South Africa's experience with TA for green hydrogen electrolysers

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Mr Selby Modiba
Deputy Director:
Multilateral Cooperation

science & technology
Department:
Science and Technology
REPUBLIC OF SOUTH AFRICA

2030 NDP

Background on the project

- In 2022, UNCTAD launched a pilot project to support the building of TA capacities in Seychelles, South Africa, and Zambia. The project focused on technologies in and for agriculture and energy.

- UNCTAD developed TA Methodology

- South Africa was invited by UNCTAD to participate in the pilot project

- Benefits to South Africa are to domestic build capacities and institutionalise TA in the National System of Innovation (NSI)

- DSTI was the coordinating body/department for the TA in South Africa

Conceptualizing Technology Assessment

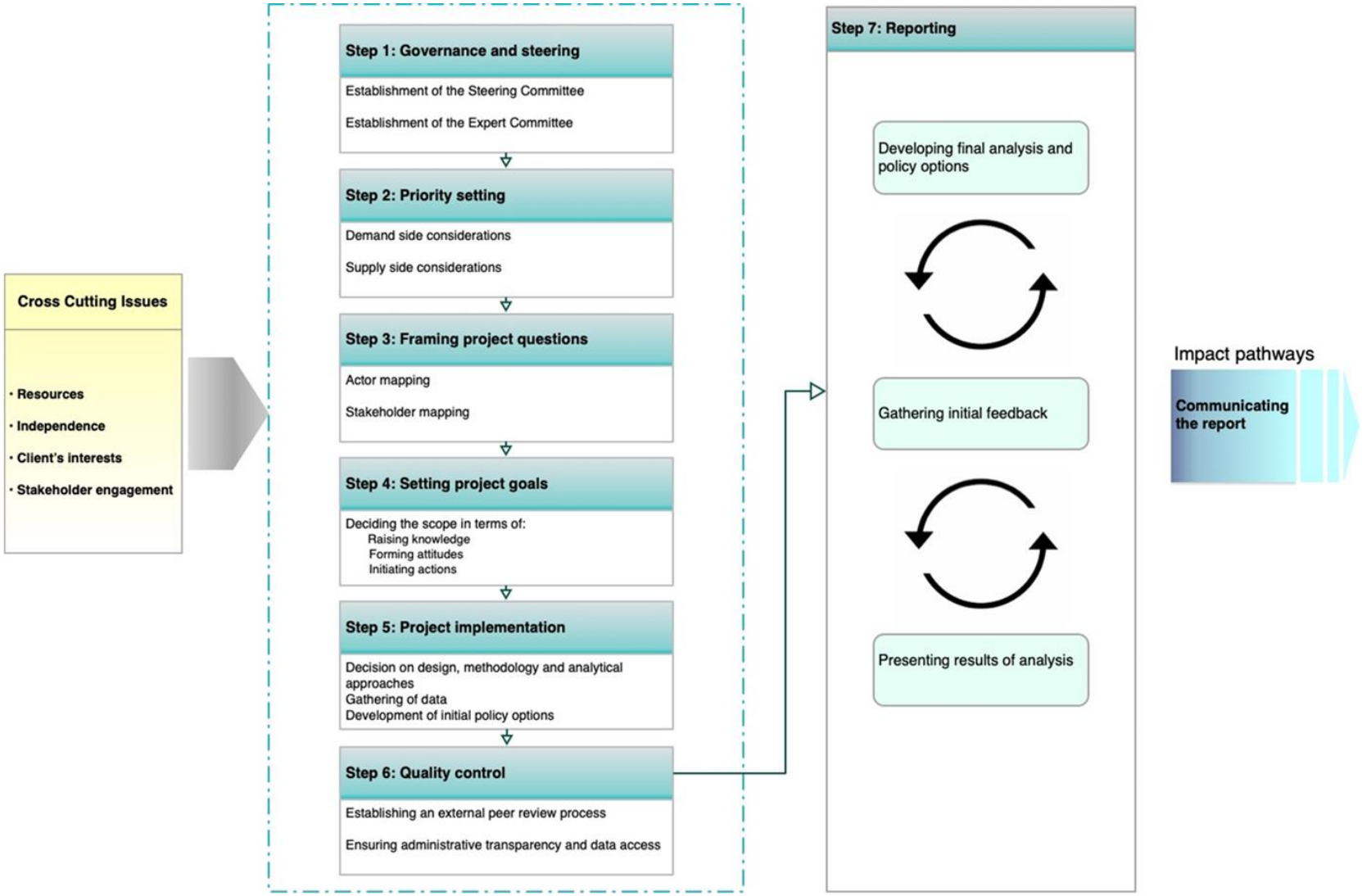
- TA as a problem-oriented process examining social, economic and environmental effects when a technology is introduced, extended, or modified. It is an interactive, communicative, and scientific process that aims to contribute to forming a public and political opinion on the social aspects of technology, risks, and opportunities, providing practical, pragmatic, and sustainable options for policy action.
- Technology assessment (TA) is a useful toolbox for assessing social, economic, environmental, and even political risks and benefits of new technologies. It is an interactive and interdisciplinary process of gathering public perceptions to inform policies for science, technology, and innovation (STI) and ensuring good governance of new and emerging technologies.
- TA is being institutionalized in many countries, particularly developed ones, through administrative and legislative processes.

Internal DSTI Process

Requested approval from the Director-General of the Department since the project was a pilot.

The Director-General wrote to UNCTAD to express South Africa's interest to participate in the project

SEVEN STEPS PROCESS/ METHODOLOGY



Step 1-Steering Committee and Expert Group

DG of DSTI appointed the Steering Committee including the Chair of the SC - SC to manage, guidance, oversight, set priorities

SC identified the experts to formulate the Expert Group

--EG to implement the TA i.e provide information in area of speciality

Identified SC and EG representatives nominated by institutions (both energy and agriculture sector)

Structure and representation

- SC chaired by the DSI and also DSI provide secretariat support.
- Chair of the SC appoints the EG
- Two TA experts/consultants to work with SC and EG to collate, consolidate and draft the report.

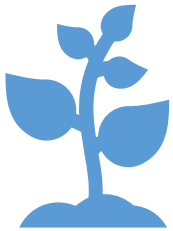
STRUCTURE AND REPRESENTATION

DSI: CHAIR OF STEERING COMMITTEE AND SECRETARIAT SUPPORT TO PROJECT	
STEERING COMMITEE	**EXPERT GROUP**
Agricultural Research Council	Agricultural Research Council
Department of Agriculture, Land Reform and Rural Development	Department of Agriculture, Land Reform and Rural Development
Department of Science and Innovation (Agric , Energy and International sections)	Department of Science and Innovation (Agric and Energy sections)
South African National Energy Development institute	South African National Energy Development Institute
Technology innovation Agency (Agric and Energy)	Green Cape
Academy of Science of South Africa (Gender desk)	(Academia) Universities of Pretoria and Cape town
	UNIDO (SADC office) and others
Independent TA Experts/Consultants	Independent TA Experts/Consultants

Process for step 2: Priority setting

Two separate meetings, starting with Agriculture group in 17 Nov 2022 in person

- Participatory process
- Reference to many policy documents in SA and at regional level
- Policy documents informs the decision on technologies
- Technologies that are suitable for TA process – new and emerging
- To address impact on social, economic and environmental impact of the technology



Identify Agricultural Technologies

-Tools for Traceability (Animal traceability in particular)

-Omics for Food

Step 2- Priority setting

Energy group meeting on 7 March 2023 remotely

- Reference to many policy documents in SA and at regional level i.e., White paper of STI, Energy policies, DSI decadal plan

Identified Energy technologies

- **Green hydrogen,**
- Floating PV Solar panels,
- Agro-Votaics,
- AI in Energy ,
- Energy storage

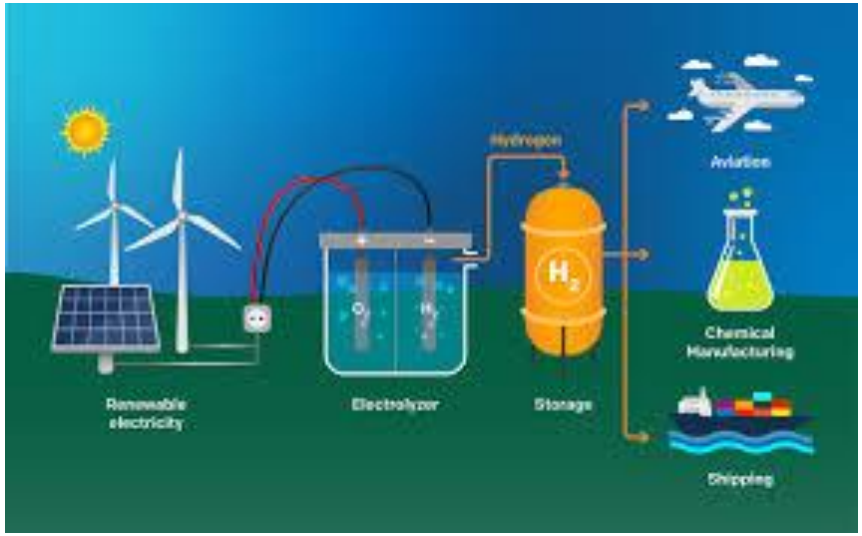
Why focus TA on electrolyser technologies?

South Africa decided to focus its TA on electrolyser technologies given the high interest in the production and commercialization of green hydrogen energy.

In 2007 Cabinet adopted Hydrogen South Africa (HySA) and in 2008 the Department of Science, technology and Innovation (DSI) established Centers of Competence (CoC) to implement the HySA strategy. HySA is based on the fact that the country has a rich endowment of platinum and renewable energies critical to produce green hydrogen.

Green Hydrogen and electrolysis process

- Green hydrogen is hydrogen produced by splitting water into hydrogen and oxygen using renewable sources of electricity



National energy challenge

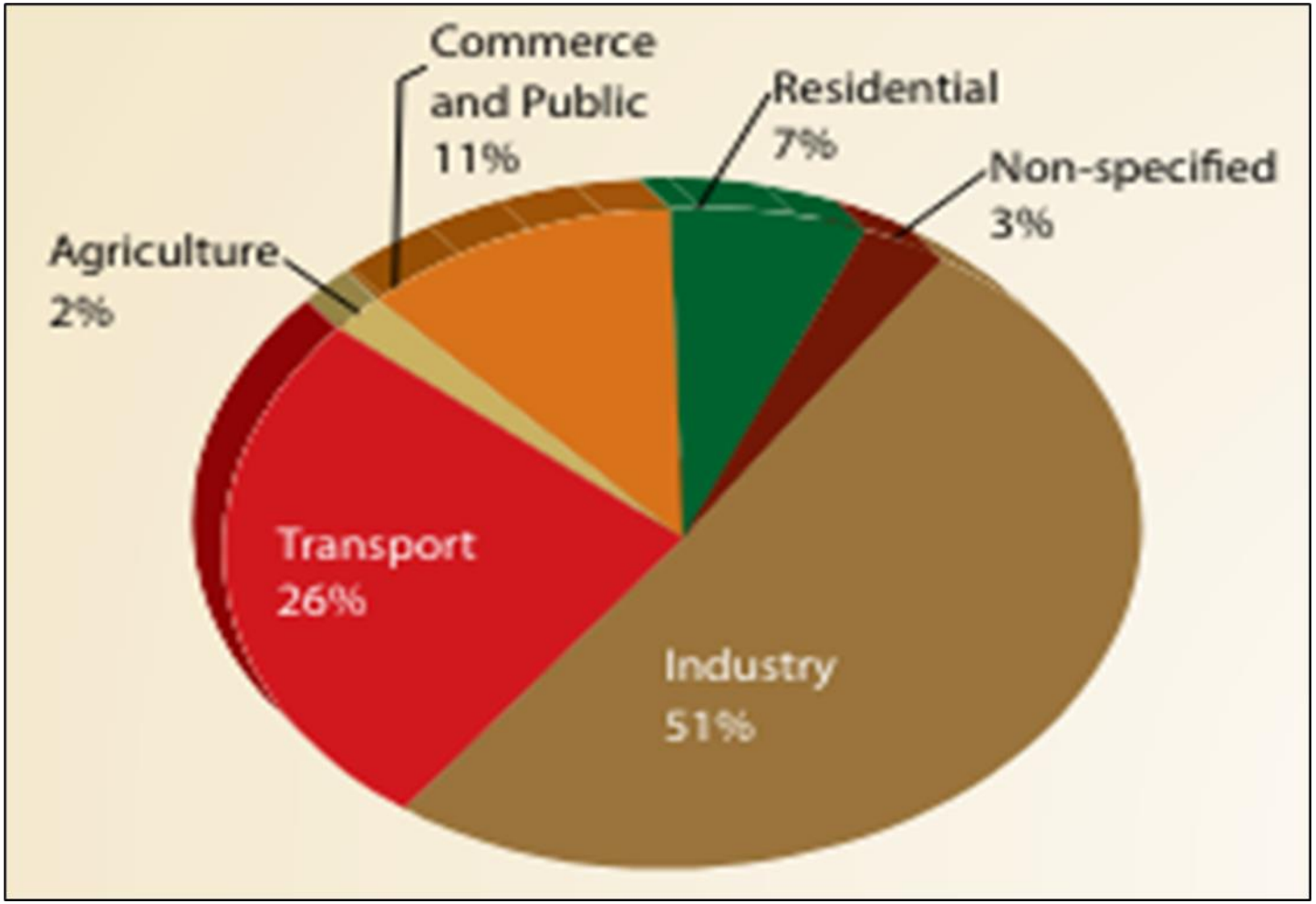
- Energy represents 81% of South Africa's emissions of which 45% is from electricity. SA among the world's top 20 greenhouse gas (GHG) emitters and has incurred international obligations under the Paris Agreement to lower its emissions. It needs to diversify sources of production of clean (low carbon) energy and address structural impediments to access and affordability of energy.

- The total nominal ESKOM generating capacity is about 44GW, and due to the unavailability of the production fleet, has failed to meet demand.

- Industrial demand for energy is in excess of 50% of the total.

- The government wants to significantly increase energy supply to meet demand while increasing the share of gas and renewables in the energy mix.

South African Energy demand by Sector, 2018



Overview of energy policy frameworks

Government	State owned enterprises	Private companies	Academia and R&D	Other
▪ **Depart of Science and Innovation (DSI)** – *research and innovation, renewable energy and South African hydrogen strategy* ▪ **Mineral Resources and Energy (DMRE)** – *energy policy, energy mix, renewables and planning* ▪ **Department of Electricity (DE),** *-energy supply* ▪ **Trade, Industry and Competition (the dtic)** –*develop manufacturing, green industries and foster trade and foreign direct investment* ▪ **Depart of Transport (DoT)** –*targets and meet green transport intent* ▪ **Department of Public Works and Infrastructure** –*utilising green technologies in buildings and infrastructure* ▪ **Department of Public Enterprises (DPE)** – *SOE shareholder, governance and oversight* ▪ **National Treasury** –*national fiscs, budgets, procurement and control* ▪ **Department of Forestry, Fisheries and the Environment (DFFE)** –*sustainability and environment management* ▪ **Provincial Governments:** key Gauteng, KZN, Limpopo, Northern and Western Cape –*by-laws, procurement and infrastructure*	▪ **ESKOM** –*power generation, distribution, export and procurement from independent power producers* ▪ **National Energy Regulator of South Africa (NERSA)** *-licence and regulate energy sector, infrastructure and tariffs* ▪ **PetroSA** –*gas and hydrocarbon exploration, acquisition, development and marketing* ▪ **Transnet** –*road, rail and port infrastructure. Green energy use and application* ▪ **Central Energy Fund (CEF)** –*security of supply and exploration, acquisition, development and marketing* ▪ **Industrial Development Corporation (IDC)** – *industrial development funding*	▪ **SASOL** *-energy and petrol capital company and develop hydrogen-based infrastructure.* ▪ **Anglo American, Impala Platinum, Isondo Precious Metals and other mining companies** – *security of supply, application develop hydrogen-based infrastructure* ▪ **Independent Power Producers (IPP)** –*energy generation* ▪ Mulilo energy holding ▪ **Refineries; Total energies, Shell Hydrogen, Astron refinery, BP, Busmark**, *-Green energy use and application* ▪ **Bambili Energy, KPMG, TongaatHulett, Africa H2 Project, CHEM Energy South Africa, Hydrox Holdings, Afrox, Air Liquide, ArcelorMittal** *-security of supply, application develop hydrogen-based infrastructure*	▪ **South African National Energy Development Institute (SANEDI)** – *Energy R&D and in green energy application* ▪ **North-West University,** *HySA Infrastructure, energy R&D, innovation and capacity development* ▪ **University of Cape Town & ESRG** - HySA Catalysis, *energy R&D, innovation and capacity development* ▪ **University of Pretoria** - *energy R&D, innovation and capacity development* ▪ **University of Witwatersrand** - *energy R&D, innovation and capacity development* ▪ **University of Western Cape** -HySA Systems, *energy R&D, innovation and capacity development* ▪ **CSIR** - *HySA Infrastructure, energy R&D, innovation and capacity development* ▪ **MINTEK** -HySA Catalysis, *energy R&D, innovation and capacity development* ▪ Public funded R&D institutions ▪ HySA Infrastructure Centre of Competence	▪ Africa Climate Foundation, ▪ Responsible care, ▪ Chemical and allied industries association ▪ RMI ▪ South African Institute of International Affairs (SAIIA) – UK Partnering for Accelerated Climate Transitions (UK PACT) ▪ Poelano High School ▪ Global Hydrogen Council

Stakeholders in energy sector

Government	State owned enterprises	Private companies	Academia and R&D	Other
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THE DECADAL PLAN

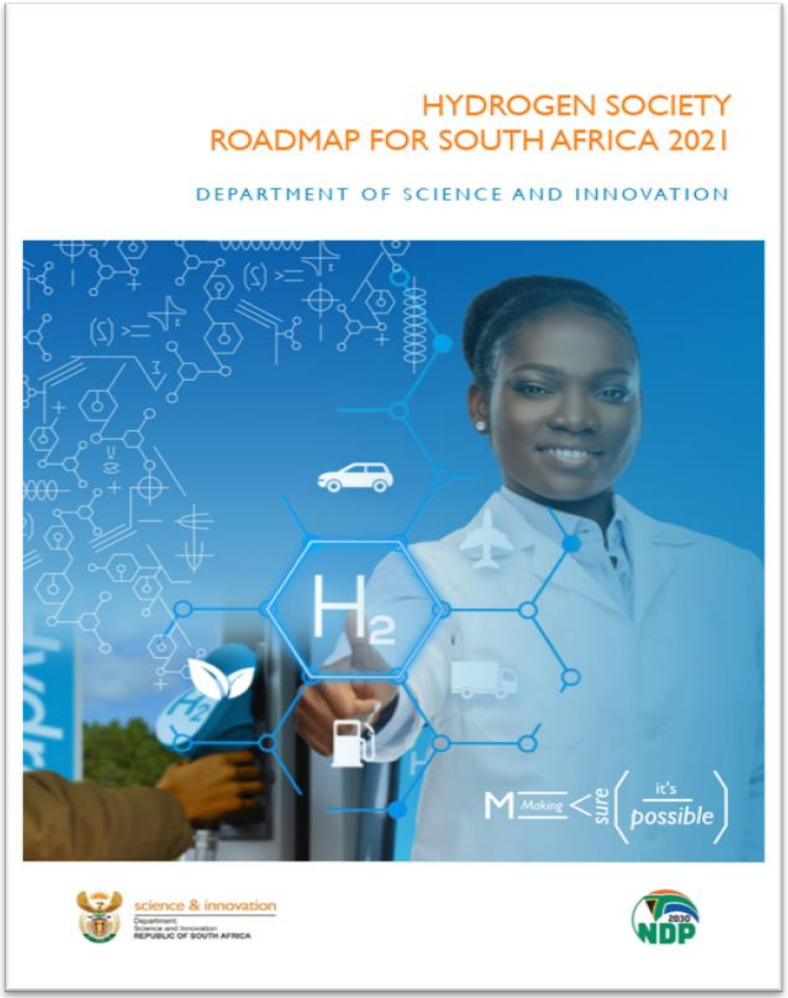
The Decadal Plan is the implementation plan for the 2019 White Paper on Science, Technology and Innovation (STI)

Vision of the White Paper: Science, technology and innovation enabling sustainable and inclusive development in a changing world

The Decadal Plan theme is:

"deepening knowledge economy for enhanced socio-economic impact"

THE HYDROGEN SOCIETY ROADMAP



https://www.dst.gov.za/index.php/resource-center/strategies-and-reports/3574-hydrogen-society-roadmap-for-south-africa-2021

Vision

An inclusive, sustainable and competitive hydrogen economy by 2050 with the goal of achieving a Just and inclusive net zero carbon economic growth for societal wellbeing by 2050.

Purpose

To align stakeholders on a common vision on hydrogen related technologies in order to create an environment where investment decisions can be made to unlock the social economic benefits for the country.

KEY ACTIONS AND MILESTONES

2021-2024

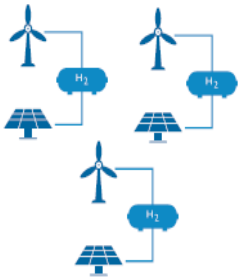
PRODUCTION
- Small scale electrolysis production
- At least 1MW GH2 production piloted

USE
- At least 100 buses and trucks powered by H2 by 2025
- At least 20 forklifts converted to fuel cell power by 2025
- At least 5 refueling stations deployed by 2025
- Demonstration in power generation and stationary fuel cells in public buildings
- Industry demonstration including SAFs

JOBS
- Upscaling of training and reskilling for new jobs

2025-2030

PRODUCTION
- 5GW electrolysis capacity under construction in NC
- 10GW electrolysis capacity deployed in NC by 2030
- 1.7GW electrolyser capacity deployed in H2 Valley by 2030
- At least 500kt H2 produced annually by 2030

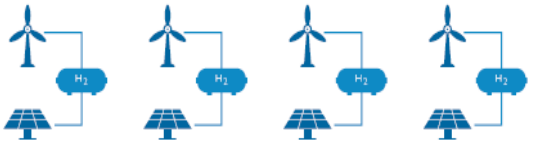


USE
- At least 500 buses and trucks powered by H2 by 2030
- Power generation in turbines using H2 and ammonia
- Sector coupling and use in transport, industry

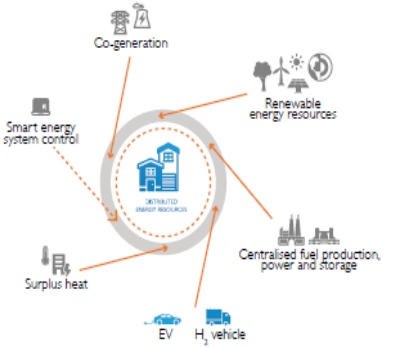
JOBS
- At least 20 000 jobs created annually by 2030

2030-2040

PRODUCTION
- Increase electrolysis capacity to at least 15GW by 2040



USE
- Sector coupling and full use in transport, industry and power



JOBS
- At least 30 000 jobs created annually by 2040


Establish targets and policy signals


Support demand creation


Mitigate investment risk


Harmonize standards and remove barriers


Promote Research, Development and Innovation

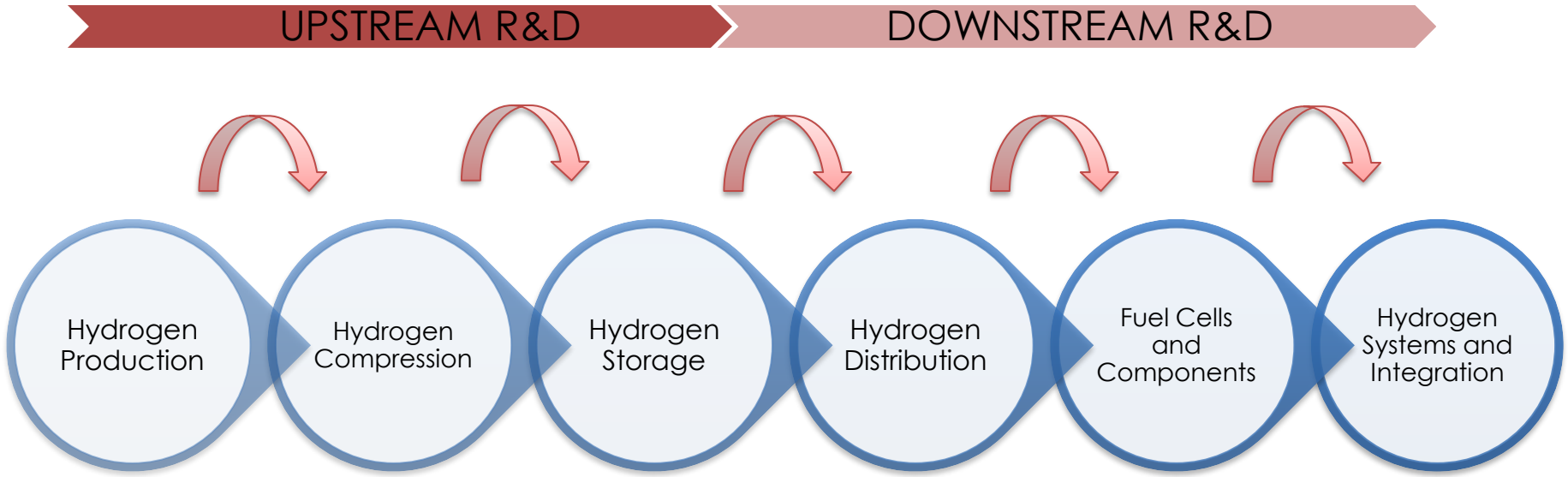

Strategic demonstration and deployment projects


Skills development and public awareness

Electrolysers research and technology development in SA

Centre of competence	Hosts	Focus area
HySA Systems	University of the Western Cape	Systems Integration & Technology Validation
HySA Catalysis	University of Cape Town and MINTEK	Catalysis (development of catalytic components for PEM electrolysers and fuel cells)
HySA Infrastructure	Northwest University and CSIR	Infrastructure (hydrogen storage and delivery/transportation)

HYSA COCS EXPERTISE AND FOCUS AREAS



- PEM electrolysers CCM
- Portable PEM electrolyser
- Water electrolyser stacks

- Electrochemical hydrogen compressor
- Metal hydride compressor

- Metal hydride Medium pressure Hydrogen storage
- Liquid organic hydrogen carriers

- Green ammonia
- Liquid organic hydrogen carriers

- PEM fuel cells and MEAs
- Fuel cell catalysts

- Refueling stations
- Electric fuel cells powered modules

HySA Infrastructure
NWU
CSIR

HySA Catalysis
UCT
Mintek

HySA Systems
UWC

Electrolysers research and technology development

DSI in partnership with private companies Anglo-American, Bambili Energy and ENGIE are establishing a hydrogen valley in the Bushveld complex and larger regions around Johannesburg, Mogalakwena and Durban. The selection of the corridor from Durban to Mogalakwena was based on the potential to switch many of the industrial, mobility and buildings activities to hydrogen fuel.

Under the HySA, the Hydrogen South Africa Public Awareness, Demonstration and Education Platform (HySA PADEP) was established to market hydrogen technology locally and internationally.

Private sector initiatives include the Anglo-American Platinum, BMW Group and Sasol South Africa piloting of hydrogen vehicles, and Phelan Green Energy's green hydrogen project to establish a state-of-the-art green hydrogen-ammonia plant in the Western Cape. Sasol already produces about 2% of global hydrogen supply using coal gasification facilities. PetroSA uses hydrogen in its gas-to-liquids refinery.

Data collection methods

- Reviewed of literature on policies for and institutional actors in the hydrogen economy as well as trends in electrolyser technology research and innovation (R&I) in the country
- Conducted a survey using questionnaire on the economic feasibility and competitiveness of South Africa in electrolyser technologies in local, regional, and international markets. Thirty-four respondents participated in the survey.
- Held virtual and face-to-face interviews with more than 25 key stakeholders from private sector, academic and policy-making groups involved in the hydrogen energy sub-sector in general and R&I on electrolysers.
- Virtual FGD and validation workshop

Questionnaire

1. If you look to the year 2030, do you assume that South Africa will be a relevant supplier of electrolysers and/or elements/ (e.g. membranes) to the domestic, regional and global market?
2. Should South Africa be subcontracted in the coming years by international manufacturers of electrolysers to supply specific components?
3. What do you see as the main advantages of South Africa in the international electrolysers market?
4. What do you see as the main disadvantages of South Africa in the international electrolysers market?
5. What should be done to strengthen knowledge creation and knowledge application in South Africa related to the electrolysers technologies?
6. Do you fear that a strong focus on hydrogen / electrolysers technologies could imply that other important science and technology fields get inadequate funding / attention?

- 4th International Conference on Electrolysis (27 August to 1 September 2023)

Findings (1)

- South Africa has a relatively high technical potential to engage in the development and use of electrolyser technologies. It has accumulated capabilities in electrolysers and is participating in international partnerships in hydrogen. However, the country needs to better coordinate its different electrolyser R&I initiatives to exploit economies of scale. Greater public-private sector partnerships or coordination may help enhance its innovativeness in electrolysers.
- There is uncertainty as to whether the country is and will become economically competitive in the regional and international markets for electrolysers.
- The country has a relatively rich body of policy frameworks for hydrogen but a poorly coordinated set of initiatives among the institutional actors.
- There was a limited understanding among the stakeholders of how electrolyser technologies would impact the natural environment and what are their social benefits and risks. This may be attributed to the nascent state of electrolyser technology deployment in the country.

Findings (2)

- There is a diverse range of actors in the green hydrogen sector but there is relatively weak coordination among them. Many government departments, SoEs, private companies, universities, civil society, and international partners have growing interest and activity in green hydrogen technologies.
- The project offered lessons for institutionalizing TA in the country. There are some capacities that have been built by the project. There is, however, a need to build both human and institutional capacities for comprehensive participatory TAs.
- Low public understanding and awareness of the green hydrogen economy and electrolyser technologies in the country. The public is not adequately informed of potential benefits and risks of electrolyser technologies and hydrogen. Investments in and the work of HySA centers of competence is known to a small circle of stakeholders in academia and industry.

Recommendations (1)

- Government should consider vesting responsibilities for coordinating hydrogen policies and programmes in an existing agency with the view to building synergies among different initiatives and actors in the NSI and exploit economies of scale. For this purpose, a mapping of the different responsible agencies should be conducted.
- The parliamentary portfolio committees for energy, STI, trade and industry, and parliament as a whole, should be actively engaged in hydrogen policy and decision-making, particularly in reviewing existing policies and developing appropriate hydrogen regulations. Capacity building to enhance legislatures' awareness or understanding of benefits and potential risks of green hydrogen is needed.
- There is need to develop a compendium of policy frameworks and instruments for STI-energy nexus to ensure policy coherence and effective governance of the hydrogen energy sector. Such a compendium could be developed by NACI.
- Government should conduct comprehensive policy instrument effectiveness assessments to identify which policies work, which instruments are effective for which policy goals, and how to improve the effectiveness of energy technology policies in the country.

Recommendations (2)

- There is a need to build energy technology policy literacy across government and the public by organizing workshops and media sessions to raise awareness of specific policy goals and actions. This would help to improve literacy and implementation of specific hydrogen energy policies in the country.
- Government may wish to develop subsidies and other fiscal policy instruments to incentivize local private sector and SMMEs participation in electrolysers for green hydrogen production development and commercialization; and
- Government should develop clear pathways for commercializing electrolysers for green hydrogen production.

Recommendations (3)

- NACI conduct at the same time specific studies on social and environmental impacts of different electrolyser technologies considering different regional and socio-economic contexts. Such studies need to be transdisciplinary to be able to gather relevant data on different aspects of South Africa's socio-technical systems.
- To enhance public understanding and awareness of green hydrogen technologies and to build strong constituencies to support continued investments in programmes for implementing HySA and related initiatives, workshops and other outreach activities using various media, including social media, should be launched and implemented.
- South Africa should develop a multi-year national TA capacity building programme that would include benchmarking exercises for policy learning, training workshops or courses, cross-departmental TA exercises, and postgraduate TA fellowships in local universities.

Proposed Action Plan

Policy recommendations	Implementation action	Responsible agency	Expected outcome	Timeframe /resources
Strengthening hydrogen research and innovation in the NSI	Establish a national committee. (DSI) Develop a compendium of hydrogen policies and programme (DSI/NACI) Increase the number of SARCHI national research Chairs (NRF)	DSI, NACI. TIA, NRF	Better coordinated governance of hydrogen initiatives; increased economies of scale in the hydrogen economy.	tbd
	Conduct feasibility studies Assess TRLs Markets Commercialisation of Technologies	TIA	Viability of hydrogen technologies	tbc
Conduct comprehensive socio-economic feasibility studies of electrolyser technologies	Commission independent studies. Conduct workshops on socio-economies of electrolysers value chains Assessment of electrolyser technologies value chains	DMRE, DSI, NACI, Presidency, Ministry of electricity? DTIC	Improved knowledge of economics of electrolysers; and better economic targeting of investments in R&I	tbd
Conduct social and environmental impact assessments	Develop a framework for impact assessments. Commission independent assessments. Assessment of electrolyser technologies value chains	Department of Environmental Affairs, NGOs, DSI. DTIC	Improved knowledge of social and environmental impacts; and increased public support for and confidence in electrolyser technologies	tbd

Action Plan Conti……

Policy recommendations	Implementation action	Responsible agency	Expected outcome	Timeframe /resources
Public awareness and understanding of electrolysers	Develop a manual and briefing materials. Integrate hydrogen in schools' curricula. Public workshops and briefing Use of media	DSI, NRF-SAASTA. DBE; GCIS, DHET, Industry	Improved public understanding and support for electrolysers	tbd
Institutionalizing TA in South Africa	Conduct benchmarking and studies on best practices TA Develop national TA guidelines	DSI/NACI, Presidency	Strengthened TA capacities	Tbd (Other role players- add a column))
	Skill development for TA	DHET, DSI, DTIC, DoL, SETAs	Strengthened TA capacities	
		TIA; TIA		

ANY QUESTIONS

Lessons learned

It is emerging that the TA process should be informed by the Technology Foresight studies that outline the priority technologies in our respective countries

Technologies that are suitable for TA process – new and emerging

There is a need for more resources (financial) for this project

More involvement and support of UNCTAD/Consultants (to clarify issues)

Combination of online and in-person meetings works

Need for more regional meetings to share experiences among the beneficiary countries.

There is a need for consistency and commitment from the Steering Committee and Expert Group.

A need for a coordinated civil society group(s), to get different perspectives.

Sensitivities in the energy sector which include indecision and reluctance from relevant Minister who should be involved.

ANY QUESTIONS