Module proposal

DC Programme:	**Energy and Climate (*Green Economy*) in South Africa**
TC module:	**Promoting the development of a hydrogen economy for South Africa (H2.SA)**
Project number:	**2021.2230.7**

Presentation of a

Offer for a TC module

at the bid estimate price of up to EUR xxx

It is a New TC module; Parts of the German contribution should be awarded to contractors.

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List of abbreviations

CO_2	Carbon dioxide
CSIR	*Council for Scientific and Industrial Research* Council for Scientific and Industrial Research
DFFE	*Department of Forestry, Fisheries and the Environment* Ministry of Forestry, Fisheries and Environment
DMRE	*Department of Mineral Resources and Energy* Ministry of Mineral Resources and Energy
DSI	*Department of Science and Innovation* Ministry for Research and Innovation
DTIC	*Department of Trade, Industry and Competition* Ministry of Trade, Industry and Competition
H2	Hydrogen
IIO	*Investment and Infrastructure Office* Office for Investment and Infrastructure
IRP	*Integrated Resource Plan* Strategic expansion planning of the electricity system
MW	Megawatt
NDP	*National Development Plan* National Development Plan
PtX	Power to X Power-to-X refers to various chemical products that can be produced with the help of hydrogen from electrolysis. These include, for example, synthetic fuels such as paraffin and petrol as well as basic chemicals such as ammonia and methanol.
RE	*Renewable Energies* Renewable energies
SAY	*South-African German Energy Programme* South African-German Energy Programme
SANEDI	*South African National Energy Development Institute* *South African National Institute for Energy Development*

Promoting the development of a hydrogen economy for South Africa

Project number 2021.2230.7

1. Brief description

Module title	Promoting the development of a hydrogen (H2) economy for South Africa
Sector	Energy
Programme	Energy and Climate (*Green Economy*) in South Africa
Programme objective	Germany is making an effective and visible contribution to supporting the South African government in achieving its climate goals.
Module Objective	The strategic, regulatory and technical conditions for building a green H2 economy in South Africa have improved.
Contribution to the national implementation of the 2030 Agenda	The 2030 Agenda is implemented through the National Development Plan and downstream policies and plans, which together cover about 93% of the Agenda targets and indicators, here directly SDG 7 (clean energy) and 13 (climate action).
Core problem	The strategic, regulatory and technical prerequisites for the development of a green hydrogen / power-to-X economy in South Africa are insufficient.
Target groups	Professionals and managers from public and private sector organisations in the energy and industrial sectors (intermediaries). The population that benefits from the development of a hydrogen economy in South Africa through job creation and local value addition.
Political sponsor	Investment and Infrastructure Office (IIO) in the Office of the Presidency.
Methodological approach (incl. instruments)	In order for governmental and private partner institutions to promote the development of a hydrogen economy, their performance is strengthened through capacity development, access to information and national and international exchange.
Key outputs	(i) Decision-making basis for improving the strategic and regulatory framework is available; (ii) Technical-economic pre-requisites for companies to participate in a South African hydrogen economy are improved; (iii) Technical competences of selected actors on the topic of H2 are strengthened; (iv) Competences of relevant stakeholders on the possible impacts of a hydrogen economy on the environment and society are improved.
Cooperations	None
Order value	
Duration	From 09/2021 to 12/2023

2. Classification of the project

2.1 Placement of the module in the programme

The module is part of the **DC programme** "Energy and Climate (*Green Economy*) in South Africa". The programme aims to support the partner government in achieving its climate goals and to contribute to a more ecologically sustainable and less coal-based as well as climate-smart economy (cf. Annex 1, Impact Matrix). While the German DC programme is primarily motivated by the climate policy dimension of an energy turnaround, South African policy tends to align its decisions with economic and growth objectives. The programme's contributions to achieving the annual expansion targets for renewable energies (RE) (programme objective indicator 1), as well as to creating new employment opportunities in the *green economy* (programme objective indicator 4), do justice to both motives.

The planned new project aims to improve the conditions for the development of a RE-based ("green") hydrogen economy in South Africa. The global market for green hydrogen products is in its initial phase. Consortia of companies are building the first larger plants and are planning plants worldwide with total investment costs of almost 100 billion euros. If South Africa were to enter the market, a massive expansion of RE capacities would be required, far beyond the government's previous expansion plans. The development of a viable market for green hydrogen products offers new export opportunities for South African industry, an increase in local value creation and the associated creation of additional jobs. Especially for workers employed in the crisis-ridden coal sector, the development of a hydrogen economy could provide alternative employment opportunities (impact hypotheses).

The TC module thus contributes directly at the programme level to the common goal of DC engagement and to the achievement of programme objective indicators 1 and 4. The strategic guidelines relevant to the design of the module can be found in the: (i) Marshall Plan with Africa (BMZ, 2021), (ii) Strategic Partnership on Technology in Africa (SPTA), (iii) in the BMZ sector concept "Sustainable Energy for Development" (BMZ, 2007), (iv) in the strategy recommendations "BMZ 2030" (BMZ, 2020) with the core theme "Responsibility for our Planet - Climate and Energy", (v) as well as in the thematic specifications of the current BMZ country strategy for South Africa.

Within the programme, the project **works together** with the TC module "Renewable Energy and Energy Efficiency in South Africa (SAGEN 3)" and its follow-up module "Supporting the Transformation of the South African Power Sector (SAGEN 4)"), which is currently being planned. SAGEN strengthens the competencies of South African decision-makers and executives for the effective implementation of a power sector reform that is geared towards an increasing share of variable RE in the national and municipal power supply. The offered TC module indirectly causes the development of additional RE capacities for power generation through the establishment of a hydrogen economy and thus has a complementary effect to SAGEN. Furthermore, the planned module is planned and implemented in close coordination with the project "Improvement of grid and system integration of variable renewable energies" SAGEN-CET, especially in the implementation of training measures and the expansion of academic educational offers in the field of hydrogen and RE for hydrogen production. As all

three projects advise public and private sector organisations in the energy sector, cost savings are expected, e.g. through the joint planning and implementation of workshops, conferences and training events.

The FC modules of the programme are important elements for the practical implementation of the energy transition in South Africa. The FC modules "Financing of grid reinforcements and grid integration of renewable energies" and "Promotion of renewable energies in municipalities" improve the infrastructure for an energy transition at national and municipal level. It is expected that the combination of targeted policy advice from TC and implementation-oriented projects from FC will make a significant contribution to building a RE-based green hydrogen economy and increase demand for financial services from the RE and hydrogen sectors in the medium term.

Programme objective: Germany makes an effective and visible contribution to supporting the South African government in achieving its climate goals.			
Indicators	Underlying	Actual value	Target value
Programme objective indicator 1: The environment for RE expansion is improved, licensing procedures are simplified and the integration of RE into the transmission and distribution grid is improved. The annual expansion targets for RE from the *Integrated Resource Plans (*IRP) (2010) are met.	2011: 7 MW wind, 1.9 MW PV	n.a.	IRP 2019: 17,742 MW wind, 8,288 MW PV and 600 MW CSP (by 2030).
Programme objective indicator 4: South Africa plans to create 300,000 new jobs in the green economy by 2020. With the help of training measures, urgently needed experts in the field of RE and EE are being trained. The training measures are designed according to the requirements of green employers. Poor and disadvantaged groups will receive special support.	The project "Skills for a Green Economy" has been managed as a separate project in the priority area "Vocational Training" since 2016 (separate reporting).		

2.2 Other development measures in the specific intervention area of the module

Two further German initiatives to promote the development of foreign trade partnerships in the field of hydrogen are currently in preparation.

H2Global" is a time-limited price subsidy funded by the Federal Ministry for Economic Affairs and Energy (BMWi) by means of so-called contracts for differences for green hydrogen-based fuels, fuels and basic materials (also referred to as "*Power-to-X,* PtX") via a foundation in order to support the market ramp-up in Germany through imports.

Furthermore, within the framework of the Bilateral Energy Partnerships, the BMWi supports the local energy transition with regard to hydrogen in the South Africa country measure. The

promotion of government dialogue on energy policy between the two countries and the inclusion of the interests of the (German) private sector through existing exchange formats should be emphasised here. Within the framework of this project, meetings of high-ranking officials and, if applicable, state secretaries from both countries are also planned, which, in conjunction with this module, will offer important synergies in terms of shaping political opinion on green hydrogen, and thus in terms of achieving the objectives of this project (outcome level).

As part of the "PtX Pathways" project, the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) is supporting the development of sustainable markets for green hydrogen and PtX as a building block for the energy transition in Argentina, Morocco and South Africa. Together with the respective partner governments, allocation scenarios for PtX are being developed and value chains analysed.

Within the framework of implementation, project-specific thematic priorities are defined, thus avoiding duplication and achieving maximum impacts. It is expected that cooperation between the two projects will save costs for the German TC system.

The BMBF has a long-standing research cooperation with South Africa. The BMBF aims to promote the topic of hydrogen within this framework. A concrete design is not yet available. Other donors have no concrete plans regarding hydrogen in South Africa at the time of the review. Based on the situation in other countries, it can be assumed that the World Bank and the EU could enter the sector in the future. Japan has been in exchange with South Africa (outside DC) for some time on possible hydrogen exports (outcome level).

No negative interactions with the above-mentioned projects are expected.

Encoder	Project	Expected synergies at the impact levels
BMWi	H2Global	Promotion of an export market (from a South African perspective) for green PtX products (impact level)
BMWI	Energy partnerships	Promoting government dialogue on energy policy between the two countries and the inclusion of the interests of the (German) private sector (outcome level)
BMU	PtX Pathways	Joint contribution to improving the regulatory conditions for H2/PtX market development (outcome level)
BMBF	H2-South Africa (exact title not yet available)	The project is still in the planning stage, but is expected to have great synergies in building know-how for a green hydrogen economy (outcome level)

3. Problem and potential analysis (related to the TC module)

Initial situation in the intervention area: Worldwide, the demand for green hydrogen and its downstream products is increasing. South Africa has the opportunity to position itself as a major supplier of PtX products due to its outstanding RE potential (mainly solar and wind

energy) and existing synthetic fuel production facilities (although still coal-based). In addition, South Africa has the world's largest reserves of the precious metal platinum, which is used in fuel cells, but also in electrolysers, which are essential for the production of green hydrogen. In 2018, 190 000 kg of platinum was produced globally, of which 137 000 kg (72%) came from South African mines. The HySA (*Hydrogen South Africa*) research and innovation network was established in 2008 with the aim of advancing the development of hydrogen and fuel cell technologies and opening up new markets for South African platinum.

The chemical company SASOL is currently South Africa's largest producer of grey hydrogen (for internal processing) and one of the world's largest producers of synthetic fuels. The basis of the SASOL production process is the Fischer-Tropsch synthesis. This is a proven large-scale process for the production of hydrocarbons (e.g. petrol, diesel, paraffin) from synthesis gas, a mixture of carbon monoxide and hydrogen. The carbon sources are mainly domestic coal and, to a lesser extent, imported natural gas. Due to the hitherto exclusive use of fossil carbon sources, the South African SASOL production sites Secunda and Sasolburg emitted 61,055,000 tonnes of CO_2 equivalent in 2020.

An essential prerequisite for the development of a green hydrogen economy in South Africa is the massive expansion of additional very low-cost RE capacity in the gigawatt range. The strategic expansion planning for the electricity system (*Integrated Resource Plan*, IRP), which was updated in 2019, does not yet include the increasing RE demand for the production of green hydrogen. The IRP, which is already ambitious, envisages that the RE share of electricity supply should increase to around 40 % by 2030. This would correspond to a total installed capacity of about 33,000 MW provided by wind and solar power plants as well as decentralised systems (e.g. solar rooftop systems). From today's perspective, the RE capacity planned so far will not be sufficient to meet the demand for renewably generated electricity for hydrogen production. In particular, this is not the case, as green hydrogen customers will probably insist on additionally installed RE capacity in order to avoid negative impacts on the classic electricity sector (increase of the fossil share in the electricity mix). However, it will be important in parallel to reduce the frequent power cuts. Possibly, the hydrogen sector can indirectly contribute to an improvement of the power supply, a faster expansion of RE and a massive cost reduction of RE electricity via this argumentation.

Political decision-makers and companies in South Africa are increasingly recognising the potential of a green hydrogen economy. SASOL is currently developing initial projects for the production and processing of green hydrogen with the participation of German companies. The *Department of Science and Innovation* (DSI) is working on the development of elements of a national hydrogen strategy (including the *Hydrogen Society Roadmap*). The *Department of* Mineral Resources and Energy (DMRE) increasingly sees a hydrogen economy as a possible alternative to the coal industry that can both create jobs and build an export economy.

The creation of new jobs associated with the development of a hydrogen economy in South Africa offers opportunities for women, who have so far been significantly underrepresented in the coal-dominated energy sector. Efforts by the *Department of* Women, Youth *and Persons with* Disabilities (*DWYPW*) to implement the national framework guidelines for gender-equitable planning, budgeting, monitoring, evaluation and auditing, which have been in force since

2019, have so far proved difficult in the energy sector. Accordingly, there is a need for action to strengthen gender-sensitive procedures from the outset in the hydrogen sector wherever possible. Potentials for improving gender equality have been identified and are addressed by the TC module (see Chapter 5.1).

The transformation of a society based on the use and export of coal to a green hydrogen economy is associated with considerable structural change. The change offers opportunities for the actors involved, but can also be associated with negative socio-economic effects and thus an impairment of human rights. In particular, the possible negative impacts of a massive expansion of very large RE power plants should be mentioned here (e.g. necessary resettlement measures, competing land use and restriction of habitat). In the context of the project, advisory measures will be taken to ensure that no unintended negative social impacts or human rights violations occur with the RE expansion and that internationally valid environmental and social standards are complied with (see Chapter 6.2, Environmental and social impact of the measure).

Derivation of the module objective: The increasing demand for green hydrogen and its downstream products is based on the willingness of potential consumer countries to establish hydrogen/PTX as a decarbonisation option. The hydrogen sector is still at a very early stage of development in South Africa, so expertise needs to be built and appropriate promotion approaches need to be developed. Accordingly, the strategic, regulatory and technical prerequisites for establishing a green hydrogen economy in South Africa are still insufficient (core problem). The TC module aims to create an enabling environment for the development of a green hydrogen economy in South Africa . The module objective is: The strategic, regulatory and technical conditions for the development of a green hydrogen / power-to-x economy in South Africa are improved.

Causes and assessment of changeability: (i) A national hydrogen strategy coordinated between relevant ministries has not yet been adopted. This cause can only be influenced to a limited extent within the framework of the TC module, as the responsibilities and mandates of the ministries on hydrogen have not yet been clarified. (ii) Hydrogen is not yet an integral part of South African strategies, policies, regulations and guidelines. This cause can be changed within the framework of the project (Output 1). (iii) Key actors in the private sector have limited access to innovative technologies and current market information regarding hydrogen. This cause can be changed within the framework of output 2 of the TC module. (iv) The knowledge and technical skills of experts and managers on hydrogen are still insufficient. This cause can be changed within the framework of the planned TC consultancy (output 3). (v) The opportunities and risks for the environment and society associated with the massive expansion of RE are still unknown. This cause can be changed within the framework of the project and is addressed by output 4.

4. Objectives, impact hypotheses, indicators and partners of the TC module

4.1 Objectives, target groups, impact hypotheses and indicators

Module Objective: The strategic, regulatory and technical prerequisites for the development of a green hydrogen economy in South Africa are improved.

Indicators:

1. 3 Recommendations based on international experience for building a hydrogen/power-to-X (H2/PtX) economy have been incorporated into the relevant national strategy documents or their drafts.

   Baseline: 0 Recommendations (There are currently no officially adopted government strategy documents on H2/PtX)
   Target: 3 recommendations (12/2023)

2. 2 Proposals for improving the regulatory framework for H2/PtX projects have been introduced into the administrative adoption process of competent institutions.

   Baseline: 0 Proposals (There are no proposals to improve the regulatory environment for H2/PtX so far)
   Target value: 1 proposal (12/2022)
   Target: 2 proposals (12/2023)

3. An H2/PtX technology roadmap developed by national and international research institutions to increase value creation in South Africa has been published.

   Baseline: 0 Technology roadmaps (currently no technology roadmap available)
   Target value: 1 Technology roadmap (06/2023)

4. A handout with standardised criteria and specifics for an environmental and social impact assessment taking into account gender equality aspects for planned H2/PtX investment projects has been introduced into an interministerial coordination process.

   Baseline: 0 handouts (Standardised criteria exist for environmental and social impact assessments in energy and chemical plant construction, but none for planned H2/PtX investment projects).

   Target value: 1 handout (08/2023)

The baseline and target values of indicator 1 are preliminary. They will be reviewed in the first year of implementation and adjusted if necessary in the first reporting.

For further details, see the graphical representation of the impact logic and the impact matrix in the appendix.

The 2030 Agenda is implemented nationally mainly through the NDP and downstream policies and plans, which together cover about 93 % of the Agenda targets and indicators. SDG 7 (significantly increase the share of renewable energy in the global energy mix by 2030) and SDG 13 (progressively decarbonise the South African economy by 2040), which are relevant here, are covered and measured by the South African Bureau of Statistics. A module target measurement based on the SDG indicators themselves appears inappropriate because it is not plausibly possible to attribute project impacts. However, the module with its indicators mentioned here contributes to the SDGs mentioned via longer impact relationships.

Target groups: The TC module addresses experts and executives from public and private sector organisations in various sectors (e.g. energy, industry, environment) who benefit from the advisory measures and training offers and act as intermediaries. These are central

government agencies working in the sectors (e.g. *Department of Trade, Industry and Competition* (DTIC)*,* DMRE, DSI), business associations (e.g. South African *National Energy Association (*SANEA), governmental technical and research institutions (e.g. South African *National Institute (*SNA)). South African *National Energy Development Institute* (SANEDI), *Council* for Scientific and Industrial Research (CSIR), HySA network), project developers, investors, providers of technology, financial and other services, and representatives of civil society.

Since 1996, gender equality has been firmly anchored in the South African Constitution. In the South African parliament, the proportion of women has been around 30% since the end of apartheid. Despite the visible progress, a large proportion of South African women still face a variety of problems and a large social imbalance. The gender gap is particularly evident in the unequal distribution of resources (education), jobs and land ownership. As a result, women have fewer opportunities to exert influence politically as well as conceptually and in planning. Within the framework of the project, the interests and needs of women are to be addressed, especially in the areas of social impacts, new jobs and *benefit-sharing* (participation in the benefits of large-scale projects by those affected and local residents).

The above-mentioned intermediaries indirectly reach those parts of the population that benefit from the development of a hydrogen economy in South Africa regardless of gender, age, income or ethnicity (e.g. through the preservation or creation of new jobs, the increase in local value creation, improved and environmentally friendly energy supply through RE). The TC module particularly targets employees in the coal sector affected by structural change. The entire coal sector employed around 130,000 people in 2015. Of these, around 87,500, predominantly male employees, work directly in coal mining. It is estimated that about 300,000 people in South Africa depend on the income generated in the coal sector. The government is therefore pursuing the goal of offering as many coal sector employees as possible future prospects in other sectors of the economy as part of the *Just Transition* Strategy (energy transition strategy, in which, among other things, job losses are to be absorbed through the phasing out of fossil technologies). It is expected that the hydrogen market, which is developing in the medium term, will offer far-reaching opportunities for this.

In all activities of the TC module, special emphasis will be placed on taking into account the "*leave-no-one-behind*" principle of the 2030 Agenda. The TC module will work to ensure that this is sufficiently taken into account (e.g. compliance with environmental and social standards).

Impact hypotheses: Output 1 aims to improve the strategic and regulatory environment for a hydrogen economy in South Africa. The impact hypothesis assumes that improved strategic and regulatory conditions will lead to a reduction of currently existing market barriers for RE, thus creating a conducive environment for a green hydrogen economy in South Africa (module objective). The advice on framework conditions and strategies leads to finding a good balance between attractive investment conditions for international H2/PTX investors on the one hand and the South African government's goal of creating jobs, strengthening the national industry and increasing government revenues on the other. This is under the

assumption that the partner institutions involved recognise the strategic importance of a hydrogen economy for South Africa and initiate cross-sectoral measures for H2/PtX market development .

Output 2 aims to improve the techno-economic conditions for companies to participate in a South African hydrogen economy. The impact hypothesis is that South African companies will respond to the global demand for green hydrogen and its downstream products and invest in H2/PtX projects. Companies can use the knowledge from generic studies on specific investment projects and thus reduce investment risks. It is assumed that an outlet for H2/PtX from South Africa will emerge, thus providing H2 with the necessary economic incentives to invest.

Output 3 aims to strengthen the technical competencies of selected actors from politics, business, research and civil society on the topic of hydrogen. The impact hypothesis assumes that relevant actors will be able to objectively assess the techno-economic potentials and limits of H2/PtX technologies, thus increasing acceptance for the development of a green hydrogen economy. This is under the assumption that training offers are accepted and participants take an active part in the dialogue process.

Output 4 improves the competences of relevant stakeholders on the possible impacts of a hydrogen economy on the environment and society. The stakeholders involved in the development of a hydrogen economy have a basis for decision-making that allows them to design hydrogen production and the associated massive expansion of solar and wind power plants in an environmentally and socially compatible manner. This minimises environmental and social problems and improves the acceptance of large-scale hydrogen projects.

The BMZ's strategic guidelines were taken into account.

4.2 Sponsors and partner structure

The **political executing agency** and **implementing partner of** the project is the *Investment and Infrastructure Office* (IIO) of the Office of the President.

With the award of the contract, the political executing agency *Investment and Infrastructure Office* (IIO) receives the right to demand the services to be provided to it directly from GIZ. The GIZ and the political sponsor will regulate the details in an implementation contract.

The IIO is the South African President's central coordinating body for infrastructure development, investment planning and mobilisation. The IIO has a clear vision of how the transition to a hydrogen economy should succeed. Capacity development needs exist in the area of planning, preparation and implementation of selected H2/PtX lighthouse projects (e.g. in the Mpumalanga coal region).

The main **institutions of the downstream partner structure** are: Department of Mineral Resources and Energy (DMRE), DTIC, DSI and the Department of Forestry, Fisheries and the Environment (DFFE).

The DMRE has the mandate to formulate and implement the country's energy policy. It is responsible for planning the power sector, monitoring the power supply and formulating

preventive measures to avoid power shortages. The ministry has about 530 employees, of which about 80 % are specialists and managers (see Chapter 4.1, Target groups). DMRE staff members have in-depth knowledge of mining and conventional power generation and transmission. However, they would benefit from advanced processes and expertise to develop and adapt policies and strategies for building a green hydrogen economy.

The DTIC promotes structural change in South Africa with the aim of building a dynamic, industrial and globally competitive economy. The ministry has about 1,200 employees, about one third of whom work in administration. With a percentage of 54%, women are represented in senior management. The Ministry's professionals have extensive knowledge in the field of economic development and financing. They would benefit from increased expertise to develop a hydrogen industrial strategy for South Africa.

The DSI aims to promote South Africa's socio-economic development through research and innovation. One of the main tasks is to create an enabling environment and resources for science, technology and innovation. The DSI developed the *Hydrogen Society Roadmap,* which include key elements of South Africa's hydrogen strategy. The DSI's technical and managerial staff have a technical and scientific background and are currently leading the hydrogen debate in South Africa. CD needs exist in the area of application-oriented research on H2/PtX.

The DFFE serves to protect the environment and climate and has the mandate to ensure the sustainable use of natural resources. Currently, the DFFE employs about 1,600 people. In order to fulfil its mandate, improved knowledge of the environmental and social impacts of a RE-based hydrogen economy would be beneficial (e.g. land use, water demand and availability, biodiversity, job creation, negative impacts on affected people/communities).

5. Design of the TC module

5.1 Methodological approach (description of PPP, if applicable) and duration

Duration: From 09/2021 to 12/2023

The *capacity development* (CD) strategy of the project includes the further development of competences and capacities on all three CD levels: person, organisation and society. At the level of the individual, the professional competences of political decision-makers as well as experts and managers of the institutions of the downstream partner structure mentioned in Chapter 4.2 and other relevant government agencies as well as the private sector are strengthened in order to support them in the exercise of their mandate. In order to increase the broad impact, training courses (e.g. on innovative H2/PtX technologies) are carried out and institutionalised in selected areas in cooperation with local providers.

At the level of organisational development, the TC module addresses the improvement of service processes (e.g. political and strategic planning), the development of new service offerings (e.g. new business and operator models, digitalisation), as well as the establishment of interdisciplinary communication structures and processes (e.g. promotion of sectoral dialogue, establishment and management of topic-related working groups, webinars), in order to network competence bearers and thus promote the exchange of experience in the field of

H2/PtX. At the societal level, the module works on the establishment of networks (e.g. expert networks, association cooperation) in order to intensify the international exchange of experience on H2/PtX and relevant topics and to initiate technology and business cooperation.

The TC module promotes gender equality by advising partners on how to make the hydrogen sector attractive for women (e.g. promotion of expert networks, strengthening the exchange of experience and knowledge, creation of a gender-sensitive working environment, offers for women at job fairs).

The module follows a *do-no-harm approach by* consistently reviewing any interventions to see what non-intended negative effects they could have on existing conflicts (e.g. competing use of land for agriculture and solar parks). In this context, the module also advocates for disadvantaged population groups within the scope of its influence (e.g. by creating profit-sharing options for villages and communities affected by RE expansion).

Use of instruments: Five international LCFs, seven national LCFs, which can react quickly to partner initiatives and drive the process forward on the ground, and 1 IF as well as CSCEs, which contribute know-how on special issues.

International LZFK are to be deployed in particular for the coordination of activities, for the contribution of international expertise and for regular coordination with the clients BMZ and BMWi. An international LZFK (AV) is responsible for steering the module and for implementing the outputs and achieving the objectives. Another international LZFK is responsible for the implementation of output 1 (strategy development and framework conditions) and output 4 (environment & social affairs). A third international LCFC advises the participating partner institutions on the establishment of an H2/PtX economy (Output 2). An international expert supports the project management in the area of monitoring and evaluation. An international LZFK based in Germany works on knowledge management and synergies with the parallel bilateral hydrogen projects.

National LCFCs are to support the project partners with capacity development, expert advice and networking, and thus create the basis for further selective support by CCIs. A total of seven national LCTCs complete the H2/PtX project team and, together with the international LCTCs, are responsible for achieving outputs 1-4.

A national LZFK takes over the implementation responsibility for outputs 2 and 3. It is supported by a second LZFK, which works to strengthen the technical capacities of selected actors from politics, business, research and civil society (also output 3). A third national LCFC coordinates with policy partners and advises in particular the DMRE and DSI on improving the strategic and regulatory framework for H2/PtX (output 1). A fourth national LCFK (also in Output 1) is working on the consideration of international norms and standards for the production and export of green hydrogen. A fifth national LCFK is working with DTIC and selected private sector stakeholders (e.g. SANEA) to improve the conditions for companies to participate in a South African hydrogen economy (Output 2). The range of tasks also includes the organisation of digital as well as analogue dialogue events, conferences, seminars and workshops on the topic of H2/PtX. The sixth and seventh national FSCs coordinate

all environmental and social activities in close cooperation with the DFFE and other relevant institutions (output 4).

An Integrated Specialist is employed at the *South African National Energy Development Institute* (SANEDI). SANEDI leads and promotes energy research and technology innovation development in the energy sector. The IF will build internal capacity at SANEDI, but also with partner organisations working with SANEDI on green hydrogen. The use of EH is not appropriate due to the political/strategic orientation of the module.

For specific technical advice (e.g. international developments in the H2/PTX market, in-depth studies on the configuration of H2/PTX projects in South Africa, communication strategy development), international CCIs will be used in selected outputs. Funding of up to EUR xxx is envisaged, recipients being the German Aerospace Center (DLR), and SANEDI . DLR is to receive up to xxx euros for the international exchange of students, teachers and researchers, for research cooperation and study trips. SANEDI is to receive a total of up to xxx EUR, of which up to xxx EUR is to be made available to the hydrogen research network HySA for applied research, scholarships, equipment, conferences and workshops. Up to EUR xxx is available to SANEDI to support the South African hydrogen industry. Among other things, the money will be used to set up and run a website where relevant information on hydrogen and power-to-X in South Africa will be published. A total of xxx EUR is available for the procurement of material goods (including vehicles, software/software licences for partner institutions) (outputs 2-4). With the highly specialised team and a high proportion of national experts, potentially expensive deployments of partly highly specialised and correspondingly highly sought-after CCIs can be significantly reduced. The project supports strategy development and other prerequisites for the export of products based on green hydrogen.

Short paths and coordination procedures with the partners as well as proven mechanisms for risk assessment and resource planning also enable short-term adjustments to the use of resources. In this way, the cost-effectiveness of the use of instruments is ensured in the course of the project.

In **Output 1,** the decision-making basis for improving the strategic and regulatory framework for a green hydrogen economy is developed. The CD strategy of the module addresses the technical and strategic competence development of mainly state actors (e.g. DMRE , IIO, National Energy Regulator of South Africa, NERSA, the electricity supplier ESKOM) at the macro level. A key element of support is the joint analysis and development of proposals to adapt existing sector strategies, policies, regulations and guidelines to improve the conditions for an H2/PtX economy (including to build additional RE capacity). Here, a high-level dialogue between BMZ and BMWI and the South African government should advance opinion formation on green hydrogen in South Africa and support the project's measures. Interministerial cooperation is promoted through interdepartmental organisational advice to South African government institutions (including the establishment of a national H2/PtX committee). A first milestone has been reached with the completion of an international benchmarking exercise on H2/PtX strategies. A second milestone marks the presentation of an analysis of the suitability of the regulatory framework for a hydrogen economy.

Output 2 starts at the macro and meso level and aims to improve the conditions for businesses to participate in a South African hydrogen economy. A core element of the development strategy is to strengthen the private sector in its role as a driver of hydrogen market development. Existing information deficits of the partners, especially with regard to global technology and market development, are to be remedied, among other things, through the establishment of a national "H2/PtX Observatory". Jointly conducted simplified feasibility studies for selected H2/PtX lighthouse projects (e.g. Boegoebaai, Mpumalanga), as well as study trips by selected partner experts and managers, are intended to consolidate the knowledge imparted on H2/PtX and lay the foundations for new business ideas. A central element of the funding is to advise the DTIC on the development of an H2/PtX industrial strategy. This is to be done, among other things, with the support of international CCIs. A first milestone marks the introduction of a digital market information platform for potential investors. A second milestone marks the acceptance of the preliminary feasibility study for a first H2/PtX lighthouse project.

Output 3 aims to strengthen the technical skills of selected actors from politics, business, research and civil society on the topic of hydrogen. In this output, there will be close cooperation with SAGEN-CET, which will work in particular on the development and expansion of university curricula on RE and H2. The CD strategy addresses on the one hand decision-makers from public and private institutions (macro level), who receive the necessary basic knowledge through target group-specific training in order to be able to make investment or personnel decisions, for example. Another important target group at the meso level are experts from national research institutions (e.g. HySA network, CSIR). Continuous support for researchers by national and international LZFK/KZE should ensure that up-to-date expertise is made available and that results of applied research from other countries (e.g. on the production of synthetic paraffin) are taken into account. Through expert networks, conferences and workshops, national and international experiences are disseminated and learning from and with each other is promoted. A first milestone has been reached with the successful completion of the first five H2/PtX specialist events.

The impacts of a hydrogen economy on the environment and society are analysed within the framework of **Output 4** using selected lighthouse projects. The insights gained form the basis for strategic decision-making processes, e.g. regarding the expansion planning of renewable energies and the necessary infrastructure. The module essentially works in ecological-social contexts on the CD levels of organisation and society. The focus of the cooperation with the participating institutions from politics and civil society is the joint development of practical and solution-oriented approaches with the aim of mastering the ecological and socio-economic challenges of building a hydrogen economy. A benefit-sharing approach (known from the RE sector) for H2/PTX is also to be further developed. Residents and neighbouring villages of large RE plants for H2/PTX production are to participate in the benefits of the plants within the framework of the benefit-sharing approach via job quotas, financial levies or infrastructure. There will be a special focus on the advancement of women. The DWYPD's national guidelines for gender-responsive planning, budgeting, monitoring, evaluation and auditing, which have been in force since 2019, provide an important starting point and orientation for this. A core element of the development strategy is the design and

implementation of a communication strategy to promote H2/PtX-related dialogue between government agencies, civil society and other relevant stakeholders (e.g. community representatives, environmental and advocacy groups, media representatives, non-governmental organisations). The CD strategy provides for the promotion of joint planning, steering and monitoring processes through the establishment of thematic working groups (macro/meso level). A first milestone has been reached with the completion of the impact analysis of a first lighthouse project with regard to its impact on the environment and society.

Outputs*	Essential activities	Timeframe / Milestones	Instruments used (number / order of magnitude)
Output 1	- Consultation on the structure and tasks of an interdepartmental H2/PtX Committee and an H2/PtX Council. - Conduct international benchmarking and derive recommendations for refining strategic planning documents. - Advice on improving the conditions for the substantial expansion of RE and cost reduction as a prerequisite for the export of green hydrogen. - Analysis of the suitability of the legal and regulatory framework for a hydrogen economy and development of proposals for adaptation.	10/2022: International analysis on H2/PtX strategies completed 08/2022: Analysis of the suitability of the regulatory framework for a hydrogen economy	International LZFK (27 FKM) National LZFK (48 FKM) KZE (63 FKM) Material goods: EUR xxx
Output 2	- Conduct and publish pre-feasibility studies for selected H2/PtX lighthouse projects. - Development of supporting instruments for H2/PtX direct investments. - Establish a national "H2/PtX observatory" for global technology and market development. - Support DTIC in developing a strategy for the hydrogen industry. - Identify the potential for local value creation and opportunities for participation in an H2/PtX economy for small and medium-sized enterprises.	08/2022: Introduction of a digital market information platform 08/2022: Preliminary feasibility study for a first H2/PtX lighthouse project accepted	International LZFK (32 FKM) National LZFK (38 FKM) TCE (129 FKM) Material goods: EUR xxx Financing: EUR xxx
Output 3	- Technical-scientific support for research institutions in applied H2/PtX research and to promote local value creation. - Advising on national technology development in close cooperation with the private sector. - Promote active participation of women in training courses. - Develop a strategy to make the H2/PtX sector attractive for women.	04/2022: Completion of the first five H2/PtX specialist events	International LZFK (13 FKM) National LZFK (38 FKM) KZE (53 FKM) Material goods: EUR xxx Financing: EUR xxx

Outputs*	Essential activities	Timeframe / Milestones	Instruments used (number / order of magnitude)
Output 4	- Analysis of the environmental and social impacts of a green hydrogen economy for selected lighthouse projects. - Identify employment opportunities for coal industry workers and identify training needs. - Development of a concept for the participation of affected population groups in lighthouse project regions. - Develop a communication strategy and appropriate tools to raise public awareness.	03/2023: Completion of the impact analysis of a first lighthouse project	International LZFK (27 FKM) National LZFK (48 FKM) FTE (70 FKM) Material goods: EUR xxx

5.2 Ensuring the sustainable effectiveness of the measures (Outcomes)

The implementation strategy of the TC module takes special account of the orientation towards sustainability. The dissemination of the results is undertaken exclusively by partner institutions. Changes in strategies, policies and regulations are aimed for that will have an impact beyond the end of the module. All tools, methods and information developed by the module are available to the participating project partners immediately after completion and can be disseminated through their individual communication channels (e.g. digital media, workshops, brochures, newsletters).

Some of the planned measures require the financial participation of third parties (e.g. investments in H2/PtX production facilities), therefore there is an interest in the further use of the investment goods as well as in the dissemination and marketing of successfully tested business and operator models. The module will pay special attention to the optimisation of cost-benefit ratios and the acceptance of selected technical solutions and products. The module will ensure that only technologies are used that have a large market potential in the medium term (e.g. for the production of ammonia and methanol) and that meet the funding criteria of relevant consumer countries of PtX products.

The cross-cutting issue of gender is firmly integrated in the project concept. Initial gender equality measures have already been implemented by the end of the project period (e.g. strengthening the exchange of experience and knowledge among women, female *key note speakers* at events, seminars, webinars, conferences). There are also opportunities for exchange within the framework of international initiatives (e.g. *Women in Green Hydrogen, Global Women's Network for Energy Transition*, GWNET).

5.3 Partner services, combined financing

	Concretisation	Estimation of the value
Combined financing	-	-

	Concretisation	Estimation of the value
Partner services	IIO: 5 FKM (e.g. for interministerial communication and steering, development of lighthouse projects) DMRE: 20 FKM (e.g. for adaptation of regulatory framework, strategy development) DITC: 5 FKM (e.g. for industrial strategy development, promotion of small and medium-sized enterprises) DSI: 8 FKM (e.g. for applied research and technology development) DFFE: 5 FKM (e.g. for cooperation in environmental and social studies) SANEA: 7 FKM (e.g. for organisation and delivery of webinars, knowledge management and dissemination). Other: project coordination, communication, provision of event spaces, workshop organisation, contributions to administration	EUR xxx

5.4 Contract value and detailed cost estimate

Up to EUR xxx.

The contract value also includes the costs for participation in the work of the "*Energy Sub-Sahara Africa*" sector network with the aim of ensuring the technical quality and knowledge management required for the implementation of the contract. Also included in the contract value are the costs for an evaluation (interim/final evaluation) of the project as an essential instrument for monitoring the success and accountability of German TC.

The preparation of the project is also part of the contract. The preliminary costs of the measure as well as the services rendered in advance will be transferred in full to the project after commissioning, as these funds are allocated to BMWi title 0904 896 02.

The preparation and evaluation of projects are otherwise carried out in accordance with the procedure agreed between BMZ and GIZ, which GIZ carries out on behalf of BMZ.

For a detailed cost overview, please refer to appendices 3a "Cost estimate and cash outflow by financial year" and 3b "Cost-output allocation".

6. Evaluation of the effects and risks of the module

6.1 Assessment of impacts

General impacts: The TC module contributes to the implementation of the National Development Plan 2030, which envisages contributions to SDG 7 (significantly increase the share of renewable energy in the global energy mix by 2030) and SDG 13 (gradually decarbonise the South African economy by 2040) by expanding the green economy. The project pursues the consistent implementation of the Do-No-Harm approach and maintains transparency and neutrality towards partners and the population.

Economic impacts: By improving the conditions for a RE-based hydrogen economy, more investments are made in climate-friendly technologies. This will diversify the energy mix in the long term and reduce the increase in greenhouse gas emissions and associated external costs. The substantial expansion of low-cost RE can save fossil fuels (e.g. coal, gas, diesel) and reduce energy costs. This relieves the burden on the national budget. It is expected that the expansion of additional RE capacities will also help to reduce the regularly practised power cuts (load shedding) and the associated economic losses. Increasing demand for H2/PtX technologies and related services (e.g. planning, installation, financing) can be economically beneficial and employment-creating in the medium to long term, thus contributing to the achievement of UN Development Goal 8 "Promote sustainable and inclusive growth", with primarily the export market having economic potential in the short and medium term.

Ecological impacts: The module indirectly contributes to making the energy sector in South Africa more environmentally friendly. In particular, the RE expansion results in a saving of fossil energy sources. This reduces the need to operate and expand the capacity of fossil power plants. Negative environmental impacts (e.g. greenhouse gas emissions, particulate matter development) associated with the construction and operation of conventional power plants are thus reduced. The unchecked increase in anthropogenic greenhouse gas emissions and the associated rise in temperature make large parts of South Africa vulnerable to the effects of climate change. The negative effects of climate change are already clearly noticeable (e.g. regular droughts and associated shortages of drinking and irrigation water). However, targeted measures to improve the climate resilience of the national energy system are not part of the module. Adaptation to climate change is therefore not a secondary objective of the module.

In individual cases, technology-specific and location-dependent non-intended environmental impacts may arise (e.g. clearing of forests during the construction of wind and solar power plants, lowering of the groundwater level through water extraction for solar module cleaning). The partners are advised to ensure that possible negative environmental impacts are already taken into account in investment planning and that suitable countermeasures (e.g. reforestation, compensation payments) are provided for. Possible environmental risks are assessed as standard in the South African context as part of the nationally established environmental impact assessment. The project itself does not pose any environmental risks.

Social impacts: Due to its strategic orientation, the module does not offer any starting points for directly improving the living conditions of the population. However, the development of a

hydrogen economy in South Africa opens up new employment opportunities and thus chances for employees to position themselves professionally in this new sector. Gender equality is not a secondary objective of the TC module. However, the project uses its influence on political decision-makers to specifically promote women, who have so far been significantly underrepresented in the coal-dominated energy sector (see Chapter 5.2).

The project is not expected to have any direct negative impacts on human rights, as it is active in areas (policy advice) in which there are no human rights violations in South Africa. As already described in Chapter 3, the project ensures that the expansion of renewable energy systems does not lead to any unintended social impacts or human rights violations (e.g. competing land use, forced resettlement) and that internationally applicable environmental and social standards are complied with.

Conclusions for the design of the module: The described effects and non-intended negative effects were taken into account in the design of the module as follows: (i) When identifying the core problem, mainly political, regulatory and economic aspects were addressed, as these are decisive for the willingness of political decision-makers to change; (ii) The core problem described in Chapter 3 remains even if non-intended effects may occur and is addressed through the design of the measure; (iii) The project concept is geared towards the implementation of the national 2030 Agenda. Through the development of a hydrogen economy, the substantial expansion of RE is indirectly brought about; (iv) The project concept relies on close cooperation with political decision-makers from different sectors who are willing to change and who are intensively involved in the planning, financing and implementation of measures and the dissemination of the resulting results. The impact hypotheses for outputs 1-4 reflect this. Their achievement depends on the active contribution of the partner institutions involved; (v) Consequently, the CD strategy of the module (see Chapter 5.1) also relies primarily on strengthening the technical and strategic competences of political decision-makers as well as experts and managers of the institutions of the downstream partner structure mentioned in Chapter 4.2.

Identifiers, markers and cross-cutting themes are summarised in a table in Appendix 4.

6.2 Assessment of the risks to the effectiveness of the module

Political risk: The TC module promotes political will-building, but for the development of a green hydrogen economy it requires the fundamental willingness of political decision-makers for comprehensive reforms and the will for inter-ministerial cooperation. The prospect of positioning South Africa as a leading nation in the field of H2/PtX production, opening up new export markets and thus generating sustainable economic growth, increases the chance that the necessary reforms will be initiated by the government. However, as reforms in South Africa can be slow, the risk is considered very high.

Implementation risks: In some institutions of the energy sector (e.g. DMRE), there are still reservations about the technical, economic and ecological advantages of RE technologies, whose capacities for the production of H2/PtX products must be massively expanded. There is a risk that individual decision-makers will prove resistant to advice. This risk can be influenced by the TC module to a limited extent. In order to minimise the risk, the module will try

to reduce existing prejudices and thus bring about a change in thinking through intensified technical and process consultation and by pointing out examples of good practice. The job potentials, which are a weighty argument with decision-makers in South Africa, are also to be presented. If necessary, this process should be supported by the strategic placement of specialised personnel within the respective partner institution.

The development of a green hydrogen economy is mainly driven by the willingness of national and international investors to invest in RE and H2/PtX technologies. There is a risk that due to the current difficult market environment in South Africa (e.g. tariffs on RE components, requirements for local value added) investments will not be made or will be delayed. As a result, South Africa could lose its connection to the dynamically developing world market for H2/PtX products. This risk can only be influenced to a small extent by the TC module and the risk is classified as high. In order to minimise the risk, the project will analyse existing barriers to investment and submit proposals to the partners for their removal (e.g. establishment of special economic zones).

Furthermore, the very short duration with a very high budget and annual cash outflow is classified as a risk. Unforeseen problems and delays can hardly be absorbed or compensated by rescheduling.

The impact of the COVID 19 pandemic can lead to restrictions in work and travel opportunities. These can be partially offset by (semi-)remote management and digital communication.

Risk for long-term anchoring: There is a risk that ambitious goals are formulated in strategies and policies for the development of a green hydrogen economy, but that goal achievement is not placed in the foreground of action. This risk can only be influenced by the TC module to a limited extent. Risk-minimising measures include close monitoring of market development at national level, regular exchange and comparison of information with the responsible partner institutions and binding agreement on measures to achieve the goals. The risk is classified as medium, as is its influenceability.

Impact of the measure on the environment and social issues**:** With the focus on policy advice, the environment and social issues are only indirectly influenced by the module. As hydrogen production mainly requires a massive expansion of RE, a comparable logic as for RE promotion applies. RE conserves fossil resources and reduces negative impacts on the environment. In the long term, the reduced need for fossil fuels reduces the necessity and associated environmental risks of exploration measures (e.g. development of coal deposits) in sensitive ecosystems. However, the large-scale expansion of renewable energy systems (e.g. solar and wind parks) can also have negative environmental and social impacts. These include, for example, the clearing of forest areas, increased pressure on available water resources for cleaning solar modules or necessary resettlement measures for the local population. As the TC module is limited to advisory measures, the non-intended negative impacts of the project described above cannot be directly attributed to the project. In output 4, the partners are advised on how to reduce or, ideally, completely avoid the negative impacts (see also the annex to the in-depth environmental assessment). Possible negative environmental impacts are already addressed in the investment planning and appropriate countermeasures

are provided. Overall, the environmental and social impacts of the TC module offered can be classified as medium and the influenceability as medium.

Corruption risks: Nepotism and corruption are widespread problems in South Africa. The unwillingness of persons and institutions firmly anchored in the fossil supply chain to cooperate remains a risk. Further corruption risks exist in connection with the design of eligibility criteria and tendering procedures, as well as in award decisions. Possible impacts on the achievement of objectives are a loss of trust on the partner side and that financed measures are not successfully implemented. The module will therefore advocate for maximum transparency in decision-making processes and for neutrality towards manufacturers and service providers. The risks of corruption are thus assessed as high and the ability to influence them as low.

Overall risk: The overall risk is classified as high and its influenceability as low.

Risk	Classification*	Influenceability*	Risk management measure
Political risks			
Readiness of political decision-makers for comprehensive reforms and the will for inter-ministerial cooperation	4	1	Promote political decision-making Advising policy makers
Implementation risks			
Lack of willingness to cooperate and change on the part of the partners involved Investments are not made, or only with delays Restrictions on work and travel due to COVID 19 pandemic	3	1	Intensified technical and process advice and demonstration of *good practice* examples; strategic placement of specialist staff within the respective partner institution. Making proposals to reduce barriers to investment (Semi-)remote management and digital communication.
Risk for long-term anchoring			
Achieving goals is not the focus of action	2	2	Monitoring of H2/PtX market development, exchange of information with partner institutions; binding agreement on measures to achieve goals.
Environmental and social impacts of the measure (unintended effects)			
Increased pressure on natural resources/ resettlement of local population	2	2	Consideration of possible negative environmental impacts already in investment planning; provide for countermeasures.

Risk	Classification*	Influenceability*	Risk management measure
Corruption risks			
Lack of willingness to cooperate on the part of individuals and institutions Tendering procedures and award decisions	3	1	The module will advocate for maximum transparency in decision-making processes and for neutrality towards manufacturers and service providers.
Overall risk	3	1	

*) Levels: 1=low, 2=medium, 3=high, 4=very high

6.3 Certificate

After examining alternative options, the TC measure described and its implementation modalities correspond to the optimal relationship between the purpose pursued by the TC measure and the funds to be deployed. The country strategies and programmes as well as binding priority area concepts and cross-sectoral strategies of the BMZ were taken into account in the planning.