ENTERING CHINA: STRATEGIC ANALYSIS OF THE TELECOMMUNICATIONS BACKUP POWER MARKET

by

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ABSTRACT

The telecommunications backup power market is an attractive early-revenue opportunity for fuel cell technology. Fuel cells offer numerous advantages over batteries and diesel generators in distributed telecom applications where extended backup time duration is required. China is an attractive geographic segment within this market, given it is home to the world’s largest telecom industry and has one of the fastest network infrastructure expansion rates. For Ballard to capitalize on this opportunity, it needs to develop an entry strategy that addresses specific marketing and commercialization challenges pertaining to this segment. This report provides a background on telecom backup power, an overview of doing business in China, an analysis of the telecommunications power market in China, as well as an assessment of Ballard’s challenges and key success factors. It also provides recommendations for a partnership strategy, including a selection criteria matrix and options overview, which may help Ballard succeed in this market.
EXECUTIVE SUMMARY

The telecommunications backup power market is considered by many to be an attractive early-adoption market for fuel cell technology. Fuel cells offer a number of advantages over incumbent value-regulated lead acid (VRLA) batteries and diesel generators for backup power applications in distributed network base-stations and telecom exchanges, such as extended runtime capability, reduced maintenance requirements, and reduced total cost of ownership. Given the size and rapid growth of the telecommunications industry in China, the rapid expansion of its wireless network infrastructure into rural areas, and the upcoming deployment of 3G networks, the Chinese market segment could be a major market opportunity for Ballard Power Systems.

Entering the China market represents a major challenge for many foreign companies due to the obstacles inherent with China's unique business cultural characteristics, direct government interventions, intellectual property protection issues, in addition to other marketing factors. Success in doing business in China requires a balanced combination of relationship building, commercial and political connections, giving and taking of favours, and patience. A China entry requires strong corporate commitment and resources over a reasonable time period, and Ballard needs to trade-off the market potential and opportunity cost of China against its other activities.

The telecommunication industry in China is a state-owned oligopoly with four major telecom operators, two in wireless and two in wireline, and two smaller operators. It is governed by the Ministry of Information Industry, and is home to the world's largest mobile subscriber base with more than 500 million users. The power system industry that supplies distributed power equipment to end-users and network infrastructure developers is highly fragmented, with sales led by multi-national companies that include Emerson Network Power, Tyco Electronics,
and Delta Electronics. The major domestic companies include ZTE, Beijing Dynamic Power, and Wuhan Putian Telecom Equipment, the latter of whom owns its own VRLA battery production facility. Backup VRLA battery supply is provided by a number of OEM suppliers, including China Shoto, Wuhan Intepower, Guangyu Coslight, Nandu, and Pearl River. These companies market and sell batteries directly to end users, as well as to power system suppliers who bundle the batteries together to provide complete turn-key telecom power solutions. There is currently no focused fuel cell developer in China who is directly pursuing the telecom backup power market, but a number of the foreign fuel cell firms are known to be interested in entering the Chinese market through partnering with market intermediaries in China.

The global backup power market for telecommunications is estimated to be $2.3 billion per year. The China telecom infrastructure expenditure accounts for about 23.5% of the global spending. Assuming an equal proportion of telecom infrastructure and backup power spending, the Chinese backup power market alone may be worth in excess of $540 million. With a compound annual growth rate of 19.4%, the Chinese market is growing faster than most other emerging economies and well above all developed countries. The addressable market for fuel cell technologies is difficult to estimate during this introductory phase, and will ultimately depend on the rate of market adoption and ability to overcome key entry barriers that include high initial cost, hydrogen distribution issues, competitive challenges from alternative technologies, and the ability to influence end users. Currently, alternative energy solutions own less than 10% of the telecom backup power market that is dominated by VRLA batteries.

Under the present and anticipated future challenges, the key success factors for Ballard as it seeks to enter Chinese telecom backup power market include reducing technology cost, supporting product integration, helping end users address hydrogen distribution issues, and identifying a partner with established channels-to-market and close end-user relationships in China. The latter is especially important for Ballard given its lack of marketing presence.
overseas and limited understanding of the local business relationships. The ideal lead customer/partner should have strong technical capabilities in power systems integration, including knowledge in HVAC and product design for telecom cabinets and enclosures; as well as strong marketing capabilities and management support to make fuel cell solutions a commercial success.

Ballard has a number of options to enter this market, including 1) working with a foreign fuel cell system integrator to access China indirectly through its partner’s market intermediaries, 2) establishing a partnership with a telecom battery / power equipment developer in China, or 3) establishing a partnership with a telecom power systems developer in China or overseas who has access to the Chinese market through one of its subsidiary. Given the oligopolistic nature of the Chinese telecom industry, this project recommends Ballard to seek partnership opportunities with power systems developers in China who are far up the value chain and have substantial influence on the selection of telecom power system architecture. Ultimately, a lead partner strategy would be largely influenced by the target customer’s level of interest in fuel cells and its product strategy (make, buy, or collaborate) on future backup power technologies. Further investigation with the key market players is required in order to understand these issues.

In addition to a partnership strategy, Ballard should also seek opportunities to drive demand for fuel cell products by attempting to persuade end users and telecom equipment suppliers to engage in field trial demonstrations with one of its current or potential system integration customers. At this early commercialization stage, success requires a multi-prong approach where Ballard is involved in driving positive influence in all layers of the value chain.
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1 INTRODUCTION

1.1 Situation Overview

Fuel cell technology has been considered to be a viable alternative solution for many small stationary power applications where the incumbent technologies have fallen short in delivering clean, reliable continuous power. By the nature of their operations, fuel cells are emission-free and provide superior energy conversion efficiency and durability in comparison to other power generation devices such as combustion engines and batteries. A number of companies have long recognized the potential of fuel cells and have invested millions of dollars over the past decade in product development and marketing efforts to bring this disruptive technology out of the laboratory and into the hands of customers. Although the high relative cost of fuel cells have limited most of the early-market demand to institutional and government buyers, recent advancements in cost reductions have started to open up new revenue opportunities in a number of emerging market segments where fuel cells can competitively compete today with little or no tax incentives or government subsidies. One of these market segments is the backup power market for distributed telecom network infrastructures, where fuel cells can be used to provide secondary power in event of power grid failure. Ballard Power Systems Inc., one of the largest players in the fuel cell industry, is currently actively pursuing business opportunities in this market segment, along with a number of other fuel cell system manufacturers.

1.2 About Ballard

1.2.1 History of Ballard

Ballard Power Systems is a recognized world leader in the design, development, and manufacturing of zero-emission proton exchange membrane (PEM) fuel cells. Ballard was
established in 1979 as a research and development company of high-energy lithium batteries and turned its focus to the development of PEM fuel cells in the 1983. Through the late 80’s and early 90’s, it had turn fuel cell concepts into numerous prototype systems to demonstrate the viability of the technology. Since then, Ballard had started to gear up for the forthcoming commercialization of fuel cells by working in close partnership with a number of the major companies including DaimlerChrysler, Ford Motor Company, GPU, Alstrom, and Ebara Corp, amongst others to the bring fuel cell products to market. A short list of Ballard’s major historical milestones includes:

1. 1993 – Demonstrated world’s first fuel cell zero-emission bus
2. 1994 – DaimlerChrysler demonstrated Ballard-power Necar 1
3. 1998 – BC Transit launched Ballard-powered fuel cell bus demonstration fleet
4. 1999 – Completed Plant 1, the world’s first fuel cell high volume manufacturing facility
5. 2000 – Introduced Mark 900 series fuel cell powered module for transportation applications
6. 2001 – Introduced Nexa, the world’s first commercially available fuel cell powered module
7. 2003 – Delivered heavy-duty fuel cell buses to DaimlerChrysler for the European Fuel Cell Car Project
8. 2004 – Ford unveiled first Ballard-powered Ford Focus; DaimlerChrysler launched Ballard-powered Fcell fleet

1.2.2 Evolution of Ballard’s Strategy

Ballard’s business strategy has significantly evolved over the past decade along with the changing market landscape of the fuel cell industry. As with other disruptive technologies, an accurate forecast of the early market demand and commercialization timeline can be difficult, requiring Ballard to adapt in a flexible manner. Back in the late 90’s, driven by the optimism of an imminent automotive fuel cell commercialization, Ballard made great strides to position itself as a complete fuel cell systems supplier. It completed a major acquisition deal in 2001 to acquire Xcellsis and EcoStar, the fuel cell engine and electric drive train businesses that it jointly owned
with its vehicular alliance partners DaimlerChrysler and Ford, in order to forward integrate into the value chain and work more closely with its potential customers. But over the next few years, as the timeline for automotive commercialization has been significantly delayed by external factors and technical readiness, the need to focus on more nearer-term markets was heightened in order to generate revenues to help fund technology advances in the long term. As a result, Ballard made a number of strategic changes once again in 2005, including the completion of a sale of its automotive fuel cell support systems business back to its vehicular alliance partners to sharpen its focus on its core competency of fuel cell stack design, development and production. Amongst other key benefits, this strategic repositioning greatly reduced the expense and risk of developing end-user products. It also brought a significant impact on the way Ballard does business – by focusing on fuel cell stack development and leaving systems integration to other fuel cell manufacturers, Ballard had opened up sales opportunities to a wider range of customers, including its former competitors.

1.2.3 Ballard's Current Strategy

Today, Ballard operates in three major market segments:

1. Power Generation: PEM fuel cell products for materials handling, backup power, and residential cogeneration markets
2. Automotive: PEM fuel cell products for vehicles

Based on the current conditions of the market, Ballard expects to be making commercial sales of its fuel cell products to the material handling and backup power segments beginning in 2007, with the residential cogeneration market lagging slightly behind. Commercialization of automotive fuel cells is not expected to take place until the 2014 time frame.

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1 Ballard, 2006
Ballard’s portfolio of fuel cell products includes a full line of differentiated solutions targeted towards each of its market segments. They include:

- **Mark902 fuel cell module** – a 85kW automotive fuel cell designed for integration into passenger vehicle applications

- **Mark9 SSL** – a scalable 4 to 21kW fuel cell based on Mk902 automotive technology primarily for the materials handling market

- **Mark1030** – a 1kW fuel cell for the residential cogeneration market, currently targeted towards Japanese customers

- **Mark1020 ACS** – a scalable 0.3 to 5kW product primarily for the backup power market

- **Nexa power module** – a 1kW fuel cell for stationary and portable applications, targeted primarily for research and academic institutes

*Source: Ballard Power Systems*
Ballard's primary product offering for the backup power market, the Mark1020 ACS, was just introduced in September 2006. Aside from major improvements in performance and cost over previous generation of designs, the Mark1020 ACS offers three key significant design elements – air cooling, self humidification, and ambient pressure operation. These three attributes combine to eliminate the need for an air compressor and heat rejection radiator, offering the potential to greatly reduce system parts count and cost. By offering a solution that significantly reduces the complexity of the fuel systems integration, Ballard hopes to be a major competitor in this market by becoming the preferred fuel cell stack supplier for current and emerging system integration customers.

**1.2.4 Why Target China**

The telecom industry is one of the top users of backup power systems due to their need for uninterrupted service during power outages. So far, most of the fuel cell market development activities have been focused in the North American and European markets. The Chinese market, a potentially significant market and home to the world's largest telecommunications industry, has largely been unexploited. The network infrastructure in China is relatively immature in comparison to North America and Europe, especially in the rural areas. Chinese telecom operators are facing tremendous growth in new network subscribers and are expected to spend more capital expenditures on network infrastructure expansion than any other parts of the world. As a result, the Chinese market appears to an attractive geographic segment for telecom backup power solutions.
1.2.5 Ballard in China

Ballard has been actively working with Chinese government officials in the past few years to identify opportunities to bring fuel cells to China. In September 2005, Chinese President Hu Jintau along with his delegation made an unprecedented visit to Ballard as part of the ongoing activities to explore possible areas of cooperation. Later that year, Ballard, along with its alliance partner DaimlerChrysler, announced the delivery of three Mercedes-Benz Citaro fuel cell buses to Beijing as part of a two-year demonstration project led by the Chinese Ministry of Science & Technology (MOST). As a result of the President’s high profile visit and publicity surrounding the fuel cell buses, Ballard has become a well-recognized leader within the Chinese fuel cell community. In July 2006, Ballard made further progress in China by entering into a memorandum of understanding and fuel cell supply agreement with Shanghai Fuel Cell Vehicle Powertrain Co. Ltd. to cooperate on the development of fuel cell vehicles for demonstration and field trial programs planned in China in 2006 and 2007. The relationships and credibility that Ballard has built at the various levels of the government and with members of the fuel cell industry through its automotive activities could play a positive role should Ballard decide to pursue the telecom backup power market.

1.3 Fuel Cells in China

The maturity of fuel cell technology in China is generally lagging behind other leading countries including US, Canada, and Japan. However, this gap is expected to close over the years as the country increases its investment in research and technology development. Most of the funding today has been driven by government-initiated programs with little investment coming from private equity. Fuel cells are high on the government’s agenda as they are considered to be a possible solution to China’s growing air pollution and energy security issues. China has 16 of the world’s 20 most polluted cities. At least 400,000 deaths per year are attributed to air pollution
related illnesses according to the World Bank\(^2\). And as the country industrializes, energy demands will continue to skyrocket. Experts have forecasted that China will require as much imported oil as the US by 2030\(^3\). Most of the national programs that were initiated to demonstrate feasibility and to stimulate early commercialization have been focused in the transportation sector where fuel cells are expected to make the biggest difference in addressing the nation’s problems. The largest of such programs is the 863 program initiated by MOST that began back in 1986. According to the latest Five Year Plan that was rolled out in 2006, MOST is expected to invest about RMB 4 million (US$480 million) in fuel cell and fuel cell vehicle research\(^4\). Aside from MOST, the National Development and Reform Committee (NRDC), the National Natural Science Foundation of China (NSFC), and the Chinese Academy of Science (CAS), along with municipal governments in both Beijing and Shanghai, are expected to continue to provide funding to various fuel cell development activities. In addition, industry associations such as the China Association for Hydrogen Energy and the China Industry Association of Power Sources have been actively promoting fuel cells as a viable energy solution for China’s future. Any advancement made in the automotive fuel cells is expected to benefit other market segments such as stationary applications. As of today, there are no commercially available fuel cell products in being offered in China.

### 1.4 Scope of Project

Given the strategic importance of the backup power market for Ballard and the potential opportunities generated by the rapid growth of the telecommunications industry in China, a more detailed assessment of the situation is required for a better understanding of the potential opportunity. The purpose of this project is to provide an assessment of the telecom backup power market in China, analyze the challenges and success factors, as well as to provide key information.

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\(^2\) Balloch Group, 2006  
\(^3\) Balloch Group, 2006  
\(^4\) Balloch Group, 2006
and recommendations needed for future strategic decisions. This report includes the following sections:

- An overview of backup power for telecommunication applications (Chapter 2)

- Important general knowledge for doing business in China and considerations for foreign firms looking to enter this market (Chapter 3)

- A market analysis of the telecom backup power in China, including the identification of the industry value chain and key players, the market size, and the drivers, retraction, and trends of this market (Chapter 4)

- A analysis for the opportunity and changes for Ballard in China, including a SWOT analysis, competitive analysis, and identification of key success factors in this market segment (Chapter 5)

- Strategic recommendations for entering this marketing, including the partner selection criteria, evaluation of partnership options, identification of target customers, and other key considerations (Chapter 6)

- Concluding remarks (Chapter 7)
2 BACKUP POWER FOR TELECOMMUNICATION APPLICATIONS

2.1 Backup Power Overview

Backup power systems are used to provide emergency electrical power in the event of public utility power outages. In telecom, they are commonly deployed at wireline remote terminals and wireless cell sites to reduce service downtime during these blackout or brownout disruptions. As network downtime could result in major revenue losses, the need for continuous, reliable power has become increasingly important.

In the telecom industry, two different power architectures are commonly used – DC Power Systems and AC UPS Systems.

DC Power is the dominate architecture and have traditionally been used for outdoor telecommunication infrastructures such as cell sites and base stations. They provide a more cost-effective backup power solution than AC, and offer higher reliability that adhere to the five-nines reliability requirement for telephony communications specified by Telecordia. The Institute of Electrical and Electronic Engineers (IEEE) standardized the use of DC power for voice transmission equipment in 1998 and the standard has been adopted by both the European Telecommunications Standards Institute (ETSI) and the American National Standards Institute (ANSI). Most fuel cell backup solutions today are focused towards DC power applications as this is where fuel cells can provide the highest level of competitive advantage over other technologies.

AC power systems are commonly used for indoor applications to power server room network equipment and IT computer servers. They often use specialized UPS, or uninterruptible

5 Frost & Sullivan, 2005
power supplies, with internal built-in batteries as the main source of secondary power. Although fuel cell solutions can also be developed to replace AC UPS systems, they do not offer the same level of value proposition compared to DC power backup systems due to short time duration requirement of AC UPS.

Today, storage batteries are often used as the source of secondary power for remote telecom infrastructures, as they can be directly connected to the DC voltage bus without the need for power conversion. The DC voltage bus for most telecom applications is -48Vdc or +24Vdc. Under regular operating conditions, AC voltage from the commercial utility grid is converted to DC voltage by a series of rectifiers to provide continuous power for the network equipment, as well as to charge the batteries when backup power is not being used. Typical remote telecom infrastructures require power in the single digit kW range. Backup power capacity is determined by the equipment load times the amount of reserve time required, varying anywhere between 2 to 8 hours depending on the application. In some situations, diesel generators are deployed together with a small battery bank when the backup power requirements involve high capacity or a long operating duration. In the US, the government has mandated wireline sites to provide at least 8 hours of backup power to maintain communications in case of emergency blackouts and/or natural disasters\textsuperscript{6}. There are no such requirements for wireless sites.

A simplified schematic of a typical DC power system is shown on Figure 2.

\textsuperscript{6} Borders, 2004
Backup power batteries are often sized to provide two to eight hours of reserve time. However, most wireless carriers have historically held design standards to the low end of this spectrum, primarily due to space and capital restrictions, and because service outage at one cell site often will not completely disable calling capability within the service area due to some overlap in network coverage between wireless base stations. Nonetheless, there has been an emerging trend to increase backup power reserve time to improve network availability and coverage to improve customer satisfaction.

2.2 Incumbent Backup Power Technologies

2.2.1 VRLA Batteries

VRLA, or valve-regulated lead acids, have long been the dominate technology for battery deployments in remote telecom sites. They entered the market in the 1980s and provided major improvements over traditional flooded or wet cell batteries that required regular maintenance and large floor space. Compared to their incumbents, VRLA batteries were easier to install and replace, required no spill-containment, and required minimal ventilation. Most importantly, they have much smaller modular foot prints, which was a major enabler for the deployment of remote
electronics equipment for remote base stations. Batteries are tied together in a parallel bus to meet the energy capacity requirements of the site.

Despite the positive attributes of VRLA batteries, they were never the ideal solution for telecom applications. Most VRLA batteries in the field experience reliability issues operating outside optimal temperature of 25°C, leading to premature capacity loss and drastic reduction in service life in comparison to the manufacturer's specifications. As a result, most telecom carriers are forced to replace their batteries every 3 to 5 years and/or to provide temperature controlled cabinets for the batteries, both of which add to the overall infrastructure maintenance cost. Another major issue with VRLA technology is the potential for thermal runaway, which occurs when the rate of heat generation exceeds its heat dissipation capacity. These conditions can occur as a result of high cycling rate or high ambient temperature operations, and could lead to catastrophic and destructive failures. As a result, most VRLA backup power infrastructures need to be equipped with thermal runaway protection rectifiers and remote monitoring equipment to alarm telecom personnel of potential issues. According to a study by Johnson Controls, more than one-third of telecom carriers are not happy with the performance of telecom batteries\(^7\).

2.2.2 Diesel Generators

Diesel generators (gensets) are internal combustion engine machines that operate on diesel fuel to produce AC or DC power. They are considered to be the die-hard backup solution for telecom applications and provide secondary power backup to the batteries under extended outages for as long as fuel is available. Diesel gensets are preferred over other fuels such as propane or natural gas gensets due to their lower operating and maintenance costs. Except for mission critical sites, gensets are not usually located permanently at remote sites due to cost and lack of floor space, but are dispatched to power outage locations by network technicians before

\(^7\) Perry, 2004
battery reserves are exhausted. Most gensets for telecom applications produce AC power and connects to the AC feed through a power transfer switch pedestal. Unlike batteries, diesel gensets can be reliable with proper maintenance and can provide extended duration power backup. However, like their counterparts, they also have a number of associated handicaps, most notably their high maintenance requirements, noise output, and combustion emissions.

### 2.3 Advantages of Fuel Cell Based Solutions

Fuel cells provide a promising alternative over the incumbent backup power solutions comprised of batteries and gensets. A fuel cell is an energy conversion device that generates electricity by converting the chemical energy stored in hydrogen fuel into electrical energy. Like batteries, fuel cells produce electricity through an electrochemical process; but unlike batteries, they are not limited by a finite energy capacity. The reactants of a fuel cell are not stored within the cell but are fed externally via hydrogen cylinders or pipelines. Thus fuel cells do not need to be recharged and will operate as long as fuel is provided. Fuel cells combine the best features of both batteries and generators – they can produce clean energy efficiently for extended durations with the limitation of storage capacity. In addition, because fuel cells are not internally charged like batteries, they are truly off and undergo minimum changes while they are in stand by. Thus, they have much better shelf life and are virtually free of maintenance requirements, which greatly reduce the site maintenance cost related to battery replacement and recycling. Fuel cells can also be designed to operate under a wide range of operating temperatures, so they do not face the same durability issues as VRLA batteries under harsh weather environments. They are also lighter in weight and have a smaller footprint compared to a battery and genset solution for the same energy capacity, therefore reducing the amount of real-estate taken up at each remote base station site. A summary table of the different backup power solutions and their key attributes are listed on Table 1.
Table 1: Comparison of Batteries, Diesel Gensets, and Fuel Cell Attributes

<table>
<thead>
<tr>
<th>Feature</th>
<th>Batteries</th>
<th>Diesel Gensets</th>
<th>Fuel Cells</th>
</tr>
</thead>
<tbody>
<tr>
<td>High efficiency</td>
<td>Yes</td>
<td>No</td>
<td>Yes (^{\dagger})</td>
</tr>
<tr>
<td>Low pollution</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Low noise emissions</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Long run time</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Low scheduled maintenance</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>High reliability</td>
<td>Yes (^{\dagger})</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Long shelf life</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Low initial cost</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

\(^{\dagger}\) Only under controlled temperature environment

2.4 Value Proposition

Fuel cell solutions are especially attractive in situations when backup run time requirements are high and the deployment of generators are prohibited. An independent study done by Battelle on behalf of the US Department of Energy have shown that despite a higher initial capital and installation cost, a 5 kW fuel cell system offers a better overall NPV versus a battery and genset solution over the operating life of the application\(^{8}\). Another analysis completed by the Citigroup Investment Research\(^{9}\) source also revealed the same conclusions but with better optimism, estimating that fuel cell life cycle cost are 12% and 18% less expensive than incumbent solutions on a ten- and 15-year useful life, respectively.

\(^{8}\) Mahadevan, 2006
\(^{9}\) Citigroup, 2005
### Table 2: NPV of Fuel Cells vs. Battery Backup Power

<table>
<thead>
<tr>
<th>5 kW Fuel Cell vs. Battery Backup Power</th>
<th>Fuel Cell Total Cost $</th>
<th>Battery Total Cost $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Cost</td>
<td>30,000</td>
<td>28,800</td>
</tr>
<tr>
<td>Installation</td>
<td>7,000</td>
<td>3,000</td>
</tr>
<tr>
<td>Fuel</td>
<td>19,999</td>
<td>-</td>
</tr>
<tr>
<td>Charger, Load Transformer &amp; Electricity</td>
<td>-</td>
<td>1,880</td>
</tr>
<tr>
<td>Generator</td>
<td>-</td>
<td>8,800</td>
</tr>
<tr>
<td>Demurrage</td>
<td>3,066</td>
<td>-</td>
</tr>
<tr>
<td>Batteries</td>
<td>1,600</td>
<td>16,000</td>
</tr>
<tr>
<td>Disposal</td>
<td>100</td>
<td>400</td>
</tr>
<tr>
<td>O&amp;M</td>
<td>2,000</td>
<td>13,900</td>
</tr>
<tr>
<td>Cash</td>
<td>45,765</td>
<td>56,980</td>
</tr>
<tr>
<td><strong>Net Present Value</strong></td>
<td><strong>$ 27,179</strong></td>
<td><strong>$ 28,172</strong></td>
</tr>
</tbody>
</table>

Assumed 15 year fuel cell life and 5 year battery life

*Source: Mahadenvan, 2006*

#### 2.5 Competing Alternative Technologies

Aside from fuel cells, many companies have been developing alternative technologies to address the shortcomings of the VRLA batteries and gensets. Alternative battery chemistries including nickel cadmium (NiCd), nickel-metal hydride (NiMH), and lithium ion (Li-ion) are amongst the top candidates competing in the backup power market. Each of these technologies has their own share of advantages as well as shortcomings. For example, NiCd batteries can provide high current outputs at constant voltages, but are relatively expensive and environmentally unfriendly. NiMH batteries address the environmental concerns of NiCd and offer up to 40% energy density, but they have a high self-discharge rate. Lithium batteries go one step further and offer up to five times the energy density compared to an equivalent sized lead-acid cell, but they require active electronics to manage and control their performance. However, the biggest advantage of all the new technologies is that they all work better at high temperature, which eliminates the need for active cooling at the site. Aside from batteries, alternative energy storage devices such as the ultra-capacitors and flywheels have also been viewed as viable solutions under the right applications.
3 DOING BUSINESS IN CHINA – CONSIDERATIONS FOR FOREIGN FIRMS

3.1 Overview

China has experienced unprecedented economic growth since its economic reform beginning in the 1980s. Over the past quarter century, gross domestic product has jumped more than 800% and growth was further accelerated when China joined the World Trade Organization (WTO) in 2001. As the world’s most populous country with 1.3 billion people, its sheer size together with its hunger to economically advance make the Chinese market too attractive to be ignored. But despite the market potential, China is also one of the most difficult markets in which to succeed.

For any organization to be successful in this emerging market, it is important to have a basic understanding of the cultural, ethical, and business values. Doing business in China is not simply doing business like in other developed countries. Success requires a complex mixture of relationship cultivating and political influencing. The following section provides an overview of some of important considerations for foreign firms looking to enter China.

3.2 Cultural Understanding

3.2.1 Guanxi

Guanxi, the Chinese translation for ‘relationships’ or ‘connections’, is an essential element of doing business in China. It is the foundation by which Chinese people have done business throughout its history. The development of a personal supportive relationship based on

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10 Jen, 2004
11 Communicaid, n.d.
mutual respect is a pre-requisite to any commercial relationship. The Chinese will rarely deal with people they do not trust and will take the time necessary to get to know their counterparts. It is important to take the time to cultivate a personal relationship before jumping into heavy business discussions. Guanxi also involves expectations of influence or consideration on behalf of each other. Hence relationships are not to be entered into lightly – if the expectations are not met, then a reputation for untrustworthiness may be established.

3.2.2 Mianxi

Mianxi, or 'face', is an important concept that needs to be considered at all times during business interactions with the Chinese. Face is what forms the basis of one’s reputation and social standing. It is also a mark of personal pride. The concept of “giving face”, “saving face” and “losing face” could make a big influence on business failure or success. Causing someone to lose face through disrespect of ranks or embarrassment could have a great negative effect whether or not it was done intentionally. Criticizing someone in public is the worst form of Chinese humiliation and is considered to be unforgivable. On the other hand, giving face through moderate praises is considered to be a considerate gesture and is often much appreciated.

3.2.3 Li

Li is act of politeness and courtesy. It is a concept used to preserve harmonious relations between people. In a business setting, the concept of Li is demonstrated through etiquette such as respecting the hierarchy, allowing the customer to seat first and speak first, and following general manners. To preserve harmonious relationship, it is important to keep up a polite and courtesy appearance and to respect face even if disagreements occur.

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12 According to C. Collins-Dodd (personal communication, March 22, 2007)
13 Communicaid, n.d.
3.2.4 Keqi

Keqi is a combination of Ke and Qi, which stands for guest and behaviour respectively. It is an aspect of Li and describes the concept of modesty and humbleness. It illustrates the importance of keeping a well-mannered polite behaviour during business interactions and unacceptable behaviour of being arrogant.

3.3 Business Customs

3.3.1 Respect of Hierarchy

The Chinese take great pride in the hierarchical structures of society and business organizations. Employees and government officials are conscientious of rank and follow hierarchical orders when entering into meeting rooms, seating, and leading discussions. Observation of ranks is vital in respecting Mianxi and cultivating relationships.

3.3.2 Entertaining

Entertaining is a big part of the business culture in China. The Chinese like to use this as a way to get to know their business partners at a personal level. Dinner banquets are the most popular form of entertainment and are often complemented with heavy alcohol drinking. Chinese like to drink together glass-by-glass as a means of friendship bonding and character understanding.

3.3.3 Goodwill

Goodwill in forms of gifts is not only friendly gestures, they are considered to be an important component of Guanxi building and business development. The Chinese often present small gifts to their visiting hosts as a token of appreciation during the foreign visits. In providing

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14 Communicaid, n.d.
15 Foreign Affairs and International Trade Canada, 2007
return gifts to the Chinese, it is important to avoid gifts with sharp objects which symbolize severing ties or clocks which symbolize death in Chinese traditions\textsuperscript{16}

3.4 Corporate Support

3.4.1 Commitment and Resources

Doing business in China requires more corporate commitment and resources than doing business in developed countries. Upper management must be actively engaged in developing and maintaining relationships to demonstrate mutual organizational support for the lower ranks of the hierarchy. The time budget for executive management participation cannot be underestimated. The cost of doing business in China does tend to be higher as a result of the required time commitment for business development and needs to be realistically allocated.

3.4.2 Patience

Results in China generally tend to take longer than other foreign market entry ventures. Companies need to realize that China is a difficult place to do business and developing the market for profitability could take a long time. Many multi-national companies in the 1990s took over a decade to develop the market before turning profitability\textsuperscript{17}. Time to success in China has generally been improving since China's accession to the WTO has increased the transparency of trade barriers, reduced bureaucratic state-owned business structures, and increased the size and importance of the commercial-minded business community. But despite better business understanding and well-developed entry plans, companies need to exercise patience when entering this market. Results might be slower than desired in many circumstances, but rewards can be great once it comes.

\textsuperscript{16} Raitiosoja, 2006
\textsuperscript{17} Balloch Group, 2006
3.5 Government Influence

Chinese government departments often have strong influence in shaping the deployment of new technologies. As such, it is vital to develop relationships at the right government levels or administrative departments. The bureaucratic structure of the Chinese government is extensive and complex. Reaching the right influential parties may require the help of the local management consultants who have the experience and understanding of where relationship building efforts should be focused. Relationships should be actively maintained after they are developed to ensure that initial efforts are not lost.

3.6 Intellectual Property

Protection of intellectual property (IP) remains to be a legitimate concern for many foreign companies looking to enter China. Despite strengthened IP framework and stronger statutory protection since the WTO, China continues to face significant problems with copyrights and counterfeits. The Chinese government has increased its commitment to address these problems through increased enforcement, but limited resources and education regarding economic and social impact often undermine the efforts. Many Chinese companies have no incentives for following IP regulations and compliance is only followed when demanded by foreign partnership companies.

In spite of these challenges, IP protection through patent or trademark registration is still the best mechanism of defence for foreign firms looking to export or collaboratively develop technologies. Even though international agreements such as WIPO, Bern Convention, and Paris Convention require China to protect IP, a company must register its patents and trademark with the appropriate Chinese agencies and authorities for those rights to be enforceable in China. The China's State Intellectual Property Office (SIPO) in Beijing is responsible for all patent

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18 US DOC, 2003
19 US DOC, 2003
filings while provincial offices are responsible for handling administrative enforcement of patent complaints. The Trademark Office under the State Administration on Industry and Commerce (SAIC) is responsible registration, administration, and enforcement of trademark protection. A more detailed discussion of IP issues is beyond the scope of this report, but readers interested in this topic can refer to http://www.sipo.gov.cn and http://www.saic.gov.cn for more information.
4 ANALYSIS OF THE TELECOMMUNICATIONS BACKUP POWER MARKET IN CHINA

4.1 Value Chain Analysis

An analysis of the value chain is an important step to understand the industry structure and the interface between the key players. Within the telecom industry, back-up power value chain can be broken down into four distinct segments: 1) telecom operators (or end-users), 2) network infrastructure suppliers, 3) power system suppliers, and 4) OEM equipment providers. For this study, the OEM equipment providers can be further divided into two separate groups – batteries and fuel cells. Firms competing in this market fall either distinctly into one segment or are vertically integrated in multiple segments.

Figure 3: Market Segments of the Telecom Power Market

The telecom backup power market in China can be characterized by a pyramid buyer-supplier structure, with a relatively few end-users and a fragmented number of OEM suppliers. This is fairly common amongst industries in China, such as the auto component industry and pharmaceutical industry, which contain thousands of manufacturers.

Figure 4 shows a value chain map containing the key buyers and suppliers in the telecom backup power market in China. The companies that have been identified in the map and profiled
in this section were found through secondary market research using a combination of research analyst reports, equity research coverage, industry conference participant lists and proceedings, industry journal articles, company news releases, and industry news articles. There may be additional layers of agents or value added resellers in between, but these were not included in to avoid adding additional complexity. Providers that are not currently active in China are not included or have been greyed out.

Figure 4: Value Chain of Telecom Backup Power Market in China

<table>
<thead>
<tr>
<th>OEM Suppliers</th>
<th>Power Equipment</th>
<th>Network Infrastructure</th>
<th>Operators</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fuel Cells</strong></td>
<td>Emerson</td>
<td>Siemens</td>
<td>China Mobile</td>
</tr>
<tr>
<td>Altergy</td>
<td>Tyco</td>
<td>Ericsson</td>
<td>China Unicom</td>
</tr>
<tr>
<td>Hydrogenics</td>
<td>Delta</td>
<td>Nokia</td>
<td>China Telecom</td>
</tr>
<tr>
<td>IdTech</td>
<td>Eaton</td>
<td>Alactel-Lucent</td>
<td>China Netcom</td>
</tr>
<tr>
<td>Plug Power</td>
<td>Eltek</td>
<td>Motorola</td>
<td>China TieTong</td>
</tr>
<tr>
<td>ReliOn</td>
<td>ZTE</td>
<td>Nortel</td>
<td>China TieTong</td>
</tr>
<tr>
<td>UTC</td>
<td>Putian</td>
<td>NEC</td>
<td>China Satcom</td>
</tr>
<tr>
<td></td>
<td>Leoch</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sacred Sun</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.1.1 Telecom Operators

The telecom communications industry in China is a state-owned oligopoly, comprising four large domestic operators of fixed-line and wireless services plus two much smaller companies\(^{20}\). Chinese telecom operators are mostly financed in Hong Kong, and are all governed under a strict regulatory environment by the Ministry of Information Industry (MII), who dictates both the technologies used and the products sold\(^{21}\). The telecom industry has long been classified as a national priority sector by the Chinese government and been protected from foreign players.

\(^{20}\) Wikipedia, 2007  
\(^{21}\) Economist Intelligence Unit, 2004
Prior to China's WTO accession in 2001, international telecom operators were completely banned from accessing the market\textsuperscript{22}. Since 2001, the MII has opened up the market to foreign investors by allowing joint ventures with local carriers, but there has been little market activities. The telecom industry in China is home to the world's largest fixed-line and wireless network in terms of network capacity and the number of subscribers. According the MII, there are over 500,000 million subscribers as of July 2006.

4.1.1.1 Key Players

China Mobile, China Unicorn, China Telecom, and China Netcom are the four dominant players in the telecom industry, with China Satcom and China Railcom operating as the niche players.

China Mobile is a full service GSM provider of voice, data, and IP telephony and is the world's largest mobile service provider in terms of network scale and customer base. As of November 2006, it has a total of 296 million subscribers and approximately 65% market share of the Chinese market. Over the past few years, it has placed a strong strategic focus on targeting rural area users and expanding its rural area coverage as it seeks further growth beyond the saturated urban markets.

China Unicorn is the country's second largest operator and ranks third in the world. It is China's only fully-licensed telecom service provider to offer wireline-phone, data, and internet service in addition to mobile services. China Unicorn is the only Chinese carrier operating a CDMA network. Both China Mobile and China Unicorn operate nationwide through fully owned subsidiaries in all 31 provinces, autonomous regions, and directly administrated municipalities of mainland China.

\textsuperscript{22} Economist Intelligence Unit, 2004
China Telecom is China's largest wire-line service provider and serves mostly the southern parts of the country. It holds about 70% of the wire-line market, and is seeking to enter the wireless market through the country's upcoming 3G network licensing.

China Netcom is the country's other major wire-line operator with operations in the northern parts of China. Both wire-line providers offer basic land line service in addition to value-added services such as broadband internet and PHS (personal handy-phone system) which is a popular short-range urban wireless mobile network used in China, Taiwan, and Japan.

China Satcom is primarily engaged in the satellite based communication services, and China Railcom is a provider of basic wireless telecom and internet services.

4.1.2 Network Infrastructure Suppliers

Network infrastructure suppliers provide a wide range of solutions for telecom operators including network equipment products, design and implementation of physical infrastructures, and equipment maintenance and support. Their product portfolio typically covers equipment for base transceiver stations, base station controllers, remote terminals, mobile switching centers, and various interfaces and connections between the mobile phone users and public switched telephone network. The level of vertical integration of network infrastructure suppliers varies amongst domestic Chinese players, with some providing a complete line of primary and back-up power system products to complement their telecom network equipment, while others rely on other power system suppliers to provide their customers with network power solutions.

4.1.2.1 Key Players

Key domestic players in this segment include Huawei, ZTE, China Putian, and Datang Telecom.
Huawei is currently China’s largest private telecommunications equipment supplier, with reported sales of US$11 billion in 2006 and 62,000 employees globally\textsuperscript{23}. It serves 31 of the top 50 telecom operators in the world, and has provided equipment for major network infrastructure deployment projects for all major Chinese telecom operators. Huawei has also been reported to spend 10 per cent of its revenue into R&D each year. In 2001, it sold its power systems business unit, Shenzhen Avansys Co Ltd., to Emerson Network Power in an effort to focus on its core business of telecom equipment design and manufacturing\textsuperscript{24}.

ZTE is the largest listed domestic telecom equipment supplier with a reported revenue of US$2.7 billion in 2005. ZTE is one of the sector’s most vertically integrated firms with a product and service portfolio that ranges from telecom infrastructure solutions to mobile handsets. It has gradually become a market leader over the years by benefiting from its flexible strategy and has competed on a low-cost structure\textsuperscript{25}. Its power systems department offers a complete DC power product portfolio with a wide range of the backup power solutions including UPS, batteries, diesel gensets, and solar energy power systems. ZTE has supplied equipment to all major Chinese telecom operators. According to its company profile, ZTE supplied telecom network products for China Unicom in a network construction project that spanned 18 provinces.

China Putian (Potevio) Group is one China’s largest technology companies and specializes in manufacturing of telecom systems and equipment. The group consists of a number of subsidiary companies, including the Putian Institute of Technology which is responsible for R&D and product development of new telecom technologies, and China Wuhan Putian Group which is the largest state-owned telecommunication systems manufacturing enterprise of landline and mobile terminal equipment.

\textsuperscript{23} Griffin, 2007
\textsuperscript{24} Emerson, 2001
\textsuperscript{25} ABI Research, 2005
Datang Telecom Technology makes and sells telecommunication equipment for core switching, optical, and wireless networks primarily for customers in China. It was established in 1993 by the China Academy of Telecommunications Technology (CATT), the communications research arm of the Chinese government.

In addition to the above players, leading multi-national network equipment companies including Siemens, Ericsson, Nokia, Alcatel-Lucent, Motorola, Nortel, and NEC are also active participants in the Chinese markets. Many of these companies have entered the China through joint ventures or partnerships with domestic companies in order to gain access to key resources. All of these companies have had business relationships with one of the top four domestic equipment suppliers on the development of various telecom technologies.

4.1.3 DC Power Systems Suppliers

DC Power System suppliers provide products and services used to power the remote network equipment. Their typical product portfolio includes rectifiers, DC switching power supplies, UPS backup power, batteries, and the cabinets and outdoor enclosures used to house the equipment. Power System suppliers also provide site surveying and planning, installation and commissioning, preventative maintenance and battery maintenance as part of their value-added services.

4.1.3.1 Key Players

The power systems market in China is highly fragmented and is currently undergoing rapid transformation. The Darnell Group estimates that five multi-national companies take up approximately 46% of the market share with the remainder made by a large number of domestic and foreign companies. Emerson Network Power leads the market with a 19% market share, followed by Tyco Electronics at 10%, and Delta Electronics, Eaton/Powerware, and Eltek trailing.

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26 Darnell, 2005
at 9%, 5%, and 3% respectively. Emerson Network Power is by far the industry’s largest player with over $20 billion of annual sales and 100,000 employees worldwide, as well as the industry’s most complete portfolio of product applications and services. According to Emerson press information, it’s Network Power Division is formed through the consolidation of three separate power system business units of Ericsson, Nortel and Huawei, the latter of which provided Emerson with a clear market leadership position in China since 2001. Second place, Tyco Electronics has also been experiencing a steadily increasing market share in China since it signed an agreement in 2003 with Wuhan Putian, to sell and distribute its Power System’s telecom power products. None of the domestic companies in China were amongst the market leaders in terms of sales, but the most significant Chinese companies are ZTE (power systems division), Beijing Dongliyuan (Dynamic Power), and Wuhan Putian Telecom Equipment. The power systems division of ZTE develops its own portfolio of telecommunications power system products and has a strong R&D force composing of about 200 staff members. Beijing Dongliyuan, according to its company profile, also claims to be a heavy technology investor with a strong focus on R&D and product expansion, supported by 15 R&D advanced laboratory specializing power systems development. Wuhan Putian, backed by the strength of its parent company China Putian, claims to be one of the top three domestic DC power systems providers in China and the top the supplier of VRLA batteries for the telecom industry.

4.1.4 Battery Suppliers

Battery suppliers provide VRLA storage batteries to power equipment developers and directly to end users. The lead-acid batteries market is highly fragmented in China, with hundreds of manufacturers that produce products for a broad range of industrial applications including telecom, computer electronics, marine, and automotive and motorcycles. Most firms compete purely based on cost-based competition while a few others are actively engaged in the

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27 Darnell, 2005
R&D and new technology development. Most of domestic companies in the sector have international exports as well as local sales.

4.1.4.1 Major Players

The identification of key players in the telecom lead-acid storage battery market is difficult to determine due to the high amount of fragmentation. But through discussion with Chinese end users and other marketing intelligence, it is believed that the top domestic telecom battery suppliers are China Shoto, Wuhan Intepower, Guangyu (Coslight), Nandu, and Pearl River. These players all have established relationships with telecom end users and network power equipment manufacturers to supply VRLA storage batteries for new infrastructure deployment and maintenance replacements. A number of these companies also own other complementary business units in addition to batteries. For example, China Shoto also specializes in the research, design, and manufacture of power systems and energy-related businesses. Wenlong Battery, Shenzhen Center Power Tech., Leoch, and Sacred Sun Batteries are other local companies that have supplied storage batteries in this market. A number of these incumbent competitors have expressed interest in entering into the fuel cell business.

4.1.5 Fuel Cell System Suppliers

Like Ballard, a number of prominent fuel cell system developers are targeting the telecom backup power market as an early-stage niche market. Depending on the fuel cell stack product strategy (make, buy, vs. partner), they could potentially be a partner or competitor of Ballard.

4.1.5.1 Major Players

There is currently no focused Chinese fuel cell developer who is directly targeting the backup power market in China. Major players in this segment are all North American-based, including Altergy, Hydrogenics, IdaTech, Plug Power, ReliOn, and UTC fuel cells. A number of these companies have formed product distribution partnerships with global telecom power
equipment suppliers for indirect access to China. Plug Power is working with Tyco Electronics, Hydrogenics is working with APC, IdaTech is working with C&D Technologies, and Algy is working with Eaton to distribute fuel cell products to end-users. A number of these companies are known to be interested in entering the Chinese market through strategic partnerships with Chinese players.

4.2 Market Size

The global battery backup market is approximately worth $2.3 billion US annually according to a research analysis report by the Citigroup\textsuperscript{28}. The China market, along with other emerging economies like India, is expected to be the fastest growing segment based on its rapid deployment of new wireless infrastructures. Frost & Sullivan estimates that China currently accounts for approximately 23.5\% of the world’s telecom investment with an estimated expenditure of $74 billion out a world total of $319 billion annually\textsuperscript{29}. With a compounded annual growth rate (CAGR) of 19.4\%, China is well ahead of the world total of 12.0\% and mature North America total of 4.0\%. Assuming that the battery backup market size of China is directly proportional to its telecom investment relative to the world, the total opportunity in China may be worth more than $540 million.

A market report published by the Darnell Group in 2005 estimates that China’s dollar market only accounts for 6.6\% of the world, based on complete the DC power system sales\textsuperscript{30}. This percentage appears to be an under-estimation of the China market position given the inconsistency between its estimated power system sales and the opportunities created by the deployment of new base stations.

\textsuperscript{28} Citigroup, 2005
\textsuperscript{29} Frost & Sullivan, 2005
\textsuperscript{30} Darnell, 2005
As with any other disruptive technology, estimating the addressable market for fuel cell solutions is difficult due to the many uncertainties that can affect the rate of technology adoption. To obtain an estimation of the Chinese market segment is even more challenging as a result of all the many different factors that could affect end-user buying behaviours. One fuel cell manufacturer had estimated the total fuel cell market to be worth $300 million, but approximations have varied amongst analysts and market experts. Most of the market research covering this industry has been focused on North America sector, probably due to the ease of information access. A credible estimation of the fuel cell market size for the China segment would require a thorough investigation with the key players in China as there is no secondary market data available.

4.3 Market Drivers

The key market drivers for the telecom backup power market in China are listed in table 3.

<table>
<thead>
<tr>
<th>Rank</th>
<th>Market Drivers</th>
<th>Near Term 2007 to 2008</th>
<th>Mid Term 2009 to 2010</th>
<th>Long Term 2011 to 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Wireless market growth</td>
<td>Very High</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>2</td>
<td>Rural area expansion</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>3</td>
<td>Deployment of 3G technology</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
</tr>
</tbody>
</table>

*Source: Based on Frost & Sullivan, 2005*

4.3.1 Wireless Market Growth

The growth of the wireless telecommunications industry is expected to directly result in additional demand for backup power systems. Not only does China have the largest wireless subscriber base, it is also the fastest growing market in the world. The CAGR of mobile subscribers over the past three years is 21.24%, ranking China amongst the top with other

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31 FuelCellWorks, 2006
emerging economies. With a mobile teledensity currently at about 37%, the industry still has a lot more room to grow before it catches up to mature markets such as the United States, which is currently at 64%. The Ministry of Information Industry expects an additional 80 million subscribers in 2007 and total subscribers to reach 825 million in 2010. Chinese telecom operators are expected to continue to invest heavily on new network infrastructures in order to keep up with the explosive growth, creating opportunities for all telecom equipment suppliers.

4.3.2 Rural Area Expansion

A large portion of new Chinese wireless subscribers are expected to come from the rural areas, where the availability of backup power is more important compared to the urban areas. In an urban area, networks are designed to provide redundancy coverage such that neighbouring base transceiver stations can provide service coverage to an area that is disrupted by power or equipment failures. In rural areas, a greater emphasis must be put on uninterruptible power and backup solutions as a power failure would lead to lost service coverage over a larger area. The expansion into the rural areas has been one of China Mobile’s key strategic initiatives and it has been expanding its network infrastructures to provide better service coverage for its growing number of rural customers.

4.3.3 Deployment of 3G Technology

The Ministry of Information Industry is expected to issue 3G licences to China’s major telecom operators sometime in 2007. 3G, short for third-generation, technology offers greater broadband capabilities plus higher data transfer rates to support greater network user capacity, and enables simultaneous voice and data services such as email and video telephony. The introduction of 3G in China is expected to further trigger increased capital expenditures on new infrastructures and equipment sales. The total capital expenditures on 3G network equipment

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32 Frost & Sullivan, 2005
33 Economist Intelligence Unit, 2006
amongst all Chinese carriers is expected to reach up to US$12 billion\textsuperscript{34}. The top three domestic operators – China Mobile, China Unicom, and China Telecom, are all expected to be granted 3G licences. The state government is expected to hold some form of industry-wide restructuring prior to the 3G launch.

### 4.4 Market Restraints

The key market constraints of the telecom backup power market in China are listed in Table 4.

#### Table 4: Market Restraints for Telecom Backup Power in China

<table>
<thead>
<tr>
<th>Rank</th>
<th>Market Restraints</th>
<th>Near Term 2007 to 2008</th>
<th>Mid Term 2009 to 2010</th>
<th>Long Term 2011 to 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Product commoditization</td>
<td>Very High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>2</td>
<td>Price pressure from end users</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>3</td>
<td>Small number of decision makers</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
</tbody>
</table>

*Source: Based on Frost & Sullivan, 2005*

#### 4.4.1 Product Commoditization

Many telecom power products including DC power systems, batteries, and generators have reached the maturity stage in their product life cycle and are perceived to be commodities. Product differentiation amongst vendors has been narrowing and price has been the single most important driver for buying decisions. A number of major power system vendors have set up factories or manufacturing joint ventures in China to reduce their cost of goods sold through reduced labour rates and more efficient economies of scale. In order to stay competitive in the power systems business in the longer term, suppliers will need to provide additional value through new product differentiation or technology innovation without significantly challenging the current price threshold of end users.
4.4.2 Price Pressures from End-Users

Network infrastructure and power system suppliers have been more aggressive with their pricing strategies in order to retain and increase their customer base. At the same time, end users have come to expect the lowest possible pricing through competitive contract tenders or through preferred supplier deals. The combination of product commoditization and demanding end users have squeezed profit margins throughout the value chain. Profitability levels have remained flat for smaller suppliers despite increases in volume. As a result, this has led to a broad consolidation of the market and limited new entrants over the years. Even larger manufacturers have been turning to mergers and acquisitions to better compete on cost, as evident by Emerson Network Power’s strategic acquisition of the power system business units of Nortel, Ericsson, and Huawei.

4.4.3 Small Number of Decision Makers

In addition to product commoditization pricing pressures, the oligopolistic nature of the Chinese market makes competition for telecommunication equipment even more difficult for suppliers. There are currently only four major end users in addition to two smaller ones in this market. Although it is possible that equipment purchasing decisions are made at local levels through the operator’s subsidiaries (thus effectively increasing the number of buyers), network operators are likely to have a short list of preferred suppliers. So despite of the tremendous market volume potential, there are relatively few decision-makers. This situation gives buyers strong purchasing power to influence pricing and creates additional barriers for new entrants looking at getting into the Chinese market.

35 Frost & Sullivan, 2005
4.5 Market Trends

4.5.1 Cost is King

Despite the growing importance of key factors such as weight, size, power density, energy efficiency, and maintenance requirements, cost is still the dominating factor for backup power equipment purchasing decisions\(^{36}\). This is consistent with most other telecom equipment as end users tend to focus on low purchasing cost first, followed by the total cost of ownership. Any product improvements associated with new technologies cannot carry a large price premium because most end users have grown to accept the disadvantages associated with incumbent solutions despite their dissatisfaction.

4.5.2 End-users Focus on Turn-Key Solutions

As discussed, DC power systems for telecom infrastructures consist of a series of independent pieces of equipment including rectifiers, voltage converters, and backup batteries within cabinets or shelters. According to Darnell, end users in China and most Asian countries are relying on power system suppliers to provide complete turnkey solutions that include the backup power batteries\(^{37}\). This is primarily due to the standardized use of VRLA batteries for recent telecom build outs, allowing power system suppliers to bundle VRLA batteries that are in their product portfolio together in their solutions. Also according to Darnell, end users still tend to go to the power system suppliers for replacement batteries as replacements are required. However, interviews conducted with a few Chinese telecom operators have revealed that operators are starting to source their backup battery replacements directly from battery OEMs. The source of replacement batteries probably depends on the overall network maintenance strategy and the end-user's relationship with their suppliers, but the latter scenario seems to make sense given the cost competitiveness of the industry.

\(^{36}\) Darnell, 2005
\(^{37}\) Darnell, 2005
4.5.3 Increase in Engineering & Installation Services

Engineering, installation, and maintenance services have become one of the key revenue streams for power equipment suppliers as they look ways to provide added-value to their customers to overcome squeezed margins from cost-based competition. Darnell has reported that China has the fastest growing service market of any other region worldwide, with domestic providers slowly gaining market share from the leading multinational companies. As batteries are one of the weakest links in the power system installation, warranties and maintenance have been an important part of a turnkey solution. Many telecom service providers often neglect their power systems especially when it comes to batteries maintenance and upgrade, as they account for a disproportional amount of cost in comparison to their purchase price. This neglect could have a negative impact to the bottom line of the power system providers if they are responsible for their warranty. On the other hand, power system providers could benefit from this if end users rely on them for battery replacements.

4.5.4 Preference to Buy Chinese

The Chinese government has openly expressed its desire to keep the telecom sector as Chinese as possible due to the sector’s significant influence on the country’s overall economic growth. Consequently, the MII has been actively promoting locally-developed technologies over past few years to reduce the dependence on foreign standards. The expected deployment of China’s 3G network based on the home developed TD-SCDMA standard by the Chinese Academy of Telecommunications Technology (CATT) is a prime example of this effort. Many prominent multi-national telecom equipment manufacturers have invested heavily in partnerships with the major Chinese network equipment suppliers to develop TD-SCDMA solutions for end users. Siemens & Huawei, Ericsson & ZTE, Nokia & Potevio, and Alcatel-Lucent & Datang have all joined forces hoping to compete for future market share. The Chinese network

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38 Economist Intelligence Unit, 2004
infrastructure suppliers could be a gateway for getting new technologies into the hands of the end users as they could have significant influence on the specifications of the new network infrastructure deployment. As such, they could play a major role in shaping the future of the backup power market.
5 ANALYSIS OF BALLARD'S OPPORTUNITIES & CHALLENGES IN CHINA

5.1 Overview

Ballard’s success in the telecom backup power market in China will depend on its ability to address the key challenges that it will face along the way. This section provides a SWOT analysis of its internal and external environment, as well as an overview of the generic strategic positioning of its potential competitors, in order to highlight some of the present and future challenges. A list of the key success factors (KSF) and their likely impact in addressing these challenges are presented at the end of this section.

5.2 SWOT Analysis

Table 5 provides a summary of the SWOT analysis including the internal and external factors that affect Ballard’s objective to gain access to the Chinese telecom backup power market. A thorough understanding of these issues is necessary in order to develop specific objectives that leverage Ballard’s strength to overcome its weaknesses and threats.

Table 5: SWOT Analysis Summary

<table>
<thead>
<tr>
<th>Internal Strengths</th>
<th>External Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ Ballard brand recognition</td>
<td>3G network expansion</td>
</tr>
<tr>
<td>+ Market leadership</td>
<td>Rural area power reliability</td>
</tr>
<tr>
<td>+ Product positioning</td>
<td>Government support for new technologies</td>
</tr>
<tr>
<td>+ Manufacturing readiness</td>
<td></td>
</tr>
<tr>
<td>- Lack of local marketing expertise</td>
<td>Low price threshold</td>
</tr>
<tr>
<td>- Limited knowledge of local business relationships</td>
<td>Lack of demonstrated track record</td>
</tr>
<tr>
<td></td>
<td>Lack of hydrogen infrastructure and distribution</td>
</tr>
<tr>
<td></td>
<td>Safety, codes and standards</td>
</tr>
<tr>
<td></td>
<td>Emerging alternative technologies</td>
</tr>
</tbody>
</table>
5.2.1 Strengths

5.2.1.1 Brand Recognition

According to interviews conducted by Ballard’s management consultants in China, the Ballard brand is well-recognized amongst major Chinese fuel cell community. Many Chinese firms perceive Ballard as a world leader of fuel cell technologies and have shown interest in collaborating with Ballard on technology and product development. In September 2005, Chinese President Wu Jintao visited Ballard’s headquarters with his government delegation to get a first hand view of Ballard’s capabilities. Ballard was the only company that the President visited in his one week North America trip and the visit played a large role in raising Ballard’s profile in China. In addition, the fuel cell bus program that has been operating in Beijing places the Ballard brand in front of millions of people every year in a high publicity demonstration.

5.2.1.2 Market Leadership

Ballard is the clear market leader in the fuel cell industry. It has provided more fuel cells to customers than any other supplier in the world, and leads all other suppliers in revenue over the past years. Ballard fuel cells have more real-life operating experience than all of its competitors, allowing Ballard to understand key failure mechanisms and to derive product improvements. Ballard’s leadership is well recognized by the industry, including major fuel cell players in China.

5.2.1.3 Product Positioning

Ballard has developed a strong product positioning in this market segment with the Mk1020 ACS, which is designed to operate at ambient pressure without liquid cooling. This fuel cell design not only reduces the amount of system parasitic loads, but also reduces the overall cost of balance of plant components. By designing a product that greatly simplifies the integration of the overall fuel cell power system, Ballard has lowered the technical barriers for its potential customers to integrate the Ballard fuel cell in their products. According to industry
competitive intelligence, Ballard is the clear technical leader in ambient fuel cell stack technology.

5.2.1.4 Manufacturing Readiness

Ballard is one of a few fuel cell companies in the world that has a commercial-ready manufacturing plant that is capable of supporting high volume production demands. Its products are produced under strict quality management control and meet the requirements of international standards. It has more than enough capacity to fulfill early-market volumes and is ready to deliver products to interested customers.

5.2.2 Weaknesses

5.2.2.1 Lack of Local Marketing Expertise

Ballard does not have a China specific marketing force and lacks the resource depth to develop a strong focus in this market until market traction can be clearly demonstrated. As doing business in China requires good local knowledge and expertise, there will inevitably be a steep learning curve involved in pursuing this market. Ballard still has a lot to learn before it fully understands all the key details.

5.2.2.2 Limited Knowledge of Local Business Relationships

One of the key issues that Ballard is currently facing is the lack of an established partner that understands the local business relationship between the key buyers in China. This is a common weakness amongst most fuel cell firms that are interested in pursuing the Chinese market. A number of fuel cell firms have formed strategic distribution partnerships with value added resellers or agents that have strong sales and marketing presence in Asia-Pacific to gain channel access without the need for directly understanding the local business climate. Local management consultants acting on behalf of a foreign company can also help to alleviate some of
knowledge gap of doing business from abroad. However, they are unlikely to have the all the
answers in an emerging industry such as fuel cells where activities have been limited.

5.2.3 Opportunities

5.2.3.1 3G Network Expansion

The deployment of new 3G network infrastructures in China represents a good
opportunity to introduce new technologies such as fuel cell backup power solutions. In mature
markets such as North America and Europe, backup power infrastructures and battery
replacement business models are well established. Breaking into the equipment replacement
market could be difficult as this would require cannibalization of existing equipment at the
wireless sites, including battery cabinets and temperature control enclosures. Thus, new
infrastructure builds could offer a better injection opportunity for fuel cells, especially in mass
infrastructure rollouts where there is a greater chance to create a high level of commonality
between the different sites.

5.2.3.2 Rural Area Power Reliability

The rapid economic development in China has placed significant strain on its electric
power supply over the past few years. Despite electric generation and transmission infrastructure
upgrades over the years, many areas of the China still face significant reliability and availability
issues. In 2003, increase in electricity consumption caused 21 out of 29 provinces to suffer
shortages of power\(^39\). In 2004, more than two dozen provinces faced rolling blackouts during the
summer season as the total demand raised with the summer heat\(^40\). Developed industrial regions
of Jiansu and Zhejiang had to impose factory shut downs to meet energy demands. Although
government officials expect the shortage problem to be eased after 2007 after the completion of a
number of capacity expansion projects, many experts believe the growing demand for electricity

\(^{39}\) Wu, 2005
\(^{40}\) Jen, 2004
will outpace the available supply over the years to come. An interview with a telecom operator conducted by Ballard in Shanghai has revealed that there is an average of 30 power outages per thousand sites per day, each lasting anywhere from 1 to 8 hours.

5.2.3.3 Government Support for New Technologies

The Chinese government has shown great support over the past few years for the development of new technologies and to demonstrate its commitment to become a technology leader in the future. Government institutes such as MOST and local government bodies have provided various levels of funding to support the development and deployment of fuel cell projects which they feel could make an impact on China's technology positioning. According to a Ballard source, the governments of Wuhan city and Hubei province have allocated US$12.5 million in funding through the Science and Technology Commissions to support fuel cell projects over the next 5 years. Although most of this funding has been targeted towards vehicle development activities, the allocation of funds could be targeted to other areas if there are signs of early-market activities in other product applications. Wuhan and Hubei governments have invested in a 30% equity stake in an unnamed company to exploit new technology opportunities in the telecom backup power market.

5.2.4 Threats and Barriers

5.2.4.1 Low Price Threshold

As discussed, telecom end-users put cost as the dominating factor ahead of other attributes in backup power equipment purchasing decisions. In order for any alternative technologies to compete in this market, the cost must go down to a level where it is comparable to the current technology. While independent studies by the Citigroup, Battelle, and US DOE have all shown that fuel cells can provide a positive value proposition, they do not account for the switching cost for the end user, which is a major component given the lack of existing business
models for hydrogen fuel distribution. These types of external factors need to be taken into consideration in order to understand the true price threshold for fuel cell solutions or other new technologies.

5.2.4.2 Lack of Demonstrated Track Record

As backup power systems are the last line of defence in the event of a power failure, end-users need to depend on solutions that they know are reliable. VRLA batteries have proven to be the tried-tested-and-true solution despite the durability issues associated with them. Most end users have many years of experience with VRLA batteries and many have developed mitigation strategies to address their shortcomings. Telecom end-users are known to be highly conservative when it comes to adoption of new technologies, especially when it comes to their mission-critical equipment. Although fuel cell solutions have demonstrated to be superior in controlled field trials, the lack of mass demonstrated track record will no doubt play a part in negatively affecting potential buying decisions.

5.2.4.3 Hydrogen Infrastructure and Distribution

The lack of an established hydrogen infrastructure is probably the key barrier for fuel cell adoption. This is true for automotive applications as well as the distributed telecom power. Although hydrogen is a common industrial gas and is readily available as a by-product of many chemical plants, it lacks a well-established distribution model for common commercial use. Telecom end users will unlikely be able to leverage off their existing transportation network for the distribution of diesel fuel, as hydrogen requires storage in heavy steel cylinder bottles that are subjected to different handling and transport regulations. Companies such as Proton Energy have looked at alternative solutions to the distribution problem with on-site hydrogen generation using the electrolysis, but system efficiency and cost will inevitably suffer. Natural gas offers another potential solution as it is more readily available through pipeline grids and can be converted to
hydrogen through reforming processes, but this solution adds to the overall system complexity and cost. Urban municipalities including Shanghai and Beijing have been actively investing in hydrogen distribution for their vehicle demonstration programs but the distribution infrastructure is relatively immature.

5.2.4.4 Safety, Codes and Standards

Safety concerns continue to be a barrier for any hydrogen-related application. Although the dangers related to hydrogen are mostly misconceptions, end users in China who were interviewed by Ballard have expressed concerns about the risk of combustion and explosion. Some end-users in China fear that they could face resistance from the public if hydrogen cylinders are placed around urban areas. Codes and standards surrounding the use of hydrogen equipment will play a large role in helping end users gain acceptance. In North America, most end users look for NEBS (Network Equipment Building Systems) Level 3 compliance on their network products to ensure they are safe or propose no risk or hazards to personnel, nearby equipment, and/or physical structures. Many fuel cell system vendors have invested in NEBS 3 certification for their products to demonstrate that their solutions meet the same level of requirements as the incumbent solutions. In China, the MII has imposed that all network equipment products are to be certified with Network Access Licences (NAL) to ensure a high level of quality standards. Although backup energy storage devices are not required to be NAL certified, many domestic battery companies in China have obtained product certification from the MII.

5.2.4.5 Other Emerging Technologies

Other alternative technologies such as lithium ion batteries and the fly wheel solutions will continue compete with fuel cells as viable energy alternatives to batteries. Lithium ion

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41 Economist Intelligence Unit, 2006
batteries offer end users with the option of direct solution replacement without modification to their infrastructure, and fly wheels are good alternatives to batteries for short duration energy outputs due to their inherent reliability. Although these solutions on their own cannot offer a complete battery and diesel genset replacement like fuel cells can, they are still expected to compete with fuel cells for a share of the alternative energy solutions market.

5.3 Competitive Positioning

As Ballard and other fuel cell companies seek to enter the telecom backup power market in China (and other parts of the world), it is inevitable that they will face fierce competition from competitors that are presently and potentially looking to serve this market. Competition will come from three categories: incumbent VRLA batteries, alternative-chemistry batteries, and other fuel cell suppliers. The different competitors are expected to adopt strategies that would provide them with the best competitive advantage based on their scope and strength. Understanding their general strategic positioning can provide Ballard with some anticipation on how competitors might respond to the introduction of fuel cell backup power solutions. Figure 8 illustrates an overview of the strategic positioning that Ballard’s competitors have adopted or will likely adopt.
5.3.1 Incumbent VRLA Batteries

VRLA batteries are the industry standard solution for backup energy storage in telecom applications, occupying more than 90% of the DC power market\(^\text{42}\). Many large battery suppliers in China compete based on a low-cost strategy by developing core competencies based around production and manufacturing. Their development focus activities are generally focused on the improvement of product quality, process efficiency, and material supplies rather than on the development of new differentiated technology and products. Many large OEM manufacturers have invested heavily in the manufacturing equipment to meet high volume production requirements and achieve their cost competitiveness through the economies of scale. Their competitive position and existing resources and capabilities suggest that VRLA battery suppliers will mostly likely respond to fuel cell competition by reducing their pricing to increase demand. Leading low-cost producers may lead the way in discounting their products, as in theory they enjoy the best profits.

\(^{42}\) Darnell, 2005
5.3.2 Alternative Chemistry Batteries

Alternative chemistry batteries such as NiCd and Li-Ion are expected to make a strong push in the telecom backup power market in the short term. Prominent companies including Alpha Technologies, Avestor, and Saft, and Chinese manufacturers such as Li-Sun, have all recently introduced new lines of Li-Ion batteries that are designed to directly replace VRLA batteries in traditional battery racks. Li-Ion batteries not only offer two or three times the runtime in the same enclosure installation, they are also about one-quarter the weight for the same energy stored in VRLA products. They also have a longer shelf life compared to the VRLA batteries, thus they provide a high value proposition when life cycle cost is taken into account. Because of their improved physical properties, they carry a price premium compared to the incumbent. In the near-term, alternative battery firms are expected to continue to compete on differentiation strategies where they target their products to niche applications where VRLA batteries are impractical due to constraints such as floor space limitations or elevated operating temperatures. Under the pressures of potential fuel cell competition, alternative battery firms are likely to seek product performance improvements to further enhance the life-cycle cost business case, or to improve cost through achieving economies of scale. Their high raw material supply cost would most likely prohibit them from competing purely on cost-based strategies.

5.3.3 Fuel Cell Solutions

In this emerging market, it is difficult to clearly classify between potential customers and competitors of Ballard. Given Ballard’s strategic positioning to be a fuel cell stack supplier only, any fuel cell system companies looking to outsource their fuel cell stack development are potential customers for Ballard. For companies who are looking to develop their own fuel cell stacks internally, they will most likely adopt a product strategy that can best allow them to compete with others through differentiated product attributes or strategic target markets. As an example, ReliOn has developed its fuel cell products based on its Modular Cartridge Technology
that allows its end users to ‘hot-swap’ fuel cell cartridges in the event of a fuel cell failure without the need of a specialized service technician\textsuperscript{43}. Its Modular Cartridge Technologies provides its end users with an additional layer of product reliability for their mission critical applications. It is believed that future competitors in the telecom backup power space will be looking for ways to clearly differentiate themselves like ReliOn has, by further focusing on specific customer needs.

5.4 Key Success Factors

Ballard’s ability to succeed in this market will largely depend on its ability to address its present and anticipated future challenges that were identified in the last two subsections. Table 6 summarizes these challenges, and identifies the top key factors that Ballard needs to focus in order to be successful. The key success factors (KSF) are separated by internal and external, where the former refers to factors that can be achieved through Ballard’s internal resources, and the latter refers to factors that require external influences. The degree of impact that each KSF has in addressing the challenges are also illustrated in the table 6 and subsequently discussed.

\textsuperscript{43} ReliOn, 2007
Table 6: Key Success Factors and Impact on Present & Future Challenges

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Key Success Factors</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Technology Improvements</td>
</tr>
<tr>
<td>Internal Weaknesses (Present)</td>
<td></td>
</tr>
<tr>
<td>Lack of local marketing expertise</td>
<td></td>
</tr>
<tr>
<td>Limited knowledge of local business relationships</td>
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<tr>
<td>External Threats (Present)</td>
<td></td>
</tr>
<tr>
<td>Low end user price threshold</td>
<td>□</td>
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<tr>
<td>Lack of demonstrated track record</td>
<td>□</td>
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<tr>
<td>Hydrogen infrastructure and distribution</td>
<td>□</td>
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<tr>
<td>Public safety perception and support</td>
<td>△</td>
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<tr>
<td>Emerging alternative technologies</td>
<td>□</td>
</tr>
<tr>
<td>Potential Competitive Responses (Future)</td>
<td></td>
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<tr>
<td>Price reduction of VRLA batteries</td>
<td>□</td>
</tr>
<tr>
<td>Improved Li-Ion and NiMH batteries value / performance</td>
<td>□</td>
</tr>
<tr>
<td>Focused customer-tailored fuel cell solutions</td>
<td>□</td>
</tr>
</tbody>
</table>

Legend:
- □ Strong Impact
- △ Moderate Impact

5.4.1 Technology Cost Reduction

In order to compete in the telecom backup power market, the total solutions cost of implementing fuel cell technologies must come down to a level that is lower than the incumbent and other energy alternatives. The total solutions cost will need to capture factors such as the switching cost involved in training new staff and the transaction cost of establishing new fuel distribution agreements. Any economic analysis that fails to account for these factors will not provide a clear value proposition for the end users to make the switch. Penetration pricing strategies could be used in the short-term to stimulate the early-market demands and demonstrations; but ultimately, the only solution in reducing cost in the long term is to improve the technology. For Ballard, this can be achieved through continuous product improvements by working with key suppliers to reduce raw material cost or improve performance attributes, and/or improving manufacturing process times and yields.
5.4.2 Product Support

In order for Ballard to be successful in any of its market segments, it must be vigilant in providing its customers with the necessary support they need to be successful. New technologies will inevitably require new learning throughout the entire value chain and Ballard will need to be available to provide technical knowledge for both its direct customers and its end users. Ballard has accumulated a great amount of technical competency through the development and testing of its product. Given its current strategic positioning to be a fuel cell stack supplier only, it should to openly share its technical know-how with its system integration customers to provide them with a better chance to accelerate their product development and time-to-market.

5.4.3 Hydrogen Supply

Hydrogen availability and distribution are major considerations that telecom operators need to address as they seek to adopt fuel cell backup systems for their remote base station sites. These considerations could be a major barrier for fuel cell adoption in this market if end users cannot find adequate solutions. As such, Ballard needs to play a proactive role to help its end users identify potential options and solutions for their hydrogen supply. A hydrogen-fuelled backup power system will likely require a major overhaul of the telecom operator's network maintenance and re-fuelling business model, as hydrogen is not readily available and cannot be easily transported like liquid diesel. Telecom operators will likely need to rely on a third-party hydrogen supplier to supply and distribute hydrogen to the fuel cell-powered remote telecom sites. Ballard could seek cross promotion opportunities with major hydrogen suppliers to educate the market about the hydrogen availability, or even consider the cross promoting with hydrogen electrolyser suppliers, which could provide potential system integrators with the option to develop "self-charging" solutions that could reproduce hydrogen using electricity from the grid and would not require manual refuelling.
5.4.4 Local Partnership

Developing local partnerships with established local firms can provide Ballard with the key market channel access that it needs to be successful in this market segment. As there are strong preferences from Chinese companies to purchase from Chinese suppliers in the telecom industry, working with strong a local partner can help alleviate any potential procurement barriers. In addition, this may also qualify Ballard for any technology subsidies and funding from government-supported initiatives. Developing local partnerships also provides Ballard with access to key local intelligence on emerging trends and market changes, as well as understanding of regulatory issues. Given Ballard’s limited knowledge and presence in China, it would be tough to establish any type of market traction in the telecom segment without local help.
6 CHINA STRATEGY AND RECOMMENDATIONS

6.1 Market Entry Overview

Ballard’s market entry strategy into the backup power market in China can play a significant role in its potential success in this high market. In general, there are four different mechanisms for entering a foreign market. The options are exporting, licensing, joint venture, and direct investment. Given the current maturity of the Mark 1020 ACS product and the uncertainty involved with early-market acceptance of fuel cell solutions, the obvious focus in the near-term should be on identifying direct export opportunities to selectively target customers. Licensing or joint venture market entry modes may become viable options for Ballard in the long term if there are strong derived demands for Ballard products, but they are not suitable at this time at the current production scale. This section of the report will discuss some of the strategic considerations for selecting local partnerships and other considerations affecting market entry.

6.2 Customer Partnership Strategy

6.2.1 Partner Selection Criteria

Due to the newness and uncertain market-adoption rate for fuel cell products in the telecom backup power market, the level of interest for the development or distribution of fuel cell products will inevitably vary among different firms and the firm’s product strategy. As a result, Ballard’s partnership options will ultimately be limited by the number of potential partners who are willing to collaborate on this technology. Nonetheless, it is important to identify a systematic way of evaluating the attractiveness of all potential customers to understand the likelihood of developing a mutually beneficial commercial success together. Table 7 shows a set of partner selection criteria that was developed as a means of evaluating the fit and attractiveness of target
customers. The list of criteria includes factors pertaining to business management support, sales & marketing, product development, and other external factors. Factors are weighted by their importance to success of the relationship.

Table 7: Selection Criteria for Evaluating the Attractiveness of Potential Customers

<table>
<thead>
<tr>
<th>Weighting</th>
<th>Selection Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>High level of interest in fuel cell solutions</td>
</tr>
<tr>
<td>3</td>
<td>Willingness to put high calibre technical team on fuel cell solutions</td>
</tr>
<tr>
<td>3</td>
<td>Willingness to work through H2 infrastructure issues</td>
</tr>
<tr>
<td>3</td>
<td>High level of corporate management support</td>
</tr>
<tr>
<td>1</td>
<td>Experience in working with foreign partners</td>
</tr>
<tr>
<td>2</td>
<td>Financial strength</td>
</tr>
<tr>
<td>Sales &amp; Marketing</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Overall influence on market adoption</td>
</tr>
<tr>
<td>2</td>
<td>Strong sales relationship with procurement decision makers</td>
</tr>
<tr>
<td>2</td>
<td>Strong understanding of specific end user requirements</td>
</tr>
<tr>
<td>3</td>
<td>Established marketing channels and distribution</td>
</tr>
<tr>
<td>1</td>
<td>Expansive customer / technical support network</td>
</tr>
<tr>
<td>Technology and Product Development</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Strong product development capability</td>
</tr>
<tr>
<td>2</td>
<td>Expertise in power systems integration</td>
</tr>
<tr>
<td>2</td>
<td>Understanding of design for enclosures and shelters</td>
</tr>
<tr>
<td>2</td>
<td>Understanding of fuel cell interfaces (electrical and HVAC)</td>
</tr>
<tr>
<td>1</td>
<td>Established manufacturing capability and capacity</td>
</tr>
<tr>
<td>External</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Support and commitment from government (all levels)</td>
</tr>
<tr>
<td>3</td>
<td>Support and commitment from external stakeholders</td>
</tr>
<tr>
<td>1</td>
<td>Recognized market leader in industry</td>
</tr>
<tr>
<td>2</td>
<td>Brand reputation in China</td>
</tr>
</tbody>
</table>

Legend
4 - must have, can not work together without
3 - very important to the success of partnership
2 - important to the success of partnership
1 - nice to have, can be addressed later

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6.2.1.1 Business Management Support

The commercialization of disruptive technologies could take a longer time to materialize than some companies would like, especially in a business environment dominated by short-term profitability focus. In selecting a target customer, Ballard needs to ensure that the customer’s management team is committed to the development timeline of fuel cell solutions and have a high interest in seeing fuel cell solutions succeed. The latter factor is the most important criteria, as it would not be possible to develop a mutually beneficial business relationship together without a high level of commitment. The target customer should have the support from its executive management team, and is willing to put a high calibre team with Ballard to work through the technical and commercial barriers. Hydrogen distribution remains to be a major barrier for commercialization of fuel cell solutions and the ideal target customer should be willing to play a leading role to help end users address this issue. The customer should also have the financial strength and resources to be able to execute against its technical and commercial plans. Lastly, some experience in working with foreign partners would be beneficial.

6.2.1.2 Sales & Marketing

In the diverse telecommunication equipment industry, having an established sales relationship with telecom end users could play a large role in the speed of adoption. The ideal target customer should have a strong sales relationship with telecom end users, or have agents or distributors who can exert influence on the selection of the technology used in the power systems architecture. Ideally, the target customer should also have established market channels and distribution network for the supply of other related telecom power products. Strong understandings of specific end user requirements and relationships with key procurement decision makers are also important factors that could affect success. It would be beneficial if the target customer has a strong customer support team already in place to help end users overcome any technical issues.
6.2.1.3 Technology & Product Development

Technical capability of the target customer is an important factor as Ballard cannot deliver complete solutions to end users without collaborating with a strong partner on the product development of fuel cell backup power systems. Identifying a partner who has strong technical capabilities and ability produce quality products will play a large role on Ballard’s ultimate commercial success. The ideal target customer should have a strong product development team with well-equipped R&D laboratories, as well as a demonstrated track record in successfully developing new products. Secondly, it should also have some expertise in power systems integration to ensure that the new product solutions will have seamless operation with the rest of the telecom power systems equipment. The understanding of design principles for electrical enclosures, shelters, and HVAC are particularly important in the design of an air-cooled fuel cell system, and should be considered to evaluate potential target customers. Manufacturing capability and capacity are also factors that should be considered, but only if the other factors above could be met.

6.2.1.4 External Factors

External factors could have direct influence on the success of this market. China’s business environment is often prone to influential forces from multiple levels of the municipal governments, some of whom may have a direct equity stake in various layers of the telecom power industry. Working with a target customer who has support from the government could go a long way to help overcome commercial barriers and secure commitment to respect intellectual property. Brand reputation and recognition in the telecom industry could also be a factor to success, as telecom end users tend to purchase from approved suppliers, and the loyalty factor could favour firms with already established business relationships. Working with a recognized leader in the industry should help with the rate of adoption of fuel cell based products.
6.2.2 Customer Partnership Options

Ballard has a number of the possible options to consider in selecting target customer groups to pursue. Target customer groups could be segregated into three classifications primarily based on their positioning in the telecom power systems value chain: 1) fuel cell system developers, 2) battery / storage energy developers, and 3) power systems developers. Each target customer group has its own advantages and disadvantages.

6.2.2.1 Fuel Cell Systems Developers

As discovered through the market analysis, there is currently no focused fuel cell system developer in China who is targeting the telecom backup power market. Ballard could take a passive approach to China by collaborating with a foreign fuel cell company on systems integration, and rely on its market intermediaries to market and promote fuel cell systems to China. This is the most indirect route of getting Ballard products into the hands of Chinese customers, and also the one that is the least costly and risky. In this collaboration model, Ballard would simply supply fuel cell stacks and product integration support to its systems development customer, and allow the customer to do the rest through its distribution partners. A potential market channel would be: Ballard → Plug Power → Tyco Electronics → China Mobile
Pros
- Dedicated focus of business partner (no other product priorities)
- Partner’s experience in fuel cell operation and integration

Cons
- No direct relationship with Chinese end users
- Small influence on early-market adoption
- Difficult to customize backup solution to meet specific end user needs
- Lack of understanding of local product regulations

6.2.2.2 Battery / Power Equipment Developers

According to Ballard sources, several established VRLA battery / power equipment suppliers in China have expressed interested in developing fuel cell solutions to diversify their product portfolio. Ballard could potentially work with one of these firms to access the Chinese market. In this collaboration model, Ballard would rely on its customer to provide systems
product development and marketing in China. The fuel cell backup power solution would most likely be designed as a universal rack mount product such that it would fit into existing battery storage battery cabinets, as this would provide more product integration options for power equipment suppliers upstream. A potential market channel example would be: Ballard → Company X → Wuhan Putian → China Mobile

**Figure 7: Collaboration Structure with Battery / Power Equipment Developer**

**Pros**
- Interest in developing fuel cell solutions
- Established relationships with end-users and network infrastructure suppliers
- Possible access for government funding for new technology projects

**Cons**
- General lack of direct fuel cells experience
- General lack of power electronics and power systems interface knowledge
6.2.2.3 Power Systems Developers

Power system developers are ideal target customers if they are interested in developing alternative energy storage solutions based on fuel cells. They have the most expertise in power systems development and have the ability to incorporate Ballard full cells within their HVAC controlled enclosures to provide completely integrated primary and secondary power solutions. In this collaboration model, Ballard would work with a power systems developer to develop complete solutions specifically targeted towards the requirements of telecom users. The ideal target customer should have close relationships with Chinese telecom operators. A potential market channel example would be: Ballard → Wuhan Putian → China Mobile.

Figure 8: Collaboration Structure with Power Systems Developer

![Diagram showing the collaboration structure between FC Supplier (Ballard), DC Power Equip. Supplier (Wuhan Putian), Network Infrastructure (China Putian), Telecom Operator (China Mobile), and Backup Power (End User).]

- **FC Supplier** (Ballard)
  - Fuel cell stacks
  - FC systems integration support

- **DC Power Equip. Supplier** (Wuhan Putian)
  - FC systems integration
  - Marketing
  - Promotion
  - Sales
  - Installation
  - Product Support

- **Network Infrastructure** (China Putian)
  - Network Design
  - Installation
  - Maintenance

- **Telecom Operator** (China Mobile)
  - Maintenance
  - Hydrogen Refill

- **Backup Power** (End User)
  - Sales and Installation

Turn-key Base station
Pros

- Systems integration expertise, including the electrical interface and HVAC enclosures
- Established relationships with end-users and network infrastructure suppliers
- Strong sales force and product support network

Cons

- May not see fuel cells as being commercially ready

Given that multi-national power system suppliers own a large part of the telecom power equipment market share in China, another option for Ballard is to seek a customer partnership with a firm that could provide fuel cell systems integration overseas, and to utilize the partners’ subsidiary in China to market products to Chinese end users. Ballard currently has a major customer in Europe, Dantherm Air Handling, who has a subsidiary in China. Ballard could utilize Dantherm China’s market channels to bring fuel cell solution to the Chinese market.

6.2.3 Partnership Strategy Recommendation

Upon evaluating the available options, Ballard is recommended to target customer partnerships with telecom *power system developers* who may be interested in developing fuel cell solutions as part of their extended product portfolio. An evaluation of the different partnership options is shown in Table 8, which shows the weighted ranking for each target customer groups based on some of the selection criteria defined in section 6.2.1. Only factors pertaining to sales & marketing and technology & product development are considered in this evaluation, as business management and external factors tend to be more company-specific. The latter factors would need to be considered to evaluate the attractiveness of each specific firm.
### Table 8: Selection Criteria Ranking of Target Customer Groups

<table>
<thead>
<tr>
<th>Weighting</th>
<th>Selection Criteria</th>
<th>Fuel Cell System Developers</th>
<th>Battery / Power Equipment Developers</th>
<th>Power System Developers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sales &amp; Marketing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Overall influence on market adoption</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Strong sales relationship with procurement decision makers</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>Strong understanding of specific end user requirements</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>Established marketing channels and distribution</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>1</td>
<td>Expansive customer / technical support network</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>Weighted Ranking</strong></td>
<td></td>
<td>13</td>
<td>18</td>
<td>27</td>
</tr>
<tr>
<td><strong>Technology &amp; Product Development</strong></td>
<td></td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>Strong product development capability</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Expertise in power systems integration</td>
<td>3</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Understanding of design for enclosures and shelters</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Understanding of fuel cell interfaces (electrical and HVAC)</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>Established manufacturing capability and capacity</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td><strong>Weighted Ranking</strong></td>
<td></td>
<td>26</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td><strong>Total Weighted Ranking</strong></td>
<td></td>
<td>39</td>
<td>33</td>
<td>52</td>
</tr>
</tbody>
</table>

Legend:  
3 = High, 2 = Medium, 1 = Low

Although table 8 was developed to provide an overview of the generic groups and may not be accurately reflect specific firms within the group, it does show that working with telecom power system developers is generally more advantageous than battery developers or even fuel cell system developers. Theoretically, a China-based power systems developer would be the most ideal, as it should have a better understanding of the end user requirements and thus be able to develop more tailored backup power solutions than a foreign partner whose universal solutions might be better adapted for other geographic segments.

From the partner selection criteria table, the ability to influence market adoption and having established marketing channels and distribution to end users are two of the most the important factors under the sales & marketing category. Power system developers are ranked the highest in these factors compared with the others groups, as they are the ones with the most visibility on the end user’s power system architecture and can directly recommend fuel cell to end
users. They also have existing channels to market through their other telecom power product offerings, and would not need to rely on additional layers of sales agents or value-added resellers to push products through the value chain. They are closer to the end-users than the other groups.

From a technical perspective, power system developers may not be as familiar about fuel cells as some of the focused fuel cell system developers. For example, power system developers may not have any prior experience with the development of electrical and balance of plant interfaces for fuel cell powered solutions. But these technical system design barriers should be easier to overcome than some of key marketing challenges. The learning curve required to develop a backup powered solution around a Ballard air-cooled fuel cell stack should not be any more difficult than the development of other power equipment products. Many telecom power system developers are already familiar with product integration inside enclosures and shelters, and this knowledge should be directly transferable to the design of fuel cell-based products.

Given the pyramid structure of the Chinese telecom industry with relatively few end-users and high number of OEM suppliers, it is important to get as close to the end user as possible in order to exert maximum influence on purchasing decisions. This is especially important during the early stages as it would allow Ballard to assess the actual attractiveness of this market with respect to its other opportunities. Partnering with a power systems division or business unit of a vertical integration telecom equipment company can provide even greater advantages as vertically integrated firms generally tend to have better control over the deployment of new technologies.

Battery and power equipment companies interested in fuel cells do not appear to an ideal market entry point for Ballard. From a technical perspective, they generally lack the depth required to develop complete backup power solutions that integrate with the electrical, HVAC, and enclosure design of the complete telecom energy solution. They also have relatively little
influence on the market adoption rate from their distant value chain position. Unless they have established end user relationships and the channel-to-market networks necessary to push fuel cell solutions upstream, they could have a tough time breaking through to market. But nonetheless, if a battery technology firm is serious and committed about getting into the fuel cell systems business, they might be able to overcome these shortcomings. So despite the short falls, these players could turn out to be a good option for Ballard if they could commit to a respectable supply volume.

Working with a foreign fuel cell system developer to get fuel cells to China is the most indirect method of market entry. Unless the fuel cell system developer already has a well established market channel in China, the chance of succeeding in this geographic market segment will most likely be low due to the numerous local market challenges.

6.2.4 Target Customers Recommendation

Based on the current understanding of the telecom power market in China, Ballard is recommended to focus its near-term business development activities to evaluate potential partnership with the following Chinese power system providers:

- ZTE, China’s largest public telecommunications equipment provider specializing in offering customized network solutions for telecom carriers worldwide. Its Power Products department receives heavy R&D investment to develop its own portfolio of power system products.

- Wuhan Putian Telecom Equipment Co., subsidiary of the China Putian Group, one of China’s top three companies in the telecom DC power market and largest domestic battery supplier for the telecom industry.
• Beijing Dongliyuan (Dynamic Power) Science & Technology, a publicly-listed professional power electronic manufacturer specializing in the development of innovative telecom power products.

The companies listed above have established business relationships with telecom end users to provide DC power systems as well as backup energy solution in telecom network infrastructures. They are also known for their technology development capabilities. However, specific details about their product strategies and the role fuel cell plays in the future are unknown at this time.

A number of multi-national telecom power system companies including the Emerson Network Power and Delta Electronics are also potential partnership candidates, as they have a strong sales and marketing network in China who may push fuel cell solutions to end users.

The following companies have expressed interest in developing fuel cell solutions but are considered to be second-tier customers at this time due to their shortcomings in market influence and technology capabilities. Nonetheless, their willingness to work through these issues to establish themselves as the market niche in China could turn them into strong players later. Ballard should continue to entertain possible partnership opportunities with them, but should not commit unless a clear channel-to-market strategy can be demonstrated.

• Company X, one of the major domestic VRLA battery manufacturers and supplier of power source of central exchange room and base stations for China's large size telecom operators.

• Company Y, a power equipment supplier which specializes in the research & design, manufacture and marketing of lead acid batteries, power supplies and energy-related
business for telecommunication, railway, electric power, UPS, photovoltaic system and wind energy storage system.

The ultimate down-selection of a lead partner would depend upon the mutual interest of the parties and benefits of the partnership structure. The partner selection criteria as show on Table 7 should be used as a guide to evaluate the attractiveness of a potential partner.

6.3 Other Considerations

6.3.1 Key Influencers

In the early stages of the China market development, Ballard will need to get a better understanding of the relationship details between every single layer of the value chain in order to refine its overall market entry strategy. A true gauge of the attractiveness of this market will require a confirmation of the actual end user demand, as well as a better assessment of the local competitive rivalry. Aside from engaging in market information gathering activities with each sub-segment of the telecom power industry, Ballard is recommended to develop relationships with key influencers in the industry who may have understanding to some of the identified key market barriers. These influencers include the Ministry of Information Industry (MII), China Industrial Associations of Power Sources (CIAPS), and the China Association of Hydrogen Energy (CAHE).

The Telecommunications Administration Bureau of the MII is the government body involved with the regulatory of all telecom equipment and networks. It could hold key information regarding the local codes and standards and/or special requirements pertaining to the deployment of new technologies.

The CIAPS is the biggest professional battery association in China. It serves as the bridge between government and local enterprises, and has demonstrated support for fuel cell
technologies by the endorsing the latest International Hydrogen and Fuel Cell Expo exhibition in Japan in February 2007. It could hold key knowledge regarding potential collaborators or competitors in the telecom backup power market.

CAHE has been a strong promoter to hydrogen and fuel cell activities in China and could hold key information regarding the hydrogen infrastructure network.

6.3.2 End User Awareness

Given the newness of fuel cells solutions and the potential lack of end user awareness in China, Ballard should attempt to play an active role to educate telecom operators, and to assist power equipment vendors to communicate the value proposition of fuel cell solutions. A market strategy that directly influences end-users or key equipment purchasers could potentially stimulate customer demands that might result in market pull for Ballard fuel cells. Ballard should actively seek opportunities with telecom equipment suppliers who have customers that are interested in fuel cells, and attempt to get them engaged in field trial demonstrations with one of Ballard's current or potential system integration partners. The major companies that Ballard should seek to establish relationships with include Huawei, Datang Telecom, and China Putian, all of whom have major market shares in the Chinese telecom equipment supply market. In this early-maturity stage, Ballard cannot simply rely on a business-to-business sales strategy with its target customers without trying to exert influence along the market chain to drive market demand. Getting fuel cell products into the hands of end-users will inevitably trigger interest amongst players in the industry and would help shape the future of the market.
The telecommunications backup power market is considered to be a key strategic near-term revenue opportunity for Ballard. With the rapid growth of the telecom industry in China, this geographic market segmentation could hold big rewards if Ballard can establish the right customer partnerships to bring fuel cells solutions to end-users. As discussed, there are a number of key external factors that would influence the success in market, including overcoming hydrogen distribution issues and cost barriers. But ultimately, success in this market will be determined by the ability for Ballard and its partners to develop products that customers want to buy because the product solution can best meet their needs. Thus, Ballard not only needs to work with its target customer to deliver product solutions, it also needs to be engaged with its target end users to understand their requirements. It also needs to work with key industry influencers such as government departments and industry associations to promote the advantages of fuel cell solutions. This multi-prong approach is necessary given the current technology immaturity and potential lack of user awareness in this market.

The telecom power market in China has undergone major transformations over the past few years, marked by emergence of new players, partner collaborations, and consolidations. With a focused marketing and business development effort and strategic targeting of the right customers, Ballard has an opportunity to become a key supplier in this opportunistic market.
REFERENCE LIST


