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Graphene, MXene and ionic liquid-based sustainable supercapacitor



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Publishable summary

The need for a change toward electrification on a global scale using renewable energy sources is driving the need for advanced electrical energy management systems. Electrochemical double-layer capacitors (EDLCs), or Supercapacitors, are fine-tuned for highly specialized applications such as regenerative braking, electrical grid stability, and rapid charge-discharge energy management or uninterrupted power supplies. Furthermore, they provide an extremely high resilience to high charge-discharge cycles, making their lifetimes longer.

Moreover, the reliability of these systems and their lower maintenance requirements are paramount, especially in applications where operational continuity and cost-efficiency are essential. As energy systems evolve, technologies that offer both robust performance and long-term reliability will be key to sustainable and economically viable energy solutions.

A key aspect of providing a reliable power source and reducing cost due to system outages is the ability to predict the need for replacement or maintenance. The implementation of a localised, intelligent integrated supercapacitor management system (SMS) can give real-time feedback on the state of health of individual cells in the system. By enabling real-time monitoring and predictive diagnostics, the intelligent SMS architecture plays a crucial role in proactive maintenance strategies. Through continuous assessment of individual cell performance and degradation patterns, the system can forecast potential failures before they impact overall functionality. This predictive capability not only minimizes unscheduled downtime but also allows for targeted maintenance, avoiding unnecessary replacements and reducing operational costs. Furthermore, by enhancing system reliability and extending the service life of supercapacitor modules, the SMS contributes to a more sustainable and economically efficient energy infrastructure—especially in mission-critical applications where performance consistency is non-negotiable.

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Project partners:

#	Partner short name	Partner Full Name
1	BED	BEDIMENSIONAL SPA
2	SOLV	SOLVIONIC
3	FSU	FRIEDRICH-SCHILLER-UNIVERSITÄT JENA
4	SKL	SKELETON TECHNOLOGIES OU
5	TCD	THE PROVOST, FELLOWS, FOUNDATION SCHOLARS & THE OTHER MEMBERS OF BOARD, OF THE COLLEGE OF THE HOLY & UNDIVIDED TRINITY OF QUEEN ELIZABETH NEAR DUBLIN
6	TUD	TECHNISCHE UNIVERSITÄT DRESDEN
7	UNISTRA	UNIVERSITÉ DE STRASBOURG
8	SM	SKELETON MATERIALS GMBH
9	UNR	UNIRESEARCH BV
10	CNR	CONSIGLIO NAZIONALE DELLE RICERCHE
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