



The advantages of battery systems and energy storage in commercial buildings

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A short history of ECO STOR

ECO STOR was founded in December 2019. The holding company is situated in Norway, with its administration in the center of Oslo and its production facilities at Ensjø in Oslo. The German subsidiary is located in Munich. ECO STOR also has a presence both in England and in the USA.

ECO STOR has heavy-weight investors backing them, like Klaveness Marine, Agder Energi, and Covalis Capital. In the fall of 2022, Farvatn Capital joined the investor group.

The revenue of ECO STOR is at 500 mill NOK in 2022, and the revenue budget for 2023 is at about 1 billion NOK.



ECO STOR's vision

ECO STOR started with a vision of solving the challenges brought on by transportation electrification and the challenges associated with more and more electricity coming from renewable sources.

These sources, especially the sun and wind, are volatile sources of electricity production. The sun does not shine during the daytime, and the wind does not blow for long periods.

Energy storage systems will enable the storage and stabilization of energy from renewable energy sources, thus increasing the accessibility of renewable energy. In addition, batteries help regulate the grid's frequency through frequency services.

Also, electricity is becoming increasingly expensive, and enabling the choice of buying electricity when it is cheap, and storing it for use when it is costly, will help save money.



Energy storage systems

As the batteries in electric vehicles become too low in capacity, the range becomes too short.

Even though they are no longer suitable for electric vehicles, these batteries still have enough capacity to be effective for stationary solutions, such as energy storage systems.

Reusing batteries from cars, boats, buses, etc., means utilizing the batteries' resources better than just sending them straight for recycling.

ECO STOR also works with recycling solutions for the batteries when they reach end-of-life. Also, ECO STOR develops first-life energy storage solutions.

In Germany, the main deliveries are within this segment. An example is the 10MW battery energy storage container solution ECO STOR has delivered in Eisenberg.



What is energy storage?

Energy storage makes possible the matching of power production to your consumption. Energy storage is, at large, all around you already.

Just think about the hot water in your tap. You don't make it when you use it. You store it, ready for usage, in a hot water tank. This kind of storage of energy in the way of heat is a very inefficient way of storing energy, and the heat in your hot water tank can not be reversed to electricity.

The battery in your remote control is another example of energy storage. You don't plug it into the wall whenever you want to use it. Power is already stored inside in the form of a battery.

When you store power in a battery, you have access to a versatile form of energy that can be used for

many things. Having stored the energy makes your access to energy flexible. In addition, it makes you prepared for unforeseen events, like power outages. If you have solar panels on your roof, energy storage also makes it possible to store energy production when the sun is shining later.

Also, the storage of energy is helpful on a power grid level. When power production is unstable, power prices become volatile. If huge battery solutions are situated at strategic places in the grid, access to power will improve, and the power prices will become easier to regulate.





Why are battery systems useful in commercial buildings?

Profitability

An energy storage system will control the energy consumption and what time of day the energy is bought. Not all buildings can profit from installing

battery energy storage systems. In many buildings, though, it will prove profitable over time.

Load management

Many electricity companies are preoccupied with load management, but not all loads are controllable. With a battery energy storage system, the loads can run their course, independently of the electricity

prices, during a 24 hour span. The battery system functions as a buffer, allowing you to buy and store electricity when it is at its cheapest and use it at times when the prices are at the highest.

Dimension solar cells in a better way

Battery energy storage systems increase the incentive for filling your roof with solar panels, as you can store the energy you don't use during the day and utilize it when the sun isn't shining, e.g., at night.

Historically, solar panels have been dimensioned to fit the energy use during daylight hours and dimensioning solar panels for covering the use

during the evening and night hours has been considered a waste.

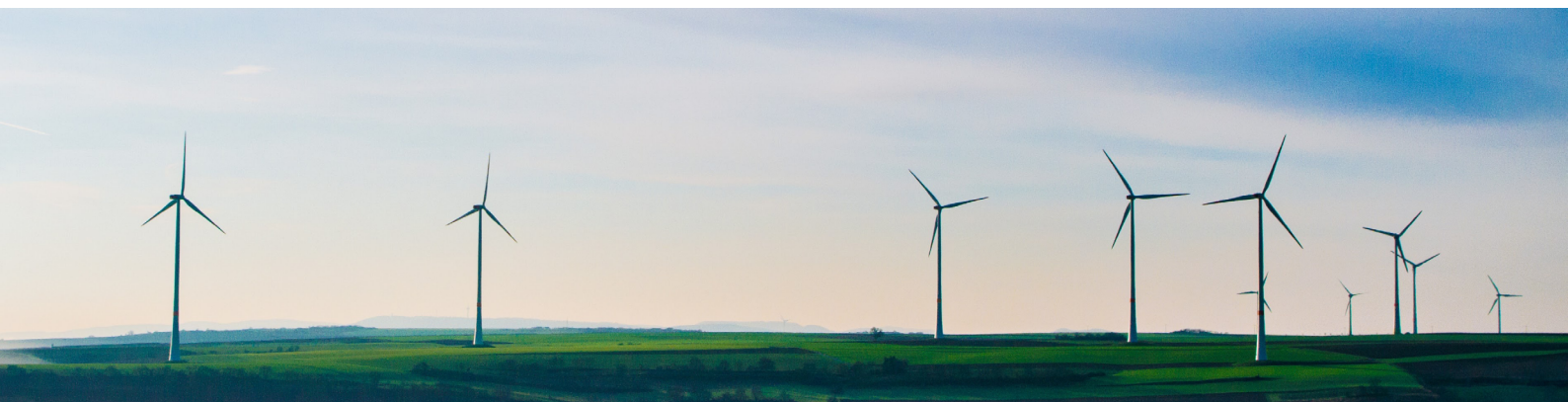
A battery system changes this, making it possible to store excess production for use during the hours the sun isn't shining. This increases the utilization of your roof space for renewable energy production and stabilizes your power consumption.

Green power

Strengthening the power grid by installing battery systems for energy storage in commercial buildings is becoming ever more critical.

In Norway, most of the power produced is green and renewable. However, for instance, in Germany and other countries in Europe and the world, a large proportion of electricity is still being produced from fossil fuels.

Better control of our power consumption is achievable in Norway through installing solar panels on our roofs in combination with battery energy storage systems. This will enable moving more of the clean power being produced in Norway out of the country, thus making more renewable, clean energy available for other countries.



Secure supplies

A battery energy storage system can contribute to securing your power supply. As more and more things are electrified, power consumption is increasing exponentially. Just think about installing 10 EV chargers in an office building so employees can charge their cars during work hours. If all the chargers have an effect of 11 kW, this means a peak of 110 kW in the morning when all employees arrive at work and set their cars to charge. At the same time, all PCs are started, the coffee machine is running, and the lights are turned on.

With a battery energy storage system in the building, all this extra energy is channeled from energy stored in the system during the night, which means no additional strain on the power grid or the electricity bill.

The alternative might be that there needs to be more power coming into the building. As the owner of the building, you will have to pay an investment contribution to get more power so that your internal power distribution system can handle this single morning peak in consumption.

When is it time to consider a battery system in a commercial building?

Below are the most common examples of when it is appropriate to consider a battery system in a commercial building.

When consumption is high or highly variable throughout the day, reducing the bill by as little as 5% will significantly affect the overall consumption and cost of electricity in the building.

If solar panels on the roof produce more electricity than the building consumes, simply selling the surplus power will give you some money. Still, when repurchasing it when the sun doesn't shine, you have to pay more than you got when you sold it, as additional fees are added to the power price. This is possible to avoid if you store the surplus power for self-consumption.

Power outages and an unstable supply of energy can stop the core functioning of your business and give you trouble, e.g., with freezer compartments containing food.

Buying power at the right time is sensible, as power is at its most expensive in the periods when consumption is at its peak. A battery system makes it possible to buy power for storage when it is at its cheapest and control the power consumption of your building according to prices, thus lowering the electricity bill.

The need for power is increasing, and many buildings don't have enough electricity going into the premises. Having to pay hundreds of thousands in investment contributions is unnecessary when a battery system can help you avoid it.

You can still benefit from a battery system when consumption is optimized, and all loads have been effectively regulated. The system integrates with the ventilation system and the heat/cold generation, and so on. The battery system will contribute to flattening the peaks and troughs of the power consumption of these systems.



A practical example.

The effect of adding a battery when you have a solar array on the roof

Solar arrays are becoming more and more common in commercial buildings. Having a battery system, in addition, has many benefits.

Here is a practical example of what there is to gain.

This example is from an office/storage building at Stabekk near Oslo. An analysis of the installment of solar panels and a battery system was done. The numbers show one random week of consumption; the only additional criterion was that it should be within a period of little sun.

The choice fell on 1-9th October 2021.

The building has a consumption of 1.2 million kWh pr. year. Eight hundred square meters of solar panels give a 180 kWh peak, producing 1.61 MWh a year, giving a yearly yield of 244 000 NOK when the price of electricity is 1.5 NOK/kWh.

A battery system of 80 kW/160 kWh will generate a yield of 90 000 NOK per year through storage of overproduction of power, peak shaving, and through

buying electricity at night when the prices are low, using it during the daytime, through periods of little or no sun during a year.

The total investment of such a system, batteries, and solar panels is approximately 2.1 million NOK, of which 600 000 is battery system and 1.5 million in solar panels.

The 900 000 that make up the yield per year consists of 600 000 NOK in reduced energy tariffs and pure peak shaving. On the weekends, when the building is not used that much, the surplus energy generated can be sold at optimum times through assistance from the battery system.

The downpayment time of the said system is 6.5 years.

When it comes to lifetime, solar panels have a lifetime of about 40 years, with peak performance at around 30 years, although this can vary. The battery system has a lifetime of 15 years, including service contract and maintenance.



Reuse of EV batteries

When they no longer have the capacity to be efficient in EVs, the batteries are taken from the cars and brought to ECO STOR's production facilities. They are tested, and if good enough, they are used in stationary applications. "Good enough" means the battery cells need to be intact, and the balance of the battery should be excellent. This is necessary to ensure that the second-life batteries have a long lifespan in the stationary phase.

This would not be the case if the battery cells were taken out of the casing and the batteries were rebuilt. ECO STOR uses the battery packs as they are, straight from the vehicles they come from. This reduces production time, and material costs are kept at a minimum. In addition, all warranties and security declarations are still valid.

The battery systems are fully scalable, from one

battery to large container systems.

If not good enough, the batteries are sent for recycling. About 98% of the materials in the batteries will be recycled in the recycling facility ECO STOR is building with Licycle. When ready in 2023, the factory will have the capacity to handle 10 000 tonnes of lithium-ion batteries per year.

Thereby, ECO STOR can ensure that they deliver a sustainable system, and the system will be handled sustainably after finishing its second life. The materials from the recycling process are as good as new and can be used for making new first-life batteries.

Through this process, ECO STOR contributes to a circular economy for EV batteries, and the final CO₂ print of the methods is low.

Two customer cases

ECO STOR has delivered a 1 MWh battery system container situated at Engene transformer station in Arendal. This is a part of the NorFlex project, supplying the grid in the area.

For "Skipet," a profiled building by G Rieber in Bergen, ECO STOR has delivered a 150 kWh system.

The technicalities of ECO STORs battery systems



The picture at the bottom left shows the batteries without the case. On the far right, the inverters can be seen.

The box in the picture on the upper left side is the proprietary technology developed by ECO STOR, making possible communication with the batteries, ensuring the balance of the batteries is good, and controlling the charging/discharging cycles of the battery system. These boxes are controlled by a master battery management system (BMS)

The battery system is hierarchically put together and, therefore, fully scalable from as little as one battery unit and one inverter to, for example, 20 batteries and ten inverters.

The battery systems are delivered turn-key with inverters and a control system.

Also, the systems have an open interface, making possible the integration of the battery system with the different technical systems of a building.

Standards like Modbus are used, and there are APIs for all the functionalities in the system, like the traditional battery applications of peak shaving, storage of energy from solar panels, storage of energy from the grid, integrations against Nord Pool, charging of the system with power when it's at its cheapest, discharging the battery system when power is expensive and so on. ECO STOR is also working on UPS and backup functions, and in addition, we are continuously developing new functionalities, like the frequency service specter.

Battery management and security

There is a significant concern regarding used batteries' security and fire safety.

The batteries of EV cars are built for being sat on top of and driving at high speeds on the highway with kids in the backseat. They are automotive-grade batteries that endure a lot of vibration, shaking, and bumps in the road and have been extensively tested and approved.

Currently, most of the batteries used by ECO STOR come from Nissan Leaf, as they were the first EVs to roll out on the roads on a large scale in 2012.

Nissan Leaf has presented numbers that suggest that of the 500 000 Nissan Leaf cars that have been on the road since 2012, no more than six or seven of these have suffered fires in the batteries.

https://en.wikipedia.org/wiki/Plug-in_electric_vehicle_fire_incidents#Nissan_Leaf,

The security of these batteries is exceptionally high. Few laws and regulations apply to EV batteries yet. Still, the main rule is that installment of battery systems should not be done in living quarters, they should be installed preferably in a fire cell, but as of now, this needs to be regulated by law.

ECO STOR applies NEK 400 and similar branch standards for battery installations. In addition, best practice recommendations from different branch organizations, like, for instance, NELFO, are applied. In addition, the battery suppliers have product-specific instructions that ECO STOR follows.



Capacity

The capacity of second-life batteries is good.

The batteries ECO STOR delivers are set up to deliver 15 to 30 kWh, although there is the possibility of an effect of 80 to 110 kWh, depending on the generation battery. These batteries, in other words, have the potential to give a yield of three times their capacity (kWh) with a discharge capacity of 20 minutes. In other words, the batteries are set up from our side to be used kindly and not as harshly as when used as EV batteries.

The second-life battery systems of ECO STOR achieve about the same amount of charge/discharge cycles and have the same guarantee periods as if the batteries were new.

A Battery weighs about 300 kg, and concerning volume, second-life batteries are not the most effective. This will change with time as the volume efficiency of batteries has increased dramatically. The batteries being produced in 2022 have the same size as the ones from 2012, but they contain about three times the capacity.

When considering the sustainability of second-life batteries, ECO STOR has a close to zero-emission of CO₂ when producing the battery systems, as this accounting has already been settled when we receive the batteries.



Frequency services

The battery systems of ECO STOR are delivered with the possibility of frequency services for the Nordic power market.

These services can increase the yield of a battery system.

In Scandinavia, power trading is done in the Day-ahead and Intraday markets. Nord Pool and Epex Spot control both.

In the Day-ahead market, power is traded according to the expected consumption the next day.

The Intraday market is a supplement, balancing the amount of power available with the actual consumption on an hour-to-hour basis within a day.

In addition, there is a balance-market Statnett has the concession to control; FCR is a primary reserve

that is set in motion if there are local unbalances in the frequency of the grid. FFR kicks in when there is more than just a slight frequency balance and is a secondary and tertiary reserve that is automatically or manually triggered by Statnett, pouring power into the grid within 1.3 seconds or quicker.

If you have a battery system, you can partake in these markets and make money by making your battery system available for frequency services. FFR is usually used only a couple of times a year, and your battery system's daily management and utilization will not be influenced by it.

The big consulting houses claim that buildings with solar arrays on the roof and batteries in the cellar are a great resource both for generating and utilizing clean energy and regulating the power grid in the coming years.



Questions and answers

Do you envision the use of new batteries in your systems?

Yes. We already do. In Germany, we are using new batteries in our systems. We will also develop hybrid solutions.

Our recycling facility will get a lot of batteries

that we can use, and we have deals with different EV car producers to get the batteries that can no longer be used in EVs, so our capacity for delivering second-life battery systems is good.

What is the cost of second-life compared to first-life battery systems?

Second-life batteries are usually about 20% cheaper than first-life batteries. Still, when it comes to larger systems, the price difference becomes smaller due to the number of other components needed for second-life systems.

The inverter is the most expensive part of the system, and you need more of them, the larger

the system gets. When the system becomes big enough, first-life batteries are cheaper than second-life ones, and one big battery with one big inverter is the best solution.

For systems up to 1 MWh, however, second-life batteries usually are more affordable.

Have you looked into the possibility of Enova support or other kinds of support when installing batteries for load management, peak shaving, and increased renewable production?

Enova supports battery installations in vessels.

<https://www.enova.no/bedrift/sjotransport/batteri-i-fartoy/>

If other things are considered, as implied in the question, it is easier to get support. Previously we have delivered systems that have achieved support from Enova, so it is possible.



How is the price- and technology development for batteries of this category expected to be?

The prices of new batteries are expected to rise due to the global situation. In contrast, the prices of second-life systems are expected to decrease as more and more second-life batteries from EVs

become available. They will have a higher capacity and thus less need for inverters, racks, and other hardware in building the systems.

Can these battery systems be used for emergency services?

Yes. Battery systems can be used for emergency power supply.

Describe the systems you have regarding smart control.

We have a control system that handles all the traditional applications of a battery system; peak shaving, storage from the sun or other sources, and backup. We also have applications for

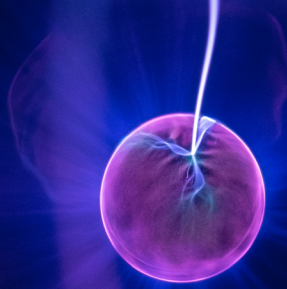
frequency services (FFR, FCR, FFR). ECO STOR can also integrate and control third-party systems (SD systems and building automation systems) and weather data.

How do you ensure fire safety?

The batteries are fire-safe and constructed to be used in EVs. In commercial buildings, it is recommended that a separate fire cell is built for the batteries, but this is, as of now, not a demand.

We strive to follow all laws and regulations regarding best practices in the branch. Also, we

make design choices based on dialogues with fire technical personnel. One solution is to put the batteries in containers with a separate, fire-safe room with an explosion hatchet and misting so that in case of fire, a hose can be connected and the fire extinguished.



Do you have water cooling or air cooling for the battery systems?

We deliver air cooling and might eventually develop water cooling systems too. When we

provide battery systems in containers, we have our HVAC if the environment demands it.

What is the life expectancy of a battery system?

Life-expectancy of a battery system depends on its use, but on average, a system will have a life expectancy of about ten years, and our guarantees are for ten years. With a service

contract, life expectancy might be in the range of 20 years. Also, there is a possibility of changing old batteries that are wearing out and getting a new warranty period.

What do you do if one of the batteries in the system wears out?

Yes, we replace the outworn batteries while the rest of the system is still operating. In that sense,

the system is very flexible.

How capable of delivery are you? How is access to "used batteries"? And do you envision using "new batteries" in your systems at some point?

We have a good supply of batteries, and the forecasts for supply look good in the future as well. We already use new batteries on a

larger scale; 3.45 MWh and above. We are also considering supplying systems with fresh batteries on a smaller scale than this.

How is the delivery situation expected to be affected by the unrest in the world?

The batteries are already in stock or on the way, so little affects battery access. We see longer delivery times for inverters and containers but

have yet to detect any problems to any great extent.