RESILIENT ENERGY INFRASTRUCTURE IN WARTIME: THE STRATEGIC CASE FOR DISTRIBUTED BATTERY STORAGE IN UKRAINE

by

Maksym Hunko

A thesis submitted in partial fulfilment of the

requirements for the degree of

BA in Business Economics, Social Science Department

Kyiv School of Economics

2026

Thesis Supervisor: Mykhaylo Vidyakin, Lecturer, Department of Economics, Kyiv School of Economics

Approved by ____

Head of the KSE Defense Committee, Professor

____

____

____

Date ______________________________

TABLE OF CONTENTS

List of Figures

List of Tables

List of Abbreviations

MW Megawatt

MWh Megawatt-Hour

BESS Battery Energy Storage System

TPP Thermal Power Plant

BM Balancing Market

DAM Day-Ahead Market

AFRR Automatic Frequency Restoration Reserve

CAPEX Capital Expenditure

OPEX Operating Expenses

IRR Internal Rate of Return

NPV Net Present Value

EIA Environmental Impact Assessment

Chapter 1. Introduction.

During the full-scale invasion, the Ukrainian electricity market faces complex systemic challenges. Large-scale destruction of thermal and damage to hydroelectric generation have significantly reduced the system's ability to balance supply and demand, while nuclear power continues to provide a stable base output but lacks flexibility. At the same time, the share of renewable energy, primarily solar, is increasing, creating daily mismatches between electricity consumption and production. Existing balancing mechanisms, such as imports or remaining hydropower, are insufficient to fully address this imbalance.

These challenges in the country's energy system have created a clear need for flexible infrastructure capable of rapid response to daily fluctuations.

The paper examines the role of battery energy storage systems (BESS) as a solution to the balancing gap. Specifically exploring the best-fitted solution configuration and evaluating the financial feasibility of constructing such an infrastructure project. The results aim to provide evidence-based arguments for the deployment of medium-scale BESS stations as a part of Ukraine's transition towards a more flexible and resilient energy system.

Chapter 2. Ukrainian power market context and the balancing gap.

2.1 Loss of variable generation due to war

Since the start of the full-scale invasion, Ukraine’s national electricity system has experienced large-scale destruction of flexible generation assets. Russian air strikes have primarily targeted thermal and hydroelectric power plants, which historically provided the system’s balancing capacity during high-demand periods.

Core facts

- By late 2024, at least 9 GW of generational capacity have been destroyed or disabled by missile and drone strikes (International Energy Agency).
- Nuclear generation remains the dominant source of electricity and provides 60 to 70 percent of base load, while demand reached approximately 18 GW during peak hours of winter 2026, as shown in Fig. 1 (Interfax).
- Nuclear power plants, because of their technical limitations, cannot provide fast response flexibility required for balancing short-term demand fluctuations.

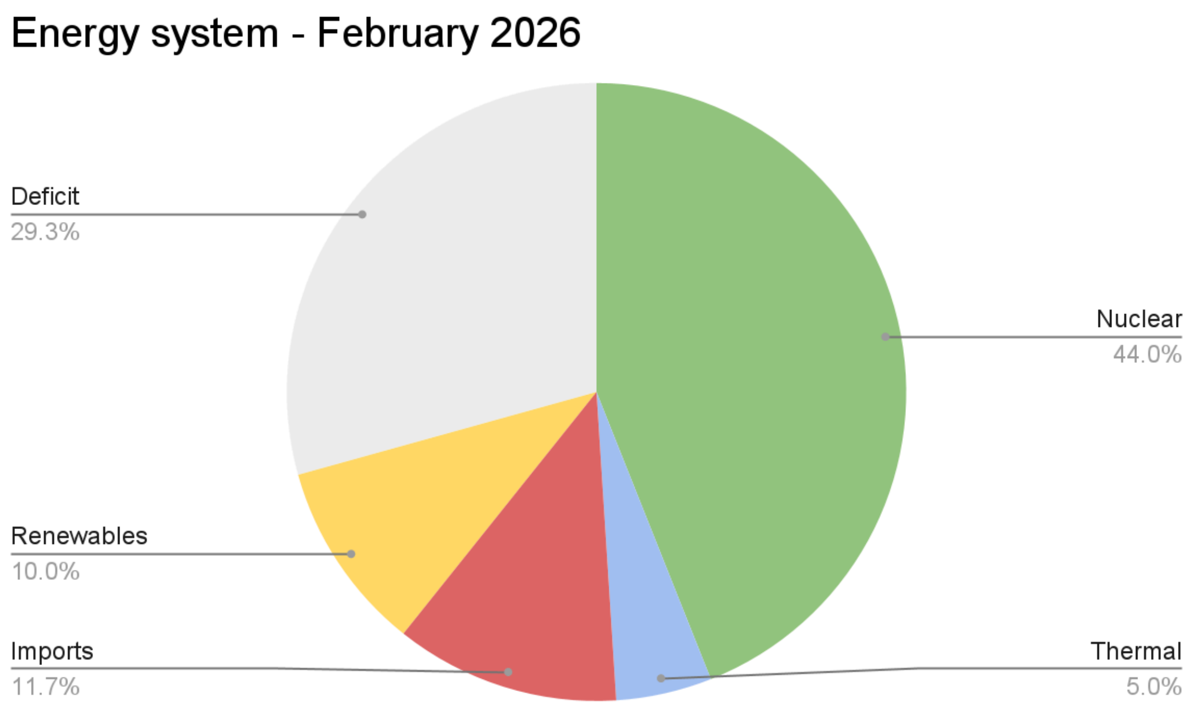

Fig. 1. Electric energy in Ukraine by source, February 2026. Source: Interfax-Ukraine. "Electricity Deficit in Ukraine Decreases from 5–6 GW to 4.3–4.5 GW due to Warming – Minister of Energy." Interfax-Ukraine, 12 Feb. 2026, interfax.com.ua/news/economic/1144224.html

As a result, the majority of power generation, which historically provided balancing capacity, is destroyed or damaged, leaving the country's energy system to rely on emergency imports and limited hydro resources to provide ancillary services.

2.2 Limitations of the remaining balancing solutions

After the destruction of thermal generation, hydro and imported energy are used to mitigate demand fluctuations. However, the amount of electric power that can be obtained from these sources is limited, as both of them have their constraints.

Core facts

- Current import capacity is approximately 2.1 GW; system deficits reach 4-6 GW due to lost domestic generation (Interfax).
- The ability to transport imported energy from west to east across the country can be limited at times, as Russians often strike substations dedicated to energy distribution.
- Hydro capacity was severely restricted since the destruction of the Kakhovka Dam and damage to DniproHES.
- The hydro generation is unstable and limited by seasonal water availability and the need to maintain reservoir levels; it cannot reliably serve as a source of balancing power.

Key implication: the Ukrainian power system requires additional, constantly available, flexible infrastructure, capable of rapidly responding to supply-demand imbalances.

2.3 Growth of variable renewable generation

Despite the war, Ukraine has seen a growth in renewable energy capacity.

Core facts

- Approximately 850 MW of new solar capacity was added in 2024 alone (Interfax).
- Solar generation accounted for about 4.5% of total electricity production in early 2025 (IFEC).
- Due to the fact that solar generation reaches its peak in midday hours, and demand for electricity peaks in the morning and evening, solar energy producers often have to curtail production.

Key implication: with no way to store available electricity generated during peak solar hours, the energy system cannot fully accommodate rising renewable energy production.

2.4 Conclusions

1. Ukraine has lost a significant share of its flexible generation, creating a structural balancing deficit.
2. Nuclear generation, which remains mostly unaffected by air attacks, provides a stable base output, however it cannot provide balancing services.
3. The share of renewable generation is increasing, but with no way to accommodate excess production, its benefits are limited.
4. Existing solutions, such as remaining TPPs and hydro, imports, cannot fully cover the system's balancing gap.

Implication: the Ukrainian electricity system requires new reliable balancing infrastructure, preferably with the ability to accommodate rising renewable energy production.

Chapter 3. Why BESS is the relevant solution.

3.1 Matching the daily demand imbalance

The Ukrainian electricity market is characterized by a mismatch between generation and consumption, combined with the destruction of facilities that were traditionally responsible for managing the discrepancies. On the one hand, there is excess electricity production during midday hours, due to solar generation, while demand peaks during morning and evening, creating recurring daily deficits. Before the war, these peaks were covered by thermal and hydro plants with a capability to cover deficits over several hours. The destruction of this capacity created a need for multi-hour balancing resources, not just short-duration frequency response.

Therefore, an effective solution must simultaneously address both aspects of the problem:

- Enable energy shifting within the same day, absorbing excess solar generation during 11:00-15:00 and discharging during peak demand periods
- Provide continuous output over several hours to support evening peaks (18:00-22:00), and also assist with the morning demand

3.2 Scalability and resilience

The war reality also has an impact on the characteristics of the solution:

- The solution needs to be deployable in modular units - modularity enables incremental capacity increase, reducing upfront investment needs, while also mitigating the risk of complete physical destruction
- It must operate at a scale comparable with the regional demand - ensures that individual units can provide meaningful outages support locally, reducing dependence on transmission infrastructure, which is in itself a frequent target for air strikes

- It must reduce dependence on large centralized assets, which are vulnerable to disruptions - decreases the probability that a single air strike can cause large-scale system failure, and increases overall grid resilience.

3.3 Operational markets flexibility

In addition to technical suitability, a balancing solution must be economically viable within the structure of the national electricity market. This requires the ability to operate across multiple market segments:

- Day-ahead market (DAM): capitalizing on price differences between low and high demand periods
- Balancing market (BM): responding to the real-time system imbalances
- Ancillary services (AFRR): providing fast-response frequency regulation

To utilize these market opportunities, the system must be capable of both short-term response and continuous energy delivery.

3.4 Conclusions: required characteristics of the solution

1. Enable the daily energy shifting between midday surplus and evening deficits
2. Provide multi-hour discharge capability to cover peak demand periods
3. Be deployable in modular distributed units to negate war risks
4. Operate across multiple electricity market segments
5. Support the integration of growing renewable generation

3.5 Relevance of a 20 MW / 80 MWh configuration

A Battery Energy Storage System (BESS) is a grid-connected infrastructure installation that stores electricity during periods of low demand and releases it back into the system when demand increases. BESS does not produce electricity but allows for a temporary redistribution of energy by providing fast-response balancing services.

A BESS with a capacity of 20 MW and 80 MWh satisfies all of the above requirements. Such a configuration enables the station to discharge for four consecutive hours, which directly corresponds with the duration of the evening peak demand period. It allows the system to charge during midday hours when solar generation output is the highest, as demonstrated in Fig. 2.

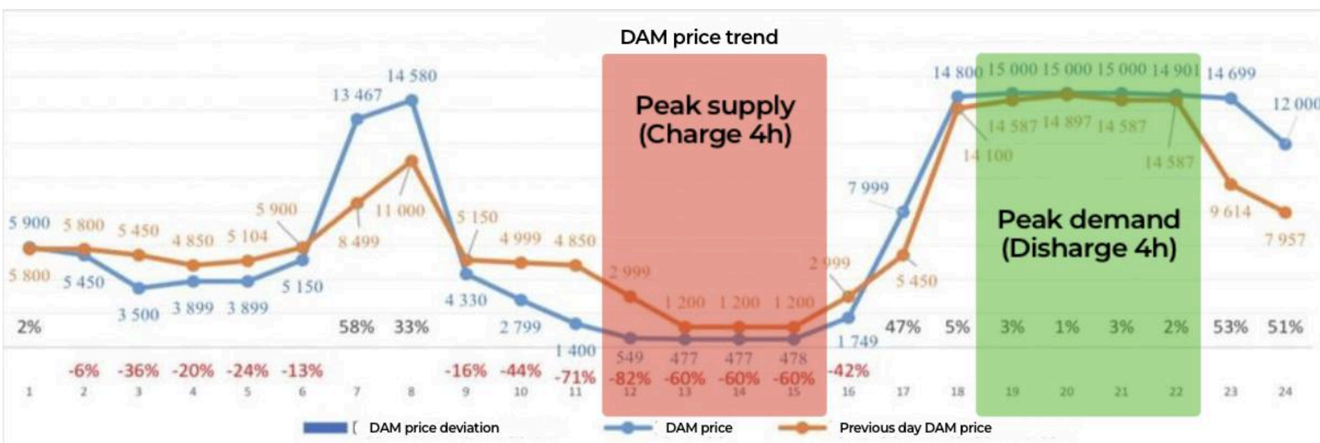

Fig. 2. Viability of 4hr cycling. Source: “Post.” Telegram, uploaded by Market Operator Ukraine (Оператор ринку), 2026, t.me/MarketoperatorUA/3860

The power scale of 20 MW aligns with the size of distributed energy infrastructure currently being deployed in Ukraine, such as gas-powered stations, making it suitable for modular and decentralized implementation. Additionally, the 1 to 4 combination between power and capacity enables participation across balancing, ancillary, and day-ahead markets. Scaling to higher capacities would require legal technical and economic feasibility justification documentation, which is expensive and takes at least a year, while smaller configuration increases non-variable capex per unit, reducing project efficiency.

Conclusion:

A 20 MW / 80 MWh BESS configuration is a direct response to the specific structural and market characteristics of the national electricity market, which makes it a relevant solution for the identified problems.

Chapter 4. Comparable projects.

4.1 DTEK x Fluence

The DTEK x Fluence BESS project in Ukraine is the country's first large-scale deployment of battery energy storage. Under the initiative, DTEK partnered with the battery storage solutions provider Fluence to install 200 MW of BESS capacity across six sites with a combined storage of 400 MWh (DTEK). The project was executed rapidly over the timespan of approximately six months (March - August 2025), significantly faster than the typical energy storage deployments, and was operational in time for the 2025-2026 winter season. The costs amounted to around €125 million, or €625 thousand per MW (DTEK).

Key implications:

- Large-scale BESS deployments in Ukraine can be implemented under wartime conditions within short timelines
- International technology providers (Fluence) are actively entering the Ukrainian market
- The project has a much larger scale than the solution proposed in this paper, designed for system-wide balancing, not localized deployment

4.2 PowerOne

The PowerOne initiative, led by Dragon Capital in partnership with industry figures, including Volodymyr Kudrytskyi, former head of Ukrenergo, and supported with international finance, combines flexible gas generation and BESS solutions to strengthen the decentralized energy capacity and grid resilience in Ukraine. Under a financing agreement with the European Bank for Reconstruction and Development, the project has secured approximately €22.3 million in loans plus €3 million in grants to construct gas power plants totalling 36.8 MW and BESS stations with a total capacity of 31.5 MW at multiple distributed sites mainly in western Ukraine, with individual units of up to 10 MW to provide peak demand support. This mixed configuration approach allows for an efficient emergency grid support - gas turbines provide rapidly available generation while the BESS offers fast-response balancing and storage for excess energy, improving flexibility of the constructed infrastructure (Kyiv Post, EBRD).

Key implications:

- BESS is not only deployed as a standalone infrastructure, but also as a part of larger energy system projects
- International financing institutions (EBRD) are ready to finance such projects
- The project has a comparable (tens of MWs) scale, which indicates a demand for smaller, flexible, distributed energy solutions
- Colocation with generational infrastructure can be a viable extension of the project (which will be discussed in detail in the Risks section)

4.3 KNESS

The KNESS energy group has been actively deploying large-scale BESS stations across Ukraine as a part of its business operations. In 2025, KNESS commissioned over 100 MW of storage capacity across multiple sites, with a plan to install around 200 MW more in 2026. The project is funded by the company's own investment as well as in cooperation with domestic and international financiers, and, per the most recently available data, has cost them about €40 million up to this point. It is worth noting that part of the funds used by the company was provided by Oschadbank, to quote the Director of Power Trading and Supply at KNESS Serhiy Kravchuk, “there are no problems with raising financing”. Set up in close cooperation with the international technology provider HiTHIUM, KNESS stations are used to provide frequency support reserve as well as frequency restoration reserve for the grid (LIGA, Interfax).

Key implications:

- Financing is available from domestic banks and international partners
- The company has a portfolio of BESS projects, with a future expansion strategy, indicating a profitable operational business model

4.4 Conclusions: cross-case patterns

1. Most projects are deployed in units of 10-50 MW, which confirms that the proposed 20 MW system is within the standard range
2. Systems are quoted to be used for prolonged peak demand support, not only frequency response, which also corresponds with the aforementioned design needs
3. Projects are often financed through a mix of (1) private capital, (2) domestic investment, and (3) international institutions, helping to mitigate risk premiums
4. Deployment is always distributed across multiple sites, per the available data
5. Hybrid models, colocating BESS with generational capacity, exist, but standalone BESS is also viable

Chapter 5. Market environment: feasibility drivers.

5.1 Auctions

An important mechanism for the construction of utility-scale battery stations in Ukraine has recently been introduced - specialized auctions for ancillary services led by the system operator Ukrenergo. For example, in August 2024, the system operator conducted its first auction for frequency support reserve, awarding five-year contracts, to be paid out in euros, for 99 MW of storage capacity. Winners are obligated to install and operate BESS facilities by October 2025. This has marked a crucial market opportunity for the development of industrial storage and sparked investor interest by providing predictable revenue for future operations. Further auctions are expected to stimulate investor competition and strengthen the energy system (Golaw). The project model for the paper does not assume direct participation in such auctions, however the existence of these mechanisms extends market opportunities for developers.

Key implications:

- Auctions provide predictable and reliable revenue streams, which increase the bankability of the project
- Reliance on volatile cash inflows is reduced
- Allows for the structure of the project with a base revenue from the auction, plus an additional revenue from market participation

5.2 Legal

The legal and regulatory environment for battery storage in Ukraine is adjusting to stimulate rapid deployment and ease the integration of BESS into the national electricity market. Legislative reforms introduced under draft law No. 13219 propose improvements that simplify grid connection and promote the utilization of storage facilities in combination with renewable generation, which increases efficiency. Other legal reforms, aimed at EU-Ukraine markets synchronisation, also take place, including clearer auction rules, contract terms that are more lenient towards operators' interests, including guaranteed revenue and longer development timelines (CMS, CSIS).

Key implications:

- Increases developer confidence with defined regulatory frameworks, improving project delivery timeline, and, consequently, project economics
- Reduces the risk of grid connection and other types of bottlenecks that can affect viability
- Enables flexible project design, including colocation with the renewable generation

5.3 International donors

International financial institutions and national governments consistently show interest in supporting Ukraine's transition towards a more distributed and resilient power system, with BESS seen as a crucial infrastructure component. Lenders such as the EBRD and World Bank have provided significant financing for projects linked with BESS development (Golaw). Additionally, valuable partnerships, like collaboration between Britain's Octopus Energy and DTEK which aim to mobilize €100 million from EU and UK national as well as private funds for distributed battery storage solutions, accelerate the ability of developers to strengthen Ukraine's grid system (Reuters).

Key implications:

- Reduced CAPEX burden for investors

- Enables insurance, allowing projects to cover high risk premia in the war environment

5.4 Conclusions

The current market environment in Ukraine is designed to support the feasibility of BESS projects through three mechanisms:

1. Auctions provide predictable long-term revenue streams, increasing project bankability
2. Regulatory reforms are adjusted to reduce development risks and accelerate project time-to-market
3. Donor financing lowers the cost of capital by mitigating war risks

Chapter 6. Business model of a 20 MW / 80 MWh station.

6.1 Model structure

The financial model evaluates the feasibility of a 20 MW / 80 MWh BESS station along an 11-year operating horizon. The horizon of 11 years was chosen to capture the period over which most major equipment is depreciated and battery capacity declines to around 70%.

Key model components:

- Technical parameters of the station
- Capital expenditure (CAPEX) and operating costs (OPEX)
- Revenue streams across electricity markets
- Operational assumptions
- Capacity degradation of the system
- Taxes and depreciation
- Sensitivity analysis

6.2 Model assumptions

Data and sources:

The model is based on historical market data for the full year of 2025 - day-ahead market prices (Market Operator), balancing market (Ukrenergo).

Technical parameters

- Installed power: 20 MW
- Energy capacity: 80 MWh
- Round-trip efficiency: 90%

- The station is able to perform 2 full charge-discharge cycles per day, which is plausible when observing current (2025) price spreads. The technical plausibility has also been confirmed by expert consultations.

Operational

- Operating days per year: 330
- The charging and discharging percentage per market has been obtained by consultations with current market participants and is as follows (see Table 1).

Table 1 Market charge-discharge percentage

	Discharge (sell)	Charge (buy)
DAM	83%	25%
BM	17%	75%

Source: Expert consultations with current market participant, Dec. 2025.

Financial

- Total CAPEX: $11.85 million
- Discount rate: 20%, reflecting elevated war risks
- Tax rate: 18%
- Exchange rate: 43 UAH/USD

Degradation

Battery capacity decreases over time, which reduces output and revenue. The model accounts for a gradual degradation profile, with capacity declining to approximately 70% by year 11.

Model limitations

- The model assumes historical price spreads persist
- Does not include possible regulatory changes, for instance, changes in the rate of fixed AFRR services revenue
- Does not model extreme disruption scenarios (outage, physical damage)
- Does not account for scenarios with a lower utilization rate, which could occur due to technical or financial reasons

6.3 Cost structure

Total capital expenditures amount to \$11.85 million, or \$592.5 thousand per MW, which is consistent with previously observed market benchmarks. The CAPEX includes:

- Battery system core equipment - \$8.5 million, or 72% of total CAPEX.
- Grid connection
- Design and construction
- Land and development

6.4 Revenue model

The project generates revenue by price arbitrage across the day-ahead and balancing markets. Additionally, the station is able to generate fixed revenue by providing AFRR services to the system.

The formula that is used in the model to calculate the daily arbitrage gain is

$$G_d = \sum [C(P_d - P_c * E)]$$

Where:

- C: The usable capacity of the battery in MWh
- E: The system's round-trip efficiency
- Pc: Market price for charge
- Pd: Market price for discharge

By using historical data from relevant sources, the model estimates expected revenue from station operation. Daily gain is averaged and is later used to calculate the yearly expected profit, while AFRR provides fixed revenue per MWh daily, which is later scaled to calculate yearly ancillary services revenue. After yearly revenue calculations, OPEX is introduced, where the majority of costs consists of tariffs calculated based on the delta between energy charged and energy discharged back to the system.

Chapter 7. Financial results and sensitivity.

7.1 Base case financial results

Under the aforementioned model assumptions, the project is expected to demonstrate strong performance over the 11-year horizon.

The model estimates:

- Internal rate of return (IRR): approximately 45%
- Payback period (simple): approximately 2.5 years
- Net present value: positive, approximately 450 million UAH.

The project is expected to generate positive cash flow from the first year of operations, which is primarily driven by the significant price spreads between low and high demand periods, and an assumed ability to perform two full cycles per day.

However, these results hold under the specific set of assumptions and should not be interpreted as guaranteed outcomes.

7.2 Sensitivity of the model to key assumptions

The financial performance of the project is highly sensitive to multiple variables, of which the most critical are:

- Price spreads
- System utilization rate
- CAPEX deviations
- Battery degradation profile
- Tariffs and regulatory conditions

These variables directly affect revenue and cost structure, and if one or a few assumptions fail, the financial performance of the model may be significantly impacted.

7.3 Reduced price spreads scenario

A severe downside scenario with a 30% reduction in price spreads has been considered to reflect potential market stabilization or increased competition.

Under this scenario:

- IRR decreased to approximately 30%
- Payback period extended to approximately 3.5 years
- NPV remained positive but reduced significantly to 172 million UAH

This case demonstrates that the project remains viable under less favorable market conditions, although with a worse performance.

7.4 Increased degradation and price spreads scenario

A second stress scenario combines lower price spreads with higher than expected battery degradation, reducing available capacity more radically over time (+30%).

Under this scenario:

- IRR decreased to approximately 29%
- Payback period extended to approximately 3.7 years

- NPV remained positive but reduced significantly to 143 million UAH

While the project remains profitable, the scenario highlights the importance of battery performance for long-term project returns.

7.5 Additional considerations

In addition to the modeled scenarios, several factors can be considered to further test the project's viability:

1. Utilization rate: The model assumes the ability to fully utilize the station for two cycles per day, in practice, actual utilization might be lower due to operational constraints or low price spreads on certain days.

2. CAPEX: Project profitability is sensitive to capital expenditure assumptions; cost underestimation may negatively impact financial performance.

3. Tariffs and regulatory changes: transmission and distribution tariffs represent a significant portion of operating costs. Changes in market regulations could materially impact the project.

7.6 Conclusions

The model shows that a 20 MW / 80 MWh BESS station can achieve strong financial results under current market conditions. However, the results are dependent on assumptions related to price volatility, utilization, and cost structure. Even under downside scenarios, the project remains economically viable.

The financial attractiveness of the project is supported by current market price spreads, but its performance is sensitive to changes in core assumptions, investors should consider possible risks before making a decision.

Chapter 8. Key risks and mitigation.

8.1 Risk priority matrix

To evaluate project risks, a probability-impact matrix is constructed (See Table 2). Risks are assessed based on:

- Probability: likelihood of occurrence under current market, environmental, and war conditions
- Impact: potential effect on project viability (profit, delays, operational capacity)

Table 2 Risk priority matrix

Risk	Probability	Impact	Priority
Regulatory and market	High	Medium	High
Price volatility	Medium	Medium	Medium
Security	Medium	Extremely high	Medium
Environmental and social	Medium	Low	Low
Technical and construction	Medium	Medium	Medium

Source: Author's estimation.

Effective risk management is vital for ensuring profitable operation and long-term viability of the BESS project. Since such projects rely on multiple revenue streams and still-emerging regulatory frameworks, poorly managed risks may significantly affect project attractiveness. The matrix analysis of probability and impact helps investors and developers evaluate the risks and prioritize them accordingly.

8.2 Regulatory and market

The electricity market in Ukraine is continuously evolving so that market structure and regulatory frameworks are in line with the ever-changing war reality, while also trying to evolve towards EU integration. Thus, many frameworks that exist today, such as auction mechanisms, are relatively new and prone to unpredictable changes in the future. Such fluctuations in technical requirements, contract duration, settlement rules, and so on, may directly influence station revenue. Furthermore, if auction volumes increase significantly, price competition may significantly reduce expected returns.

Mitigation strategies include securing long-term contracts through auctions organised by Ukrenergo, preferably with foreign currency-backed revenue structures, while also constantly adjusting the model to reflect any changes in market conditions. Developers also should actively engage with Ukrenergo and other interested parties in consultations on regulatory frameworks, to influence, or at least be informed of, anticipated changes. Revenue distribution could also help mitigate risks by relying on multiple different markets for operational revenue. Despite possible mitigation, regulatory uncertainty remains a key consideration of the projects, as it is highly vulnerable to policy changes that can affect long-term viability.

8.3 Price volatility

BESS profitability is highly dependent on price spreads between peak and off-peak hours; volatility of wholesale prices can both increase or decrease the expected revenue. If price spreads shrink, for example, due to the rapid development of new flexible generation like gas turbines, project returns may decline significantly. Other factors, such as increased competition or unpredictable seasonal or weather circumstances, may contribute as well. According to the model, a 30% decrease in price spread reduces projected IRR from 45% to 30%, with a payback period increase from 2.5 to 3.5 years, which demonstrates that price spreads are key to the project return.

Risk mitigation requires adjusting model input data and assumptions; sensitivity analysis has to be conducted across a wide range of scenarios to reflect possible changes in the market environment. Consultations with current industry figures could also deepen the understanding of what factors should be considered. If electricity prices become extremely high, BESS operators may construct solar or wind generation close to the storage systems, allowing the BESS to charge using its own renewable energy, instead of relying on expensive grid power. Constant monitoring of key assumptions, such as the persistence of historic price spreads, is required to assess project relevance at the time. The project remains highly sensitive to price volatility, while mitigation strategies can reduce dependence on arbitrage, there is no way to fully eliminate this risk. Rising transmission tariffs for new market entrants increase the cost of BESS project limiting new capacity solutions, while solar generation is expected to grow steadily, which reinforces historic price spreads.

8.4 Security

The current security environment in Ukraine introduces significant risks of physical destruction to energy infrastructure, which immediately after construction becomes a primary target for Russian strikes. BESS stations, while being modular and distributed installations, remain a static asset that can be easily targeted.

The main mitigation measure for such risks is insurance that, though it has a high price for obvious reasons, can be sponsored, fully or partially, by international donors. For developers considering the construction of a larger BESS operation, an obvious strategy is to construct multiple distributed nodes instead of a single large centralized facility. Furthermore, the development of physical passive protective infrastructure for such stations may also be a viable option, but further research pertaining to efficiency and viability is required.

8.5 Environmental and social

BESS projects are generally considered to have lower pollution impact than other conventional types of generation, such as coal, but they still create legal and reputational risks connected with proper lifecycle and end-of-life disposal. Lithium-ion systems contain hazardous materials, require fire prevention designs, and need credible scrapping pipelines to avoid regulatory risks and public concerns. In Ukraine, these issues are regulated in accordance with the Environmental Impact Assessment (EIA) law, which is designed to identify and manage risks connected to environmental pollution and public health.

Infrastructure projects may encounter resistance from local stakeholders, potentially affecting land allocation, permitting processes, and construction timelines. When a project triggers EIA requirements, the regulatory framework calls for public consultations, such as hearings at a hromada level. While these procedures are designed to ensure transparency and stakeholder engagement, they may introduce non-technical barriers, including formal objections, extended review periods, or administrative delays. These factors can impact project timelines and increase uncertainty during the development phase. Mitigation strategies should therefore include proactive engagement with local communities, transparent disclosure of safety and environmental standards, and early cooperation with relevant authorities to secure a successful streamlining of permitting processes.

8.6 Technical and construction

Technical risks of BESS operation include possible faultiness of one or several of its many components - battery degradation, inverter underperformance, system fire safety, control-system compatibility with the grid, etc. These risks can reduce available arbitrage capacity, response time, and compliance for ancillary services and should be managed through accurate technical specifications and supplier guarantees. Key mitigations include attentive operation of the station, for example, adequate speed of charge-discharge cycling, in accordance with the provider recommendations, and further adjustment of the model to include possible maintenance costs. Also, it is important to require a commitment from the technical supplier to replace or rapidly repair any faulty modules of the station, with clearly defined contract time and cost details.

Construction and supply chain risks are critical since most of the aforementioned station components are imported and may be affected by customs and certification delays. Grid connection may also become a bottleneck, since many factors like grid substation readiness or technical protocols may significantly push construction deadlines. Mitigation strategies include setting certain connection and delivery timelines with the grid operator and supplier; above supply replacement commitments help further ensure that if any defective units are discovered during the early-stage construction, they can be quickly swapped and station commissioning resumed.

Chapter 9. Recommendations to investors/government/donors.

9.1 Recommendations for the government of Ukraine

The government is the key player when it comes to creating a stable regulatory and investment environment for the development of energy infrastructure.

Firstly, policymakers should continue the development of a clear framework specifically designed to account for energy storage systems deployment on a large scale. While current reforms allow for simplifying grid connection and integrating storage with renewable energy sources, further clarifications of licensing requirements, market participation rules, and standardized operational regulations would significantly reduce the uncertainty factor for both developers and investors. A predictable legal environment is also crucially important since many regulatory mechanisms, like ancillary service auctions, are relatively new and constantly evolving.

Secondly, the government should expand the use of long-term ancillary service auctions organized by Ukrenergo, since they have already been proven as an effective tool for stimulating investment into the sector, mainly by offering predictable revenue streams for storage operators. Further expansion of auction volumes and contract durations would attract private investors and allow them to quickly scale BESS stations across the country.

Thirdly, policymakers should encourage the co-location of BESS with renewable energy generation. Ukraine has experienced rapid growth in solar capacity, which created a significant mismatch between production and consumption in peak daylight hours, with no way to accommodate excess energy. Incentivizing integration of BESS stations with renewable energy through tax incentives or simplified permitting could significantly improve grid flexibility.

Finally, a critical priority should be the systemic transition towards a decentralized energy architecture. The current centralized structure has demonstrated its vulnerability under wartime conditions, particularly its reliance on large-scale generation assets, which proved to be easy targets for air strikes. This is a structural issue and cannot be addressed through incremental measures, such as ad hoc financial incentives for developers. Instead, the government should adopt a comprehensive long-term strategy aimed at fully restructuring the energy system away from the legacy model - away from large power plants and towards the hundreds of smaller units distributed across the country. Lack of a clearly defined strategic framework undermines further development of the sector, disallowing accurate assessment of system needs, relevant investment prioritization, and coordination in infrastructure deployment. The current reactive approach remains inadequate relative to the scale of the challenges the Ukrainian energy system faces. Adoption of a systemic approach would lead to more efficient resource allocation and be mutually beneficial for all parties involved.

9.2 Recommendations for private investors and developers

Private investors will be responsible for the majority of BESS deployment in Ukraine. Based on the analysis conducted in the study, several recommendations can be provided.

Firstly, developers should prioritize multi-hour storage configurations of approximately 4 hours, as this directly corresponds to the structure of the Ukrainian balancing gap. Such a configuration allows it to participate in both arbitrage and balancing markets.

Secondly, as demonstrated in the financial model sensitivity analysis, price spreads are the main profitability driver for the project. Therefore, it is highly recommended to diversify revenue streams. For example, participation in Ukrenergo-organized ancillary service auctions is a well-suited strategy for securing a part of future revenue, which is unaffected by price spread changes. Where possible, developers should structure revenues as a combination of both set contracted income and arbitrage gains. Additionally, when selecting a construction site, developers should consider the possibility of future addition of generational capacity (gas turbines, renewables) to reduce dependence on grid power for station operations. Before the executive decision, developers should also consult with interested parties, where possible, to assess multiple factors such as realistic utilization rate, battery degradation, regulatory changes, and increased competition to better understand the plausibility of core assumptions and adjust the project accordingly. These measures can significantly de-risk the project, allowing the developers to launch safely.

Thirdly, given the risk of physical damage, the project should incorporate security measures from the start. The developers should prioritize the distributed deployment, as a multiple-site structure is much more resilient, negating the risk of destruction from a single attack. Moreover, developers should secure insurance coverage for the project, potentially supported by international financial institutions.

Fourthly, to mitigate technical and construction risks, developers should partner with experienced contractors and technology providers, as well as incorporate guarantees for performance and faulty components replacement into contracts with suppliers. To ensure clear timelines, it is important to be in close coordination with the grid operator to secure a timely connection and reduce time-to-market.

The Ukrainian market presents developers with a potentially highly profitable investment opportunity, but project success depends on the ability to manage key risks related to price volatility, regulations, and security. A 20 MW / 80 MWh configuration combined with a diversified revenue source, well-engineered operational strategy, and mindful risk management provides a viable approach for market entry.

9.3 Recommendations for international donors

International financial organizations and donor governments play an important role in supporting Ukraine's energy transition; many institutions, like the European Bank for Reconstruction and Development, have already financed projects related to BESS deployment.

One of the most important contributions that international partners can provide is financing, particularly with the ability to provide risk-sharing instruments to domestic developers. Since energy facilities remain one of the primary targets for potential airstrikes, related projects carry extremely high risk premiums. Financial assistance programs that would cover war-related risks can help investors secure insurance coverage and continue the deployment of energy storage capacity with a lower risk.

Secondly, donors should actively provide technical assistance and knowledge-sharing programs on energy storage integration. Ukraine's electricity market is still adapting, and cooperation between international organizations and the government, along with domestic developers, could significantly improve the regulatory environment, market mechanisms, and provide expertise on technical aspects, which would be beneficial for the faster development of the sector.

Chapter 10. Conclusion.

This study examined the feasibility of deploying a 20 MW / 80 MWh battery energy storage system, focusing both on system-wide level implications and project scale economics.

The analysis demonstrates that, within the current context of the Ukrainian power system, particularly the balancing gap and lack of means to cover it, the proposed BESS represents a technically suitable solution. Multi-hour configuration allows energy shifting between periods of excess generation and peak demand, while modular deployment aligns with the need for a more decentralized and resilient energy system.

Analysis of comparable projects confirms that similar systems are already being deployed in Ukraine, supported by private investors and international donors. The market environment further supports feasibility by the introduction of ancillary auctions and regulatory improvements.

The financial model indicates that, under the stated assumptions, the project can achieve strong economic performance, with high estimated returns and a short payback period. However, the results are sensitive to key factors such as price spreads, operational rates, capital expenditure, and regulatory conditions. This highlights both the attractiveness of the project and the importance of disciplined risk management.

The construction of a 20 MW / 80 MWh BESS station in Ukraine is supported by system needs and market conditions, making it a feasible and strategically justified investment, taking into account that the risks are actively managed and assumptions hold continuously.

Works Cited

Center for Strategic and International Studies. "Striving for Access, Security, and Sustainability: Ukraine's Transition to a Modern and Decentralized Energy System." Center for Strategic and International Studies, 02 Jul. 2025, csis.org/analysis/striving-access-security-and-sustainability.

CMS Law. "Ukraine passes draft law improving its green auction mechanism." CMS Law, 03 Oct. 2025, cms.law/en/ukr/legal-updates/ukraine-passes-draft-law-improving-its-green-auction-mechanism.

DTEK. "DTEK selects Fluence to deliver 200 MW advanced energy storage systems in Ukraine." DTEK, 13 Jan. 2025, dtek.com/en/media-center/news/dtek-fluence-energy-storage-ukraine.

DTEK. "DTEK and Fluence energise the largest battery storage facility in Ukraine with a total capacity of 200 MW." DTEK, 11 Sep. 2025, dtek.com/en/media-center/news/dtek-and-fluence-energise-the-largest-battery-storage-facility-in-ukraine-with-a-total-capacity-of-200-mw.

EU NEIGHBOURSEAST. "EBRD finances new private peak energy generation and storage capacity in Ukraine." EU NEIGHBOURSEAST, 17 Nov. 2025, euneighbourseast.eu/news/latest-news/ebrd-finances-new-private-peak-energy-generation-and-storage-capacity-in-ukraine.

International Energy Agency. "Ukraine's Energy System under Attack – Ukraine's Energy Security and the Coming Winter – Analysis - IEA." International Energy Agency, 2024, iea.org/reports/ukraines-energy-security-and-the-coming-winter/ukraines-energy-system-under-attack.

International fuel and energy company. "Відновлювальні джерела енергії в Україні: що змінилось у 2025 році." International fuel and energy company, 05 Mar. 2025, ifec.org.ua/vidnovlyuvalni-dzherela-energiyi-v-ukrayini-shho-zminylos-u-2025-roczi.

Interfax-Ukraine. “Electricity Deficit in Ukraine Decreases from 5-6 GW to 4.3-4.5 GW Due to Warming – Minister of Energy.” Interfax-Ukraine, 12 Feb. 2026, interfax.com.ua/news/economic/1144224.html.

Interfax-Ukraine. “Solar power capacity in Ukraine grows by 800-850 MW in 2024 – Solar Energy Association head” Interfax-Ukraine, 2025, en.interfax.com.ua/news/press-conference/1039627-amp.html.

Interfax-Ukraine. “KNESS plans to install about 200 MW of energy storage in 2026 – top executive.” Interfax-Ukraine, 19 Dec. 2025, en.interfax.com.ua/news/press-conference/1129967.html.

Kyiv Post. “Power One Secures €22.3 Million EBRD Loan for Decentralized Generation Rollout.” Kyiv Post, 15 Nov. 2025, kyivpost.com/post/64257.

Market Operator Ukraine. “Day-Ahead Market Results.” Market Operator Ukraine, oree.com.ua/index.php/control/results_mo/DAM.

Susanna Twidale. “Octopus Energy, DTEK to raise $115 million for Ukraine solar and battery projects.” Reuters, 23 Jun. 2025, reuters.com/sustainability/climate-energy/octopus-energy-dtek-raise-115-million-ukraine-solar-battery-projects-2025-06-23.

Ukrenergo. “Balancing Market Results.” Ukrenergo, ua.energy/uchasnikam_rinku/rezultaty-balansuyuchogo-rynku-2.

Valentyn Gvozdiy, “Batteries in the energy sector: how storage devices are changing the rules of the game.” GOLAW, 01 Jul. 2025, golaw.ua/insights/energy-alert/batareyi-v-energeticzi-yak-nakopichuvachi-zminyuyut-pravila-gri.

Vodianyi Andrii. “Ukraine launches its first domestically developed industrial energy storage system.” Liga.net, 26 Sep. 2025,

biz.liga.net/en/all/tek/novosti/the-first-industrial-energy-storage-device-of-domestic-developme
nt-was-launched-in-ukraine.

APPENDIX 1

Model assumptions

1. Data	
Data period	Full year of 2025
Day-ahead market data	Market operator
Balancing market data	Ukrenergo
2. Technical	
Power MW	20
Capacity MWh	80
Round-trip efficiency	90%
Cycles per day	2
3. Operational	
Days of operation per year	330
Day-ahead market charge percentage	25%
Day-ahead market discharge percentage	83%
Balancing market charge percentage	75%
Balancing market discharge percentage	17%
4. Financial	
CAPEX total USD (Breakdown in CAPEX tab)	11 850 000
OPEX UAH/year	27 223 294
Transmission tariff 2025 UAH/MWh	686,23
Distribution tariff (2025 average) UAH/MWh	2500
Tax rate	18%
UAH/USD	43
Discount rate	20%
5. Limitations	
Model assumes historical price spreads persist	
No regulatory changes included	
No extreme scenarios (outage, destruction) modeled	

APPENDIX 2

CAPEX and OPEX

CAPEX item	USD	UAH	Ammortisation yrs
Land and its development	300 000	12 900 000	
Design development	90 000	3 870 000	
Main equipment	8 572 000	368 596 000	5
Support equipment	640 000	27 520 000	10
Construction	952 000	40 936 000	15
Grid connection	1 296 000	55 728 000	10
Total	11 850 000	509 550 000	

OPEX item	Price UAH
Tariffs	16 823 294
Maintenance	3 200 000
Land	7 200 000
Total	27 223 294

APPENDIX 3

Day-ahead market and AFRR

	Day-ahead market price UAH/MWh												
	2025												
	Січ	Лют	Бер	Кві	Тра	Чер	Лип	Сер	Вер	Жов	Лис	Гру	
1	4 073,76	4 971,01	5 025,15	4 324,89	5 021,15	5 466,85	5 464,85	5 174,96	4 481,33	4 396,66	3 984,93	4 744,96	
2	3 443,75	4 339,99	4 154,90	3 682,21	4 102,61	5 381,36	5 326,24	5 285,30	3 357,87	4 163,05	2 662,01	3 820,24	
3	3 039,22	3 797,55	3 588,27	3 071,23	3 243,88	5 209,45	5 134,46	5 008,07	2 415,71	3 904,16	1 814,50	3 402,42	
4	2 709,28	3 389,31	3 036,15	2 554,10	3 202,23	5 097,83	4 940,22	4 902,97	2 153,62	3 088,61	1 135,34	2 943,15	
5	2 723,88	3 525,98	2 995,89	2 603,67	2 996,49	5 108,51	4 879,73	4 966,90	2 208,35	3 027,02	1 322,27	3 030,68	
6	3 204,90	4 200,25	3 718,60	3 554,63	3 044,87	5 079,17	4 801,05	4 793,73	2 711,34	4 085,34	2 478,42	3 881,51	
7	3 991,13	4 617,83	4 847,11	4 201,01	4 382,77	5 083,64	5 166,62	5 299,17	4 403,26	3 578,02	3 807,71	4 461,99	
8	5 796,16	6 096,42	5 720,44	5 616,27	5 276,82	5 431,22	6 097,94	6 122,07	5 609,77	5 516,09	5 370,92	5 908,57	
9	6 205,90	6 442,05	5 701,01	5 257,58	5 021,33	4 641,41	5 785,34	5 526,58	5 488,76	5 918,49	5 863,81	6 541,79	
10	6 355,29	6 346,15	4 803,04	4 187,40	4 290,72	3 336,55	4 621,83	3 973,12	4 266,95	5 795,89	6 005,64	6 704,84	
11	5 829,89	5 724,10	3 708,02	3 322,24	3 499,43	2 026,78	3 430,61	2 090,89	2 433,22	5 055,74	5 594,32	6 719,25	
12	4 810,79	4 403,54	2 527,41	1 733,06	2 009,97	878,29	2 960,82	1 268,95	1 082,19	3 666,92	4 631,92	5 494,18	
13	4 449,91	3 957,61	1 962,09	1 164,51	1 692,24	720,09	2 266,03	1 055,54	549,30	2 801,67	4 729,66	5 493,54	
14	4 609,04	4 134,61	2 272,08	1 087,49	1 683,61	685,41	2 417,01	1 256,51	762,51	2 911,31	4 892,29	5 517,25	
15	5 087,18	4 521,33	2 893,99	1 692,91	1 825,00	1 196,85	2 807,19	1 538,16	1 042,23	3 349,28	5 254,00	5 579,44	
16	5 383,72	5 238,66	3 656,15	2 001,71	1 852,94	1 324,09	2 892,01	1 649,30	1 790,82	4 292,03	5 487,19	5 587,89	
17	5 538,67	5 575,95	5 098,08	2 789,41	2 416,29	2 898,95	3 475,93	2 453,65	2 872,27	5 138,74	5 597,20	5 595,53	
18	8 567,47	8 721,58	8 254,54	3 979,02	4 467,20	4 341,84	4 774,80	4 846,55	5 153,56	9 862,56	13 454,15	11 490,46	
19	8 532,12	8 872,47	8 762,77	6 171,48	6 478,46	6 344,76	6 387,45	7 560,11	7 214,71	11 752,30	13 453,29	11 733,20	
20	8 394,54	8 842,72	8 816,93	8 106,92	7 337,79	7 890,35	7 882,32	10 017,14	9 084,74	12 729,66	13 216,34	11 614,23	
21	8 211,72	8 676,68	8 755,59	8 642,08	8 383,14	8 416,55	8 319,04	10 800,10	10 361,01	12 987,99	13 310,76	11 615,39	
22	8 006,94	8 565,74	8 497,45	8 503,74	8 746,50	8 710,64	8 509,31	11 835,97	8 602,95	11 168,48	12 867,82	11 227,91	
23	6 960,93	8 304,07	7 927,62	7 620,55	8 457,88	8 617,52	8 333,76	9 665,14	6 401,36	8 284,54	9 759,16	8 984,51	
24	6 387,35	6 737,38	6 328,57	5 582,17	6 204,49	6 813,55	6 514,02	6 294,21	5 150,21	5 244,89	5 701,51	5 926,91	
	Buy (charge) Day-ahead												
Average price 2-5	2 979	3 763	3 444	2 978	3 386	5 199	5 070	5 041	2 534	3 546	1 734	3 299	
Average price 12-15	4 739	4 254	2 414	1 419	1 803	870	2 613	1 280	859	3 182	4 877	5 521	
Total average price	3 859	4 009	2 929	2 199	2 595	3 035	3 841	3 160	1 696	3 364	3 305	4 410	3 200
Price to charge station 2-5	238 323	301 056	275 504	238 224	270 904	415 943	405 613	403 265	202 711	283 657	138 682	263 930	
Price to charge station 12-15	379 138	340 342	193 112	113 559	144 216	69 613	209 021	102 383	68 724	254 584	390 158	441 688	
Total price to charge station	617 461	641 398	468 616	351 783	415 120	485 556	614 634	505 648	271 436	538 240	528 840	705 618	512 029
	Sell (discharge) Day-ahead												
Average price 7-10	5 587	5 876	5 268	4 816	4 743	4 623	5 418	5 230	4 942	5 202	5 262	5 904	
Average price 19-22	8 286	8 739	8 708	7 856	7 736	7 841	7 775	10 053	8 816	12 160	13 212	11 548	
Total average price	6 937	7 308	6 988	6 336	6 240	6 232	6 596	7 642	6 879	8 681	9 237	8 726	7 317
Station disharge revenue 7-10	402 273	423 044	379 289	346 721	341 490	332 871	390 091	376 577	355 837	374 553	378 865	425 110	
Station disharge revenue 19-22	596 616	629 237	626 989	565 636	557 026	564 521	559 766	723 840	634 741	875 492	951 268	831 433	
Total station disharge revenue	998 888	1 052 281	1 006 278	912 357	898 515	897 392	949 857	1 100 417	990 579	1 250 045	1 330 133	1 256 543	1 053 607

AFRR service					
	Revenue UAH/MWh	Daily capacity MWh	Daily revenue UAH	Days per year	Yearly revenue UAH
AFRR (upward)	939	144	135 216	40	5 408 640
AFRR (downward)	300	160	48 000	330	15 840 000
Total					21 248 640

APPENDIX 4

Balancing market

	BM (upward) UAH/MWh											
	2025											
	Січ	Лют	Бер	Кві	Тра	Чер	Лип	Сер	Вер	Жов	Лис	Гру
1	5189,5139	5 846,63	6 320,33	6 536,87	6363,8468	6388,5053	6493,7974	6 500,27	6 438,53	6505,0674	6551,4113	6510,2455
2	4503,9884	5 740,86	6 265,60	6 104,99	6033,1403	6117,9223	6103,2871	6 290,89	6 198,61	6278,6865	6464,1847	6514,2729
3	4285,0826	5 110,97	5 734,04	6 315,77	5322,8042	5141,3293	5572,6123	5 664,47	5 616,90	6153,351	6451,326	6535,589
4	4065,2697	4 878,07	4 527,10	5 867,08	5725,8358	5683,475	5803,6213	5 834,89	5 398,73	6000,3319	6224,248	6543,699
5	4085,379	5 042,46	4 989,24	6 176,31	5864,6742	5868,9323	6061,3645	6 095,90	5 742,00	6126,9658	6284,3543	6542,4603
6	4434,8029	5 378,84	6 210,83	6 411,45	6122,5268	6071,913	6290,7087	6 400,47	5 957,67	6174,8748	6433,996	6552,8087
7	5168,3845	5 593,90	6 281,01	6 542,67	6117,1487	6124,4813	6255,5465	6 330,54	6 378,19	6473,8461	6525,3703	6455,96
8	7006,7687	7 304,85	7 914,82	8 206,73	7935,2435	7840,4163	7925,7087	8 131,62	8 041,37	8098,1239	8100,8713	8165,6968
9	7408,3968	7 738,53	8 011,36	8 189,69	8018,951	8015,7933	8037,61	7 959,37	8 162,69	8227,2445	8177,5337	8191,899
10	7486,1281	7 740,66	8 086,50	8 204,18	8050,7629	8064,9	8147,3658	8 184,55	8 090,45	8195,9884	8138,9797	8195,6029
11	7169,8377	7 412,39	7 638,98	8 033,05	8000,4671	7920,8023	7955,1819	7 996,52	7 779,34	8186,6919	8205,7863	7972,5865
12	7020,7132	6 462,08	7 186,94	7 882,38	7775,8768	7698,842	7941,8068	8 069,98	7 916,41	8007,3274	8036,779	8150,8913
13	6177,8552	5 698,99	6 903,97	7 805,77	8060,4419	8077,3173	8082,3603	8 163,81	8 043,54	7947,801	7953,6683	8190,9758
14	6323,3358	5 310,86	6 718,56	7 450,82	7988,8942	7636,04	7813,8958	7 941,76	7 763,55	7815,5877	7908,9973	8209,211
15	7274,8058	6 028,34	7 456,45	7 929,20	8070,7742	8017,2983	8066,2555	8 156,52	7 990,24	8039,51	7923,421	8209,0826
16	7143,3787	6 698,24	7 576,80	7 538,49	7882,1481	7827,9233	8014,3458	8 111,65	7 943,09	8086,9145	8212,59	8198,6726
17	7111,3165	7 301,51	8 035,57	8 160,11	7992,0123	7843,9313	7850,8513	7 991,11	7 887,34	8052,151	8146,8047	8222,1284
18	9504,2171	9 542,04	9 846,89	9 942,91	9784,8968	9606,698	9549,5281	13 438,61	15 226,25	15360,495	15949,337	15932,415
19	9260,9194	9 586,41	9 393,71	9 914,02	9957,6123	9575,3533	9946,2519	14 857,57	15 654,91	15876,809	15863,994	15733,031
20	9029,299	9 651,94	9 563,13	9 785,87	9934,9613	9724,214	9862,7948	13 251,44	15 657,27	15853,218	15855,644	15707,058
21	8947,9294	9 529,15	9 764,45	9 924,12	9928,8368	9721,2233	9858,0477	13 497,72	15 662,10	15897,94	15786,656	15399,575
22	8751,0639	9 321,36	9 933,89	9 996,14	9943,6032	9969,9347	9768,9339	13 686,67	15 670,99	15820,765	15877,714	15662,548
23	8291,7558	9 335,10	9 936,93	9 998,27	9995,3103	9923,8463	9921,9665	14 429,84	15 754,08	15859,705	15880,897	15729,741
24	7326,6919	7 587,23	8 143,68	8 238,11	8231,2526	8222,306	8242,8471	8 248,30	8 213,44	8203,2729	8198,4667	8087,8981

Sell (discharge) BM													
Average price 7-10	6 767	7 094	7 573	7 786	7 531	7 511	7 592	7 652	7 668	7 749	7 736	7 752	
Average price 19-22	8 997	9 522	9 664	9 905	9 941	9 748	9 859	13 823	15 661	15 862	15 846	15 626	
Total average price	7 882	8 308	8 619	8 845	8 736	8 630	8 725	10 737	11 665	11 805	11 791	11 689	9 786
Station disharge revenue 7-10	487 254	510 803	545 286	560 579	542 198	540 821	546 592	550 910	552 109	557 914	556 970	558 165	
Station disharge revenue 19-22	647 806	685 599	695 793	713 163	715 770	701 833	709 849	995 281	1 127 615	1 142 077	1 140 912	1 125 040	
Total station disharge revenue	1 135 060	1 196 402	1 241 080	1 273 742	1 257 968	1 242 654	1 256 441	1 546 191	1 679 723	1 699 991	1 697 882	1 683 205	1 409 195

	BM (downward) UAH/MWh											
	2025											
	Січ	Лют	Бер	Кві	Тра	Чер	Лип	Сер	Вер	Жов	Лис	Гру
1	1382,6013	2 611,61	200,43	125,99	475,16226	718,659	830,09613	397,98	25,32	43,669355	580,576	694,16452
2	938,72194	2 279,06	221,93	472,17	638,86968	513,89267	1528,0423	567,55	103,05	353,36097	393,32767	382,77645
3	739,4329	2 367,19	257,12	76,52	502,40968	214,98667	1216,1594	338,88	237,80	105,11968	161,429	142,11968
4	861,49677	1 930,50	402,69	186,01	178,36774	221,882	929,08355	238,48	236,81	21,165	13,328333	11,464516
5	886,73742	2 095,89	390,39	50,16	251,13484	216,034	307,26226	290,81	369,82	176,65742	129,482	110,87742
6	943,71871	1 897,32	175,33	250,90	331,24581	245,99867	532,08387	185,13	359,61	166,67903	141,25567	134,1129
7	1113,9871	3 109,76	642,35	282,47	931,59	232,402	664,14194	822,05	447,23	158,30129	299,092	365,92645
8	2154,1184	4 300,34	1 205,81	850,26	720,24226	309,96533	411,59516	511,75	869,27	708,54452	1418,0867	1149,4726
9	3850,8661	5 048,68	1 364,91	594,98	625,83355	71,08	266,65935	440,74	410,31	446,34194	885,442	900,61581
10	4395,0261	4 744,35	953,05	244,03	217,07548	54,805333	22,063226	23,20	6,83	59,605484	589,52967	712,12258
11	4214,6623	3 950,74	649,11	113,29	24,902903	0,414	257,74129	37,63	7,73	222,51839	723,52233	1506,0832
12	3324,201	2 158,81	448,72	105,51	51,633548	1,4693333	1,8909677	8,00	1,03	191,79839	946,77833	1270,7152
13	2564,1984	1 948,43	318,34	44,69	23,785484	1,0183333	1,7767742	1,89	0,61	145,07839	637,59567	912,36194
14	2896,7735	1 849,19	405,23	76,49	35,613548	5,8843333	13,579677	9,66	0,58	220,19032	632,68333	1283,9174
15	3431,3971	2 774,05	361,38	50,47	12,254839	7,076	7,2012903	3,17	0,56	164,76871	821,96	1191,7626
16	3108,1139	3 391,74	706,65	255,87	25,765806	6,7696667	4,7667742	2,15	1,86	308,59677	1539,064	1998,5913
17	3002,4065	4 007,45	974,45	263,74	175,82581	14,688	158,55871	17,35	15,34	214,66677	1603,29	1964,7832
18	4995,2861	6 674,45	1 676,45	623,26	270,51581	185,28233	244,19806	68,44	11,30	70,388065	1886,5227	2750,7132
19	4835,6884	7 563,74	2 078,94	1 107,85	381,07484	362,84933	295,33839	112,64	42,81	231,79194	2602,3423	2849,6981
20	4678,1916	7 352,33	4 423,96	2 320,46	1288,4219	850,76633	826,3671	1 191,23	538,38	740,6529	3750,662	5057,7481
21	3759,17	6 555,23	3 142,52	2 401,31	1425,1823	1718,659	1591,9684	1 975,67	1 810,25	1382,5184	3509,985	3932,1081
22	2935,4229	4 929,96	2 359,09	1 728,32	1293,1429	822,433	1982,569	1 051,75	218,01	583,64355	2400,0887	3039,7039
23	2191,2348	5 202,48	381,08	378,39	122,80419	470,53467	473,23742	65,07	88,66	230,08871	1381,6677	1605,0071
24	2008,9148	4 231,56	440,88	280,63	131,8629	23,83	40,276129	18,83	208,74	444,39097	1196,7567	1310,8403

Buy (charge) BM													
Average price 2-5	857	2 168	318	196	393	292	995	359	237	164	174	162	
Average price 12-15	3 054	2 183	383	69	31	4	6	6	1	180	760	1 165	
Total average price	1 955	2 175	351	133	212	148	501	182	119	172	467	663	590
Price to charge station 2-5	68 528	173 453	25 442	15 697	31 416	23 336	79 611	28 714	18 950	13 126	13 951	12 945	
Price to charge station 12-15	244 331	174 610	30 673	5 543	2 466	309	489	454	56	14 437	60 780	93 175	
Total price to charge station	312 859	348 063	56 116	21 240	33 881	23 645	80 100	29 169	19 005	27 563	74 732	106 120	94 374

APPENDIX 5

Yearly revenue calculations

Yearly buy capacity MWh	52 800
Yearly sell capacity MWh	47 520

Yearly market revenue	Revenue UAH	Expenses UAH	Yearly sell capacity MWh	Yearly buy capacity MWh	Average sell price UAH	Average buy price UAH
Day-ahead	288 582 964	42 242 408	39 442	13 200	7 317	3 200
BM	79 055 828	23 357 658	8 078	39 600	9 786	590
AFRR	21 248 640					

Default scenario

Year	Degradation	Profit before tax	Ammortization	Tax	Profix after tax		
0	N/A	N/A	N/A	N/A	- 509 550 000	IRR	45%
1	1	296 064 071	84 773 067	38 032 381	258 031 690	Payback	2,47
2	0,931	275 635 650	84 773 067	34 355 265	241 280 385	NPV	450 717 127 UAH
3	0,891	263 793 087	84 773 067	32 223 604	231 569 484		
4	0,858	254 022 973	84 773 067	30 464 983	223 557 990		
5	0,829	245 437 115	84 773 067	28 919 529	216 517 586		
6	0,803	237 739 449	11 053 867	40 803 405	196 936 044		
7	0,78	230 929 976	11 053 867	39 577 700	191 352 276		
8	0,757	224 120 502	11 053 867	38 351 994	185 768 508		
9	0,736	217 903 156	11 053 867	37 232 872	180 670 284		
10	0,717	212 277 939	11 053 867	36 220 333	176 057 606		
11	0,697	206 356 658	2 729 067	36 652 966	169 703 691		

APPENDIX 6

Sensitivity calculations

Scenario -30% price spread

Year	Degradation	Profit before tax	Ammortization	Tax	Profix after tax	IRR	30%
0	N/A	N/A	N/A	N/A	- 509 550 000	Payback	3,50
1	1	205 452 454	84 773 067	21 722 290	183 730 164	NPV	171 542 100 UAH
2	0,931	191 276 234	84 773 067	19 170 570	172 105 664		
3	0,891	183 058 136	84 773 067	17 691 312	165 366 824		
4	0,858	176 278 205	84 773 067	16 470 925	159 807 280		
5	0,829	170 320 084	84 773 067	15 398 463	154 921 621		
6	0,803	164 978 320	11 053 867	27 706 402	137 271 919		
7	0,78	160 252 914	11 053 867	26 855 828	133 397 085		
8	0,757	155 527 507	11 053 867	26 005 255	129 522 252		
9	0,736	151 213 006	11 053 867	25 228 645	125 984 361		
10	0,717	147 309 409	11 053 867	24 525 998	122 783 412		
11	0,697	143 200 360	2 729 067	25 284 833	117 915 527		

Scenario +30% degradation

Year	Degradation	Profit before tax	Ammortization	Tax	Profix after tax	IRR	29%
0	N/A	N/A	N/A	N/A	- 509 550 000	Payback	3,73
1	1	205 452 454	84 773 067	21 722 290	183 730 164	NPV	142 746 976 UAH
2	0,9103	187 023 368	84 773 067	18 405 054	168 618 314		
3	0,8583	176 339 841	84 773 067	16 482 019	159 857 822		
4	0,8154	167 525 931	84 773 067	14 895 516	152 630 415		
5	0,7777	159 780 373	84 773 067	13 501 315	146 279 058		
6	0,7439	152 836 080	11 053 867	25 520 798	127 315 282		
7	0,714	146 693 052	11 053 867	24 415 053	122 277 998		
8	0,6841	140 550 023	11 053 867	23 309 308	117 240 715		
9	0,6568	134 941 171	11 053 867	22 299 715	112 641 457		
10	0,6321	129 866 496	11 053 867	21 386 273	108 480 223		
11	0,6061	124 524 732	2 729 067	21 923 220	102 601 512		