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Innovation in Environmental Technologies in China

The Case of Feida's Power Plant Pollution Control Equipment

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Abstract

Innovation is important for developing a strong brand. This chapter introduces a leading provider of environmental solutions for power plants in China. Feida is a company located in the Zhejiang province in China that develops products and technology to remove small particles from the exhausts of coal-fired power plants. The chapter describes the company's evolution towards a leading company in environmental technology in China and analyzes the role of R&D and innovation in its brand development. The chapter further assesses how the nature of the company's innovation is connected to the production and functional/user side of the innovation system and institutional environment in which it operates. Feida's strategy is to expand internationally to foreign markets but it is facing significant challenges in that process.

Introduction

The availability of electricity plays a pivotal role in China's economic development and much of its electricity has been produced by coal-fired power plants. In the past decades between 70% and 80% of the electricity generated in China was based on coal (Yuan et al. 2018). Alongside the benefits of coal-fired power generation there are significant negative side-effects. They include air emissions which can lead to increased local air pollution and contribute to climate change. In recent years the focus has shifted from ensuring that economic growth can be facilitated by electricity generation to a more sustainable growth based on cleaner and greener electricity generation (NEA 2016; Lin 2017). For coal-fired power generation this has triggered an increasing use of counter-acting measures to reduce air emissions and their harmful impacts, globally as well as in China (Metz et. al. 2001; Hofman 2005; NEA 2016; Lin 2017). In the global industry for pollution control systems for power plants, China is playing an important role given its strong demand for pollution control equipment for coal-fired power stations. One of the leading companies in pollution control equipment for thermal power plants in China is Zhejiang Feida Environmental Science & Technology Co. Ltd. (in short: Feida)¹. This chapter will analyze and evaluate the case of Feida in more detail and focus on the following questions:

- What have been the major milestones and accomplishments in the development of Feida?
- What role did research and development (R&D) and innovation play in enabling Feida to become a market leader and well-known domestic brand?
- To what extent can the company be considered as a global leader and why?

The chapter will continue with a short introduction of the history of Feida, followed by a more detailed analysis of innovation in Feida and its role in brand building. Consequently, we will focus on the international position of Feida and compare

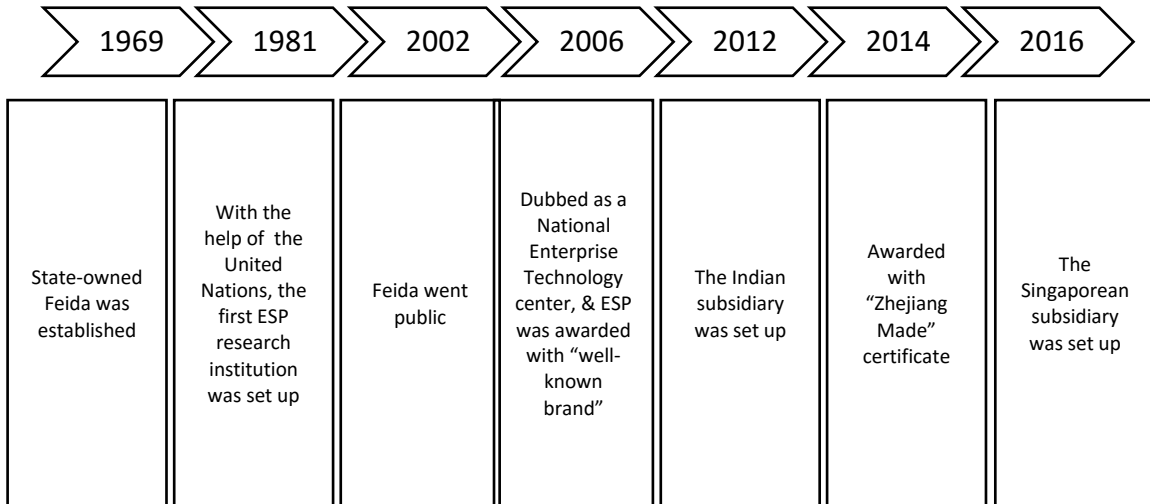
¹ See the website of Feida at <https://www.feidaep.com/En>

Feida's strategy and innovation with a leading global player. We end with some recommendations and a number of questions that could be central to a teaching case on strategy and innovation in emerging market firms.

Feida's development

Feida was founded in 1969 in the Zhejiang Province in China. Figure 1 demonstrates milestones in the company's development from 1969 to 2016. Feida has specialized in power plant emission control systems from the 1980s, and set up a research institute on electrostatic precipitators (ESPs) with the help of the UN development program. ESPs can remove fine dust and small particles from gases and smoke and are widely used in power plants that use coal. Feida became a leading firm domestically in ESPs and broader environmental technologies and received the title of national flagship enterprise and Equipment Manufacturing Base for Environmental Protection Machinery because of its solid performance and good reputation. Feida has also been awarded as a High-Tech Enterprise by the Central Government of China and was recognized as a "Zhejiang Made" brand by the Zhejiang Provincial Administration of Quality and Technology Supervision. Feida was named as "Pilot Enterprise of Environment Protection" by the United Nations Environment Program for their contribution towards environmental protection in China in 2011.

Figure 1 Company history



Source: Feida official website (Feida 2018a)

The firm provides a series of products, including electrostatic precipitators (ESP), flue gas desulphurization equipment, fabric filters, pneumatic conveyor equipment, hazardous solid waste treatment equipment, and electrical control equipment. It also provides technical guidance and installation services both in China and outside of China. Picture 1 gives an example of Feida’s products. The 600 MW power plant was built by the China Huaneng Group. It was one of the first power plants that used localized ultra-supercritical ESP technology provided by Feida in 2002.

Picture 1 Qinbei Power Plant in Jiyuan City, Henan Province, China



The connection between innovation and branding

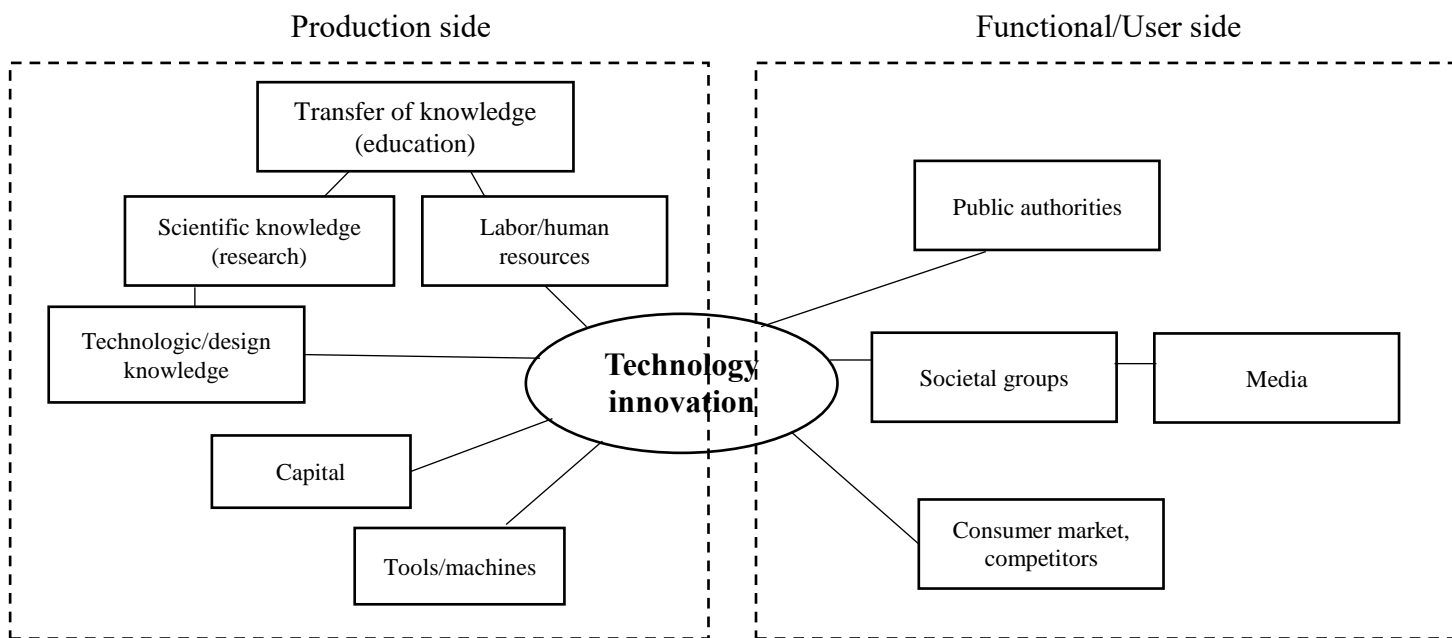
Various studies have identified and confirmed the significant influence of innovation on brand performance (Agarwal, Erramilli, and Dev 2003; Beverland, Napoli, and Farrelly 2010). In fact, the most well-known companies in the world are often also at the forefront of innovation; consider, for example, firms like Apple, Siemens, General Electric, Unilever, Volkswagen, Bosch, Alibaba, Alstom, and so forth. There are also many well-known brands from Asian companies such as Toyota, Honda, Samsung, and Hyundai, whose success has been a combination of providing quality and value for money next to innovation strength (Kapferer 2012). In a well-known textbook on strategic brand management it is mentioned that innovation is like ‘oxygen’ for a company's brand (Kapferer 2012, p. 202). A steady flow of innovation may be necessary to remain attractive to customers; this can be a range of incremental innovations or every now and then a new business model or pioneering innovation,

depending on the industry in which the firm is active (Srinivasan et al. 2009). In a competitive industry environment, a company's internal learning ability is critical for its innovation capabilities and innovation output, and the significance of its innovation output influences the company's reputation and brand performance (Weerawardena, O'Cass, and Julian 2006). Apart from internal sources and capabilities for innovation, it is well established that the nature of innovation in firms is also connected with the context in which it operates which can be represented by a broader innovation system. "The capability of a firm to innovate is therefore not solely determined by internal factors, such as its strategy, culture and organization, but also by the nature of a firm's interaction with external actors, such as knowledge institutes, government organizations, users and capital providers" (Hofman and de Bruijn 2010, 116) and institutions such as regulators of the electricity sector and power plants as in the case of Feida. These interactions are shaped to some extent by firms themselves, but also significantly by the nature of the innovation system in which they operate. This innovation system shapes the direction of innovation and consists of various actor groups that are connected to the production, use, and function of the innovation practices. Figure 2, based on Geels (2004), illustrates the various actor groups involved in innovation systems. From the perspective of the production side, the firm-level innovative practices could be influenced by scientific knowledge (e.g. universities, public and private laboratories), capital (e.g. venture capital suppliers, banks, insurance firms), technologic/design knowledge (e.g. design firms, technical institutes, consultancies), transfer of knowledge (e.g. school, universities), labor/human resources (e.g. laborers, skilled personnel), tools/machines (e.g. suppliers of materials, components, tools). For the functional/user side, the innovation system approaches could also be affected by the factors of public authorities (e.g. government), societal groups (e.g. NGOs), consumers, and media (e.g. TV, newspapers, magazines).

Our description and analysis of Feida will be embedded within the context of this innovation system. The purpose is to understand what key actors and institutions

influence Feida’s innovation, analyze to what extent Feida is connected to the most advanced innovation actors related to emission control of power plants (such as knowledge institutes, research centers, and other companies), and assess how Feida could further advance its innovation as well as its branding.

Figure 2 Elements of firm-level innovation system practices



Source: Geels (2004)

Technology innovation at Feida

Technology innovation has been one of the main elements of the company’s strategy. Through continuous emphasis on research and development (R&D) and innovation the company has been distinguished as a leading innovation company in the power generation sector and environmental technology industry in China. Within China,

Feida has more than 50 domestic patents of original innovation and secondary innovation², and the company received around 60 prizes for its technologic progress. As chair of the Machinery Division of the National Environment-protection Institute of Standardization in China, Feida has played a leading role in drafting 14 documents of national standards, and 103 files of industrial standards.

Table 1 Key research projects at Feida

No.	Project	Project category	Year	Funding (million RMB)	Source of funding	Collaborators
1	Big coal-fired plant boiler smoke elec-bag dust-remover technology and equipment	863 plan	2007-2010	28.04	National funding: 4.73 Local funding: 1.15 Feida: 22.16	Zhejiang University; Northeastern University
2	Technology and equipment for PM2.5 collector at coal-fired plant	863 plan	2013-2015	14.61	National funding: 4.08 Feida: 6.42	Zhejiang University
3	PM2.5 collection based on the technology of electrocoagulation and new type power supply	Zhejiang Key research project	2008-2012	7.13	Provincial funding: 0.71 Feida: 6.42	Zhejiang University
4	High-ash coal and low technology and its application	National key research plan	2016-2020	Budget 12.06	National funding: 4.39 Feida: 7.67	Zhejiang University; Shanghai University of Electric Power; Huadian Electric Power; Zhejiang

² Secondary innovation in China refers to innovations developed by companies through importing advanced technology from abroad, and adjusting it for the Chinese market.

						Hope Environmental Protection Engineering Co. Ltd
5	Air protection innovation base	National key research plan	2016-2019	Budget 13.25	National funding: 5.25 Feida: 8	/
6	New high-efficiency electrostatic precipitators	National key research plan	2017-2020	Budget 22.70	National funding: 5.2 Feida: 17.50	Shandong University; University of Nottingham, Ningbo, China; China Power Engineering Consulting Group; University of Science & Technology Beijing

Table 1 presents some of the most important research projects at Feida. Feida does not only focus on new product innovations but also invests in research on process innovations, e.g. approaches to lower the production costs of emission control systems, enhance the efficiency of dust removal systems, and enhance the operational reliability and stability of power plants and their emission control systems. Picture 2 shows the Sanhe power plant that was built by the Guohua Electric Power Group in 2015. Feida provided wet ESP for one of the 300 MW units. The dust density reached 0.41mg / m³, which set a new world record of the lowest dust emission of a coal-fired power plant. It is one of the three “Energy Conservation and Emission Reduction Demonstration Power Plants” in China.

Picture 2 Sanhe Power Plant, Sanhe City, Hebei Province, China

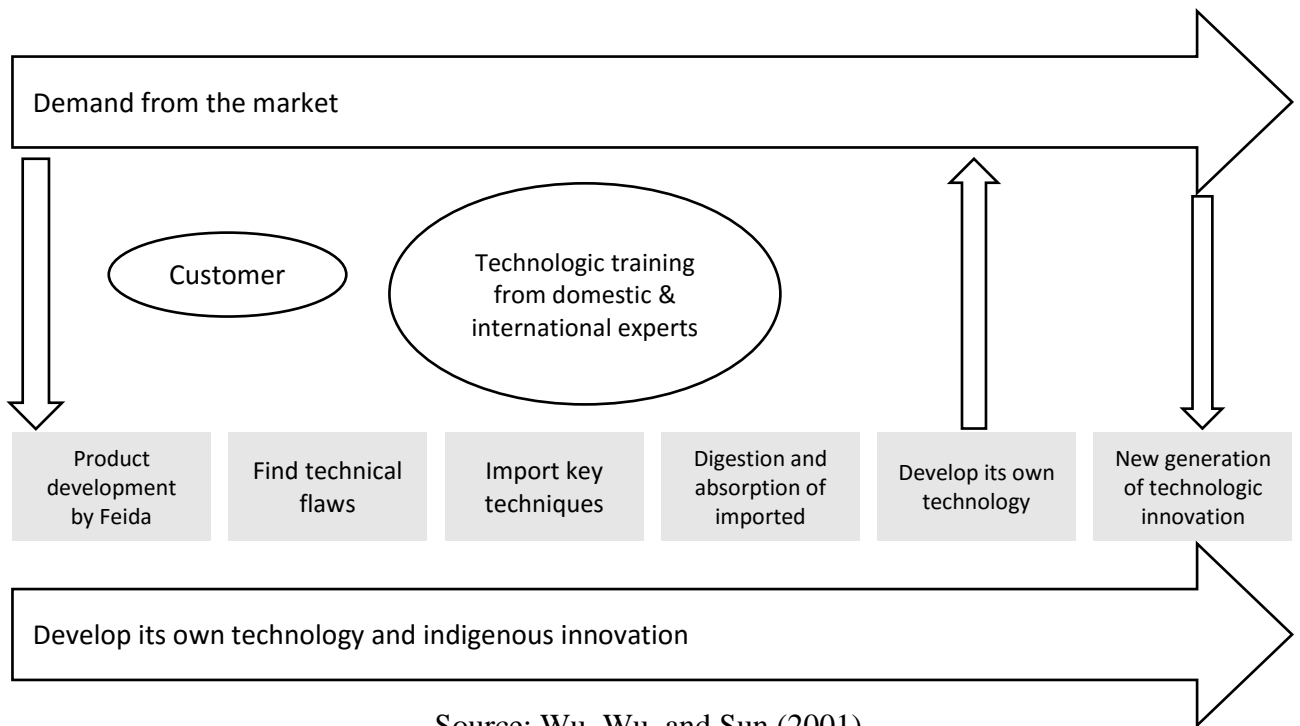


Technology Innovation Strategy

A continuous focus on technologic innovation is critical for Feida to maintain its leading position in the industry. Generally, the evolution of technology in Feida has been driven by three main factors, namely the needs of the market, the internal capabilities and strategy of Feida, and its links to international leading companies (Wu, Wu, and Sun 2001). Figure 3 shows the evolution of Feida's technologic innovation strategy. Feida firstly developed its own products by relying on its own technology and resources. After the development of this first generation product, Feida has kept on improving the performance of the product through careful analysis of customers' feedback and by reducing the gap between their product and the products provided by leading international competitors. One of the pathways Feida has used to improve its technology performance is through the purchase and importing of key technology from abroad and by collaborating with foreign companies. For example, it has obtained ESP technology through a license from Alstom in the 1980s and later in 2004 also obtained a license for fabric filter technology for particulate removal of coal-fired power plants. More recently in 2013 it obtained wet ESP technology from Mitsubishi-Hitachi while in 2014 it established a joint-venture with Mitsubishi-Hitachi for environmental systems business development, where technology from Mitsubishi-

Hitachi (MH) would be customized for the domestic Chinese market by Feida and MH together in the joint-venture.

Figure 3 Technologic Innovation Strategy in Feida



Source: Wu, Wu, and Sun (2001)

Another pathway of improving technology performance is through research projects with local research institutions and universities. While collaborating with foreign companies or collaborating with research institutions might provide the core technology, further localized research will allow the company to make the technology suitable for the specific demands of the Chinese market. For instance, Chinese coal commonly has a higher proportion of sulphur compared to other countries, which creates technologic difficulty in desulfurization. The further improvement stage is called “secondary innovation”. The products are promoted to local clients and the technology is protected through applying for domestic patents.

Table 2 First product innovation on national and provincial level at Feida

Year	Product	Certification
2007	Electric precipitator for ultra-supercritical coal-fired plant with the power of 1000MW	First product on the national level
2009	High efficiency bag-type dust collector for coal-fired units, with the power of 300MW	First product on the provincial level
2011	Rotary electrode type electric precipitator for big coal-fired plants	First product on the national level
2012	PM2.5 pre-charged particle collecting device for coal-fired plant	First product on the provincial level
2014	PM2.5-controlling wet electric precipitator	First product on the national level
2015	Low temperature electric precipitator	First product on the provincial level
2018	Phase change condensing dedusting and waste heat recovery and utilization integrated device	First product on the provincial level

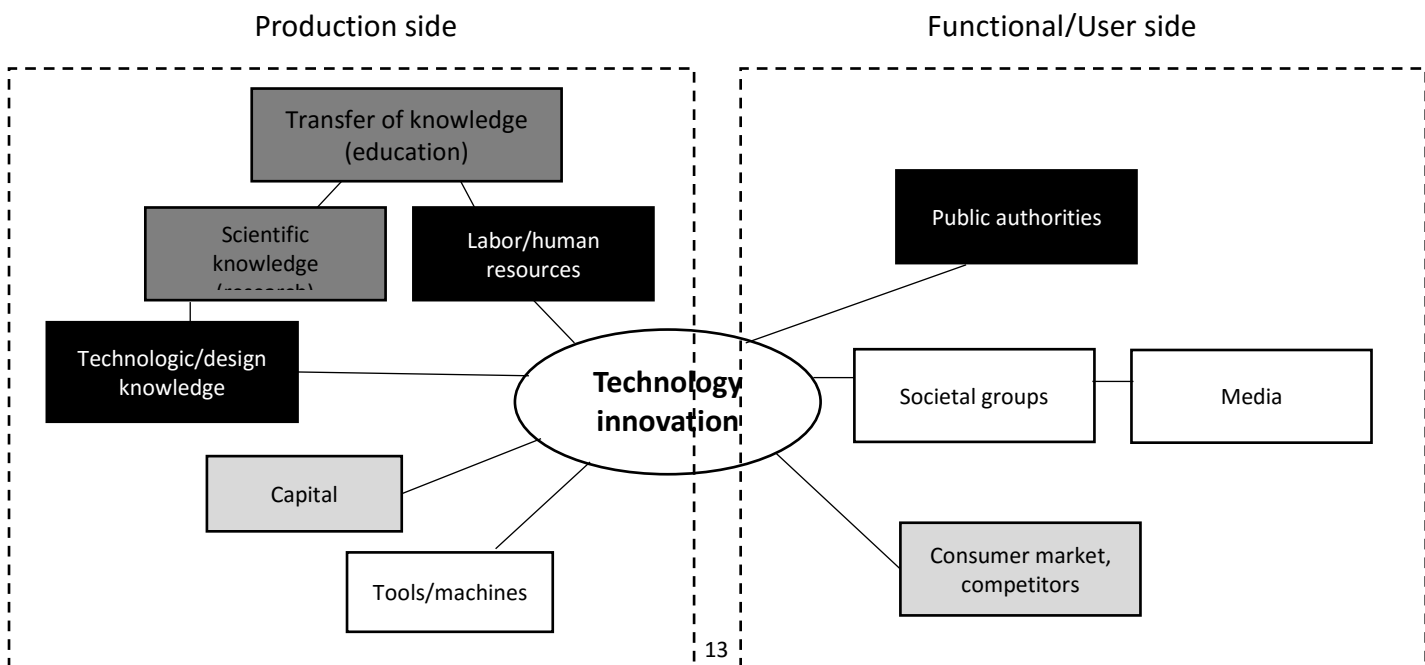
Feida’s innovation strategy fits well with broader government policy. In order to encourage domestic companies to develop key innovative equipment, the National Development and Reform Commission (NDRC) launched a series of policies to support the development of ‘First Piece (Set) of Crucial High-Tech Equipment’ (hereinafter referred to as the ‘first equipment’), which is defined as ‘the crucial equipment of the country and relevant to comprehensive national strength and national security’ (NDRC 2018). Feida owns a distinguished record in developing “first

equipment”. For instance, in the 1980s, Feida single handedly designed and built the very first power station ESP, with the capability of 50MW (Wu, Wu, and Sun 2001). It was also the first enterprise to develop ESPs for circulating fluidized-bed boilers and alkali-recovered boilers in China. Feida has been awarded 7 different certifications as the developer of first equipment on national and provincial levels. The details of first product innovation is depicted in table 2.

Factors Contributing to Technology Innovation

The technology innovation process in Feida is fostered both from the production and the user side. In Figure 4, the blocks filled in black (technologic knowledge, labor/human resource, public authorities) represent the factors that most strongly affect innovation at Feida; the blocks filled in dark grey (transfer of knowledge, scientific knowledge) represent the second most influential factors; the blocks with light grey (capital, consumer markets) represent the third most important factors, and the groups represented in white (tools, societal groups, media) have the least influence on Feida’s innovation.

Figure 4 How the innovation system affects innovation in Feida



Technologic/design knowledge, labor/human resources, public authorities

Feida invests significantly in R&D, in terms of time and resources, reflecting the value that Feida sees in research and development as key for its innovation. Feida's manufacturing base covers a land area of 1600 acres with the State-level Enterprises Technical Center, National Postdoctoral Workstation, Engineering Design Academy, and five research institutes (ESP Research Institute, Pneumatic Conveying Research Institute, Desulfurization Research Institute, Fabric Filter Research Institute, Electric Control Research Institute), and further includes a large R&D team, research laboratory measurement facility, and a strong marketing network. As Feida realizes the significance of research, it makes large investments in R&D. Table 3 indicates the detailed information of R&D investment and R&D employees in 2016 and 2017. The figure of R&D investment and employees is around 114 million RMB in 2017 and 649 respectively (Feida 2017).

Table 3 R&D investment and R&D employees in Feida

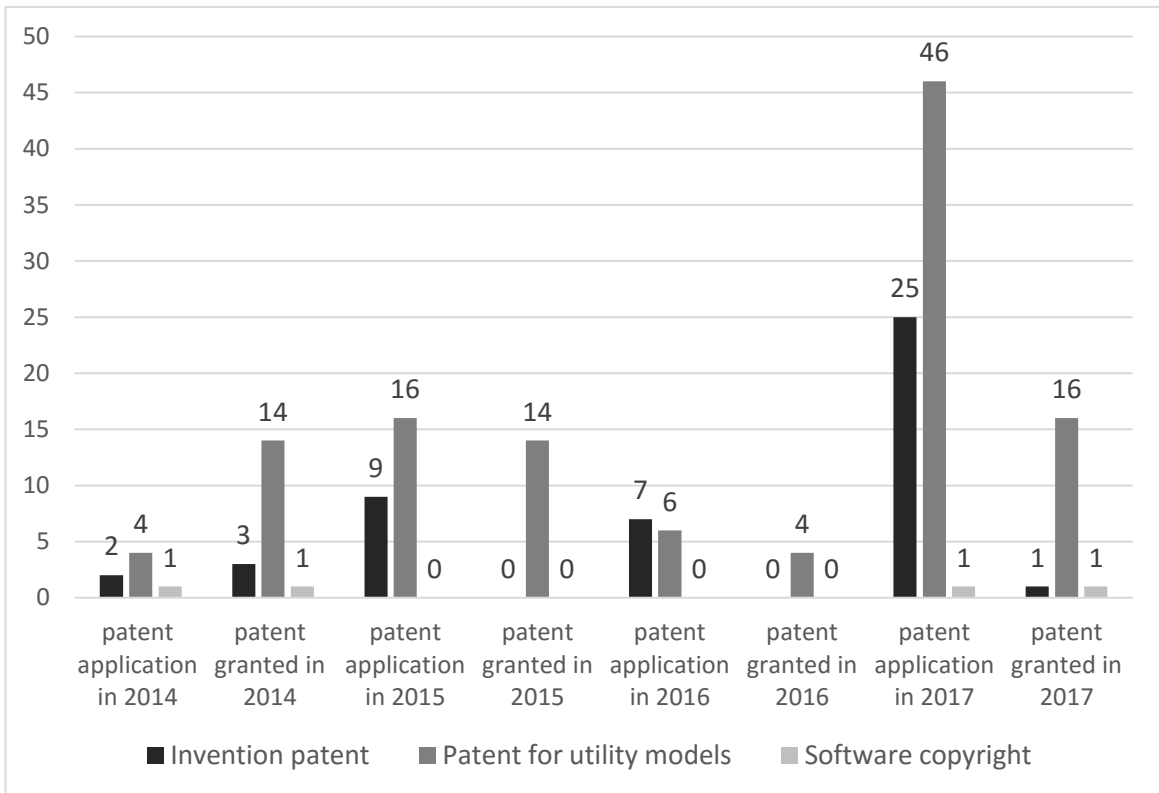
	2017	2016
R&D investment	114.19 million RMB	110.72 million RMB
The percentage of R&D investment over operating profit	3%	3%
Number of R&D employees	649	627

The percentage of R&D employees over all staff	16.58%	14.71%
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Source: Feida 2017

In addition, it holds more than 200 domestic patents in total, the majority being utility model patents but among them also 25 invention patents which are regarded as the most significant patents in the Chinese patent system. Figure 5 presents the patent applications from 2014 to 2017 by Feida. The motivation for patenting for utility model patents tends to be more protective, while invention patents are more important for developing new products and markets. The main function of protective patenting is to prevent potential imitation and allow legal ways for punishing violators; it is less focused on generating product innovation. The protective patenting behavior is triggered by the patent laws, giving rise to the increased patent value and knowledge, while strategic patenting through invention patents is more likely to respond to market needs and change. Feida's patents are all domestic Chinese patents, reflecting its current dominant focus on the domestic market. It also has not obtained international patents due to unfamiliarity with the international patent system. The company however is aiming to increase its income from international activities significantly so may have to consider developing an international patenting strategy.

Figure 5 Patent application from 2014-2017 in Feida



Source: Feida³

For R&D, the quality of human resources, especially scientists and engineers, is one of the major factors that affects technologic innovation capacity. Therefore, Feida takes a lot of effort to establish a high-efficiency research team. The number of R&D staff in Feida has reached 649, accounting for 16.58% of all employees (Feida 2017). Among the R&D employees, 3 are state council experts with a special allowance and 72 are senior engineers. There are two divisions of R&D staff: design division and product development division. According to the interview, 20 % of R&D technicians are working specifically on new products and innovation, and their performance will be evaluated based on the patent applications and new product development. For the design division staff, they work on specific commercial projects, from the beginning of contract negotiation,

³ This is based on internal documents of Feida

to field trips, testing, and after-service. Moreover, it provides incentives for staff to be involved in R&D, for staff in technical and marketing positions, and at a management level. It encourages employees to apply for patents. For instance, 50,000 RMB will be awarded for an invention patent and an “Innovation Award” is provided for technical and managerial innovation.

Public authorities

The public authorities refer to those entities who make new policies and regulations, including local government, international organizations such as the world trade organisation (WTO), and central-level government bodies. The coal industry in China is mainly government-led and the monitoring system is still an administrative one, thus pressures for innovation for Feida to a large extent come from government standards and policies and are less market-driven. The main means of government intervention are through top-down mandates and through performance indices, such as measuring innovation on the number of patents that a company has. Being a state-owned enterprise, Feida is more responsive to government policies and regulations, compared to being driven by the (international) market or other entities.

Research collaboration and knowledge transfer

Feida has collaborated with multiple research institutions and universities in various key research projects. Feida is involved in two State High-Tech Development Programs, called the 863 program, in which it is the key investigator for specific sub-themes. The total funding of these two projects is more than 10 million RMB and Zhejiang University is a key collaborator for both projects. Feida also collaborates in research projects with other universities, e.g. the University of Nottingham Ningbo China, Northeastern University, Shandong University, and with state-owned companies involved in power generation in China, e.g. the China Huadian Corporation and the China Guodian Corporation. The cooperation with

Zhejiang University is focused on the detailed analysis of discharge patterns of PM 2.5 particles in power plants, as tiny particles emissions are different depending on the combustion process, and Feida is testing technology to further remove PM 2.5 particles from the exhaust gases of power plants. Related to this project, Feida, together with Shenhua Guohua Electric institute, also established a platform for the research on exhaust gas pollutants.

Feida does not only acquire technologic knowledge from collaborators through research projects, but also aims to improve its management and R&D capacity by collaborating with external institutions. For instance, the joint education of school and enterprise is adopted to cultivate talents. This practice can share common resources and advantages between each other and provide new opportunities for employee training. In 2011, a contract of expert training workstation was signed. Over 30 employees graduated with an Executive Master of Business Administration (EMBA) at Zhejiang University in 2017 (Zhejiang Academic and Expert Workstation 2017). In addition, Feida established a college for employee training in 2006, providing distance network education and face-to-face training. In 2017, it organized general technical and professional skill training on 140 occasions (Feida, 2017).

Partnership and market competitors

Feida has developed partnerships (i.e. focusing on technology import and joint ventures) with international leading companies to improve its products. Table 4 presents the examples of partnerships. For instance, a license agreement between ALSTOM and Feida had been made in 2004 in terms of fabric filter technology. It grants Feida rights to market, sell, and supply ALSTOM's proprietary fabric filter technology for particulate removal for the power generation industry in China. A joint venture company was set up in 2014 between Feida and Mitsubishi Hitachi Power Systems, Ltd. The new company is dedicated to providing

comprehensive solutions of removal of PM 2.5 and other pollutants emitted by coal-fired power plants.

The management system of the environmental-protection industry in China is mainly directed and managed by the macro-policy (government policies, targets, and investments) and associations. This means companies in this industry are highly responsive to the regulation and policies, with less exposure to the market competition. In recent years, the coal power industry has gradually matured, and exhaust emission standards have become stricter and more strictly supervised. Government policy is also more focused on increasing other cleaner sources of energy, such as wind, solar, hydropower, and gas. This implies that the market for emission control of coal-fired power plants is not likely to expand and the demand will be smaller. One of the significant strategies for Feida is to expand internationally to explore new sources for business and profits. The international market for emission control systems of power plants is highly competitive. The main competitors include Alstom (before 2015, later became GE-Alstom), Babcock & Wilcox, Babcock, Hitachi, BPI, Doosan, and BHEL in India. Feida has been successful in some international projects; however, due to having limited experience in the international market and its limited exposure to international competition, Feida has also suffered some setbacks in its international expansion.

Table 4 Technologies imported from different countries by Feida

Year	Company	Event
1993	Dynamic Air	Import technology of pneumatic conveyance
1999	ABB	Import technology of NID semi-dry flue gas desulfurization

2004	ALSTOM	Import technology of bag-type dust remover
2013	Mitsubishi	Import technology of wet electro-static precipitator
2014	Mitsubishi	Joint venture between Feida and Mitsubishi

Source: Feida official website 2018b

Societal groups, tools/machines, and media

The societal group refers to civil society organizations and non-governmental organizations (examples are Greenpeace or consumer groups), while the tools/machines category is about suppliers of materials, components, and tools (Geels 2004). These dynamic systems provide opportunities for companies to improve their products and achieve product innovation. Nevertheless, because of the nature of the industry and the relatively weak position of NGOs in China, Feida has paid less attention and effort to these groups.

Picture 3 Feida's Electrostatic Precipitator is visible here at the 370 MW Santa Maria power plant in Chile, operated by the Colbun group



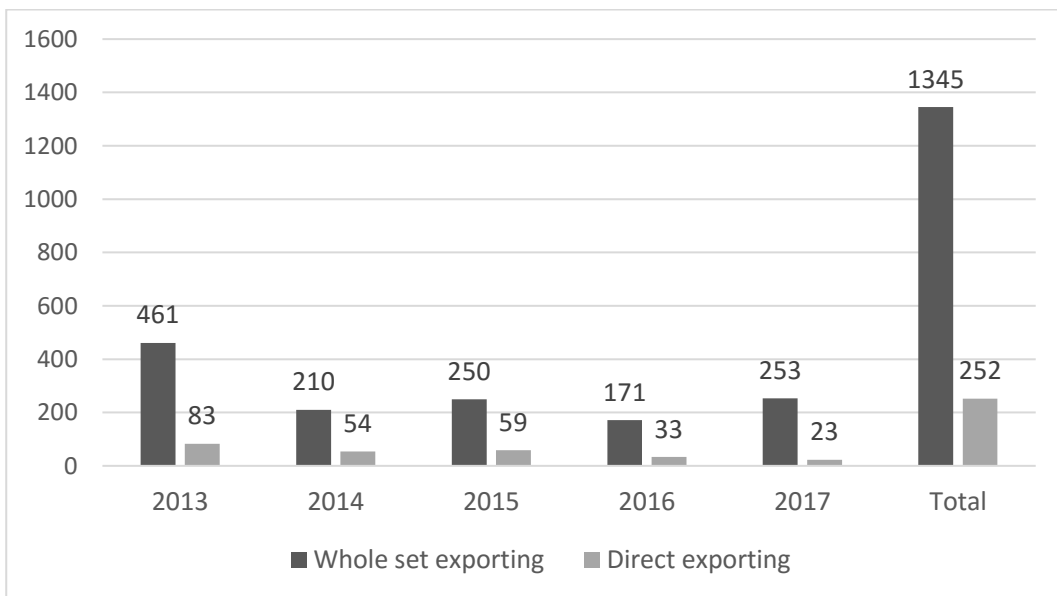
Internationalization of Feida

International expansion is a vital strategy for Feida to expand its markets and to create new sources of income and profits. In recent years the company has set up subsidiaries in India and Singapore. In May 2016, with 70% of the shares owned by Feida, Feida International Power Technology Co. Ltd was established in Singapore. Its main business is in power generation based on biomass, waste, and coal and targeted towards Southeast Asia. Compared to Western competitors, Feida offers cost effective products to the market, at about one third of the price of Western companies. It has already generated some success in providing high quality products to customers at affordable prices (see picture 3 for example), and combining this with reliable after-sale service, which has earned the trust of various international customers.

Feida is utilizing two types of exporting strategy: whole set exporting and direct exporting. Whole set exporting refers to its emission control systems being sold as part of a larger deal such as power plant construction through cooperation with big state-owned companies, including Dongfang Electric Corporation and TBEA Xi'an Electric Technology (Zhou, Ma, and Weng 2015). Direct exporting refers to selling its emission control systems directly to international competitors. For whole-set

exporting, the profits that Feida can make are limited, whereas this profit potential is higher in direct exporting. However, whole-set exporting involves limited political and management risk for Feida as these are covered by the main company in the transaction. The exporting data from 2013 to 2017 is depicted in Figure 6.

Figure 6 Exporting data from 2013 to 2017



Source: Feida⁴

⁴ This comes from the Overseas Department at Feida

It can be concluded from the data that the exporting trade is dominated by whole set exporting as it occupies 82%. For direct exporting Feida needs to strengthen its expertise in overseas markets to make sure that it will not suffer losses due to its inexperience with overseas local markets and politics. The problems Feida recently encountered in India with one of its projects showcase the importance of understanding overseas markets and having good relations with overseas partners and customers. Another important strategy for “going out” are projects signed with “One Belt One Road” countries. In 2017, Feida has been involved in a 2.2 billion dollars project in Jordan (Feida 2018c).

An example of a leading global competitor, Alstom

With over 100 years’ experience, Alstom is experienced in power generation services, turnkey power plants, air quality control systems, and carbon capture equipment. With the Thermal Power sector sales figures of 6163 million euros in 2014, Alstom is a market leader in environmental-protection activities for the power generation sector. As Alstom’s energy and power systems activities were acquired by the General Electric Company in 2015, we will mainly focus on the performance of its emission control systems for power generation before 2015.

The key priorities for the Alstom Thermal Power sector are to deliver operational excellence and good service to achieve high customer satisfaction. The company is involved in different development projects to improve the emission efficiency of coal-fired power plants, and these projects are partly funded by the European Union and the US Department of Energy. Alstom’s innovation has been strongly R&D driven through intensive R&D programs over the past years. This R&D and innovation is guided by technologic and economic challenges of reducing emissions of fossil fuel-based electricity production. There are 17 “R&D execution” centers across Europe, North America, and Asia (Alstom 2011). Their major responsibility ranges from technical support, to conducting cutting-edge activities that will create innovative products. It is estimated that the total number of Thermal Power R&D employees and

its associated partners is over 2,500, among which 10 are Senior Experts, 132 are Experts, and 430 are Principal engineers (Alstom 2014). Alstom applied for several hundred international patents worldwide in 2013, half of which involved innovative mechanical design, chemical process, and new or improved cycles. With the strategic focus on advanced combustion, steam cycle, and steam turbine blade technologies, Alstom aims to achieve a 50% reduction of emissions from fossil-based power plants.

Specific development programs are built to encourage employee contribution and ensure the company is at the edge of the most sophisticated techniques. The Expert Program is valued by Alstom to form a specific innovation community. Additionally, in 2008, Alstom launched the “Alstom Innovation Awards”, which were designed to reward employees for the development and implementation of innovative solutions. In 2011, over 1,100 employees from 22 countries were involved in this competition, with 399 applications received that year (Alstom 2011).

Alstom implements a series of management procedures and tools to train qualified personnel, stimulate the innovative mind, and encourage the expression and the sharing of ideas and knowledge. In July 2013, a “Learning Solutions and Alstom University” was set up for face-to-face and distance training and learning. The number of trainees at Alstom University in 2014 was 28,766 (Alstom 2014).

Furthermore, Alstom keeps good relationships with academic and scientific partners across the world, to access facilities, expertise, and research talent and accelerate the time-to-market product innovation. They have established more than 350 partnerships with universities, and Alstom actively participates in all important associations and standard-setting bodies.

Challenges for Feida

With its goal of international expansion, one of the challenges that Feida faces is its limited experience with and knowledge of overseas markets. The main business of Feida is located domestically in the environmental-protection equipment for coal-fired

plants. The viable domestic market tends to be shrinking and is highly competitive, as there is excess capacity in thermal power generation while renewable technology development is supported by the local government. Therefore, international expansion is essential for Feida. As India has a strong base in coal-fired power plants, and is facing challenges to limit the air emission of these power plants, it comes as a priority for Feida's internationalization under the strategy of "going out". However, the company has encountered problems in the Indian market as it had difficulty adapting to this different international environment, and has a lack of management experience, talent, expertise, and knowledge of international markets. Consequently, it suffered a significant loss in 2017 on a collaborative project in India with BGR Energy Systems Limited.

Part of the challenge Feida is facing is due to its limited exposure to the market, international environment, and competition. With the efforts and contribution in four decades, Feida has obtained a leading position in the air quality industry in the domestic market. The nature of its industry in China requires the company to put significant effort into building good relationships with (local) government(s) and responding to their needs. This has implied that the company has been much less exposed to the international market and the competitive pressures from international markets. It has also led to a technologic development trajectory that is mostly domestic and only involves very limited international activities, projects, and R&D efforts. This is reflected in the gap between Feida and international leading companies such as Alstom, with regard to patenting behaviors, international R&D projects, and training and talents programs.

Ways to move forward for Feida

Some of the ways forward for Feida include further development of its international innovation activities, a strengthening of its R&D and innovation activities with international and external partners, and finally a strengthening of its talent training and recruitment.

The first suggestion is to implement more internal innovation actions and programs. A series of management procedures and tools (e.g. incubators, ventures) are encouraged to build an innovative and dynamic atmosphere, stimulate the innovative mind, and encourage the expression and the sharing of ideas and knowledge. For instance, SUEZ, a leading company in the environmental-protection domain, established an experimentation lab within its company, while Siemens developed open innovation activities to enhance innovation projects and activities among its employees, cross-cutting various departments. Acting as an incubator, it helps to share the innovative minds, and nurture and support projects in terms of commercial and industrial support.

It is also recommended that Feida can increase its R&D and innovation activities with external and especially international partners. Competition in a more open environment can help companies to quickly respond to market changes and customer needs. Feida can also promote “open innovation”, where cooperation with academic and scientific partners is encouraged. Moreover, partnership culture is encouraged to be active through local public or private players (industrial, financial, or non-profit org) with an in-depth knowledge of the local context. This could substantially decrease the potential cost, share the technology and information, and help Feida to develop dynamic and innovative products. Programs such as an incubator with top universities, and venture programs for SMEs and innovative companies, could be good examples to support innovation eco-systems.

The final suggestion is associated with developing systematic employee training and recruiting more talents. Various training programs and continuing training initiatives framework are advised to help employees to learn specific knowledge or skills in the industry. This includes domestic and international training of personnel by top industry experts, opportunities of attending relevant conferences, and the high-value added courses with academic professionals. In addition, more talents who have access to international business knowledge and cutting-edge technology, and are aware of differences in foreign institutional environments, need to be recruited.

Further Investigation

1. Examine how Feida has been able to develop a strong brand both domestically and internationally. Is there a significant difference between the strength of its domestic brand and international brand? Discuss some of the factors that explain this difference.
2. Why may R&D and innovation be important in brand building? To what extent has it been important for Feida? What are the major approaches that Feida has used for innovation and brand building and how is this different from an international competitor such as Alstom? What key recommendation would you give to Feida to further strengthen its innovation and branding strategy?
3. Feida has a strong presence in the emission control systems for power plants and is now considering to further develop other areas of business including solid waste treatment and water pollution treatment. Discuss what the rationale is for Feida to consider moving into these areas and assess current strengths and weaknesses of Feida that could help or inhibit them to be successful in these new business areas.

References

- Agarwal, Sanjeev, M. Krishna Erramilli, and Chekitan S. Dev. "Market orientation and performance in service firms: role of innovation." *Journal of Services Marketing* 17, no. 1 (2003): 68-82.
- Alstom "Annual Report of Alstom for 2011," 2011, accessed July 5, 2018. <http://www.alstom.com/Global/Group/Resources/Documents/Investors%20document/DDR%202011-12%20VA%20FINAL.pdf>.
- Alstom "Annual Report of Alstom for 2014," 2014, accessed July 15, 2018. http://www.alstom.com/Global/Group/Resources/Documents/Investors%20document/ALSTOM%20DDR-2014-15_UK_MEL.PDF.
- Beverland, Michael B., Julie Napoli, and Francis Farrelly. "Can all brands innovate in the same way? A typology of brand position and innovation effort." *Journal of Product Innovation Management* 27, no. 1 (2010): 33-48.
- Feida, "Summary of Annual Report of Zhejiang Feida Environmental Protection Technology Co. Ltd. for 2017," 2017, accessed October 16, 2018. http://quotes.money.163.com/f10/ggm_x_600526_4273531.html
- Feida "Feida Company History," 2018a, accessed July 13, 2018. <https://www.feidaep.com/FZLC.html>
- Feida "Technology Development," 2018b, accessed July 13, 2018. <https://www.feidaep.com/>
- Feida "Feida 2017 Corporate Social Responsibility Report," 2017, accessed July 22, 2018. http://quotes.money.163.com/f10/ggm_x_600526_4273542.html
- Feida "Entering Middle East Market Under The 'Belt and Road' Strategy," 2018c, accessed July 13, 2018 <https://www.feidaep.com/ZXD/DT/show/id/251.html>
- Geels, Frank W. "From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory." *Research Policy* 33, no. 6-7 (2004): 897-920.
- Hofman, Peter S. *Innovation and institutional change: The transition to a sustainable electricity system*. CSTM: University of Twente, 2005.
- Hofman, Peter S., and Theo de Bruijn. "The emergence of sustainable innovations: Key factors and regional support structures." In *Facilitating Sustainable Innovation Through Collaboration*, pp. 115-133. Springer, Dordrecht, 2010.
- Kapferer, Jean-Noël. *The New Strategic Brand Management: Advanced insights and strategic thinking*. Kogan Page Publishers, 2012.
- Lin, Boqiang. *China Energy Outlook 2017*. Beijing: Peking University Press, 2017.
- Metz, Bert, Ogunlade Davidson, Rob Swart, and Jiahua Pan, eds. *Climate Change 2001: mitigation: contribution of Working Group III to the third assessment report of the Intergovernmental Panel on Climate Change*. Vol. 3. Cambridge University Press, 2001.
- NDRC "Promoting Demonstrative Application of the First Piece (Set) of Major Technological Equipment, Opinions of NDRC, MOST, MIIT, et al. Document number 558 of the National Development and Reform Commission," 2018, accessed October 16, 2018

- <http://lawinfochina.com/display.aspx?id=28143&lib=law&SearchKeyword=&SearchCKeyword>
- NEA "13th Five-Year Plan for Power Development, " 2016, accessed October 18, 2018 https://www.sohu.com/a/122347707_464105
- Srinivasan, Shuba, Koen Pauwels, Jorge Silva-Risso, and Dominique M. Hanssens. "Product innovations, advertising, and stock returns." *Journal of Marketing* 73, no. 1 (2009): 24-43.
- Weerawardena, Jay, Aron O'Cass, and Craig Julian. "Does industry matter? Examining the role of industry structure and organizational learning in innovation and brand performance." *Journal of Business Research* 59, no. 1 (2006): 37-45.
- Wu, Hua., Wu, Xiaobo. and Sun, Ying. "The technological innovation strategy at Feida (菲达集团的可升级技术创新战略 in Chinese) ". *Economic Management Journal* 1, (2001): 48-50.
- Yuan, Jiahai, Chunling Na, Qi Lei, Minpeng Xiong, Jingsheng Guo, and Zheng Hu. "Coal use for power generation in China." *Resources, Conservation and Recycling* 129 (2018): 443-453.
- Zhejiang Academic and Expert Workstation "The Establishment of An Academic and Expert Workstation in Feida, " 2017, accessed July 9, 2018. <http://yszx.zast.org.cn/html/yszjgzz/gb2312/>.
- Zhou, Zhiming, Ma, Keyuan and Weng Junfei, "One Belt and One Road, Cultivation of Key Technology," *Zhejiang Daily*, December 14, 2015, 1.