Netherlands Enterprise Agency

Dutch Green Hydrogen proposition for South Africa

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IMPACT. HYDROGEN

May 31rd, 2023

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A study for RVO Netherlands, with recommendations for the Netherlands Embassy in South Africa

Dutch Green Hydrogen proposition for South Africa

Summary

The urgency to mitigate climate change, and to ensure energy security in the face of current and future political tensions linked to energy supply, have created a need for alternative solutions to decarbonize hard-to-abate sectors. Green hydrogen is seen as one such solution and could make up 12% of final energy demand globally by 2050 (IRENA, 2022). Both the Netherlands and South Africa have expressed concrete interest in developing a green hydrogen economy. The Netherlands aims to reduce greenhouse gas emissions by 49% by 2030 and become carbon-neutral by 2050, with green hydrogen seen as a key component in achieving these goals. South Africa, being highly dependent on coal, sees green hydrogen as critical to decarbonise hard-to-abate sectors in the country and to contribute towards mitigating both climate change and current stress on the electricity grid.

The Netherlands and South Africa have a long history of cooperation. The two countries have signed various agreements to promote bilateral trade and investments, stimulate private sector development, and explore opportunities for mutual benefit in areas such as port development, water management and climate resilience. The Netherlands aims to develop mutually beneficial partnerships in Green Hydrogen and become a key trade partner with South Africa for green hydrogen. For South Africa it is important to develop green hydrogen projects that contribute to the export market as well as the development of local economies and regional prosperity. Both countries want to play an important role in green hydrogen and a responsible energy transition. The combination of Dutch knowledge and expertise in the field of hydrogen to adjacent activities can contribute to the needs of South Africa. In this way, both countries can benefit from the green hydrogen economy.

Building on this foundation, the goal of this proposition is to identify synergies between the Netherlands and South Africa and advise on market- and investment opportunities and mobilisation of Dutch businesses and knowledge institutes and explain how and in which niches of the green hydrogen value chain the Netherlands is best suited to partner with South Africa. Throughout the process, interviews were conducted with Dutch and South African stakeholders to identify opportunities and validate findings. Based on these insights, we identified the key opportunities for skills, development, trade, collaboration, and ecosystem building between the Netherlands and South Africa, and the necessary steps that need to be taken to reduce the risks of setting up a green hydrogen corridor between the countries.

Currently, green hydrogen and its derivatives are not yet cost-competitive with fossil fuel-based energy. While the costs of fossil fuels will increase rapidly over the next decade, due to the ambitious and necessary CO2 emission reduction targets and the ‘social costs of carbon’, scientists estimate that green hydrogen production costs can be more than halved in the coming decade, driven by enhanced economies of scale and innovations. However, with this "technical learning curve," an investment in today's technology could soon become uncompetitive, making investors weary. Likewise, this uncertainty over long-term production costs will make off-takers cautious about making long-term contractual commitments on price.

Hence, it is of great importance that the Dutch government takes concrete steps to mitigate the risks for green hydrogen projects, in order to facilitate collaboration, cooperation and trade between South Africa and The Netherlands and drive investments. The opportunities identified in this proposition are related to this risk-mitigation. Based on the data obtained through research and interviews, the following risk mitigation strategies were identified:

1. Developing a long-term yet flexible vision; both countries have formulated hydrogen strategies, which need to be aligned with each other in order to create a joint vision for mutually beneficial engagement and cooperation; yet they have to stay flexible enough to allow for disruptive technologies.
2. Stepwise development of multiple small-scale projects with various production routes and derivates; The rate of technical innovation is phenomenal, which favours higher numbers of small steps and investments, each benefitting from the lessons learned. Starting small and scaling it up is therefore considered better than only focussing on large scale and locking in capital into today's technologies, which are not fully developed yet. Various routes should be explored for both production (electrolysis versus biomass) and form (pure form, liquified, ammonia, (bio) methanol, solids)
3. Alignment between stakeholders in the upcoming hydrogen innovation system; cooperation between all relevant stakeholders is crucial in the beginning phases of a technical innovation system. The enabling environment should be aligned with innovative agents, and user-producer relationships are crucial.
4. Ensure relevance to local development challenges; in the end, hydrogen should be an enabler of local development. Without relevance to the local economy, there will be no social license to operate.
5. Closing the investment gap; the green premium for green hydrogen produced with current technologies needs to be bridged.

The opportunities described below are enabling and integrating these strategies. Hence, they facilitate future hydrogen relationships between South African and the Netherlands. Alongside each opportunity, potential Dutch and South African partners are proposed, as well as next steps to realise them. Where South African partners are proposed, these are based on direct engagement with the stakeholder, or on recommendations of relevant parties from the stakeholders engaged. These partners are not exhaustive, and detailed stakeholder mapping and engagement should be performed to engage all relevant partners.

The main opportunities

Opportunity 1: Set up a Green Hydrogen Office

The Netherlands and South Africa are interested in collaborating on the development of green hydrogen, but there are concerns due to the ambitious goals and short time frames. To address this, the Netherlands proposes setting up a *Green Hydrogen Office* that will facilitate the development and alignment of national hydrogen initiatives, develop risk mitigation routes, and advance cooperation between the two countries and where opportunities arise, also other EU countries. This includes advancing and facilitating collaboration on the value chain in South Africa, as well as the export route to the Netherlands and Europe. Another key role of the Green Hydrogen office is to ensure that green hydrogen projects contribute to socio-economic impact around the value chains, and to create awareness and engagement with the surrounding communities, herewith contributing to public and (local) political support and a social licence to operate.

Furthermore, the office will manage all ecosystem stakeholders: the businesses in the value chain, as

well as the stakeholders in the enabling environment, such as policy makers, investors, and training- education- and knowledge institutes. As such, the office will play both a strategic and a brokering role between South Africa and the Netherlands, and possibly other EU countries.

The office will be managed by a project team, and accountable to a steering committee consisting of representatives of the ecosystem partners in South Africa, as well as the Netherlands. The office will expand to branch offices located in the different subregions (e.g. Western Cape, Northern Cape, Eastern Cape) where hydrogen initiatives are being developed, to ensure representation of all stakeholder interests and alignment between the regions. Key objectives of the office include facilitating trade relations and exports, developing a national green hydrogen economy, creating an enabling environment, anchoring a Just Energy Transition, promoting knowledge and innovation, and focusing on education, skills development, and human capital strategies that benefit both the Dutch and South African partners. The office aims to identify and remove barriers and accelerate projects through a country-wide strategy that addresses the energy-water-food nexus and ensures public support.

The funding of the Green Hydrogen Office should, after initial funding from the Dutch government, come from the consortium partners. In the first phase, all companies engaged in the current and currently planned green hydrogen value chains contribute to the set-up of the initial office. When more projects are developed in different regions, branches of the office can be developed with the additional funds that new consortium partners bring in.

Opportunity 2: Industrial and Port development

The Netherlands has the potential to support South Africa in the industrial development of hydrogen projects. Dutch companies are interested to help create a hydrogen ecosystem that promotes the use of hydrogen in various industries. However, the development of green hydrogen on an industrial and export scale is capital intensive and perceived as high risk, which could hinder the Dutch and South African ambitions. To address this, financing solutions such as H2Global and the European Hydrogen Bank must be explored, along with collaboration between the Dutch Ministry of Foreign Affairs and the South African Department of International Relations and Cooperation. Dutch ports can also offer their expertise as a knowledge provider, matchmaker, and support hub for port master planning to support the development of ports such as the one planned in Boegoebaai.

Port of Rotterdam intends to play a leading role in this by investing and-or taking a management role in the development and operations of the port or hydrogen hub, building on its experience in the development of other ports and industrial zones. Vopak and other companies from the Rotterdam Port Community of over 3.000 companies, can be of key assistance in the development of storage solutions for hydrogen, ammonia, and potentially methanol. Other seaports of the Netherlands can also play a role, as more ports in South Africa could play a role in the future green hydrogen corridor either connecting initiatives on the west coast or the east coast.

With regards to infrastructure development, there is significant opportunity for public and private sector collaboration, and investment in network infrastructure such as road, rail, grid infrastructure and pipelines among others. The Netherlands proposes to nurture bilateral (business, knowledge and government) collaboration on this, through the Green Hydrogen Office. This would then leverage existing relations between the Western and Northern Cape, and to leverage existing infrastructure to enable accelerated development and market entry.

Opportunity 3: Hydrogen filling station pilot for long-haul trucking and local transportation

The logistics industry in Southern Africa heavily relies on long-haul trucking, which requires a green fuel alternative to meet the region's low-carbon future goals. However, hydrogen transportation costs over land are high, especially in large countries like South Africa, making decentralised production necessary for transportation routes. Decentralised hydrogen production can also provide community development opportunities through small-scale production facilities owned and operated by SMEs in local communities. Furthermore, hydrogen fuel can be expanded to green public transport and municipal collection vehicles, contributing to improved air quality and health in urban areas, social license through public visibility, and improving the public transport sector overall. The Netherlands proposes to start the production on a small scale, so that this can be developed in the short term, which will help speed up the development of the hydrogen sector overall. A pilot study is therefore proposed, preferably in an area where the feasibility of fuelling long haul trucking and local public transportation and/or municipal vehicles could be assessed an optimised. An important side note is that this route would not be immediately profitable, and as such, financial instruments such as subsidies, green premiums or carbon taxes will be required to create a realistic business case. Collaboration and alignment with Namibia (both in terms of infrastructure, technologies and financing) should be sought in this regard.

Opportunity 4: electrolysers and fuel cell equipment study to explore local production options

South Africa is the world's leading producer of PGM metals, contributing significantly to the economy, and an opportunity for the country is to capitalize on the increased demand for hydrogen applications that require PGM metals. With its abundance of PGM metals and developed knowledge economy, South Africa is well-positioned to develop an electrolyser or fuel cell sector, which would not only create jobs but also add value to the local economy and make the country more competitive in green hydrogen production. The Netherlands, on the other hand, has the knowledge but not the capacity to scale up the production of fuel cells and electrolysers. Therefore, a agreement with South African manufacturers would be beneficial for Dutch companies. By leveraging the Memorandum of Agreement between the Northern Cape and the Port of Rotterdam, the Netherlands can initiate an analysis of the European demand for electrolysers and fuel cells, securing long-term off-take agreements for South African manufacturers. It's crucial to support the development of electrolysers and fuel –cell (technology) in South Africa and explore the possibility of building a partnership between Ditch companies and electrolyser and fuel-cell knowledge institutes and companies in South Africa.

Opportunity 5: Feasibility study for a desalination plant addressing the food-water-energy nexus

South Africa's water scarcity requires caution in the production of green hydrogen to avoid stressing the already vulnerable water system. Desalination is key to preventing this, and projects in coastal areas like Boegoebaai and Saldana Bay can supply water for hydrogen production while also benefiting the local community through improved drinking water and agriculture. However, accessing local funding for hydrogen-specific feasibility studies is challenging. A partnership between South Africa and the Netherlands could be mutually beneficial in this regard, as they have expertise in desalination and can work on improving energy efficiency and reducing costs. Furthermore, desalination can be designed for systemic sustainability, addressing the food-water-energy nexus. Dutch institutions like the Center of Expertise Water Technology have already designed solutions that can reroute desalinated water to communities for bioproducts and ultra-pure water for electrolysis. Close collaboration with local stakeholders and organisations like GIZ could ensure that desalination projects

are locally implemented and co-owned, thus contributing to addressing inequality and poverty in rural communities.

Enabling environment

This study has also mapped the enabling environment, which includes necessary financial and governmental arrangements that are needed to make the proposition a success, along with skills development and training needs that can be co-developed with institutes from the Netherlands. The development of this enabling environment is necessary to lay the ground for solidifying commitment from the private sector to fund, collaborate and contribute to development. In this regard, further discussions and alignment are needed between the government and private sector on scope, roles and responsibilities.

In the context of *policies and legislation,* the Netherlands and South Africa could work together to develop incentives that encourage import and export, de-risk investments, lower barriers for investors and development finance institutions, exchange knowledge, skills building efforts, and collaborate on infrastructural development, particularly port development.

Regarding the *financial side,* it was found that before a hydrogen economy can be built, securing a purchase guarantee from one or more off-takers, improving the risk profile, setting up structured procurement mechanisms, embedding financing throughout the value chain, and government intervention in the early stages, are necessary. To support this, the establishment of a H2 Global is a step towards closing the investment gap and connecting the future supply of renewable hydrogen with demand objectives. Moreover, the Dutch Invest International and Climate Fund Managers can provide mixed funding, including concessionary loans and grants, which are much needed for the development of local SMEs and industry. It is recognised that financial commitments and off-take are needed from the private sector, but that the private sector is still uncertain regarding financial commitments and support from the government. Further alignment is needed.

On the *human capital side,* it was found that South Africa has the potential to create 1.6 million jobs by 2050 through the energy sector transformation[1] (compared to a total of nearly 15.6 million people estimated as employed in 2022)[2], with hydrogen playing a key role. However, a critical skills gap exists between industry demands and technical and vocational college offerings. The Netherlands, with its advanced hydrogen research and innovation ecosystem and education institutes with a developed hydrogen curriculum, could be an important strategic partner to help overcome this gap. Dutch and South African universities and knowledge institutes have a long history of collaboration in various fields, including science and innovation, which can be leveraged to facilitate knowledge exchange between the two countries in the field of green hydrogen. Dutch universities, knowledge institutes, universities for applied sciences and vocational training have developed advanced knowledge on both the technical, economic, and systemic aspects of hydrogen, which could be shared with South African counterparts. The Netherlands also specialises in system integration and stakeholder management, both of which will be of great importance for the development of a local hydrogen economy in South Africa. Stakeholders in the private sector would play an invaluable role in knowledge transfer and developing technical skills.

[1] Powering a green hydrogen economy workforce: What South Africa needs to do now - SAIIA

[2] South Africa: number of people employed 2012-2023 | Statista

The document also lists how the opportunities address local climate mitigation and a Just Transition, where local SMEs are included in project proposals and funding requests, and collaboration between Dutch and South African incubators is promoted. This can lead to more equitable distribution of the economic benefits from projects across the local community, job creation, and training opportunities. Furthermore, addressing unemployment, especially among the youth, is also important, and the Hydrogen Economy has the potential to contribute to decent work and economic growth. Gender equality is also emphasised in the South African Hydrogen Society Roadmap as important to integrate into the planning and implementation for hydrogen developments; and embedding Gender, Equality, and Social Inclusion (GESI) indicators into employment is seen as crucial.

Key recommendations

1. Nourish and further develop a collaborative environment between Dutch and South African businesses and policy makers
2. Develop and collaborate on policies that stimulate the international hydrogen sector,
3. Remove barriers for investors by offering securities regarding financing and off-take
4. Co-develop education and skills building as soon as possible.
5. Stimulate awareness and inclusion on the ground
6. Integrate adaptive flexibility as part of opportunity design
7. Ensure that positive socio-economic and ecological impact is anchored throughout the value chain

Although some of these actions can be taken by the Dutch government directly, the Green Hydrogen Office can play a leading and facilitating role in all of them, ensuring that both the Dutch and South African perspectives are represented and that interests of all ecosystem partners are represented, and that value chain development is accelerated.

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1. Introduction

This document sets out to explore and align concrete market opportunities recognised by Dutch companies in the development of green hydrogen value chains in South Africa, with needs identified by South African counterparts. The opportunities for engagement identified, in addition to providing mutual benefit through connecting green hydrogen demand and supply, also provide opportunities in contributing to climate mitigation and a Just Energy Transition in South Africa. The aim of this research project, commissioned by the Dutch Embassy in South Africa together with RVO, was to formulate a proposition outlining what goods, knowledge and services participating Dutch companies can offer, to facilitate a sustainable green hydrogen economy in South Africa and create mutual benefits. To this end, the central research question was where South African demands meet Dutch strengths across the green hydrogen value chain, and what Dutch companies and stakeholders can offer in a joint proposition.

Through a series of interviews and document reviews on both the Dutch and South African side, five key 'opportunities' were identified. These opportunities align with key priorities and needs as outlined in the South African Hydrogen Society Roadmap and the Green Hydrogen Commercialisation Strategy Objectives. The opportunities were supported by an assessment of the current enabling environment in South Africa and how the Netherlands could support on a financial, policy, supportive, and educational level. Facilitating such an environment is deemed particularly relevant for materialising these propositions. Furthermore, the opportunities integrate a focus on the Sustainable Development Goals, the Just Transition, and key challenges embedded in the local South African context; including energy poverty and instability, water scarcity, unemployment, and inequality. These considerations are elaborated on in the proposal and embed green hydrogen developments in the broader local context. Integrating this local context from the onset ensures that the Dutch proposition can prioritise not only meeting green hydrogen demand in Europe, but also the needs of every South African in this transition. The analysis concludes with a set of key recommendations formulated to bridge the opportunities, enabling environment, and just transition/sustainable development considerations, with a vision for long-lasting trade relationships between South Africa and the Netherlands.

2. Methodology

The key objective of this proposition was to identify existing synergies between the Netherlands and South Africa that could lead to kickstarting the green hydrogen economy in South Africa and integrate sustainable development. In order to put together the Dutch GH2 proposition the following actions were taken:

In the first phase, interviews were conducted with Dutch stakeholders to determine key opportunities recognised by stakeholders. Input from RVO and the Netherlands Embassy was provided through a joint reflection session. The findings and opportunities identified through this initial round of interviews were plotted against data from conversations with stakeholders with whom Impact Hydrogen had engaged on two earlier visits to South Africa (in November and December 2022). In the second phase, important South African stakeholders were identified and interviewed, to formulate further opportunities and synergies, and to validate findings from the first round.

In the third phase, stakeholders from both countries were matched and mapped in a framework based on their location in the value chain, expertise, stage of green hydrogen realisation, and business potential. In addition to the matching between stakeholders and their technical capabilities, the enabling environment and potential for sustainable development were mapped.

As a fourth step an indication of necessary actions was given to make the proposition a success, including financial arrangements. In the final step, the identified opportunities were verified in additional interviews with both Dutch and South African stakeholders, and with two round table sessions at the World Hydrogen Summit 2023. Through these five steps, which are outlined in more detail below, a foundation was created to successfully realise a Dutch proposition for GH2 in South Africa.

To formulate a mapping of the most promising opportunities, key stakeholders along the entire hydrogen value chain and within the enabling environment were interviewed:

- The green hydrogen value chain consists of stakeholders in green energy production, water processing, production of hydrogen (and or derivatives such as ammonia), storage and transportation, distribution, recycling and waste management, and the end-users in different off-taker markets.
- The stakeholder ecosystem also requires an enabling environment, which includes the knowledge, training and education institutes that are necessary to develop skilled staff for all steps in the value chain, the policy and legal frameworks and stakeholders, the financial frameworks and stakeholders, and representatives of the communities in the region where the hydrogen project is built. While community representatives were not interviewed for this proposal, it is deemed crucial that they be included and represented at all stages of potential projects.

In total, 25 interviews were conducted on the Dutch side, and 13 on the South African side.[3] Each interview lasted between 30-60 minutes and the questions were related to key opportunities and companies' ambitions for the South African green hydrogen economy, as well as the necessary enabling conditions required in terms of policies, bilateral agreements, investments, human capital and knowledge development.

The framework developed provided the initial stakeholder and enabling environment mapping based on results from interviews. The more detailed overview of the enabling framework in Chapter 5 summarises the financial, governmental, educational, and supportive arrangements that need to be in place for the propositions to materialise. From these key insights, the five main opportunities were formulated. The opportunities were tested and validated in an online round table with the Dutch stakeholders, and a roundtable session with South African stakeholders during the World Hydrogen Summit 2023 in Rotterdam.

3. Background analysis of Green Hydrogen market development in the Netherlands and South Africa

The urgency to mitigate climate change, and to ensure energy security in the face of current and future geopolitical tensions linked to energy supply, has necessitated an accelerated shift to cleaner fuels and energy sources. While energy efficiency, electrification, and installation of renewable capacity can achieve close to 70% of necessary emissions mitigation, there remains a need for alternative solutions

[3] The difference is due to the lower response rate on the South African side.

to decarbonize hard-to-abate sectors, including heavy industry and long-haul transport. Green hydrogen, produced from water using electrolysis and renewable energy, is one such solution that could make up 12% of final energy demand globally by 2050 (IRENA, 2022a)

Currently, roughly 99% of hydrogen produced globally is produced from fossil fuel energy sources including coal and natural gas. While fossil fuel reserves are historically concentrated in a small number of countries, the potential for producing green hydrogen using renewables exists globally. Most of the renewable capacity, especially solar, is, however, concentrated in Global South countries, especially sub-Saharan Africa, conveying greater technical potential to produce large volumes of hydrogen at lower cost in these regions (IRENA, 2022b). South Africa, already one of the hydrogen frontrunners on the African continent, is committed to producing green hydrogen both for local use and export to European countries such as the Netherlands. It has already carried out several studies and designated locations for Hydrogen Valleys through the Hydrogen Society Roadmap and has integrated hydrogen into the Just Energy Transition Investment Plan in order to accelerate their transition. Moreover, there is a growing awareness in South Africa regarding the opportunity to increase PGM beneficiation, as global demand for PGM containing components grows.

3.1 The Netherlands and Green Hydrogen

The Netherlands has set ambitious goals for the use of renewable energy, including hydrogen, as part of their commitment to reducing greenhouse gas emissions (Dutch Government, 2020). The country aims to reduce greenhouse gas emissions by 49% by 2030 compared to 1990 levels and become carbon-neutral by 2050. Green hydrogen is seen as a key component in achieving these goals.

The Netherlands is setting up import hubs for clean energy, especially green hydrogen, and is conducting initial discussions with priority producer countries to lay the ground for meeting upcoming European and Dutch energy requirements. With its vast experience in system integration, regional development of green hydrogen valleys, and experience with gaseous molecules, the Netherlands is well placed to play a crucial role in European hydrogen development. There is also an eagerness in Dutch companies and knowledge institutes to develop substantial and long-lasting (trade) relationships and seize investment opportunities, and a willingness to cooperate with other EU-countries, such as Germany, on the H2global project. Finally, the Netherlands can act as a key demand aggregator for not only green hydrogen and its derivates, but also essential value chain technologies such as electrolysers, fuel cells, and solar cells, as well as hydrogen products such as green steel and cement. All of this makes cooperation between South Africa and The Netherlands highly interesting from both an investment, and a climate mitigation standpoint. The sustainability of this relationship rests on ensuring that partnerships between South Africa and the Netherlands stimulate local demand and socio-economic development for South Africa. This is noted among Dutch and South African stakeholders as a critical priority.

In terms of existing capabilities, the Netherlands has a number of hydrogen refuelling stations for fuel cell vehicles and a number of pilot projects that are using hydrogen as an energy carrier (Holland Renewable Energy Technologies, 2021). The country is also home to several research institutes and companies that are developing hydrogen-related technologies. Moreover, 13% of energy use in Europe comes in via the Port of Rotterdam. As the largest and most innovative port of Europe, the Port of Rotterdam will be a key player in establishing the green hydrogen corridor between South Africa and the North-western Europe. Their plans and preparations towards becoming a green hydrogen import terminal are far advanced, and the Port has signed an MoA with the Northern Cape

to act as an aggregator of demand for green hydrogen from the Northern Cape in South Africa (Global Africa Network, 2022).

One of the key success factors of the development of the green hydrogen economy in the Netherlands so far has been the integrated approach taken by the Provincial and Municipal governments, as a kick-starter and supporter of public-private hydrogen projects. Through active stakeholder management and inventive financial and regulatory systems, the Netherlands has created an environment where innovation can flourish, and SMEs are supported. This supportive and forward-looking environment creates ideal grounds for the design and development of a regionally embedded hydrogen ecosystem focused on green hydrogen. This approach proved to align well with the Hydrogen Valley model, as defined by the European Union.

Another competitive advantage of the Netherlands is their previous experience with a national gas grid. The Netherlands holds one of the largest onshore natural gas fields in Europe: the Groningen field. For over 60 years the region has developed infrastructure to disseminate the gas within the country and abroad. The entire country provided gas pipelines to industry and households, and, as a consequence, the Netherlands has developed a strong foundation of knowledge relevant to green hydrogen. Many companies have developed expertise in handling and using gas molecules, requiring full system integration to produce, store, transport and use these gas molecules. Nowadays the natura gas extraction has almost stopped because of earthquakes due to the natural gas mining. The expertise of molecules was used to create a new perspective for the region and the region is home of the first Hydrogen Valley of the world.

3.2 South Africa and Green Hydrogen

In South Africa, hydrogen has been identified as a national priority, and one of the priority sectors in the Just Energy Transition Investment Plan for 2023-2027 (The Presidency of the Republic of South Africa, 2022). While the country's focus on hydrogen extends back to the establishment of the Hydrogen South Africa (HySA) strategy in 2007, the focus was further solidified through publishing the South African Hydrogen Society Roadmap (HSRM) in 2021 (Department of Science and Innovation, 2021). As a country highly dependent on coal, comprising 75% of the primary energy mix, green hydrogen is seen as critical to decarbonise hard-to-abate sectors in the country and contribute towards mitigating both climate change, and current stress on the electricity grid. Declining grid stability in the country has resulted in years of intensified loadshedding - scheduled blackouts. This has significantly impacted local livelihoods and economic growth in recent times. These challenges are therefore noted in South Africa's National Development Plan among key drivers to accelerate the integration of low-carbon energy sources.

Currently, roughly 2% of global hydrogen production comes from South Africa, the majority of which is produced by Sasol (Department of Science and Innovation, 2021). By 2050, scenarios indicate the potential for 6-20Mt of demand for local green hydrogen per annum (The Presidency of the Republic of South Africa, 2022). In terms of future positioning in the green hydrogen economy, a number of advantages and opportunities have been identified in South Africa. In terms of resources, the country is endowed with abundant solar and wind resources, large scale availability of land, and is the global leader in PGM output; including the platinum and iridium necessary for fuel cells and electrolysers. Furthermore, the patented Fischer-Tropsch process owned by Sasol endows the country with skills and technical expertise of value in the production of liquid fuels such as aviation fuel. At a global level,

the existing port infrastructure in South Africa and trade partnerships with other countries set a foundation for the further development of strategic trade partnerships for green hydrogen (Department of Science and Innovation, 2021).

To kickstart the hydrogen economy in South Africa four catalytic projects were identified by the government through engagements with stakeholders in the private sector. These include the Platinum Valley Initiative (South African Hydrogen Valley), the CoalCO2-X Project, Boegoebaai Special Economic Zone (SEZ), and the Sustainable Aviation Fuels (SAF) project. Through their implementation, the flagship projects are expected to produce approximately 500kt of hydrogen and create at least 20 000 jobs annually by 2030, and a Gross Domestic Product (GDP) contribution of at least USD5 billion to the economy by 2050. The projects are expected to contribute to the growth of sustainable green industries that are resource and energy efficient, low-carbon and low-waste, non-polluting, and safe. Following on from this, nine projects were selected among a total of nineteen for priority status (Omarjee, 2022). Under the lead of Sasol, the private sector is expected to co-fund and lead the execution of large-scale deployment projects to demonstrate commercial viability (Department of Science and Innovation, 2021).

In terms of a local hydrogen economy, hydrogen can contribute to the decarbonisation of heavy industry, the grid through storing renewable energy for backup power generation, and possibly through micro-grids. The potential exists to manufacture key hydrogen equipment, such as hydrogen fuel cells and electrolysers in the country, adding local value through the manufacturing industry. Hydrogen fuel cells utilising both pure hydrogen and methanol have been deployed in a number of pilots and small-scale stationary applications in the country, including as backup generators for schools, hospitals and cell phone base stations. While too costly to deploy at large scale, such projects highlight the use of hydrogen to address key sectors and community services, as well as the local knowledge and skillset (Department of Science and Innovation, 2021). Additionally, green steel production using green hydrogen presents an interesting opportunity to capture value in South Africa, with Sasol and ArcelorMittal having signed an agreement to undertake a feasibility study towards this. Furthermore, hydrogen has significant potential in the automotive industry, especially for long haul transport and later, shipping and aviation fuel. In terms of the global hydrogen economy, South Africa could produce hydrogen at a price of $1.60 per kg by 2030 due to the abundance of renewables, making it a cost-competitive exporter of green hydrogen[4].

Beyond significant economic benefits, the potential to advance sustainable industrial growth, and the potential to create thousands of green jobs, green hydrogen is recognised in the HSRM as having the potential to catalyse enhanced equality and empowerment within the country. However, while significant potential exists towards these ends, both through local production of green hydrogen and export, there is a recognised need for a clear regulatory environment, investment, a skilled workforce, and scaled collaboration. Attracting investment and partnerships which contribute towards these needs, while ensuring all collaboration aligns with just transition processes and outcomes, will prove critical in shaping the future potential green hydrogen in South Africa (Department of Science and Innovation, 2021).

At the time of writing (May 2023), several green hydrogen projects are being developed, including a new facility by Sasol at Boegoebaai in the Northern Cape, the Prieska Power Reserve in the Free State,

[4] South Africa | Green Hydrogen Organisation (gh2.org)

and the Hydrogen Valley initiative in Limpopo, Gauteng and KwaZulu-Natal[5]. These initiatives are also referred to as the Platinum Valley.[6]

3.3 The Basis for Cooperation

The Netherlands has a long history of cooperation with South Africa, which has progressed from support during the anti-apartheid struggle and traditional development cooperation, to a partnership built on mutually beneficial economic cooperation, trade, and shared responsibility. This trade relationship materialised into the Netherlands importing €2,262 million worth of goods from South Africa, and South Africa importing €1,753 million worth of goods from the Netherlands (CBS, 2021). Furthermore, due to the long history the Netherlands and South Africa share, the country has been one of the most popular destinations in Africa for Dutch companies to start their business in. To facilitate this fruitful trade relationship between the Netherlands and South Africa, various Memoranda of Understanding (MoUs) have been signed and a Joint Commission for Cooperation has been established. These existing agreements can be leveraged towards cooperation between the two countries toward the development of a hydrogen economy.

The Joint Commission for Cooperation established between the Dutch Ministry of Foreign Affairs and the South African Dept. of International Relations and Cooperation emphasises that bilateral trade and investments be stimulated to higher levels, including organizing trade and investment missions, frequent and structural dialogues, and enhancement of private sector development. Specifically, the Ministers agreed that green hydrogen is to play an important role in lowering the joint greenhouse gases contributing to climate change. The parties agreed to jointly explore concrete opportunities for mutual benefit in areas such as port development, safe transport of energy carriers, and technology developments for the production of green hydrogen. In addition, parties agreed to discuss and promote investments dedicated to sustainable energy, to exchange views on regulations, and to collaborate on training and education (DIRCO, 2020).

Furthermore, there exists a Memorandum of Understanding (MoU) between the Government of South Africa and the Government of the Netherlands to promote cooperative activities in science and technology for peaceful purposes based on mutual benefit and equality. The coordination authorities responsible for implementing the MoU are the Department of Science and Innovation in South Africa and the Ministry of Education, Culture, and Science in the Netherlands. Forms of cooperation may include meetings, exchange of information, exchange of researchers or technical personnel, and other mutually decided activities. Implementing arrangements with specific details and procedures for cooperative activities may be made between the Signatories, government agencies, research institutes, or any other parties working in the field of science and technology, while complying with respective domestic laws. Joint meetings will be held for effective implementation of the MoU.

On a European level, the Netherlands is supporting South Africa with their decarbonisation strategy in the Just Energy Transition Investment Plan (JET-IP). Together with the EU, US, Germany, UK, and France, an initial 8.5 billion USD is mobilized over three- to five years, to support South Africa's just energy transition. Within the developed investment plan, green hydrogen has been outlined as one of the prioritised portfolios (The Presidency of the Republic of South Africa, 2022).

[5] 'Hydrogen Valley' in South Africa could be a billion light in the growing dark (businesstech.co.za)
[6] Science and Innovation on South Africa's Platinum Valley project | South African Government (www.gov.za)

Finally, the Embassy of the Netherlands in South Africa has developed a combi-track on green hydrogen. This combi-track is meant to promote mutual benefits in green hydrogen cooperation, which means that the import of green hydrogen is met with sustainable development in return. The combi-track GH2 South Africa aims to position the Netherlands as a transition partner on both trade and investments, and jobs and skills, to work towards a green and inclusive green hydrogen sector.

4. The Dutch proposition

The Netherlands aims to become a key trade partner with South Africa for green hydrogen. In the long term, the Netherlands envisages to develop a green hydrogen corridor between the South African ports and those in the Netherlands, to facilitate large-scale export to Europe and to contribute to energy security. For South Africa it is important to develop green hydrogen projects that contribute to the export market as well as the development of local economies and regional prosperity and lead to international investment and funds to accelerate the transition.

Currently, green hydrogen and its derivatives are not yet cost-competitive with fossil fuel-based energy. While the costs of fossil fuels will increase rapidly over the next decade, due to the ambitious and necessary CO2 emission reduction targets and the 'social costs of carbon', scientists estimate that green hydrogen production costs can be more than halved in the coming decade, driven by enhanced economies of scale and innovations. However, with this "technical learning curve," an investment in today's technology could soon become uncompetitive, making investors weary. Likewise, this uncertainty over long-term production costs will make off-takers cautious about making long-term contractual commitments on price.

Hence, it is of great importance to mitigate the risks for green hydrogen projects, in order to facilitate collaboration, cooperation, trade and the growth of hydrogen based ecosystems between South Africa and The Netherlands. The opportunities identified in this proposition are related to this risk-mitigation. Based on the data obtained through research and interviews, the following risk mitigation strategies were identified. These recommendations are directed at the government of the Netherlands. However, the concrete development and implementation of these could be executed through the Green hydrogen Office.

1. Developing a long-term yet flexible vision; both countries have formulated hydrogen strategies, which need to be aligned with each other in order to create a joint vision for mutually beneficial engagement and cooperation; yet they have to stay flexible enough to allow for disruptive technologies.
2. Stepwise development of multiple small-scale projects with various production routes and derivates; The rate of technical innovation is phenomenal, which favours many little steps and investments, each benefitting from the lessons learned. Starting small and scaling it up is therefore considered much better than starting large and locking in capital into today's technologies, which are not fully developed yet. Various routes can be explored for both production (electrolysis versus biomass) and use (pure form, ammonia, bio methanol, solids)
3. Alignment between stakeholders in the upcoming hydrogen innovation system; cooperation between all relevant stakeholders is crucial in the beginning phases of a technical innovation system. The enabling environment should be aligned with innovative agents, and user-producer relationships are crucial.

4. Ensure relevance to local development challenges; in the end, hydrogen should be an enabler of local development. Without relevance to the local economy, there will be no social license to operate.
5. Closing the investment gap; the green premium for green hydrogen produced with current technologies needs to be bridged.

The opportunities described below are enabling and integrating these strategies. Hence, they facilitate future hydrogen relationships between South African and the Netherlands. Alongside each opportunity, potential Dutch and South African partners are proposed, as well as next steps to realise them. Where South African partners are proposed, these are based on direct engagement with the stakeholder, or on recommendations of relevant parties from the stakeholders engaged. These partners are not exhaustive, and detailed stakeholder mapping and engagement should be performed to engage all relevant partners.

4.1. The main opportunities

The Netherlands and South Africa are interested in collaborating on the development of green hydrogen, but there are concerns due to the ambitious goals and short time frames. To address this, the Netherlands proposes setting up a *Green Hydrogen Office* that will facilitate the development and alignment of national hydrogen initiatives, develop risk mitigation routes, and advance cooperation between the two countries and where opportunities arise, also other EU countries. This includes advancing and facilitating collaboration on the value chain in South Africa, as well as the export route to the Netherlands and Europe. Another key role of the Green Hydrogen office is to ensure that green hydrogen projects contribute to socio-economic impact around the value chains, and to create awareness and engagement with the surrounding communities, herewith contributing to public and (local) political support and a social licence to operate.

Furthermore, the office will manage all ecosystem stakeholders: the businesses in the value chain, as well as the stakeholders in the enabling environment, such as policy makers, investors, and training-education- and knowledge institutes. As such, the office will play both a strategic and a brokering role between South Africa and the Netherlands.

The office will be managed by a project team, and accountable to a steering committee consisting of representatives of the ecosystem partners in South Africa, as well as the Netherlands. The office will expand to branch offices located in the different subregions (e.g. Western Cape, Northern Cape, Eastern Cape) where hydrogen initiatives are being developed, to ensure representation of all stakeholder interests and alignment between the regions. Key objectives of the office include facilitating trade relations and exports, developing a national green hydrogen economy, creating an enabling environment, anchoring a Just Energy Transition, promoting knowledge and innovation, and focusing on education, skills development, and human capital strategies that benefit both the Dutch and South African partners. The office aims to identify and remove barriers and accelerate projects through a country-wide strategy that addresses the energy-water-food nexus and ensures public support.

4.1.1 Opportunity 1: Set up a Green Hydrogen Office

There is a clear interest from Dutch stakeholders to collaborate with South African business partners, and vice versa, on the acceleration of Green Hydrogen development in South Africa. At the same time, there is also a clear voice about the concerns. On one hand, the ambitions are high, and the envisaged time frames very short. A whole new economy needs to be developed and this requires significant

coordination between a wide variety of stakeholders, on the level of value chain design, ecosystem development (policy frameworks, investments, knowledge and innovation, skills building) and ensuring a just energy transition that benefits the people in and around the green hydrogen ecosystem. Moreover, there are many different green hydrogen initiatives that will benefit from coordination and collaboration between parties, to ensure efficient system integration and optimisation.

To facilitate the development of national hydrogen initiatives and to advance the cooperation between the Netherlands and South Africa, the Netherlands proposes to open a Green Hydrogen Office. The role of this office will be to facilitate the advancement of green hydrogen projects through identifying and removing or reducing barriers, develop risk mitigation routes, and accelerating projects through a country wide strategy. The office will expand to branch offices located in the different subregions (e.g. Western Cape, Northern Cape, Eastern Cape) where hydrogen initiatives are being developed, to ensure representation of all stakeholder interests and alignment between the regions. Key elements would be:

Trade relations and export

Facilitating collaboration between South African and Dutch business partners; identifying strategic business and project development opportunities; facilitating the development of a hydrogen corridor between South Africa and the Netherlands - and the Northwest European hinterland.

Governance

The office, with its different regional branches but operating as a single entity, will be managed by a project team and accountable to a steering committee, to harmonise initiatives and balance the different interests of regions. This steering committee should represent Dutch stakeholders, South African stakeholders from all relevant regions, and stakeholders from entire ecosystem, including the enabling environment - such as knowledge institutes and civil society representatives - to safeguard the local socio-economic impact goals of projects, as well as the Dutch strategic objectives. Representation from other EU countries should also be explored. The Netherlands proposes to assess what would be the best locations for regional branches operating under this committee, to facilitate presence in regions where projects are being planned and developed. This is important to ensure representation, consultation, alignment of regional priorities with national and bilateral approaches, and to ensure that the focus areas and developments enabled by the hydrogen office are regionally relevant.

National green hydrogen economy

Facilitating the development of green hydrogen projects for the domestic market that contribute to the South African green hydrogen strategy; identifying existing and potential local off-taker markets; Facilitating regional collaboration between hydrogen development projects in e.g. Saldanha Bay and Boegoebaai (the Western SADC green hydrogen corridor), Platinum Valley Initiative (PVI), and other (planned) green hydrogen hubs to develop a regional masterplan and integrated infrastructure.

Special attention would be given to (1) infrastructural development between the projects, off-takers and export routes (e.g. pipelines or trucking routes); (2) exploring options for localisation and enhanced local value creation – for example by developing industries that develop half or full products from raw materials (e.g., locally manufacturing green steel, hydrogen fuel cells or electrolysers); (3) acceleration of the incubation environment for new South African hydrogen businesses.

Creating an enabling environment

Facilitating the development of policy frameworks and legislative frameworks to increase ensured off-take; facilitate coordination and alignment between policies at all levels; including EU – SA, NL – SA, national, and sub-national level; addressing public-private collaboration and roles; facilitate the development of de-risking strategies for investments; matchmaking between South African stakeholders and European financiers; addressing financial challenges such as the high cost of capital.

Anchoring a Just Energy Transition

Identifying the key needs and opportunities based on the Sustainable Development Goals (SDGs); developing a framework for the Just Energy Transition; setting standards for monitoring and reporting on socio-economic and ecological impact parameters; active involvement of local communities; public communication and awareness campaigns to ensure public support. This function would give special attention to issues around the energy-water-food nexus, with potential demonstration projects showing how local energy, water, and food resilience can be integrated with green hydrogen production; the involvement of local companies (SMEs) where possible; and the participation of women and youth. The office could be linked to the envisaged establishment of the Just Energy Transition Centre as proposed in the Hydrogen Society Roadmap (HSRM).

Knowledge and innovation

Housing a Centre of Excellence; Research, Development and Innovation exchange between South African and Dutch institutions (universities and applied science, research centres, as well as companies working on innovation); accelerating feasibility studies; facilitating and promoting organic collaboration through events such as summits.

Education, skills development and Human Capital strategy

Engaging education institutes to prepare the labour market (skills readiness) for the new green hydrogen economy; strategies to ensure sufficient supply of, and access to, education content and skills building; development and exchange of (online) content and methods; contribution to labour market development strategies; special attention for re-skilling marginalised groups.

Next steps:

To realise this, the Dutch government should take the following steps:

1. Allocate an initial development budget in phases. In the first phase (6-9 months), a small grant should be provided by the Dutch government (possibly through Invest International/ Climate Fund Managers) and ideally also with some financial commitment from the South African government, for the initial design and set up of the office and to bring together a consortium of stakeholders in the value chain. In the next phase (6-12 months) a consortium of first movers in the green hydrogen value chain should jointly fund the development of a professional Green Hydrogen Office, with co-funding from both governments and/or Development Financing Institutes. In the next phases, the office and its branches should be expanded on par with the developments of the hydrogen sector;
2. Assign a neutral entity (meaning, with no direct stakes in the hydrogen value chain) that can represent both NL and SA interests (e.g. a collaboration between one Dutch and one South African party), to lead the development of the Green Hydrogen Office. It should be noted that local ownership and support is a prerequisite;
3. Together with key stakeholders, including both the South African government and private parties, investigate what would be the most preferable location(s) for the office, as stakeholder opinions regarding the best location differ greatly;
4. Develop generic Terms of Reference for the office;

5. Identify additional South African partners (ecosystem stakeholders);
6. Co-create demand-driven concept of the office with both South African and Dutch partners;
7. Develop (co-)funding proposal for GH2 consortia and DFIs.

Suggested lead partner:

- Newly to be developed entity: There is not one company who could do this based on their direct experience. This new entity should be a project organisation consisting of the various stakeholders in the value chain and ecosystem. Key to the success is that this should be a collaboration between companies, governments and educational institutions.
- Impact Hydrogen has developed models for this (based on the first European Hydrogen Valley in the Netherlands) and as such, could be lead partner – together with technical expert partners such as TNO or ISPT.

Potential Dutch partners with relevant expertise:

- Embassy of The Netherlands in South Africa
- RVO
- TNO
- ISPT
- Gasunie
- Vopak
- TU Delft
- Port of Rotterdam
- Centre Expertise Water Technology (CEW)

Potential South African partners:

- Freeport Saldanha
- Mahlako
- Sealzed (and Devac Investment Platforms)
- Navitas Holdings
- Stellenbosch University
- Wesgro
- OneWorld Sustainable Investments
- Northern Cape Economic Development Agency
- Western Cape

4.1.2 Opportunity 2: Industrial and Port development

The Netherlands could play a vital role in supporting South Africa with the industrial development of hydrogen projects. The Port of Rotterdam is already a key European hub for the import and export of energy products, including LNG and crude oil. The port aims to become a hub for the import and export of hydrogen as well. The Netherlands can facilitate demand aggregation for South African hydrogen at the Port of Rotterdam and Groningen Seaports by working with Dutch companies to create a hydrogen ecosystem that promotes the use of hydrogen in various industries.

Collaboration on financing

Developing green hydrogen on an industrial and export scale is very capital intensive and

investments in this (largely) new industry are perceived high risk. Consequently, stakeholders express their concern that the Dutch and South African ambitions in terms of scale and timelines are not realistic, unless governments take strong measures.

The Netherlands is working together with Germany and the EU on financing solutions such as H2Global and the European Hydrogen Bank. These institutions would facilitate trade between South African producers and off-takers in the Netherlands and its hinterland. By bridging the investment gaps for hydrogen projects, these institutions would help to mitigate the risks associated with developing a new industry. This would encourage investment in the development of hydrogen infrastructure in South Africa and promote the growth of the hydrogen market in the Netherlands.

The Joint Commission for Cooperation (JCC) established between the Dutch Ministry of Foreign Affairs and the South African Department of International Relations and Cooperation could be leveraged for this purpose. The parties agreed to jointly explore concrete opportunities for mutual benefit in areas such as port development, safe transport of energy carriers, and technology developments for the production of green hydrogen. In addition, parties agreed to discuss and promote investments dedicated to sustainable energy, to exchange views on regulations, and to collaborate on training and education (DIRCO, 2020).

Collaboration on infrastructural development

In terms of infrastructure development, the Port of Rotterdam has the potential to support the development of ports such as the one planned in Boegoebaai, by offering its expertise as a knowledge provider, matchmaker, and support hub for port master planning. Additionally, the Port of Rotterdam could potentially invest in the development and operations of the port or hydrogen hub. The Port of Rotterdam is one of the few ports in the world that offers international consultancy services, and it has extensive experience in developing green hydrogen plans for its own port area. By collaborating with Boegoebaai and potentially other ports, cooperation between South Africa, the Netherlands, and the European hinterland could also be strengthened. Alongside Port of Rotterdam, Vopak can be of key assistance in the development of storage solutions for hydrogen, ammonia, and potentially methanol.

Other seaports of the Netherlands can also play a role, as more ports in South Africa could play a role in the future green hydrogen corridor either connecting initiatives on the west coast or the east coast.

In line with infrastructure development, there is significant opportunity for public and private sector collaboration, and investment in network infrastructure such as road, rail, grid infrastructure and pipelines among others. The development of this infrastructure would assist in creating an enabling environment for energy, transport and export. Furthermore, it is relevant to leverage existing relations between the Western and Northern Cape, and to leverage existing infrastructure to enable accelerated development and market entry.

Next steps:

1. Facilitate warm trade relationships between Dutch off-takers and South African producers by means of trade missions;
2. Leverage the JCC to align national hydrogen strategies;
3. Cluster and align Dutch demand and South African supply by enabling parties.

Suggested lead partner:

- Port of Rotterdam
- Alternatively, or together with Vopak

Potential Dutch partners with relevant expertise:

- Ministry of Economic Affairs and Climate
- Ministry of Foreign Affairs
- Embassy of The Netherlands in South Africa
- RVO

Potential South African partners:

- Sasol
- South African Dept. of International Relations and Cooperation
- Wesgro or Freeport
- Mahlako
- Northern Cape Economic Development Agency

4.1.4. Opportunity 3: Hydrogen filling station pilot for long-haul trucking

Long-haul trucking is a vital component of the logistics industry in Southern Africa, and as the region moves towards a low-carbon future, an alternative green fuel is needed for long-haul trucks. In and between South Africa and Namibia, the trucking routes are limited to a number of long corridors that are extensively used. Due to the high cost of hydrogen transportation, especially in large countries like South Africa, decentralised production is necessary for transportation routes.

Decentralised hydrogen production for filling stations can provide a key opportunity for community development. This could involve the establishment of small-scale hydrogen production facilities, where excess green electricity beyond that needed to supply surrounding local communities is used for green hydrogen production. These facilities could be owned and operated by local communities, providing a source of income and promoting energy independence.

Hydrogen for greening the transport sector could also open up other opportunities, for example expansion to greening public transport and municipal collection vehicles. This can contribute to improved air quality and improved health in urban areas, social licence through public visibility and demonstration of safety, and improving the public transport sector overall through investments. Here it is important to work closely with, and identify roles for, local authorities and city planning; to ensure alignment and uptake.

Compared to the time scale necessary to realise large scale hydrogen projects, such a project can be realised in a shorter timeframe and provides immediate visibility for a hydrogen project. This is relevant to gaining public support, as well as providing opportunities for communities and SMEs through a decentralised production environment. A pilot study is therefore proposed, preferably in an area where the feasibility of fuelling long haul trucking and local public transportation/ municipal vehicles could be assessed an optimised.

Beyond decentralised hydrogen production using electrolysis, another option to produce decentralised hydrogen for transport is the production route of (biomass) waste to hydrogen. The Netherlands is home to multiple companies that have expertise on the use of (biomass) waste to produce hydrogen and bio methanol. It is proposed to include this option in feasibility studies.

Next steps:

1. Work with RRS Trade & Investment as lead partner, to identify and mobilise relevant Dutch and South African stakeholders in the value chain and ecosystem;

2. Project design and coordination by the Green Hydrogen Office: to develop timelines, roadmap, business case;
3. Devise a bankable proposal to apply for funding at Invest International or Climate Fund Managers
4. Feasibility study comparing opportunities of hydrogen trucking, public transport and municipal vehicles from decentralised electrolysis and biomass by both business case and (potential) social impact
5. Develop pilot project with a single filling station
6. Roll-out of filling stations with hydrogen trucks along one corridor and/or hydrogen buses and municipal vehicles in one municipality
7. Local factory and extension to all relevant corridors in South Africa and between neighbouring countries

Suggested lead partner:

- RRS Trade & Investment

This South African company is committed to champion the exploration of this opportunity and engage Dutch and South African consortium partners around a feasibility study and possibly a pilot project.

Potential Dutch partners with relevant expertise:

- Nettenergy
- HyGear
- Obbotec
- BAM
- VDL

Potential South African partners:

- RRS Trade & Investment
- Saldanha Bay (are already looking at this)
- Bambili Group
- Anglo American
- Mahlako

4.1.5 Opportunity 4: electrolysers and fuel cell equipment development

South Africa is the world's leading producer of PGM metals which contribute significantly to the economy (ZAR187.6 billion or EUR 9.4 billion in 2019). In the light of the urgent need to address significant unemployment in the country, aggravated by the phasing out of coal and reduced export demand, an important opportunity for South Africa could be to capitalise on the increased demand for hydrogen applications that require PGM metals. With its abundance in PGM metals and developed knowledge economy, South Africa has made PGM beneficiation a priority in the hydrogen strategy and as such, is well-positioned to develop an electrolyser or fuel cell factory. In addition to job creation, local value addition is a very promising way for the South Africa to strengthen its economy. Other benefits would be a more competitive green hydrogen production, and potential export of these technologies to countries which are not endowed with the raw materials to produce them locally. The development of such an industry in South Africa could be undertaken in collaboration with, for instance, Wesgro, Greencape, IDC and DBSA.

The high ambitions of The Netherlands to ramp up production of green hydrogen locally will create a need for a reliable and stable supply of fuel cells and electrolysers. As these are expected to become scarce in the coming decade, it will be beneficial for Dutch companies to have a trade agreement with South African manufacturers. Although the Netherlands has the knowledge to develop the equipment, it doesn't have the capacity to scale it up. To this end, Dutch companies should collaborate with South African companies to jointly identify opportunities for fuel cell or electrolyser manufacturing in South Africa. The Green Hydrogen Office will facilitate this collaboration. Moreover, it will coordinate the contribution of the international ports of the Netherland to the import of green hydrogen equipment.

By leveraging the Memorandum of Agreement (MoA) between the Northern Cape and the Port of Rotterdam (POR), where the POR signed to act as a demand aggregator for green hydrogen into Europe, the Netherlands can initiate an analysis of the European demand for electrolysers and fuel cells, with the intent of securing long-term off-take agreements for South African manufacturers. Such agreements are crucial in the current market in South Africa, where local financing for feasibility studies and early project demonstration is challenging. Alongside this study, the Netherlands should support a broad techno-economic study of the possibilities around electrolyser and fuel cell production in South Africa.

The future electrolyser market will be high tech, very competitive and global. It should be investigated whether South Africa has the technical means to develop the high tech and complex electrolyser from scratch, or opt for local assembly, leveraging their expertise on the automotive industry. Another option would be the local production of membrane units, the core of an electrolyser, which will probably be targeted at niche applications. This development would build upon the expertise in PGM processing in South Africa. Various South African companies are already active in this field but could certainly benefit from more support in the development of their membrane cells. Here a combination could possibly be made with Dutch suppliers of high-tech manufacturing equipment working on the development of specific processes for the production of more high-tech membranes.

This could be an interesting win-win. The Netherlands could support further development of membrane technology in South Africa through building a partnership between high tech manufacturing equipment developers from The Netherlands and membrane cell manufacturers in SA. This option would require substantial investments and efforts but is worth to be explored. TNO, the leading Dutch research institute on electrolysers, would be interested to further explore such an initiative together with private sector parties in the Netherlands and South Africa. They could further develop the business case, find the right partners and also assist with technology development and testing.

Next steps:

1. Confirm need and viability of study on top level
2. Establish clear parameters of the technologies included in the study
3. Secure funding at RVO CERF or Invest International

Suggested lead partner

- HyCC
- (Alternatively, or with) TNO

Potential Dutch partners:

- TNO
- HyCC

Potential South African partners:

- CSIR
- HySA Catalysis/ HyPlat
- Mitochondria
- Bambili Group

4.1.6 Opportunity 5: Feasibility study for a desalination plant

South Africa is a water scarce country, and it is therefore critical to ensure that the demand for water for green hydrogen production should not further increase pressure on an already vulnerable water system. To prevent this from happening, desalination will be of key importance. In South Africa, the opportunity for desalination to supply water for hydrogen production is significant in coastal development projects like Boegoebaai and Saldana Bay. Furthermore, there exists potential for such desalination projects to have socio-economic benefit for communities in the surrounding area, contributing to drinking water supply and agriculture. While there is interest in such projects in South Africa, accessing local funding for hydrogen-specific feasibility studies is challenging. A partnership between the Netherlands and South Africa towards such a feasibility study could prove mutually beneficial, further enabling desalination for green hydrogen production for export, contributing to empowering the local community, and demonstrating local benefits from green hydrogen production.

Currently, desalination is expensive due to high energy consumption and infrastructure costs, but costs can be reduced in the future. To make it more affordable in the future, the Netherlands and South Africa could cooperate on improve energy efficiency through implementing energy-efficient technologies like the Advanced Electro Deionization (EDI) technology, in which Dutch company Pure Water Group has expertise, and through the use renewable energy sources like solar and wind power (of which costs will be declining). Additionally, increasing the scale and efficiency of desalination plants through improved plant design and operation and maintenance practices can help reduce the cost per unit of water produced. Since both countries have experience in designing, operating, and maintaining desalination plants, such a project offers the opportunity to explore co-learning to further develop the technology, optimise for the hydrogen industry, and to extend this to drive community benefit through the food-water-energy nexus.

When designed for systemic sustainability, desalination presents a key opportunity to address the food-water-energy nexus. Innovative Dutch institutes such as the Center of Expertise Water Technology (CEW) have designed solutions to reroute desalinated water to communities, to then utilise the wastewater for the production of bioproducts, like green fertiliser, and ultra-pure water for electrolysis. Key to such a project are CEW and other organisations in this space, who already have collaborative experience and networks within South Africa. In combination with the Dutch expertise in agri-voltaics, agriculture and horticulture, such a solution could have a large impact on addressing the food-water-energy nexus issues in South Africa. Freeport Saldanha is already in discussion with Saldanha Bay Municipality (SBM) to see whether the SBM and Freeport Saldanha (representing industrial Green Hydrogen interests) can work collaboratively on a desalination plant as the SBM holds an existing EA for desalination. There is a salt production facility around Saldanha where the by-product of brine can be sold.

The experience of GIZ in working on projects including the natural environment, energy, and water, could make them a valuable partner in a project such as this. Furthermore, such a project would benefit from close collaboration with local stakeholders including NGOs, farmers and communities. Through enabling local participation across all scales from the feasibility study to the final project implementation, and ensuring the projects are locally implemented and co-owed, water desalination projects could contribute to addressing inequality and poverty. In rural communities, basic needs such as water, food, and energy access remain a challenge. Sustainable water desalination projects for hydrogen could address all three areas.

Next steps:

1. Establish contact between CEW, Pure Water Group and Freeport Saldanha
2. Confirm broad viability of the proposal and identify location
3. Identify additional South African partners and establish consortium
4. Apply for feasibility study at Invest International or Climate Fund Managers

Suggested lead partner

- CEW
- (Alternatively) Pure Water Group

Potential Dutch partners:

- CEW
- Pure Water Group

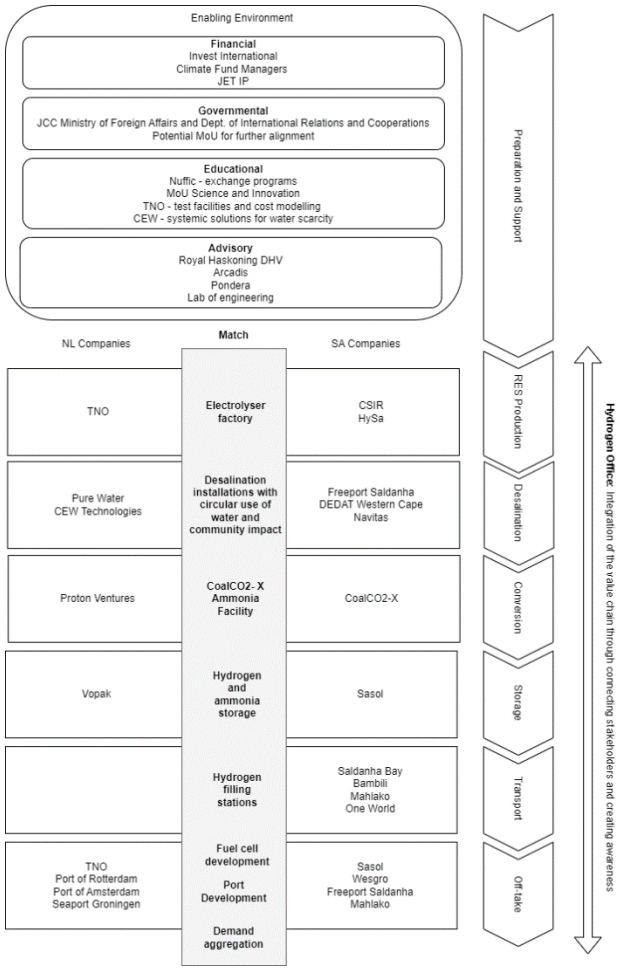
Potential South African partners:

- Freeport Saldanha
- DEDAT Western Cape
- Navitas Holdings
- NGOs, farmers, communities

4.2 Matchmaking Framework

Based on the initial identified opportunities for cooperation between the Netherlands and South Africa, a matchmaking framework was developed (Figure 1). Here Dutch and South African companies are aligned along the entire hydrogen value chain and the five key propositions, outlining opportunities for collaboration to realize these opportunities. Mapping the opportunities along the entire value chain showcases that the proposition offers a complete solution. The value chain is then further embedded into an enabling environment of financial, educational, governmental, and supportive institutions, further discussed in the next chapter.

Figure 1: Framework- aligned opportunities for collaboration between the Netherlands and SA



5. The enabling environment

5.1 Government

On a bilateral basis, the Netherlands and South Africa could develop policies and incentives on both sides that stimulate and facilitate export & import. Of key importance, as will be explained in more detail in the financial part, is the de-risking of investments. The Netherlands aims to explore together with South Africa how barriers for commercial investors and DFI's (WB, AfDB, EIB, etc.) can be lowered or removed. Another pillar for governmental cooperation rests on collaboration on knowledge exchange and skills building (through collaboration of institutes). Finally, both governments could collaborate on infrastructural development, especially port development, but also relating to roads and pipelines. Finally, the revival of the double tax treaty could be explored.

The double tax treaty between the Netherlands and South Africa is a bilateral agreement aimed at avoiding double taxation of income earned by individuals and businesses in both countries. The treaty was signed on 26 November 1996 and came into force on 21 December 1998. Under the treaty, residents of either country who earn income in the other country are entitled to certain tax benefits and protections (Government of the Republic of South Africa & Government of the Kingdom of the Netherlands, 1996). This includes the right to claim a tax credit for taxes paid in the other country, as

well as exemptions or reduced rates on certain types of income, such as dividends, interest, and royalties.

5.2 Finance

South Africa has the potential to produce green hydrogen at relative low cost thanks to its abundant sunshine, steady coastal winds, seawater, and ample space. However, producing hydrogen is capital intensive, and the cost of capital is critical for the final cost of hydrogen. The cost of servicing debt and equity can be up to 75% of total cash outgoing for large-scale export-oriented green hydrogen projects, according to the Oxford Institute for Energy Studies. This means that financing costs are a crucial consideration for investors, and countries with higher perceived commercial, technical, and political risks will have higher costs of capital, making it more challenging to attract investment.
The higher the risk profile, the more equity investors will require, and equity requires a higher return than interest on (secured) debt. Additionally, interest is mostly tax-deductible, making debt the cheaper form of leveraged financing for long-term projects. In emerging and developing countries, the weighted average cost of capital (WACC) can be much higher than in developed economies. Hence, the finance and investment framework needs to go hand in hand with risk mitigation management. A few actions need to be implemented before a hydrogen economy can be built, including:

1. Securing a purchase guarantee from one or more off-takers to signal the need for green hydrogen and encourage companies to change their business models.
2. Improving the risk profile to lower interest costs and the costs of capital. For example, by co-financing by DFIs to demonstrate trust, through fiscal policies, through anti-corruption policies and enforcement, and more generally, through the Hydrogen Valley approach, as this mitigates risk by coordinating the value chain in all stages (which can be overseen by the Green Hydrogen Office).
3. Setting up structured procurement mechanisms such as carbon contracts for differences auctions to provide a stable income for hard-to-abate industries committed to using green hydrogen.
4. Embedding financing throughout the value chain, including towards end-users.

5.2.1 Securing a purchase guarantee from one or more off-takers to signal the need for green hydrogen and encourage companies to change their business models.

Government intervention is required in the early stages of developing a global green hydrogen trade, given the lack of precedents (especially in Europe) for funding large-scale export-oriented hydrogen projects (Hydrogen Council & McKinsey, 2022). Furthermore, green hydrogen cannot yet compete with fossil fuel-based energy, so off-take agreements for green hydrogen and its derivatives are less straightforward than for more mature energy projects. There is substantial uncertainty around the terms and pricing mechanism, which adds to projects' financial risks.

Scientists estimate that green hydrogen production costs can be better than halved in the coming decade, driven by enhanced economies of scale and innovations. With this "technical learning curve," an investment in today's technology could soon become uncompetitive. However, this uncertainty over long-term production costs will make off-takers cautious about making long-term contractual commitments on price. They are firmer on the volumes they require. An additional risk is that if off-takers default, it is unlikely a replacement will be found on similar terms.

In South Africa, the green premium and higher IRRs on foreign projects in are delaying the development of the green hydrogen industry. Hence, governments of off-taker countries will have to step in to mitigate some of the risk, as they have an interest in securing their energy needs and facilitating the energy transition. To this end, the Netherlands is planning to cooperate with Germany on the H2Global fund. However, on a much larger scale, the European Union has announced the establishment of a European Hydrogen Bank. The objective of the Bank is to close the investment gap and connect future supply of renewable hydrogen with our demand objective of 20 million tonnes of renewable hydrogen. The European Hydrogen Bank will facilitate both renewable hydrogen production within the EU and imports, contributing to the RepowerEU objectives and to the transition to climate-neutrality (European Commission, 2023).

The Commission is intending for the EHB to cover and lower the cost gap between renewable hydrogen and fossil fuels for early projects. This will be achieved through an auction system for renewable hydrogen production to support producers through a fixed price payment per kg of hydrogen produced for a maximum of 10 years of operation. The first pilot auctions are currently being designed and they are due to be launched in autumn 2023, backed by €800 million from the Innovation Fund. The Bank will create an EU auction platform offering “auctions-as-a-service” for Member States, using both Innovation Fund and Member State resources, to fund renewable hydrogen projects without prejudice to EU state aid rules (European Commission, 2023)[7].

5.2.2 Improving the risk profile to lower interest costs.

The risk premium due to perceived country and political risk will be key in the considerations by banks and project developers in which countries to start with green hydrogen production first. Therefore, it is essential that South Africa works on its attractiveness for investors and on lowering country risk as calculated by export credit agencies and credit insurance companies. Atradius listed South Africa in Q4 2022 as "moderate risk," whereas green hydrogen competitors Chile and Australia are classified as "moderate-low risk" and "low risk," respectively (Atradius, 2022). Likewise, Allianz rates South Africa as a "sensitive risk for enterprise," Chile as "medium risk," and Australia as "low risk" (Allianz, 2022).

Moreover, South Africa's insufficient measures to monitor and combat money laundering and terrorist financing activities have led to its placement on the grey list by the FATF. While the FATF does not explicitly require increased due diligence, grey listing would effectively necessitate more vetting of clients and their income sources for banks dealing with cross-border financial flows and companies investing in South Africa. This increased due diligence could be expensive and dissuade investment, leading to higher interest rates and cost of capital. As a result, the cost of living for ordinary South Africans is likely to rise due to the higher costs incurred by domestic and international companies trading or investing across South African borders. Moreover, foreign investment that is crucial for economic growth and job creation is likely to decline due to the grey listing, posing a significant concern to ordinary South Africans (Burger, 2023).

South Africa is currently working with the FATF to identify strategies and time frames to improve its monitoring mechanisms. It must then implement these improvements at the latest by January 2025, which might require improved legislation and better monitoring mechanisms to red-flag potential money laundering and terrorist funding flows (Burger, 2023). Alongside these improvements, there

[7] https://energy.ec.europa.eu/news/commission-outlines-european-hydrogen-bank-boost-renewable-hydrogen-2023-03-16_en

is scope for South Africa to improve its rating, for example, by negotiating double tax treaties and improving the ease of doing business for foreign investors.

5.2.3 Setting up structured procurement mechanisms such as carbon contracts for differences auctions to provide a stable income for hard-to-abate industries committed to using green hydrogen.

Carbon contracts for differences (CCfD) auctions are a type of financial mechanism that provides a stable income for low-carbon energy producers, including those producing green hydrogen. They work by offering a guaranteed price for the difference between the market price and a pre-agreed strike price for low-carbon energy, which effectively provides a revenue stream for low-carbon energy producers. The idea behind CCfDs is to provide a stable income stream for producers of low-carbon products, such as green hydrogen, by guaranteeing a premium price for their product. This can help to overcome some of the economic barriers to the adoption of green hydrogen, which is currently more expensive to produce than grey hydrogen (produced from fossil fuels). By providing a financial incentive for the production of green hydrogen, CCfDs can help to drive down the cost of production over time, making the technology more competitive with grey hydrogen and other fossil fuel-based alternatives.

The European Commission (EC) will roll out carbon contracts for difference (CCfD) subsidies for green hydrogen using cash from its Innovation Fund "to support a full switch of the existing hydrogen production in industrial processes from natural gas to renewables and the transition to hydrogen-based production processes in new industrial sectors such as steel making". To avoid the risk that investments in renewable energy may be diverted from the energy transition in partner countries to the production of renewable hydrogen as export commodity, strict standards will ensure that renewable hydrogen imports to the EU can only be produced from additional renewable energy sources. This is particularly relevant for countries like South Africa where there is the additional challenge to address energy access (Collins, 2022)[8].

5.2.4 Embedding financing throughout the value chain, including towards end-users.

To build a hydrogen economy, a variety of financial funds are required throughout the value chain, including development funds, concessionary funds, and grants. Development funds are loans provided for development projects that contribute to economic growth and poverty reduction, concessionary funds are loans provided at below-market rates for low-income countries and vulnerable populations, and grants are non-repayable funds provided to support specific activities or projects.

Development finance can play a critical role in establishing a green hydrogen economy by providing funding for research, development, and commercialization of green hydrogen technologies. This can be done through grants, concessional loans, and technical assistance programs. For example, the European Investment Bank has pledged to invest €10 billion in the hydrogen sector over the next decade (EIB, 2021)[9]. In addition to direct funding, development finance institutions can also use their leverage to mobilize private sector investment in the green hydrogen economy. This can be done through mechanisms such as guarantees, co-investments, and risk-sharing arrangements. For

[8] https://www.rechargenews.com/energy-transition/eu-announces-full-switch-of-existing-grey-hydrogen-production-to-green-h2-backed-by-carbon-contracts/2-1-1221044

[9] European Investment Bank. (2021). EIB to scale up hydrogen investment with new €10 billion initiative. Retrieved from https://www.eib.org/en/press/all/2021-108-eib-to-scale-up-hydrogen-investment-with-new-10-billion-initiative

example, the African Development Bank has partnered with the Climate Investment Funds to provide $100 million in guarantees to mobilize private investment in renewable energy and energy efficiency projects in Africa (AfDB, 2021)[10].

South Africa has its own Development Finance Investors and local banks (including the Industrial Development Bank), but investors need de-risking. Here, the EIB and African Development Bank could provide a large chunk of de-risking by taking a bigger part of the risk, while South Africa takes a smaller part. To support this, the Netherlands could link with the EIB and the Dutch banking system.

However, development funding alone is not enough. To scale and accelerate development, there is a need for concessionary funding and grants for projects or 'business oxygen'. This type of funding and grants are lacking in South Africa and are preventing project development – the largest barriers for local SMEs and entrepreneurs in South Africa is gaining access to this 'business oxygen'. Business oxygen is essential for entrepreneurs, SMEs and large corporations to adapt to the new hydrogen economy. The Netherlands would be able to provide a mixture of development, concessionary, and grand funding through Invest International and Climate Fund Managers. Moreover, any follow-up studies to this report could potentially be financed by RVO.

To ensure that these funds are effectively deployed in the green hydrogen sector, it is important to have a clear strategy that prioritizes investments in areas with the greatest potential for impact. This strategy should be informed by a comprehensive analysis of the market, regulatory, and technological factors that are driving the growth of the green hydrogen economy. It should also be guided by principles such as transparency, accountability, and inclusivity to ensure that the benefits of green hydrogen are shared widely and equitably.

5.3 Support: Consultancies

To achieve the development of a green hydrogen economy in South Africa, it is important to have a comprehensive understanding of the entire value chain, from production to distribution and utilization of hydrogen. Consulting firms with expertise in sustainable energy solutions, such as Lab of Engineering, Pondera, Royal Haskoning DHV and Arcadis, could play a significant role in supporting the development of a green hydrogen economy in South Africa. These consultancies can offer services ranging from developing hydrogen strategies and roadmaps to conducting feasibility studies, designing and optimizing production facilities, and integrating hydrogen systems into existing energy infrastructure. With their expertise in various areas of the green hydrogen value chain, these consultancies can provide valuable insights and support to both government and private sector stakeholders and help drive the transition towards a sustainable and low-carbon economy in South Africa.

Lab of Engineering is a Dutch engineering and consultancy firm that specializes in sustainable energy solutions. They offer services in various areas, including renewable energy, energy efficiency, and sustainable mobility. When it comes to the green hydrogen economy, Lab of Engineering has expertise in:

- Feasibility studies for hydrogen projects
- Design and optimization of hydrogen production facilities
- Hydrogen storage and transportation solutions

[10] African Development Bank. (2021). AfDB, Climate Investment Funds launch $100 million green financing partnership for Africa. Retrieved from https://www.afdb.org/en/news-and-events/afdb-climate-investment-funds-launch-100-million-green-financing-partnership-africa

- Integration of hydrogen systems into existing energy infrastructure
- Safety and risk assessments for hydrogen applications

Pondera is a Dutch consultancy firm that focuses on renewable energy projects, including wind, solar, and hydrogen. With regards to the green hydrogen economy, their key areas of expertise include:

- Developing hydrogen strategies and roadmaps for businesses and governments
- Feasibility studies for hydrogen projects
- Design and engineering of hydrogen production facilities
- Hydrogen supply chain optimization
- Environmental and social impact assessments for hydrogen projects

Royal Haskoning DHV is a global engineering and consultancy firm with expertise in various fields, including water, infrastructure, and energy. When it comes to the green hydrogen economy, their areas of expertise include:

- Developing hydrogen strategies and business models for companies and governments
- Feasibility studies for hydrogen projects
- Design and engineering of hydrogen production facilities
- Hydrogen storage and transportation solutions
- Integration of hydrogen systems into existing energy infrastructure
- Safety and risk assessments for hydrogen applications

Arcadis is a global engineering and consultancy firm that specializes in sustainable infrastructure solutions. Their expertise in the green hydrogen economy includes:

- Developing hydrogen strategies and roadmaps for businesses and governments
- Feasibility studies for hydrogen projects
- Design and optimization of hydrogen production facilities
- Hydrogen supply chain optimization
- Integration of hydrogen systems into existing energy infrastructure
- Environmental and social impact assessments for hydrogen projects

Overall, these consultancies[11] offer a wide range of services related to the green hydrogen economy, from developing strategies and roadmaps to designing and engineering production facilities, storage and transportation solutions, and safety and risk assessments.

5.4 Education and skills development

According to a study conducted in 2019 by the CSIR and the German-based Institute for Advanced Sustainability Studies, South Africa has the potential to create up to 1.6 million jobs through energy-

[11] References:

Arcadis. (n.d.). Hydrogen. Retrieved April 12, 2023, from https://www.arcadis.com/en/global/what-we-do/sustainability/solutions/hydrogen/

Lab of Engineering. (n.d.). Hydrogen. Retrieved April 12, 2023, from https://www.labofengineering.com/expertise/hydrogen/

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Royal Haskoning DHV. (n.d.). Hydrogen. Retrieved April 12, 2023, from https://global.royalhaskoningdhv.com/en-gb/services/sustainability/energy-transition/hydrogen

sector transformation by 2050. The study suggests that a future sustainable hydrogen society in South Africa could offer sectoral job opportunities for skilled graduates in various areas such as operations and maintenance, management of PGM mining, refining and beneficiation, transportation and construction, and industrial manufacturing.

To acquire these job opportunities, artisanal, technical, digital, and other relevant skills related to the relevant stages of the value chain will be required. The study indicates that most of these new jobs will be classified as skilled, requiring either university education or vocational training. However, the estimation that one-third of Technical and Vocational Education and Training (TVET) graduates in South Africa are unemployed suggests a critical skills gap between industry demands and the public college offering. The Department of Labour has identified limited skill acquisition as one of the key challenges that contribute to the high unemployment rate among the youth in South Africa. This results in inadequate preparation of the youth for entry into a rapidly changing labour market characterized by increasing digitization and automation. Therefore, it is crucial to address this skills gap between industry demands and public college offering to create job opportunities for South African graduates.

The HSRM has listed key priority actions to be pursued in the short term (2021-2024) to achieve this objective. These actions include identifying the skills required for a hydrogen workforce, developing a plan to build these skills while recognizing the objectives of GESI, and continuing to build the research ecosystem to support innovation. This will be essential to ensure that costs are reduced, and hydrogen and hydrogen fuel-cell technologies (HFCT) move from a niche technology to market adoption.

With its advanced hydrogen research and innovation ecosystem, the Netherlands could be an important strategic partner in order to these key priority goals. The Netherlands and South Africa have a long and rich history in higher education. Dutch and South African universities and knowledge institutes have intensively collaborated in various fields such as student exchanges, joint research, joint degrees, cooperation in European research projects and community service/social impact projects. Currently 30 candidates participate in the NRF NUFFIC doctoral program. Both countries agreed to extend the MoU in science and innovation to continue collaboration, especially in the field of energy, agriculture, health and water (JCC South Africa – the Netherlands, 2021). Within this MoU, various cooperative activities including the exchange of information and researchers was agreed upon. Hence, this MoU can be leveraged to facilitate knowledge exchange between the two countries in the field of green hydrogen.

To this end, world-leading universities and knowledge institutes such as TU Delft and University of Groningen and TNO have developed advanced knowledge on both the technical, economic, and systemic aspects of hydrogen. In addition to this, the Netherlands excels in applying knowledge to meet the specific demands from the industry. An example of this is the Energy Transition Center (EnTranCe) in Groningen. This approach could be shared with South African counterparts. Specific areas of expertise are electrolysers, circular solar PV, and water technologies. The latter could be provided by CEW, who can offer education, research, and consultancy that addresses systemic solutions for water scarcity in South Africa. For example, within a hydrogen value chain, desalinised water can be rerouted to local communities, after which the wastewater is treated for producing local manure and the effluent water is made available again for hydrogen production.

6. A Just transition to a green hydrogen economy

Stability in a region is necessary to guarantee economic security, mitigate the complexities in a region, secure good (international) cooperation and trade, and secure the basic needs and livelihoods of the local population. Integrating sustainable development into the core of the hydrogen economy can secure success and stability over the long term; raising equity within society, and creating opportunities for all of society in terms of jobs, business, and education. South Africa has made strong commitments to ensure a 'Just Transition,' with a goal for 'a just and inclusive net-zero carbon economic growth for societal wellbeing by 2050' outlined in the HSRM (Department of Science and Innovation, 2021, pg. J). This goal is underscored by the triple threat of unemployment, inequality and poverty, which form part of key local considerations for a just transition. Other highlighted considerations, which are further elaborated on below, include energy poverty, water scarcity, and vulnerability to climate change.

6.1 Access to energy and water

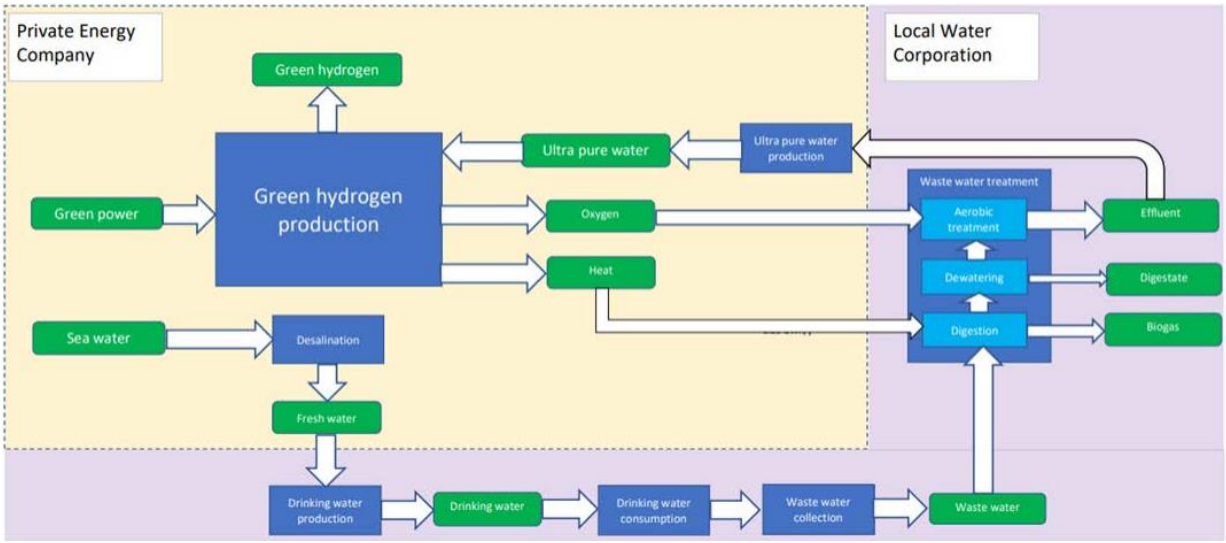
There is a potential business case for creating overcapacity for renewable energy generation and desalination for green hydrogen projects. Renewable energy will be produced in large quantities and overcapacity could be created to supply local communities. The Netherlands can support in feasibility studies on the business case for overcapacity, system integration, and grid management.

Desalination is an energy-intensive process that requires a significant amount of electricity, which can be provided by renewable energy sources such as wind and solar. Green hydrogen projects can serve as a reliable source of demand for excess desalination capacity, creating a new revenue stream for investors and promoting sustainable water use in regions with water scarcity.

Furthermore, in regions where desalination is currently not economical due to the high cost of energy, the integration of desalination with green hydrogen production could make desalination a viable option. This can benefit local communities by providing a new source of fresh water for domestic and industrial use, which can lead to improved health and economic outcomes.

Besides the overproduction of water, there is a business case to address the freshwater and sanitation demands of local communities by rerouting the desalinated water into a more integrated system which utilises waste streams. By developing an integrated desalination and wastewater treatment system, local water scarcity issues are addressed, there is potential water supply for other uses such as agriculture, and less energy and resources are wasted. Figure 2 shows such a design by the Dutch Center of Expertise in Water Technology (CEW). The Netherlands proposes to undertake a feasibility study to establish whether a similar system would be possible in South Africa.

Figure 2: Integrated water system linking desalination-green hydrogen and local water uses



6.2 Inclusion of local SMEs and communities

The Netherlands can contribute to a Just Transition by including local SMEs in project proposals and funding requests, and by promoting collaboration between Dutch and South African incubators. Including local SMEs and fostering a healthy start-up environment can contribute to promoting local community involvement in green hydrogen projects.

Firstly, by promoting the participation of local SMEs, there is potential for the economic benefits of the project to be distributed more equitably across the local community. This can also lead to job creation and training opportunities. Additionally, supporting a healthy start-up environment can encourage the development of new green hydrogen start-ups, and supporting existing ones can help to foster local innovation and expertise in the sector. This recognition of local knowledge and expertise can lead to more inclusive decision-making processes and the recognition of local community needs and preferences. A 'hub' environment like the hydrogen office sets a foundation for community and SME involvement through promoting dialogue and concentrating broad opportunities for skills development, as outlined in the HSRM.

With the establishment of the green hydrogen office, the Netherlands also aims to initiate awareness campaigns on green hydrogen, and to actively inform and involve local communities. Moreover, the office can be leveraged to develop support programmes for youth and women entrepreneurs in the Hydrogen Economy. Such initiatives align well with the GESI priorities and public engagement platform proposed in the HSRM, with the intention to facilitate national discourse on hydrogen and technologies, showcase deployments and conduct outreach.

6.3 Employment: maximum local employment, reduce inequality, include women and youth

In the first quarter of 2022, South Africa experienced a 34.5% unemployment rate, with an even higher rate of 47.8% unemployment among the youth (South African Government News Agency, 2022). With the South African youth comprising for over half of the employable population in the country (Reuters,

2023), there is a huge opportunity through university and TVET level, to transfer relevant skills to the youth and absorb them into the labour sector. With unemployment fluctuating above 30% over the long term, there is a need for significant progress in reducing this number. Beyond improving economic development and status, and contributing to local livelihoods, addressing unemployment has the potential to indirectly reduce civil unrest and improve social cohesion, underscoring the local value of this (Roodt, 2021). Within the HSRM it is recognised that hydrogen can contribute to SDG8 - decent work and economic growth- towards unemployment. As part of a just labour transition, jobs in the (PGM) mining sector could be preserved, and new, quality green jobs could be provided through introducing new industry, to address the loss of jobs linked to the coal sector. Through implementing identified catalytic hydrogen projects, there is the possibility to create at least 30,000 jobs locally per annum by 2040. Projects implemented as part of the Dutch proposition could serve as a foundation for these jobs in the future or could lead to direct employment.

Overall, there is an important and fundamental alignment between South Africa and the Netherlands on important considerations with regards to employment. Within the Netherlands, the Dutch government has recognised the increase in demand for people with technical skills, and has signed a technology pact with relevant sectors, including trade unions, employers and education. This plan includes plans for making technical education more relevant to the labour sector (Government of the Netherlands, n.d). The need for skilling, also in technical institutes, is recognised in South Africa, and a similar pact/plan could prove of value in formulating embedded solutions. Furthermore, a particular focus in skilling in the TVET system could address a high unemployment rate among these graduates. Gender equality has been underscored as a guiding principle in any involvement of the Netherlands in foreign efforts, as a foundation for economic prosperity (UN Women, n.d.). This principle aligns with the priority of embedding Gender, Equality and Social Inclusion (GESI) indicators into employment, and the monitoring, evaluation and learning of the HSRM in South Africa. An important part of GESI prioritised in both the HSRM and the JET-IP includes scaling the number of women and youth employed, ensuring these women and youth are included in skilling programs, and providing opportunity for women to advance to more senior levels. The Netherlands and South Africa could collaborate on ensuring GESI indicators are effectively implemented, monitored and evaluated throughout project development.

All projects co-developed, funded, or initiated by the Netherlands will prioritise compliance with local labour laws, as well as Broad-Based Black Economic Empowerment (B-BBEE) policy. Important will be ensuring local ownership and capacity building. Such capacity building can be accomplished through training programmes at all levels of society, including both soft skills (e.g., collaboration) and hard skills (e.g., technology). Empowering local business and the local labour force will support the sustainability of new jobs over the long term, and ensure benefits are funnelled into the local economy and workforce. The creation and scaling of these jobs will only be sustainable should the appropriate skills development and training programs be in place to support reskilling and upskilling. As previously discussed, collaboration between the Netherlands and South Africa on skills and training, while ensuring that all implemented activities align with national GESI priorities, would provide value here. Of special relevance are the technical skills and expertise with hydrogen system operations where the Netherlands has experience, and which are less developed in South Africa. Finally, any implemented projects should remain sensitive to potential knock-on effects or unintended consequences with regards to sector development and jobs. It is important to extend the view on job creation to consider the creation of indirect jobs through sector development, as well as how rural communities can be connected to centres of skilling and employment. Here it is important that there be local assessment and collaboration to map risks and opportunities.

6.4 Local climate mitigation

Besides the global emission reductions that will be achieved through the use of hydrogen instead of natural gas, this proposition is expected to lead to local emission mitigation. The Dutch companies Proton Ventures, Gasunie, HYCC, and MTSA all have the potential to contribute significantly to local climate mitigation efforts in South Africa. Through their respective projects, each company can play a crucial role in reducing carbon emissions and promoting sustainable energy practices in the region.

Proton Ventures' focus on making coal factories more efficient can have a significant impact on reducing emissions in South Africa, where coal-fired power plants are a primary source of energy. By improving the efficiency of these plants, Proton Ventures can help to reduce the amount of coal burned and the resulting greenhouse gas emissions. This can be achieved through by optimizing the use of existing equipment and processes. Meanwhile, Gasunie, HYCC, and MTSA's together with South African parties can develop a green hydrogen grid balancing demonstration project that can help to promote the use of renewable energy sources in South Africa. By creating a system that balances the supply and demand of the local energy grid, Gasunie and MTSA can help to increase the use of this sustainable energy source in the region.

7. Recommendations

1. **Nourish and further develop a collaborative environment**- There is eagerness from both the Netherlands and South Africa to collaborate on green hydrogen. As such, there is room to create an environment where this is further facilitated, promoted, and enabled. Bilateral cooperation between governments should be extended to regional and local level. Since projects often find ground at regional level, it follows that significant challenges are experienced at this level, and regional developments may be limited by the progression of discussions at national and bilateral level. Enabling regional cooperation with a focus on specific needs and barriers may help fast-track project formulation and development. Furthermore, to promote regional development and business-business collaboration, initiatives are being driven on both sides, such as the inaugural South Africa Green Hydrogen Summit (2022) in Cape Town, and both the South African trade mission and Africa Hydrogen Forum integrated with the World Hydrogen Summit (2023) in Rotterdam. Such events, which provide space for knowledge sharing and networking at both public and private level, should continue, and further integrate the needs of attendees to provide maximum mutual benefit. In addition, since the opportunity presented by such events is often limited to the chosen attending delegation, there is room to co-create a collaborative platform where learnings and information can be shared, and where networks can be extended to key parties beyond industry leaders. Such a platform could be broadened to include universities, where educational material could be shared and co-developed. Finally, solidifying this collaboration requires concrete steps towards materialising propositions. Appointing a key individual (FTE) on both sides to take the lead and drive materialising this proposition, is crucial. In developing all opportunities, it is deemed important that local coordination, ownership and leadership is ensured, with co-representation of the interests of the Netherlands.

- **Activate and guide the industry-** The success of the new green hydrogen economy will largely depend on the behaviour of the private sector companies. It needs pioneers who take the risk and make the first investments, even though it may mean that they will not have the highest

return on investment in the long run. But being a frontrunner in the market may provide them with a strong market position. The new hydrogen economy also needs collaboration. Where in the “old energy sector", companies are battling for competition, building hydrogen value chains requires “holding hands” and collaborating. Another key requirement is a proactive Human Capital Strategy: companies have to start developing (partially new) skills and knowledge for an entire value chain and as such, need to collaborate with educational institutions.

- **Stimulate awareness and inclusion on the ground**- Given the nascent stage of green hydrogen developments globally, and especially in South Africa, raising public awareness and building public support is key. This is especially important in (rural) communities which may be co-located with hydrogen developments, and who have previously been excluded from project benefits through, among others, land-rights struggles, insufficient provision of clean energy and other basic needs, or a lack of education. As such, civil society and communities should be included in project discussions and developments from planning to end-use. Important to the success of larger projects will be the involvement of SMEs and demonstration of benefit to local communities through publicly visible pilot projects; especially benefit aligned with basic needs such as transportation, energy access, food and water security, and education. Education and training programs should be co-developed and tailored to the local context, and green hydrogen should be included in educational and public-awareness materials. Grass-roots communication from municipalities, local NGOs, and community organisations should be leveraged to reach and inform marginalized groups that have limited access to digital communication and have a more limited knowledge foundation.

- **Provision of finance and off-take**- Essential to the feasibility of any opportunity is creating the necessary local enabling environment. In the case of green hydrogen, this partly rests on the need to de-risk projects and financing, and the important role the Dutch government can play in this. There is a need to develop a concrete financial plan; either through provision of the necessary financial funds to cover the green premium by the Netherlands, or through developing a (national/bilateral) carbon-taxing system to facilitate the appropriate financial climate. In addition to a need for grant funding and funding for feasibility studies, there is also room to consider the development of a sovereign wealth fund for the Boegebaai project that can be leveraged for the food-water-energy nexus and for the stabilization of the currency. Linked to financing is a clear need for secure off-take agreements. Stimulating and promoting off-take and finance by off-takers will lay the necessary conditions for further co-funding by finance institutions such as the African Development Bank.

- **Integrate adaptive flexibility as part of opportunity design**- Due to the political and economic climate in South Africa, as well as gaps in technical capacity, there is the potential for project implementation to be delayed. A delay in certain projects such as Saldanha Bay may further delay opportunities such as the hydrogen office. It is therefore recommended to keep the scope of opportunities open and flexible, while not allowing this flexibility to evolve into a barrier to development. Such flexibility could be integrated through investigating multiple locations for the hydrogen office, including more developed cities such as Cape Town, Durban or Johannesburg. Furthermore, due to associated risk being higher with some required technologies such as electrolysers, project developers and involved stakeholders should on all sides ensure that, as far as possible, the most innovative and upmarket technologies be

implemented, and new learnings and best practices be shared. Finally, in terms of stakeholder engagement, maintaining an adaptive approach allows room for gathering, and integrating stakeholder input. Such local inputs will be necessary for project success aligned with local regulation, as well as public acceptance .

- **Jointly identify concrete indicators through which to measure socio-economic and environmental impact-** The GESI indicators as well as sustainable development goals form part of planning for green hydrogen developments in South Africa. All opportunities proposed should integrate these priorities, as well as concrete indicators of success. Such indicators will allow for the monitoring and evaluation of projects and provide insight for future project formulation as well as public engagement. Indicators should be: bridge global best practices, industry standards, feasibility, and the needs of all stakeholders. This should be preceded by alignment on what a just transition means, and what key outcomes are desired in this regard.

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Annex 2 Green Hydrogen Commercialisation Strategy

This annex outlines the Green Hydrogen Commercialisation Strategy of South Africa objectives and

Sustainable Development Goals addressed by each of the three propositions (in addition to SDG 1, 4, 7, 9, 10, 13 which are addressed by all).

Opportunity 1 and 2

Commercialisation Strategy objectives addressed:

- Strategically position South Africa as a preferred and reliable provider to key markets, specifically EU/ UK, leveraging trade relationships and government support.
- Demonstrate feasibility of GH applications in hard-to-abate sectors such as non-ferrous metals, green steel, and cement in order to foster short term pilot projects and long-term commercialisation.
- Define a key set of “catalytic” infrastructure projects that will frame the national GH strategy and enable private sector leaders to roll out their strategies whilst meeting Government’s longer-term objectives for inclusive economic growth. Such projects should be declared as Strategic Integrated Projects (SIPs) by the Department of Public Works & infrastructure (DPWI).
- Contribute towards reaching South Africa’s emission reduction goals as per the Peak, Plateau, Decline Emissions Trajectory Range reflected in the NCCRP and NDP
- Create partnerships and joint ventures to secure investment, technology partnerships, and long term demand off-take agreements.
- Develop training and skills development programmes to support job creation within the GH sector.

Sustainable Development Goals addressed:

- Encourage innovation and entrepreneurship (8.1, 9.2, 9.b)
- Increase local and international investment (8.1, 8.10, 17.11)
- Decouple economic growth from resource use (12.5, 12.6, 12.7, 12.4)
- Promote higher quality and industry-relevant education and training (4.4, 9.2, 8.3)

Opportunity 3

Commercialisation Strategy objectives addressed:

- Strategically position South Africa as a preferred and reliable provider to key markets, specifically EU/ UK, leveraging trade relationships and government support.
- Contribute towards reaching South Africa's emission reduction goals as per the Peak, Plateau, Decline Emissions Trajectory Range reflected in the NCCRP and NDP
- Create partnerships and joint ventures to secure investment, technology partnerships, and long term demand off-take agreements.
- Identify options for local value addition of PGM materials

Sustainable Development Goals addressed:

- Encourage innovation and entrepreneurship (8.1, 9.2, 9.b)
- Increase local and international investment (8.1, 8.10, 17.11)

Opportunity 4

Commercialisation Strategy objectives addressed:

- Contribute towards reaching South Africa's emission reduction goals as per the Peak, Plateau, Decline Emissions Trajectory Range reflected in the NCCRP and NDP
- Create partnerships and joint ventures to secure investment, technology partnerships, and long term demand off-take agreements.

Sustainable Development Goals addressed:

- Encourage innovation and entrepreneurship (8.1, 9.2, 9.b)
- Increase local and international investment (8.1, 8.10, 17.11)

Annex 3 What Dutch companies can offer

Category	Company	Stage in SA	Partners in SA	Offering for SA
Hydrogen production (electrolysis)	HyCC	Not active, open to business	-	• Electrolyser development
	MTSA	Not active, open to business	-	• Decentralized hydrogen installations • Hydrogen pilot projects • System design and integration
Solar Park developer	TerraWatt	Ready for business, awaiting funding	Part of SA/NAM Powerpool Navitas/Kabi Solar (could be a partner- explore)	• Short term energy provision through solar park development
Desalination and pure water	Pure Water Group	Active	Water treatment companies	• Water purification • Desalination

Green ammonia	Proton ventures	Not active, open to business	-	• Engineering and project development of ammonia plants • Decarbonize 30-35% of coal plants by replacing it with ammonia.
Fuel cell technology	Nedstack	Preparing	HyPlat (have worked with Nedstack) HySA Catalysis (could be a partner)	• Fuel cell development
Hydrogen storage	Vopak	Preparing	Sasol	• Storage of hydrogen and ammonia • Training and education
Hydrogen transport	Gasunie	Not active, but open to business		• Advisory and education on hydrogen distribution network • Project development of distribution network
	Soluforce	Preparing	-	• Non-metallic hydrogen pipelines
Financing	Invest International	Preparing	-	• Investing in hydrogen production projects
	Climate fund managers	Preparing		• Investing in entire hydrogen value chain
International Ports	Port of Rotterdam		Various	• International hydrogen corridor building • Stakeholder management across value chain • Access to European market • Knowledge sharing
	Port of Amsterdam	Preparing	-	• Access to European market • Knowledge sharing
	Groningen Seaports	Preparing	-	• Access to European market • Knowledge sharing

Research/ Consultancy	TNO	Exploring	CSIR	• Skill development through trainings • Cost analysis models • Testing of technology
	Lab of engineering	Not active, but open to business	-	• Feasibility studies • Expertise on storage
	CEW	Active and researching new areas	Navitas (potential partner-explore)	• Solutions that address water-energy-food nexus through circular use of desalinated water • Education and research for water management
	Pondera	Not active but open to business	-	• RES project contracting and planning advisory
	Royal Haskoning DHV	Active and ready to expand	Various	• One-stop-shop for technoeconomic hydrogen value chain consultancy
	Arcadis	Not active but open to business	-	• One-stop-shop for technoeconomic hydrogen value chain consultancy

Annex 4 Barriers

1. Political instability: South Africa has a history of political instability, and investors may be concerned about the potential for future political turmoil that could negatively impact their investments. Especially given the vested interest of coal companies – with coal making up over 70% of the energy supply – a transition towards sustainable energy is likely to be highly political and cause some societal disruptions.
2. Economical and developmental challenges: South Africa has struggled with economic challenges such as high unemployment rates, low economic growth, and a high debt-to-GDP ratio. In recent times, the energy black-outs are a major issue for the countries economy, while water scarcity is also a growing problem. Any large-scale projects in South Africa should address these challenges, otherwise public spending is misdirected.
3. Regulatory environment: South Africa has a large bureaucratic government, which makes getting the required permits a very expensive and slow process. South Africa needs to ensure the regulatory environment is in place for GH2, and that there are no policy concerns as development progresses. A consultation should take place on the current policies to negate potential future obstacles.
4. Finding the right partners and bridging the skills gap: It is considered difficult to navigate in South Africa, with regards to finding the right stakeholders in the value chain, and local skilled workforce. The business landscape in South Africa is different than in Europe, mainly due to cultural differences,

a critical skills gap, and a complex regulatory environment. Local partners that can offer long-term assistance are relative scarce, but important for doing business. Within this partnership, knowledge transfer and education should be included, to ensure a skilled workforce.

5. Financial risk and high credit ratings: It has been observed that South Africa became grey-listed by FATF (Financial Action Task Force) in February 2023, for not fully complying with international standards around prevention of money laundering, terrorist financing and proliferation financing. For South African companies, grey-listing could increase the cost of raising finance and trading with global counterparts. Businesses and non-governmental organisations will face additional requirements around sources of funding which are likely to increase costs and delay transaction execution. Countries can remain grey-listed from one to three years while they address deficiencies. In response to the grey-listing announcement, President Ramaphosa said: “It is noteworthy that the strategic deficiencies identified by the FATF do not relate directly to the country’s financial sector. However, because of the high credit rating of South Africa, the total cost of green hydrogen is likely to be higher than more stable economies than Australia, even though the cost of RE is very low in South Africa.
6. Chicken-and-egg problem: A key barrier for green hydrogen remains the lack of an off-take market. The famous "chicken and egg" problem for green hydrogen refers to the situation where the demand for green hydrogen is not sufficient to justify investment in the infrastructure needed to produce and distribute it, while at the same time, the lack of infrastructure makes it difficult to create the necessary demand. In the case of South Africa, large companies like Sasol have the financial means to start developing hydrogen projects, but they are waiting on off-take guarantees. Off-takers are slowly starting to understand that availability rather than price will be crucial, and companies need to start engaging with producers. There has until now however been hesitancy on the producer side as off-takers don’t commit – they are in their turn waiting on subsidies. The Netherlands is working on a price guarantee mechanism together with Germany, but these contracts are reserved for projects that can be delivered within five years, which is unlikely in the case of South Africa.

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Publication number: RVO-167-2023/RP-INT

NL Enterprise Agency is a department of the Dutch ministry of Economic Affairs and Climate Policy that implements government policy for agricultural, sustainability, innovation, and international business and cooperation. NL Enterprise Agency is the contact point for businesses, educational institutions and government bodies for information and advice, financing, networking and regulatory matters.

Netherlands Enterprise Agency is part of the ministry of Economic Affairs and Climate Policy.