Submission to the Department of Climate Change, Energy, the Environment and Water - Review of the National Hydrogen Strategy

AUSTRALIAN STEEL INSTITUTE

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The Australian Steel Institute (**ASI)** is pleased to make a submission to the Review of the National Hydrogen Strategy.

The Australian Steel Industry

The Australian steel industry consists of four primary steel producers, supported by over 300 steel distribution and processing sites throughout the country and hundreds of manufacturing, fabrication and engineering companies.

Australia's primary steel producers and steel product manufacturers together form a strategically important value chain that has the capability to supply in excess of 90 per cent of the steel grades and qualities required in this country. If special categories such as very large diameter pipe, stainless steel, electrical steel, and tinplate are excluded, then the capability is significantly closer to 100 per cent.

Australia produces around 6 million tonnes of steel per annum across five major manufacturing locations, with approximately 74 percent produced via the more emissions-intensive method in the blast furnace - basic oxygen steelmaking (BF/BOS) and the remainder produced via the electric arc furnace (EAF) method.

It is important to note the economic and social contribution of the Australian steel industry. It employs over 100,000 people and generates $29 billion in annual revenue, and it associated with a disproportionally large share of skilled jobs in regional and rural areas.

Australia has world leading manufacturing capability in many areas of steel product application. Some examples include wear resistant and ballistic plate steels for mining and defence applications, grinding media for mineral processing, strata control products for underground mining, wire rope for open cut mining, wheels, rail, and sleepers for both mainline and heavy haul railway applications, strapping for load restraint, engineered bar and resultant products such as automotive springs and specialty fasteners, high pressure gas storage tanks, racking and shelving for automated warehouse solutions, highly durable coated steel water pipe for infrastructure, and a myriad of specialised components for defence applications.

Similarly, the steel fabrication sector is well served by a wide range of domestic businesses, each with an area of unique capability or specialisation. Steel fabrication is essential for manufacturing of bespoke construction products such as foundations, piling, columns, beams, girders, gantries, platforms, and towers. Areas of specialisation include wind turbine towers, transmission towers, storage tanks, chemical processing plant, boilers and pressure vessels, mining infrastructure refurbishment, mobile equipment for underground and surface mining, mobile cranes, bridges, armoured vehicles for Defence, naval and domestic ship building, rolling stock, truck bodies and trailer chassis.

How can Australia enable decarbonisation through the development of a clean hydrogen industry?

The Australian steel industry is closely aligned with at least three of the key applications identified in the National Hydrogen strategy, and indirectly aligned with several others. These key applications are:

- Transport - Domestic and International
- Industrial process heat – Domestic
- Green Iron and Steel production - Domestic and Export

Transport - Domestic and International. The steel industry is a significant user of freight and logistics for product transport and distribution, primarily via road and rail. Ocean freight is used for steel product exports and some bulk raw material supply e.g. iron ore and coal. Rail is also used for raw material supply e.g. iron ore and coal. Whilst the industry is a major user of various modes of transport, the specific characteristics and requirements are not unique to the steel industry. Therefore, it is reasonable to expect that the steel industry will support the adoption of hydrogen fuelled transport at the same rate and under the same policy circumstances as may apply to the general economy.

Industrial process heat – Domestic. Process heat is used in the steel industry for three main applications – hot rolling, heat treatment, and drying / curing. In the various rolling operations that are used to transform large cross section crude steel into finished products, it is typically necessary to heat the steel to a high temperature such that it can be readily deformed and shaped without damage to rolling equipment. (Hot rolling temperature is typically in the range of 1,000°C to 1,200°C). Because of the large cross section in combination with the speed of operation, this heating is normally done in a gas fired furnace (mostly natural gas) as opposed to induction heating. It may be possible to substitute a significant proportion of hydrogen (potentially 5% to 10%) for existing fossil fuel heating sources, with limited changes to equipment and need for investment. It is probable that these processes could be converted to run on 100% hydrogen fuel but that is likely to require significant upgrades and capital investment.

Heat treatment is a process used to transform the physical structure of steel products in order to achieve improved mechanical properties such as hardness, strength, and wear resistance. Whilst there are many variants, most typically involve heating the steel to a critical temperature and then subjecting it controlled cooling. (Heat treatment is typically conducted at temperatures in the range of 500°C to 800°C). The method of heating employed is again mostly determined by the cross-sectional thickness involved, with natural gas fired heating predominating and some use of induction heating. As noted for hot rolling, it may be possible to substitute a significant proportion of hydrogen for existing fossil fuel heating sources, with limited changes to equipment and need for investment.

Pre-heating, drying and curing is normally associated with the application of surface coatings that are used for corrosion protection and decoration. Some examples of surface coatings include a thin layer of zinc (galvanizing) or zinc/aluminium, paint, or passivation chemical. The surface coating processes typically use a natural gas fired oven or furnace to remove volatiles as part of paint curing, or to drive out moisture to dry water born chemicals. (Operating temperature is typically in the range of 100°C to 200°C.) Again, it may be possible to substitute some of the natural gas with hydrogen in these surface coating processes.

Recommendation: Existing renewable energy funding schemes and programs be investigated to ensure that their scope of application includes the study, feasibility investigation, and pilot scale conversion of existing industrial heating applications to blended natural gas / renewable hydrogen operation.

Green Iron and Steel production - Domestic and Export. As noted in the introduction, there are two main steel production processes employed in Australia. Electric arc furnace (EAF) steelmaking accounts for approximately one quarter of steel production. The EAF process uses recycled scrap steel as a feedstock, which is melted using electrical energy. Whilst the process also relies on a significant amount of chemical energy from natural gas burners and oxidation of various carbon sources, in the main its carbon emission intensity correlates directly with that of the electrical power grid. Therefore, decarbonisation of the power grid is the key strategy for decarbonising the EAF steelmaking process. The chemical energy input that is currently supplied from combustion of natural gas could potentially be replaced by hydrogen, using a similar logic to that explained in the section on industrial heating.

The integrated steelmaking process accounts for the remaining three quarters of steel production. This process uses iron ore and coke (from coal) in a blast furnace to make liquid iron. The role of the coke is to remove the oxygen that is chemically combined with iron in the iron ore. This chemical reaction is called ‘reduction’. The liquid iron is subsequently refined in the basic oxygen steelmaking (BOS) process. Small scale industrial trials are being conducted around the world (with examples in Germany, China, Japan) to evaluate the use of hydrogen injected into the blast furnace to displace some portion of the coke requirements. This practice may offer the opportunity for an incremental reduction in carbon emissions in the short term for blast furnace operations, but it is not technically possible to eliminate the use of coke in this process.

An alternative commercial process for production of iron from iron ore is the direct reduced iron (DRI) process. The process uses reformed natural gas to reduce iron ore in the solid state, typically in a shaft reactor. Whilst operating in a solid state means that the process can operate at significantly lower temperatures than a blast furnace, it also means that impurities associated with as-mined iron ore can't be removed. These impurities (typically referred to as 'gangue') are very deleterious for the energy efficiency and iron yield of subsequent steelmaking processes that use the DRI as feedstock, and therefore are preferably removed. This is typically done by upgrading or 'beneficiating' the iron ore prior to being charged to the DRI process. Certain iron ore mining regions (e.g. Sweden) around the world have naturally occurring ore bodies that are suited to production of 'DR grade' pellets for the DRI process. The majority of Australian iron ore is hematite, which is not readily beneficiated. There is a significant proportion that is magnetite, which is more suited to efficient beneficiation.

It is probable that the commercial DRI processes can be converted to replace most of the reformed natural gas with hydrogen, thereby achieving a significant reduction in carbon emissions. This process requires DR grade iron ore pellets as feedstock, which are likely to be associated with significant additional energy and investment cost compared with as-mined iron ore.

It should be noted that there is a huge amount of research and development activity being conducted both nationally and internationally to investigate and prove up the viability of the various decarbonisation options available to the steel industry. In addition to the approaches mentioned in the preceding paragraphs, significant effort is being put into options such as electric smelting of DRI to make liquid iron, and direct electrolysis of iron ore. Given the considerable technical uncertainty associated with the scale-up and commercialisation of decarbonised ironmaking processes, it is essential that a wide range of technologies are included in the mix.

Recommendation: Continued funding support for fundamental iron and steelmaking process research, piloting and scale-up is essential to support the commercialisation of decarbonised ironmaking technologies. Examples of key industrial research groups working in this area include the Heavy Industry Low-carbon Transition Cooperative Research Centre (HILT CRC) and the ARC Steel Research Hub. These need to be supported on an ongoing basis. The scope of new initiatives such as the National Reconstruction Fund needs to ensure that it is available for support of piloting and scale-up of promising hydrogen intensive ironmaking technologies.

How could Australia further activate its hydrogen and related industries?

[Please refer to the preceding discussion on use of hydrogen for industrial heating for context.]

Recommendation: Policy measures that encourage and incentivise the partial replacement of natural gas by hydrogen in industrial heating applications offer the quickest and lowest cost pathway to creating a significant baseload demand such that investment in hydrogen production will be catalysed.

Addressing Supply Chain Risks / How should we develop the necessary infrastructure needed to support the development of our hydrogen industry?

Based on anecdotal evidence provided by ASI members, a significant barrier to increased use of hydrogen generally in the steelmaking process is the unique issues associated with the storage and transport of hydrogen. These issues derive from the unique physical characteristics of hydrogen.

Hydrogen is the smallest element, which in practice means that on an atomic scale it is capable of penetrating and passing through the matrix of other elements. For example, gaseous hydrogen in contact with solid steel can cause it to become embrittled, which is a significant concern for structures such as pressurised pipelines and storage vessels. This can be managed with a combination of impervious lining materials and the selection of less susceptible steel grade types. The relatively low density of hydrogen means that it needs to be pressurised in order to be stored efficiently, which necessitates significant investment in specialised storage facilities.

Another characteristic of hydrogen is that it is odourless and burns with an invisible flame, which means that leaks are very difficult to detect and can readily lead to hazardous situations in the presence of an ignition source.

These issues are not unique to the steel industry and need to be addressed by all industrial and commercial users, therefore the ASI does not have a specific recommendation to offer.

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About the Australian Steel Institute

The ASI is the nations peak body representing the entire steel supply chain, from the primary producers through to end users in building and construction, resources, heavy engineering and manufacturing.

Its membership base includes approximately 6,000 individuals that are associated with more than 500 corporate memberships and over 350 individual memberships.

A not-for-profit member based organisation, the ASIs activities extend to, and promote, advocacy and support, steel excellence, standards and compliance, training, events and publications. The ASI provides marketing and technical leadership to promote Australian-made steel as the preferred material to the resources, construction, and manufacturing industries, as well as policy advocacy to government.