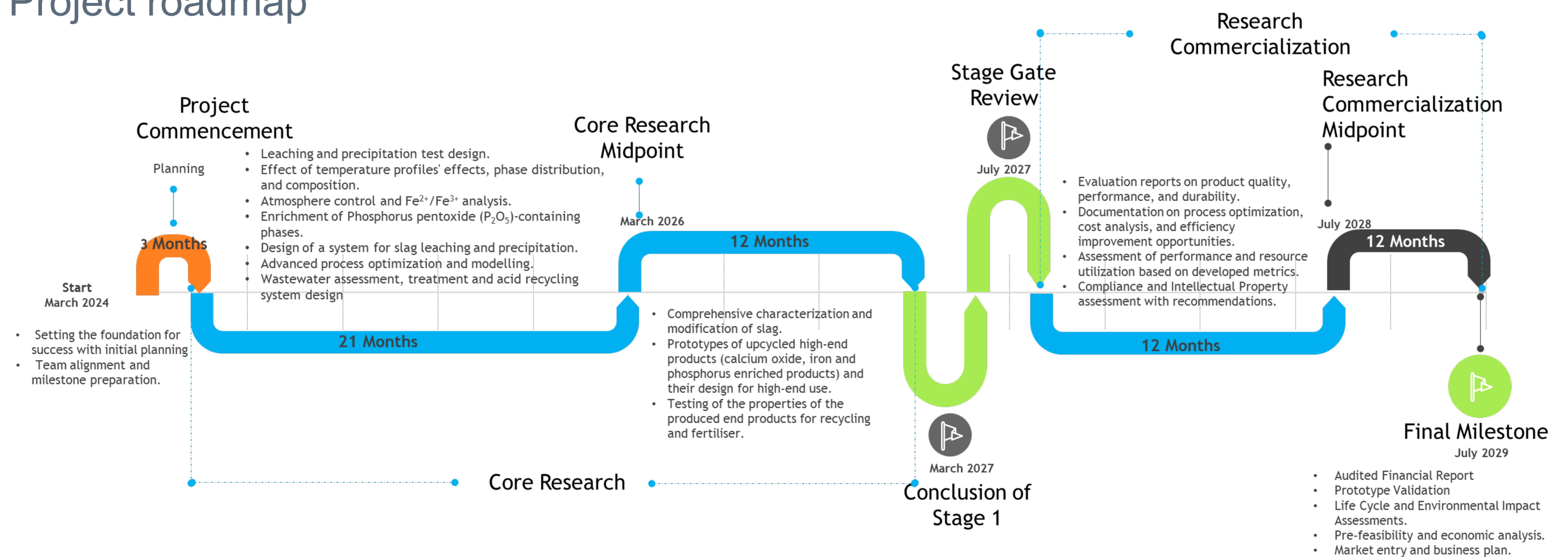# Upcycling of steelmaking slag for material reuse

Project aim

The project will design a technology for reusing steelmaking furnace slag (SFS) and enhance the value of high-phosphorus ores. By innovatively processing molten slag, we will optimize the separation of its components and use leaching technology to extract valuable elements, including calcium oxide, iron and phosphorus. The adoption of the new technology has the potential to significantly reduce CO_2 emissions. If applied globally, it could potentially reduce emissions by approximately 138 Mt per year across the entire steelmaking processing industry, while also enabling the utilization of lower-grade iron ores.

Methods & expected results

The method combines chemical, mechanical, and physical techniques to optimize the technology for the selective separation of iron (Fe), phosphorus (P) and calcium (Ca) from steelmaking slag. System integration is critical before advancing to commercialisation, ensuring efficient operation and readiness for prototype-scale implementation. The project will remove the barriers for using lower-grade Australian iron ores in low emissions steel production.
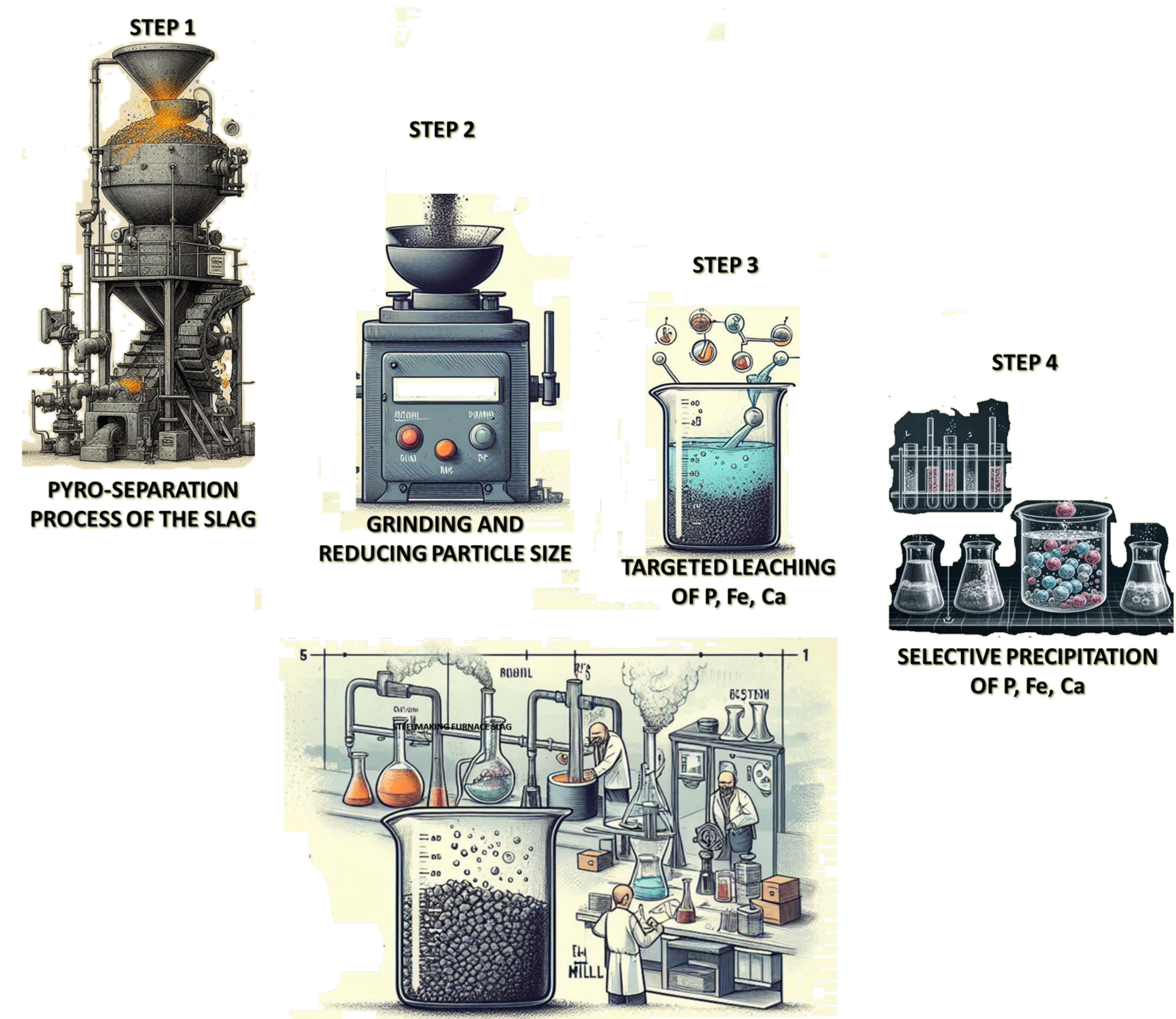
Technology & research process

STEP 1 — PYRO-SEPARATION PROCESS OF THE SLAG
STEP 2 — GRINDING AND REDUCING PARTICLE SIZE
STEP 3 — TARGETED LEACHING OF P, Fe, Ca
STEP 4 — SELECTIVE PRECIPITATION OF P, Fe, Ca

Note This image is a conceptual representation and does not accurately depict the actual chemical process or equipment.

Extraction Process and Resource Recovery from Steelmaking Slag Infographic: The process involves pyro-separation, leaching of Ca, Fe and P, and selective precipitation

Project roadmap

Project Commencement
Planning
3 Months
Start March 2024
- Setting the foundation for success with initial planning
- Team alignment and milestone preparation.

21 Months

- Leaching and precipitation test design.
- Effect of temperature profiles' effects, phase distribution, and composition.
- Atmosphere control and Fe^{2+}/Fe^{3+} analysis.
- Enrichment of Phosphorus pentoxide (P_2O_5)-containing phases.
- Design of a system for slag leaching and precipitation.
- Advanced process optimization and modelling.
- Wastewater assessment, treatment and acid recycling system design

Core Research Midpoint
March 2026
12 Months

Core Research

- Comprehensive characterization and modification of slag.
- Prototypes of upcycled high-end products (calcium oxide, iron and phosphorus enriched products) and their design for high-end use.
- Testing of the properties of the produced end products for recycling and fertiliser.

Stage Gate Review
July 2027

March 2027
Conclusion of Stage 1

- Evaluation reports on product quality, performance, and durability.
- Documentation on process optimization, cost analysis, and efficiency improvement opportunities.
- Assessment of performance and resource utilization based on developed metrics.
- Compliance and Intellectual Property assessment with recommendations.

Research Commercialization

Research Commercialization Midpoint
July 2028
12 Months

12 Months

Final Milestone
July 2029
- Audited Financial Report
- Prototype Validation
- Life Cycle and Environmental Impact Assessments.
- Pre-feasibility and economic analysis.
- Market entry and business plan.

Next steps

1. **Macquarie University Researchers –** Optimization of leaching and precipitation
2. **The University of Queensland Researchers –** Enrichment of Phosphorus pentoxide (P_2O_5)-containing phases in steelmaking furnace slag

Acknowledgements & disclaimers

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- Tim Evans, Hamersley Iron, Rio Tinto

Project partners

RioTinto

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