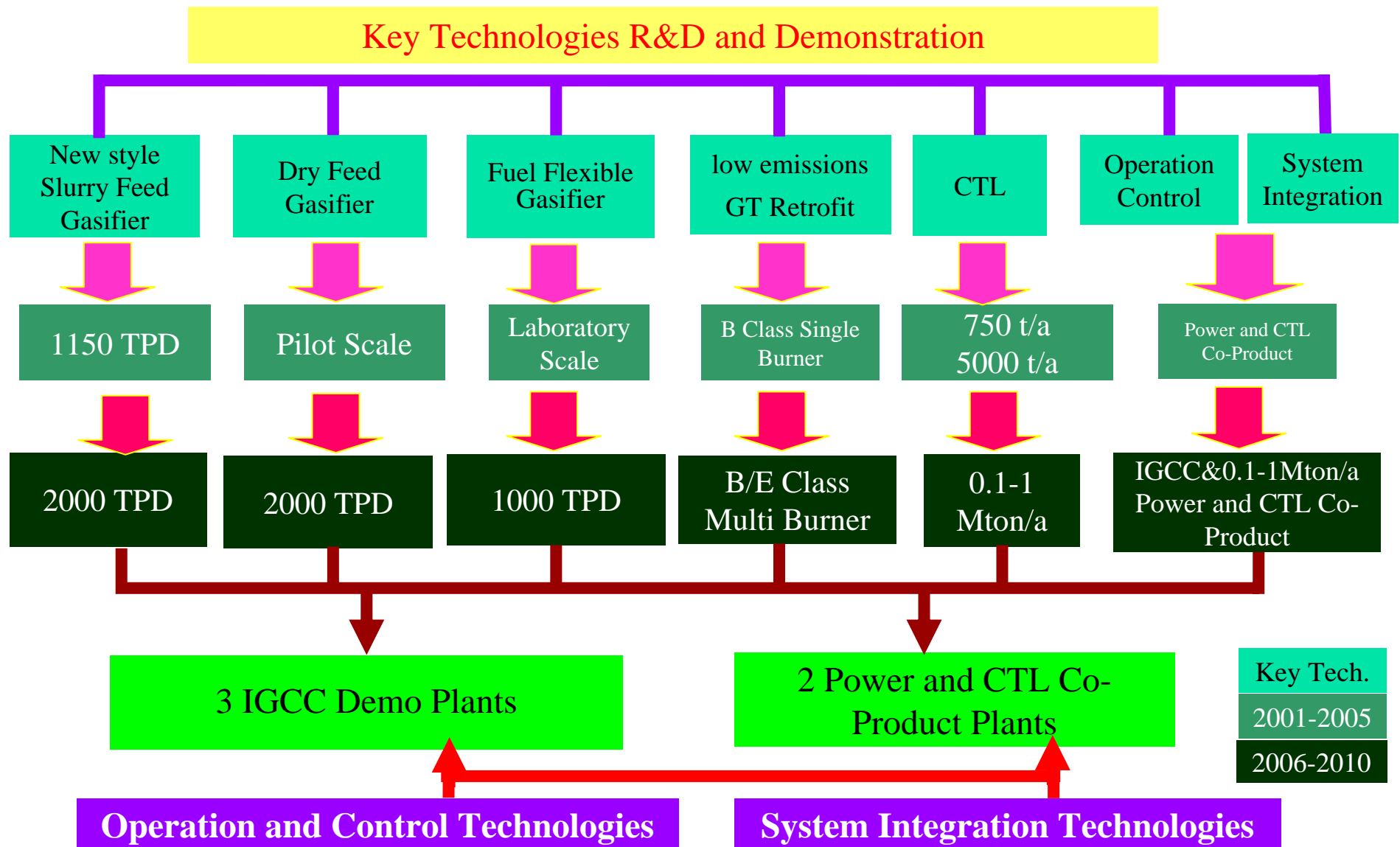


The 11th Five-Year Plan Co-Production Projects

- High Technology Research and Development Program of China (863 program)
- RMB 350 million from government
- RMB 25000 million from industries

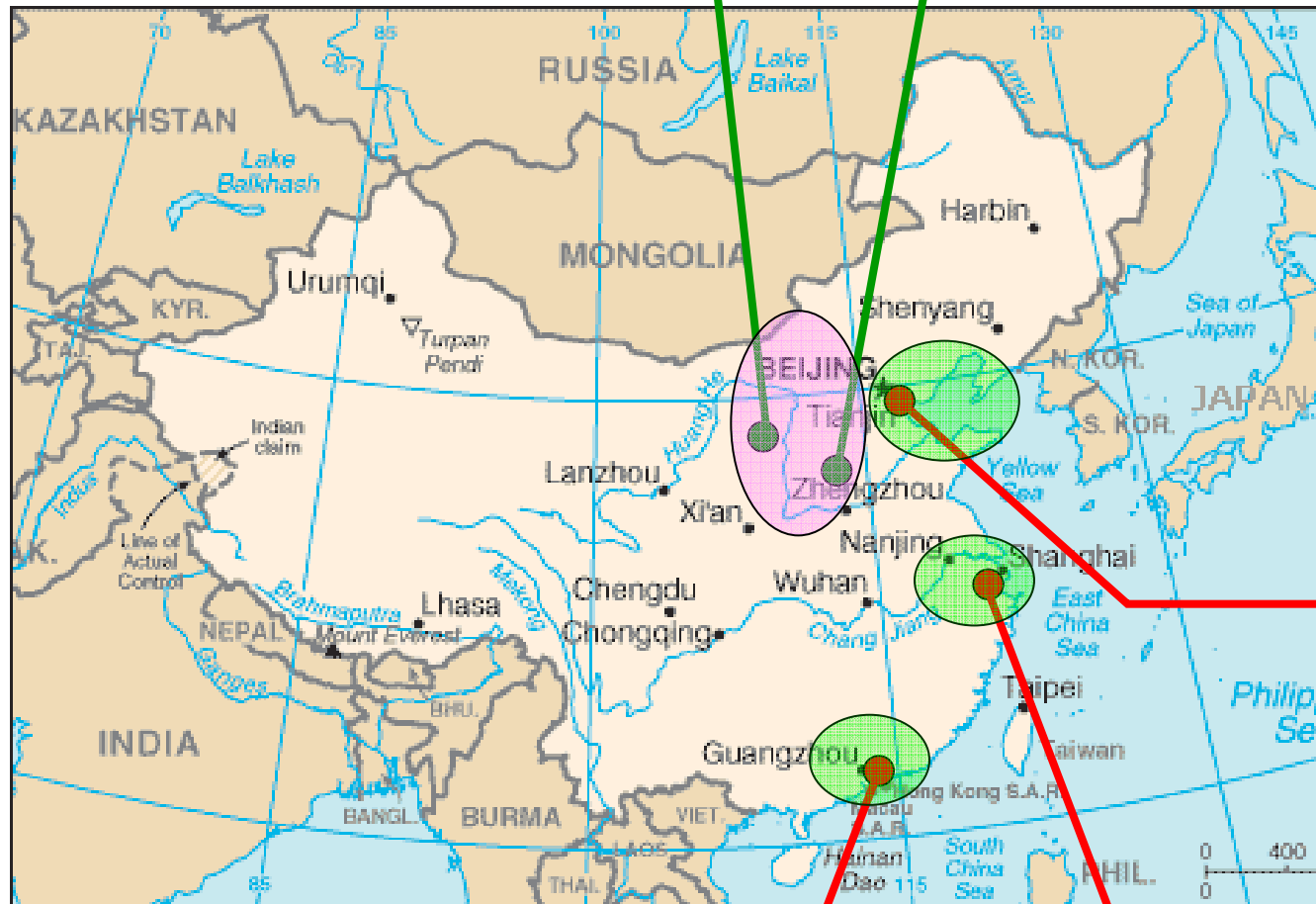
The 11th Five-Year Plan Co-Production Projects

—863 Major Project, 2006-2010



Co-Product
Yankuang Group Project
Coal Mine

Co-Product
Shanxi Lu'an Group Project
Coal Mine



IGCC
Huaneng Group Project
Bohai Rim

IGCC
Dongguan Electrization Industry
Ltd. Project
Pearl River Delta

IGCC
Huadian Group Project
Yangtze River Delta

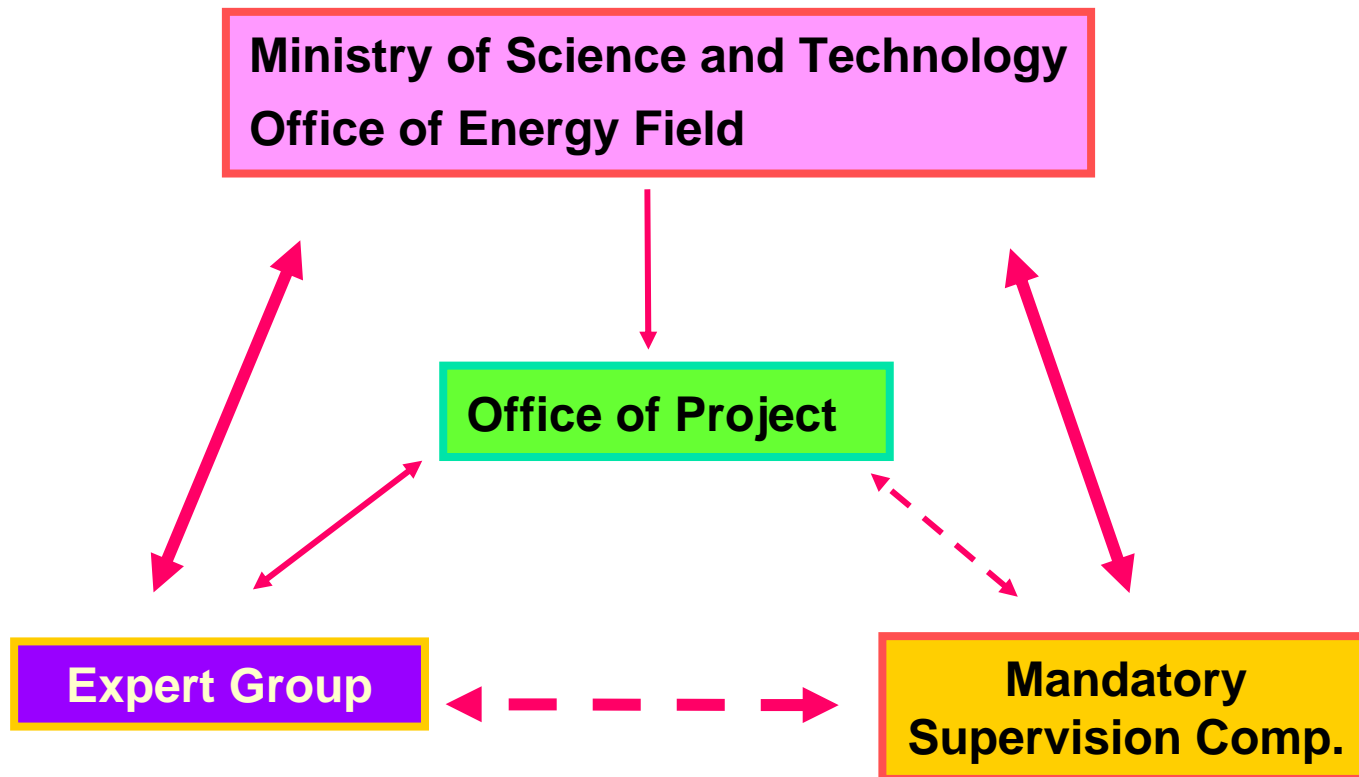
The 11th Five-Year Plan Co-Production Projects

—Projects

| | Demo Projects | Power Class /MW | CTL tons/a | Features | Joint Key Tech. R&D Projects |
|-----------------------------|---------------|-----------------|------------|---|---|
| IGCC | Dongguan | 120, 200 | — | <ul style="list-style-type: none"> ■ Fuel Flexible Gasifier ■ B/E Class GT | <ul style="list-style-type: none"> ■ Fuel Flex. Gas. ■ GT Retrofit ■ System int. ■ Oper. & Contr. |
| | Huadian | 200 | — | <ul style="list-style-type: none"> ■ Slurry Gasifier ■ E Class GT | <ul style="list-style-type: none"> ■ Slurry Gas. ■ GT Retrofit ■ System int. |
| | Huaneng | 250 | — | <ul style="list-style-type: none"> ■ Dry Feed Gas. ■ E Class GT | <ul style="list-style-type: none"> ■ Dry Feed Gas. ■ Oper. & Contr. |
| Power and CTL Co-Production | Yankuang | 200 | 1000,000 | <ul style="list-style-type: none"> ■ Slurry Gasifier ■ B Class GT ■ CTL | <ul style="list-style-type: none"> ■ Slurry Gas. ■ GT Retrofit ■ CTL ■ System int. |
| | Shanxi Lu'an | 60 | 160,000 | <ul style="list-style-type: none"> ■ Fix-bed Gasifier ■ B Class GT ■ CTL | <ul style="list-style-type: none"> ■ GT Retrofit ■ CTL ■ System int. ■ Oper. & Contr. |

The 11th Five-Year Plan Co-Production Projects

—Administrative Framework of the Project



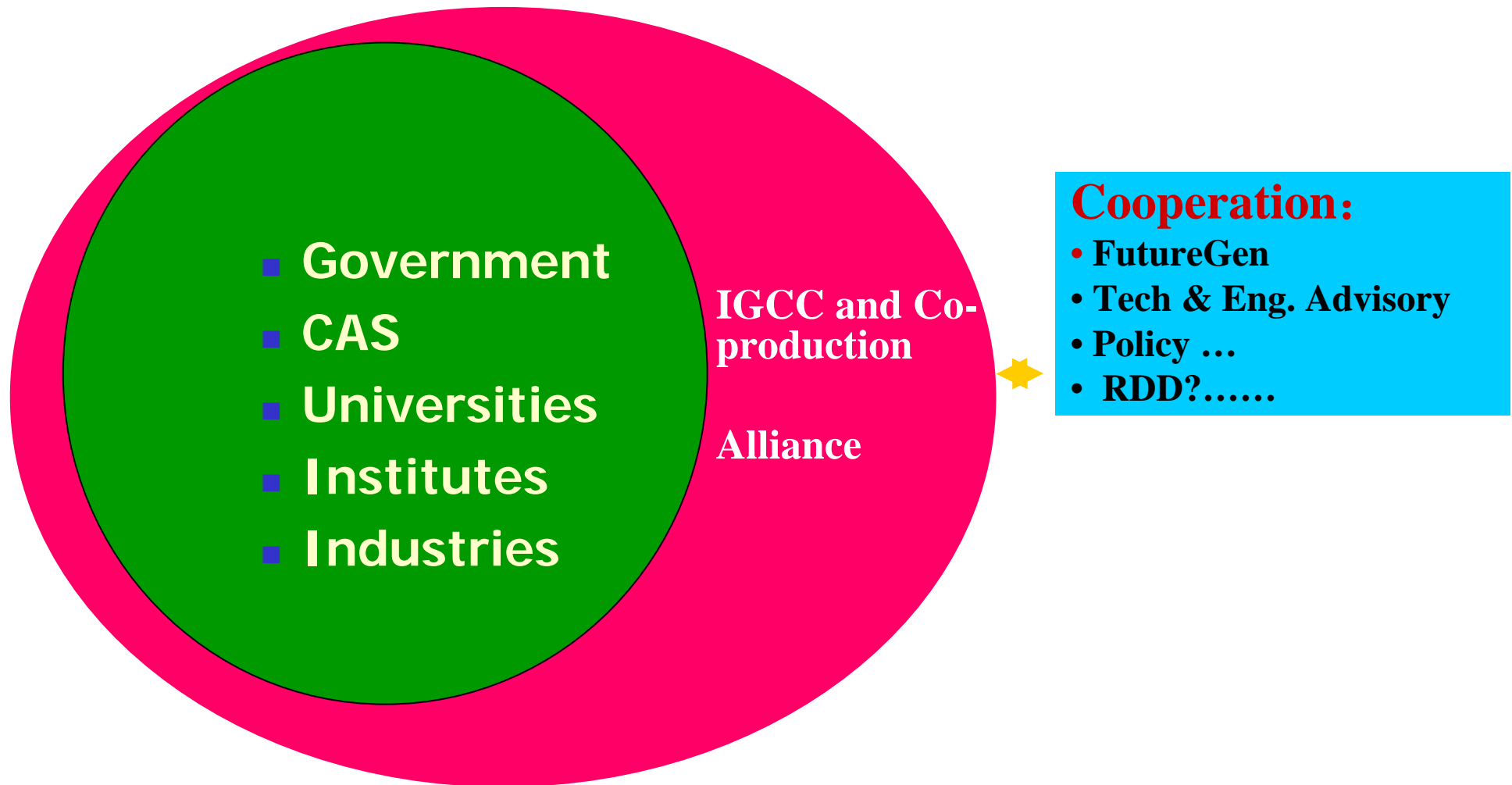
The 11th Five-Year Plan Co-Production Projects

—Administrative Framework of the Project (cont.)

Expert Group

| | |
|---|--|
| Head: Prof. Xiao, Yunhan | Bureau of High-technology Research and Development, CAS |
| Members: | |
| Prof. Cai, Ningsheng | Tsinghua University |
| Prof. Luo, Zhongyang | Zhejiang University |
| Prof. Xu, Minghou | Huazhong University of Science and Technology |
| Prof. Wang, Fuchen | East China University of Science and Technology |
| Senior Engineer Xu, Shisen | GreenGen Corporation, China Huaneng Group |
| Senior Engineer Sun, Qiwen | Yankuang Group |
| Senior Engineer Ma, Zhiming | China Huadian Corporation |
| Senior Engineer Zhou, Yigong | Shanghai Electric Power Generation Group |
| Senior Engineer Liu, Weining | Nanjing Turbine & Electric Machinery Co., LTD. |

The Alliance for IGCC and Co-production



The Alliance for IGCC and Co-production

—Organization of the Alliance

- Integration of Industries, Universities and Institutes
 - Industries: Manufacturer, Designing Institutes, Coal Companies, Power Companies
 - Institutes
 - Universities
- Start with current participants in the IGCC and co-production demonstration engineering

The Alliance for IGCC and Co-production

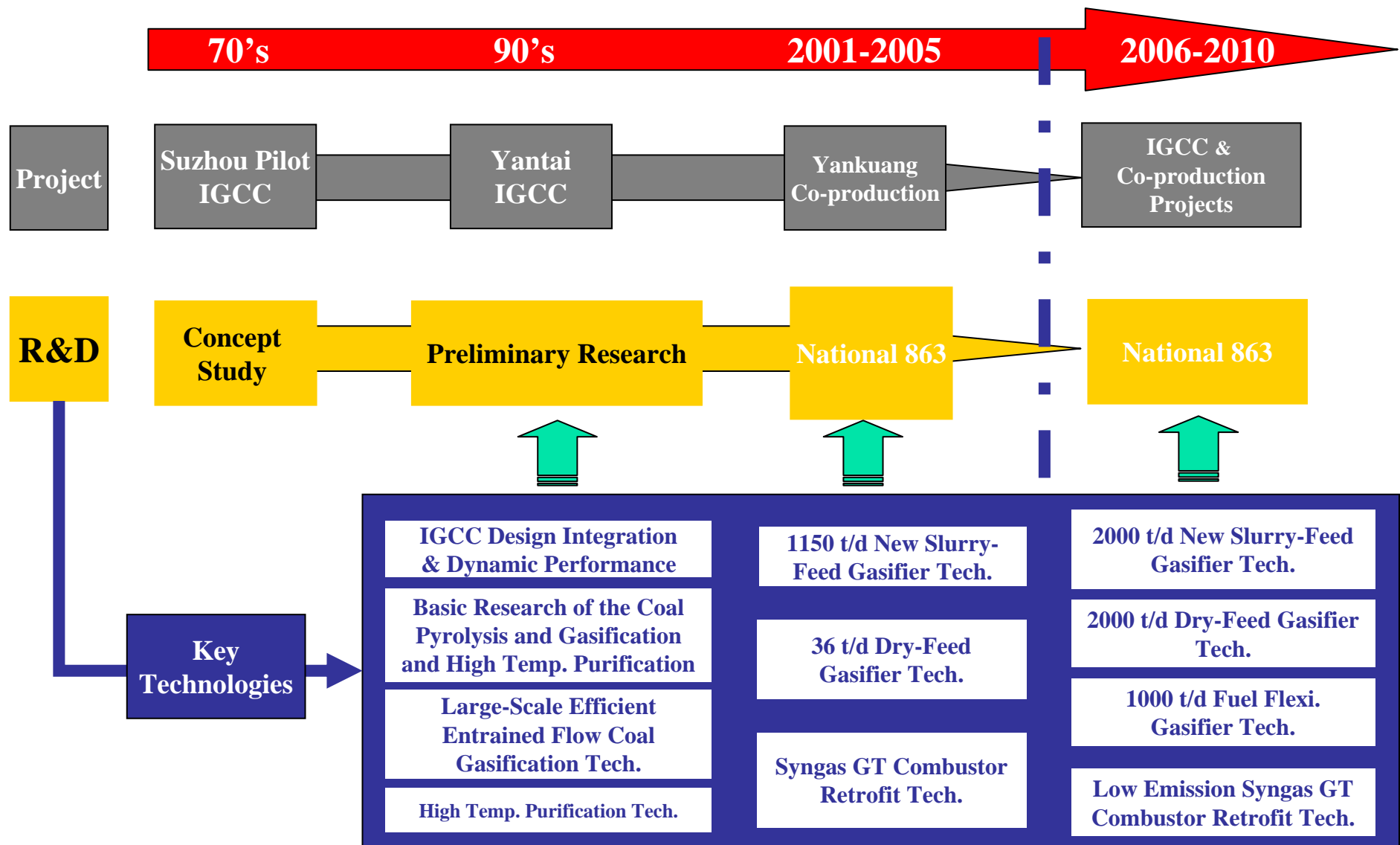
——Functions of the Alliance

- Coordinate R&D² activities on IGCC and co-production technologies
- Jointly develop and construct platform for key technologies R&D²
- Accumulation of information and experience, assessment of technical direction, promote application and development
- Form industrial norms and standards
- Provide consultation and suggestions for formulating national policies

The Alliance for IGCC and Co-production

—Functions of the Alliance (cont.)

- Provide a platform for international cooperation
 - Speed up the learning process of IGCC and Co-production technologies
 - Joint R&D² on IGCC and Co-production technologies
 - International cooperation on CCS



Remarks

- IGCC/Co-production is very important to China. It is the direction of the development of clean coal technology and an option to resolve energy problems of coal, power, oil and transportation
- Efforts and progresses were made and will continue
- Governmental support and right decision, combination of industry, university and institute, effective international collaboration are needed

The background of the slide features a traditional Chinese motif of two golden dragons facing each other. The dragons are intricately detailed with scales, whiskers, and flowing manes. They are set against a vibrant red background that is decorated with stylized, swirling golden clouds. The overall aesthetic is classic and celebratory.

**Thanks for
Your Attention!**