Analysis of Clean Energy Development in China on Mission Innovation to Face the Global Climate Change

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Abstract. The Chinese Government is promoting the revolution of energy production and consumption. The governmental and/or state-directed R&D input of China in clean energy on “Mission Innovation” totalled 25 billion RMB (roughly 3.8 billion US dollars) in 2015, and increased in the input to 50 billion RMB (roughly 7.6 billion dollars) by 2020. “Clean energy” on “Mission Innovation” covers safe, clean and efficient development and utilization of coal and new energy-saving, renewable energy and hydrogen energy technology, advanced nuclear energy and nuclear safety, power and energy storage technology, energy efficiency, etc.

1. Introduction
In support of economic growth, energy access and security, and an urgent and lasting global response to climate change, China jointly announced the “Mission Innovation”, to accelerate the pace of clean energy innovation to achieve performance breakthroughs and cost reductions to provide affordable and reliable clean energy solutions that will revolutionize energy systems throughout the world over the next two decades and beyond.

Mission innovation (MI) is a global initiative involving 23 members (22 countries and the European Union) to accelerate global clean energy innovation, which was announced on November 30, 2015, as world leaders came together in Paris to undertake ambitious efforts to combat climate change. Each of the 22 participating countries and the European Union—which represent more than 80 percent of global clean energy R&D budgets—plans to seek to double its governmental and/or state-directed clean energy R&D investment over five years, reaching around a combined USD $30 billion per year in 2020 or 2021. New investments are focused on transformational clean energy technology innovations that can be scaled to varying economic and energy market conditions that exist in participating countries and in the broader world.

2. Fields of Clean Energy
MI Members agreed to provide information on strategies and plans for their respective governmental and/or state-directed clean energy research and development investment over five years. Each country—according to its own priorities, policies, processes, and laws—independently determines the best use of its R&D funding and define its own R&D priorities and path to reach the doubling goal.
3. Target of Governmental Clean Energy Research and Development Investment

3.1. Background
More than USD $35 billion additional clean energy R&D is committed by Mission Innovation members over the five years. MI Baseline of USD $15 billion per year in clean energy R&D is compiled from reports of 21 MI Members. Table 1 is the baseline target of each MI member. The United States ranked first among MI members, and China is the second one. Due to the government exchange, in 2017 United States announced the goals of doubling plan that may not be completed.

Figure 1. Mission Innovation Clean Energy R&D Focus Areas

Figure 2. Clean Energy R&D Investment Chart for MI
Table 1. Governmental Clean Energy Research and Development Investment

| Country                        | Baseline Amount Million USD per year |
|--------------------------------|-------------------------------------|
| Australa                      | 81                                  |
| Brazil                         | 150                                 |
| Canada                         | 295                                 |
| Chile                          | 4                                   |
| China                          | 3800                                |
| Denmark                        | 45                                  |
| European Union                 | 1111                                |
| Finland                        | 58                                  |
| France                         | 494                                 |
| Germany                        | 506                                 |
| India                          | 72                                  |
| Indonesia                      | 17                                  |
| Italy                          | 250                                 |
| Japan                          | 410                                 |
| Kingdom of Saudi Arabia        | 75                                  |
| Mexico                         | 21                                  |
| Netherlands                    | 113                                 |
| Norway                         | 140                                 |
| Republic of Korea              | 490                                 |
| Swenden                        | 17                                  |
| united Arab Emirates           | 10                                  |
| United Kingdom                 | 290                                 |
| United States                  | 6415                                |
| Total                          | 14864                               |

3.2. Doubling plan of China

The Chinese Government is promoting the revolution of energy production and consumption. China is dedicated to clean and efficient utilization of coal resources, and the development of non-coal energy, oil, gas, so as to form an energy supply system driven by balanced development of coal, nuclear and new energy and renewable energy, simultaneously consolidating the power transmission and distribution net, as well as the construction of storage facilities.

The R&D input of China in clean energy on “Mission Innovation” totalled 25 billion RMB (roughly 3.8 billion US dollars) in 2015, which was set as the baseline and baseline year of China on MI. And China’s Doubling Plan target on MI seeks to double the governmental and/or state-directed investment in clean energy research and development over five years, which means increasing in the input to 50 billion RMB (roughly 7.6 billion dollars) by 2020.

China proposes that “clean energy” on “Mission Innovation” covers safe, clean and efficient development and utilization of coal and new energy-saving, renewable energy and hydrogen energy technology, advanced nuclear energy and nuclear safety, power and energy storage technology, energy efficiency, etc. Table 2 is shown the growth ratio of the Clean Energy R&D focus areas emphasized in Mission Innovation portfolio in 2015 and 2020. The datum is under investigation of R&D inputs from more than 50 Government departments and state-owned enterprises.
Figure 3. The R&D input of China in clean energy on MI

Table 2. China's R&D Funding Growth Ratio in Various Clean Energy Areas in Baseline Years and Double-Year (100 Million RMB)

| Clean Energy Areas                                           | R&D Funding in 2015 | R&D Funding in 2020 | Growth Ratio |
|--------------------------------------------------------------|---------------------|---------------------|--------------|
| Safe, clean and efficient development and utilization of coal and new energy-saving | 457                 | 810                 | 77%          |
| Renewable energy                                            | 264                 | 560                 | 112%         |
| Nuclear energy                                              | 182                 | 320                 | 76%          |
| Power and energy storage technology                          | 159                 | 270                 | 70%          |
| Energy efficiency                                           | 26                  | 50                  | 92%          |
| Hydrogen and fuel cells                                     | 6                   | 15                  | 150%         |
| Cross field                                                 | 109                 | 450                 | 313%         |

4. Action of China on MI

From 2016 to 2017, China’s Ministry of Science and Technology successively launched a number of state key research and development programs in areas of clean and high efficiency utilization of coal and new type of energy saving technology, new energy vehicle and smart grid, and provided active support to such R&D and demonstration in the field of clean energy. In the area of clean and high efficiency utilization of coal, the objective is to fully carry out energy saving strategy, comprehensively improve clean and high efficiency utilization of coal and independent R&D capability in areas of processing, system, equipment, materials and platforms, and realize industrial application demonstration. In the area of new energy vehicle, the program aimed at continued in-depth implementation of the strategy of technological transformation towards “pure electric drive” new energy vehicle, and upgrade the technological platform of new energy vehicle power system, take full advantage of the opportunity of the new round of technological change brought about by technologies in areas of new energy, new materials and informatization, deploy R&D for the next generation of technology to support large scale industrialization by 2020. And in the area of smart grid, the objective is to realize full range deployment from basic research to major generic key technological research to typical application demonstration, and to realize China’s overall leading position in smart grid technology internationally.

In April 2017, a number of government agencies including the state Ministry of Science and Technology, National Development and Reform Commission and the Ministry of Education jointly published the “Plan for State Technological Innovation Project during the ‘Thirteenth Five-year Plan’ Period”. The Plan defined that the key areas of clean energy deployed by the State Technological Innovation Center included nuclear energy, smart grid and clean and high efficiency utilization of coal.
The Plan put forward the general objective of the perfection of an enterprise-centered, market-oriented technological innovation system with combined resources from industry, academy and R&D, improvement of enterprises’ independent innovation capability and core industrial competitiveness, and strengthening of the transformation of technological achievements and the perfection of an innovation and start-up business service system. One of the key tasks of the Plan is to “strengthen the support to technological innovation, and encouragement of innovation resources to concentrate in enterprises”. The Plan also stressed importance to guide the establishment of diversified financing channels, on one hand the state will strengthen guidance and support to technological innovation through state science and technology programs, while on the other hand take advantages of the state medium and small enterprise development fund, state emerging industry start-up and investment guidance fund and state technological achievement transformation guidance fund, to encourage development of angel investment, venture capital investment, industrial investment, and strengthen direct financing support to enterprises in seed and initial stages.

5. Case study- smart grid

The Smart Grids Innovation Challenge (IC) is the first of seven ICs under the Mission Innovation (MI). The IC is co-led by China, India and Italy. Its member countries include Australia, Brazil, Canada, China, Denmark, Finland, France, Germany, India, Indonesia, Italy, Mexico, Norway, Saudi Arabia, South Korea, Sweden, The Netherlands, United Kingdom, United States of America and European Commission. Objective of the IC1 is to accelerate the development and demonstration of smart grid technologies in a variety of grid applications, including demonstrating the robust, efficient, and reliable operation of regional grids and distribution grids as well as micro grids in diverse geographic conditions, in order to facilitate the cost effective uptake of renewable energy.

In China, the electricity mix includes coal-fired, gas-fired, nuclear, wind, solar, pumped storage, and etc. Although 65% of electricity is from coal-fired power plants, The power system of China is still being dominated by coal, however by 2020, the targets specify 675 GW of Renewable Energy including hydro, wind, solar and biomass. The governmental investment on RDD in field of smart grids is mainly configured through the National Key R&D Program of China and the Program of NSFC. The Projects of Technology and Equipment of Smart Grids, under framework of the National Key R&D Program of China, is the most important projects undergoing and will support about 60 projects from 2016 to 2020. The State Grid Corp. of China and the China Southern Power Grid Corp. are two large investors in business sector.

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