Green Hydrogen Organisation

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Integrated Water Resource Management for Green Iron Production

About the Green Hydrogen Organisation (GH2)

The Green Hydrogen Organisation (GH2) is an international non-profit foundation working to accelerate the production and use of green hydrogen globally. GH2 collaborates with governments, producers, financial institutions and civil society to promote key applications such as green fertilisers, shipping fuels and green iron and steel.

Founded in 2021, GH2 has established a presence in Geneva, London, Jakarta, Nairobi and Oslo. It serves as the secretariat for the Africa Green Hydrogen Alliance (AGHA), a government-led platform uniting eleven African countries to drive regional cooperation on green hydrogen.

GH2 is a founding member of the Global Renewables Alliance (GRA).

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Key Findings

1. The green iron industry has a once-in-a-generation opportunity to lead on responsible water stewardship, learning from the successes and failures of the past.

2. Investors and customers are not just asking whether iron is low-carbon; they are asking whether it is genuinely sustainable.

3. Integrated water resource management is not a constraint on green iron—it is a prerequisite for scaling it responsibly.

4. As projects move from ambition to investment, water is fast becoming a decisive factor for credibility, bankability, and social licence.

Executive Summary

Green iron production is emerging as a critical pillar of the global industrial decarbonisation agenda. By combining renewable electricity and green hydrogen in new ironmaking pathways, green iron production has the potential to eliminate a substantial share of greenhouse gas emissions from one of the world's most carbon-intensive industries. As green iron projects progress from feasibility studies to final investment decision, integrated water resource management requires greater attention.

Experience from conventional iron ore mining and steelmaking demonstrates that water-related risks—ranging from competition with other local users to contamination and tailings dam failures—can have severe environmental, social, and financial consequences. These risks have historically undermined trust between industry, communities, regulators, and investors. The green iron industry must avoid repeating these mistakes if it is to secure a durable social licence to operate.

This guidance note responds to growing interest from industry, investors, customers, and policymakers in understanding how water is being managed across emerging green iron value chains. While the absolute volumes of water required to produce green iron are modest compared to many agricultural and industrial uses, the location, timing and quality of water withdrawals and discharges matter greatly. Many of the most attractive locations for renewable energy—particularly high-quality solar resources—are in water-stressed regions. Without systematic planning, green iron projects could exacerbate existing pressures on scarce water resources.

This note builds on GH2's **Green Iron Principles[2],** which require that the environmental, social, and governance consequences of green iron production are thoroughly evaluated and that development opportunities and impacts are fully considered. Water management is a clear illustration of these requirements in practice. Effective water stewardship requires an integrated approach that considers cumulative impacts, basin-level dynamics, climate variability, and the needs of other water users.

[2] Green Hydrogen Organisation (2025) Green Iron Principles. https://drive.google.com/file/d/1ui58aWwU1w2_PcNo1xl0ipdPqQFmZf_S/view

Executive Summary

To support this approach, this guidance note reviews four established sustainability frameworks that address water resource management: the International Hydropower Association's Hydropower Sustainability Standard[3], the ResponsibleSteel International Production Standard V2.1[4], ICMM's Water Stewardship Maturity Framework[5], and GH2's own Green Hydrogen Standard 2.0[6]. Together, these standards demonstrate growing international consensus around principles such as basin-scale assessment, stakeholder engagement, impact mitigation, transparency, and adaptive management.

The guidance concludes by identifying priorities for further work. These include embedding integrated water resource management more explicitly in definitions of green iron, strengthening policy and advocacy efforts, and demonstrating best practice through high-quality projects on the ground. Addressing water responsibly is not only essential for managing risk—it is central to the credibility and long-term success of the green iron industry.

[3] International Hydropower Association (2023) Hydropower Sustainability Standard. Version 1.2. https://www.hs-alliance.org/hs-standard

[4] ResponsibleSteel (2024) ResponsibleSteel International Production Standard. Version 2.1.1. https://www.responsiblesteel.org/standards

[5] ICMM (2023) Water Stewardship Maturity Framework https://www.icmm.com/en-gb/guidance/environmental-stewardship/2023/water-stewardship-maturity-framework

[6] Green Hydrogen Organisation (2023). Green Hydrogen Standard. Version 2.0. https://greenhydrogenstandard.org/standard

Background

The Green Hydrogen Organisation recently published the Green Iron Principles to promote a shared foundation for defining, developing, and scaling green iron production. These principles reflect a growing recognition that decarbonisation alone is not sufficient to define sustainability. Green iron must be produced in a way that is environmentally sound, socially responsible, and governed transparently if it is to attract long-term investment and public support.

At the heart of the Green Iron Principles is the requirement that “the environmental, social and governance consequences of iron production are thoroughly evaluated, and that the development opportunities and impacts fully considered.” This requirement is intentionally broad. It recognises that green iron projects intersect with multiple systems—energy, water, land, labour markets, and local communities—and that sustainability outcomes depend on how these interactions are managed throughout the life of the project (including project decommissioning and site rehabilitation).

Water is a particularly salient example. Green iron production brings together several water-using activities: iron ore mining and processing, renewable power generation, green hydrogen production, and ironmaking itself. Each of these activities has distinct water profiles, but their combined impacts are often felt within the same hydrologic system. Climate change further complicates this picture by increasing hydrological variability and uncertainty.

The Green Iron Principles establish expectations across four broad dimensions:

- Climate integrity – Green iron must achieve deep, verifiable reductions in greenhouse gas emissions relative to conventional production, including across the value chain.
- Environmental responsibility – Projects must minimise harm to ecosystems, manage land and water responsibly, and address cumulative impacts.
- Social responsibility – Green iron development should respect human rights, engage meaningfully with affected communities, and contribute to local development.
- Governance and transparency – Robust governance, disclosure, and assurance are required to build trust with investors, customers, and society.

Water management cuts across all four dimensions. Poor water stewardship can undermine climate outcomes (for example, through energy-intensive desalination), damage ecosystems, generate social conflict, and expose governance weaknesses. Conversely, strong water management can deliver co-benefits, enhance resilience, and reinforce credibility.

This guidance note focuses on integrated water resource management (IWRM) as a practical framework for addressing water-related ESG risks and opportunities in green iron production. IWRM[7] is explicitly embedded in the Sustainable Development Goals (SDGs), promoting the coordinated development and management of water, land and related resources to maximize economic and social welfare in an equitable manner, without compromising the sustainability of vital ecosystems[8].

By situating green iron within existing international approaches to water stewardship, GH2 aims to help align emerging projects with best practice and to inform ongoing discussions among policymakers, financiers, and industry leaders.

How much water is needed to produce green iron?

There is no single, definitive figure for the amount of water required to produce green iron. Water use depends on ore quality, mining and processing methods, hydrogen production pathways, cooling technologies, and local water management practices. It is, however, possible to establish a credible range based on existing industry data and emerging green hydrogen benchmarks.

Conventional iron ore production involves several water-using steps:

- Mining and extraction, including drilling and dust suppression
- Crushing and grinding of ore
- Beneficiation and concentration, particularly for lower-grade ores
- Tailings transport and storage
- Ancillary uses, such as equipment cooling and site services

Academic and industry studies[9] indicate that mining and processing one tonne of iron ore typically requires:

- ~0.4–1.0 m^3 of water per tonne for high-grade hematite ores with minimal beneficiation
- ~1.5–3.0 m^3 of water per tonne for magnetite ores requiring fine grinding and wet magnetic separation

[7] UNEP (2025) Integrated water resources management. https://www.unep.org/topics/fresh-water/water-resources-management/integrated-water-resources-management

[8] UN-Water (2025) Integrated Monitoring Initiative for SDG 6. https://www.unwater.org/our-work/integrated-monitoring-initiative-sdg-6

[9] See for example, Meißner, S. The Impact of Metal Mining on Global Water Stress and Regional Carrying Capacities—A GIS-Based Water Impact Assessment. Resources 2021, 10, 120. https://doi.org/10.3390/resources10120120, Andries R., Silva R., Alves G. (2025) Water Management in Iron Ore Mining: Regression Models for Optimizing Regression Models for Optimizing Water Use in Mining Complexes Water Use in Mining Complexes, International Mine Water Association (IMWA) Conference, https://www.imwa.info/docs/imwa_2025/IMWA2025_Andries_1051.pdf and Moerk Water (2025). Bespoke water solutions for mine sites. https://moerkwater.com.au/updates/water-use-different-minerals

These figures are consistent with disclosures from major iron ore producers and sectoral reviews by organisations such as the International Council on Mining and Metals (ICMM). Importantly, modern operations often recycle 70–80% of process water, meaning net consumption is lower than gross withdrawals, though evaporation losses can be significant in arid regions.

The global study of the impact of metal mining on global water stress by Meißner (2021) notes that the water scarcity profiles are significantly influenced by the water stress of only a few geographic regions hosting large production capacities which are of global relevance and characterized by major market shares. The basins with the highest global water consumption in the mining sector are mainly subject to large-scale iron ore mining, particularly Fortescue River (Australia), Tocantins (Brazil), Ashburton River (Australia) and Sao Francisco (Brazil)". Meißner's findings on water stress in the Pilbara region in northwestern Australia is particularly relevant:

> *Pilbara comprises three river basins, namely De Grey River (basin no. 321), Fortescue (basin no. 323) and Ashburton (basin no. 327), altogether providing 53.3% of the global iron ore fine supply ... the percentage of water consumption for mining in Pilbara varies significantly between the basins. For instance, while mining's influence on the basin's water stress in De Grey River is basically low (usually below 10% of the basin's total water consumption per month), its contribution to the overall water stress in Ashburton is slightly above 10% in the period from January to March but exceeds the EWR [environmental water requirement] limits significantly from September to October, thus causing a range of 'low–medium' to 'extremely high' water stress throughout the year. By contrast, in Fortescue River Basin, mining alone is responsible for the 'extremely high' water stress during most of the year, particularly surpassing EWR thresholds from April to December.*

Green hydrogen production via electrolysis requires approximately 9 litres of demineralised water per kilogram of hydrogen, with additional water for purification and cooling depending on system design. GH2's review of green hydrogen and water[10] highlights that, even when upstream losses are included, hydrogen's direct water demand is modest in volumetric terms. For green iron production, hydrogen demand depends on the ironmaking route, but indicative estimates suggest 50–60 kg of hydrogen per tonne of iron, implying ~0.5–0.6 m³ of water per tonne of iron for electrolysis itself.

[10] Green Hydrogen Organisation (2023) Green Hydrogen and water – we don't need that much overall, but water management needs to be responsible. https://us14.campaign-archive.com/?u=1cf0e67e26a4e1528b65f3cae&id=1347269720.

In 2025, the CSIRO published a detailed review on securing water for Australia's emerging hydrogen industry[11]. The findings for the Pilbara region noted:

> *Groundwater resources in the region can initially supply the water needed for large-scale hydrogen production but not sustainably towards 2050. Potential impacts on existing bores and groundwater-dependent ecosystems are possible. Climate-independent desalination of ~680 GL/yr of seawater is needed to produce ~6.8 Mt/yr of green hydrogen in 2050.*

When iron ore mining, processing, and hydrogen production are considered together, a reasonable indicative range for green iron production is ~1.0–3.5 m³ of water per tonne of iron, depending on ore type, recycling rates, and hydrogen pathway. This does not include water associated with renewable power generation, which is generally low for wind and solar but may be material for certain cooling or cleaning practices.

Critically, while it is not the total amount of water used which will be a challenge for our industry, some of the best opportunities for mining iron ore, producing renewable energy (in particular solar energy) and green hydrogen are in water-stressed environments. In such contexts, even relatively small additional demands can have disproportionate impacts, underscoring the need for integrated water resource management.

[11] CSIRO (2025) Securing water for an emerging Australian hydrogen industry - Methods report https://publications.csiro.au/publications/publication/PIcsiro:EP2025-0743

Review of existing approaches to integrated water resource management

IHA Hydropower Sustainability Standard

The Hydropower Sustainability Standard, governed by the International Hydropower Association, provides a globally recognised framework for assessing and certifying hydropower projects across their lifecycle. It is operational, independently governed, and widely used by developers, financiers, and governments. Water resource management is central to the standard. Relevant topics include hydrology, environmental and social flows, water quality, cumulative impacts, and climate resilience. The standard requires that projects demonstrate an understanding of basin-level water dynamics and interactions with other users. For example, the standard requires that:

> *"The project's water use and operational regime are consistent with basin-scale planning and do not compromise environmental flows or the rights of other water users."*

This basin-scale, integrated approach is directly relevant to green iron projects that rely on shared water resources.

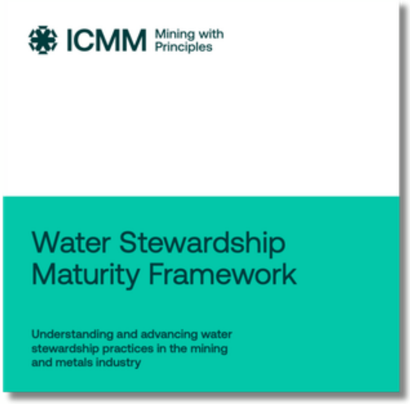
ResponsibleSteel International Production Standard V2.1.1

ResponsibleSteel is a multi-stakeholder standard covering environmental, social, and governance performance across the steel value chain. Version 2.1.1 is currently in force and supported by certification and independent assurance. The standard includes explicit requirements on water stewardship, particularly in water-stressed areas. These include site-level water balances, risk assessments, reduction targets, and stakeholder engagement. The standard states that certified sites must:

“Identify shared water challenges and engage with stakeholders to contribute to the sustainable management of water resources.”

While primarily site-focused, ResponsibleSteel increasingly emphasises collaboration and transparency beyond the fence line.

ICMM’s Water Stewardship Maturity Framework



The Water Stewardship Maturity Framework is a voluntary, practical tool designed to help mining and metals companies enhance their stewardship of shared water resources—balancing social equity, environmental sustainability, and economic value. It focuses primarily on a company’s direct operations, rather than broader supply chains.

The Framework organizes water stewardship into five key elements, each representing a pillar of effective water stewardship practices:

1. Governance and Strategy – Establishing strong internal water governance structures, clear corporate direction and ambition on water stewardship, and embedding accountability at both corporate and site levels.
2. Understanding Water Context, Risks and Opportunities – Systematic assessment of the biophysical, social, cultural and economic context of water catchments where operations occur, including current and future risks and shared opportunities.
3. Integration in Business Planning and Decision Making – Embedding water considerations into operational planning, risk systems, infrastructure decisions, water efficiency, and circularity across life-of-asset planning.
4. Performance and Measurement – Monitoring compliance and operational performance, using adaptive management, and participating in collective action and public policy where appropriate.
5. Transparency and Reporting – Publicly communicating water stewardship approaches and performance, sharing data, and demonstrating leadership to build trust with regulators, communities and stakeholders.

For each element, the Framework defines practice levels—typically framed as: “Basic Practice” - early stages of implementation; “Advanced Practice” - holistic and integrated approaches aligned with broader business agendas; “Leading Practice” - practices at the forefront of global leadership in water stewardship. The goal is to help companies benchmark their current performance and plan progressive improvements over time.

While the framework embodies integrated water resource management through the “Systematic assessment of the biophysical, social, cultural and economic context of water catchments where operations occur, including current and future risks and shared opportunities”, the framework “focuses on a company’s direct operations and does not directly consider water stewardship actions related to broader supply or value chains”. It also only includes operational water management activities that are directly relevant to water stewardship practices (i.e., it does not provide comprehensive coverage of operational water management practices)

GH2 Green Hydrogen Standard

Green Hydrogen Standard®2.0
The Global Standard for Green Hydrogen and Green Hydrogen Derivatives

GH2’s Green Hydrogen Standard defines what constitutes green hydrogen and establishes sustainability requirements for its production. It is increasingly referenced by policymakers, investors, and certification bodies. The standard requires that water sourcing for electrolysis avoids significant harm to ecosystems and communities. It encourages the use of non-competitive sources such as desalinated seawater or treated wastewater where appropriate. The standard specifies that:

> *“In water-stressed regions, hydrogen producers must demonstrate that water use does not undermine local water security or environmental flows.”*

These provisions are highly relevant to green iron, given hydrogen’s central role.

Summary

All four standards converge on several core principles: understanding local water contexts, engaging stakeholders, mitigating impacts, and ensuring transparency. However, they differ in emphasis and scope. The IHA standard is the most explicit in adopting a basin-scale, cumulative impact perspective, reflecting hydropower's direct interaction with river systems. ResponsibleSteel and ICMM focuses more on site-level stewardship, while acknowledging shared challenges. GH2's standard bridges these approaches by tying site-level requirements to broader water stress considerations. Together, the standards provide complementary building blocks, but none alone fully addresses the integrated water challenges of green iron production across mining, hydrogen, and ironmaking.

Conclusion and priorities for further work

Integrated water resource management must become a defining feature of credible green iron production. Two priority areas stand out. First, policy and advocacy. Definitions of green iron should explicitly incorporate wider sustainability considerations, including IWRM. GH2 can play a leadership role in ensuring that emerging taxonomies, standards, and procurement frameworks reflect this reality. Second, project-level demonstration. High-quality projects that apply basin-scale assessment, engage stakeholders meaningfully, and disclose water performance transparently are essential. These projects can provide practical evidence of what good looks like and help build confidence across the value chain.

By embedding integrated water resource management at both policy and project levels, the green iron industry can avoid legacy risks, strengthen social licence, and deliver on its promise of genuinely sustainable industrial transformation.