CEFC China & Westinghouse Strategy

A case for the acquisition of Westinghouse Electric Company

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This document provides a rationale as to why Westinghouse Electric Company is a desirable and valuable acquisition for CEFC China. It argues that Westinghouse's expertise and extensive know-how in an owner's engineer role will help CEFC China capitalise on future nuclear new build. The document will cover in detail the strategy that is envisioned as the way towards acquiring the majority stake in the company.

EEIG

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3 INTRODUCTION

This paper is meant to be a strategy document for the possible targeting of Westinghouse by CEFC China, with the participation of Bernhard Capital Partners. This if completed would be the most significant strategic energy transaction of recent years and would solidify CEFC China, as the primary economic and political driver of the global energy industry, and the world leader in nuclear new build. We present a comprehensive overview of the market and organisations proposed for the deal: CEFC China, Westinghouse Electric Company, Bernhard Capital Partners and European Energy and Infrastructure Group (EEIG). It also presents a summary of the Chinese nuclear market and a comparison of the world's foremost nuclear powers.

The following sections describe the role and benefits of an owner's engineer and concludes that Westinghouse / CEFC is tailor made to be a global integrator, providing expertise, assurance and risk mitigation. Leading to a CEFC's complete China / US dominate of market, also projecting the CEFC brand top astronomic heights.

Figure 1 – Sanmen Nuclear Power Plant using AP1000 technology

4 PRIMARY COMPANY PROFILES

4.1 CEFC CHINA ENERGY COMPANY LIMITED

CEFC China Energy Company Limited (CEFC China) is a private collective enterprise with energy and financial services as its core business. As the corporate name implies, CEFC China speaks for credibility of the Chinese. The strategy of the company seeks to serve the national industrial interest by building a modernised "economic community" to compete as a multinational enterprise that expands cooperation in the international energy economy and achieves influence in the energy industry.

CEFC China was established in 2002 by Ye Jianming, followed by the establishment of the Board of Directors in 2006. In 2014, Ye Jianming was re-elected by unanimous consent as Chairman of the Board of Directors at the 1st Session of the 4th Board of Directors. For over ten years under the leadership of Chairman Ye Jianming, the people of CEFC China have taken guaranteeing and serving China's energy security and development as their primary responsibility through all manners of difficulties with cohesiveness, and have vigorously implemented the "going global" strategy through trade promotion and personnel training in a trade-driven economy, making CEFC China a successful global trader of energy. In recent years, the company, closely following the "One Belt and One Road" Initiative, has sped up its strategic transformation and has been making efforts to build an international investment bank specialized in the financial services and investment in the energy industry, thus promoting its stable and rapid development.

In 2014, the company was on the Fortune Global 500 List and among the World's 500 Most Influential Brands with its annual revenues exceeding RMB 220 billion. It has been awarded the "2014 Most Influential Chinese Enterprises", and has won the title of "Top Ten Chinese Philanthropic Enterprises" for four consecutive years. The company, committed to exploring the development model of private enterprises, has set a unique business model of independent innovation and built an organized "economic community". Its corporate governance adopts a "three-in-one" management model integrating "entrepreneurship, Confucianism, and military-style regimentation".

CEFC China Headquarters is dedicated to strategic and financial control while its subsidiaries operate with partnership. All these efforts contribute to sustained improvement in institutional innovation. It has three group companies, nine tier-1 subsidiaries and an A-share listed company, and has acquired shares of several foreign public companies, totalling a workforce exceeding 20,000 people.

4.2 WESTINGHOUSE ELECTRIC COMPANY

Westinghouse

Westinghouse Electric Company LLC is a US based nuclear power company and world leader in offering nuclear products and services to utilities internationally, including nuclear fuel, service and maintenance, instrumentation, control and design of nuclear plants. As of 2014 Westinghouse builds and operates approximately **one-half of the world's operating nuclear plants**. Westinghouse's world headquarters are located in the Pittsburgh suburb of Cranberry Township, Pennsylvania. Toshiba Group is the majority owner of Westinghouse with an 87% stake in the company.

On October 16, 2006 the acquisition of Westinghouse Electric Company for $5.4 billion from BNFL was completed, with Toshiba obtaining a 77% share, partners The Shaw Group, whom Mr. Jim Bernhard was CEO, a 20% share and Ishikawajima-Harima Heavy Industries Co. Ltd. a 3% share. On 13 August 2007 Toshiba sold 10% to Kazatomprom, the national uranium company for the Republic of Kazakhstan, for US$540 million, leaving Toshiba with 67%. In September, 2011, Toshiba was reported to be in talks to acquire the 20% Shaw stake and both companies confirmed the sale soon thereafter.

4.3 BERNHARD CAPITAL PARTNERS

BERNHARD
CAPITAL PARTNERS

Bernhard Capital Partners Management LP is a private equity firm specializing in buyouts. It primarily invests in businesses that touch the entire energy services spectrum throughout the upstream, midstream, downstream, and power verticals. It focuses on upstream through midstream to downstream, power segments sector, engineering and construction, environmental services, specialized equipment and manufacturing, transportation and storage services, offshore/onshore maintenance and operations, and data acquisition and management. The firm makes investments in North America. It seeks to make control or path-to-control investments. Bernhard Capital Partners Management LP was founded in April 2013.

Mr. Jim Bernhard, the company's Founder and Partner, is an industrial business mogul and representative for building US primary nuclear and energy delivery support as a private company. Mr. Bernhard is highly respected in political spheres with an unsurpassed lobbying network in energy. His former company, The Shaw Group, was previously part owner of Westinghouse, holding a 20% stake in the company, which was later sold to Toshiba.

Mr. Bernhard serves as Chairman of the Investment Committee, serves on the Portfolio Committee and is involved in all areas of the firm's investment activities. Mr. Bernhard started The Shaw Group in 1987 with a small personal investment and grew the company into one of the leading global energy services firms with over $6 billion in revenue and 25,000 employees. For over 25 years, Mr. Bernhard led the growth of The Shaw Group as the CEO, President and Chairman of the Board. Mr. Bernhard played a leading role in every major decision of the company from its founding until its sale. Under his stewardship, Shaw became one of the fastest growing companies in the Fortune 500 offering a broad range of engineering, construction, equipment, environmental and manufacturing services across the energy spectrum.

The Shaw Group became an industry leader in the power industry, a top environmental services provider and the global leader in nuclear power services, in particular. Mr. Bernhard is regarded as an expert in the energy services industry and has testified before the U.S. Senate's Energy Subcommittee to discuss pending energy issues in the United States and across the globe.

Mr. Bernhard has served on numerous boards of trade and civic organizations and is very active in his community. In 2001, Mr. Bernhard was recognized as "U.S. Entrepreneur of the Year".

4.4 EUROPEAN ENERGY AND INFRASTRUCTURE GROUP

EEIG

EEIG is a Global integration and advisory organisation, working with governments and global corporations to create strategic business opportunities, integrate and deliver programmes through its global network of partners. EEIG has represented the foreign ministry of Korea until 2015, as advisor on the internationalisation of the Korean energy market and in particular the Nuclear sector and was instrumental in bid support for Korean power and heavy industry. Our capabilities include construction; engineering; power generation; information technology; built asset management and transportation.

EEIG represents the US industrial sector and high level strategic influences at the highest level within Washington, D.C. and Its daughter company, J2cR, is the leader in U.S based border security, law enforcement and legal compliance.

5 A REVIEW OF THE CHINESE NUCLEAR MARKET

5.1 FUTURE OF NUCLEAR

- Mainland China has 30 nuclear power reactors in operation, 24 under construction, and more about to start construction.
- Additional reactors are planned, including some of the world's most advanced, to give more than a three-fold increase in nuclear capacity to at least 58 GWe by 2020-21, then some 150 GWe by 2030, and much more by 2050.
- The impetus for increasing nuclear power share in China is increasingly due to air pollution from coal-fired plants.
- China's policy is for closed fuel cycle.
- China has become largely self-sufficient in reactor design and construction, as well as other aspects of the fuel cycle, but is making full use of western technology while adapting and improving it.
- China's policy is to 'go global' with exporting nuclear technology including heavy components in the supply chain.

Most of mainland China's electricity is produced from fossil fuels, predominantly from coal. Rapid growth in demand has given rise to power shortages, and the reliance on fossil fuels has led to much air pollution. The economic loss due to pollution is put by the World Bank at almost 6% of GDP, and the new leadership from March 2013 has prioritised this. Chronic and widespread smog in the east of the country is attributed to coal burning. Official measurements of fine particles in the air measuring less than 2.5 micrometres, which pose the greatest health risk, rose to a record 993 micrograms per cubic metre in Beijing on 12 January 2013, compared with World Health Organization guidelines of no higher than 25. The problem that burning of fossil fuels has created is severe. While coal is the main energy source, most reserves are in the north or northwest and present an enormous logistical problem – nearly half the country's rail capacity is used in transporting coal. Because of the heavy reliance on old coal-fired plant, electricity generation accounts for much of the country's air pollution, which is a strong reason to increase nuclear share. The State Nuclear Power Technology Corporation (SNPTC) has made the Westinghouse AP1000 the main basis of technology development in the immediate future, particularly evident in the local development of CAP1400 based on it. This has led to a determined policy of exporting nuclear technology, based on China's development of the CAP1400 reactor with Chinese intellectual property rights and backed by full fuel cycle capability.

The Chinese government plans to increase nuclear generating capacity to 58 GWe with 30 GWe more under construction by 2020. China has completed construction and commenced operation of 28 new nuclear power reactors over 2002-15, and some 24 new reactors are planned or under construction. These include the world's first four Westinghouse AP1000 units and a demonstration high-temperature gas-cooled reactor plant. Many more are planned, with construction due to start within about three years. China is commencing export marketing of a largely indigenous reactor design. R&D on nuclear reactor technology in China is second to none.

5.2 AP1000 & CAP1000

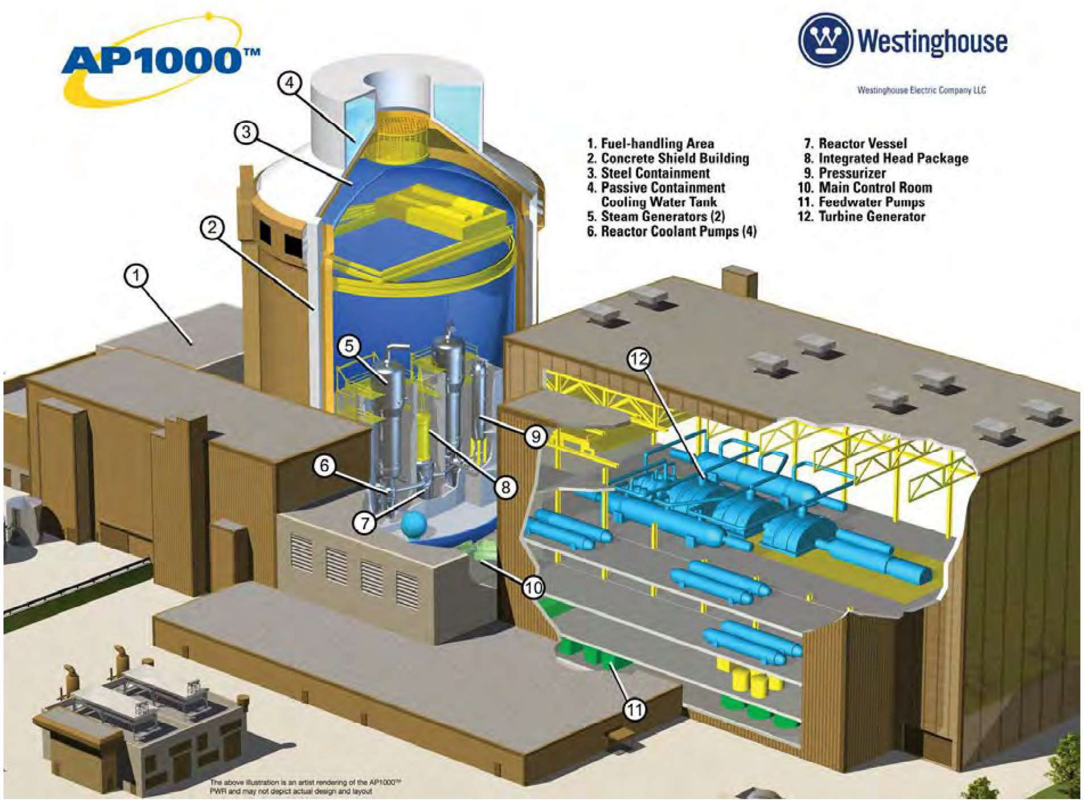

Figure 2 - The Westinghouse AP1000

The Westinghouse AP1000 is the main basis of China's move to Generation III technology, and involves a major technology transfer agreement. It is a 1250 MWe gross reactor with two coolant loops. The first four AP1000 reactors are being built at Sanmen and Haiyang, for CNNC and China Power Investment Corp (CPI) respectively. Six more at three sites are firmly planned after them, at Sanmen, Haiyang and Lufeng (for CGN), and at least 30 more are proposed to follow. A State Council Research Office report in January 2011 emphasised that these should have priority over alternative designs such as CPR-1000, and this position strengthened following the Fukushima accident.

Westinghouse and Shaw Group have an engineering, procurement, commissioning and start-up as well as project management contract with SNPTC for the first four reactors (Sanmen & Haiyang). Also Shaw has a contract with State Nuclear Power Engineering Corp. Ltd, a SNPTC subsidiary, for technical support for the first two Dafan, Xianning units in Hubei province, including engineering and design management, project controls, quality assurance, construction management and project management.

CNEA estimated in May 2013 that the construction cost for two AP1000 units at Sanmen are CNY 40.1 billion ($6.54 billion), or 16,000 Yuan/kW installed ($2,615/kW), instead of CNY 32.4 billion earlier estimated. This is about 14% higher than the latest estimate for the CPR-1000, but likely to drop to about CNY 13,000/kW (**$2,120/kW**) with series construction and localisation as envisaged. Grid purchase price is expected to exceed CNY 0.45/kWh at present costs, and drop to the standard CNY 0.43/kWh with series build and reduced capital cost.

SNPTC also refers to a CAP1000, which is a local standardization of the design, transitional to CAP1400. It is said to have reduced cost and improved operation and maintenance attributes. The base design, commenced in 2008, is complete, the detailed design, started in April 2010, was due by June 2013.

Westinghouse has agreed to transfer technology to State Nuclear Power Technology Corp (SNPTC) over the first four AP1000 unit designs at Sanmen and Haiyang, so that SNPTC can build the following ones on its own.

5.3 CAP1400

Figure 3 - The SNPTC CAP1400 Conceptual Model

Westinghouse announced in 2008 that it was working with SNPTC and Shanghai Nuclear Engineering Research & Design Institute (SNERDI) to develop jointly a passively safe 1400-1500 MWe design from the AP1000/CAP1000, for large-scale deployment. SNPTC initially called it the Large Advanced

Passive PWR Nuclear Power Plant (LPP or APWR). It is one of 16 Key National Projects in China. This development with SNERDI opens the possibility of China itself exporting the new larger units with Westinghouse's cooperation.

The CAP1400 is an **enlarged version of the Westinghouse AP1000** pressurized water reactor developed from the Westinghouse original by SNPTC with consulting input from the Toshiba-owned company. As one of China's 16 strategic projects under its National Science and Technology Development Plan, the CAP1400 is intended to be deployed in large numbers across the country. The reactor design may also be exported.[1]

In 2008 and 2009, Westinghouse made agreements to work with the State Nuclear Power Technology Corporation (SNPTC) and other institutes to develop a larger design, the CAP1400 of 1,400 MWe capacity, possibly followed by a 1,700 MWe design. In 2014 SNPTC signed a further agreement with Westinghouse to deepen cooperation in relation to AP1000 and CAP1400 technology globally and "establish a mutually beneficial and complementary partnership." China will own the intellectual property rights for these larger designs. Exporting the new larger units may be possible with Westinghouse's cooperation. In September 2014 the Chinese nuclear regulator approved the design safety analysis following a 17-month review.[2]

Westinghouse is providing technical consulting services to SNPTC for the design. More than 80% of the components will be indigenous, and contracts for 21 of 29 long lead time components had been signed by February 2015. Construction cost is expected to be CNY 15,751/kWe ($2454/kWe) and power cost CNY 0.403/kWh for the first unit and dropping to CNY 0.38/kWh (USD 5.9 cents) subsequently. A 2014 government figure is CNY 42.3 billion ($6.5 billion) for the first two units.

The next page shows a list of the AP1000 and CAP1400 that are planned and/or currently under construction, with a further 24 AP1000 units proposed.

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[1] Preparations continue for initial CAP1400 units. World Nuclear News. 27 April 2015. <http://www.world-nuclear-news.org/NN-Preparations-continue-for-initial-CAP1400-units-2704155.html>

[2] "Nuclear Power in China". World Nuclear Association. 2 July 2010. Archived from the original on 31 July 2010. Retrieved 09 February 2016.

Plant	Province	MWe gross	Reactor model	Project control	Construction start	Operation, grid connect
Sanmen units 1&2	Zhejiang	2x1250	AP1000	CNNC	**3/09**, **12/09**	mid-2016, 2017
Haiyang units 1&2	Shandong	2x1250	AP1000	SPI	**9/09**, **6/10**	mid-2016, 2017
Shidaowan units 1&2	Shandong	2x1400	CAP1400	SNPTC & Huaneng	3/16, delayed	12/2020, 2021
Xudabao/Xudapu units 1&2	Liaoning	2x1250	AP1000	CNNC, Datang	2016*	2020-21
Sanmen units 3&4	Zhejiang	2x1250	AP1000	CNNC	2016*	2020-21
Haiyang units 3&4	Shandong	2x1250	AP1000	SPI	2016*	2020-21
Lufeng (Shanwei) units 1&2	Guangdong	2x1250	AP1000	CGN	2016*	2020-21
Bailong units 1&2	Guangxi	2x1250	AP1000	SPI	2016-17	
Huizhou units 1&2	Guangdong	2x1250	AP1000	CGN	2015-18	
Zhangzhou units 1-4	Fujian	4x1250	AP1000	Guodian & CNNC	2016	
Taohuajiang units 1-4	Hunan (inland)	4x1250	AP1000	CNNC	2016-18*	
Pengze units 1&2	Jiangxi (inland)	2x1250	AP1000	SPI	2016-17*	
Xianning (Dafan) units 1&2	Hubei (inland)	2x1250	AP1000	CGN	2016-17*	

Figure 4 - Nuclear reactors under construction and planned

5.4 THE PROSPECT FOR NUCLEAR EXPORTS

China has a determined policy at NDRC level of exporting nuclear technology, based on development of the CAP1400 reactor with Chinese intellectual property rights and backed by full fuel cycle capability. The policy is being pursued at a high level politically, utilising China's economic and diplomatic influence. CNNC and SNPTC are focused on the export potential of the CAP1400, and SNPTC aims at "exploration of the global market" from 2013, particularly in South America and Asia. In January 2015 the cabinet announced new incentives and financing for industry exports, particularly nuclear power and railways, on the back of $103 billion outbound trade and investment in 2014.

SNPTC is keen to export the CAP1400 reactor, and considers Turkey and South Africa to be good prospects. In November 2014 SNPTC signed an agreement with Turkey's utility EUAS and Westinghouse to begin exclusive negotiations to develop and construct a four-unit nuclear power plant in Turkey. In December 2014 it signed two agreements in South Africa with a view to nuclear power plant construction, and CNNC signed another there.

6 ENERGY TECHNOLOGIES OVERVIEW

Over the last few decades, there has been growing ever-growing demand on utilities to produce more power to fulfil our energy needs. There are several power production technologies that are currently widely used. These are: coal-fired generated technologies, gas-fired-generated technologies, nuclear generating technologies, and renewable generating technologies. Due to the scope of this document, we will be pointing out details and comparisons primarily of coal and nuclear generating technologies since these are the prevailing sources of power production.

The OECD carried out a study entitled “Projected Costs of Generating Electricity: 2010 Edition”, co-authored by the International Energy Agency (IEA) and the Nuclear Energy Agency (NAE) which presents a comparison of coal, gas, nuclear and renewable power production technologies and their respective Levelised Cost of Electricity (LCOE).

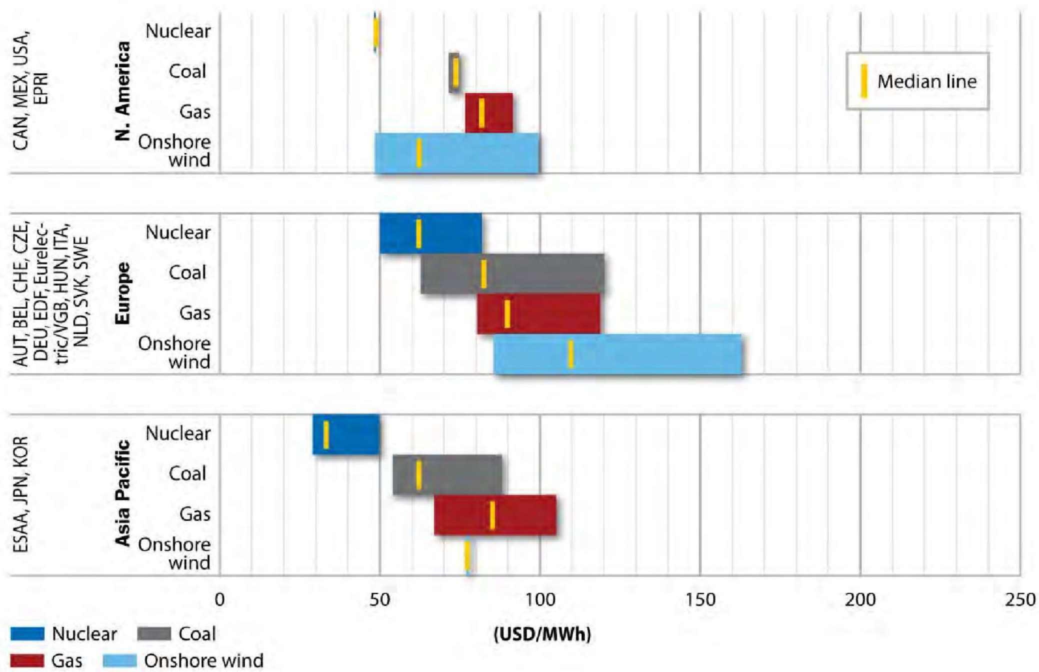

Figure 5 - Regional ranges of LCOE for nuclear, coal, gas and onshore power plants (at %5 discount rate) Source: OECD, IEA, NEA

Among all of the OECD countries (plus Brazil, China, Russia and South Africa), the figure above shows that as long as discount rates are favourable, nuclear power generation remains the most competitive form of power production when compared to coal, gas and wind. This is true because although nuclear carries high capital costs and more inherent risk, fuel costs are, over time, low compared to coal and gas.

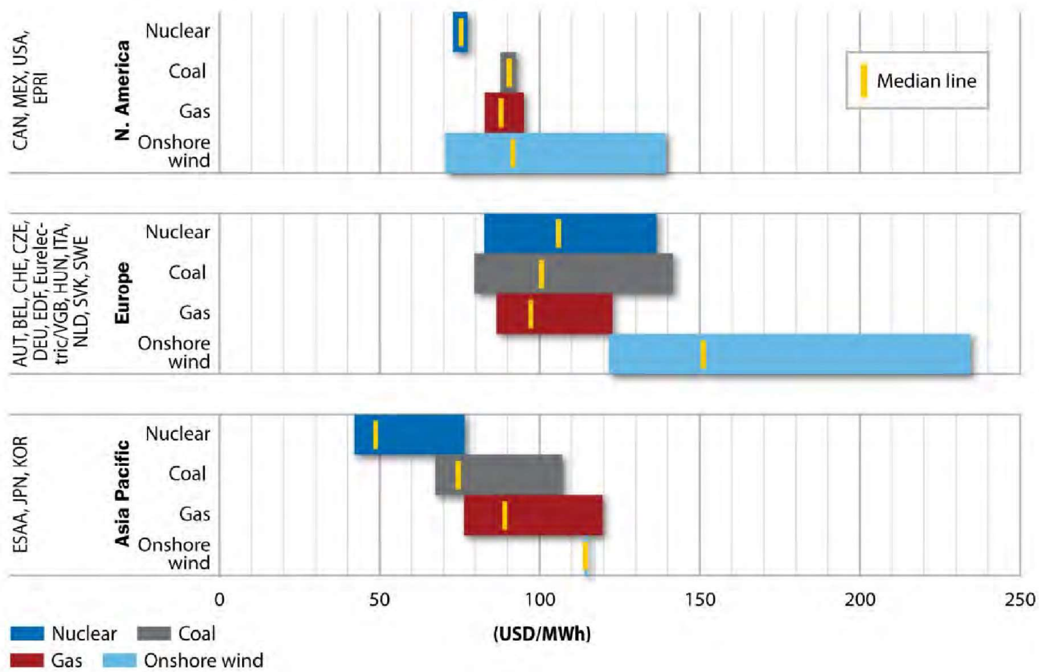

Figure 6 - Regional ranges of LCOE for nuclear, coal, gas and onshore power plants (at 10% discount rate) Source: OECD, IEA, NEA.

The above figure shows, however, that at least in Europe when the discount rate is 10%, coal is more competitive because the fact that higher discount rates mean that the cost of financing the capital costs become more expensive over time. The lesson here is that in order for nuclear to be a viable option, favourable discount rates must be available from creditors when covering capital costs. This will be elaborated more on later.

The method of calculation and key assumptions used to calculate the LCOE are elaborated in the full document, "Projected Costs of Generating Electricity: 2010 Edition.[3] The information to be deduced from the data is that cost competitiveness will rely more than anything on the local characteristics of each particular market and the associated cost of financing, CO_2 costs and the fossil fuel prices.[4] As mentioned above the lower the cost of financing, low carbon solutions like nuclear generated technologies will remain highly competitive.

Although the study is exhaustive, the most important data to extract from our point of view is the cost of generating electricity for each mainstream technology in order to use as a foundation for

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[3] International Energy Agency, Nuclear Energy Agency, and the OECD. Projected Costs of Generating Electricity: 2010 Edition. Paris, France: 2010.

[4] International Energy Agency, Nuclear Energy Agency, and the OECD. Projected Costs of Generating Electricity: 2010 Edition. Paris, France: 2010.

making decisions on what technology to choose for generating electricity. We have extracted a few key results from the data below, but the entire table can be found in Appendix A for further review. We will first examine relevant information regarding electricity generating costs in OECD countries and then review the overnight costs of generating electricity.

6.1 ELECTRICITY GENERATING COSTS FOR SELECTED OECD AND NON-OECD COUNTRIES

Figure 5 shows data on electricity generating costs for selected OECD countries for mainstream technologies.

Nuclear (includes decommissioning costs)				
Technology	Investment Costs	O&M	Fuel & Carbon	LCOE
	USD/MWh			
Czech Republic (PWR)	45.67	14.74	9.33	**69.74**
France (EPR)	31.10	16.00	9.33	**56.42**
Japan (ABWR)	23.88	16.50	9.33	**49.97**
Korea (APR-1400)	12.20	8.95	7.90	**29.05**
Slovak Republic (VVER 440 / V213)	33.91	19.35	9.33	**62.59**
USA (Adv Gen III)	26.53	12.87	9.33	**48.73**
Russia (VVER-1150)	22.76	16.73	4.00	**48.73**
	Coal			
Technology	Investment Costs	O&M	Fuel & Carbon	LCOE
	USD/MWh			
Czech Republic				
Br PCC	32.51	8.53	43.50	**84.54**
Br PCC w/ CC(S)	53.04	13.43	22.22	**88.69**
Br PCC w/BioM and CC(S)	55.39	14.98	32.22	**102.59**
France	**No data available**			
Japan (Bk)	22.53	10.06	55.49	**88.08**
Korea (Bk PCC)	7.74	3.84	54.28	**65.86**
Slovak Republic (Br SC FBC	23.73	8.86	87.43	**120.01**
USA				
Bk PCC	17.73	8.76	46.00	**72.49**
Bk IGCC w/CC(S)	29.96	11.31	26.76	**68.04**

Figure 7 - Country-by-country data on electricity generating costs for mainstream technologies

Figure 6 shows the estimated overnight costs of electricity generating technologies. It compares data from 14 OECD countries and 4 non-OECD countries. The table compares overnight costs from nuclear, coal, natural gas and wind.

Country	Nuclear	USD/kWe	Coal	USD/kWe	Gas	USD/kWe	Onshore wind	USD/kWe
Belgium	EPR-1600	5 383	Bk SC	2 539	Single Shaft CCGT	1 249	3x2MWe	2 615
			Bk SC	2 534	CCGT	1 099	1x2MWe	2 461
					CCGT	1 069		
					CCGT	1 245		
Canada							33x3MWe	2 745
Czech Republic	PWR	5 858	Br PCC	3 485	CCGT	1 573	5x3MWe	3 280
			Br FBC	3 485	CCGT w/CC(S)	2 611		
			Br IGCC	4 671				
			Br FBC w/ BioM	3 690				
			Br PCC w/CC(S)	5 812				
			Br FBC w/CC(S)	6 076				
			Br IGCC w/CC(S)	6 268				
			Br FBC w/BioM and CC(S)	6 076				
France* **	EPR	3 860					15x3MWe	1 912
Germany	PWR	4 102	Bk PCC	1 904	CCGT	1 025	1x3MWe	1 934
			Bk PCC w/CC(S)	3 223	Gas Turbine	520		
			Br PCC	2 197				
			Br PCC w/CC(S)	3 516				
Hungary	PWR	5 198						
Italy					CCGT	769	25x2MWe	2 637
Japan	ABWR	3 009	Bk	2 719	CCGT	1 549		
Korea	OPR-1000	1 876	Bk PCC	895	LNG CCGT	643		
	APR-1400	1 556	Bk PCC	807	LNG CCGT	635		
Mexico			Bk PCC	1 961	CCGT	982		
Netherlands	PWR	5 105	Bk USC PCC	2 171	CCGT	1 025	3MWe	2 076
Slovak Republic	VVER	4 261	Br SC FBC	2 762				
Switzerland	PWR	5 863			CCGT	1 622	3x2MWe	3 716
	PWR	4 043						
United States	Adv GenIII+	3 382	Bk PCC	2 108	CCGT	969	100x1.5MWe	1 973
			Bk IGCC	2 433	AGT	649		
			Bk IGCC w/CC(S)	3 569	CCGT w/CC(S)	1 928		
NON-OECD MEMBERS								
Brazil	PWR Siemens/Areva	3 798	Br SUBC PCC	1 300	CCGT	1 419		
China	CPR-1000	1 763	Bk USC PCC	656	CCGT	538	200MWe (Park)	1 223
	CPR-1000	1 748	Bk SC	602	CCGT	583	33x1.5MWe	1 541
	AP-1000	2 302	Bk SC	672			41x0.85MWe	1 627
							30MWe (Park)	1 583
Russia	VVER-1150	2 933	Bk USC PCC	2 362	CCGT	1 237	100x1MWe	1 901
			Bk USC PCC w/CC(S)	4 864				
			Bk SC PCC	2 198				
South Africa			Bk SC PCC	2 104				

Source: OECD, IEA, NEA. Includes pre-construction, EPC and contingency costs.

Figure 8 - Overnight costs of electricity generating technologies (USD/kWe) - mainstream technologies

7 GLOBAL NUCLEAR INDUSTRY OVERVIEW POST-2012

The suppliers and buyers in today's nuclear market hold surprisingly different viewpoints on the state of the industry. While it might be expected that rationalization and shared global practices would encourage consistency, the positions of different players vary markedly depending on their own location and individual circumstances. Cultural differences also play a significant role, but it is one that most often not discussed or analysed. Every single major nuclear supplier comes from a different part of the world and all have subtle, yet noticeable differences with how each deals with all issues that arise out of the overwhelmingly complex and challenging task of putting together nuclear power plants.

Japan's Fukushima Daiichi nuclear power plant accident forced these companies to review safety and preparedness, as the issue of nuclear safety was heightened. Beyond a fresh emphasis on safety, countries that currently buy nuclear energy express different, and constantly evolving, requirements from their vendors, depending on the needs of their markets and their national priorities. Nuclear suppliers, meanwhile, are adopting varying strategies as they attempt to compete in an ever tighter market.

As a new market entrant, Korea continues to consolidate an increasingly competitive position, although questions remain among potential buyers regarding its ability to conduct several international projects at the same time. Its strength is in its value proposition and safety record, as they have had no major incidents.

As in other high-tech sectors, China has strong satisfying domestic demand remains a priority for the moment. Developing domestic nuclear capacity will help China build the experience and credibility needed to win foreign contracts.

Japan is facing two challenges since it is still suffering from the Fukushima accident: planning the international development of its nuclear industry while dealing with surging critical domestic public opinion.

In North America, Canada shows a strong commitment to export and, with a well-structured marketing and sales approach, has the potential to become a future leader in nuclear upgrade and related services. The US boasts a unique brand that inspires global confidence, has the world's largest and oldest nuclear fleet, and benefits from recognized leadership in consulting and engineering.

So while the nuclear industry may look homogeneous at first sight, in reality it encompasses a wide range of distinct and specific evolution. What's more, rapid change and rising demands mean that staying competitive will become increasingly challenging. An analysis of vendors in 7 countries shows that, while vendors should not expect to meet the requirements of all clients all the time, addressing a number of key factors will increase their chances of success in a competitive market.

7.1 COUNTRY ANALYSIS

On average, 14% of the world's electricity comes from nuclear energy. In the Czech Republic, the average is closer to 30%. The high output potential, efficiency and relatively low cost of nuclear have been the main reasons why many countries have decided to develop their own civil nuclear programmes.[5]

7.1.1 CANADA

Canada manufactures CANDU technology. Some minor technological upgrades are expected on operating plants to increase their resistance to worst-case scenarios such as large earthquakes. Some administrations such as the Ontario Government have stalled decisions regarding prolonging a plant's life cycle.

CANDU technology is inherently suited for using alternative fuels. CANDU can burn recycled recovered uranium from light-water reactors, and tests are currently under way on CANDU's potential use of thorium, which is abundant in China and India. CANDU allows for the production of smaller, modular nuclear reactors that offer several advantages: Modularity and simplicity (do not require large forged pressure vessels, but use pressure tubes); Use alternative fuels to enriched uranium; Scalable: possibility to add or shut units as demand changes; and lower and security needs.

But Canadian reactors, built between the 1970s and 1990s, are ageing. Future Investment in Canada's nuclear power generation will need to focus on improving the efficiency of the refurbishment of these reactors, with the aim of extending their lifespan. Investment is also needed to enhance certain aspects of CANDU, including its IT functionalities.

Advantages

- Large reserves of the world's highest-grade uranium
- Wide global presence and international sales experience in six countries
- Integrated and coordinated approach to selling abroad
- Strong government support
- Positive safety record and reactor performance record
- Good economics for refurbishment/upgrades

Weaknesses

- Strong dependence on the domestic market
- Canada is expected to remain the main customer of CANDU Energy
- Dependence on government funding
- Suitability of substitute fuel not yet confirmed
- Vulnerable supply chain

[5] Earnst & Young. "Benchmarking the global nuclear industry 2012: Heading for a fast recovery". 2012.

- Potential international market for maintenance, repair and modernization services

7.1.2 CHINA

China is currently the most important entrant in the nuclear market. China is rapidly expanding its nuclear capabilities. Chinese manufacturers are yet to develop their own design capabilities, and plants are currently based on clients' designs. When selling abroad, current government rules insist manufacturers produce 80% of exports in China.

In recent years, has developed significant experience in a range of technologies. Plants designed by American, Canadian, French and Russian vendors are now operating or being constructed in China. Strategic partnerships with these vendors give China access to the world's leading technologies and nuclear expertise.

In the domestic market, Chinese vendors are the main suppliers, offering a broad range of products and solutions. China can provide all the necessary equipment needed to construct nuclear power plants and has the ability to build the entire plant, apart from the nuclear island. However, in the foreign market, Chinese companies are currently only able to act as suppliers of equipment. Moreover, huge demand in the domestic market is exacerbating tensions created by tough competition for scarce resources.

China has plans to expand its overseas activities and develop EPC (engineering, procurement and construction) offers for foreign clients. China's in-house production capabilities, low labour costs and a focus on quality create a strong competitive advantage. While their solution is still based on Gen2 design players, it may be more competitive than solutions from other developing countries — but this is yet to be proven, as building overseas is a different matter from building at home.

Advantages

- Competitive price due to low wages
- Diversified offer of components, full range of products for different generations of nuclear power technologies
- Strong ability to integrate foreign skills for design
- Good quality (nuclear island equipment is class #1 of the nuclear safety classification)
- Leading position on the domestic nuclear market

Weaknesses

- Newcomer, insignificant experience in construction abroad
- Limited offer of technologies, only generation II and II+
- Design more demanding of raw materials than competitors' designs
- No experience or ability in dismantling and upgrading
- Tensions regarding resources

7.1.3 FRANCE

France's nuclear programme has a unique and very strong nuclear industry due to a combination of technological know-how, national commitment and a large workforce that covers the entire nuclear value chain. The size of their workforce makes it possible for France to handle multiple projects both domestically and abroad.

France's nuclear industry has very strong political and public support. EDF is a strong asset as it is the world's largest operator of nuclear power plants. The French do not engage in offering turnkey solutions such as "build-own-operate", although certainly have the capability to do so. For them, the responsibility to operate a nuclear is too great to delegate to a supplier.

The French have great lobbying power having the second largest network of embassies throughout the world (2nd only to the United States) and it's argued that they could use more political clout when bidding for tenders.

Because France has its own in-house engineering and planning capacities, it has not developed large consulting and engineering companies that could benefit from getting on the ground early for emerging countries that are developing their own nuclear programmes. It is this reason that prevents France from having a country presence early in the decision-making processes of potential clients.

Advantages

- Coverage of the entire value chain, including fuel provision and waste treatment
- Strong know-how and high-quality technology and products
- Large nuclear fleet compared to the size of the country, with 1,400 reactors
- Years of experience without accident, with a strong and experienced operator
- A recognized regulatory body; nuclear safety is of the utmost importance

Weaknesses

- Limited range of products as the EPR may be oversized for some client countries
- Difficult to identify a clear leader of the French nuclear industry; international approach is sometimes disjointed
- Industry lacks visibility on an international level
- Innovative solutions for financing still to develop

7.1.4 JAPAN

Japan has one of the largest nuclear fleets in the world, with 54 reactors generating 30% of the country's electricity supply. Although the Fukushima accident was a shock to both the nuclear industry and the nation, Japan does not have any plans to phase nuclear out.

Besides fuel enrichment and waste management, Japan still has superior expertise across the whole value chain in nuclear energy. It can offer a complete solution, including engineering, construction, operation and services, while individual companies also often act as subcontractors in large foreign projects. Japan is currently working on providing a complete nuclear solution to some Asian countries (including Vietnam), Middle Eastern locations (Jordan), Turkey and Central and Eastern Europe (Poland, Lithuania).

Advantages

- Extensive experience, good technology
- Strong national vendors that have partnerships with top foreign companies
- Strong support from the METI
- Reputation for industrial excellence
- Valuable experience from the Fukushima accident, including growing expertise in nuclear waste treatment

Weaknesses

- Internal competition: three national vendors competing against each other when competing for foreign contracts
- Greatly damaged public opinion of nuclear

7.1.5 RUSSIA

Russia is a pioneer in the civil nuclear industry and was the first country to produce nuclear power. Russia's nuclear industry is part of its national history and the continued development of nuclear power is a strategic goal for the country. High scientific standards and a unique offer package are Russia's biggest assets in its quest for industry leadership. Russia perceives itself as a world leader in fast neutron reactor technology and continues to pursue significant innovation in the field. It has one of the world's largest pools of universities and scientists with nuclear expertise.

Rosatom oversees Russia's nuclear industry. It comprises more than 250 enterprises and scientific entities, including all civil nuclear companies of Russia, nuclear weapons complex facilities, research organizations and the world's only nuclear-propelled fleet. Rosatom is the only vendor in the world able to offer the nuclear industry's entire range of products and services.

Having said that, most stakeholders of the Russian nuclear industry agree that their nuclear technology offers little that is not already available on the international market. Russian vendors instead try to create a point of difference through offering additional products and services. However, Rosatom anticipates orders for up to 80 reactors, with demand coming mostly from developing countries. In line with this, the corporation has announced plans to train about 60,000 foreign specialists by 2030 to work on these new plants.

Given all the above, Russia still has difficulties to contend with, given its current business culture and political history. Corruption has been a serious issue, although the past decade has seen substantial efforts to address this. The lack of transparency within the nuclear industry is also problematic, making it difficult for buyers to access the right people and companies.

Russian manufacturers work mostly with older equipment and processes they have inherited from Soviet times. Unfortunately, even though much has been done to modernize the industry, investments are still required in order to improve the manufacturing efficiency of Russian producers.

Advantages

- High safety standards and reliable technology
- Only vendor to offer the entire industry's products and services

Weaknesses

- Less efficient manufacturing than that of Western competitors
- Opaque environment
- Unclear line of products

- Innovation capacity and collaboration with universities
- Original financing solutions
- Excellent waste management expertise
- Full government involvement

- A one-generation gap in the country's human resources, coupled with a generally unfavourable age structure

7.1.6 THE REPUBLIC OF KOREA

Korea's reputation makes it known as a strong competitor in the world's nuclear market, although recent scandals have somewhat tarnished this image. Korea's nuclear product is universally respected. This is enhanced by the country's nearly flawless record (recently tarnished by the fraudulent certification scandal) in construction and operation and a strong national commitment to building its nuclear offering.

Korea's nuclear fleet is relatively new and is composed mainly of modern pressurized light water reactors, its flagship being the APR1400. The government has also ramped up campaigns aimed at ensuring the public's awareness of Korea's continued commitment to developing nuclear energy. Plans are under way to build another 10 nuclear plants by 2030, in addition to the seven already under construction. The increased domestic demand has allowed Korean nuclear vendors to defy international nuclear trends and maintain high levels of production.

While Korea's participation in the nuclear industry was previously limited mostly to supplying components, Korean companies are steadily gaining experience in design. Recent projects include those with American designed reactors (six with Westinghouse), Canadian plants (four using CANDU reactors) and French plants (two Framatome reactors).[6] In the 1980s, Korea began the transfer of foreign technology that enabled it to establish its own domestic industry. The focus now is on generation III technology design, fully indigenous and independent of the constraints of Westinghouse's license.

The Republic of Korea's progression from a supplier to an exporter of complete nuclear solutions is driven by its technically well-structured supply chain and the coordination of foreign bids by KEPCO (Korea Electric Power Corporation). However, the commercial skillset inside the KEPCO organisation seems to be weak in understanding of the commercial relations required to maximise the outturn deliverable costs of bids and maximise the commercial returns for Korea, Inc.

Korea has potential for improvement in the fields of financial support and developing an adequate network of subcontractors. For example, there is no sizeable international bank that is able to secure the substantial funds for costly nuclear projects. Competitor vendors source upwards of 70% of their

[6] Nuclear Power in South Korea, World Nuclear Association, www.world-nuclear.org, February 2012.

workforce from local subcontractors. Finally, Korea has to keep up its efforts in training human resources in order to satisfy the current needs of domestic and international projects.

Advantages

- The UAE deal makes Korea the first newcomer to beat the incumbents: becoming an important global nuclear player, able to export its know-how
- Nuclear history built on successful transfer and integration of technology
- Highly structured marketing and commercial approach, mirrored across all the fields where it wants to achieve success
- Consolidated approach within a well-coordinated consortium
- Experience on the domestic market, several units under construction

Weaknesses

- Capacity of the Korean nuclear industry may need to expand to meet export goals
- May not have enough human resources and an adequate network of subcontractors
- Geopolitical power and commercial groups not aligned.
- No Korean international banks involved in bidding for contracts
- No experience in building a nuclear plant abroad (UAE commercial success still has to be proven as an industrial success)

7.1.7 UNITED STATES

The United States has built and operated the largest nuclear fleet in the world, currently totalling 104 units with more than 100GW of installed capacity. While the US nuclear industry is also building, its pace is slower, with key vendors focused on executing a sound commercial strategy that will increase market presence and participation.

The last US nuclear facility to commence commercial operations was the Watts Bar Unit 1 plant in Tennessee, in 1996. In 2005, the introduction of The Energy Policy Act saw a boost to the nuclear industry through loan guarantees, tax breaks and increased funding for research and development. The act, along with other policy decisions, helped revive the dormant domestic nuclear industry, and today American vendors are gearing up for several new large projects. In 2012, the granting of licenses for four new Westinghouse units represents the first new nuclear construction in the US industry since 1978.

When bidding for larger contracts, the US nuclear industry turns to a new action plan that aims to increase its competitiveness against countries such as France and Russia. This plan focuses on a strategic, methodical and coordinated approach, with an emphasis on strong communication. The plan is backed by the recently established Nuclear Trade Advisory Centre and the appointment of a White House-based Director of Nuclear Energy Policy who ensures national alignment of action and priorities. The American nuclear industry also benefits from the US' network of embassies that play a key role in the country's commercial operations around the world.

US companies are better than many of their competitors at localizing the production of nuclear plants in the client country. US-based firms also have a strong and valuable track record of partnering with other international firms to construct and provide support services for numerous global projects.