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PLAN DE COMERCIALIZACIÓN DE UN SISTEMA DE GESTIÓN DE BATERÍAS EN EL MERCADO MANUFACTURERO DE SISTEMAS DE BATERÍAS DE IONES LITIO EN ALEMANIA

TESIS PARA OPTAR AL GRADO DE MAGISTER EN GESTIÓN PARA LA GLOBALIZACIÓN

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RESUMEN

PLAN DE COMERCIALIZACIÓN DE UN SISTEMA DE GESTIÓN DE BATERÍAS EN EL MERCADO MANUFACTURERO DE SISTEMAS DE BATERÍAS DE IONES LITIO EN ALEMANIA

El Acuerdo de París es un compromiso para reducir las emisiones de carbono y mitigar el cambio climático. En consecuencia, muchos países han optado por incluir y promover la producción de energía renovable, como la generación de energía solar y eólica. Sin embargo, algunas de estas tecnologías no pueden producir energía de forma continua y pueden crear problemas cuando se conectan a la red de distribución. Un sistema de baterías resuelve estos problemas y crea la oportunidad de almacenar energía en peaks de generación y vender el excedente a la red eléctrica.

Brill Power, un start-up de Inglaterra, ha diseñado un sistema de gestión de baterías (BMS), un componente de los sistemas de baterías de iones litio, que mejora el rendimiento de las baterías. Esta tesis examina el potencial para comercializar este producto en un mercado extranjero.

Actualmente, Brill Power está desarrollando proyectos piloto centrados en validar la tecnología con compañías en el mercado de energía en Inglaterra. Además, están trabajando en un proyecto para incluir una garantía con el producto en asociación con una compañía de seguros independiente. Según sus planes, esperan generar ingresos en el año 2020 e ingresar a nuevos mercados geográficos en el año 2021.

El mercado de baterías de países como Alemania, Australia, Japón, Corea del Sur y Estados Unidos ofrecen una oportunidad para expandir sus operaciones. Alemania mostró el mayor potencial debido a un mercado de energía renovables maduro, políticas correctas para promover los sistemas de baterías y las excelentes variables macroeconómicas y de accesibilidad al mercado energético.

Se utilizó el modelo CANVAS para desarrollar el modelo de negocio mediante la identificación de la propuesta de valor de Brill Power. Dentro de Alemania, los servicios que muestran el mayor potencial son el de almacenamiento con fines residenciales o comerciales. Este mercado está dominado por los fabricantes alemanes que poseen el 67% de la cuota de mercado. Estas empresas valoran la diferenciación porque se centran en un producto premium en lugar de atraer a un mercado masivo.

Adicionalmente, se desarrolló el plan de marketing, de operaciones, de recursos humanos y financiero con un horizonte de proyección de 5 años. El éxito de esta iniciativa depende del precio inicial y los esfuerzos de marketing, es clave promover el producto a través de los canales de distribución.

Por último, este plan de negocios es rentable con un valor de VAN US$ 505.976 y un TIR del 46,3%. El análisis de sensibilidad mostró que el éxito está fuertemente relacionado con el precio del producto. Si el precio se mantiene constante en el valor inicial, este negocio no es rentable. Sin embargo, con incrementos superiores al 5% cada dos años, este negocio es rentable.

AGRADECIMIENTOS

Haber cursado el Global MBA será una experiencia que nunca olvidaré tanto por mi crecimiento académico, profesional como personal.

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EXECUTIVE SUMMARY

The Paris Agreement is a commitment to reduce carbon emissions and mitigate climate change. Consequently, many countries have chosen to include and promote renewable energy production like solar and wind energy generation. However, some of these technologies cannot produce energy continuously and can create issues when connected to the grid. A battery system solves these problems and creates the opportunity to store energy in peaks of generation and sell the surplus to the grid.

Brill Power, a start-up from the United Kingdom, has designed a battery management system (BMS), a component of lithium-ion batteries systems, which improves the performance of batteries. This thesis examines the potential of a foreign market to commercialize this product.

Currently, Brill Power is developing pilot projects focused on validating the technology with companies in the energy market in England. Also, they are working on a project to include a warranty for the product provided by an independent insurance company. According to their plans, they expect to generate revenues by 2020 and to enter new geographic markets by 2021.

The storage market of countries like Germany, Australia, Japan, South Korea, and the United States presents an opportunity to expand its operations. Germany showed the biggest potential due to a mature renewable energy market, the right policies to promote storage systems, and outstanding macroeconomic and market accessibility variables.

The CANVAS model was used to develop the business model by identifying the value proposition of Brill Power. In Germany, the services that show the biggest potential is stationary storage for residential or commercial purposes. This market is dominated by German manufacturers that hold 67 percent of the market share. These companies value differentiation because they focus on a premium product rather than to appeal to a mass market.

Additionally, the marketing, process, human resources, and financial plan was developed with a projection of 5 years. The success of this initiative depends on the initial price and marketing efforts, it is key to promote through the channels.

Lastly, this business plan is profitable with a value of NPV US$ 505.976 and IRR 46,3%. Sensitivity analysis showed that success is strongly connected to the price of the BMS. If the price stays constant at the initial value, this business is not profitable. However, with increments higher than 5 percent every two years, this business is profitable.

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1. INTRODUCTION

Climate change poses a threat to every country in the world. Scientific evidence predicts that the world will suffer from severe consequences in the short and long-term due to climate change. Example of these consequences are sea level rise, changes in rain pattern, draughts and increase frequency of extreme weather events like hurricanes, storms, and wildfires. Furthermore, these consequences can rapidly be expressed in economic loss.

Each country has committed under the Paris Agreement to reduce carbon emissions. In this context, many countries have chosen to include and promote renewable energy production. Carbon emissions from electricity and heat production account to 49 percent of the global emissions (The World Bank, 2014) due to a strong reliance on fossil fuels for electricity production. Thus, technologies like solar and wind energy generation are becoming widely spread to decarbonize the electricity grid. Furthermore, the cost of these technologies has significantly reduced over the last few years. However, some of these renewable technologies cannot produce energy continuously and can create issues when connected to the grid such as problems with harmonic currents. A battery system solves these problems and creates the opportunity to store energy in peaks of generation and sell the surplus to the grid.

Brill Power, a start-up from the United Kingdom, has designed a battery management system (BMS), a component of lithium-ion battery systems, which improves the performance of batteries. This thesis examines the potential of a foreign market to commercialize this product.

1.1 ORGANIZATION DESCRIPTION

Brill Power is an organization that was born in the year 2016 from the initiative of postgraduate students of the University of Oxford in the United Kingdom. This entrepreneurship commercializes a product of original design that aims to revolutionize the lithium-ion battery market. This product is a BMS, consists of a combination of hardware and software installed in multi-cell batteries. The hardware corresponds to a printed circuit board (PCB) and through the software designed, it improves the performance of batteries and extends the useful life by 60 percent (Brill Power, 2018). At present, this product has three patent applications pending and expects to be completely patented by 2020.

Currently, Brill Power has a full-time staff of 6 people with an office in the city of Oxford in the United Kingdom. This team has the support of expert consultants in entrepreneurship and the energy market. In addition, they are associated with groups focused on smart energy research such as The Energy and Power Group of the University of Oxford, and with groups that support innovations related to mitigation and adaptation to climate change, such as EIT Climate-KIC and The Enterprise Europe Network.

This organization is financed by seed capital of the EIT Climate-KIC group and by funds granted by Innovate UK, a public body supported by the government of the United Kingdom. Although this organization is in an initial stage, it has received prestigious awards that reaffirm its innovation potential. For instance, the election within the top 50 start-ups of the European Union and its presentation to the European Parliament at the Innovation Conference of the year 2017.

Currently, Brill Power is developing pilot projects focused on validating the technology with companies in the energy market in England, and consequently, promote the product in this market. For example, a project with the company Shell, which seeks to replace their lead batteries in installations on maritime platforms with limited access, by lithium-ion batteries with this improved energy system management. These pilot projects will validate the product for stationary storage (residential and grid-scale) and electric vehicles services.

1.2 GLOBALIZATION OPPORTUNITY JUSTIFICATION

Brill Power is a company with significant growth potential in an expanding market. Brill Power has established a roadmap for the next years, by 2020 they expect to generate revenues, and by 2021 they expect to enter new geographic markets. Therefore, the objective of this company is to introduce its product to foreign markets.

The storage market of countries like Germany, Australia, Japan, South Korea, and the United States presents an opportunity to expand its operations outside the United Kingdom. First, because of the high rate of adoption of renewable energy and the presence of a mature renewable energy market. Second, due to financial incentives such as grants and subsidies for the deployment of storage projects. Lastly, current policies in these countries are in line with the promotion of investment in energy storage at residential and grid scale. All of these countries have high GDP and in most cases a society with a high purchasing power. These reasons support the potential of marketing this product with a value proposition that differentiates from other similar products.

1.3 OBJECTIVES

GENERAL OBJECTIVE

To develop a business plan for the commercialization of a battery management system design and produced by Brill Power to enter into the market of energy storage in Germany.

SPECIFIC OBJECTIVES:

- Carry out an analysis of the market for BMS for battery systems in a set of potential countries.
- Identify the most attractive country in the BMS/battery system market.
- Strategic analysis to assess the potential of the BMS/battery system market in the selected country.
- Generate a marketing, process, human resources, and financial plan.

1.4 METHODOLOGY

The development of this thesis follows the structure of a business plan.

First, a market analysis of the current global battery industry was carried out, compiling bibliographic information through statistics, reports, and studies related to the industry. Then, a set of variables were defined to compare markets and chose the country with highest potential considering macroeconomic, market accessibility, and renewable and energy storage market variables.

Then, market research was done beginning with the elaboration of the chain value to identify the position of Brill Power and the main participants at a global scale. In particular, the German market was analyzed to quantify the size and identify main competitors through statistics, reports, and interviews with potential clients and Brill Power's CEO.

Subsequently, a strategic analysis was carried out using the frameworks PESTLE, SWOT and Porter's five forces. PESTLE is an acronym that stands for Political, Economic, Social, Technological, Legal, and Environmental and factors. It is a framework used to analyze the external environment that can have an impact when entering a foreign market. SWOT is an acronym that stands for Strengths, Weaknesses, Opportunities, and Threats. It is a framework used to analyze competitive advantages based on internal and external factors. Lastly, Porter's five forces framework (rivalry among existing competitors, bargaining power of suppliers, bargaining power of buyers, threat of new entrants, and threat of substitute products) is used to assess the forces that interact in a market that set industry profitability in the medium and long run.

Next, and based on the information and conclusions from the previous analysis, the value proposition of Brill Power was defined along with the business model using the CANVAS framework. The marketing plan is described, using the theory of strategic marketing (segmentation, targeting, and positioning) and 4Ps (product, price, place and promotion). And, the process and human resources plan was developed.

Lastly, the financial evaluation of the business was carried out, to present a cash flow in the medium term (5 years) and the calculation of indicators that define the viability of the project (NPV and IRR).

1.5 EXPECTED RESULTS

The expected results are the following:

- Quantification of the economic potential of the battery market in the selected country.
- Definition of an entry strategy to a potential country, considering the process, commercial, financial and human resources strategies.
- Conclusions and recommendations for the decision to expand Brill Power to the selected market.

2. MARKET ANALYSIS AND SELECTION

2.1 PRODUCT DESCRIPTION

Batteries consist of a system that absorbs energy in some form at one time and releases it later. Technologies of batteries differ from the storage medium such as mechanical, chemical and electrochemical. In particular, electrochemical batteries use chemical reactions with two or more cells to enable the flow of electrons (AECOM, 2015). Within electro-chemical batteries, there are different material for the cells being lithium-ion and lead-acid the most common.

A battery is comprised of a group of cells with a management system within each pack as shown in Figure 1. This part of the system (BMS) is the one commercialized by Brill Power to improve the performance of the cells. There are other parts of the system to control the operation of the group of packs like the energy management system and thermal management.

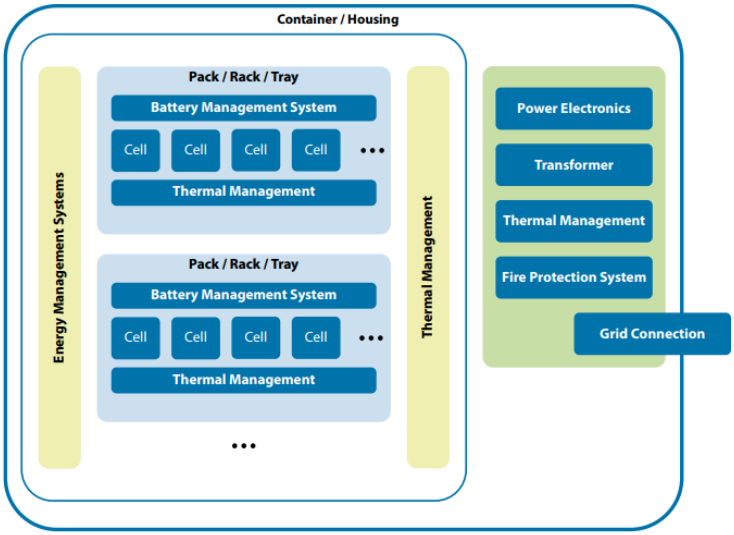

Figure 1. Generic battery scheme. Reprinted from International Renewable Energy Agency, 2017.

The BMS designed and commercialized by Brill Power is only for lithium-ion multi-cell batteries. This is the most used technology, and it represents around 55 percent of the battery installed capacity on a global scale as shown in Figure 2.

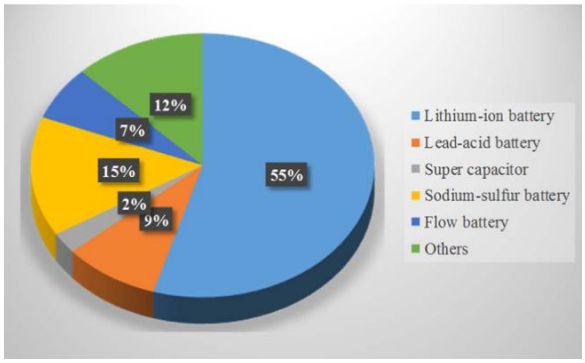

Figure 2. Global batteries installed capacity by technology. Reprinted from Zhang, Wie, Cao & Lin, 2018.

Lithium-ion batteries are preferred over other materials because of better performance (higher energy and power density) and longer lifespan. However, cost production is higher than in other technologies. This technology started to be used in electric vehicles and recently has been introduced in large scale grid storage (Zhang, Wie, Cao & Lin, 2018).

Brill Power assessment of current BMS configurations has shown that battery packs fail prematurely because of how they are designed. The pack capacity is the capacity of the weakest series connected cell (weakest link) that leads to battery oversizing to counteract it. This oversizing lead to an increased cost of 18 percent and among other disadvantages, increases the size and weight of the system. Their approach is to use total current control to manage all the current through each series connected cell or module during charge and discharge based on intelligent diagnostics of battery module health and innovative hardware designs. Current approaches used by competitors are based on passive balancing or active balancing which do not solve the weakest link problem.

Regarding demand, in 2017 South Korea, United States, Japan, United Kingdom, Germany, and Australia led the market. Moreover, South Korea surpassed the United States and became the country with more storage installed capacity as shown in Figure 3.

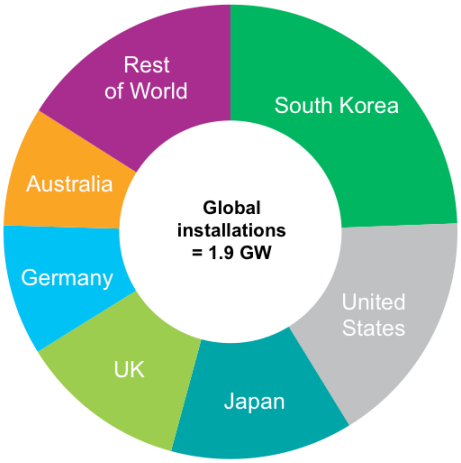

Figure 3. Global energy storage installation by country in 2017 in MW. Reprinted from Jansen, 2018.

Furthermore, projections show exponential growth in storage deployment as shown in Figure 4, in particular for the United States, China, Japan, India, Germany, United Kingdom, Australia, and South Korea. By 2030 global storage is expected to double six times with a total investment of US$ 103 billion and 70 percent of projects will occur in eight countries (Bloomberg New Energy Finance, 2017).

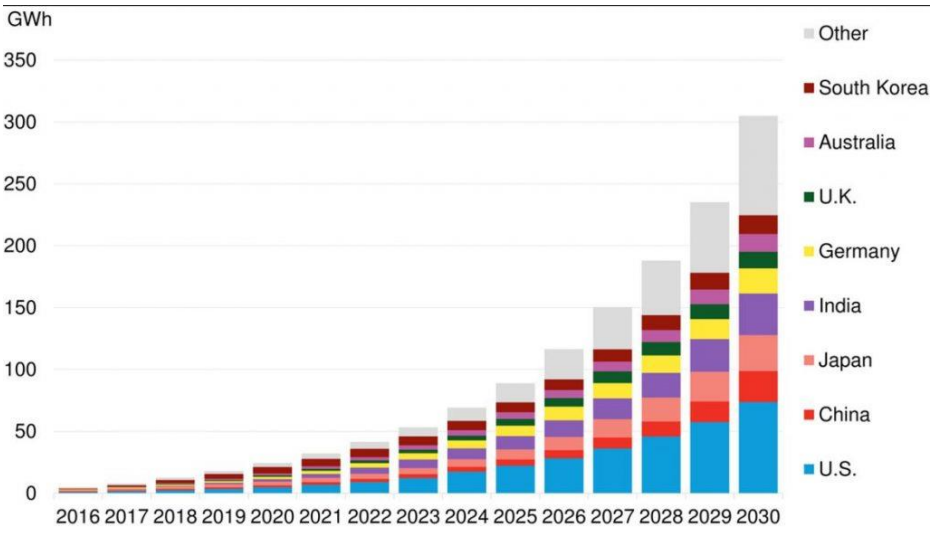

Figure 4. Global cumulative storage deployments. Reprinted from Bloomberg New Energy Finance, 2017.

Therefore, the most attractive markets to commercialize a battery management system are South Korea, the United States, Japan, Germany, and Australia. This five countries will be analyzed considering macroeconomic variables, market accessibility variables, and renewable energy and storage market variables, which are summarized in Table 1.

Table 1. Analyzed variables for chosen countries.

Macroeconomic variables	Market accessibility variables	Renewable energy and storage market variables
• Population • GDP • GDP per capita • Economic growth • Inflation • Unemployment rate • Purchasing power parity	• Competitiveness level • Ease of doing business index • Current national policies and trends	• Renewable energy production • Renewable share in electricity production • Electricity retail price • Installed storage capacity • Storage projects announced or under construction • Desire of self-sufficiency

Note: Own elaboration.

2.2 MACROECONOMIC VARIABLES

Macroeconomic variables are considered to assess the stability of the countries. Table 2 and Table 3 presents the data from the selected countries from different secondary sources and corresponds to information of the year 2017.

Table 2. Macroeconomic variables for selected countries.

Country	Population	GDP	GDP per capita	Economic growth
Unit	Million people	Billion USD	USD per capita	Percent
South Korea	51,466	1.530	36.629	3,1
United States	325,719	19	57.591	2,3
Japan	126,785	4.872	42.292	1,7
Germany	82,695	3.677	49.187	2,2
Australia	24,589	1.323	48.021	2,0

Note: Data of population, GDP and economic growth from The World Bank, 2018. Data of GDP per capita from OECD, 2018.

Table 3. Macroeconomic variables for selected countries.

Country	Inflation	Unemployment rate	Purchasing power parity
Unit	Percent	Percent	National currency/USD
South Korea	2,3	3,8	877,1
United States	1,8	3,9	1
Japan	-0,2	2,4	99,6
Germany	1,5	3,4	0,8
Australia	3,7	5,4	1,5

Note: Data of inflation from The World Bank, 2018. Data of unemployment and purchasing power parity from OECD, 2018.

2.3 MARKET ACCESSIBILITY VARIABLES

Another set of variables essential to assess the potential of a country are market accessibility variables. Table 4 presents the data from the selected countries from different secondary sources and corresponds to information of the year 2017.

Table 4. Market accessibility variables for selected countries.

Country	Global Competitiveness Index	Ease of doing business index
Unit	Score	Position in ranking
South Korea	5,07	4
United States	5,85	6
Japan	5,49	34
Germany	5,65	20
Australia	5,19	14

Note: Data of global competitiveness index from World Economic Forum, 2017. Data of ease of doing business index from The World Bank, 2018.

Moreover, there are policies in every country aim to promote energy storage. These policies can be grants, subsidies and tax incentives. Grid modernization plans, direct financial incentives for storage projects and phase-out of feed-in tariffs are also drivers for the investment in storage systems (Deloitte, 2018). Table 5 summarizes the situation in each country considering these specific drivers.

Table 5. Current national policies and trends in selected countries.

Country	Current national policies and trends
South Korea	*Grid modernization:* South Korea is a leader in smart grid development, it is considered a fundamental part of the action plan to build a green economy. They have defined a roadmap with short-to medium-term goals to achieve a nationwide smart grid by 2030 (United Nations ESCAP, 2012). *Financial incentives:* The government gives incentives to operators who install energy storage systems alongside their utility-scale solar plants. These incentives are additional points on the assessment of their renewable energy certificates. The government expects to invest US$391.6 million in new energy storage systems from 2017-2020 (Deloitte, 2018). These incentives are to promote the internal production of batteries since South Korea has important companies in the manufacture of batteries such as Samsung SDI, LG Chem, and Kokam. *National policy:* Renewable Portfolio Standard is the main policy tool that helps renewable energy projects become economically competitive by providing market-based incentive. With each project, Renewable Energy Certificates are emitted. When projects include energy storage, the weight of this certificate is the highest (Heo, 2018).
United States	*Grid modernization:* In 2007, the Smart Grid Investment Matching Grant program was established to help support the modernization of the nation's electricity system. However, funds have been scarce which have led to a slow modernization of the grid; the specialists advised for the need for more funds from Congress to achieve the goal (Campbell, 2018). *Financial incentives:* There are financial incentives only at a state level. California has a Self-Generation Incentive Program, which provides financial incentives for installing customer-sited distributed generation at the residential scale (U.S. Energy Information Administration, 2018a). *Phase-outs of the net metering policy:* Hawaii has a mature solar market. Since 2015 the state eliminated the net metering policy and included incentives programs for feeding electricity into the grid. Although, these policies are only present in Hawaii and are not a national trend. *National policy:* The US Department of Energy's Advanced Research Projects Agency-Energy program has invested significantly in energy storage R&D through a number of its programs (Australian Academy of Technology and Engineering, 2017). However, there is no national policy. Many states have implemented policies to support energy storage, particularly at utility scale. California stands out from the rest and has introduced the most measures related to energy storage, energy targets and incentives (U.S. Energy Information Administration, 2018a).

Germany	*Grid modernization:* The German government is providing a framework in which the system operators can invest in modern grids. The government is analyzing the purposes for which smart grids and meters can usefully be deployed, and it is putting policies in place for these to be used securely (Federal Ministry for Economic Affairs and Energy, 2015). *Phase-out of feed-in tariffs:* In 2016 Germany ended feed-in tariffs in favor of competitive auctions and clear volumes for wind energy development (Hill, 2016). Thus, the owners of these technologies are more inclined to invest in storage to obtain higher returns from their energy investment. *Financial incentives:* An example of financial incentives in Germany is the primary control reserve market. Participants in this market generate revenue by winning a weekly auction and receiving remuneration for providing the capacity to balance the grid. With the decline of battery cost, this market has promoted the deployment of battery systems. *National policy:* In 2011 the German Government implemented the Energy Storage Funding Initiative, focused on using energy storage to relieve pressure on distribution grids (Australian Academy of Technology and Engineering, 2017). The Federal Government spends roughly 820 million euros a year on supporting all phases of research and development of new energy technologies, from basic research to project applications (Federal Ministry for Economic Affairs and Energy, 2015).
Japan	*Grid modernization:* Japan is already considered to have a widespread smart grid compared to other countries, is one of the world leaders in smart grid and energy storage technology (Berre, 2016). There are Japanese companies, like Fujitsu and NEC, developing smart grid technology to make the grid more suitable for the connection of renewables (Influence Map, 2017). *Financial incentives:* Japan has extensive public funding and support for energy storage research, as well as vast subsidies for energy storage at both residential and utility scale. Examples are a feed-in tariff scheme and high-budget energy storage subsidies. *National policy:* Japan is actively subsidizing and promoting energy storage as part of broad restructuring efforts, aimed at ensuring reliability and reducing dependency on international energy companies and imports (Deloitte, 2018).

Australia	*Grid modernization:* Due to issues with the reliability of the current energy supply, Australia is undergoing a grid modernization to improve resilience and address supply shortfalls. An example is the installation of the biggest lithium-ion battery (100 MW) in South Australia with the participation of Tesla (Deloitte, 2018). *Financial incentives:* There is a range of different programs and incentives in Australia that support industry development and research opportunities in energy storage. Examples are grant funding through ARENA for financial support for early-stage research and development in the energy sector, subsidies for energy storage installation for pilot projects, support for startups, direct procurement and R&D tax incentive (Australian Academy of Technology and Engineering, 2017). *Phase-out of feed-in tariffs schemes for small-scale solar PV:* Since 2012, these schemes have been phased out and replaced by 'market offers' from electricity retailers at unregulated prices. These incentives tend to be much lower than premium feed-in-tariff rates (Australian Energy Regulator, 2017). This has led to more investment in batteries to capitalize on the existing investment in solar PV. *National policy:* National policies are oriented to direct incentives for storage projects that are comprised by two schemes. First, the Emissions Reduction Fund, a voluntary scheme that provides incentives to adopt new practices and technologies to reduce emissions or store carbon (Clean Energy Regulator, 2017). Second, the Renewable Energy Target that encourages the supply of additional electricity from renewable sources (Clean Energy Regulator, 2017).

2.4 RENEWABLE ENERGY AND STORAGE MARKET VARIABLES

Lastly, it is important to consider variables from the renewable energy and storage market because it shows the level of maturity of these technologies in each country. Table 6 and Table 7 presents the data from the selected countries from different secondary sources and corresponds to information of the year 2017.

Table 6. Renewable energy market variables for selected countries.

Country	Renewable energy production	Renewable share in electricity production	Electricity retail price
Unit	TWh	Percent	USD (PPP)/MWh
South Korea	18.935	3,7	160
United States	3.223	8,3	125
Japan	86	8,5	240
Germany	189,4	34,6	375
Australia	954	2,1	175

Note: Data of South Korea from Korea Energy Statistical Information System, 2018. Data of United States from U.S. Energy Information Administration, 2018b. Data of Japan from International Energy Agency, 2016. Data of Germany from Burger, 2018. Data of Australia from the Department of Industry, Innovation, and Science, 2016. Data of electricity retail price from International Energy Agency, 2018.

Table 7. Renewable energy market variables for selected countries.

Country	Installed storage capacity*	Storage projects announced or under construction*
Unit	MW	MW
South Korea	162	49
United States	642	1055
Japan	90	8,5
Germany	301	87
Australia	222	450

Note: Data from the Office of Electricity, 2018.
*Only projects with lithium-ion battery technology.

The desire of self-sufficiency from customers is a qualitative variable that is an influential driver for the deployment of storage energy projects. This trend has been only recognized in Germany and Australia. The energy market in these countries presents a unique behavior, driven by the demand/supply combined with government incentives. These communities have a preference for clean energy and batteries and follow the same trend that has been presented with photovoltaic solar panels. Moreover, they want to be energetically self-sufficient and independent of centralized electricity supply.

2.5 AGGREGATED VARIABLES ANALYSIS

A ranking was made between the three groups of variables assessed in points 2.2, 2.3 and 2.4 to identify which is the country with the most significant potential of entry for this product. The variables in each group were given a rank between 1 and 5, where 5 is the best and 1 is the worst. Then, an average was calculated for each group of variables. Finally, each group was given weight to include the importance of these variables to calculate a final score.

The weight was determined according to the leading drivers for the deployment of storage projects summarized by Deloitte (Deloitte, 2018). Amongst these drivers, the following stand out.

- Grid modernization actions to boost resilience, reduce system outages and improve overall efficiency.
- The presence of financial incentives to invest in batteries such as tax rebates, grants or subsidies.
- Phase-outs of feed-in tariffs or net metering
- The desire for self-sufficiency from energy consumers
- National policy in line with the promotion of deployment of storage projects

Each one of these drivers was identified in each country and are considered to be the most critical variables. However, macroeconomic variables where also considered for the final score to include the stability of the country in the assessment. Consequently, the three set of variables analyzed were given the following weigh to obtain a final score.

- Macroeconomic variables: 15%
- Market accessibility variables: 55%
- Renewable energy and storage market variables: 30%

For variables of renewable energy production, installed storage capacity and storage projects announced or under construction, per capita values were used to assess the market size.

The final ranking of the selected countries is summarized in Table 8. For more details see Appendix A.

Table 8. Average ranking and final average of variables for selected countries.

Country	Average Macroeconomic Variables	Average Market Accessibility Variables	Average Renewable Energy and Storage Market Variables	Final Average *
Germany	3,3	3,0	3,8	3,29
Australia	1,9	3,2	3,8	3,17
Japan	3,7	3,0	1,8	2,76
South Korea	3,0	2,8	2,3	2,71
United States	3,1	2,5	2,2	2,50

Note: Own elaboration.

*Average includes weighing.

Therefore, Germany is the country with the most potential to commercialize the BMS designed by Brill Power. The variables showed a mature renewable energy market and the right policies to promote storage systems. Moreover, Brill Power has recently started to contact prospects from this country to expand their operations. Thus, Germany is the country selected to design the business plan.

3. MARKET RESEARCH

3.1 CHAIN VALUE

A chain value of the process of manufacturing and selling lithium-ion batteries was prepared to position Brill Power and identify who are their potential clients. This value chain is presented in Figure 5, and an exhaustive list of companies is shown in Table 9. In this list, German companies are separated from the rest to identify the companies from the potential market for lithium-ion batteries. In parentheses, it is indicated the country of origin of the companies from the rest of the world.

Figure 5. Value chain of lithium-ion batteries. Source: own elaboration.

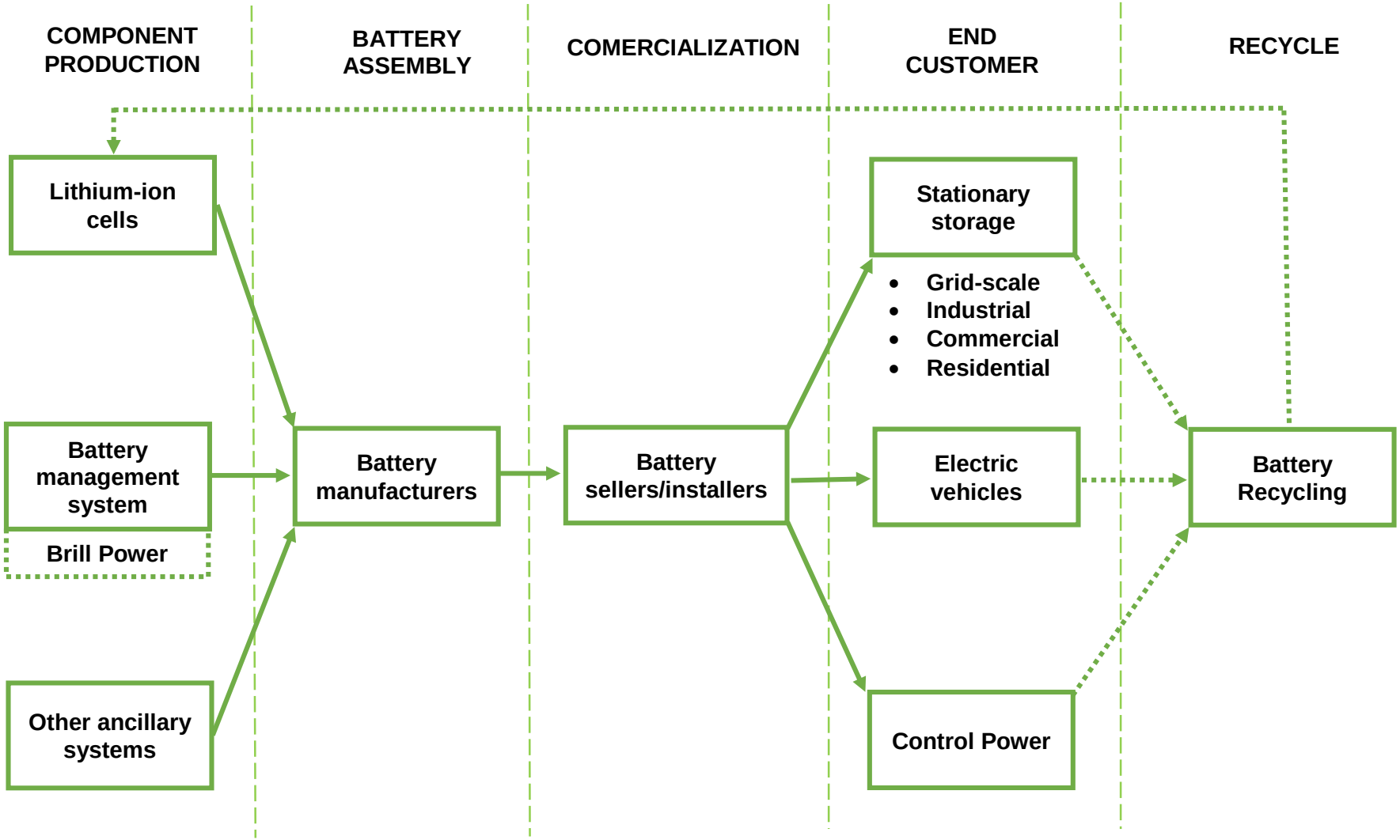

Table 9. Companies in the lithium-ion battery value chain.

Germany		Rest of the world	
Lithium-ion cells producers			
• Custom Cells Itzehoe • EAS Germany • Electrovaya-Litarion	• Leclanché • Liacon • SSL Energy	• Panasonic (Japan) • Sony (Japan) • Toshiba (Japan)	• CATL (China) • Saft (USA)
Battery management systems producers			
• BMZ • Fox BMS • Lion Tec • Presse Box • Tesvolt		• DENSO (Japan) • NEC (Japan) • Panasonic (Japan) • Sony (Japan) • BYD (China) • CATL (China) • Elithion (USA) • Navitas (USA) • Nuvation (USA)	• Linear Technology (USA) • Texas Instruments (USA) • LG Chem (S. Korea) • Samsung SDI (S. Korea) • Lithium Balance (Denmark) • Relectrify (Australia) • **Brill Power (UK)**
Other ancillary systems producers			
• MAHLE • SIBA		• ALLCELL (USA) • DANA (USA) • Littelfuse (USA) • Modine (USA)	• Mersen (France) • ETI (Slovenia) • SOC fuse (Japan) • Kingsbeech (UK)
Battery manufacturers			
• Accusysteme Transwatt • Ads-Tec • AKASOL • AXXellon • Be-Power • BMZ • Deutsche ACCUmotive • E3/DC • E-SpeicherWerk • HOPPECKE Batterien	• KOSTAL Solar Electric • Leclanché • Liacon • SENEC • SMA Solar Technology • Solarwatt • Sonnenbatterie • SSL Energy • Tesvolt • Varta Storage	• A123 Systems (China) • BAK (China) • BYD (China) • CALB (China) • CATL (China) • Lishen (China) • Furukawa (Japan) • Hitachi (Japan) • NEC (Japan) • Panasonic (Japan) • Sony (Japan) • Toshiba (Japan) • EEMB (USA) • Johnson Controls (USA) • Saft (USA)	• Tesla (USA) • Kokam (S. Korea) • LG Chem (S. Korea) • Samsung SDI (S. Korea) • Aceleron (UK) • APS (UK) • Denchi Power (UK) • EasyLi (France) • SCLE SFE (France) • Lithium Batteries (Australia) • Relectrify (Australia) • Northvolt (Sweden) • Fronius (Austria)
Battery sellers/installers			
• Accusysteme Transwatt • Ads-Tec • E-SpeicherWerk • Leclanché	• Siemens • Bosch • Daimler • Varta Storage	• Solar City (USA) • STEM (USA) • Tesla (USA) • ABB (Switzerland)	• Ingeteam (Spain) • Nissan (Japan) • BYD (China)
Battery recycling			
• Accurec		• Dowa Eco-System (Japan) • Sumitomo Metals (Japan) • 4R Energy (Japan) • SNAM (France)	• Umicore (Belgium) • INMETCO (USA) • Glencore (Switzerland) • CATL (China)

Note: Own elaboration.

In the component production stage, the companies can be divided into three major groups,

- Lithium-ion cells producers consist of companies that produce lithium-ion cells that can later be assembled into modules and packs. This corresponds to the first step to manufacture batteries and relies on natural resources like lithium, cobalt, nickel and graphite anode. In this sector, large-scale Asian companies stand out such as Panasonic, LG Chem, CATL and Panasonic. These companies have mega factories with a capacity of production of more than 1 GWh of cells per year and together have 49 percent of the market share (Benchmark Mineral Intelligence, 2017).

- BMS producers consist of companies that produce and sell BMS for lithium-ion battery assemblers such as Brill Power.

- Other ancillary systems producers consist of companies that produce and sell ancillary systems for lithium-ion batteries such as housing, thermal management, and power electronics.

According to Brill Power, research and development in this stage of the value chain are concentrated in lithium-ion cells. Latest innovations have caused the cost to drop and technology to improve as shown in Figure 6. Since 1991 the cost of lithium-ion cells has reduced by more than 12 times and energy density has advanced more than 2,5 times approximately.

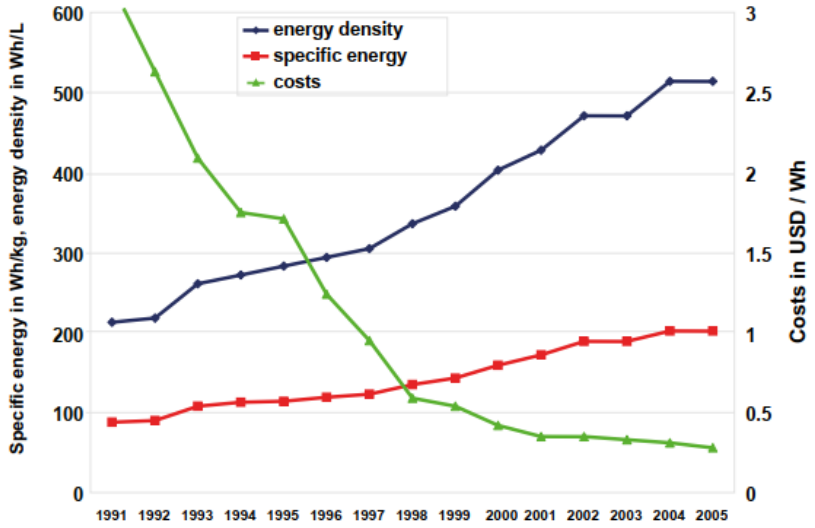

Figure 6. Evolution of specific energy, energy density, and costs of lithium-ion cells between 1991 and 2005. Reprinted from International Renewable Energy Agency, 2017.

Innovation in BMS is less frequent, and it is the value proposition of Brill Power to include innovation in this component to improve the performance of batteries. Brill Power has had conversations with big-scale manufacturers of lithium-ion batteries,

and they have shown no interest in innovating in this area. However, innovation is appreciated in smaller and local producers of batteries that focus on a premium product rather than to appeal to a mass market.

The average cost of a lithium-ion battery is approximately 520 USD/kWh. It varies depending on the type of materials used in the battery from 200 to 840 USD/kWh. The cost follows the following distribution of cost

- Lithium-ion cells 35 - 45 %
- Power Electronics 30 - 40 %
- Periphery 20 - 30 %

The distribution of costs of each part varies with the size of the batteries. The bigger the size, electronics, and periphery costs increases. Moreover, cells represent the most critical cost. BMS is not an essential part of the cost since it represents only a part of the electronics. Moreover, according to Brill Power's market research, BMS can be accounted for 10 percent of the total cost of batteries.

The battery assembly stage consists of companies that buy the parts and assemble the batteries. These are the potential clients for Brill Power, in particular, German companies.

The commercialization stage consists of companies that sell and install batteries. Some of these companies are only specialized in batteries for electric vehicles such as BYD, and others are specialized in stationary or power control such as BOSCH.

The end consumer of lithium-ion batteries can be divided into three, depending on the purpose of the storage system,

- Stationary storage, sizes of batteries can vary depending on the service such as grid, industrial, commercial and residential services.

- Electric vehicles that are becoming increasingly popular and almost every automotive company have released an electric model to the market. Companies that stand out in this sector are Tesla, Nissan, BYD and Chevrolet. Moreover, this service has extended to different types of transports such as scooters, bikes, and motorbikes.

- Control power is used at generation, transmission, and distribution services to adjust loads, compensate line loss, and stabilize power at grid-scale. Current power grids were designed for a centralized power generation, but with the inclusion of renewable energy sources, issues like instability and overloading appeared. Thus, the application of control power is gaining importance to solve these issues.

Finally, the last stage of the value chain is the recycling of batteries. These companies take used and discarded batteries and recover critical raw materials such as lithium, cobalt, nickel, and manganese for the production of cells. Although this stage closes the loop, there are still some weaknesses in the recollection of used batteries due to ignorance of the reuse value of batteries. Chinese companies are the ones who lead this sector, more than 66 percent of lithium-ion batteries are expected to be recycled in China (Messenger, 2018)

Regarding the companies of the value chain, many companies are vertically integrated; involved in the production of cells, assembly of batteries and in some cases in commercialization. Moreover, there are many large-scale Asian multinational companies integrated like CATL, LG Chem and Samsung. This trend is also present in Germany, for example, Leclanché produces cells, assembles and commercializes battery packs.

Lastly, companies that produce BMS and integrates it with their cells hold an important advantage over companies that assemble battery systems with components of different suppliers. The first type of company offer warranties with their systems because they can assure that the cells are being correctly operated and controlled by their BMS design. Examples of companies that integrate their own BMS into systems are LG Chem, Samsung SDI, and BYD. Brill Power is currently addressing this disadvantage. They are involved in a grant-funded project expected to finish in 2020, to develop a warranty product offered by an independent insurance company.

3.2 GERMAN STORAGE MARKET

The German energy market presents most of the drivers discussed in Chapter 2 that promote the deployment of storage systems. First, retail prices of electricity in Germany are high and have made solar PV and more recently, storage competitive as an energy source for residential clients. Figure 7 illustrates the evolution of prices and costs in Germany, and how projections position storage as a competitive option for houses that already have invested or want to invest in solar PV.

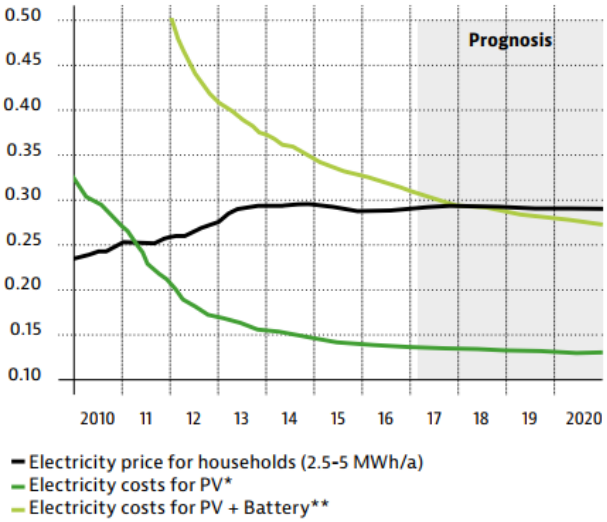

Figure 7. Evolution and projection of electricity prices and costs for solar PV and battery storage projects in Germany from 2010. Reprinted from Germany Trade & Invest, 2018a.

Germany had an effective feed-in tariff program to promote investment in solar PV in households since the year 2000. This program allowed the growth of this market that is now considered a mature and extended market. However, this program has been phased out and inadvertently promoted storage investment. Households started to look for other ways to recover their investment and storage systems have been the choice. Today only 4 percent of solar PV systems have batteries, but projections showed that by 2030, 80 percent would invest in storage.

Another driver for the deployment of storage systems is the desire for energy self-sufficiency from consumers such as municipalities and households. This trend has changed the energy model of Germany, from a centralized, stable and predictable energy grid to a decentralized grid with customers that are both consumer and producers, a concept defined as prosumage. Moreover, the producers feed the grid at a variable rate due to the inclusion of renewables such as solar PV and wind. Renewables now represent 36 percent of the electricity consumed in Germany, and the commitment is to reach 80 percent by 2050.

Transition to renewable energy brings challenges, and storage batteries offer a solution to integrate new renewable sources into the energy infrastructure. The German government has recognized this opportunity. National policies directly promote the deployment of storage projects. An example is KfW Program No. 275, a funding program in place since 2016. This program has the participation of the KfW Bank and the Federal Government. The first provides low-interest loans and the second, subsidies new battery storage connected to an existing solar PV system. The objective of this program is to create a commercially viable storage market in the long term in Germany.

Furthermore, developing smart grids is also another objective of government policies. Germany environmental commitment is to reduce fossil fuel and nuclear as a source of energy production and reach 80 percent of renewables into their energy mix by 2050. A smart grid is the only way to successfully integrate variable sources of energy and allow prosumage to work without affecting the supply energy. Moreover, it is an urgent matter since renewables now account for more than 30 percent of the power mix.

These conditions in Germany has driven the energy storage market that has grown and shows high potential. Every demand for different services of batteries has increased in the last years. For example, storage for solar PV has expanded and has the potential to continue further, as shown in Figure 8 and Figure 9.

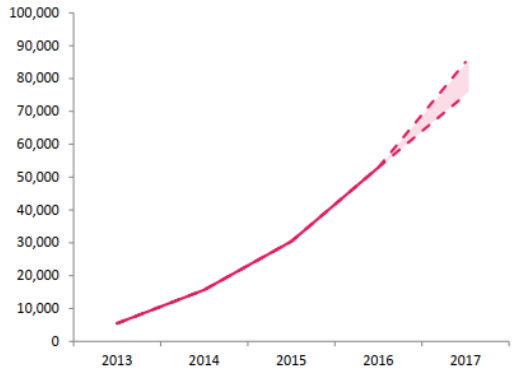

Figure 8. Number of systems cumulated of battery storage with solar PV systems in Germany from 2013 to 2017. Reprinted from Germany Trade & Invest, 2018a.

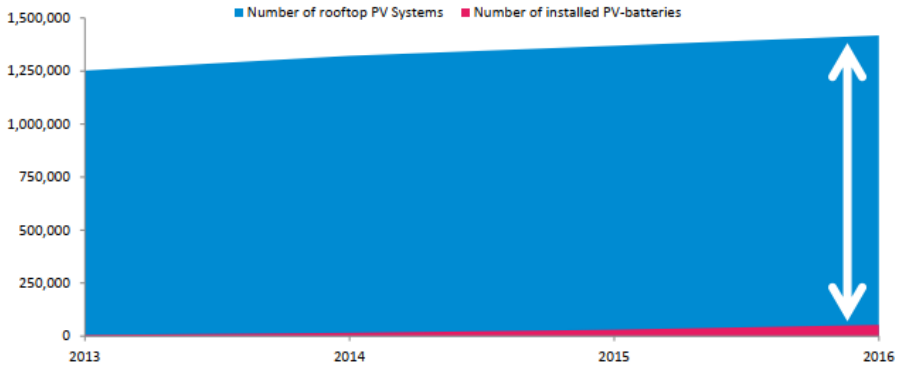

Figure 9. Number of rooftop PV systems and installed PV with battery storage cumulated in Germany from 2013 and 2016. Reprinted from Germany Trade & Invest, 2018a.

Moreover, electric vehicles are also expanding and reaching the stage of a mass market product, as shown in Figure 10.

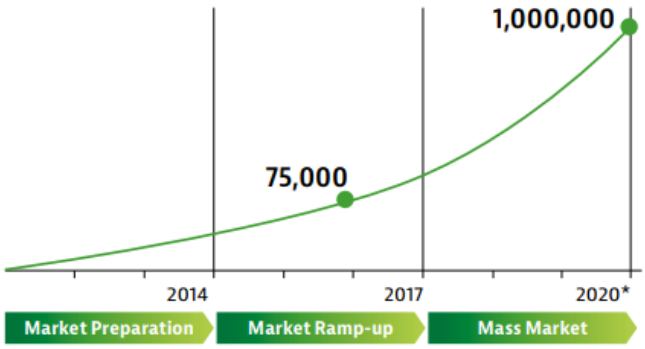

Figure 10. Number of electric vehicles in Germany. Reprinted from Germany Trade & Invest, 2018a.

In particular, for lithium-ion batteries in Germany, there are companies in every stage of the value chain. The potential clients of Brill Power manufacture batteries for stationary storage, electric vehicles, and control power, for the domestic and international market.

Figure 11 shows the market share in 2017 of manufacturers of residential storage battery systems. From the ten largest companies present in the German storage market, six are from Germany and hold 67 percent of the market share; while four international companies hold 27 percent. This fact shows that German companies have a strong presence in their domestic market against multinationals that have a strong presence outside of Germany.

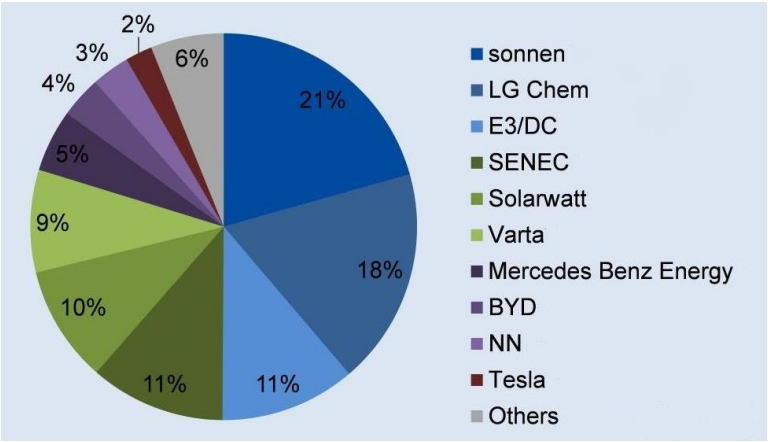

Figure 11. Market share of home storage providers in Germany 2017. Reprinted from Seeger, 2018.

From the companies identified as lithium-ion battery manufacturers in Table 9, seventeen are selected as potential clients of Brill Power, as it will be discussed in Chapter 5 and 6. These companies, shown in Table 10, are German, of similar size,

satisfy similar needs focus on small-scale storage for residential and commercial purposes, and are present in the domestic market.

Table 10. German manufacturers of lithium-ion batteries (potential clients).

	Name of company	Location in Germany
1	Accusysteme Transwatt	Soest, North Rhine-Westphalia
2	Ads-Tec	Dresden, Saxony
3	Be-Power	Fernwald, Hesse
4	BMZ	Karlstein, Hesse
5	E3/DC	Osnabrück, North Rhine-Westphalia
6	E-SpeicherWerk	Pfullendorf, Baden-Württemnerg
7	HOPPECKE Batterien	Zwickau, Saxony
8	KOSTAL Solar Electric	Hagen, North Rhine-Westphalia
9	Leclanché	Willstät, Baden-Württemnerg
10	Liacon	Itzehoe, Schleswig-Holstein
11	SENEC	Leipzig, Saxony
12	SMA Solar Technology	Niestetal, Hesse
13	Solarwatt	Dresden, Saxony
14	Sonnenbatterie	Wildpoldsried, Bavaria
15	SSL Energy	Geesthacht, Schleswig-Holstein
16	Tesvolt	Lutherstadt Wittenberg, Saxony-Anhalt
17	VARTA Storage	Nördlingen, Bavaria

Note: Own elaboration

These potential clients were contacted to conduct an interview and complement secondary data from the German energy market. In Table 11 there is a summary of the characteristics of some of these companies and in Appendix B the structure of the interview.

It was possible to approach E3/DC, the third largest battery manufacturer in Germany (See Appendix C for interviewed people). This company sells battery systems for residential purposes, and its products are under the German subsidy program (KfW). Currently, they have three different suppliers of the battery systems, all of them include the cells with own BMS integrated. Apart from the compliance of the BMS with safety and technical standards, they also look for low cost, a lifetime of more than ten years and scalability. They stated that they are always looking for the best solution to battery with BMS, and that is the reason to have different suppliers. Also, they are moving forward to better operative systems that communicate with the battery and are actively searching for optimization. When asked about suppliers and costs, they did not want to give that information. Lastly, when asked about competitors, they said that they had been approached by LG, BMZ, and Panasonic as BMS suppliers. These companies are all BMS producers and also battery manufacturers. Therefore, they include warranties in their products.

Table 11. German manufacturers of lithium-ion batteries

Company	Sonnenbatterie	E3/DC	VARTA Storage	BMZ
Size	Medium, between 51 to 250 employees	Medium, between 51 to 250 employees	Large, more than 250 employees	Large, more than 250 employees
Value chain participation	Battery manufacturer	Battery manufacturer	Battery manufacturer Seller of batteries	BMS producer Battery manufacturer
Battery services	Stationary storage	Stationary storage	Stationary storage Electric vehicle	Stationary storage Electric vehicle
Size of units of batteries	4 - 20 kWh	6 - 10 kWh	2 - 750 kWh	6 - 12 kWh
Units sold and market share under the KfW program in 2017	779 units 19,33% of market share	727 units 18,94% of market share	129 units 3,2% of market share	-
German Market share	21%	11%	9%	-
Price of batteries	Price varies with size, between 900 – 2.000 USD/kWh			

Note: Data of Sonnenbatterie from Sonnen, 2018. Data of E3/DC from E3/DC, 2018. Data of VARTA Storage from VARTA Storage, 2018. Data of BMZ from BMZ Innovation Group, 2018.

Considering the information gathered in interviews with Brill Power CEO and members of E3/DC, some conclusions were made that are reflected in the business model proposition and marketing plan. First, to target small and medium-size German companies that have different BMS suppliers and are open to smaller suppliers. Second, the value proposition of Brill Power is in line with the commercial strategy of these companies, they are looking for smart BMS to improve the experience of their customers, but always considered a low price to optimize costs. Lastly, it is crucial for Brill Power to include a warranty in their products, there is a strong preference from battery manufacturers towards these type of products.

4. STRATEGIC ANALYSIS

4.1 PESTLE ANALYSIS

The PESTLE framework is used to assess the external environment considering the challenges Brill Power, a company from the UK can face in Germany.

Political

Currently, Germany and the UK are a part of the political and economic European Union (EU), but, the UK has decided to leave this pact (Brexit). Thus, current political relations will change, and the UK is still facing many challenges to leave this economic region. Negotiations are occurring at the moment to establish a new framework for the UK and the relations with the EU. Thus, there are some uncertainties about future political relationship between these countries such as trading policies.

Economic

Germany has the largest economy in Europe with low unemployment and inflation rates. It has a social market economy, and it is a part of the political and economic European Union. It has a higher GDP and economic growth rate than the UK. Germany is a country of a low level of corruption and a high level of innovation.

Trade tariffs in Germany are the one sets by the EU. Thus, there are some uncertainties related to future trade tariffs and exchange rates due to Brexit.

Social

Germany is one of the countries with most installations of solar PV at a residential scale and with a mature solar market. These consumers are demanding storage system to complement their investments which have caused an exponential growth of the storage demand in Germany.

The high electricity price, phase out of feed-in tariffs and the strong desire for energy self-sufficiency from German society drives the consumption pattern. Furthermore, Germany has a high GDP and a population with high purchasing power, in line with the product Brill Power offers.

Technological

Germany has a thriving technology market related to renewable energies and storage systems. There are many German manufacturers of these technologies and researchers are actively seeking innovations.

The government funds research for storage systems and there are strong policies aim to integrate storage systems to the current grid. Moreover, Germany has a strong law to protect Intellectual Property. Thus, there are favorable technological factors.

Legal

Current legislation is directed to promote the deployment of the battery storage systems with subsidies and low-interest loans. Future regulations are expected to continue with the same trend, towards the transition of the energy grid and the incorporation of batteries in the business energy model.

Environmental

This product is in line with the environmental commitments of Germany to reduce carbon emissions. Germany has ratified the Paris Agreement and has agreed to reduce emissions by 80 to 95 percent by 2050.

Moreover, environmental regulations and government policies are in line with this target, and the current view is favorable to the development of a strong market for storage systems.

Regarding PESTLE analysis, there are some uncertainties on some political and economic aspects due to Brexit. Before the Brexit comes into place, the UK and the EU are expected to reach satisfactory agreements without problems. Other elements, such as social, technological, legal and environmental show favorable conditions to pursue business in Germany.

4.2 SWOT ANALYSIS

The SWOT analysis is used to assess the competitive advantages based on internal (strengths and weakness) and external (opportunities and threats) aspects. The objective is to design a business plan that takes into consideration these aspects to mitigate weakness and threats and to promote strengths and opportunities.

Strengths

- Possession of a high value and innovative product protected by intellectual property (when the patenting process is finished).
- Possession of a high value-added product that extends the lifetime of lithium-ion batteries. Current BMS producers do not provide this service and have a more basic configuration.
- Possible capture of ‘first mover advantage’, the current trend is to innovate around lithium-ion cells rather than BMS.

Weaknesses

- Low penetration of the product in the global market, it requires technological validation.
- Scalability problems, no experience in large-scale production.
- No presence of this product in Germany.
- Preference for low-cost products rather than high value added.
- Preference for battery systems with BMS and warranty included.

Opportunities

- Germany is a market with consumers with high purchasing power willing to pay a higher price.
- Germany has a mature solar PV market that is strongly connected to more demand for batteries.
- Demand increase for batteries in Germany.
- Strong desire for self-sufficiency from the German community.
- The decrease in battery production costs.
- Strong support from government policies, a tendency towards clean and renewable energies.
- A strong presence from local battery manufacturers on the German storage market.

Threats

- It is difficult to enter the market due to a highly integrated value chain
- Closed market led by multinational enterprises with a global scope.
- Presence of companies not willing to open to new suppliers in the German market.
- The market is in constant change due to technological improvements, there is a risk of having a new competitor

In conclusion, the fundamental strength of this business is the ownership of an innovative product that has the potential to stand out from other products of the market. The major weakness is the lack of validation of the product in the market; German clients are reluctant to try a new product without being a proven technology or preferred to stay with a known supplier that offers warranties. Thus, with the internal analysis, the business needs to focus on protecting and promoting this product to ensure the success and introduction of this product in the energy market.

Furthermore, the main opportunity is the potential of being a part of a thriving market, the battery storage market in Germany is going forward with the support of the German government and increasing demand form the German community. The most important threat is the difficulty to enter the value chain that is highly integrated and not open to new entrants. Thus, the business model needs to address and consider the closed value chain.

4.3 PORTER'S FIVE FORCES ANALYSIS

Porter's analysis is used to assess the forces that interact in a market that set industry profitability in the medium and long run. This tool allows to position the company, understand the forces that shape the market and include them in the strategy.

The market is narrowed to BMS producers for lithium-ion battery manufacturers that commercialize in Germany.

Rivalry among existing competitors

There are two types of competitors, companies that are dedicated to producing BMS and companies that make energy storage systems as well as their own BMS included in the package. Table 12 shows these companies.

Table 12. Competitors in the BMS producing market.

BMS producers	BMS producers and storage systems manufacturers
• Elithion (USA) • Navitas (USA) • Nuvation (USA) • Linear Technology (USA) • Texas Instruments (USA) • Fox BMS (Germany) • LionTec (Germany) • Presse Box (Germany) • Lithium Balance (Denmark) • **Brill Power (UK)**	• Tesvolt (Germany) • BMZ (Germany) • Panasonic (Japan) • Sony (Japan) • NEC (Japan) • LG Chem (S. Korea) • Samsung SDI (S. Korea) • CATL (China) • BYD (China) • Relectrify (Australia)

Note: Own elaboration

There is not much product differentiation in BMS products – BMSs on the market are basic in functionality and designed to minimize cost. Differentiation is starting to emerge in connection with battery monitoring platforms, which allow the user to monitor the state of the batteries, as determined by the BMS, through a software platform. This is an area where Brill Power stands out with its value proposition.

Furthermore, this market is dominated by the leading lithium-ion cell suppliers, such as LG Chem, Samsung SDI, and BYD. They tend only to sell cells packaged up in modules and racks with their own low-cost BMS included. This enables them to maintain control over the way the cells are used and to ensure compliance with their warranty policies.

Low differentiation in BMS and the dominance of strong multinationals has led to a market being driven by low prices rather than quality. Therefore, most customers

tend to look for low-cost BMS with basic functions. However, the precarious market for intelligent BMS is advancing, and Brill Power offers an outstanding product in line with future demands.

In the case of companies that only produce BMS, there is no brand loyalty. However, for companies that integrate their own BMS into the battery systems, there is brand loyalty. Companies have their preferred supplier of cells, and in the case of BMS integration, they tend to stay with that supplier for BMS. This is largely because the cells determine much of the performance, cost and reliability of an energy storage system and customers tend to have a favorite cell supplier.

The cost of switching from a BMS integrated by the battery manufacturer to an independent BMS is high initially because it involves a redesign of the system. There is also a perceived risk due to warranties – cell warranties generally do not extend to BMSs other than the ones supplied by the cell (and pack) maker.

Therefore, the rivalry among existing competitors is HIGH due to,

(++) a market dominated by multinational companies that produce their own BMS along with their battery systems
(++) the presence of companies that offer a similar product with low differentiation
(++) a market driven by low prices rather than premium quality
(++) high switching cost to a company like Brill Power from a company that supplies the battery with own BMS integrated

Bargaining power of suppliers

There are two types of suppliers, component suppliers, and PCB manufacturers. These companies are highly specialized and predominantly located in low-cost manufacturing countries such as China. Moreover, numerous suppliers offer similar prices and quality standards for electrical components and PCB.

Switching cost is relatively low because there is typically a range of components for the same functionality and PCB manufacturers can be easily switched by supplying design files. However, they hold some power because there are concerns when switching supplier around intellectual property protection and contract negotiation. These suppliers have contracts to secure high volume and supplier discounts.

Therefore, the bargaining power of suppliers is LOW due to,

(--) low-cost products
(--) many suppliers to choose from with low differentiation
(+) low switching costs but issues with intellectual property protection

Bargaining power of buyers

There are not many buyers, and in the case that they already have a preferred BMS supplier, it is difficult to get into their supply chain. Moreover, if their supplier integrates BMS into the battery systems, the difficulty is even higher.

The buying decision for a BMS is highly dependent on the price rather than improved technical specification or new applications.

Moreover, an actual threat is for battery manufacturers to integrate backward in the supply chain, and start producing their own BMS. As detailed before, many companies already supply their battery systems with their own BMS.

Moreover, there is a high initial switching cost when changing BMS supplier due to changes in the design of the system.

Therefore, the bargaining power of buyers is HIGH due to,

(++) buyers with fix preferences when it comes to buying a BMS
(++) buyers focus on lower prices rather than quality
(++) high initial switching costs
(+) likely for battery manufacturers to backwardly integrate

The threat of new entrants

Starting a BMS producing company has many barriers. Although this is a technological product that does not require a significant investment, it does require to have some specific know-how and reputation in the market.

This is a relatively crowded market which does not see many purely BMS focused new entrants. The main barriers to new entrants are competing with the low-cost electronics provided by the major battery system makers. Another barrier is reputation, especially regarding safety. It is crucial to have a well-established safety record.

Therefore, the threat of new entrants is LOW due to,

(--) a competitive market with few purely BMS companies
(--) strong competition with major battery system makers that produce their own BMS
(--) the necessity of a reputation or technological validation due to safety requirements
(++) low investments requirements
(+) likely for battery manufacturers to backwardly integrate

Threat of substitute products

The BMS is an essential part and necessary for every battery system. Between the current offers of BMS, there is no great differentiation. Although, there can be a difference in the algorithms used in the BMS.

Essentially is a unique product that is tightly integrated with the components to build a battery system.

Therefore, the threat of substitute products is LOW due to,

(--) the necessity of a BMS to build the battery systems
(--) unique product difficult to replace with another component

Figure 12 presents the assessment of Porter's forces.

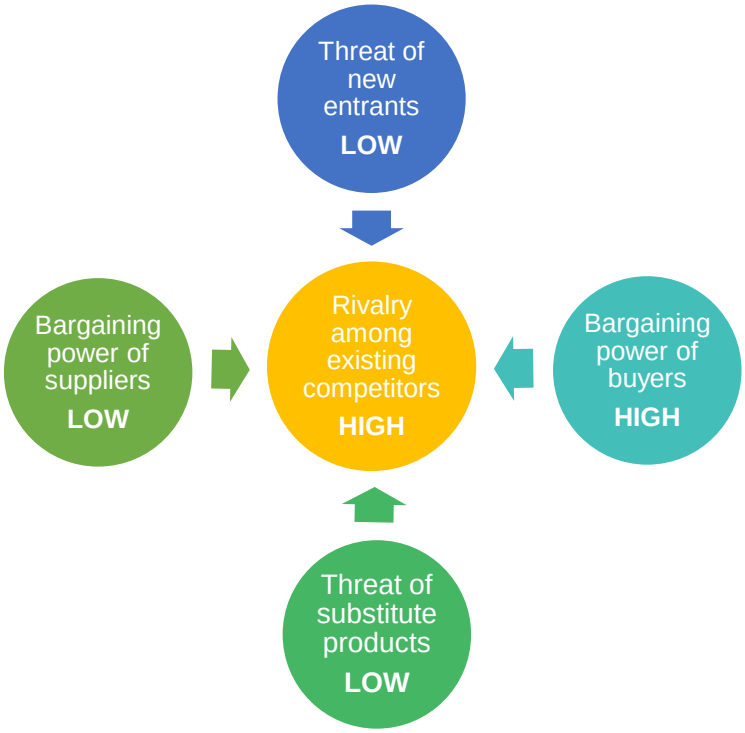

Figure 12. Porter's five forces analysis. Source: own elaboration.

There are two significant forces that correspond to the competitors and buyers. Both hold a strong position of power in the market and need to be addressed. Although Brill Power is protected from new competitors, it is still a newcomer that needs to face many challenges. This business plan needs to consider the importance of having a patented product with a warranty included to compete with existing participants and to attract clients.

5. BUSINESS MODEL

5.1 CUSTOMER SEGMENTS

The target is lithium-ion battery manufacturers from Germany that sell batteries for households. This business is B2B directed to companies that produce batteries for many services, but in particular, for small and medium companies that manufacture small and medium size batteries in Germany. Although some of these companies also produce batteries for other services or sell outside of Germany, the intended segment is the one that produces battery systems to sell in the domestic market to households.

Large companies with a worldwide presence are excluded as a customer (like LG Chem, Samsung SDI, and Panasonic) because most of them include their own BMS in the battery systems and are more concentrated in mass manufacturing. Therefore, German companies detailed before are more inclined as niche customers.

5.2 VALUE PROPOSITIONS

The value proposition is to extend life service and improve the performance of lithium-ion batteries. This value addition creates a differentiated product; it has the basic functions as other BMS with an improved algorithm to ensure better management of the lithium-ion cells and the overall battery system.

Residential products from German battery manufacturers show potential for innovation and value addition, according to the interviews done to potential clients and Brill Power's market research. Some companies are currently developing own operative systems to communicate with the battery and improve the customer experience with the system.

Furthermore, an important aspect of the value proposition is to have a patented product that includes a warranty to compete with similar products.

5.3 CHANNELS

- An updated website with information about the product, latest projects and contact information of sale representatives.
- Linkedin and similar social media to post the latest projects and participation in social events; to show an active company and up to date with the latest news.
- Fairs, summits, and seminars of renewable energy and innovation related-topics around the world.
- Technical visits to clients in Germany. The idea is to have periodic visits to existing clients to maintain a relationship and also, look for new clients to promote the product.
- Pilot projects with key partners to introduce the product and generate a reputation between clients.

5.4 CUSTOMER RELATIONSHIPS

Interactions will depend on the status of the relationship with the customer. New customers will have personal contact giving continuous support to establish a strong relationship with them. For existing customers, the contact will be remote or personal depending on the purpose. The idea is to maintain a strong relationship through email, video conferences, and when needed, a personal meeting.

Brill Power will not have an office in Germany but will have a representative to have immediate contact with the customers, and when more support is needed, part of the team in the UK can travel to support the representative.

5.5 REVENUE STREAMS

The main revenue stream will be from the direct sale of the product to battery manufacturers. The customer is expected to establish a contract of units per month and establish a payment agreement.

There is a possibility of a different revenue stream, for licensing the design. This option will be available for battery manufacturers that already produce their BMS and have the production process already implemented. In this case, it is possible to license the design and charge them a fee for the use of it.

It is expected to have the majority of the revenues from the direct sale, the licensing option is expected to be less frequent but an important option for particular clients.

5.6 KEY ACTIVITIES

- The complete patent process of BMS design to ensure intellectual protection of design.
- Complete grant-funded project to develop a warranty product.
- The update of the company website, Linkedin profile and other social media to maintain an active presence on the Internet.
- Participation in fairs, summits, and seminars in renewable energy and innovation related-topics around the world to promote the product, connect with clients and networking.
- Analyze potential clients and engage with them through technical visits, meetings, and development of pilot projects.
- Maintain periodic contact with stable clients through virtual or physical meetings when required.
- Look for suppliers for electronic components and PCB and ensure a good price, quality, and intellectual property protection.
- Look for a stable courier to send the product to Germany.

5.7 KEY RESOURCES

- The patent license of the BMS design. Currently, Brill Power is under a process of patenting their design and is expected to be finished by 2020.
- The warranty of the product by an insurance supplier.
- Positioning of Brill Power as a known and reliable supplier of BMS in Germany, including technical validation through pilot projects.
- The company team, the talent, and experience accumulated by the technical and business employees. It is important to have experience in the business part because they are the ones that will close contracts or pilot projects.
- Since it is a B2B, the seller needs to be technically prepared to handle selling to another company.
- Reliable suppliers of electronic components and PCB to have a good supply chain.
- Reliable courier to send products to Germany since it is a B2B business, delivery times and costs are relevant.
- Post sales and technical assistance.

5.8 KEY PARTNERS

- Expert consultants in entrepreneurship and the energy market.
- Groups focused on smart energy research and innovations related to mitigation and adaptation to climate change. Currently, Brill Power has the support of The Energy and Power Group of the University of Oxford, EIT Climate-KIC and The Enterprise Europe Network.
- Funding agencies. Currently, Brill Power is financed by seed capital of the EIT Climate-KIC group and by funds granted by Innovate UK, a public body supported by the government of the United Kingdom.
- Germany Trade & Invest (GTAI) or similar agencies. GTAI is an economic development agency of the Federal Republic of Germany. This company supports foreign companies that look to locate to Germany and want to position Germany as an attractive business location for international companies (Germany Trade & Invest, 2018b).
- Suppliers of electronic components and PCB.
- Couriers to send the products to Germany.
- Insurance company to include a warranty in their products.

5.9 COST STRUCTURE

- Fee and travel expenses of representative in Germany.
- Administrative expenses
- The production cost, including fees of transport to Germany.
- Technical and business travels to Germany plus travel expenses
- Registration fee to fairs, summits or seminars plus travel expenses

6. MARKETING PLAN

6.1 SEGMENTATION

Battery manufacturers can be segmented by their presence in the energy market in Germany. First, the companies that have only a local presence or in countries of the EU and second, companies that have a worldwide presence.

Every battery manufacturer needs a BMS to control the operation of the lithium-ion cells, but not all companies want or need an intelligent BMS, like the one offered by Brill Power. Battery manufacturers with the worldwide present like Samsung and LG Chem, look for lower costs when it comes to deciding for a BMS. They produce batteries at a large scale and have the power to negotiate lower prices due to big volumes. In some cases, like the companies Samsung and LG Chem, they also produce lithium-ion cells that represent the biggest cost of batteries and is where the innovation is focused. Thus, these companies look for safety, low cost and minimal development of the software, just enough to control the operation.

On the other hand, local battery manufacturers produce low volume and aim for a differentiated product. In this segment, apart from safety, they look for improvements in the control and to add value to the product with more elements like an integral controller of all the operations of the system. Thus, it is possible to find companies that look for intelligent BMS that will increase their prices because they provide high-quality batteries to the customer with high purchasing power, like German society.

Companies with worldwide presence tend to have mass production while companies with local presence relate to a niche market.

Battery manufacturers can also be divided by their service. Many companies specialize in manufacturing batteries for vehicles while others in batteries for residential stationary storage. These companies have different products, and they provide batteries with different specifications. Table 9 detailed German battery manufacturers, three of them are dedicated to manufacturing batteries for vehicles (AKASOL, AXXEllon, and Deutsche ACCUmotive), the remaining seventeen for stationary storage.

6.2 TARGETING

The growth rate from both segments is similar, the demand for lithium-ion batteries is increasing around the world and at local-scale. The reasons behind this growth are an improvement in the lithium-ion technology that has led to lower costs and the trend towards green energy.
Moreover, in Germany, both consumption for vehicle batteries and household is growing exponentially with positive projections towards more demand in the next

years, as shown in Figures 8 and 10 in Section 3.2. Thus, when considering the growth rate, all segments look attractive for commercializing the BMS.

However, as detailed before, not all segments look for an intelligent and high-cost BMS. Thus, the most attractive segment is battery manufacturers with a local presence. In particular, companies that provide services for residential houses. German companies that specialize in lithium-ion batteries for vehicles are not considered in this business plan because they are highly specialized and concentrated in a few companies. Therefore, access to this market is more complex.

6.3 POSITIONING

Brill Power wants to lead the market for intelligent BMS for lithium-ion batteries in the UK and Germany. This leadership will be secured with their patented product with warranties, and with a differentiation business strategy focus on value addition and benefits to consumers. The 4 P's of marketing (product, price, place, and promotion) will be used to define the position of Brill Power.

This product needs to penetrate an existing market. Therefore, the strategy needs to start with low prices and big marketing efforts to promote the product.

Product

Brill Power offers one product, an intelligent BMS for lithium-ion battery systems. Is a component used for battery systems that control the operation of multi-cells. This product of original design improves the performance of lithium-ion batteries compared to basic designs. Figure 13 shows a mock-up of the product.

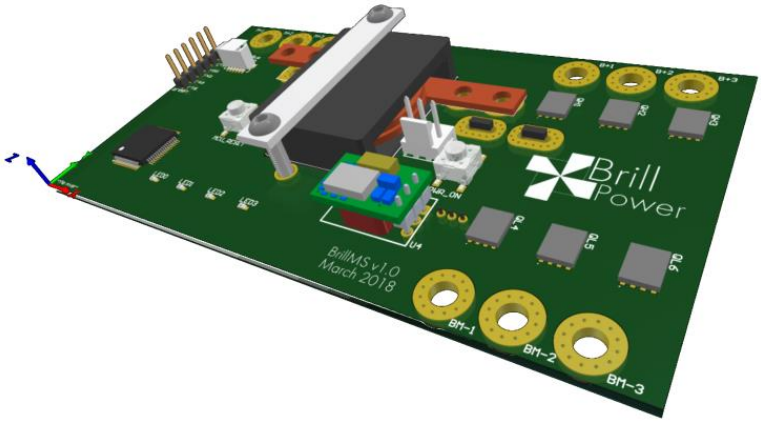

Figure 13. Brill Power product, BMS. Reprinted from Brill Power, 2018.

This product will be offered in two ways, direct sale or licensing. This will depend solely on the requirements of the clients, as detailed in Section 5.5, some clients

already produced their own BMS. They could benefit from using their supply chain and infrastructure to produce this product with a license agreement.

This product adds value to the battery systems. The market for battery systems is still developing with frequent technological development and consumer habit changes since technology is becoming more affordable and mature. However, it is still a growing market. Therefore, this BMS is a premium component for a product still in a niche market.

Price

The price will be set at the market price to penetrate the German market. According to market research done by Brill Power, an average price for a basic configuration of BMS is 25 US$/kWh.

Thus, the initial price will be set at 25 US$/kWh with a low margin to validate the technology, enter a new market and generate a reputation. It is expected to have this price for the first two years; the price will be readjusted from the third year when Brill Power has established contracts and managed to enter the German market.

Place

The place will be Germany, where all potential clients are located. Brill Power will not open an office in Germany but will have a representative there to have immediate contact with clients.

Figure 14 shows a list and location in Germany of the companies that are a part of the target segment.

Promotion

As detailed before, Brill Power needs to be actively present in the storage market through all channels. The website and social media will be updated to show the news about the latest projects and to show participation in social events around the storage market and networking.

Moreover, the product will be promoted in technical visits to potential clients and with alliances through pilot projects to generate a reputation in Germany.

1	Accusysteme Transwatt	7	HOPPECKE Batterien	13	Solarwatt
2	Ads-Tec	8	KOSTAL Solar Electric	14	Sonnenbatterie
3	Be-Power	9	Leclanché	15	SSL Energy
4	BMZ	10	Liacon	16	Tesvolt
5	E3/DC	11	SENEC	17	VARTA Storage
6	E-SpeicherWerk	12	SMA Solar Technology		

Figure 14. Location of target companies in Germany. Map reprinted from Maps of World, 2015.

7. PROCESS AND HUMAN RESOURCES PLAN

This chapter will describe how to achieve what has been proposed in the business and marketing plan. Firstly, the process plan will explore the logistics and operations required to enter the German market. Secondly, the human resources plan will detail the organization chart and new employees to implement the business plan.

Currently, Brill Power is working on two major plans, to validate the product and to follow through pilot projects. The first plan consists of finishing the patenting process and including an independent warranty through an insurance company. The second plan is based on the existing pilot plans and starting new ones to continue further the insertion of the product in the battery manufacturer market. Therefore, it is a functioning company with goals to enter the storage market fully.

The main objective of this business plan is to close contracts with battery manufacturers from Germany. To achieve this objective, there will be a representative in Germany, and when needed, people from Brill Power will travel to Germany. Figure 15 shows the process to contact clients.

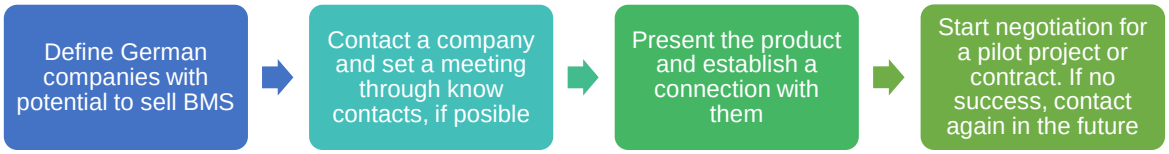

Figure 15. Process to present the product to German battery manufacturer companies. Source: own elaboration.

This business plan includes a database of potential customers in Germany. However, this market is on the move, and new companies can appear. The representative will need to show proactivity and keep up with the German market.

Brill Power team members have the support of advisors and specialists in the energy market. Experience has proven that introduction from these contacts has better results than trying to set a meeting with no prior connections. Moreover, the storage market is small and relatively closed to new entrants. Therefore, when possible, meetings will be arranged through known contacts to create a closer and effective connection with German companies.

It will be important to have a structure for the meetings with potential clients to present the product. This meeting can be supported by media like a PowerPoint presentation or similar. This presentation needs to focus on the advantages of the product, important pilot projects that have finished or are still ongoing, the results and experiences so far with the product. This presentation must be updated to showcase the current activity of the company.

The process shown in Figure 15 can have three possible outcomes, to further explore a pilot project, to close a contract or no success. In the last case, the representative should contact this company again in the future, to show updates on the development of the product. In other cases, the representative will follow the process represented in Figures 16 and 17. Throughout these processes, the representative will have the support and continuous communication with team members of Brill Power. Moreover, when needed, they will travel to Germany to support the closure of pilot projects or contracts.

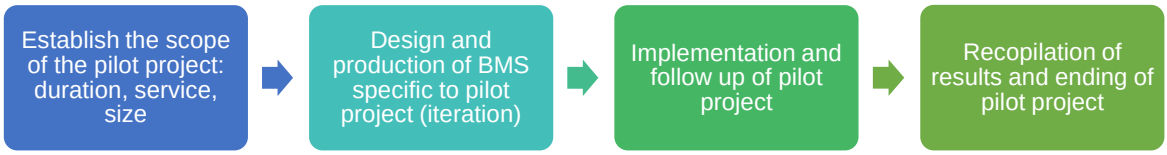

Figure 16. Process to start a pilot project with a German battery manufacturing company. Source: own elaboration.

Before starting a pilot project, both parties need to define the scope of the project, duration, size and services of batteries, against which BMS will be compared to and in which variables. The test can be done in a lab or the field. When the scope is decided, starts the design and production of the BMS specific to the pilot project. This step of the process will have iterations; Brill Power will have to run tests in their laboratories to fit the BMS to the specific battery system and run tests to make sure that the BMS complies with safety and other technical specifications. Each production of BMS is customized to the specific battery system. After the iteration of hardware and software is finished, it starts the implementation, follows up and recompilation of the results of the project.

On the other hand, in the case of closing a contract with a German company, the process is explained in Figure 17.

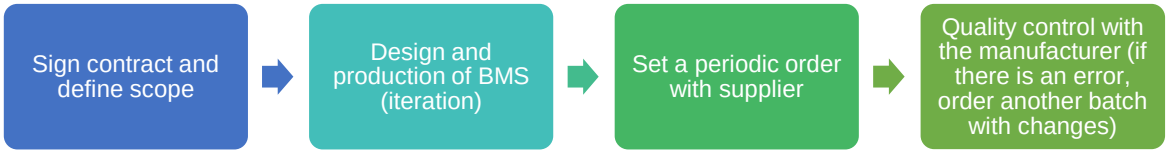

Figure 17. The process to close a contract with a German battery manufacturing company. Source: own elaboration.

The contract will include a quantity of BMS per month along with the terms of the overall contract. It is important to establish the technical specifications of the product. The next step is to design and order the first batch of BMS to be proven with the manufacturer system in the laboratory of Brill Power. This stage will have iteration until the hardware and software complies with every technical specification. In case

of any error of design, changes and new orders will be made until the compliance with specifications. When this process is finished, a periodic order will be established with the supplier for the period of the contract.

The difference is that the pilot projects have a one-time-only production, whereas contracts will have periodic orders.

The production process is make to order (MTO) due to the particular sizes, geometry and technical specifications that each battery manufacturer has. It is not possible to have a universal product to fit every battery system of every client. Even within different products of a client, there can be differences in the size and geometry of the BMS. Therefore, this is a customized product.

There will be no necessity for a warehouse for raw material, components, unfinished product or finished product. The product will be ordered accordingly to contracts and be fitted to a specific battery system. The supplier will send the product directly to the factory where the client assembles the battery systems. In most cases, these factories are in Asian countries.

Regarding suppliers, Brill Power currently has a UK supplier that provides the PCB and electrical components for the pilot projects. However, they are working in contacting suppliers from Asian countries to reduce costs when they start producing full-scale.

Lastly, Brill Power has an external company that provides the services of accounting and expect to continue with them when they start billing.

Regarding the human resource plan, Brill Power has six employees that have been working on the two major plans detailed before. The staff is composed of,

- Christoph Birkl, CEO & co-founder, Ph.D. in engineering at the University of Oxford, UK
- Carolyn Hicks, CFO & co-founder, MBA at the University of Oxford, UK
- Damien Frost, CTO & co-founder, Ph.D. in engineering at the University of Oxford, UK
- Adrien Bizeray, Chief Data Scientist & co-founder, Ph.D. in engineering at the University of Oxford, UK
- James Smith, Senior Embedded Software Engineer, BSc in computer science at the University of Staffordshire, UK
- Stuart Grondel, Strategy and Operations Lead, MBA at the University of Oxford, UK

Brill Power has established a roadmap for the next years and expects to grow. They forecast to have 13 employees by 2019, 22 by 2020 and 28 by 2021. Figure 18 shows the projected organization chart of Brill Power. Existing staff is represented in blue whereas future hiring is in red.

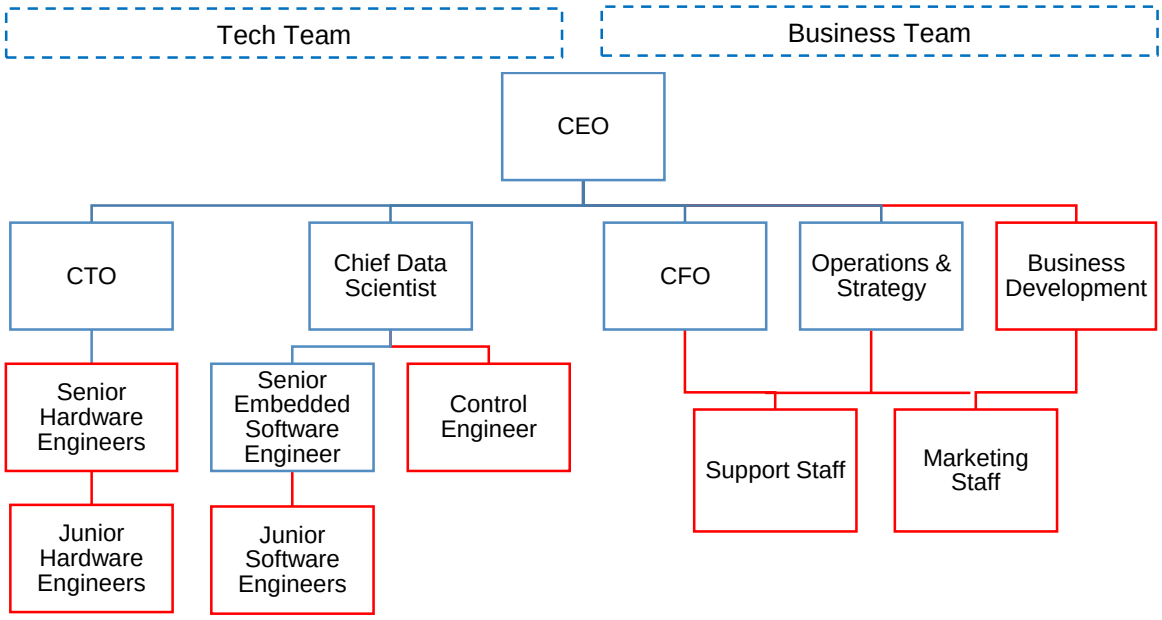

Figure 18. Projected organization chart of Brill Power. Source: own elaboration.

This staff projection is considered to continue the operations inside of UK and according to the company strategy to grow at a controlled pace and accordingly to new necessities as they appear. Moreover, this projection is to prepare the company to expand to foreign operations by 2021. For this business plan, it is considered that the company has already grown and has an organization chart similar to the projected in Figure 18. Moreover, to expand to Germany a new member is required, a sales representative or agent in Germany. This agent can be an independent person or part of a company with the representation of a product portfolio for the battery market. This person would respond directly to the CEO and work tightly with the CTO and Strategy and Operations Lead.

The new organization chart is shown in Figure 19.

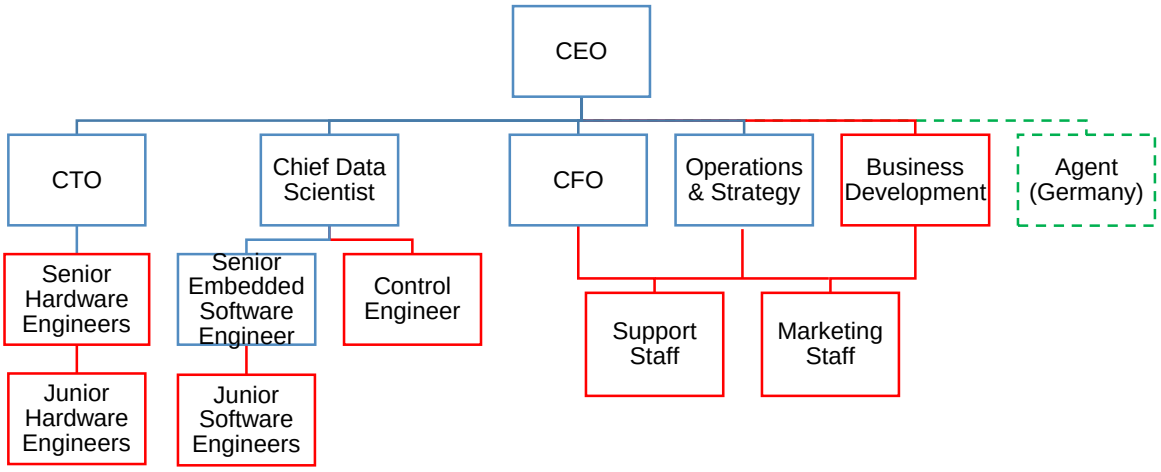

Figure 19. Future organization chart of Brill Power. Source: own elaboration.

Amongst the job requirements, the sales representative needs to have,

- Proven sales and technical experience in battery systems or related products
- Excellent selling, communication and negotiation skills
- German and English proficiency
- Own transport and flexibility to visit clients
- Motivation and being target driven

Amongst the job responsibilities, the sales representative needs to,

- Present, promote and sell the products using solid arguments to existing and prospective customers
- Establish, develop and maintain positive business and customer relationships
- Reach out to customer leads through cold calling
- Expedite the resolution of customer problems and complaints to maximize satisfaction
- Achieve agreed upon sales targets and outcomes within schedule
- Coordinate sales effort with team members of Brill Power

Lastly, the sales representative will be looked for in Munich, a city that is connected to the most important potential clients; it is less than a two-hour drive to the locations of the companies Sonnen and Varta, and less than a one-hour flight to E3/DC, SENEC, and SolarWatt. Traveling expenses will be covered by Brill Power. The representative will have a commission for the sales of the month of 10 percent.

8. FINANCIAL PLAN

8.1 FUNDING SOURCES AND INVESTMENTS

Since its starting operations in 2016, Brill Power has been funded by various seed capital and grants. To date, they have raised more than US$ 2.200.000 and expect to sustain their operations until 2020. In 2020 they plan to raise more than US$5.000.000 for the operation of the years to come. From 2021 they expect to generate revenues and start to sustain the business with incomes.

For the purposes of this business plan, the funding for the next years and UK operations are covered since Brill Power has effectively raised funds before. The following investments are required to start the operations in Germany, and they are expected to come from future seed raises.

- The initial approach to German companies: at the beginning, the staff of Brill Power will travel to Germany to visit and present the product to potential clients. It was considered six visits to Germany for three days of two members, including airplane tickets, hotel, car rental and other traveling expenses (US$11.880)
- Marketing: participation in seminars from Europe and around the world to promote the product. It was considered the participation in three international fairs of two members of Brill Power, including airplane tickets, hotel, car rental and other traveling expenses (US$23.940)

Therefore, the initial investment required is US$35.820.

8.2 INCOME ESTIMATION

In 2017, 4.031 units of battery system were sold and installed in households of Germany under the KfW program, 60 percent came from German manufacturers (RWTH Aachen University, 2018). The sales from the subsidy program account for the 44 percent of the total battery systems sold in Germany, and around 92 percent of these systems correspond to lithium-ion batteries (German Trade & Invest, 2018a). Therefore, approximately 8.428 lithium-ion batteries for households were sold in 2017 in Germany. Assuming that 60 percent came from German manufacturers, 5.057 units were sold in 2017.

To estimate an income for year 2021, it will be assumed that Brill Power will start with participation of the 15 percent of the units sold in 2017 in Germany by German manufacturers of lithium-ion batteries which accounts for 759 units. The compound annual growth rate for the demand for household batteries from 2013 to 2016 was 113 percent (German Trade & Invest, 2018a). Extrapolating, the demand by 2021 would be 104.092 units. Therefore, to consider 15 percent of the sales in 2017 is a small share of the projected demand (less than 1 percent). Furthermore, it will be

considered the current growth rate to include the increase of the demand in the income estimation.

Residential batteries size range from 2 to 20 kWh. To simplify calculations and for the purposes of this business plan, a unit sold will correspond to a battery system of 10 kWh of capacity. Therefore, it will include a BMS of this capacity.

Lastly, Brill Power intends to sell the BMS at US$25/kWh, the market price for non-smart BMS and expects to increase the price a ten percent every two years within the first five years, which will be the forecast horizon.

Table 13 shows the income estimation for the first five years for Brill Power.

Table 13. Income estimation.

Year	**0**	**1**	**2**	**3**	**4**	**5**
Units	-	759	1.616	3.441	7.330	15.614
Price, US$/kWh	-	$ 25	$ 25	$ 28	$ 28	$ 31
Revenue, US$	-	$ 189.750	$ 404.000	$ 963.480	$ 2.052.400	$ 4.840.340

Note: Own elaboration

8.3 COSTS ESTIMATION

Variable costs

There are two variable costs, production costs of the BMS and the fee to the agent. According to Brill Power, the production cost is US$20/kWh. Moreover, a 10 percent fee will be considered for the agent.

Table 14 shows the variable costs estimation for the first five years for Brill Power.

Table 14. Variable costs estimation.

Year	**0**	**1**	**2**	**3**	**4**	**5**
Units	-	759	1.616	3.441	7.330	15.614
Production cost, US$	-	$ 151.800	$ 323.200	$ 688.200	$ 1.466.000	$ 3.122.800
Fee, US$	-	$ 18.975	$ 45.248	$ 106.671	$ 249.220	$ 577.718
Total variable cost, US$	-	$ 170.775	$ 368.448	$ 794.871	$ 1.715.220	$ 3.700.518

Note: Own elaboration

Fix costs

Fix costs are related to administrative expenses such as participation in seminars, travels to Germany and the travel within Germany of the agent. Administrative expenses such as office rent, office supplies and salaries of the staff of Brill Power are not considered for this business plan, only the additional expenses because of the expansion to Germany.

To estimate these costs, it was considered the participation in two international fairs per year of two members of Brill Power, including airplane tickets, hotel, car rental, and other traveling expenses. Also, it was considered twelve 3-day visits to Germany per year of two members, including airplane tickets, hotel, car rental, and other traveling expenses. Lastly, it was considered eighteen 3-day visits within Germany per year of the agent, including airplane tickets, hotel, car rental, and other traveling expenses. This totals US$ 25.820 in fix costs for year 0, and US$57.900 per year from year 1 to 5. Table 15 summarizes these fix costs.

Table 15. Fix costs.

Year	**0**	**1 to 5**
Cost of seminars, US$	$ 1.800	$ 1.800
Cost of flights, hotel + expenses, US$	$ 2.190	$ 2.190
Seminars per year / Participants	3 / 2	2 / 2
Total Cost Seminars, US$	$ 23.940	$ 15.960
Technical visits to Germany per year	6	12
Cost of flight, hotel + expenses, US$	$ 990	$ 990
Participants	2	2
Total Cost Technical Visits, US$	$ 11.880	$ 23.760
Technical visits agent	-	18
Cost of flight, hotel + expenses, US$	-	$ 1.010
Total Cost Technical Visits, US$	-	$ 18.180
Total Fix Costs, US$	$ 35.820	$ 57.900

Note: Own elaboration

8.4 CASH FLOW

Cash flow was made considering a horizon of 5 years (Table 16).

This business plan does not require significant investment in assets. Therefore, depreciation was not considered in the cash flow. Also, the corporation tax rate for company profits in the UK is 19 percent (GOV.UK, 2018).

The year before revenues (year 0) were considered to have an intensive activity for Brill Power staff. It was considered visits to Germany and participation in international fairs of members of Brill Power, as it was detailed in section 8.1. Lastly, the cost of opportunity was considered to be the time spent by the staff of Brill Power in the entrance in this new market. For year 0, it was considered to require 30 percent of the worked time per year of three staff members with a value of US$40/hour (US$79.380). For years 1 to 5, it was considered 20 percent of two staff members at the same cost per hour (US$35.280).

The working capital was considered 5 percent of the revenues, for the first two years. From the third year, the business is profitable.

The net present value (NPV) and the internal rate of return (IRR) of the business were calculated. The used discount rate was based on a survey done to investors of renewable energy projects distributed across ten geographies which have strong renewable markets: Australia, Canada, France, Germany, Ireland, Italy, Nordics, Spain, the UK, and the USA. Investors in UK and Germany used discount rates from 4,25% to 9% (Grant Thornton, 2018). The highest value was used, 9%.

Table 16. Cash flow estimation.

Year	**0**	**1**	**2**	**3**	**4**	**5**
Units		759	1.616	3.441	7.330	15.614
Revenue, US$		$ 189.750	$ 404.000	$ 963.480	$ 2.052.400	$ 4.840.340
Costs, US$		-$ 170.775	-$ 363.600	-$ 784.548	-$ 1.671.240	-$ 3.606.834
GROSS MARGIN, US$		**$ 18.975**	**$ 40.400**	**$ 178.932**	**$ 381.160**	**$ 1.233.506**
Administrative expenses, US$		-$ 57.900	-$ 57.900	-$ 57.900	-$ 57.900	-$ 57.900
OPERATING INCOME, US$		**-$ 38.925**	**-$ 17.500**	**$ 121.032**	**$ 323.260**	**$ 1.175.606**
Depreciation, US$						
EARNINGS BEFORE TAX, US$		**-$ 38.925**	**-$ 17.500**	**$ 121.032**	**$ 323.260**	**$ 1.175.606**
Tax, US$				-$ 22.996	-$ 61.419	-$ 223.365
NET PROFIT, US$		**-$ 38.925**	**-$ 17.500**	**$ 98.036**	**$ 261.841**	**$ 952.241**
Depreciation, US$						
Travels to Germany, US$	$ 11.880					
Marketing, US$	$ 23.940					
Opportunity cost, US$	$ 79.380	$ 35.280	$ 35.280	$ 35.280	$ 35.280	$ 35.280
Working capital, US$		$ 9.488	$ 20.200			
NET CASH FLOW, US$	**-$ 115.200**	**-$ 83.693**	**-$ 72.980**	**$ 62.756**	**$ 226.561**	**$ 916.961**

Note: Own elaboration

8.5 FINANCIAL EVALUATION

The results were,

NPV: US$ 505.976
IRR: 46,3%

8.6 SENSITIVITY ANALYSIS

Sensitivity was analyzed by changing the values of price and demand to see the results on NPV and IRR values.

Demand sensitivity

Two cases were analyzed, to change the initial demand and the growth rate in a range of ±30 percent. Table 17 shows the results.

Table 17. Demand sensitivity results.

Variable	Initial demand		Demand growth rate	
Escenario	**NPV**	**IRR**	**NPV**	**IRR**
-30%	US$ 229.186	29,0%	-US$ 135.622	-
-20%	US$ 321.440	35,4%	US$ 16.245	10,9%
-10%	US$ 413.684	41,1%	US$ 225.668	29,5%
actual	US$ 505.976	46,3%	US$ 505.976	46,3%
+10%	US$ 598.240	51,1%	US$ 872.015	61,9%
+20%	US$ 690.494	55,5%	US$ 1.339.957	76,7%
+30%	US$ 782.776	59,7%	US$ 1.927.468	91,0%

Note: Own elaboration

Results show that the business remains profitable even with changes in the projected demand. It can be concluded that the evaluation is more sensitive to changes in the growth rate rather than the initial demand. Therefore, success is linked to the expected growth of this market.

Price sensitivity

The initial price was established at market price with a low margin. It was considered that the price would be increased 10 percent every two years. These assumptions were tested to see the impact in the NPV and IRR. Table 18 shows the results.

Table 18. Price sensitivity results.

Escenario	NPV	IRR
Constant price	-US$ 58.749	
Price growth of 5% every two years	US$ 129.493	21,9%
Price growth of 10% every two years	US$ 505.976	46,3%
Price growth of 15% every two years	US$ 694.218	55,1%

Note: Own elaboration

Results show that the business does not remain profitable with changes in the projected price. It can be concluded that the evaluation is highly sensitive to changes in the price. In particular, if the price stays constant at the initial value, this business is not profitable. However, with increments higher than 5 percent every two years, this business is profitable.

9. CONCLUSIONS

There are opportunities to commercialize the BMS designed and produced by Brill Power outside of UK. From the assessment of the most thriving storage markets around the world, Germany showed the most prominent potential against Australia, Japan, South Korea, and United States. The factors analyzed for each country were macroeconomic, market accessibility, renewable energy and storage market variables. In this context, Germany stands out in the macroeconomic and market accessibility variables. Moreover, Germany showed a mature renewable energy market and the right policies to promote storage systems such as grid modernization initiatives and financial incentives for investment in battery systems.

The value chain of lithium-ion batteries is highly integrated and dominated by large-scale Asian companies such as LG Chem and Samsung SDI. These companies have a mass market production. Furthermore, research and development are concentrated in lithium-ion cells rather than BMS or other components of battery systems. Cells represent the most critical cost with 35-45 percent of the total cost, while the BMS can be accounted for only 10 percent. From the market research, it was concluded that innovation in BMS is appreciated in smaller and local producers of batteries that focus on a premium product rather than to appeal to a mass market.

Inside of Germany, the value chain is also integrated and every demand for different services of batteries has increased in the last years, such as storage for solar PV and electric vehicles. The service that shows the biggest potential is stationary storage for residential or commercial purposes. This market is dominated by German manufacturers that hold 67 percent of the market share.

From the PESTLE analysis, it can be concluded that the conditions are favorable to conduct business between Brill Power and German manufacturers.

From SWOT analysis, it can be concluded that the fundamental strength is the ownership of an innovative product. However, the lack of validation is a major weakness. Furthermore, the main opportunity is the potential of being a part of a thriving market, however, the value chain that is highly integrated and not open to new entrants.

From Porter’s forces analysis, it can be concluded that competitors and buyers hold a strong position of power in the market. Brill Power is still a newcomer. Therefore, it is essential to validate the technology and include a warranty with their product to be fully inserted in the storage market and to start the promotion in other markets such as Germany.

The most attractive segment in Germany is battery manufacturers with a local presence. In particular, companies that provide services for residential houses. The strategy will be focus in differentiation, value addition and benefits to consumers.

The success of this initiative depended on the initial price and marketing efforts. It is key to start promoting the product through technical visits to German manufacturers and participation in energy storage seminars to divulge the results of the pilot projects, along with the website and social media promotion. Moreover, a low-initial price is proposed at 25 US$/kWh, the average price of a basic configuration of BMS.

Regarding the process, the production is MTO due to the particular sizes, geometry and technical specifications that each battery manufacturer has. Therefore, this is a customized product. Moreover, there will be no necessity for a warehouse; the supplier will send the product directly to the factory where the client assembles the battery systems.

For this business plan, a new member is required, a sales representative or agent located in Munich, Germany. This city is connected to the most important potential clients in Germany. Also, a 10 percent of sales commission was considered.

Lastly, this business plan is profitable under the assumptions made in this report with a NPV of US$ 505.976 and IRR of 46,3% with a forecast horizon of five years and a discount rate of 9%. It was considered an investment of US$ 35.820 which accounts for travel expenses from visits to clients and participation in international energy fairs. The size of the market is expected to be of 104.092 units of BMS by the year 2021. The demand capture was defined as 759 units which accounts for less than 1% of the market share. The annual sale growth rate was defined as the actual rate, 113% per year.

Sensitivity analysis showed that success is strongly connected to the price of the BMS and not to the initial demand and growth rate of sales. If the price stays constant at the initial value (25 US$/kWh), this business is not profitable. However, with increments higher than 5 percent every two years, this business is profitable.

10. APPENDIX

10.1 APPENDIX A: MARKET SELECTION RANKING

In tables 19, 20 and 21 there are the scores of each variable within the group of variables for the selected countries. These scores were assigned for quantitative and qualitative variables, where 5 is the best score and 1 the worst score. For quantitative variables, the best score was assigned to the best value, depending on the variable assess. For example, the highest GDP got the highest score. However, for inflation, the lowest got the highest score. For qualitative variables, a comparison was made between the countries and the highest score was given to the country that had better characteristics. For example, most countries are implementing smart grid initiatives, but not all of them are doing what it is necessary to accomplish this in the short time. Stronger policies and actions were given the best score.

Table 19. Macroeconomic variables scores for selected countries.

Country	Population Score	GDP Score	GDP per capita Score	Economic growth Score	Inflation Score	Unemployment rate Score	Purchsaing power parity Score
South Korea	2	3	1	5	2	3	5
United States	5	1	5	4	3	2	2
Japan	4	5	2	1	5	5	4
Germany	3	4	4	3	4	4	1
Australia	1	2	3	2	1	1	3

Note: Own elaboration

Table 20. Market accessibility variables scores for selected countries.

Country	Global competitiveness index Score	Ease of doing business index Score	Grid modernization Score	Financial incentives Score	Phase out of feed-in tariff Score	National policy Score
South Korea	1	5	5	4	0	2
United States	5	4	1	1	3	1
Japan	3	1	4	5	0	5
Germany	4	2	2	3	4	3
Australia	2	3	3	2	5	4

Note: Own elaboration

Table 21. Renewable energy and storage market variables scores for selected countries.

Country	Renewable energy production Score	Renewable share in electricity production Score	Electricity retail Price Score	Installed storage capacity Score	Storage projects announced or under construction Score	Desire for self-sufficiency Score
South Korea	5	2	2	3	2	0
United States	3	3	1	2	4	0
Japan	1	4	4	1	1	0
Germany	2	5	5	4	3	4
Australia	4	1	3	5	5	5

Note: Own elaboration

Considering the scores of the last three tables, an average was calculated within each set of variables. Results are shown in Table 22.

Table 22. Average ranking of set of variables for selected countries.

Country	Average Macroeconomic Variables	Average Market Accessibility Variables	Average Renewable Energy and Storage Market Variables
Germany	3,3	3,0	3,8
Australia	1,9	3,2	3,8
Japan	3,7	3,0	1,8
South Korea	3,0	2,8	2,3
United States	3,1	2,5	2,2

Note: Own elaboration

Lastly, each set of variables were given a weigh considering the influence they have as a driver for battery storage projects in each country. This weigh was used to calculate the final average shown in Table 23. The weigh considered were,

- Macroeconomic variables: 15%
- Market accessibility variables: 55%
- Renewable energy and storage market variables: 30%

Table 23. Final average ranking of variables for selected countries.

Country	Final Average
Germany	3,29
Australia	3,17
Japan	2,76
South Korea	2,71
United States	2,50

Note: Own elaboration

10.2 APPENDIX B: STRUCTURE OF INTERVIEW OF POTENTIAL CLIENTS

Interview for Market Research for Thesis
MBA of University of Chile

Business plan to enter the manufacturer market of lithium-ion battery systems in Germany for Brill Power

Objetives of the interview

- Quantify the size of the German market for lithium-ion battery systems
- Assess interest from potential clients
    - Estimate annual sales of a Battery Management System (BMS) commercialized by Brill Power (volume and price)

Presentation of the company

Brill Power was incorporated in 2016 as a spin out company of Oxford University. The company is commercialising intelligent battery management systems to deliver a step-change improvement in the lifetime of lithium-ion battery systems.

Located in the city of Oxford in the UK, Brill Power was founded by experts in lithium-ion battery technology, power electronics and business and enjoys support from energy storage specialists from industry and academia. In addition, the company is associated with groups focused on smart energy research such as The Energy and Power Group of the University of Oxford, and with groups that support innovations related to mitigation and adaptation to climate change, such as EIT Climate-KIC and The Enterprise Europe Network.

Presentation of the product

Brill Power has designed a BMS for multi-cell lithium-ion batteries which materially improves the lifetime and performance of the battery systems.

The Brill Power BMS consists of a combination of patent-pending hardware (printed circuit boards) and software and can extend the useful cycle life by up to 60 percent while maintaining high performance.

Currently, Brill Power is developing pilot projects focused on validating the technology with companies in the UK energy market, and consequently, promote the product in this market. Possible applications of Brill Power's BMS technology include residential, commercial & industrial and grid-scale energy storage as well as electric vehicles.

Please answer the following questions. Feel free to skip any question that can be confidential or not relevant to you.

Name:

Name of company:

Location:

1. Are you interested in extending the cycle life of your energy storage product(s)?
Yes No

2. Which qualities (in addition to safety) do you look for in a BMS?
Low cost Efficiency of the system Extended battery life
Other (specify):

3. Has any other company offered you a BMS to extend cycle life? If yes, please specify the name(s) of companies.
Yes No

4. How much do you pay for your current BMS? (price or as a percent of the total production cost)

5. Who are your suppliers of cells and BMS?

10.3 APPENDIX C: INTERVIEWS

Table 24.Details about interviews.

Name	Position and company	Date of interview
Christoph Birkl	CEO and founder Brill Power, UK	June 5, 2018 October15, 2018 November 29, 2018 December 12, 2018
Vinay-Kumar Krishnappa	Hardware Developer E3/DC, Germany	November 22, 2018
Nils Hülsmann	Software Developer E3/DC, Germany	November 27, 2018

Note: Own elaboration

11. BIBLIOGRAPHY

E3/DC. (2018). Product overview. Retrieved from https://www.e3dc.com/en/products/

AECOM. (2015). *Energy Storage Study: A storage market review and recommendations for funding and knowledge sharing priorities*. Retrieved from https://arena.gov.au/assets/2015/07/AECOM-Energy-Storage-Study.pdf

Australian Energy Regulator. (2017). *State of energy market May 2017, Australian Energy Regulator Melbourne*. Retrieved from https://www.aer.gov.au/system/files/AER%20State%20of%20the%20energy%20market%202017%20-%20A4.pdf.

Australian Academy of Technology and Engineering. (2017). *Energy storage: Opportunities and challenges of deployment in Australia*. Retrieved from https://www.atse.org.au/Documents/reports/energy-storage-opportunities-challenges.pdf

Benchmark Mineral Intelligence. (2017). Rise of the lithium ion battery megafactories: What does 2018 hold?. Retrieved from https://www.benchmarkminerals.com/where-is-new-lithium-ion-battery-capacity-located/

Berre, M. (2016). *The Energy Storage Landscape in Japan*. Retrieved from https://www.eubusinessinjapan.eu/sites/default/files/energy_storage_landscape_in_japan.pdf

Bloomberg New Energy Finance. (2017). Global storage market to double six times by 2030. Retrieved from https://about.bnef.com/blog/global-storage-market-double-six-times-2030/

BMZ Innovation Group. (2018). Products. Retrieved from https://www.bmz-group.com/Products/EN_index_1808.html

Brill Power. (2018). Brill Power. Retrieved from www.brillpower.com/

Burger, B. (2018). *Power generation in Germany – assessment of 2017*.Retrieved from https://www.ise.fraunhofer.de/content/dam/ise/en/documents/publications/studies/Stromerzeugung_2017_e.pdf

Campbell, R. J. (2018). *The Smart Grid: Status and Outlook*. Retrieved from https://fas.org/sgp/crs/misc/R45156.pdf

Clean Energy Regulator. (2017). *2016–2017 Annual Report: Accelerating carbon abatement for Australia*. Retrieved from http://www.cleanenergyregulator.gov.au/DocumentAssets/Documents/Clean%20Energy%20Regulator%20Annual%20report%202016-17.pdf

Deloitte. (2018). *Supercharged: Challenges and opportunities in global battery storage markets*. Retrieved from https://www2.deloitte.com/content/dam/Deloitte/bg/Documents/energy-resources/gx-er-challenges-opportunities-global-battery-storage-markets.pdf

Department of Industry, Innovation and Science. (2016). *Australian energy update 2016*. Retrieved from https://www.industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/aes/2016-australian-energy-statistics.pdf.

Federal Ministry for Economic Affairs and Energy. (2015). *The energy transition - a great piece of work, Making a success of the energy transition, On the road to a secure, clean and affordable energy supply.* Retrieved from https://www.bmwi.de/Redaktion/EN/Publikationen/making-a-success-of-the-energy-transition.pdf?__blob=publicationFile&v=6

Germany Trade & Invest. (2018a). *The energy storage market in Germany*. Retrieved from https://www.gtai.de/GTAI/Content/EN/Invest/_SharedDocs/Downloads/GTAI/Fact-sheets/Energy-environmental/fact-sheet-energy-storage-market-germany-en.pdf?v=11

Germany Trade & Invest. (2018b). Profile. Retrieved from https://www.gtai.de/GTAI/Navigation/EN/Meta/About-us/Who-we-are/profile.html

GOV.UK. (2018). Corporation Tax rates and reliefs. Retrieved from https://www.gov.uk/corporation-tax-rates

Grant Thornton. (2018). *Renewable energy discount rate survey results – 2017*. Retrieved from http://www.cleanenergypipeline.com/Resources/CE/ResearchReports/renewable-energy-discount-rate-survey-2017.pdf

Heo, Y. (2018). *Integrating solar and storage technologies into Korea's energy landscape Business models and policy implications*. Retrieved from http://esi.nus.edu.sg/docs/default-source/doc/korea-solar-and-energy-storage-market_public.pdf?sfvrsn=2.

Hill, J. S. (2016).Germany confirms end to renewable energy feed-in tariffs. *Clean Technica*. Retrieved from https://cleantechnica.com/2016/07/12/germany-confirms-end-renewable-energy-feed-tariffs/

Influence Map. (2017). *Japan's energy choices to 2020 How its focus on coal power is misaligned with the strategic interests of Japanese industry*. Retrieved from https://influencemap.org/site/data/000/299/Japan_Report_Summary_Sept_2017.pdf.

International Energy Agency. (2018). *World energy prices, an overview*. Retrieved from http://www.iea.org/publications/freepublications/publication/WorldEnergyPrices2018Overview.pdf

International Energy Agency. (2016). *Energy Policies of IEA Countries, Japan, 2016 review*. Retrieved from https://www.iea.org/publications/freepublications/publication/EnergyPoliciesofIEACountriesJapan2016.pdf

International Renewable Energy Agency. (2017). *Electricity storage and renewables: costs and markets to 2030*. Retrieved from http://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Oct/IRENA_Electricity_Storage_Costs_2017_Summary.pdf?la=en&hash=2FDC44939920F8D2BA29CB762C607BC9E882D4E9

Jansen, J. (2018). Market insight: Global battery storage pipeline reaches record 10.4 GW in the first quarter of 2018. Retrieved from https://technology.ihs.com/601950/global-battery-energy-storage-pipeline-reaches-record-104-gw-in-the-first-quarter-of-2018

Korea Energy Statistical Information System. (2018). Generation by power source. Retrieved from http://www.kesis.net/sub/subChartEng.jsp?report_id=32140&reportType=0

Maps of World. (2015). Political map of Germany. Retrieved from https://www.mapsofworld.com/germany/germany-political-map.html

Messenger, B. (2018). In depth: Lithium battery recycling - The clean energy clean up. Retrieved from https://waste-management-world.com/a/in-depth-lithium-battery-recycling-the-clean-energy-clean-up.

OECD. (2018). OECD data. Retrieved from https://data.oecd.org/

Office of Electricity. (2018). Global energy storage database. Retrieved from http://www.energystorageexchange.org/projects

RWTH Aachen University. (2018). *Wissenschaftliches mess- und evaluierungsprogramm solarstromspeicher 2.0 jahresbericht 2018* [Scientific measurement and evaluation of solar power storage program 2.0 annual report 2018]. Retrieved from http://www.speichermonitoring.de/file admin/user_upload/Speichermonitoring_Jahresbericht_2018_ISEA_RWTH_Aachen.pdf

Seeger, D. (2018). Sonnen und LG Chem verkaufen am meisten auf dem deutschen heimspeichermarkt [Sonnen and LG Chem sell the most in the German home storage market]. *PV Magazine*. Retrieved from https://www.pv-magazine.de/2018/03/21/sonnen-und-lg-chem-dominieren-deutschen-heimspeichermarkt/

Sonnen. (2018). It's time to declare your independence – sonnenBatterie. Retrieved from https://sonnengroup.com/sonnenbatterie/

The World Bank. (2018). World bank open data. Retrieved from https://data.worldbank.org/

The World Bank. (2014). CO2 emissions from electricity and heat production, total. Retrieved from https://data.worldbank.org/indicator/EN.CO2.ETOT.ZS

United Nations ESCAP. (2012). *Low Carbon Green Growth Roadmap for Asia and the Pacific: Case Study - Republic of Korea's smart grid development*. Retrieved from https://www.unescap.org/sites/default/files/37.%20CS-Republic-of-Korea-smart-grid-development.pdf

U.S. Energy Information Administration. (2018a). *U.S. Battery Storage Market Trends*. Retrieved from https://www.eia.gov/analysis/studies/electricity/batterystorage/pdf/battery_storage.pdf

U.S. Energy Information Administration. (2018b). U.S. energy facts explained. Retrieved from https://www.eia.gov/energyexplained/?page=us_energy_home#tab1

Varta Storage. (2018). Varta energy storage systems. Retrieved from https://www.varta-storage.com/products/energy/?lang=en

World Economic Forum. (2017). *The global competitiveness report 2017-2018*. Retrieved from http://www3.weforum.org/docs/GCR2017-2018/05FullReport/TheGlobalCompetitivenessReport2017%E2%80%932018.pdf

Zhang, C., Wie, Y., Cao, P., & Lin, M. (2018). Energy storage system: Current studies on batteries and power condition system. *Renewable and Sustainable Reviews, 82*(2018), 3091-3106. doi: https://doi.org/10.1016/j.rser.2017.10.030