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Energy Security Project

Battery Storage Business Models for Ukraine

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Kyiv, Ukraine

Recommended applications of battery storage systems in Ukraine

Application	Description
1) Provide frequency containment reserve (FCR)	Storage can be used for frequency regulation and voltage support providing frequency containment, frequency restoration, and reactive power for voltage control.
2) Provide automatic and manual frequency restoration reserves (aFRR and mFRR)	
3) Provide voltage control	
4) Provide black start	Storage can support black start after a power outage and provide backup energy to bridge a power outage.
5) Provide backup energy	
6) Reduce imbalance	Storage can help reduce imbalances as a results of inaccurate forecasts, adding power supply/ demand when needed, for instance, during periods of unforeseen changes to the demand/generation profile.
7) Shift supply/demand peaks	Storage can smooth out supply/demand curves and shave peaks
8) Support arbitrage trade	Storage can improve power trades by buying at low and selling at high prices, including the utilization of surplus power from an onsite renewable energy source.

Energy storage business models relevant to Ukraine

Based on analysis of the power system requirements and energy market prices and trends in Ukraine the following business models are identified for further research:

- Installation of batteries at existing hydropower plants (HHP) for hybrid operation with the plant units to improve and extend the range of ancillary services provided by the HPP, and improve the mode of operation of the plants and decrease the plant maintenance costs.
- Installation of batteries at the existing and new wind power plants to be used to provide all of the services described in the previous slide.
- Installation of batteries at the existing and new PV plant sites

Ukrhydroenergo battery storage project

- Project includes installation of battery storage at five HPP plants and solar panels as back-up power supply in low water conditions.
- A financial model exists for every plant to conduct cost-benefit analysis of the hybrid hydro power plant/battery storage system for providing ancillary services. Project CAPEX for all sites is around **US $167.3 million.**
- The models clearly show the financial viability of each of the sub-projects.

Key project assumptions

ASSUMPTION PARAMETER	VALUE	UNIT	SOURCE
Nominal discount rate	10.5%	%	-
Average market price of ancillary services	0.046	USD/kWh	Local market price
Average number of cycles per day	3	Cycles	TT team
Battery useful life	10,000	Cycles	Industry benchmark
Battery energy storage (Lithium-ion) capital cost	0.694	USD/W	Lazard v.5
Battery depth of discharge	80%	%	TT team

Key project characteristics

Site	Lithium-ion Batteries MW	Lithium-ion Batteries MWh day	Zinc-air Batteries MW	Zinc-air Batteries MW day	Total CAPEX ESS USD mln	Total CAPEX Solar USD mln
Kyiv PHP	46	110.4	-	-	33.3	7.3
Kaniv HPP	66	158.4	-	-	47.6	9.2
Kremenchuk HPP	60	144.0	-	-	43.3	4.5
Serednedniprovska HPP	25	60.0	-	-	18.4	3.7
Total business project	**197**	**472.8**			**142.6**	**24.7**
Dnistrovska PHP&HPP	-	-	15.0	36.0	9.0	19.0

Project appraisal results

CONSERVATIVE SCENARIO

TOTAL FOR ALL PROJECT SITES	
NPV	118.7 Million USD
IRR	22.6%
Discounted Payback	5.2 years

BASE CASE SCENARIO

TOTAL FOR ALL PROJECT SITES	
NPV	204.1 Million USD
IRR	31.4%
Discounted Payback	3.8 years

The models clearly demonstrate the financial viability of each of the projects. The project's IRR for both cases is exceeds 20 %.

Sensitivity analysis – ESS Project component

Project Sensitivity to price of batteries

		NPV, $ Mil	IRR,%
		119	22.56%
-20%	0.555	154	29.32%
-10%	0.625	137	25.61%
0%	0.694	119	22.56%
5%	0.729	110	21.22%
10%	0.763	101	19.99%
15%	0.798	92	18.85%
20%	0.833	83	17.79%
25%	0.868	74	16.80%

Project Sensitivity to the discount rate

	NPV, $ Mil
	119
8%	172
10%	128
15%	57
20%	15
25%	(12)
30%	(31)

Project Sensitivity to ancillary services prices

	NPV, $ Mil	IRR,%
	119	22.56%
-40%	(8)	9.63%
-30%	24	13.11%
-25%	40	14.77%
-20%	56	16.39%
-15%	71	17.97%
-10%	87	19.52%
-5%	103	21.05%
0%	119	22.56%
5%	135	24.04%
10%	150	25.51%
15%	166	26.97%

Energy storage services: SUMMARY

- ESP recommends avoiding a public subsidy for energy storage, particularly a storage capacity auction.
- ESP recommends energy storage to be allowed to participate on a fair basis in all wholesale market segments, including balancing and ancillary services markets, and other segments.
- ESP recommends no favoritism for energy storage in the market design and pricing.
- The wholesale market (including balancing and ancillary services markets), will provide strong incentives to service providers, including storage.
- If under Ukraine's legal framework, market participants get special treatment or undue privileges (e.g., aid for market entry, guaranteed prices, etc.) coupling of the Ukrainian markets with the EU markets will not be possible.
- Thus, key benefits of joining ENTSO-E will be lost.
- ESP conducted a power system flexibility study assessing all tested and certified power generators and found there is sufficient flexibility to provide key ancillary services.

Energy storage services: SUMMARY

- ESP prepared recommendations for storage-related amendments to the Electricity Market Law. These are consistent with EU directives and regulations on storage.
- ESP is working with TSO (Ukrenergo) to model and analyze reserve requirements for the Ukraine power system for the next 10 years.
- ESP and the World Bank are conducting a feasibility study on adding battery storage to UkrHydroEnergo's hydro plants to enable them to serve the Ancillary Services Market. World Bank is packaging this for planned implementation in 2021.
- ESP is preparing cost comparisons of proposed hydro-storage hybrid project and storage-only projects.
- Prefeasibility analysis showed the financial viability of each of the projects. The project's IRR for both cases is near 20 %.
- The cost of storage facilities dropped 87% since 2010 and is $132/kWh in 2nd half of 2020.
- It is projected that by 2030 the price will further decrease to $58/kWh in 2030 and $45/kWh in 2035.

Thank you!

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