TECHNOLOGY FACTSHEET

ZINC-BROMINE (ZnBr) BATTERY FOR LARGE-SCALE TEMPORAL ELECTRICITY STORAGE

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Sector	Electricity generation
ETS / Non-ETS	Non-ETS
Type of Technology	Storage
Description	In a Zinc Bromine (ZnBr) hybrid flow battery, two aqueous electrolyte solutions contain the reactive components, which are based on zinc and bromine elements, stored in two external tanks. During the charging/discharging phases, these two electrolyte solutions flow through the cell stack consisting of carbon-plastic composite electrodes with compartments. Thus, the reversible electrochemical reactions occur in these electrolytic cells (Luo et al., 2015). Flow batteries can be used for multiple applications, however due to their typical size and economics, they are best suited for small to medium scale temporal storage applications (IRENA, 2017). This factsheet focuses on long-term electricity storage for applications such as load shifting, typically with discharge times of >1 hour.
TRL level 2020	TRL 8
	Utility electric energy storage (EES) applications using ZnBr batteries are in the early stage of demonstration/commercialization (Luo et al., 2015).

TECHNICAL DIMENSIONS

	Functional Unit	Value and Range		
Capacity	kWh	2,250		
		500	-	4,000

	Functional Unit		Current			2030			2050		
Potential	Global	GWe	N/A			-			-		
			-	–	-	*Min*	–	*Max*	*Min*	–	*Max*
Market share	Global utility storage capacity	%	See explanation			-			-		
			-	–	-	*Min*	–	*Max*	*Min*	–	*Max*

Capacity utlization factor	-
Full-load running hours per year	
Unit of Activity	PJ/year
Technical lifetime (years)	5-10 years, over 2,000 cycles (Chen et al., 2009). IRENA (2017) reports a lifetime of up to 20 years and over 10,000 cycles.
Progress ratio	N/A
Hourly profile	No
Explanation	The potential for all battery types is high, as there are no significant space or resource constraints, instead demand for storage and costs are usually determining factors when it comes to potential installed capacity. As of 2015, the total global grid-connected redox flow battery (both VRB and ZnBr) capacity is 46 MW - 0.03% share of utility-scale storage capacity, which is dominated by pumped hydro storage (99%) (IRENA, 2015).

COSTS

Year of Euro: 2015

	Euro per Functional Unit	Current			2030			2050		
Investment costs	€ / kWh	950.00			337.50			-		
		120.00	–	1465.00	175.00	–	500.00	*Min*	–	*Max*
Other costs per year	€ / kWh	-			-			-		
		Min	–	*Max*	*Min*	–	*Max*	*Min*	–	*Max*
Fixed operational costs per year (excl. fuel costs)	€ / kWh	19.00			6.75			-		
		2.40	–	29.30	3.50	–	10.00	*Min*	–	*Max*
Variable costs per year	€ / MWh	2.0			2.0			-		
		Min	–	*Max*	*Min*	–	*Max*	*Min*	–	*Max*

Costs explanation	The large range of cost estimates could be because ZnBr battery is still at a demonstration phase, with large differences between project scales and costs. Fixed operation and maintenance (FOM) and variable operation and maintenance (VOM) costs are based on JRC ETRI (2014) estimations for a Vanadium Redox Flow Battery (VRB). FOM is 2% of CAPEX and VOM is €2/MWh. VOM costs are only provided for 2013 by JRC ETRI (2014) and it is assumed that the VOM costs remain the same in 2020, 2030 and 2050. VOM costs are defined by JRC ETRI as production-related O&M costs that vary with electrical generation. They exclude personnel, fuel, and CO2 costs.

ENERGY IN- AND OUTPUTS

	Energy carrier	Unit	Current			2030			2050		
Energy carriers (per unit of main output)	*Main output:* Electricity	PJ	-1.00			-			-		
			-1.00	–	-1.00	*Min*	–	*Max*	*Min*	–	*Max*
	Electricity	PJ	1.33			-			-		
			1.25	–	1.67	*Min*	–	*Max*	*Min*	–	*Max*
		PJ	-			-			-		
			Min	–	*Max*	*Min*	–	*Max*	*Min*	–	*Max*
		PJ	-			-			-		
			Min	–	*Max*	*Min*	–	*Max*	*Min*	–	*Max*

Energy in- and Outputs explanation: The required amount of electricity input for 1 PJ of electricity output is calculated based on roundtrip efficiencies of 65-80% (Chen et al., 2009; Luo et al., 2015).

EMISSIONS (Non-fuel/energy-related emissions or emissions reductions (e.g. CCS)

	Substance	Unit	Current			2030			2050		
Emissions			-			-			-		
			Min	–	*Max*	*Min*	–	*Max*	*Min*	–	*Max*
			-			-			-		
			Min	–	*Max*	*Min*	–	*Max*	*Min*	–	*Max*
			-			-			-		
			Min	–	*Max*	*Min*	–	*Max*	*Min*	–	*Max*
			-			-			-		
			Min	–	*Max*	*Min*	–	*Max*	*Min*	–	*Max*

Emissions explanation:

OTHER

Parameter	Unit	Current			2030			2050		
Depth of discharge	%	100			-			-		
		100	–	100	*Min*	–	*Max*	*Min*	–	*Max*
Charge time	Hours	N/A			-			-		
		-	–	-	*Min*	–	*Max*	*Min*	–	*Max*
Discharge time	Hours	3			-			-		
		2	–	6	*Min*	–	*Max*	*Min*	–	*Max*
Self discharge	% / month	0			-			-		
		-	–	-	*Min*	–	*Max*	*Min*	–	*Max*

Explanation	No estimation of charge times is found in literature. Discharge times are an estimation based on SANDIA's Energy Storage Project Database (SANDIA, 2019). Chen et al. (2009) mention that discharge times can be seconds up to 10 hours.

REFERENCES AND SOURCES

Luo et al. (2015). Overview of current development in electrical energy storage technologies and the application potential in power system operation

IRENA (2015). Renewables and Electricity Storage: a technology roadmap for REmap 2030

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