# Large-Scale Trials Validate Scalability of Iondrive's Battery Recycling Technology

## Highlights

- **Large-scale bench trials at the University of Adelaide return positive results for Iondrive's DES battery recycling technology, showing high metal recoveries and minimal solvent losses at a 1,000x scale-up.**
- **Metal recoveries independently verified by Independent Metallurgical Operations (IMO) in Perth.**
- **Large-scale trials validate scalability of Iondrive's DES battery recycling technology while low solvent losses enhance the economics.**
- **Large-scale process optimisation trials are currently underway at the University of Adelaide to further improve reagent loads and selectivity in metals recovery.**
- **The remaining key activities under the PFS are focussed on estimating the operating and capital costs of an optimised commercial scale recycling plant, including benchmarking against the economics against the incumbent hydrometallurgical recycling processes.**
- **The PFS activities seek to de-risk the technical, commercialisation & execution paths and build upon a global market study which concluded Iondrive's DES recycling technology offers a unique environmental value proposition compared to incumbent technologies.**
- **PFS activities remains on track for completion by October 2024. A successful PFS clears the way for greater industry collaboration and progression to a Pilot Plant in FY2025.**

**Iondrive Limited (ASX: ION) ("Iondrive" or the "Company")** is pleased to announce the successful completion of its large-scale bench trials including independent verification of the metal recoveries by Independent Metallurgical Operations (IMO) in Perth. These results confirm the robustness and economic potential of Iondrive's deep-eutectic solvent (DES) battery recycling technology.

**Iondrive's CEO, Dr. Ebbe Dommisse, commented:**

*"The independent verification of our large-scale bench trials at a 1,000x scale-up to the earlier University research is a significant milestone for Iondrive. It confirms that our DES battery recycling process scales effectively and maintains high metal recovery rates with minimal solvent losses. Our aim is to process black mass where it is needed, particularly in key markets like Europe, US and Australia. This approach aligns with the growing demand for recycled battery materials and ensures that the economic value of these critical minerals remains within these regions, rather than being lost through exporting to Asia. Furthermore, we convert these recovered minerals to battery-grade materials, directly supplying EV battery manufacturers. We are proud to have delivered these results as promised and are excited to continue our work towards optimising the process and advancing our pilot plant studies."*

## Iondrive's DES Battery Recycling Process

Iondrive utilises Deep Eutectic Solvents and benign, biodegradable organic solvents in a non-toxic, closed-loop process. This eco-friendly method avoids toxic mineral acid leaching, ensuring a minimal environmental footprint.

Currently, most battery recycling processes involve pre-treating and shredding waste batteries to create a substance known as black mass. Black mass is a powdered mixture of the shredded anodes and cathodes containing various critical minerals, including lithium, cobalt, nickel, and manganese. This material is then typically exported to Asia for further processing to extract these critical minerals and then refining to battery-grade materials for reuse.

The prevailing methods for processing black mass are energy-intensive pyrometallurgical processes, which involve high-temperature smelting, and hydrometallurgical processes, which use acid leaching. These methods are predominantly used in Asia, where most of the world's battery recycling capacity is currently located.

## Large-scale Trial Results

The successful completion and independent verification of large-scale bench trials mark a pivotal achievement in the development of Iondrive's DES technology.

The large-scale bench trials, conducted at the University of Adelaide, involved a 1,000x scale-up at 120g of black mass from initial small-scale trials at 120mg. These trials investigated the DES process in larger volumes to verify the scalability of the chemistry and establish an accurate mass balance to quantify solvent losses. The trials showed that Iondrive's DES Battery Recycling Technology achieves very high recovery of critical minerals from Li-ion batteries. Moreover, the detailed mass balance showed that the process incurs minimal solvent losses, which is crucial for the economic viability of the process, as solvent costs are one of the key cost drivers.

The IMO trials independently confirmed the results of the initial large-scale trials performed at the University, indicating that the process chemistry scales effectively, maintaining high recovery rates for critical minerals such as manganese, cobalt, and nickel.

In summary, the large-scale trials confirmed:

- **High Metal Recoveries:** Both the University and IMO tests confirmed metal recoveries remained high demonstrating the process's efficiency in extracting critical minerals.
- **Minimal Solvent Losses:** The University's initial tests confirmed solvent losses were minimal, which is critical to the economic viability of the process. Further work is being undertaken in this regard.
- **Scalability:** The DES process chemistry scales effectively with larger volumes.
- **Selectivity:** selectivity of metal separation was lower than in small-scale trials, however the reasons for this are well understood and will be the focus of ongoing optimisation work.

The table below summarises the results obtained from the original small-scale trials performed on black mass (120mg) compared to both large-scale trials at a 1,000x scale-up (120g) using pCAM material, which did not contain lithium.

**Table 1: Metal Recoveries from large scale and small-scale trials**

| Battery Metal | Total Recovery | | |
|---|---|---|---|
| | IMO Large Scale | UoA Large Scale | Small Scale |
| Lithium | NA | NA | 99.9% |
| Nickel | 98.3% | 97.6% | 99.7% |
| Cobalt | 98.6% | 97.6% | 97.3% |
| Manganese | 84.6% | 87.7% | 92.4% |

From the table, it is evident that the results are closely correlated between the IMO large-scale, UoA large-scale, and UoA small-scale trials. Both nickel (Ni) and cobalt (Co) showed total recoveries exceeding 97%, with slightly lower recoveries for manganese (Mn).

It is important to note that the trials were conducted with non-lithiated battery-grade materials, pCAM (MCN-622), to better understand the main process chemistry without the influence of other variables. This choice allowed for a more accurate validation of the scale-up. Further research is currently underway with black mass material that includes lithium, aiming to enhance the understanding and efficiency of the process.

These verified results provide a robust foundation for ongoing optimisation work, which will be essential for the design and costing of a commercial-scale plant. This work will feed into the engineering and economic studies being performed as part of the Pre-feasibility Study's techno-economic analysis which is a precursor to the pilot plant study.

### Pre-Feasibility Study Next Steps

Currently, large-scale optimisation trials are underway at the University of Adelaide, focusing on refining the DES process and further enhancing its efficiency. These trials aim to also confirm the minimal solvent losses from the previous UoA large scale trials. The ongoing trials will provide valuable data for the upcoming pilot plant studies.

These validated results, along with the data from the optimisation trials, will guide the engineering studies being conducted as part of the PFS. These include:

1. **Conceptual Engineering Study:** Concept design and costing (Capex and Opex) of a 10,000 tpa black mass plant by shortlisted EPC partners.
2. **Benchmarking Study:** Economic comparison of the DES process against conventional hydrometallurgical processes.
3. **High-Level Value Engineering Study:** Review of the DES solvent recovery process to enhance efficiency and cost-effectiveness.

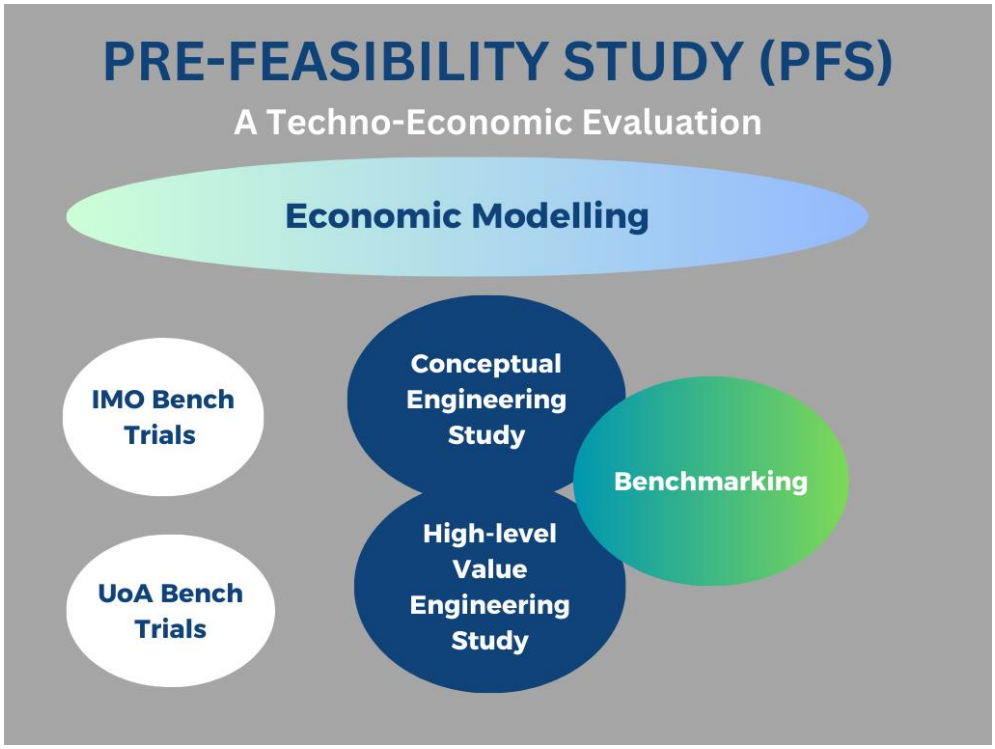


**Diagram 1:** Overview of ION's PFS Activities

The outcomes of these engineering studies and the ongoing large-scale optimisation trials and economic modelling form an integral part of the PFS, scheduled for completion in October 2024. These studies will further enhance the technology's economic competitiveness and sustainability, aligning with global trends and regulatory frameworks that emphasise the importance of environmentally friendly recycling processes.

As Iondrive progresses towards completing the PFS, the Company is well-placed to capitalise on the growing demand for sustainable battery recycling solutions, particularly in the EU, US, and Australia. The supportive government policies and regulatory changes in these regions provide a favourable environment for the adoption and commercial success of Iondrive's DES technology.

*Authorised for release by the Board of Iondrive Limited.*

## Further Information

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## Iondrive Limited: Company Profile

Iondrive is an emerging leader in battery recycling technology, listed on the Australian Securities Exchange (ASX ticker "ION"). The company's primary focus is on developing and commercialising innovative solutions for lithium battery recycling. Iondrive's Hydrometallurgical Battery Recycling project employs a patented, environmentally safe solvent to gently separate critical components from used batteries, providing a safer and more efficient alternative to traditional methods.

In addition to its battery recycling initiatives, Iondrive holds exclusive worldwide licenses from the University of Adelaide for next-generation battery technologies, including an enhanced performance non-flammable lithium-ion based battery and a low-cost, high cycle life water-based battery.

While the main emphasis is on battery technology, Iondrive also maintains a portfolio of exploration projects in South Korea, focusing on lithium. Backed by a first-class technical team, Iondrive is dedicated to advancing sustainable battery technologies and contributing to the circular economy in both Europe and Australia.

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