

HUST Research Achievement on Energy field during urbanization process

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Abstract:

China is facing severe challenges in sustainable development of energy . More secure and environmental friendly energy are required. Huazhong University of Science and Technology(HUST), one of the most renowned universities in China, is devoted to research and development in the fields of traditional energy utilization, clean and renewable energy technology and energy conservation, and has obtained plentiful achievements in the past 10 years. This paper introduces some key points about research strength of HUST and research institute related to energy(Wuhan New Energy Institute, the State Key Laboratory of Coal Combustion and 35MWth Oxy-fuel Combustion Demonstration). The final part demonstrates the international cooperation in energy field of HUST, and presents China-EU Institute for Clean and Renewable Energy(ICARE) and China-US Clean Energy Research Center(CERC).

Keywords: HUST, Traditional energy, Renewable energy, Research Strength, International cooperation

Background:

With the rapid development of urbanization process of China, Chinese government is facing the distinguished gap between energy consumption and energy supply. On one side, comparing to level of developed country reaching to 6 tce/(p*year), Energy Consumption per capita (PCE) of China is still very low. It increased from 0.864 tce/(p*year) in 1990 to 2.671 tce /(p*year) in 2012, and expected to reach 3~4 tce /(p*year) 30 to 40 years later because of urbanization process[1,2]. while the total energy demand will further increase due to population urbanization at the same time. On the other side, the energy mix of China is unsatisfied. In 2014, China's domestic oil demand growth picked up, the annual consumption of crude oil reaches to 518 million tons , representing an increase of

5.8% compared with last year. China consumes 4.26 billion tce in which nearly 70% comes from coal and less than 9% provide by renewable energy[3,4], just as follows in figure 1.

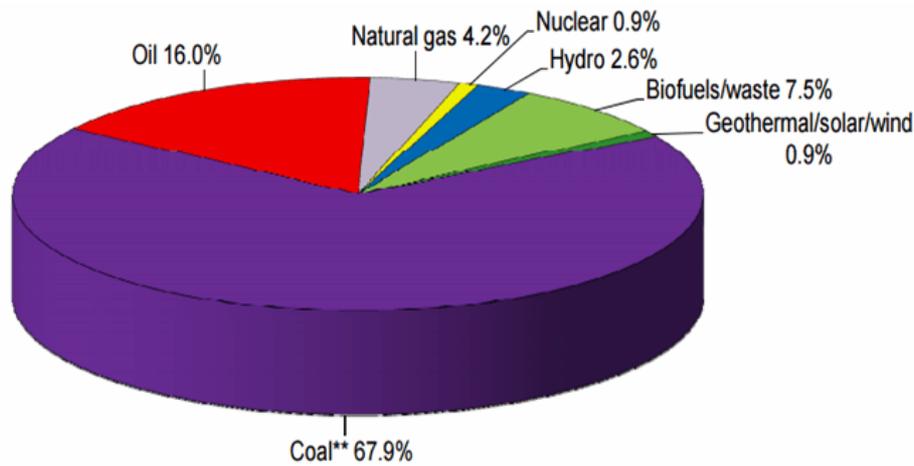


Figure 1. China's Energy Structure in 2014

Obviously, Energy security, Environmental protection and Economical development drives Chinese government to reform their energy program and vigorously promote clean and renewable energy and advanced fossil fuel technology. Under these circumstances, as a one of the prestigious research universities of China which are directly supervised by the Ministry of Education, HUST get advantages in energy research, especially in Clean and Renewable (New) Energy , Clean Coal Technology, utilizing of traditional energy and energy conservation. HUST is obliged to make some contribution to solving these problems.

In this paper, HUST is carried out by a brief introduction, followed by introducing development of conventional clean energy utilization and research and development of clean and renewable energy by Wuhan New Energy Institute, State Key Laboratory of Coal Combustion and other platforms. In final part, achievements of cooperative research between HUST and international partners in the energy field are demonstrated.

Key figures about research strength of HUST

HUST is a national key university directly under the administration of the Ministry

of Education of P. R. China, and is one of the first batch of Universities joining the national “211 Project” and “985 Project”. It was founded on May 26, 2000 as a result of the merger of the former HUST, Tongji Medical University and Wuhan Urban Construction Institute.

At present, the University has eleven disciplines: engineering, medicine, management, science, philosophy, economics, law, education, literature, history and agriculture, offering a variety of degree programs, including 86 undergraduate programs, 303 graduate programs, 237 PhD programs. There are 31 post-doctoral research centers, 7 national key disciplines, 15 national key sub-disciplines[5]. And the top 5 in HUST in table 1 are as follows .

Table 1. TOP 5 Disciplines of HUST in China

Disciplines	Ranks
Mechanical	#1
Public Health& Preventive Medicine	#1
Optical Engineering	#1
Electrical Engineering	#2
Bio-Medical Engineering	#3
Power Engineering& Thermo-Physics	#5
Journalism & Communication	#5
Public Administration	#5

Now the University has over 1,000 professors and 1,300 associate professors, including 24 academicians, 65 professors receiving funds from the Cheung Kong Scholars program, 36 winners of National Science Fund for Distinguished Young Scholars, 36 listed in the “National Talents Project” and 135 young scholars listed in “New Century Outstanding Talents Project” of the Ministry of Education.

In recent years, the university receives increasing research funds from government and companies. As presented in the figure 2, HUST got ¥1.5 billion funding comes from government and company to support its research activities in

2014 .Further more, there is a rising trend in the future.

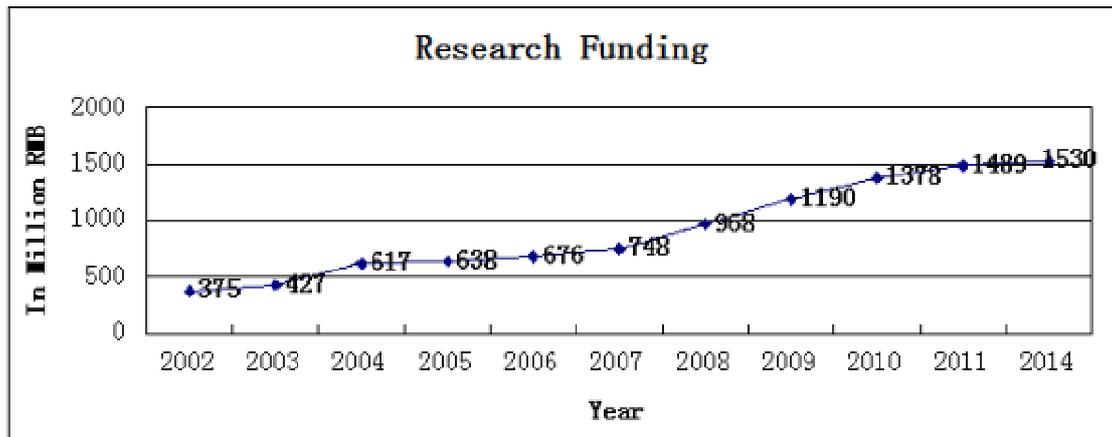


Figure 2. Research funds from government and companies in HUST

In area of energy, HUST has done much excellent work in the research and education these years. There are more than 100 Professors (4 CA. & CAE, 10 National Outstanding Youth Funds Winners, 10 Cheung Kong Scholars) have made great contributions on the field, 1700 graduate students and 400 PhD students graduated from the relevant areas. Over 3000 papers and 80 books published in last 3 years, more than 100 patents applied within last 3 years, and had won 16 National awards, depending on Wuhan National Laboratory for Optoelectronics, State key laboratory of coal combustion, State key laboratory of material forming, and National energy research center. There are four related disciplines: Power Engineering and Thermo-physics, Electrical Engineering, Material Science and Engineering, Hydraulic and Hydropower Engineering.

Energy research achievements of HUST

- 1)Wuhan new energy institute



Figure 3. the bird view of Wuhan new energy institute “Calla”

Wuhan New Energy Institute was established by the cooperation of HUST and the local government. As figure 3 shows, the beautiful “Calla” merges with lot of renewable elements, which was designed by Grontmij group in Netherland. On the roof of building, PV panel could generate electricity during day. The yellow towel is a vertical axis wind turbine. In addition, rain water could be collected to supply the building.

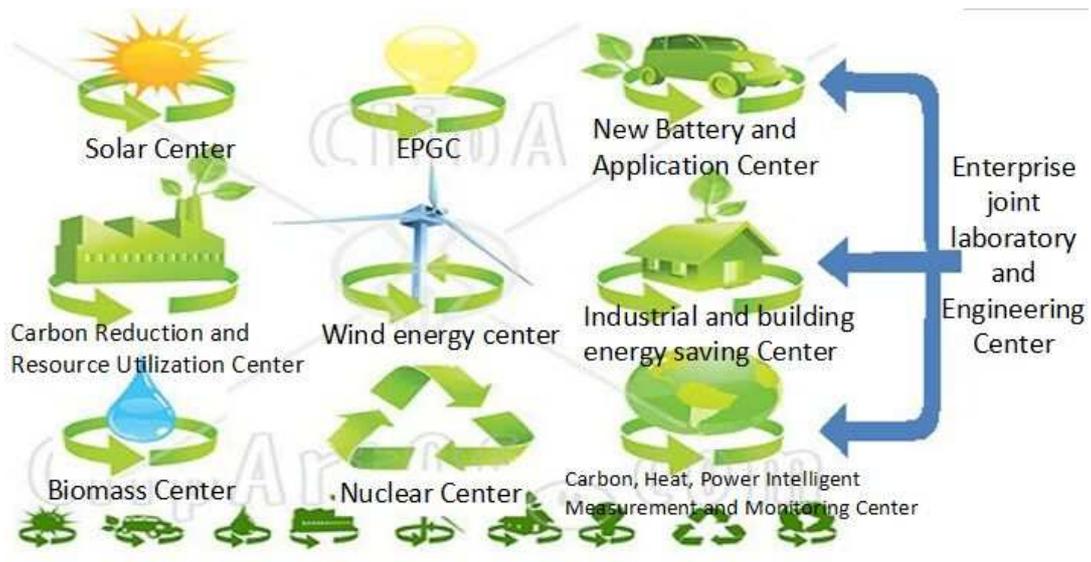


Figure 4. the mission of Wuhan New Energy Institute

It was expected to be a research center, talent center, cultivation center and creative service center of new energy field. It aims to deal with critical technical problems, achieve a batch innovative result, obtain a series of core technologies and patents, lead certain points in the development of new energy and promote the new energy industry of Hubei and Wuhan[6]. Technology research and development platforms are introduced in figure 4 above. Companies has joint labs and R&D Centers, which is covered with a wide range of areas, including solar energy, wind power, biomass energy, Battery & Fuel Cell, smart grid, energy efficiency and so on.

2)The State Key Laboratory of Coal Combustion (SKLCC)

The SKLCC in HUST is an advanced Clean Coal Technology Institute in China. It was established by the Chinese central government in 1988 and applied R&D on developing advanced, efficient and clean coal combustion technologies. Many high level scientists and researchers have been brought up in the laboratory. The key research areas in the laboratory include: Coal combustion and reactive multi-phase turbulent fluid mechanics; Pollutant formation and control; Advanced technologies of thermal energy utilization and conversion; Diagnostics, optimization and system synthesis of thermal power equipment and systems. There are three platforms in SKLCC: China-US Clean Energy Research Center, National Energy Coal Clean and Low-carbon Power Generation R&D Center and CCUS Industry Promotion Center.

There are many outstanding achievements in sklcc, such as:

Zhaoli Guo etc. Discrete lattice effects on the forcing term in the lattice Boltzmann method.[7]

Yang, Haiping etc. Characteristics of hemicellulose, cellulose and lignin pyrolysis.[8]

Liu Huan etc. Catalytic role of conditioner CaO in nitrogen transformation during sewage sludge pyrolysis.[9]

3) 35MWth Oxy-fuel Combustion Demonstration System

The figure 5 shows the scene of the actual oxy-combustion.



Figure 5. the scene of 35MW oxy-combustion

Coal accounts for about 70% in our energy mix, thus lead to great potential output of CO₂ to the environment. While oxy-combustion provide a possible method to deal with the settlement of CO₂ in the plant.

This 35 MW oxy-combustion industrial demonstration project is a key step (0.4MWth → 3MWth → 35MWth → 200MWe → 600MWe) for the oxy-combustion capture technology to reach commercial operation. Supported by the National Key Technology R&D Program and based on the National Energy Coal Clean and Low-carbon Power Generation R&D (Experiment) Center, the total investment of the project is over RMB 100 Million. Its construction started on 2012.12.31 in Yingcheng City, Hubei Province with the main construction finished at the end of 2014 and commissioning started on 2015.01.28. When the project is completed, it will obtain the objectives of the concentration of CO₂ in the flue gas over 80% and the rate of CO₂ capture over 90%. Based on above, industrialized amplification will be carried out for the applications of oxygen-combustion technology to 200~600MW power plants to achieve large scale of emission reduction and CO₂ utilization in China.

International cooperation

1)China-EU Institute for Clean and Renewable Energy (ICARE)

ICARE at HUST is the third China–EU educational institute jointly established by Chinese government and European Commission in China. In July 2010, the European Commission approved the ICARE programme in HUST. ICARE was built together by 10 universities and 1 institute from 7 countries, they are Paris Tech, Universität Kassel, HUST, Southeast University, Wuhan University of Technology, National Technical University of Athens, University of Zaragoza, Northumbria University, University of Rome, University of Perpignan and International Office for Water[10].

ICARE provides highly quality China-EU double master programme, joint doctorate programme, vocational training, research and project consulting activities. It aims to facilitate the exchange and cooperation between China and Europe in clean and renewable energy, boost the developments and applications of clean and renewable energy business in China, promote the sustainable economic and social development, and enhance the education in clean and renewable energy in China. As is shown in table 4, we have already obtained lots of achievements in recent 3 years.

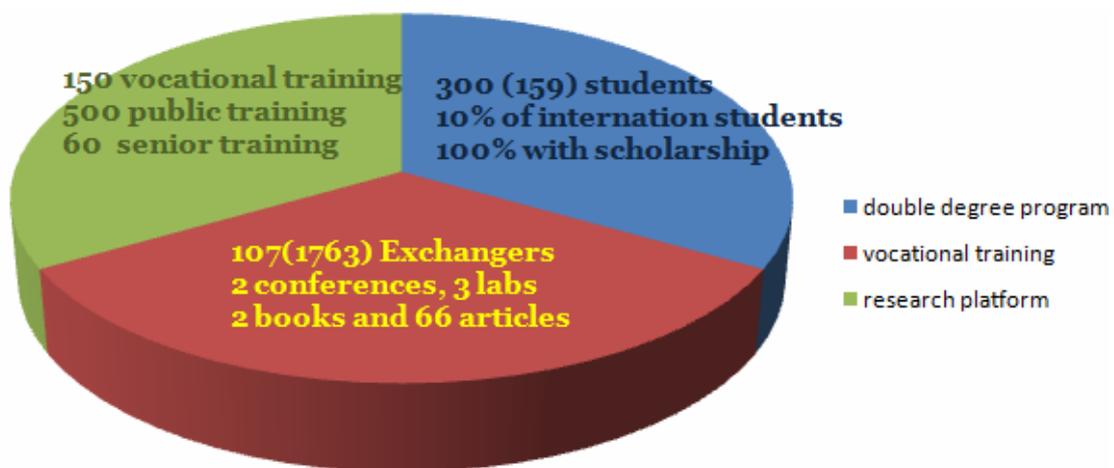


Figure 6. Achievements of ICARE.

2)China-US Clean Energy Research Center (CERC)

In November 2009, China and US Presidents announced the establishment of the Clean Energy Research Center. On November 17, U.S. Secretary of Energy Steven Chu, Chinese Minister of Science and Technology Wan Gang, and Chinese National Energy Administrator Zhang Guobao signed the Protocol, launching the CERC. There are three consortia in CERC, Advanced Coal Technology, Clean vehicle, and Efficient

Building. The Clean Coal including CCS program addresses technology and practices for clean coal utilization and carbon capture, utilization, and storage. HUST was selected as the host institute of Advanced Coal Technology Consortia (ACTC). The team consists of several famous universities(Tsinghua University, HUST, West Virginia University, etc.), world class laboratories(Lawrence Livermore National Laboratory, Los Alamos National Laboratory, etc.) and enterprises(Alstom, General Electric (GE), American Electric Power (AEP), China HuaNeng Group, Shenhua Group, etc.) from both of China and US, figure7 shows all the participated members.



Figure 7. Participated members[11]

Conclusion

China's development must regard the sustainable energy as a precondition. We have to make adjustment to adjust the proceeding world, we need international partners to cope with the energy problem together. Russia is the biggest natural gas exporting country, and playing a very important role in the world energy structure. To cooperate with Russia is an excellent choice either in resource aspect or in technology aspect. HUST has strong research strength in the field of energy and has experience to do international research combined with foreign partners. We hope to

expand cooperation with universities in Russia, and to make contribution to the energy field together.

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