



The Establishment of the UK-China Nuclear Partnership

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1. Executive Summary

The Nuclear Industry Association (NIA) expressed its interest to support the expansion of the UK supply chain in the Chinese nuclear power market.

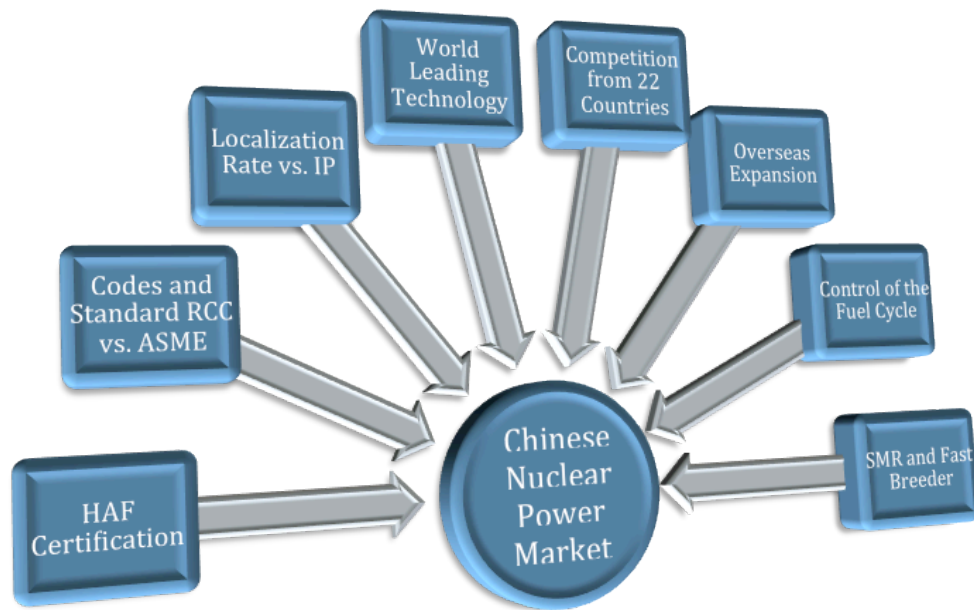
This proactive plan from Dynatom International GmbH (DI) aims to demonstrate the opportunities in the Chinese market and to institute a profitable and long-term business for the UK nuclear industry within the Chinese nuclear projects.

- The meaning of profitable business must be seen from a Chinese perspective (15-40% margin). Chinese buyers understand the pricing and the level of the competition in their market and will use any negotiating tool available to lower the expectations of their foreign supplier.
- The meaning of long-term must be divided in two parts: the phase 2014-2020, and the phase 2020-2030.
 - Up to 2020, the country will build a preponderance of Nuclear Power Plants of Generation 2+, some Generation 3, SMR; the Chinese holdings go global to test the market and export their latest technology based on 1000 Mwe, including in the UK.
 - From 2020-2030, the country will build 100 NPP of Generation 3, launch several projects of Generation IV, and establish the Chinese nuclear industry as a global leader.

In this proposal, Dynatom International GmbH (DI) will show its global vision of the Chinese market and the elements of research to be used for the report on the opportunities for UK industry to supply directly to utilities and OEM's or partner with Chinese companies in order to adapt their technology and market their products through China's nuclear supply chain.

We realize the Chinese nuclear market is influenced by other several business cultures, from France, USA, Russia and Canada.

The UK business has the opportunity, with our team, to participate to the overall Chinese nuclear industry.



What can we learn from this chart?

These eight forces in the Chinese market represent barriers and opportunities, depending how UK is prepared to face the competition and market needs. Each force must be matched, for example by an adjustment from the UK industry, or a focal point on one segment of the market, such as the reprocessing, decommissioning, waste management, or new type of fuel (Thorium).

These forces represents the new needs that China will need to fulfill with new partners from Europe and North America. The market is not closed because nobody can match these forces altogether.

2. Foreign Enterprises face new blockages

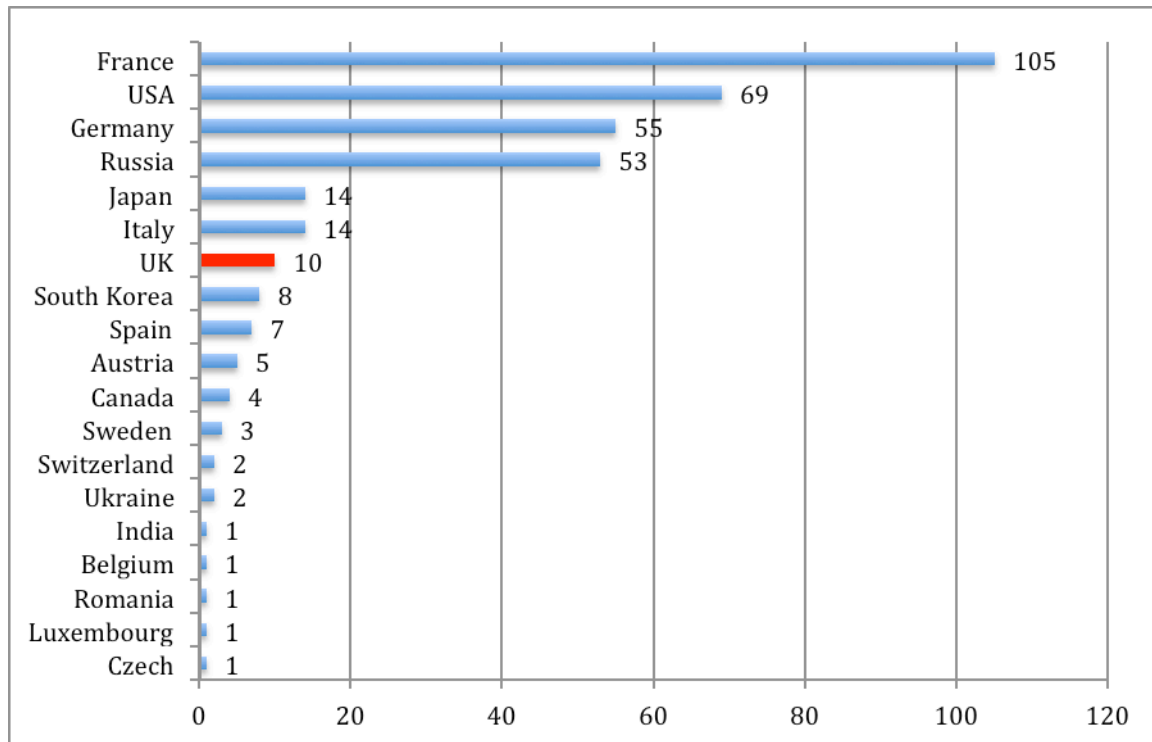
a. The HAF 604 barrier and its impact in the tenders

Foreign entrants in the market must obtain the HAF 604 certification to sign commercial agreement for safety related equipment. At the same time, new entrants without purchase orders cannot get this certification.

- Until 2013, 202 foreign enterprises, from 20 countries, provide 356 type of safety related equipment. As for the non-safety equipment, the market is closed to foreign entities.
- Most bidding include a maximum of three foreign companies.
- During the tenders, local competitors already challenge class 1 equipment; class 2 and 3 equipment is progressively awarded to state owned enterprises or Chinese champions

close to the government.

Below: List of HAF 604 awarded to foreign companies up to April 2012; the new batch of HAF 604 will be released in November 2013.



What can we learn from this chart?

The nuclear power market in China is designed like a pyramid: The top of the pyramid is the leading technology to be transferred; the core and bottom are the supply chain and related services.

- The French companies lead the amount of equipment delivered because Areva sold/transferred a leading technology (EPR).
- The American reach the second place thanks to Westinghouse technology with its AP1000.
- The German industry benefit from the commercial orders of Areva Germany.
- The Russian just obtained a large number of HAF thanks to the construction of the VVER in Tianwan. This project in Tianwan is the result of the future sells of the fast reactor technology BN800, and the floating reactor from Russia to China.

Conclusion: In order to participate to the supply chain in China, UK must become a technological leader in a specific field, such as Fuel reprocessing, Thorium fuel, small reactor, or participate to the ACP1000 project with CNNC.

Download the Dynatom dedicated on the HAF 604 in DI website.

b. Second challenge, the condition of the listing at the EPC

Foreign companies that obtain the HAF 604 (or HAF 601 if the foreign entity decide to

localize in China) must proceed to the supplier listing with the EPC:

1. CNPE (CNNC Group)
 2. CNPEC (CGNPC Group)
 3. SNPEC (SNPTC Group)
- Three departments review the application before approval:
 1. Design/ Engineering
 2. Procurement
 3. Commercial
 - This registration takes three to six months, according to the added value of the equipment.

c. Government Policy and impact on localization rate

The supply chain for all new projects in China is redefined by the procurement department of the EPC according to the National Energy Administration policy: To provide top notch nuclear power plants with a growing rate of localization, technology transfer and control of the price for imported equipment.

- Rosatom is the last company that was awarded a turnkey project in China, (VVER Tianwan 3 and 4). Jiangsu Nuclear Power Company (JNPC) and China Nuclear Power Engineering (CNPE) procured a large part of the equipment.
- Foreign suppliers that used to sell directly to Areva (France), Westinghouse (USA) and Rosatom (Russia) face deeper requirement to localize or transfer their manufacturing and design capabilities in the bidding process. For example: the DCS of Areva will be transferred to CNCS (China Nuclear Control System) for Fuqing 5/6; the DCS of Lockheed Martin is localized with SNPAS (State Nuclear Power Automation System) for the new AP1000.
- Key projects such as CAP1400 and ACP1000 increase the localization rate in order to support the globalization of the Chinese companies, (KSB for the RCP of the CAP1400, Shangshang Cable for the ACP1000 in Karachi,).

d. New entrants meet new challenges

(i) The French Nuclear Industry is still the largest partner

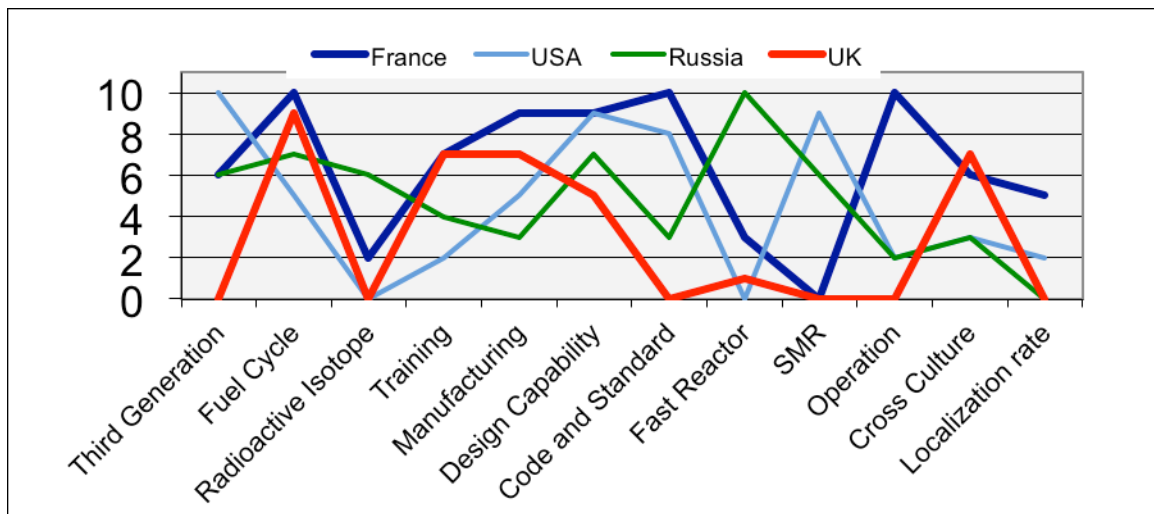
The French nuclear industry regularly educated the EPC, the Safety Authority and several utilities since 1994. The Chinese industry uses the RCC-M and RCC-E codes for design and manufacturing of mechanical and electrical equipment.

- The first two projects in China, Daya Bay and Qinshan 1 shaped the actual leaders of all the nuclear power plants. They keep a strong relation with the French utility EDF and the engineering company Areva.
- Relation with the Safety authority: guidelines must be respected and influenced by EDF culture.

- Other foreign competitors are involved in a specific project, not committed to the development of the Chinese nuclear market.
- North American companies are cut from half of the market due to the lack of knowledge of the French code used in the ACP1000, EPR, and CPR1000. The AP1000 and CAP1400 are being more Europeanized, (we noticed that NIA will organize the RCC-M Fundamentals course for Nuclear Equipment Manufacturers in the mid of November).

Ex: for the new AP1000 and CAP1400, the SNERDI will use European standards for the electric cable. For all NPP of CGNPC, American cables are banned from the tenders.

Ex: Andritz (Austria) and KSB (Germany) joint respectively Haerbin Pump and Shanghai Electric to design and manufacture the RCP for the next AP1000 and CAP1400



What can we learn from this chart?

This assessment is based on the presence of foreign companies in China. It is not based on the actual know-how / capabilities in the home country. The assessment reflects the needs of the Chinese market and how each major country answers to the necessities.

(ii) The Small and Medium Size Enterprise are not insistent

The SME, which supplied their products to companies such as Areva, AECL, Rosatom, and Westinghouse, face a market with intense domestic and international competition.

- The lack of reactivity from new entrants is rapidly the cause of failure.
- New entrants do not include in their strategy the Chinese globalization plan: (South Africa, Turkey, Argentina, UK, Pakistan). They just focus on the Chinese mainland market.

(iii) Cross Cultural issue

The new entrants have no clue of the local culture, and still believe their foreign technology is ahead of the local competition (counter ex: the EPR in Taishan is being built faster than in

Flamanville and Olkiluoto, EDF and Areva are learning from the Chinese regarding the integration of their supply chain and construction process).

- Lack of Chinese representation: more international tenders are in Chinese. Ex the DCS for Fuqing 5/6, influenced by Areva's Chinese team, and recently the valve bidding for the new AP1000 in Xudapu.
- The Chinese companies commonly criticize the professorial behavior of foreign enterprises.

(iv) The lack of financial strength and lower margin

The lack of financial support from the EXIM banks for new projects in China is a major problem for the foreign SME: they cannot grow and adapt to the demand in this market: in contrary, the State Owned Enterprises (SOE) get strong support from local and national banks. The UK Export Finance (Export Credits Guarantee Department) should be involved at each level of the manufacturing process of the nuclear market in China.

- Net revenue is reduced: The Government directives are to build safe but cheaper nuclear power plants. The main target is to redesign the business of building and operating nuclear power plants. More Joint Venture and Partnerships are compulsory to decrease the cost. Biddings that deal with a package for 2-4 plants are recurrent.
- In term of revenue and sales margin, only the leading company that masters a specific technology (for example pump speed sensor for AP1000 RCP) can charge a premium with 40% margin. In average, during the tenders, the margin is around 15%.

Conclusion: This is a strategic market, highly competitive. Chinese EPC and other SOE know the market, the value of the manufacturing and design. A sustainable profitability in China cannot be compared to the UK market: expect 15% at most. Only the leader can charge the end user at premium price with a margin of 40%, such as Sellafield for the reprocessing, or Weir for Turbine bypass valve. This estimation is based on 6 years of experience in bidding process in the Chinese nuclear industry.

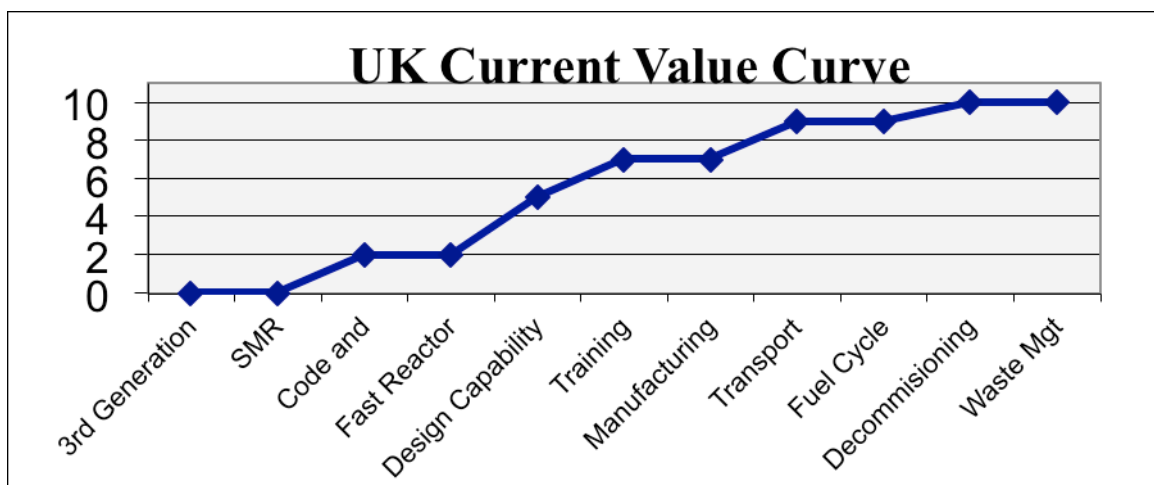
3. UK enterprises confront several concerns

UK does not offer at the moment a leading technological project in China: Since the completion of Daya Bay, most of the UK companies withdrew their interest from China and were not associated with the development of the Chinese market (except companies such as International Nuclear Services, Weir Valves and Controls, Clyde Union Pump, Sheffield Forgemasters, Ovivo Water...). The EPC consider the UK as fresh contenders in this new nuclear power market.

- Limited knowledge of the French standard; that means the UK companies will face difficulties to enter in CGNPC projects, which represents 50% of the opportunities.
- Lack of eagerness and reactivity: interest for India, Turkey and Czech programs, but limited in China. (With the support of the China Britain Business Council, our team proposed in 2010 to introduce the Chinese market to NIA in England. The focus on that

time was Jordan projects and there was no follow up).

- Lack of support from large groups, such as Rolls Royce, contrary to EDF, Areva and Alstom.
- Inexistence of a dedicated lobbying group to the Chinese market, such as the PFCE (France) or the SNG (Spain).
 - a. <http://www.pfce-online.com/>
 - b. <http://www.sngc.es/en/>
- No communication on UK know-how with the EPC, utilities and other SOE, except the few companies that obtained the HAF 604.
- Time zone is 7 to 8 hours of difference, which impacts the need of communication between both countries.



What can we learn from this chart?

This chart shows how the Chinese perceive the UK’s technology and potential support. The UK industry is well known in China through Sellafield site and NDA program.

4. Opportunities in the Chinese market

a. Remodeling of the key players

The Chinese government used to separate the market between three nuclear operators (China Power Investment, China National Nuclear Corporation, China General Nuclear Power Company). Right now the market is being distributed between three holdings, CGNPC, CNNC and SNPTC. CPI still remains operator. SNPTC becomes the main designer and procurement center for the AP1000 nuclear island. CGNPC keeps the ACPR1000 design, and CNNC the ACP1000 design.

- The head of procurement department change every three to five years, with their management, which damages the relation with the original supplier and create new

opportunities for proactive entrants.

- Due to the speed of the market, many new entrants are promoted faster. Your relation with key people in the procurement department may vanish from one year to another. Keeping a constant relation with the department is a key factor of success.

b. International ambitions

UK must create series of leading technological projects, for national and international expansion, ex. The UK is working with CNNC on Decommissioning with the strong support of NDA.

- SNPTC, CNNC and CGNPC expand overseas and need International partnership (ex: CAP1400 in Brazil, ACP1000 in Argentina).
- UK has already a strong experience in project finance and management.
- The UK Technology Strategy Board (TSB) maintains a nuclear industry strategy to foster development of nuclear manufacturing capability in the UK, and can support Chinese expansion within Europe and overseas.
- China has a poor image of quality in overseas markets; UK keeps a good reputation, and understands cross-cultural issues.
- The Chinese quality is still untrusted and not competitive globally; a match making with the UK industry for the global market will lift its brand and technology.
- China face visa issues almost everywhere, UK has just released a specific program that can ease Chinese business to work with UK companies.

c. Creating national champions

China aims to become one of the leaders of the nuclear power market, in term of research, operation, design and manufacture, which means long-term support.

- Partnership with local companies for equipment of Class 2 and 3 will contribute to the localization policy and opens a larger market.
- After 2020, China will be able to produce and export equipment for the following reactors: Atmea (or ACE type), EPR, AP1000, CAP1400, and the small reactors HTR and ACP. The equipment will be duly tested and improved in the domestic market during the next six years. UK's involvement during the first phase of the design and manufacturing can influence the expansion of the Chinese nuclear during the second phase (2020-2030).

Read our article "Made in China" in Nuclear Engineering International

d. The education market is burgeoning

The ongoing training for NPP does not exist yet. The operators will hire large number of technicians with none or small experience in nuclear power plants. The training must be taken into account from the beginning of studies at the universities in order to catch the speed of the market expansion.

- Lack of training for nuclear power plant operation in universities: Need is greater than resource.
- Lack of leadership for the executives.
- Lack of safety culture.
- The Nuclear Advanced Manufacturing Research Centre (AMRC) at Sheffield University does not have its counterpart in China.

e. The waste management and reprocessing business is not born yet

The Fukushima accident raised the issue of the fuel storage from all the new NPP in China. China has only 17 NPP in operation and has no experience in waste management.

- The Beishan repository just started to be built.
- The EPC do not have design capabilities for large Cask/ Flask (100 tons), only Holtec, Ensa and Areva are the contenders, the local EPC lose each tender.
- UK can provide a technology to reprocess the fuel from PWR in Sellafield.

f. Nuclear Medicine

China partners with different countries but cannot provide enough radioactive elements for its hospitals. Only Canada and Russia cooperate in this area with Qinshan III and CIAE.

- The training in radiation protection is inexistent in hospitals.
- Manufacturing of Dosimeters for the civil nuclear and hospitals.

g. CGNPC

- CGNPC has a long history with the Areva and EDF, but the French cannot cover all the needs of the holding. Ex: Ovivo (UK) supplies water treatment systems for Daya Bay.
- CGNPC needs support in the fuel cycle, such as design and manufacture of line of production of nuclear fuel.
- CGNPC wants to export its ACPR1000 and remains constraint to Areva's IP of the M310 reactor.
- CGNPC wants to create a manufacturing for BORON and avoid the monopoly of US firms.

h. CNNC

- CNNC covers all the nuclear power market and its EPC, CNPE has good relation with the UK industry. The partnership with overseas nuclear groups is right now the strategy of CNNC.
- Before 2020, CNNC will create a strong supply chain that can be trusted overseas (Ex. IOM, the subsidiary of Invensys, is black listed from future domestic and international projects).
- CNNC needs support in operation management, maintenance, tooling and logistic for its subsidiary CNPO (AMRC could partner with CNPO).

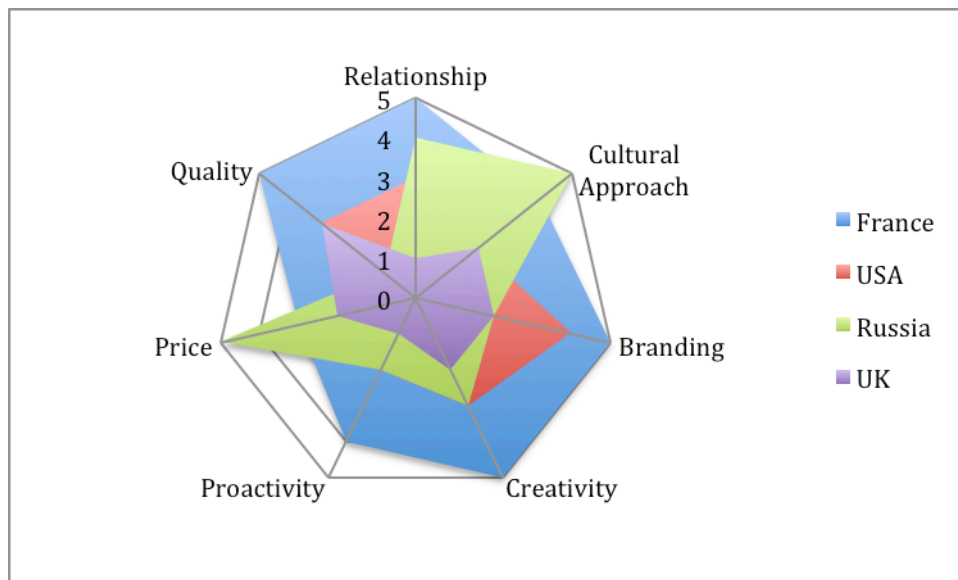
i. SNPTC

- Westinghouse signed a strategic partnership with SNPTC. However, several US companies frustrate SNERDI and SNPEC (Ex. EMD for the RCP, Lockheed Martin for the DCS). SNPTC is the key player for the international market and needs to expand its partnership and need to increase the localization rate.
- SNPTC is looking to acquire mines of uranium, and needs to create an expert team for overseas prospection.
- SNPTC wants to launch its own small modular reactor (a first MOU was signed with Westinghouse).
- Note: Sheffield Forgemasters is a subcontractor of Curtiss-Wright Flow Control for the AP1000 in Sanmen NPP and has orders for ten others reactors in China.

5. Recommendations

DI will provide a list of recommendation to fill the gaps in the UK supply chain. These recommendations will be the results of our research. We remind some elements of our research below:

- How to fill the gap between the RCCM / RCCE codes with the UK code** for design and manufacturing (support from our partner Bureau Veritas and consultant from EDF). Many UK companies will be entirely integrated in the Chinese market.
- Rebranding the UK Industry and expertise in China** using Dynatom platform and specific events with the China Nuclear Energy Association and Chinese Nuclear Society.



What can we learn from this chart?

DI unique approach in the Chinese market is to provide top-notch equipment, service and technology from all over the world. Based on our experience in the sales since 2007, we have

determined seven aspects of the behavior of foreign companies in China.

The UK industry is considered as reliable, but most of it unknown from the EPC (only 10 companies have HAF 604 against 53 for Russia), and relation is fresh between both countries. However the branding and creativity of UK enterprises is not admitted by the industry. These aspects are mostly due to the poor communication of UK in the Chinese nuclear power industry.

Recently the US government organized a trade mission with all the major holdings in China. The Spanish Nuclear Group participates in the CGN Nuclear Equipment Cooperating Innovation Society – CNECIS meeting, and organizes several visits in China and Spain. The French have been doing exactly the same with their lobbying group PFCE for more than ten years, and the Russian have specific relations with the Chinese since their strong involvement in fuel enrichment, radio isotope production, transfer of technology for the fast reactor (CEFR), and many other aspects.

Download Dynatom dedicated to the Russian technology on DI website

- c. **UK will find a technological lead**, it does not need to be as strong as what France, USA and Russia have done. **Ex:** Alstom (France) and MTU (Germany) are the world leaders in the Emergency Diesel Generator. As technological leaders, they bring most of their suppliers for each EDG built in China.
- d. **UK must create a consortium of companies** around a specific technological project that hunt altogether based on the French PFCE/ Spanish SNGC strategy: the more companies hunt together, the more the Chinese will expand their needs: each project will federate a group of suppliers.

Ex: Michel Monnier, the head of Velan for the Chinese market, is the VP of the PFCE group (French China Electricity Partnership/ Partenariat France Chine Electricité); during his meetings in the name of PFCE he generally introduced technology from other members to match the needs of his interlocutors.
- e. **UK will involve its entire industry, safety authority, universities, technical school and government body** in each niche market of the Chinese industry defined by DI. As for example: The French Government involved each entity of the French nuclear to educate the Chinese since 1984. UK could create an entity similar to the IFCEN project, or the US-China Center of Excellence.
- f. **UK will focus on the reprocessing technology** for the used fuel of the PWR; this technology is a leading project for the Chinese government.

6. Methodology to be used to create the UK-China Consortium.

- To meet the NIA and discuss in detail the existing competition in China and needs from the market.
- To split our offer per type of segment (new builds, decommissioning, engineering, fuel cycle, transport...)
- To meet each corresponding company in China that is considered either as a “champion” or a “preferred vendor” by the EPC but needs international support.
- To gather with each EPC and related subsidiaries and conduct interview with sales

presentation of the UK contenders (ex: the procurement of CNPE has several department, each of them deal with different type of equipment).

- To crosscheck trends, opportunities between different markets.
- To create a specific leading technological project per type of market for a Chinese-UK consortium.

7. Human resource involved

DI involves two teams, In China; the team will conduct the survey, face-to-face meetings and research. In Europe, the second team will keep close relation with NIA member, conduct interview, proceed to the writing of the marketing research, and coordination with NIA.

a. In China

- Liu Yang: CEO of DI, specialized in instrumentation and control for French companies and fuel cycle for British and Belgian Companies.
- Zhao Bo: Project manager, specialized in sales, involved in successful sales for Sanmen and Haiyang projects for US companies.
- Chen Wenhua: Project manager, former operator in Qinshan II, specialized in instrumentation and control for UK and US companies and sourcing for Chinese EPC.
- Elaine Li: Project manager, specialized in the HAF certification and relation with the safety authority.
- Qi Jia: marketing assistant, specialized in daily research of domestic information and editor of the Dynatom Magazine.

b. Overseas

- Arnaud Lefevre: Founder of DI, head of the international business and relation with government bodies, will conduct the interview of NIA members and writing of the report.
- Frederic Mouen: Founder of DI and Chief Technological Officer, will assess the technology of each NIA member and advise the Chinese team for business strategy.

8. Our unrivalled advantages

Dynabond Powertech Service is the leading sales and consulting company in China. Our approach is based on sales of equipment and services directly to the end user.

We focus our business at two levels: the engineering level that reviews the technology; the management level, or “best buyer” which approves the sales of equipment.

Our strategy is based on direct meeting, intense lobbying and creation of leading technological projects with CGNPC, CNNC and SNPTC.

Our main business in Beijing offers these unmatched advantages:

- The National Energy Administration, the Ministry of Environment Protection, the National Development and Reform Commission and the Ministry of Science and Technology select all decisions related to nuclear power in Beijing.
- We deal directly in the headquarters of CNNC, SNPTC and the CGNPC Beijing branch.
- We meet regularly the Safety Authority, and we are the leader of the HAF 604 registration.
- We cooperate with EDF Asia and ASME headquarters on standards and codes and their impact with the safety authority.
- We keep constant communication with the UKTI at the British Embassy.

DI provides service for countries around the world; we do not contain ourselves in the North American market or French Market. We deal with everybody thanks to our multicultural approach.

Our new international base, located in Fribourg, Switzerland strengthens the communication between foreign clients and China, and further support for Chinese companies that aim to grow overseas.

9. Our relation with the UK Nuclear Industry

2009: first meetings with International Nuclear Services (INS) in Beijing.

2010: Representation of INS.

2010: First discussions with NIA regarding the Chinese market

2011: Technical meetings organized in Sellafield for CNPE and other subsidiaries of CNNC.

2012: Regular meetings with the FCO in Beijing on the Chinese nuclear market

2013: Signature of a MOU between NDA-INS and CNPE in Beijing.

10. Deliverable and Commercial offer for the marketing research

- DI will create business opportunities based on the Leading Technology Project during the research (Ex. Fuel reprocessing, Equipment manufacturing, overseas NPP projects of CNNC ...).
- DI will review and report with our existing surveillance tool on existing Chinese information on key industry players, key projects and identified gaps and opportunities in China's nuclear supply chain.
- DI will conduct face to face meetings with key industry players to determine supply chain gaps/opportunities, including causes, and suggest how UK suppliers with extensive nuclear supply experience could best position themselves for Chinese nuclear market, including the international expansion.
- DI will produce a final report on the opportunities for UK industry to supply directly to utilities and OEM's or partner with Chinese companies in order to adapt their technology and market their products through China's nuclear supply chain.

- The following offer will be discussed in detail with NIA and the cost associated to the project. DI suggests using the same model as for PFCE, a annual membership fee to keep a permanent marketing presence in China.