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BATTERY STORAGE TECHNOLOGICAL INNOVATIONS. CASE STUDY: BAXENERGY LTD*

Marco Di Mauro[1], Salvatore Gulina[1], Antonio Zerbo[1], Concetta Patania[2], Simone Massaro[2]**

[1]Department Economics and Business- University Of Catania-Corso, Italia 55 - 95129 Catania, Italy
[2]Baxenergy Italia S.R.L. - Via Sclafani 40 - 95024 Acireale, Italy

Abstract

Innovative developments concerning battery technology are deeply changing our lives, from transportation to stationary applications used to store energy.
Batteries are composed of materials whose production may cause adverse environmental impacts. In case the demand for these materials outpaces supply, scarcity may become a relevant problem and impact the price and feasibility of large-scale adoption of battery-powered vehicles.
This paper presents the technological innovations applied to battery storage management systems. We analyzed BaxEnergy, a proactive company which aims to deliver innovative solutions to renewable energy stakeholders for complete data analysis and optimization of their power plants. BaxEnergy links multiple plants together to form a larger and interlinked system, called power-grid.
BaxEnergy continuously look for new clients in order to undertake new project and becoming an even more important business reality. The current potential clients operate across a large part of the world and perform a portfolio of renewable energy and battery storage project.

Keywords: battery storage, electric vehicles, energy renewable resources, environmental impacts, technological innovations

1. Introduction

Mobility is the opportunity that is given to people to move freely throughout the territory by promoting aggregation, free time and work, while recognizing, at the same time,

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** Corresponding author: e-mail: dimaurom110@gmail.com

safety and comfort. Unfortunately, private vehicles continue to be preferred over public transport, with obvious economic and environmental repercussions. This is the reason why, there is great interest in solutions that make it possible to encourage citizens towards sustainable mobility (Chan et al., 2004).

The term "sustainable mobility" highlights two important declinations, the environmental and the social one. On the one hand mobility can be sustainable from an environmental point of view when it reduces impacting effects such as traffic congestion in the city and consequently atmospheric and noise pollution caused by emissions from both public and private vehicle (Bielaczyc et al., 2001). On the other hand, it can be sustainable from a social point of view if it facilitates the choice and use of means of transport by citizens, improving the value of their free time, the speed of service as well as reliability. New technologies offer further efficiencies, as a matter of fact they offer the promise of higher productivity, increased efficiency and decreased pollution. Not only do electrically driven vehicles have many advantages but also electricity is more efficient than the combustion process. Electricity can be generated through renewable sources, such as hydroelectric, wind, solar and biomass. Electric vehicles (EVs) will allow to overcome the transport-pollution binomial (Mi and Masrur, 2017). EU emissions regulations require a change: less diesel and petrol, more battery. The electric motor converts electric energy into mechanical energy to propel the vehicle; because energy and power densities of storage batteries are smaller than that of fuel for ICE (internal combustion engine), a larger number of batteries must be used to assure a certain level of power performance. However, more batteries on a vehicle reduce interior and luggage space, the resulting increase in vehicle weight sacrifices acceleration and other performances and the cost of the vehicle also rises. The structure provides an electric motor powered by one or more accumulator batteries. EVs are at the brink of entering the commercial market. To succeed in a competitive market, attention should be paid to finding the optimal cost customers are willing to pay. It is important that the power consumption of the air conditioning systems used in EVs is minimized, to minimize penalties to vehicle driving distance and performance.

In the latest EVs the concept of weight-saving design that turns into energy-saving ought to be adopted. Innovative ideas propose the vehicle sale separated from the battery, which is instead rented through a third company. This mechanism allows people to reduce the car price, paying a monthly fee for the battery (ICSU, 2017). Moreover, in case the performance of the battery decreases, the renting company is required to replace it with a new or regenerated one, to guarantee at least 75% of the original autonomy. Sustainable development underlines the limits imposed in the use of environmental resources, it is aimed at climate change on a regional, national and international scale (Smith et al., 2012). Scientists underline urgent but complex problems: CO_2 and CFC emissions, contribute to stratospheric ozone depletion and global warming. Environmental degradation, first seen as a problem of the rich nations and a side effect of industrial wealth, has become a survival issue for developing nations.

There is no doubt about the direct emissions reduction associated with the spread of electric cars. As a matter of fact, absence of combustion means that electric vehicles do not emit nitrogen oxides (NOx), carbon monoxide (CO), particulate matter (PM10 and PM2.5), unburnt hydrocarbons and volatile organic compounds. Consequently, the EVs spread is certainly advantageous for the air quality in the inhabited center (ICSU, 2017). Concerning greenhouse gas emissions on a global scale (often evaluated in terms of carbon dioxide CO_2 equivalent), the advantages offered by electric cars are not certain as they depend on the emissions associated with the electricity production needed to recharge the batteries. Development cannot subsist upon a deteriorating environmental resource base; changes are required in all countries as part of a package of measures to maintain the stock of ecological capital (Ehsani et al., 2018). The urgency with which risk mitigation needs to be solved is high,

people cannot afford the luxury of producing theory for its own sake in the hope that someday it might somehow be useful.

The objective of this paper is to outline an analysis prospectus which may highlight the huge impacts induced by the vehicle sector and in particular analyze the even more developed industry of battery storage. For this purpose, the case study has been accomplished in BaxEnergy, one of the most proactive companies of the Sicilian territory. It is located in Acireale (CT) and develops solutions adopted worldwide to monitor and control infrastructures in the sectors of energy, telecommunication, healthcare and industrial.

2. Materials and methods

A battery cell consists of three primary elements: two electrodes (positive and negative) immersed into an electrolyte (Fig. 1). The lead-acid battery has been a successful commercial product for over a century and is still widely used as electrical energy storage in the automotive field and other applications. The advantages concern low cost, mature technology, and relative high- power capability (Ehsani et al., 2018). Lead-acid batteries also have several disadvantages; among these, the low energy density should be highlighted, as a consequence of the high molecular weight of lead. Fuel cells can be used as alternative power sources for electric and hybrid vehicle sys- tems. Normally, even a pure EV using a fuel cell will need a battery to initiate the fuel cell activation process. In a fuel cell electric vehicle, it is possible to eliminate the alternator as a power generating source (ISO 6469-1, 2019). In place of a battery, it is possible to have an ultracapacitor and even though the ultracapacitor could be eliminated; it is recommended to retain it under normal circumstances.

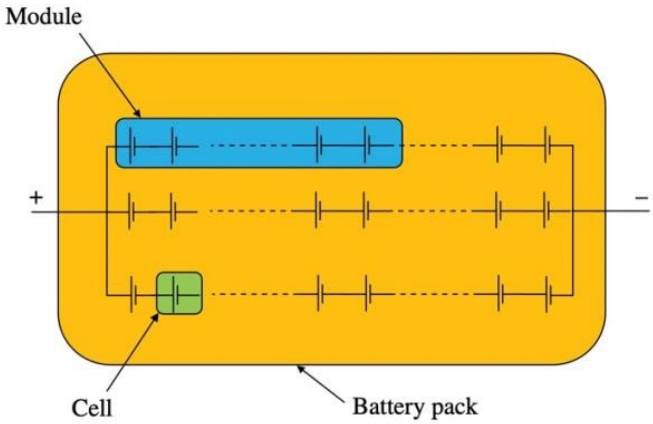

Fig. 1. Battery cell

Hybridization of energy storage is one of the leading recent technologies, it consists on combining two or more energy storages together so that the advantages of each one can be used and disadvantages compensated (ISO 15118-3, 2015). Batteries are composed of materials whose production may cause adverse environmental impacts and consume large amounts of energy. Moreover, if demand for these materials (especially lithium or cobalt) for batteries outpaces supply, scarcity may become a relevant problem and impact the price and feasibility of large-scale adoption of battery-powered vehicles. When an EV battery reaches the end of its useful first life, manufacturers have three options: they can dispose of it, recycle

the valuable metals, or reuse it. Disposal most frequently occurs whether packs are damaged or if they are in regions in which there is not the appropriate market structure. Recycling can make sense if the battery electrodes contain highly valued metals such as cobalt and nickel (CEI EN 61960, 2014). Reuse can provide the most value in markets where there is demand for batteries for stationary energy storage applications that require less-frequent battery cycling. Nowadays, battery recycling procedures are realized in large part thermochemically, through pyrolysis, producing significant quantities of toxic emissions (Reddy et al., 2020). The cost of recycling a ton of lithium batteries is on average between 4 thousand and 6 thousand euros, it is therefore an expensive process considering that the value associated with recoverable raw materials does not exceed one thousand euros. Second life batteries management represents an effective way for accumulators (conserve energy and distribute it in the form of electricity) to enter the circular economy (Bai et al., 2020). Accumulators do not necessarily have to meet the standards required for batteries, they can be reused for applications associated with less binding specifications from the performance point of view.

Waste from electrical and electronic equipment is increasing at a growth rate of 3-5% per year. They include any electrical product with a plug or battery that people want to discard (Zhang et al., 2017). The treatment takes place in special centers adequately equipped; the recycling processes make it possible to recover up to 90% of the entire product. Second-life batteries may be 30 to 70 percent less expensive than new ones in these applications until 2025, requiring significantly less capital per cycle (Engel et al., 2019). Renewable power sources are typically intermittent. On the contrary, batteries overcome this limitation warehousing energy when the sun shines or the wind blows, and releasing it overnight, or when the wind drops. In so doing storage ensures uninterrupted power to consumers. Through accumulating additional energy and releasing it when necessary, storage systems can optimize energy consumption and ensure that business activities can effectively combine cost savings, efficiency and resilience.

3. Case study: BaxEnergy

BaxEnergy, at the beginning operated only in the wind power industry but going through its timeline is possible to discover how the company broke into the whole sustainable global energy market. In 2012, projects spread in Portugal and Austria reaching 10 GW energy handled. In 2013 it was present even in South America and only a year later in Africa. In 2019, 100 GW were treated by BaxEnergy but the company never stopped going forward, even considering the difficulties the world pandemic has brought, until the actual result of more than 110 GW. Even if BaxEnergy has its main operations center in Italy, has commercial offices in Germany, South Africa, Portugal and Chile, as well as representatives in India, Austria, Ireland and and UEA. BaxEnergy provides an all-inclusive strategy which offers on-site hardware and software solutions with 24/7 ICT (Information and Communication Technologies) infrastructure monitoring and cyber defense services. The customers are: Multi-Giga Utilities, TSO (Trasmission System Operators), Operation and Maintenance, Independent Power Producer and Investment and Pension Found (D'Arienzo, 2017).

The company's products also integrate smart modules for power and price prediction, energy trading and support for industrial-grade battery storage management. The monitoring platform extends even beyond the renewable energy field to cover monitoring of electric vehicle charging stations and other critical segments of the national infrastructure such as transportation and telecommunications. With over 110 GW of renewable energy power plants connected, BaxEnegy is leading the green ecological transition. Several analysts making part of the BaxEnergy's team deal with the large amount of GW treated, their role is to provide technical support from the control rooms situated in the office to clients all over the world. It is possible to affirm that the company's goal is to make renewable energy more efficient, affordable, and safe. BaxEnergy provides the most innovative technologies available in the

market, such as the IoT and AI. IoT (Internet of Things) uses a precise computing technology to acquire information from industrial devices in the power plant and performs intelligent and complete data. It also refers to the interconnection of electronic devices each other to gather, monitor, control, and transfer information over the network (Esposito and Massaro, 2017).

The main purpose is to collect the entire amount of data generated by those devices in a unique scenario, then extracting and leveraging information to promote useful and innovative applications and services. BaxEnergy invests in renewable energy sources and tries to make the initial approach to the green energy field easier for the other companies. The aim of company is to guarantee a constant inflow of energy that could both face the demand and prevent the excess and shortage of energy. In order to make the system more efficient and able to contrast potential drawbacks.

In line with the innovative approaches to green energies, BaxEnergy goes further with the sustainable process. The next step concerns the transition from renewables to green hydrogen.

4. Results and discussion

New developments in battery technology are deeply changing our lives, from transportation to stationary applications used to store energy. Batteries are promoting the adoption of renewable energy worldwide and as a response the government policies in support of this evolution are leading to an increase in grid storage capacity (Patania et al., 2021). Thanks to continuous innovations, the energy market is changing faster. Energy transition is moving forward worldwide.

The growing interest and investments in renewables are making people aware about the energetic needs and renewable energy sources' potential (La Cagnina et al., 2020). BaxEnergy, aware that battery storage is one of the promising technological applications that might help to accelerate the energy transition and, at the same time, reducing the overall costs of this process, helped Enel Green Power realizing the first large battery storage project in Italy. The project "Catania 1" represents a crucial step for the green energy market. EGP is using BaxEnergy's integrated software solution to monitor and analyze the battery storage system's data. BaxEnergy provided a data interface which integrates several services for scheduling and controlling energy production through a battery storage system. After the success of "Catania 1" project, EGP has entrusted BaxEnergy with a similar project for the 18 MW wind farm "Potenza Pietragalla" (Bottino, 2022).

The wind farm is the first in Italy to be combined with a storage system and connected to the grid. Thanks to the collaboration, BaxEnergy and EGP continue to lead innovative changes in the renewable energy market, providing new opportunities to progress and power a greener tomorrow (Li et al., 2018). If the energy produced by sun and wind can be stored, and then released at exactly the right time, that could fundamentally change the world's power dynamics.

BaxEnergy aims to deliver innovative solutions to renewable energy stakeholders for complete data analysis and optimization of their power plants.

5. Concluding remarks

Society needs to move away from fuels that are polluting the air and water and warming the entire planet. We need to make energy globally available, making the storing system easy for individuals all over the world. By storing renewable energy and delivering it when the demand requires, people may reliably and cleanly power houses, work environment and entire

buildings even when there is no wind and the sun has set. The energy management system works as an intelligent central brain able to take affective decisions on how to use energy as required. Consume energy when the price is low, sell it when the price is high, optimize energy and storage. BaxEnergy offers a comprehensive, scalable solution ranging from field-level energy data aggregation to grid-wide energy analysis at the management level. A proactive approach allows the system to plan appropriate actions timely, thus preventing problems before they occur. An effective monitoring saves both costs due to unforeseen failures and to physical replacement of all monitoring chain elements out of service or whose behavior is unexpected. Health and economic benefits are clear and cannot be ignored anymore. The more we invest in efficient energy strategies and technologies, the more we will create responsible, self-sustaining jobs and empower countries, improving our life, making the world greener. As a matter of fact, advancements and forward-thinking green actions have led to the birth of new renewable energy industries. Sustainable energy sources are now more affordable and accessible than ever.

Society and modern applications of energies need to make energy globally available, making the storing system easy for individuals all over the world.

In a competitive environment in which companies have to provide more and more effective and efficient services/products, asset management allows to achieve the company's business objective. To accomplish both the goals to ensure good operational performance and long durability of the final products/services, it is necessary to define effective business processes, to monitor their performances and to provide corrective actions when necessary. Energy storage can automatically inject power to support grid stability during contingency events. This enables operators to increase the capacity of existing transmission lines, without having to build another trellis. The goal is to create networks that never go down. Furthermore, energy storage can be used as a fast-acting load resource to ensure supply and demand are managed in lockstep. The balancing capability ensures the maintenance of a stable network throughout the whole process. Co-locating renewables with storage let capture all the energy resources generated and dispatch it when it is needed. As a result, there is no longer the necessity to use it or lose it.

References

Bai Y., Muralidharan N., Kook Y., Passerini S., Stanley M., Belharouak I., (2020), Energy and environmental aspects in recycling lithium-ion batteries: concept of battery identity global passport, *Materials Today*, **41**, 304-315.

Bielaczyc P., Szczotka A., Brodzinski H., (2001), Analysis of the exhaust emissions from vehicles fuelled with petrol or LPG and CNG alternatively, *Journal of Kones*, **1**, 363-369.

Bottino F., (2022), The Sicilian BaxEnergy brings its intelligent platforms for the management of plants also in the hydrogen sector (in Italian), *Hydronews*, On line at: https://hydronews.it/la-siciliana-baxenergy-porta-la-sue-piattaforme-intelligenti-per-la-gestione-degli-impianti-anche-nel-settore-dellidrogeno/

CEI EN 61960, (2014), Secondary cells and batteries containing alkaline or other non-acid electrolytes - Secondary lithium cells and batteries for portable applications, On line at: https://www.eurolab.net/it/testler/batarya-testleri/lityum-pil-testi-ve-sertifikasyonu/

Chan T.L., Ning Z., Leung C.W., Cheung C.S., Hung W.T., Dong G., (2004), On-road remote sensing of petrol vehicle emissions measurement and emission factors estimation in Hong Kong, *Atmospheric Environment*, **38**, 2055-2066.

D'Arienzo S., (2017), Catania BaxEnergy knows how to do business in the renewable energy sector. In Catania BaxEnergy knows how to do business in the renewable energy sector 250 thousand euros in financing for Simone Massaro's company (in Italian), *Sport Enjoy Project Magazine*, On line at: http://www.sportenjoyproject.com/web/?p=36393

Ehsani M., Gao Y., Longo S., Ebrahimi K.M., (2018), *Modern Electric, Hybrid Electric, and Fuel Cell Vehicles*, 3rd Edition, CRC press, Boca Raton, Florida, U.S.A.

Engel H., Hertzke P., Siccardo G., (2019), Second-life EV batteries: the newest value pool in energy storage, McKinsey & Company, On line at: https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/second-life-ev-batteries-the-newest-value-pool-in-energy-storage

Esposito D., Massaro S., (2017), Controlling the uncontrollable- inside the true nature of renewable energy, On line at: https://www.baxenergy.com/2019/11/20/controlling-the-uncontrollable/

ICSU, (2017), *A Guide to SDG Interactions: from Science to Implementation*, Griggs D.J., Nilsson M., Stevance A., Mccollum D. (Eds), International Council for Science, Paris.

ISO 15118-3, (2015), Road Vehicles-vehicle to grid communication interface- Part 3: Physical and data link layer requirement, Geneve, On line at: https://www.iso.org/standard/59675.html

ISO 6469-1, (2019), Electrically propelled road vehicles Safety specifications Part 1: Rechargeable energy storage system (RESS), Geneve, On line at: https://www.iso.org/standard/68665.html

La Cagnina L., Di Giacomo M.D., Mertoli F., Matarazzo A., Di Martino M., (2020), *The* carbon footprint applied to the transport sector as an instrument of transition to the circular economy, *Procedia Environmental Science, Engineering and Management*, **7**, 95-104.

Li X., Chalvatzis K.J., Stephanides P., (2018), Innovative energy islands: life-cycle cost-benefit analysis for battery energy storage, *Sustainability*, **10**, 1-19.

Mi C., Masrur M.A., (2017), *Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives*, 2nd Revision, John Wiley & Sons, West Sussex, United Kingdom.

Patania C., Cali R., Matarazzo M., Massaro M., Lodi A., (2021), Application of social LCA to a pilot project monitoring the charging infrastructure for electric vehicles, *Procedia Environmental Science, Engineering and Management*, **8**, 689-695.

Reddy M.V., Mauger A., Julien C.M., Paolella A., Aghib K., (2020), Brief history of early lithium-battery development, *Materials*, **13**, 1884, http://doi.org/10.3390/ma13081884

Smith S., Gaffney O., Brito L., Ostrom E., Seitzinger S., (2012), Interconnected risks and solutions for a planet under pressure-overview and introduction, *Current Opinion on Environmental Sustainability*, **4**, 3-6.

Zhang S., Ding Y., Liu B., Chang C., (2017), Supply and demand of some critical metals and present status of their recycling in WEEE, *Waste Management*, **65**, 113-127.