South East Asia Capacity Building Workshop,
11-12 June 2017 Double Tree Johor Bahru in Malaysia

Foresight for Policymaking

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Chinese Academy of Sciences

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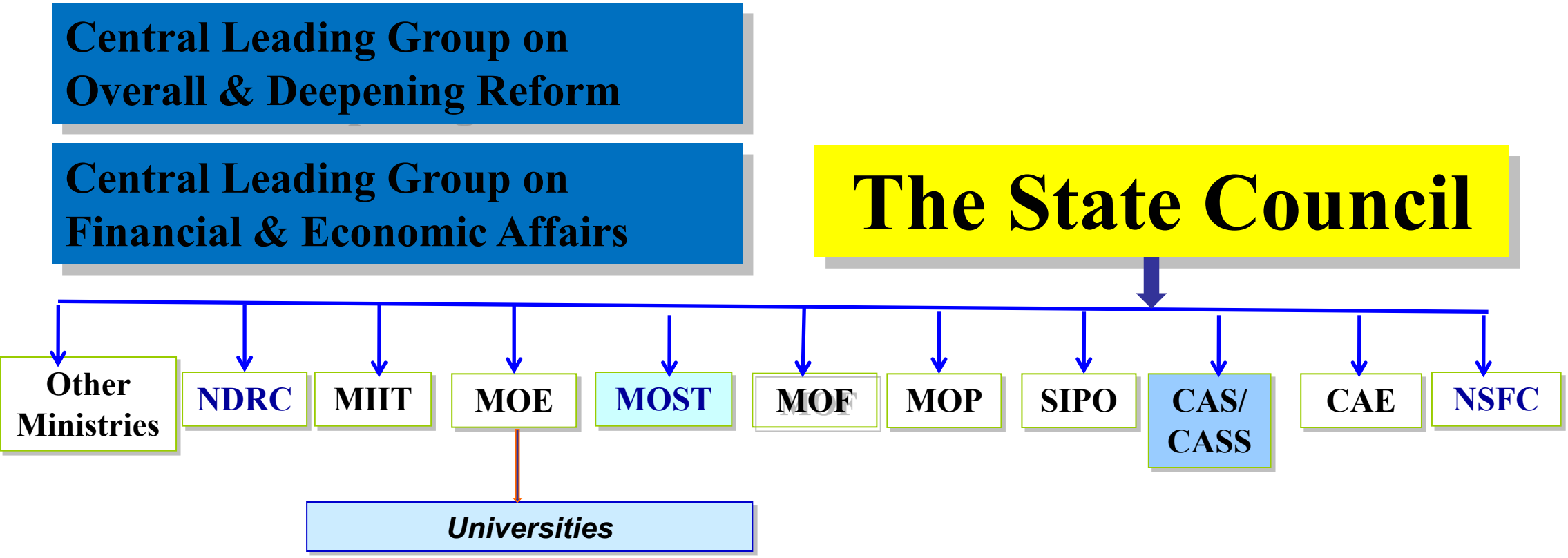
I. Chinese Academy of Sciences

Central Government Structure in China



I. Chinese Academy of Sciences

CAS Academic Division Presidium

Special Committees

- Consultation and Evaluation Committee
- Enforcement of Scientific Ethic Committee
- Academic Works and Publications Committee
- Science Popularization and Education Committee

Academic Divisions

- Division of Mathematics and Physics
- Division of Chemistry
- Division of Life Sciences and Medicine
- Division of Earth Sciences
- Division of Information Technological Sciences
- Division of Technological Sciences

Administrative Bureaus

Research Institutions (105)
- *Institute of Physics*
- *Institute of Chemistry*
- ……
- ***CASISD/CASIPM***

University of CAS
USTC

Information Center / Library

Enterprises

I. Chinese Academy of Sciences

Demands from Government

- ✓ Key Strategies
- ✓ Key Projects
- ✓ Key Measures

◆Implementation of 13th National Economic & Social Development

Taking the task

Active Advice

Advisory of AD

Aiming at

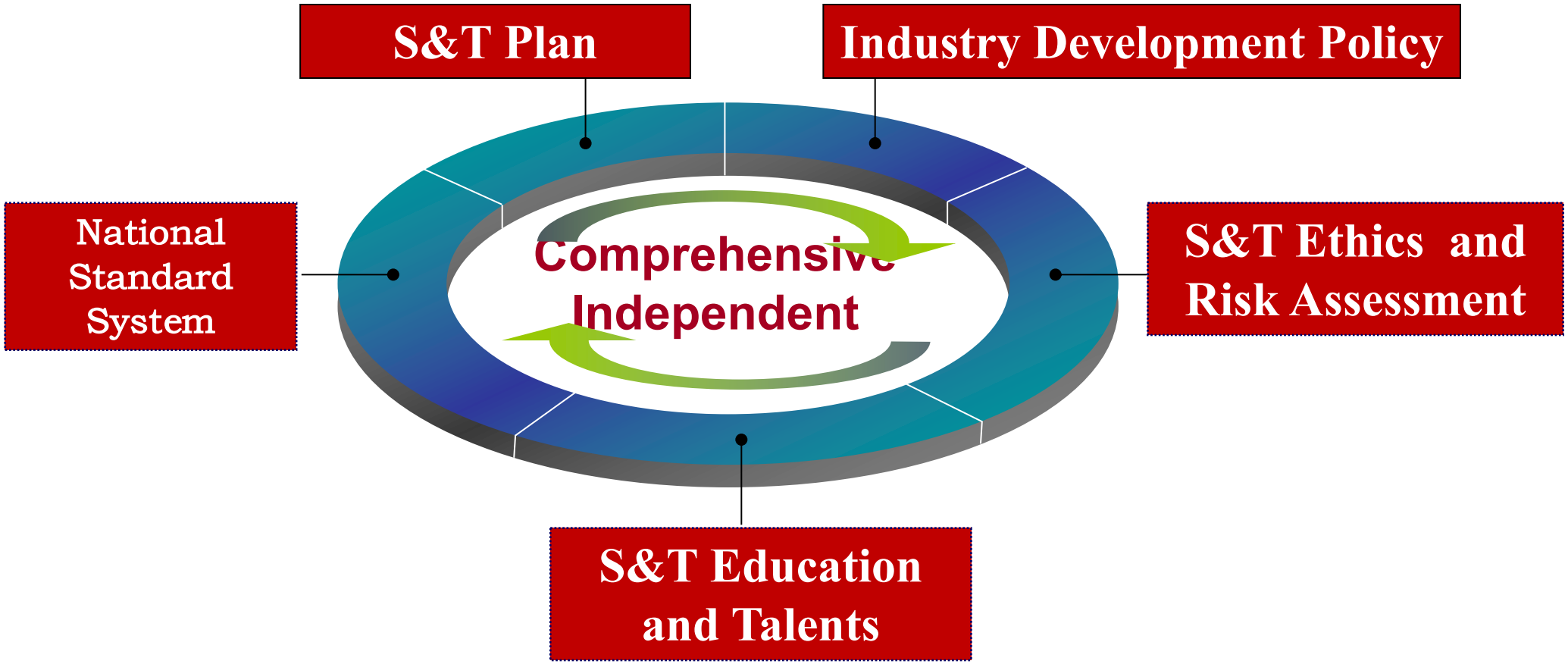
- One Belt One Road
- Yangzi River Economic Belt
- The Joint Development of Beijing, Tianjin and Hebei
- End Poverty Initiative

Systematic Layout

- Feasibility Analysis

I. Chinese Academy of Sciences

The key fields of Science Advice of Academic Division



I. Chinese Academy of Sciences

- The Pilot program of National High-level Think tank in 2015

CAS is one of the ten comprehensive think tanks, consists of the Academic Division (700 academicians) of CAS, the Research Institutes and Universities of CAS.

- **CASISD (Institutes of Science and Development of CAS) has been established on the basis of CASIPM (Institute of Policy and Management of CAS) since January 2016.**

Institute of Policy & Management of Chinese Academy of Sciences (now Institute of Science and Development) pay great attention to international cooperation and global issues since 1985, and have global partnership in the field of STI policy.

Institutes of Science & Development, CAS

1. Research Center of Academic Disciplinary Studies

- To support *Academic Works & Publications Committee of the CASAD*

2. Research Center of Scientific Norms and Ethics

- To support the Scientific Ethics Committee of ***the CASAD***.

3. Research Center of Science Publicity and Education

- To support the Science Popularization and Education Committee of ***the CASAD***.

4. Research Center of the Consultation and Support

- To support the Consultation and Evaluation Committee of ***the CASAD***.

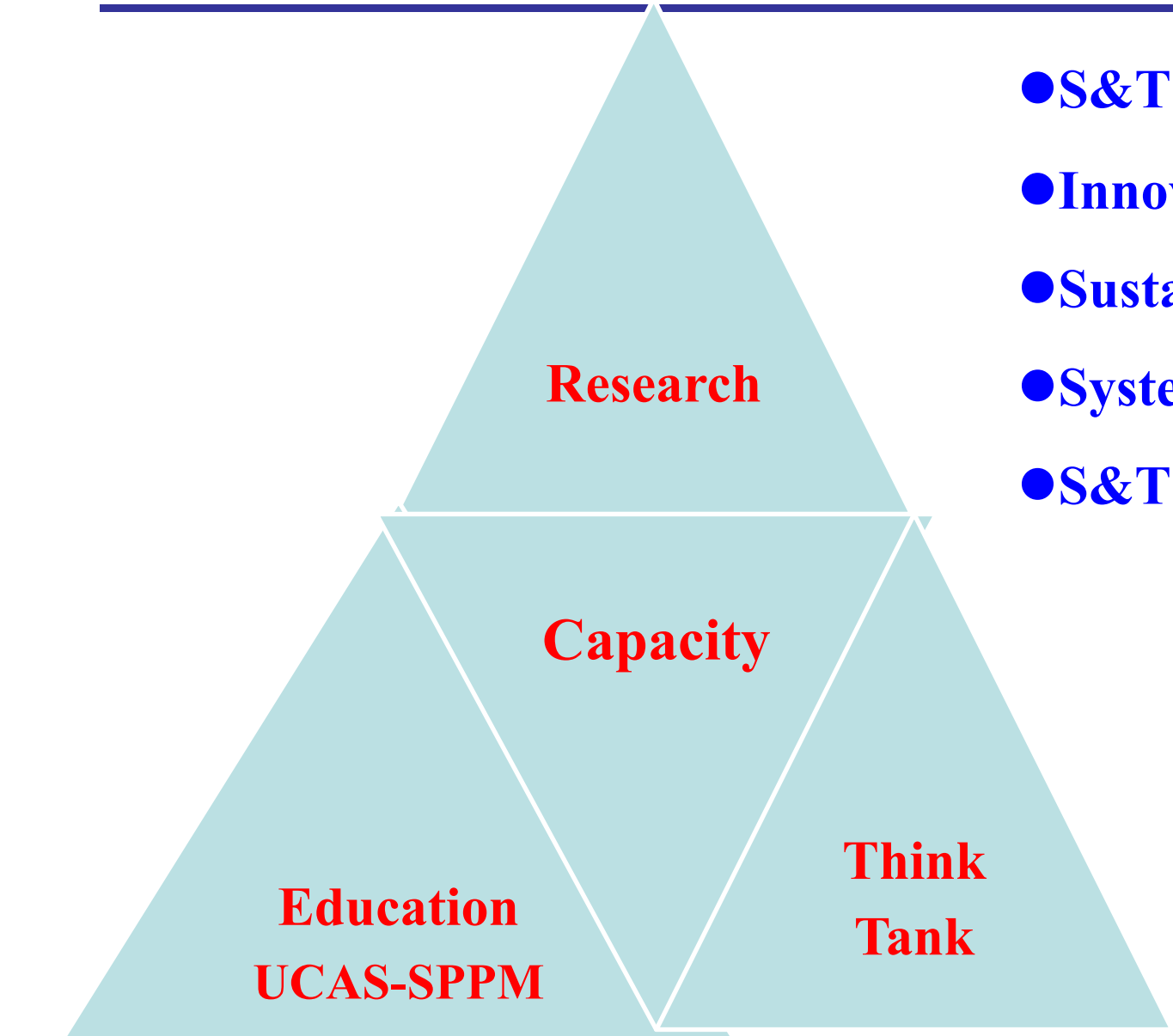
5. Center of the Third Party Evaluation

- To support CAS to conduct assessment tasks from the State Council

Institutes of Science & Development, CAS

1. Institute of S&T Development Strategy
2. Institute of Innovation and Development Policy
3. Institute of Sustainable Development Strategy
4. Institute of System Analysis and Management
5. Institute of S&T Strategic Information

Institutes of Science & Development, CAS



- S&T Development
- Innovation Development
- Sustainable Development
- System Analysis and Management
- S&T Information Research

- Strategy
- Policy
- Management

II. Evolution of Technology Foresight

Generation	First	Second	Third	Fourth	Fifth
Focus	Technology forecasts	Technology and Markets	Technology, markets and the social dimension	Distributed actors in innovation ecosystem	Tailored approaches in R&I ecosystem
Programme Structure	Science and technology	Industry & Service Sectors	Thematic, socio-economic, problem-solving	Distributed role in innovation system rather than single policy sponsor	A mix of foresight programmes and exercises, also distributed across many sites but in combination with other elements of strategic decision-making.
Actors	Experts	Academics and Industry	Academics, industry, Gov & social stakeholders	As for 3rd generation but widening scope for example to regional level	Domain experts working alongside stakeholders and foresight experts.

II. Evolution of Technology Foresight

Objectives	Picking winners	Networking the economy	Wiring up NIS	Self-organising NIS – link to concepts of industry ecosystem and open innovation	Policies and structures or actors within the STI system or the S&T dimensions of broader social or economic issues.
Evaluation Criteria	Accuracy of prediction and diffusion of results particularly to non-experts	Take-up of priorities and development of networks among industry/academia participants	Involvement of stakeholders in evaluation and embedding of a foresight culture.	As for 3rd generation but reflecting different expectations and needs of stakeholders	Focus on additionality of foresight in wider set of activity in sector or domain.

Georghiou (2008)

II. Evolution of Technology Foresight

- Technology foresight in China in broad sense can be traced to "The 12 Years Planning for Science Development (1956-1967) issued in 1956", when over one thousand top scientists participated in work ranging from technology selection, priority setting, subject arrangement, resource distribution, by using a method similar to a Delphi survey.

II. Evolution of Technology Foresight

Projects	Duration	Organization
National Key Technology Selection	1992～1995	MOST
Technology Forecast of National Key domains	1997～1999	MOST
Technology Forecast and key technology selection of high and emerging technology in China	2002～2003	MOST
Technology Foresight towards 2020 in China	**2003～2005**	**CAS/CASIPM**
Innovation 2050: Science, technology and future of China	2007～2009	CAS
Technology Forecast for the 13th National S&T Plan	2013～2015	MOST CASTED
Strategic Studies on Engineering Technology of China towards 2035	2014～2016	CAE NSFC

Regional level foresight activities in Shanghai, etc.

II. Evolution of Technology Foresight

National level foresight activities:

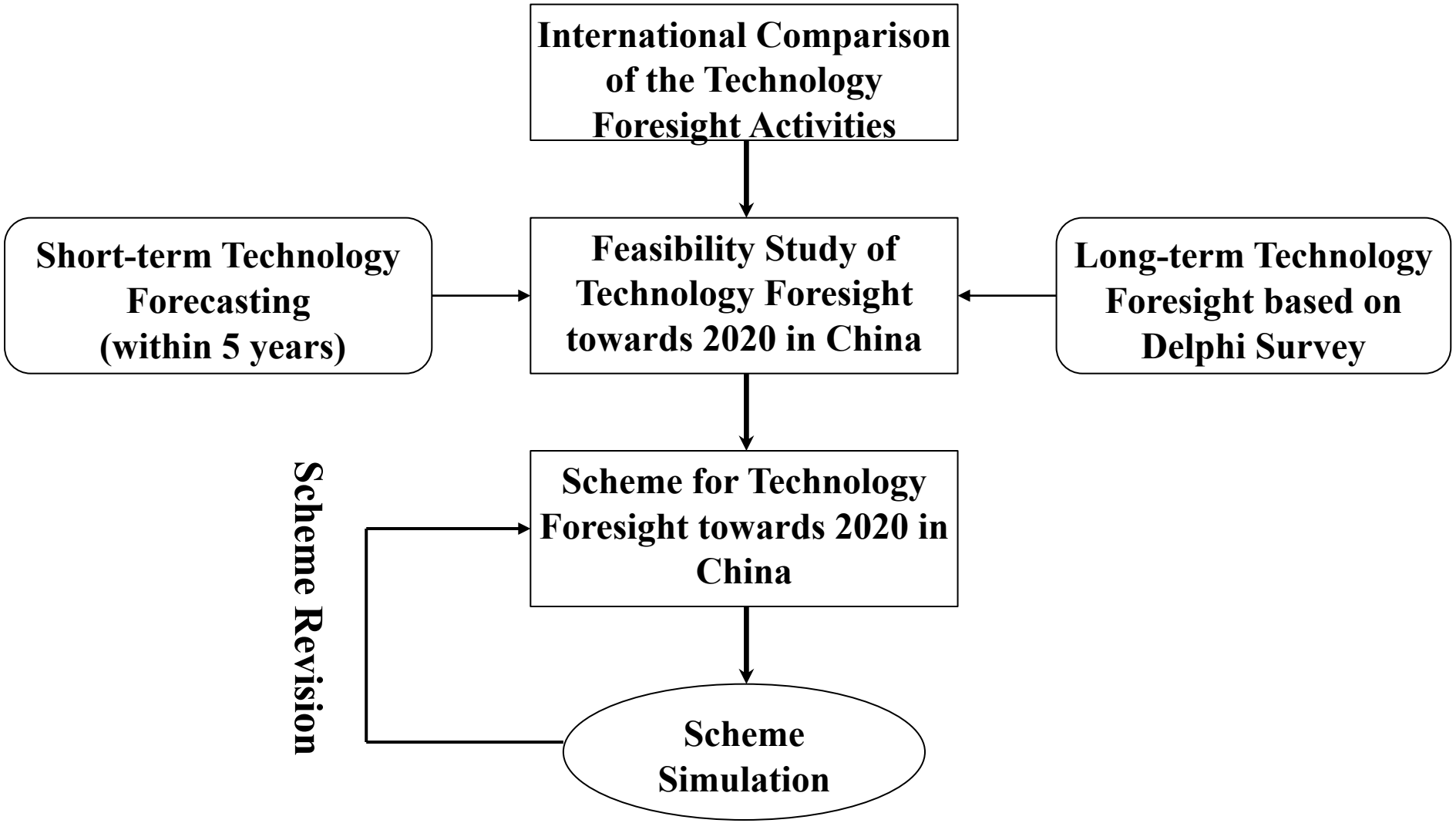
- CASTED of MOST 10 years
- CASIPM of CAS 15-20 years
- CAS 30-40 years
- CAE 20 year

Regional level foresight activities:

Shanghai, Guangdong, Jiangsu 5-10 years

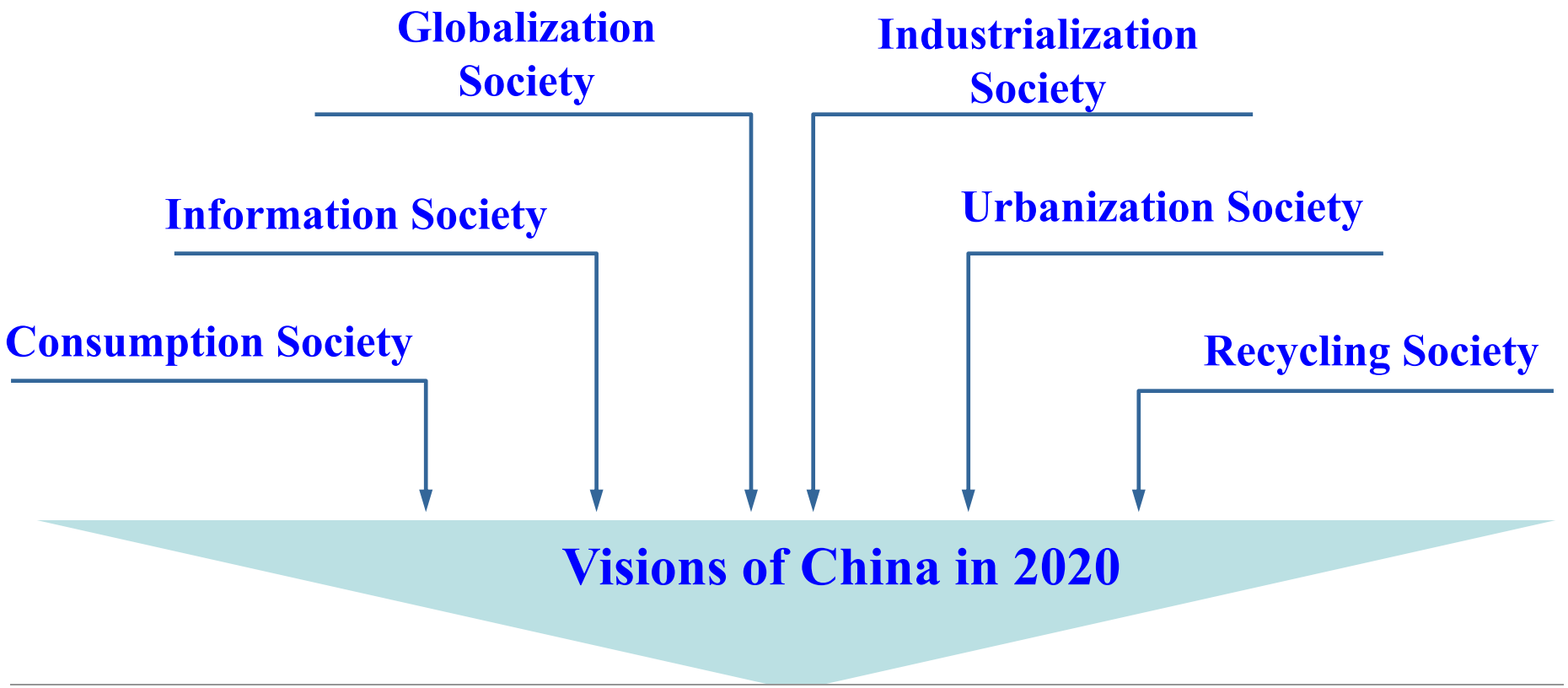
III. Technology Foresight for Policymaking in China

Technology Foresight toward 2020 in China



Technology Foresight toward 2020 in China

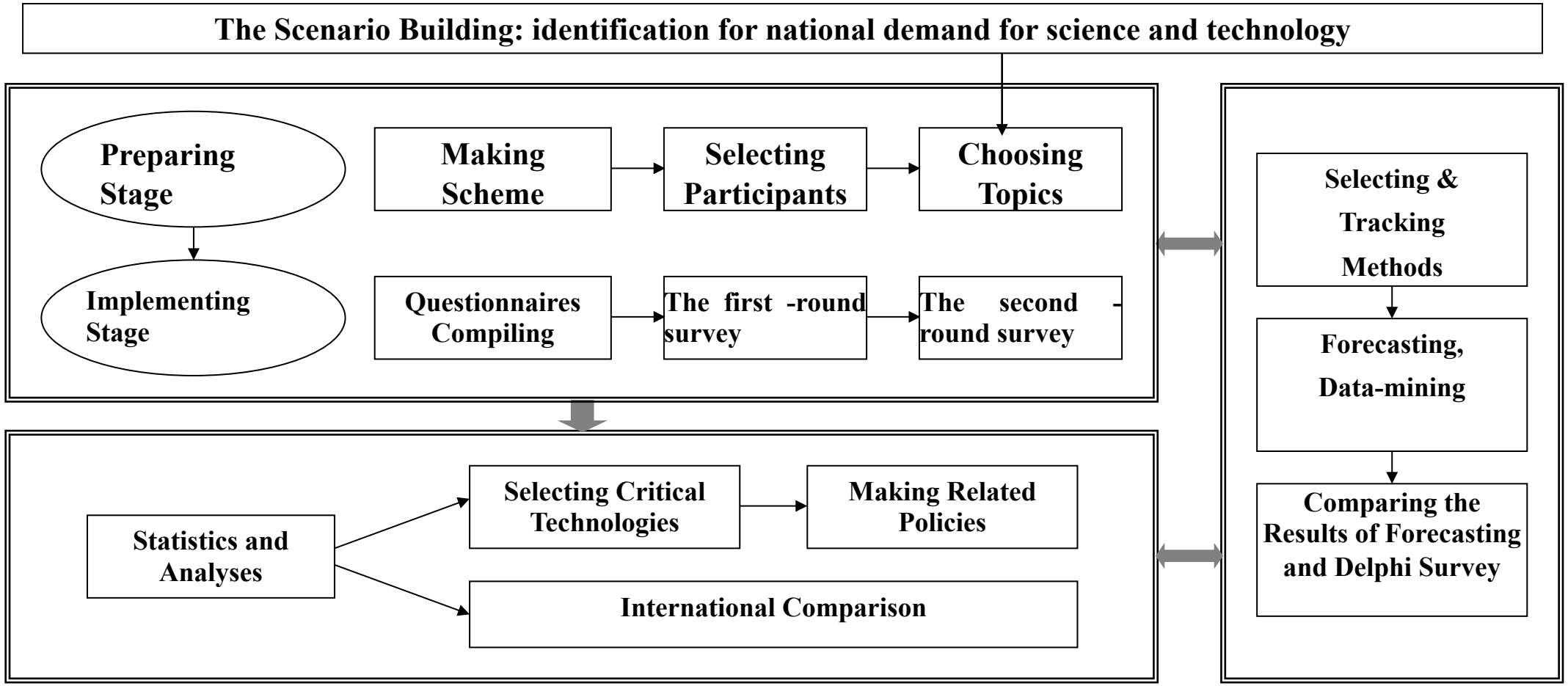
Scenario Building

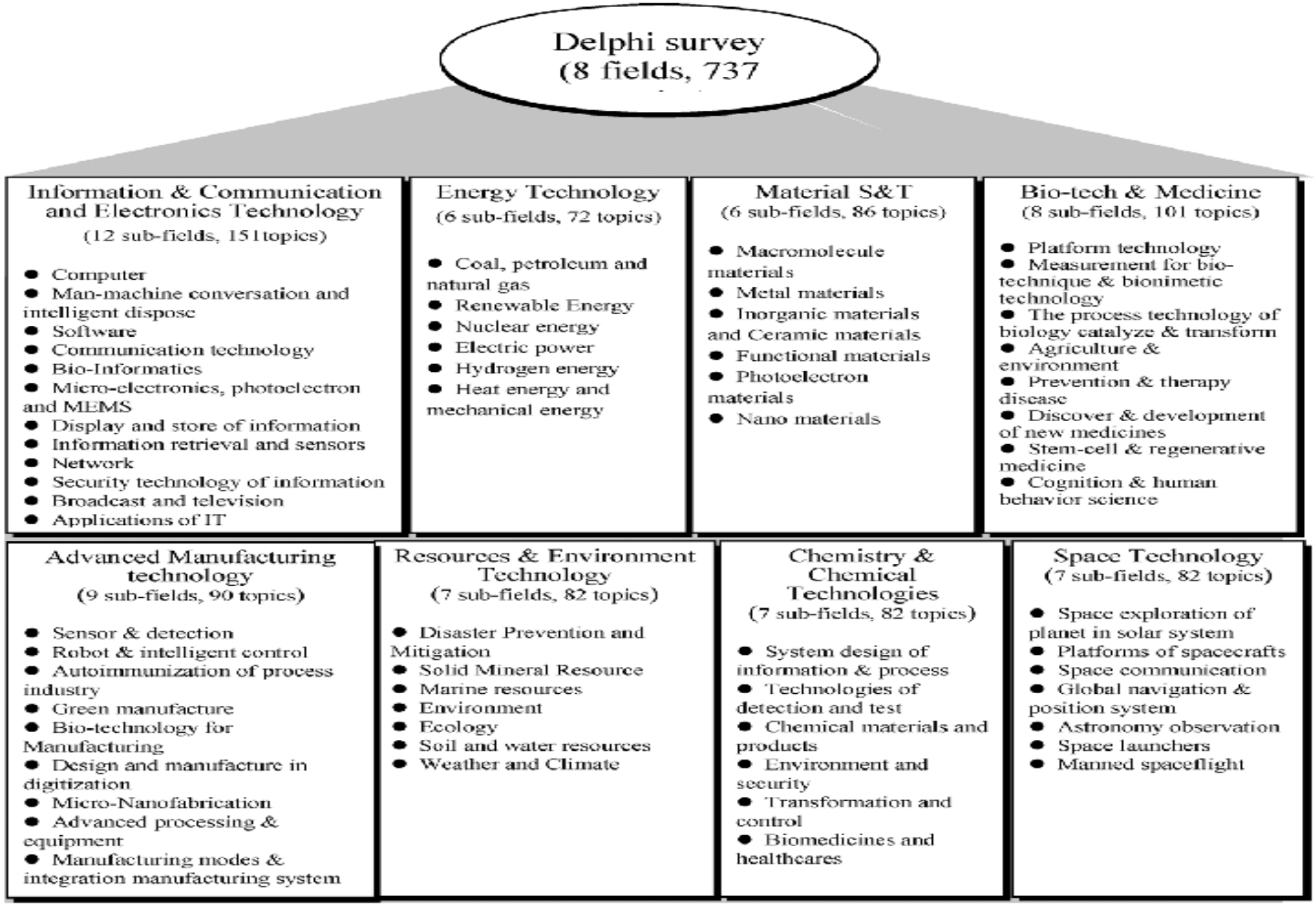


Technology Demand in the Comprehensive Well-off Society

Innovation Driven-country

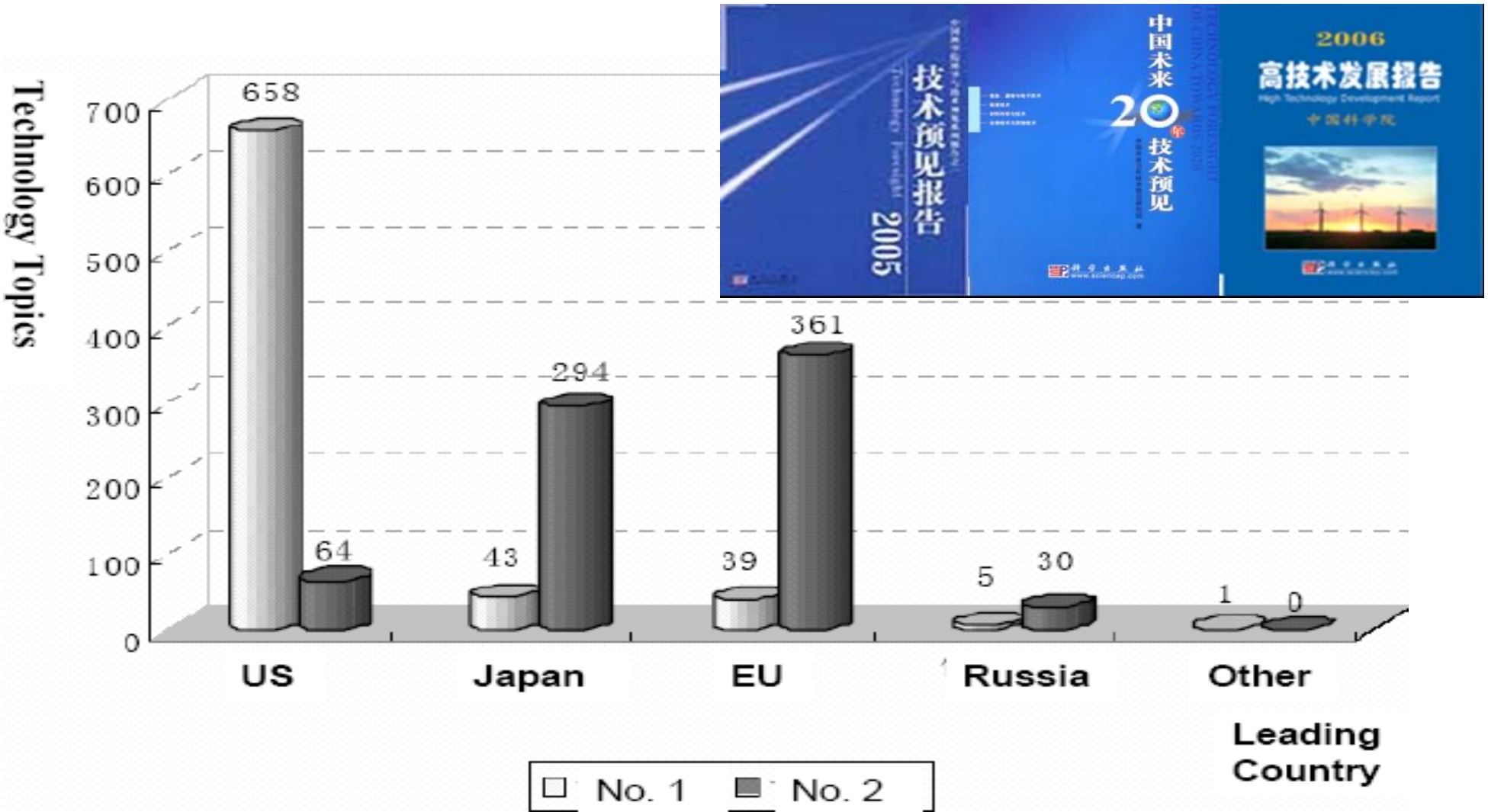
Technology Foresight toward 2020 in China




Delphi survey
(8 fields, 737
Information & Communication and Electronics Technology
(12 sub-fields, 151topics)
● Computer
● Man-machine conversation and intelligent dispose
● Software
● Communication technology
● Bio-Informatics
● Micro-electronics, photoelectron and MEMS
● Display and store of information
● Information retrieval and sensors
● Network
● Security technology of information
● Broadcast and television
● Applications of IT
Energy Technology
(6 sub-fields, 72 topics)
● Coal, petroleum and natural gas
● Renewable Energy
● Nuclear energy
● Electric power
● Hydrogen energy
● Heat energy and mechanical energy
Material S&T
(6 sub-fields, 86 topics)
● Macromolecule materials
● Metal materials
● Inorganic materials and Ceramic materials
● Functional materials
● Photoelectron materials
● Nano materials
Bio-tech & Medicine
(8 sub-fields, 101 topics)
● Platform technology
● Measurement for bio-technique & bionimetic technology
● The process technology of biology catalyze & transform
● Agriculture & environment
● Prevention & therapy disease
● Discover & development of new medicines
● Stem-cell & regenerative medicine
● Cognition & human behavior science
Advanced Manufacturing technology
(9 sub-fields, 90 topics)
● Sensor & detection
● Robot & intelligent control
● Autoimmunization of process industry
● Green manufacture
● Bio-technology for Manufacturing
● Design and manufacture in digitization
● Micro-Nanofabrication
● Advanced processing & equipment
● Manufacturing modes & integration manufacturing system
Resources & Environment Technology
(7 sub-fields, 82 topics)
● Disaster Prevention and Mitigation
● Solid Mineral Resource
● Marine resources
● Environment
● Ecology
● Soil and water resources
● Weather and Climate
Chemistry & Chemical Technologies
(7 sub-fields, 82 topics)
● System design of information & process
● Technologies of detection and test
● Chemical materials and products
● Environment and security
● Transformation and control
● Biomedicines and healthcares
Space Technology
(7 sub-fields, 82 topics)
● Space exploration of planet in solar system
● Platforms of spacecrafts
● Space communication
● Global navigation & position system
● Astronomy observation
● Space launchers
● Manned spaceflight

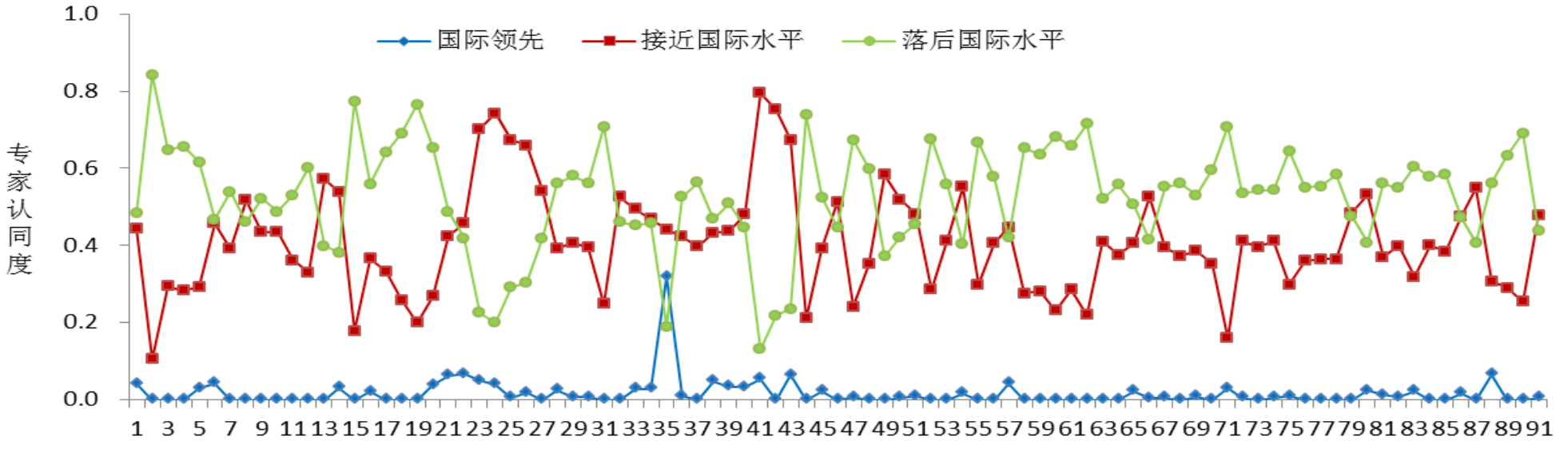
Technology Foresight toward 2020 in China

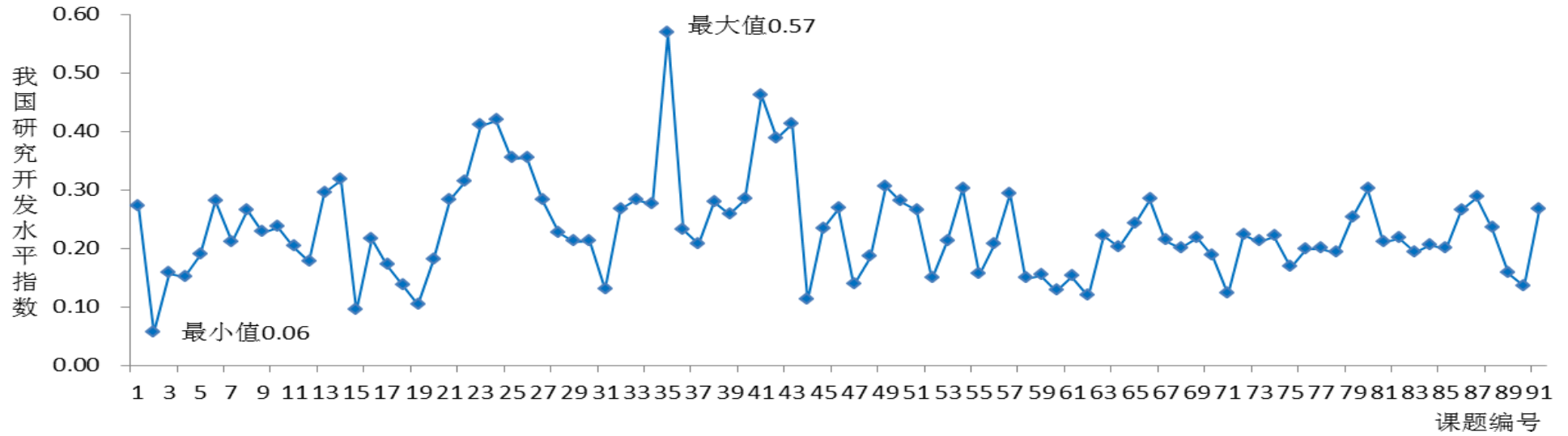
Significance: Economic Development, Life Quality, National Security



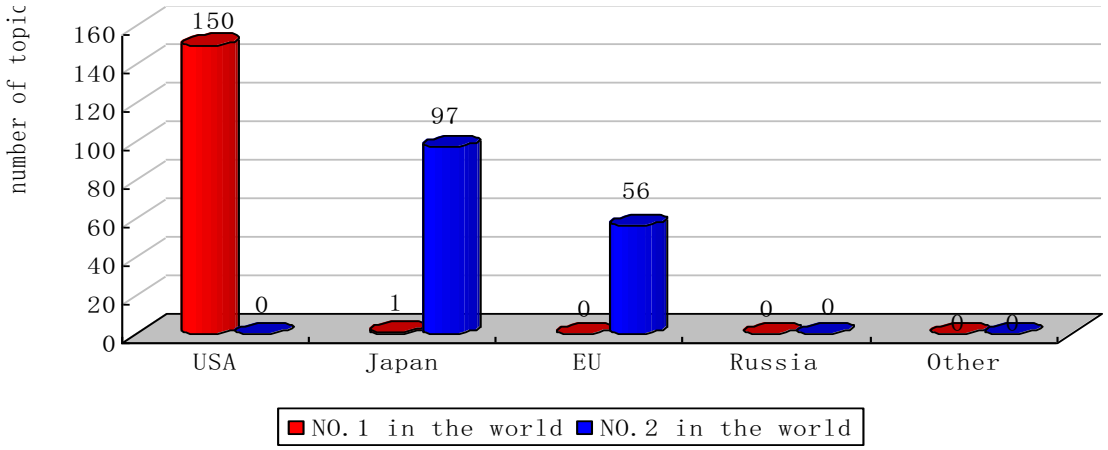
Space Science and Technology Foresight

Current research capability of China V.S. International top level

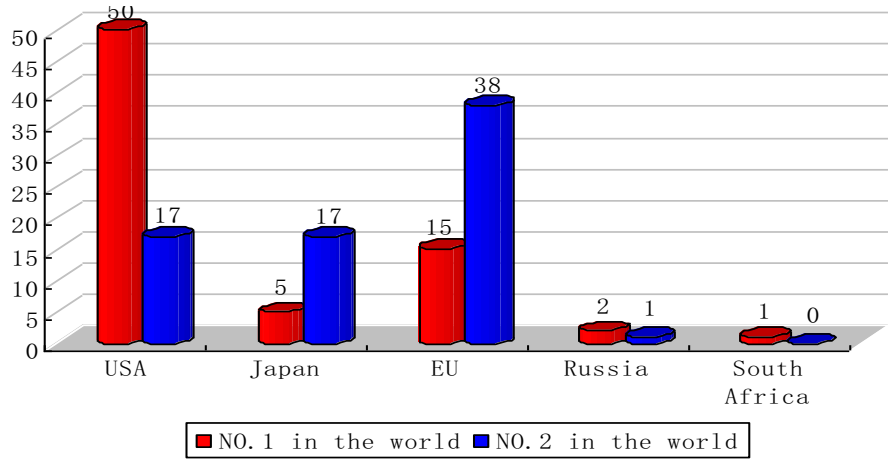




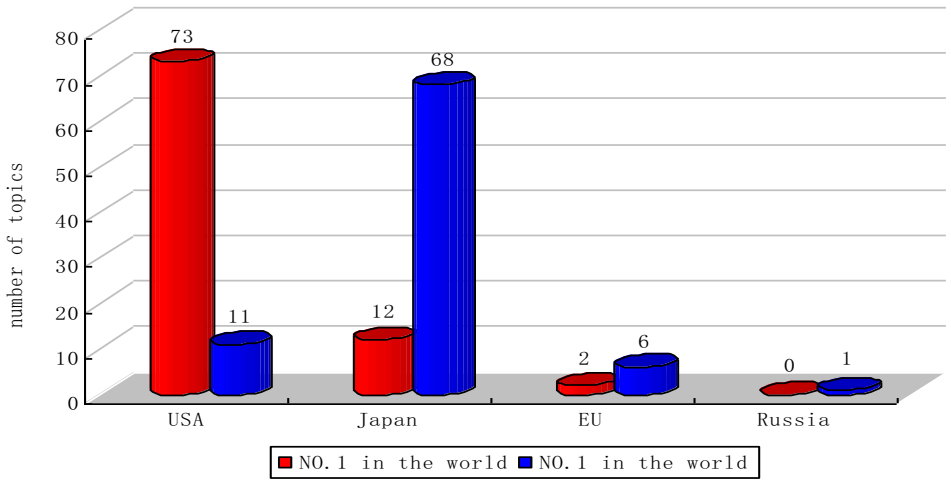
Technology Foresight toward 2020 in China



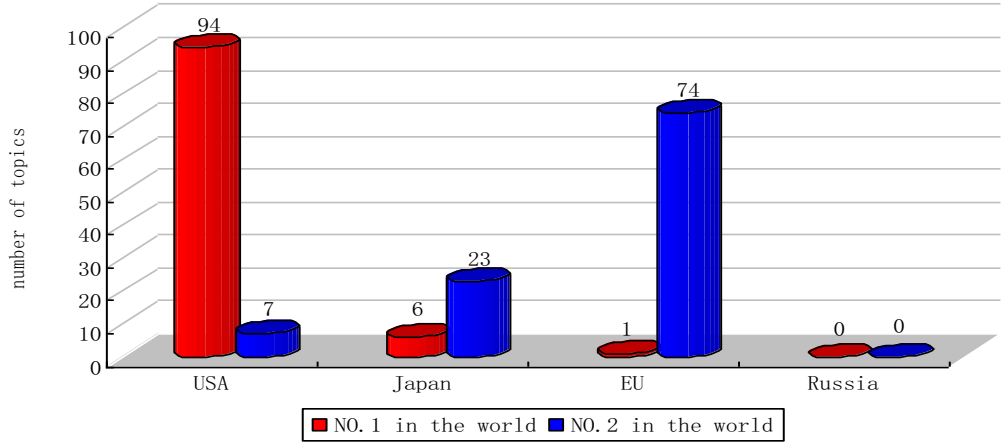
ICT



Energy

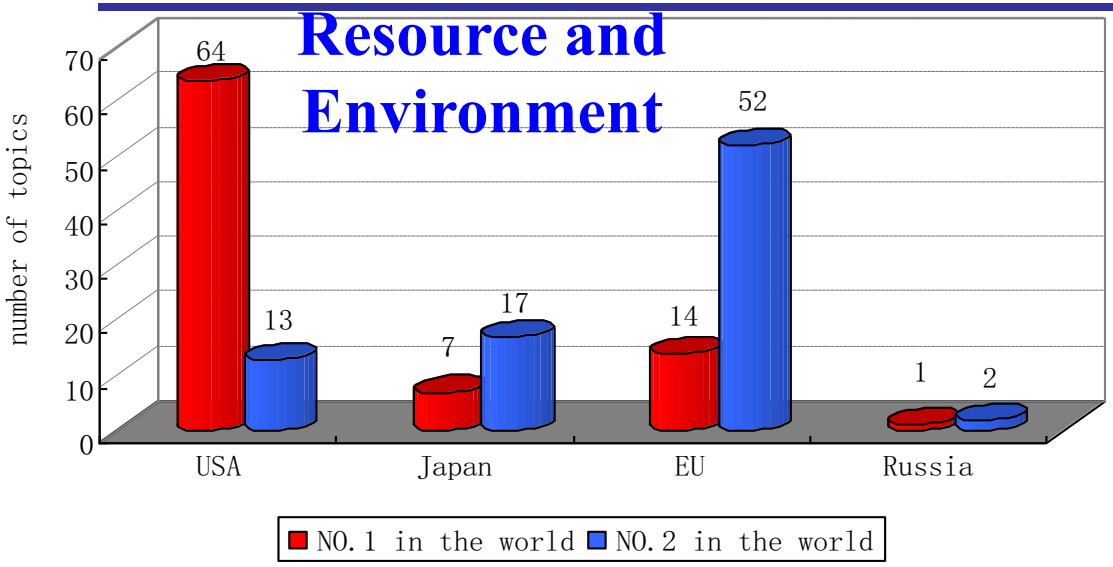


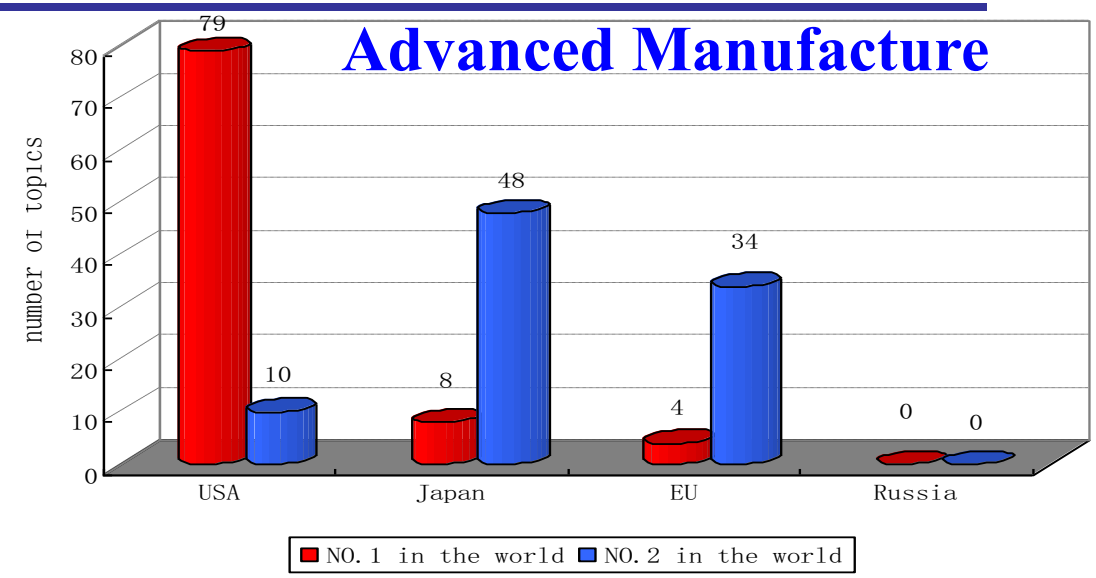
Materials

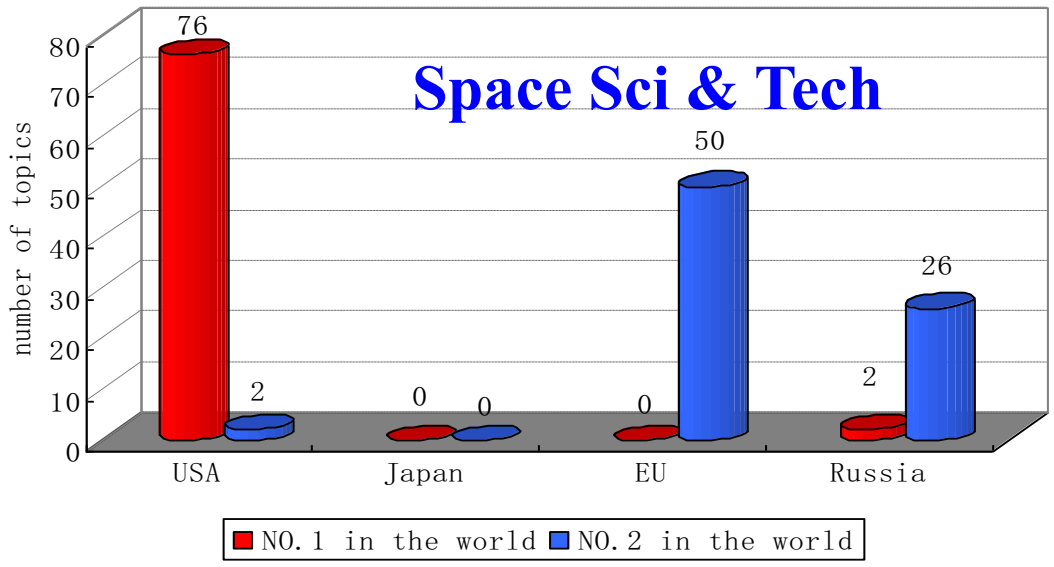


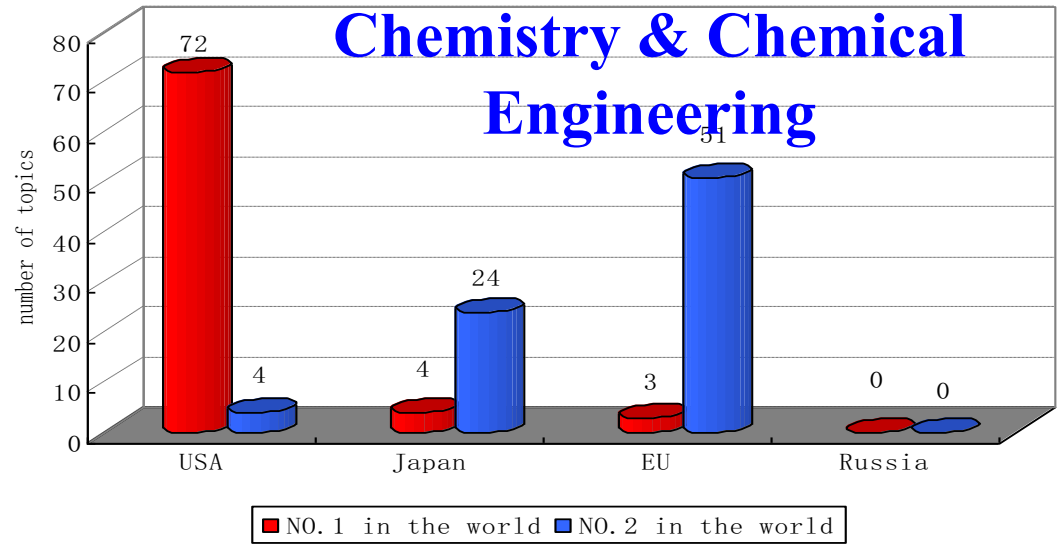
Bio&Medicine

Technology Foresight toward 2020 in China







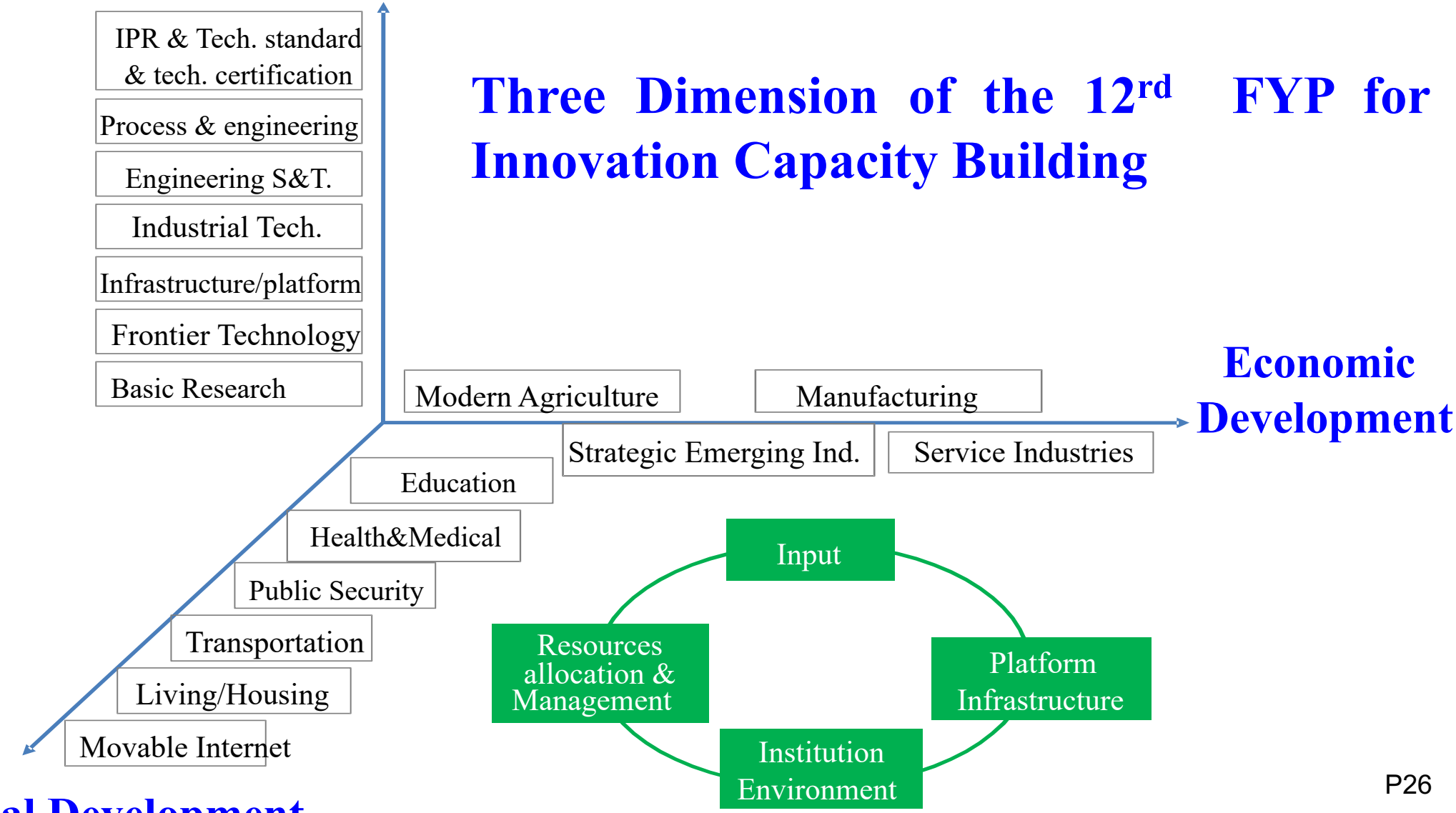


Impact

Foresight has no systematic and direct arrangement for supporting STI policymaking before 2012.

- **Deliverables to Policymakers**
- **Publications/books to the public**: Technology Foresight of China towards 2020; Technology Foresight of China towards 2020 (Continued);Technology Foresight Report 2005; Technology Foresight Report 2008
- **Individual policymaking evolvements** such as 11th FYP in CAS/NDRC
- **New project**: Innovation 2030: Roadmap for Development
- **Foresight Special Commission** of **China Association for Science of Sciences and S&T Policy**, Annual Conference on Technology Foresight since 2002

Three Dimension of the 12rd FYP for Innovation Capacity Building



III. Technology Foresight for Policymaking in China

CAS released the report "S&T in China: A Road Map to 2050", including: "Innovation 2050: the S&T Revolution and China's Future" and 18 S&T Fields Roadmap focusing on 8 basic and strategic systems for social & economic development " in 2009.

S&T in China: A Road Map to 2050

8 basic and strategic systems

1. Sustainable Energy and Resources
2. Advanced Materials and Smart Green Manufacturing
3. Ubiquitous Information Networking
4. Ecological, High-value Agriculture & Bi-industry
5. Generalized Preferential Health Assurance
6. Ecological, Environmental Conservation & Development
7. Space and Ocean Exploration Capability
8. National and Public Security

S&T in China: A Road Map to 2050

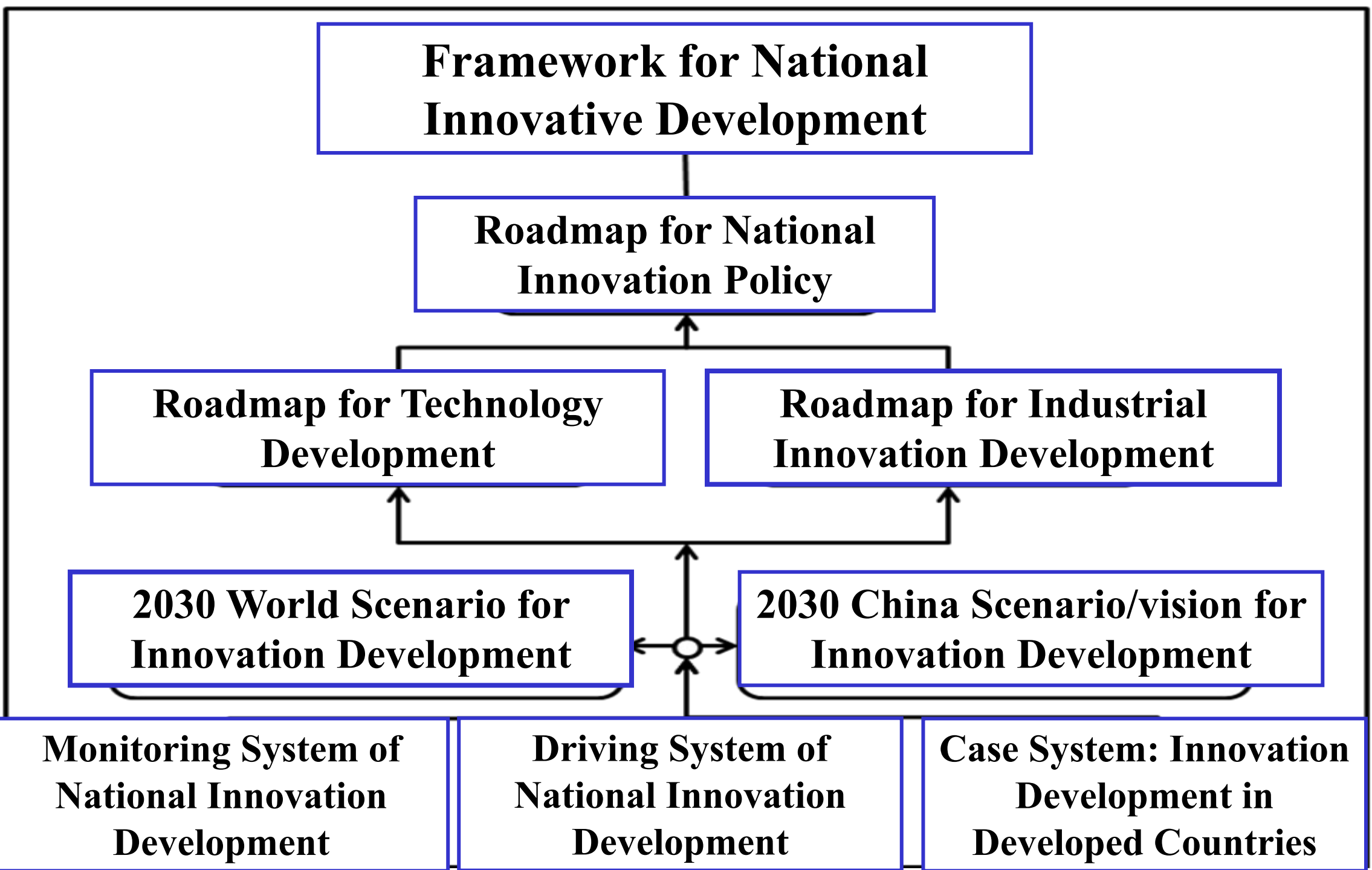
18 Research Field Roadmap Report

- Energy
- Water Resource
- Mineral Resources
- Marine
- Oil and Gas
- Population & Health
- Agriculture
- Ecological Environment
- Biomass
- Regional Development
- Space
- Information Technology
- Advanced Manufacturing
- Advanced Materials
- Nanometer Technology
- Scientific Equipment
- Notable Intercross Science
- National Security & Public Security

III. Technology Foresight for Policymaking in China

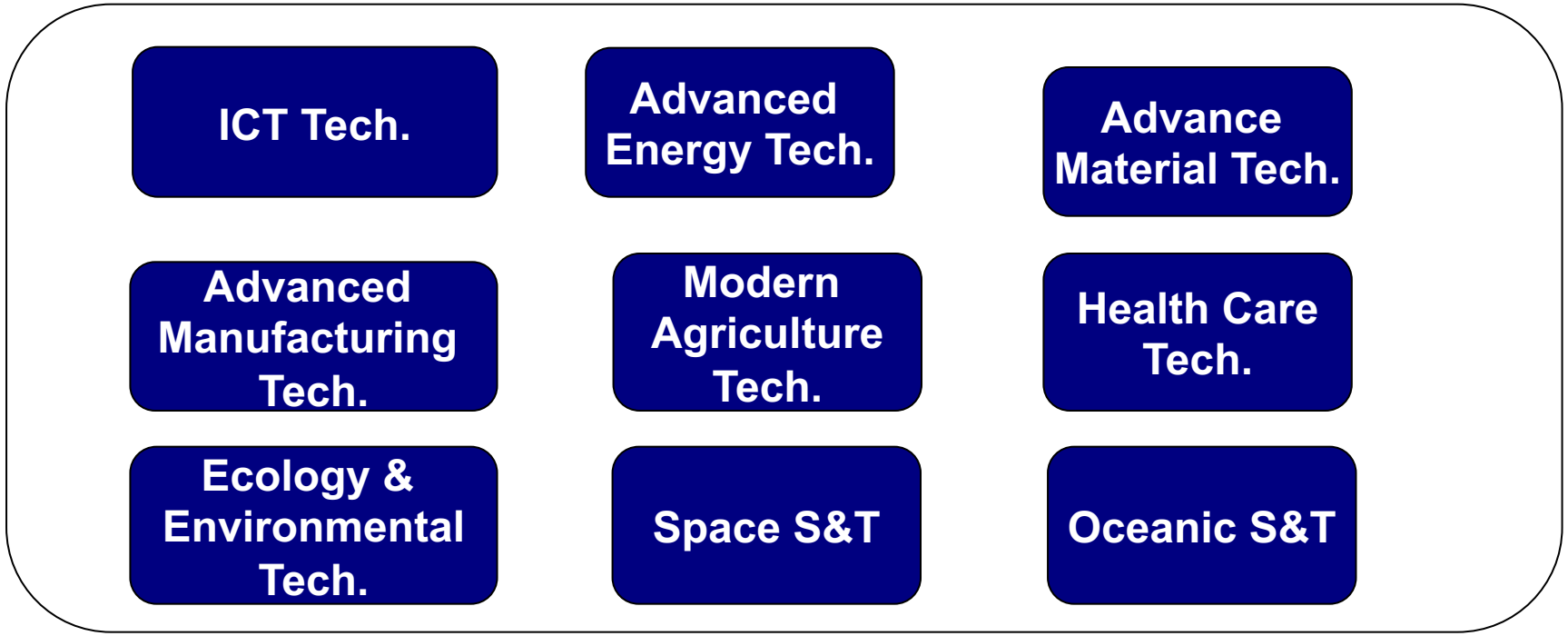
Innovation 2030: Roadmap for Development

Innovation is a complex process of value creation, including: scientific value, technological value, economic value and the social value, and even cultural value, concerning activities of scientific discovery, technological invention, methodological innovation, and their commercial applications as well as social diffusion.


Framework for National Innovative Development
Roadmap for National Innovation Policy
Roadmap for Technology Development
Roadmap for Industrial Innovation Development
2030 World Scenario for Innovation Development
2030 China Scenario/vision for Innovation Development
Monitoring System of National Innovation Development
Driving System of National Innovation Development
Case System: Innovation Development in Developed Countries

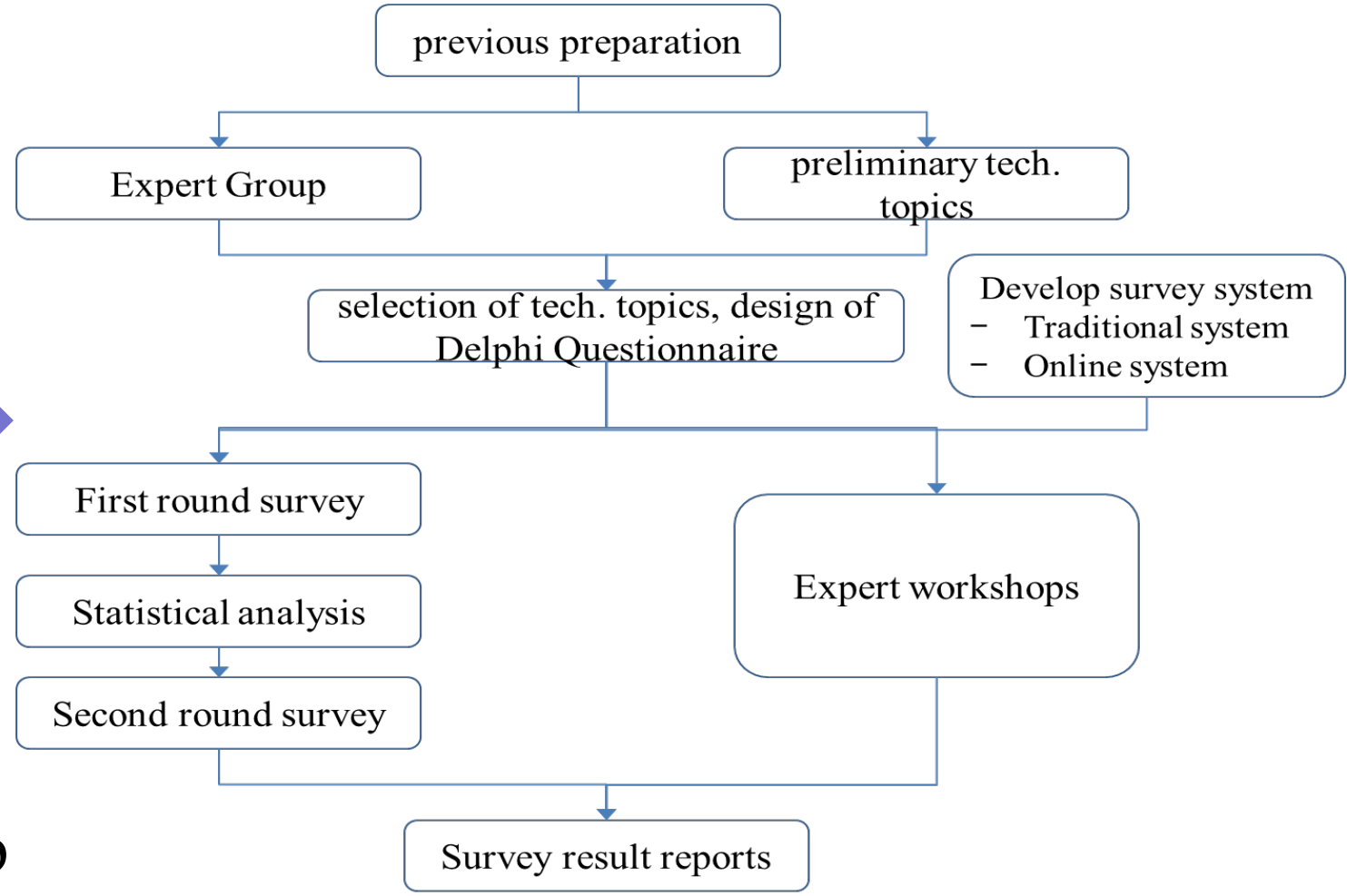
Delphi Surveys of Key S&T Domains

- Two rounds of large scale Delphi surveys;
- Figure out the most important technology fields and topics for innovation development towards 2030 in China;
- Identify key factors to develop and commercialize these technologies



Methodology

- Literature review
- Bibliometrics
- Scenario workshops
- Technical topics
- Delphi survey
- Statistical analysis
- Expert panels
- Brain-storming
- Technology roadmap



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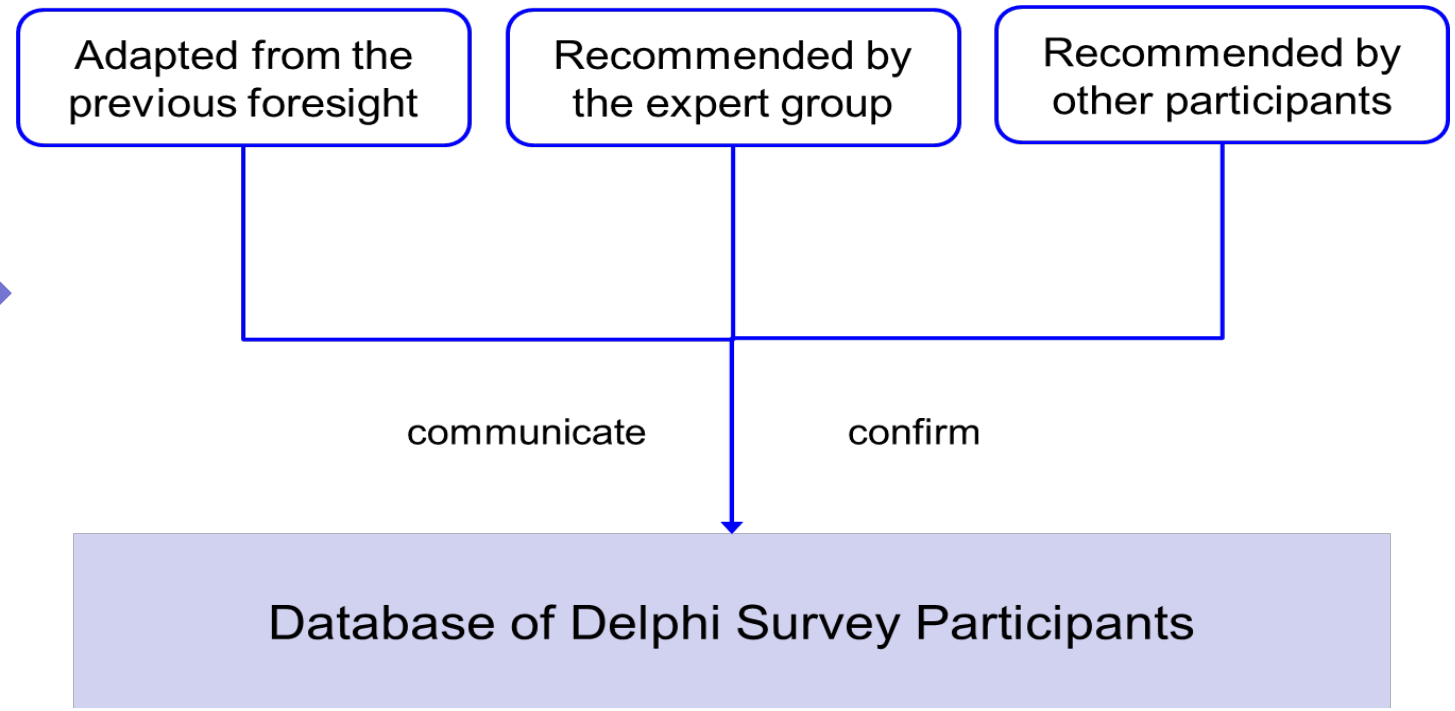


III. Technology Foresight for Policymaking in China

China-Japan-Korea Joint Research on Renewable Technology Foresight 2030

Scenario analysis to 2030

- **Step1:** Identification of key drivers
- **Step2:** Mapping the causal relationship among key ingredients
- **Step3:** Selecting and building scenarios
- **Step4:** Description of scenarios

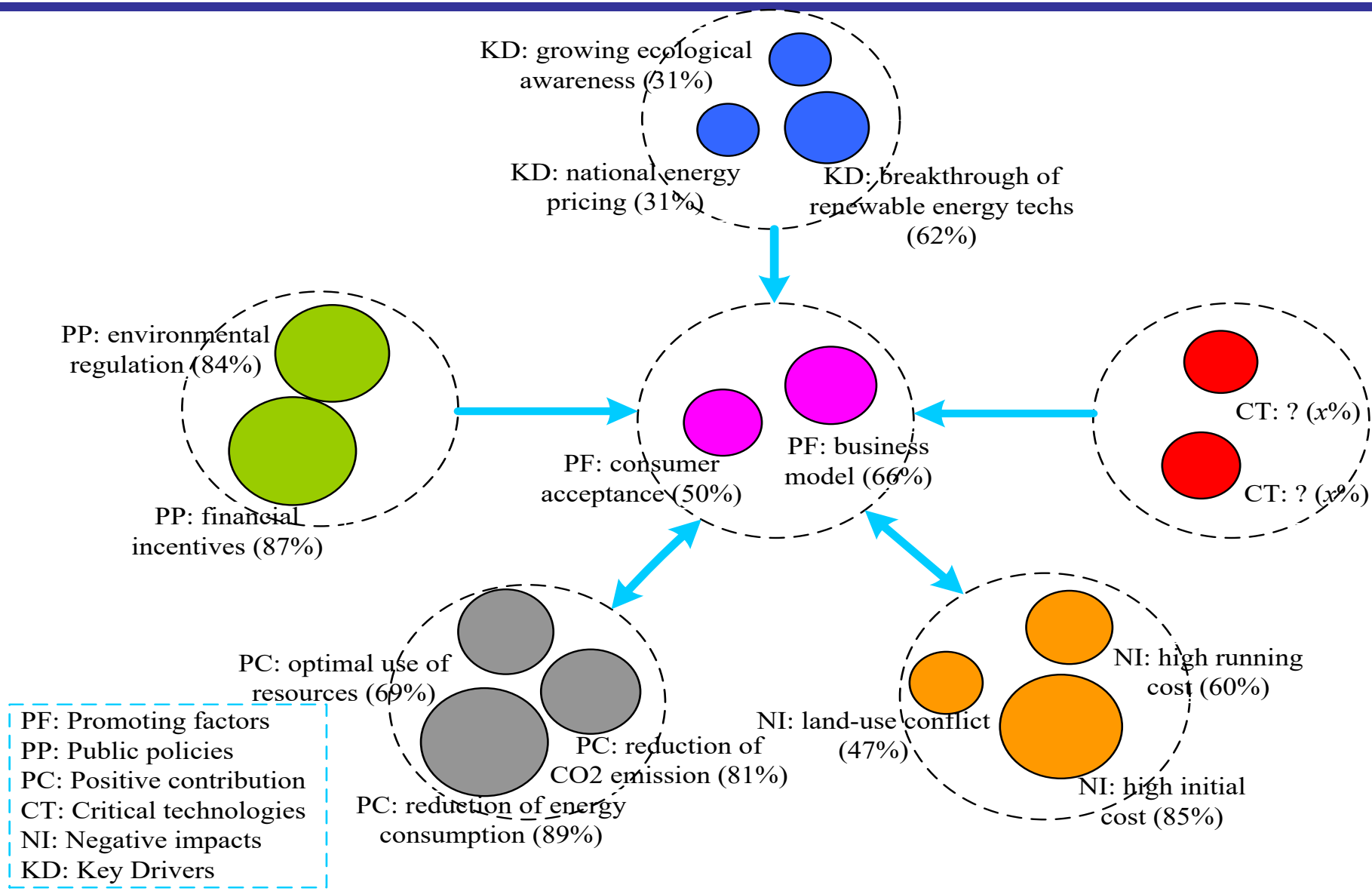
Step1: Identification of key drivers

Based on the Delphi survey

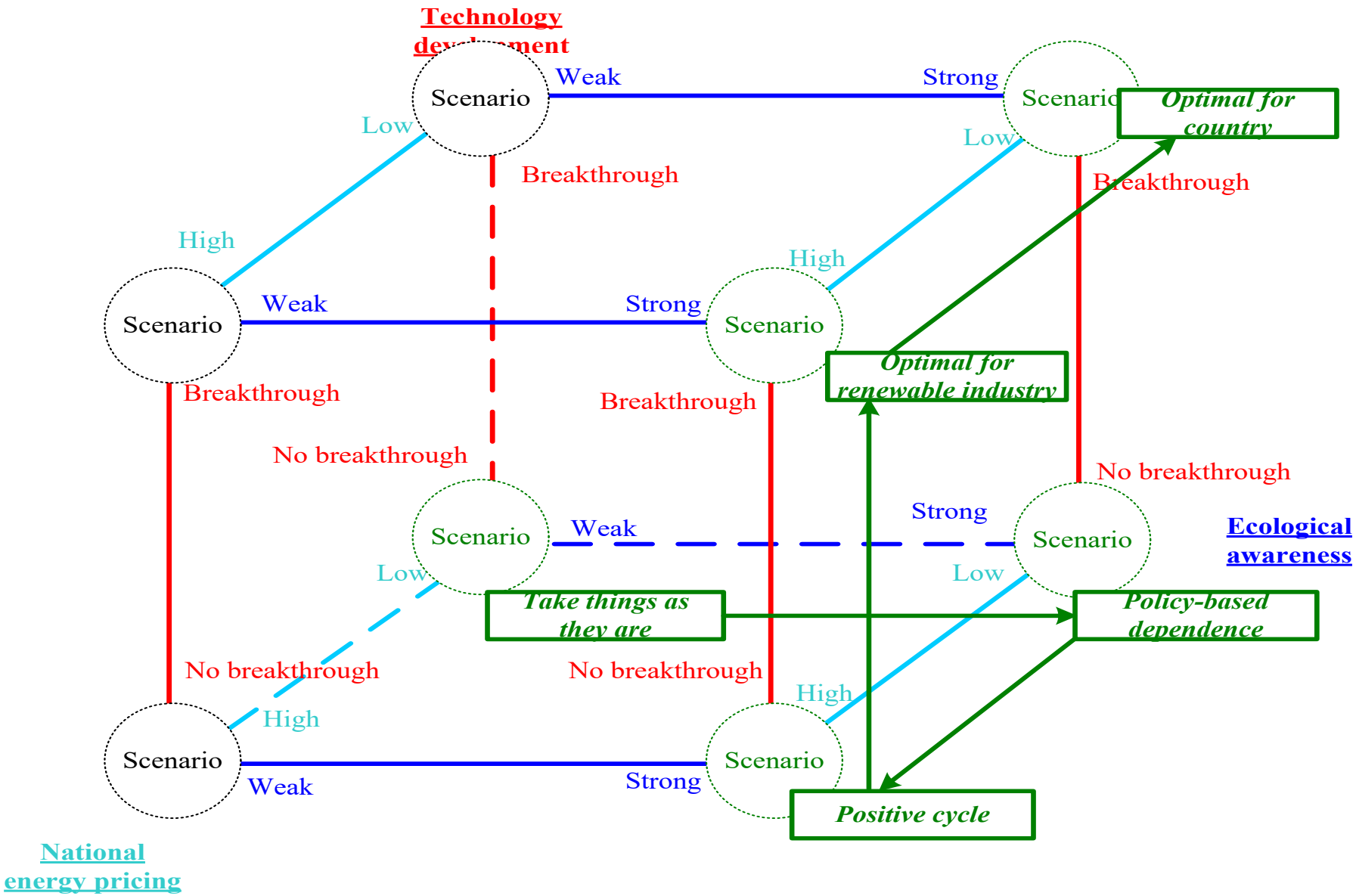
Three key drivers:

1. Breakthrough of renewable energy techs
2. Growing ecological awareness
3. National energy pricing

Step2: Overall causal relationship among key ingredients



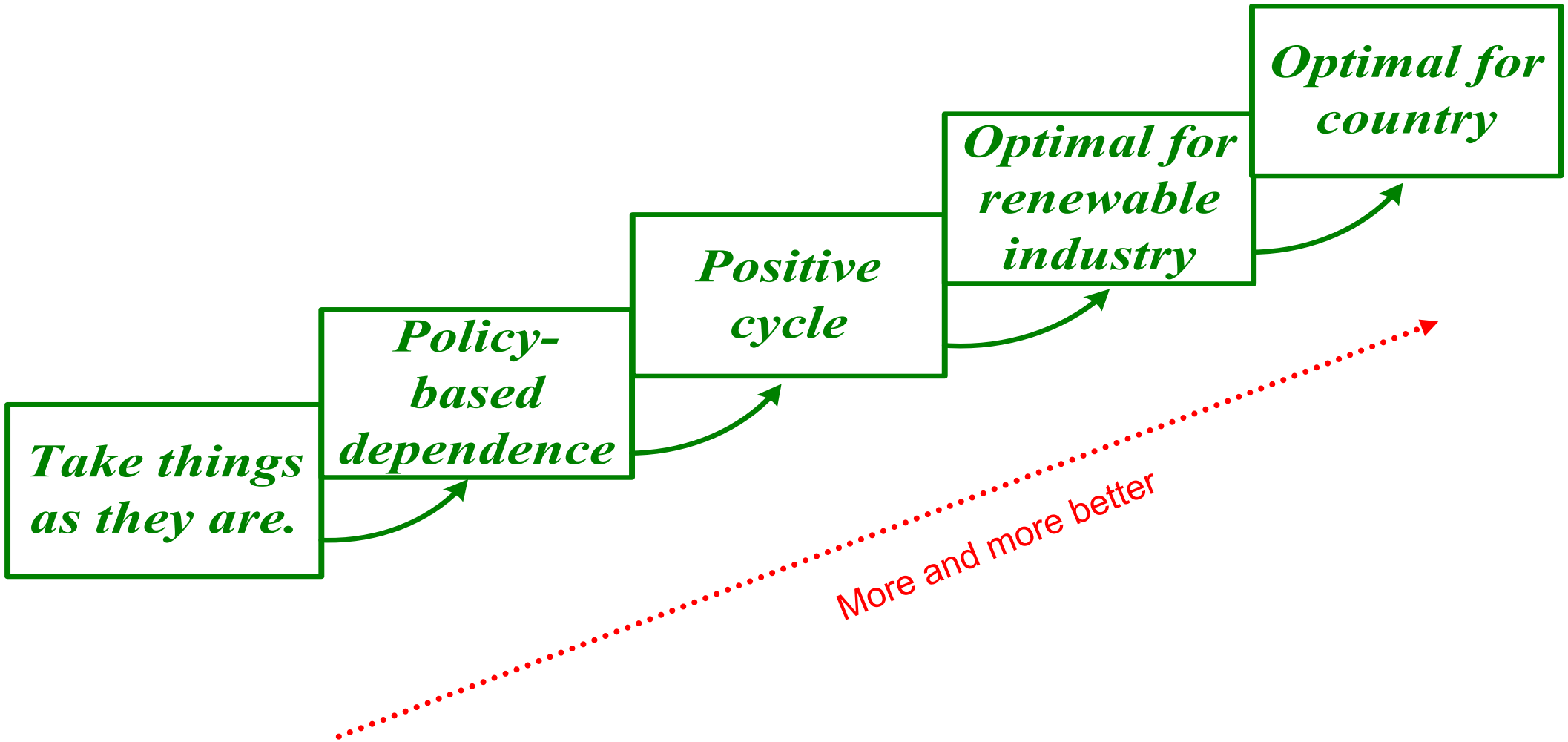
Step3: Selecting and building scenarios



Step3: Selecting scenarios

Technology development	National energy pricing	Ecological awareness	Evaluation	Description of scenarios
Breakthrough	Low	Strong	Best	Optimal for country
Breakthrough	High	Strong	Better	Optimal for renewable industry
No breakthrough	High	Strong	Moderate	Positive cycle
No breakthrough	Low	Strong	Worse	Policy-based dependence
No breakthrough	Low	Weak	Worst	Take things as they are.

Step3: Hierarchical relationship of selected five scenarios



Step4 Best scenario: Optimal for country

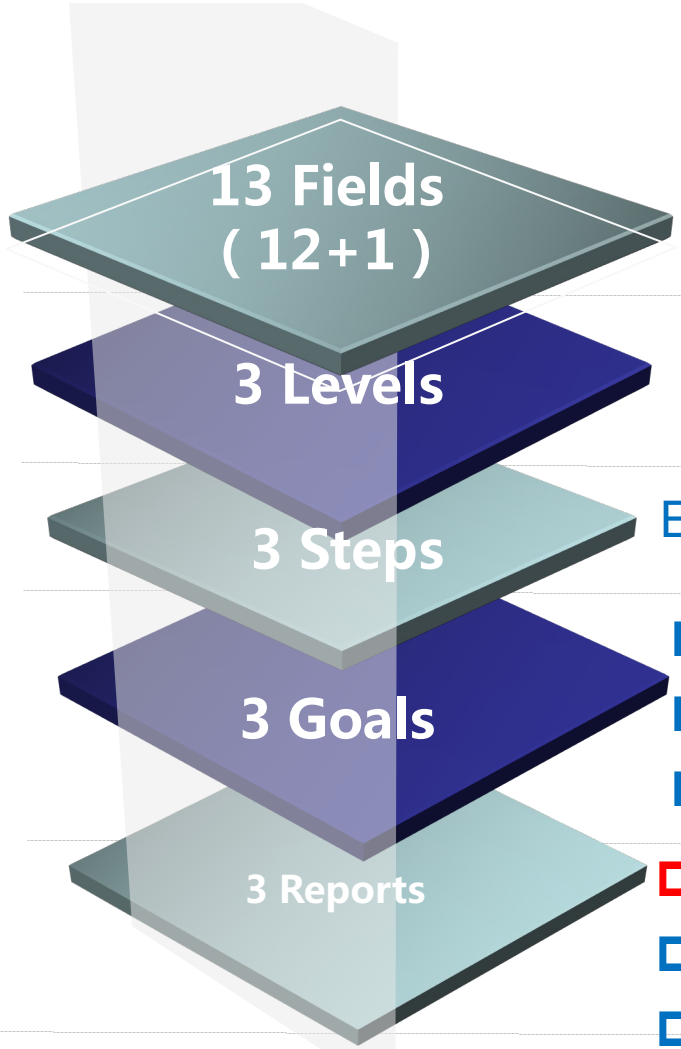
Description of scenarios	Policy Preference
The renewable energy technology has got breakthrough. However, the price of renewable energy is still higher than that of the fossil energy. Promoted by the strong ecological awareness, the development of renewable energy markets is relatively active. The utilization cost of fossil energy with major share is lower which leads the overall cost of the country development to being low, and brings the optimal development of country. In this scenario, the government plays the role of guidance and supervision.	Continually increase the investment in the research and development of critical technology as well as industrial development, enhance the price advantage of renewable energy, and expand renewable energy market share.

Step4 Better scenario: Optimal scenario for renewable industry

Description of scenarios	Policy Preference
The renewable energy technology bas got breakthrough. The cost price of renewable energy is significantly lower than that of fossil energy, and the market is more active, which usually attracts more private capital. Coupled with the strong ecological awareness, the technology, market and society present the development force for renewable energy. In this scenario, the additional financial subsidies are not necessary, and the renewable industry development is in the optimal scenario. But the overall development cost of the country is higher due to the higher utilization cost of fossil energy with major share.	Promote the transfer and application of the renewable technology, increase the investment in the renewable energy industry to enhance its share in the entire energy industry.

III. Technology Foresight for Policymaking in China

Technology Forecast for 13th FYP for National S&T &I



Information Technology, Biotechnology, New materials, Advanced manufacturing, Energy, Resources and environment, Earth observation and navigation, Agriculture, Modern transportation, Marine, Population and health, Public security , Urbanization

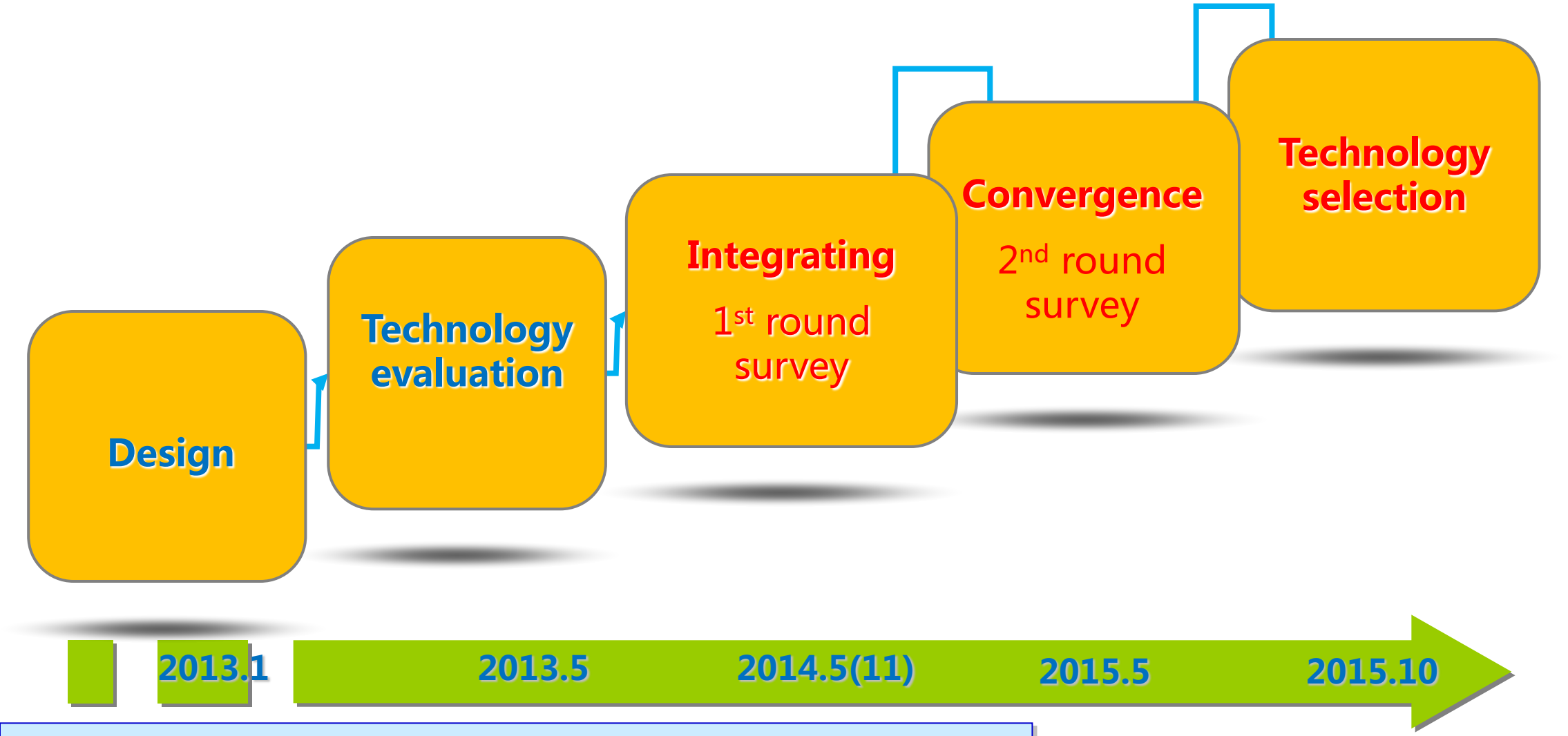
Leading group Overall research group Fields research group

Evaluation → Foresight → Selection

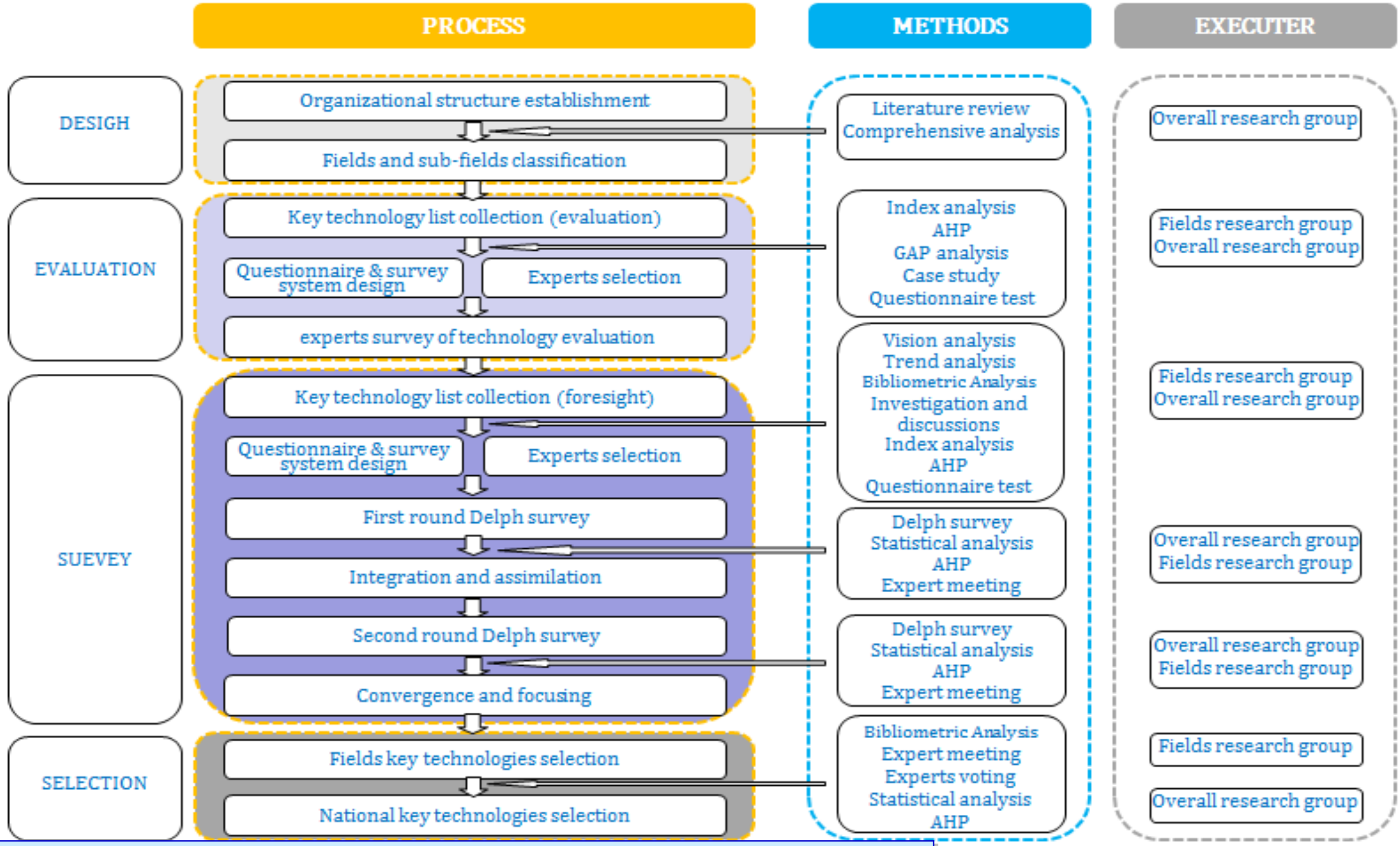
- Understanding the current technology level
- Identifying key technologies for S&E Dev. in next 5-10 years
- Providing the advice for national key technology selection

- *China' s report of technology competitiveness evaluation*
- *China' s report of technology foresight*
- *China' s report of national critical technology*

Process



Cited from WANG Ge of CASTED



Cited from WANG Ge of CASTED

Technology Forecast for 13th FYP for National S&T &I

Characteristics of Technologies

- **Delphi Survey**

Technology Realization Time

Cost Estimates

R & D Approach

Source of R & D Funding

Cross-cutting Situation

Patent Restrict

Target

Technology Forecast for 13th FYP for National S&T &I

- Key Technology Selection

●Key Technology Selection (fields level)

Characteristics of Technologies

Technology Title	Importance Composite Index	R & D Level index	Patent Restrict Index	Technology Type	Target
0801001	91	79	29	Foundation Technology	Ahead
0801002	94	75	47	Foundation Technology	Parallel
0801003	94	76	33	Foundation Technology	Parallel
0801004	98	75	33	Public Welfare Technology	Parallel
0801005	89	90	23	Public Welfare Technology	Ahead
0801006	95	75	58	Foundation Technology	Parallel
0801007	88	78	29	Foundation Technology	Ahead
0801008	94	68	33	Foundation Technology	Parallel

Principles for Selecting Key Technology

Definition of Key Technology： Core Technologies which play decisive and fundamental role to economic development , ecological civilization construction, national defense and living hood improvement.

1. Principles：

- Scientific: Should be the key frontier of the global science area or the core technology of the global competition.
- Advanced: China can be the leading role
- Significant: Significant and unique role on economy development, ecological civilization, living hood improvement.

  ––For economy development(30 billion,50 billion,100 billion)

  ––For Social benefit (100 million,500million,1billion)

  ––For Ecology Improvement (Water safety, Air pollution, Ecology reconstruction
- Realizable: Can be developed or industrialized in 10 years.

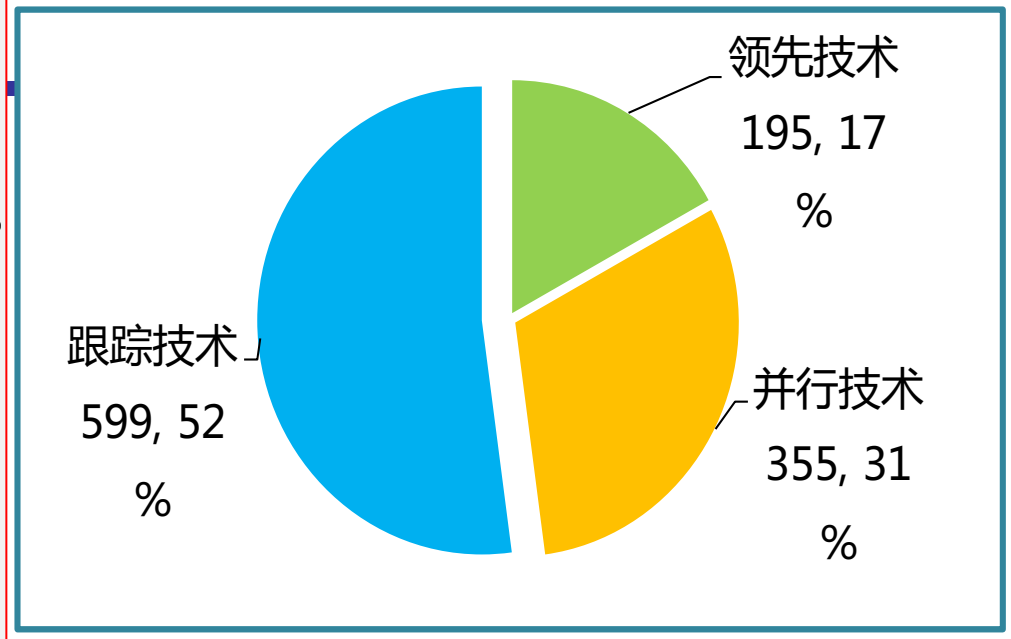
2. Methods： Expert panel meeting.

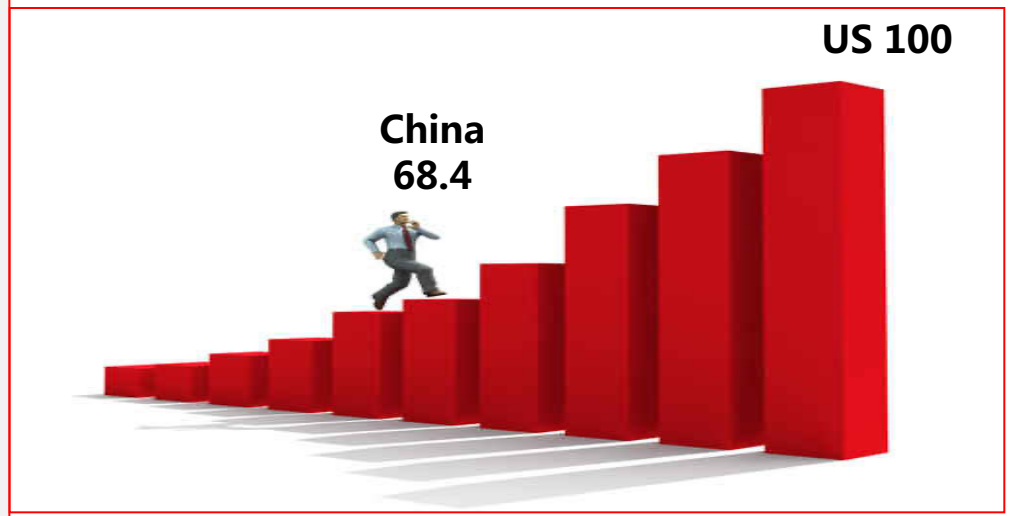
Conclusion 1 Since 2006, the gap in S&T between China and advanced countries has been narrowing in general.

Conclusion 2 In terms of technological level, China leads in 17% of technologies, while 31% of technologies takes the parallel position, 52% of technologies remain in the following phase.

Conclusion 3 China's technological level is about 68.4% of that of the U.S. in general.

Conclusion 4 In terms of the capability of transforming basic research achievements into advanced technologies, China lags behind the developed countries such as the U.S., Japan, and Germany.





Conclusion Remarks

The ***Outline of the 13th FYP for National E&S Development*** (2016-2020) raised five Development Concepts.

- **Innovative Development**
- Coordinated Development
- Green Development
- Open Development
- Sharing Development

5 developments

Thank you for your attention!

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