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Training in Uncertainty: Skills Foresight for a Just Green Hydrogen Transition

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Recommendations

- The DHET and HRDC should embed strategic foresight into green skills planning, forming a dedicated foresight team within the DHET, funded by the NSF. The Presidential Climate Commission should oversee the dissemination of findings via an online platform.
- The DHET should advance skills anticipation in TVET, empowering lecturers and students and offering futures literacy training and collaborative workshops on skills foresight for decision makers. The DHET's task team should lead, thereby enhancing sectoral agility.
- The Presidency should establish a Cross-Sectoral TVET Advisory Board for Green Transversal Skills in the HRDC to manage whole-person formal and informal skills development, assess credentialing, address barriers and promote knowledge-sharing, guided by the DHET foresight task team.
- The Presidency should launch participatory futures dialogues to co-create a vocational education social compact, facilitated by the DSI's online forums and SETAs' advocacy on TVET campuses to inform DHET-led anticipatory exercises for policy enhancement and bridging TVET–university green skills gaps.

Executive summary

Persistent mismatches between technical vocational skills and industry needs pose a significant challenge in establishing South Africa's local green hydrogen economy (GHE), which depends on a workforce with mid-level renewable energy-related skills. Drawing on successful implementations in countries such as Russia, Brazil and Finland, integrating skills foresight approaches can address these challenges effectively. Embedding skills foresight as a complementary approach throughout the South African skills development system is imperative. By employing a participatory futures approach and conducting a strategic foresight-informed three-day workshop, two policy dialogues and several interviews with government officials and experts, the research identified four priority areas. These are: strengthening skills anticipation systems, enhancing technical vocational education and training (TVET) sector responsiveness, developing transversal skills and fostering a renewed education-related social compact. Recommendations include integrating skills foresight into skills plans, providing skills foresight and anticipation training for decision makers, using strategic foresight to enhance credentialing systems and initiating participatory futures dialogues for building a new educational social compact. The research emphasises the urgent need for skills foresight integration to address industry-training mismatches. By adopting futures thinking strategies and engaging stakeholders, South Africa can better prepare its workforce for the demands of the GHE and transform its post-school education and training (PSET) system.

Introduction

Green hydrogen (GH₂) is championed as the fuel of the future, owing to its potential to decarbonise heavy industries through an emission-free production process.¹ New research and investment proposals on the development of a global hydrogen value chain are released weekly.² This signals the need for a proactive understanding of the technical vocational education and training requirements and associated skills for this burgeoning multi-purpose energy carrier.

The establishment of a local GHE relies on the availability of a skilled workforce in renewable energy-related fields with technical, digital and artisanal expertise.³ Mismatches between the skills provided at the technical vocational level and the needs of industry are a key concern in this regard.⁴ Employers have, for instance, already noted a shortage of hydrogen fuel transporters.⁵ This is despite the presence of well-established skills anticipation and development components related to the South African TVET ecosystem,⁶ such as the Human Resource Development Council (HRDC), the National Skills Authority (NSA) and Sector Education and Training Authorities (SETAs).

These shortcomings are attributed to the South African skills planning system's limited anticipatory capacity⁷ and inadequate coordination, as well as the absence of a focused, contextually appropriate approach to skill development.⁸ The system primarily relies on quantitative data such as econometric forecasts, surveys and tracer studies.⁹ This has its limitations, including a narrow window of data validity. As such, international best practice advocates for a holistic approach to skills development, integrating both quantitative and qualitative data sources.¹⁰

Strategic foresight emerges as a crucial approach. Unlike traditional forecasting methods, which rely heavily on quantitative data and probable outcomes, foresight takes a systematic approach to thinking about multiple futures to anticipate and imagine transformative

1 Green Hydrogen Organisation, *Green Hydrogen Standard: The Global Standard for Green Hydrogen and Green Hydrogen Derivatives Including Green Ammonia* (Geneva: GH₂, January 2023).

2 Sanjay Kumar Kar, Sidhartha Harichandan and Biswajit Roy, "Bibliometric Analysis of the Research on Hydrogen Economy: An Analysis of Current Findings and Roadmap Ahead", *International Journal of Hydrogen Energy* 47, no. 20 (2022): 10803–10824.

3 Bambili Advisory, "The South African Hydrogen Economy: A TVET-Industry Skills Gap Analysis" (Unpublished Working Paper, UK PACT-SAIIA, June 2021).

4 Bambili Advisory, "The South African Hydrogen Economy".

5 Yershen Pillay, "South Africa Faces a Hydrogen Skills Crisis", *Cape Business News*, February 5, 2023.

6 The South African TVET ecosystem is a complex system encompassing various stakeholders, policies and initiatives to enhance technical and vocational education and skills development. It involves a wide range of actors, including government bodies, educational institutions, industry representatives and other organisations, working together to improve the quality of TVET education and address the country's technical and vocational skills development needs.

7 The Presidency, Republic of South Africa, *Just Energy Transition Implementation Plan 2023–2027* (Pretoria: The Presidency, 2023).

8 Human Resource Development Council, *Review of the Current Skills Development System and Recommendations Towards the Best Model for Delivering Skills in the Country* (Johannesburg: HRDC, 2013).

9 Stephanie Matseleng Allais, "Beyond 'Supply and Demand': Moving from Skills 'Planning' to Seeing Skills as Endogenous to the Economy", *Journal of Vocational, Adult and Continuing Education and Training* 5, no. 1 (2022): 19.

10 International Labour Organization and OECD, *Approaches to Anticipating Skills for the Future of Work*, Report (G20 Employment Working Group, Second Meeting of the Employment Working Group, Geneva, June 11–12, 2018).

alternatives.¹¹ The key tenets of foresight include recognising the future as a realm of possibilities beyond precise prediction, prioritising long-term perspectives and adopting holistic approaches that consider peripheral and systemic factors.¹² By using narrative or visual representations, foresight promotes inclusive and engaging discussions among stakeholders, offering fresh perspectives on current challenges.¹³ The embrace of diverse perspectives also helps mitigate individual and collective biases.¹⁴

Skills foresight (SF) is the specific branch of strategic foresight related to anticipating skills demand in the face of rapidly increasing uncertainty. It involves systematically integrating anticipatory intelligence from various sources¹⁵ to inform policy planning and preparing for future skills needs.¹⁶ SF is a process wherein outcomes are consistently assessed and integrated into strategy implementation, allowing for continuous feedback that contributes to targeted skills development.¹⁷ SF thus necessitates significant systemic changes in thinking and behaviour to foster truly transformative educational outcomes.

The Committee of the Future in the Finnish Parliament exemplifies the power of SF – it has identified 200 new professions projected to emerge in the future. Through this proactive approach, it ensures preparedness for forthcoming challenges by cultivating the requisite knowledge and skills in the present.¹⁸ Brazil’s SENAI¹⁹ model serves as a further example of effective SF. Through its engagement with a broad range of stakeholders, it achieved a comprehensive understanding of the occupational landscape before employing diverse foresight methods to project worker demand and identify required skill adjustments.²⁰ Implemented across various industries, including petrochemicals, heavy equipment, telecommunications and construction, the SENAI model’s success highlights SF’s broad applicability and adaptability.²¹

Without a skilled workforce driving the transition to a GHE, South Africa will inevitably struggle to fully harness the economic and environmental benefits of this promising industry. Consequently, this policy briefing addresses the potential skills gap between South Africa’s TVET sector and the evolving demands of the emerging GHE. To tackle these challenges, foresight-oriented consultations, including interviews, a high-level three-day futures literacy lab and series of policy dialogues, were conducted with diverse

11 Nicholas Gilmore et al., “Clean Energy Futures: An Australian Based Foresight Study”, *Energy* 260 (December 1, 2022): 125089.

12 Olivier Woeffray and Paulo Carvalho, “Why Strategic Foresight Is Essential for Future Preparedness”, World Economic Forum, February 6, 2023.

13 Gilmore et al., “Clean Energy Futures”.

14 Woeffray and Carvalho, “Why Strategic Foresight”.

15 European Training Foundation, *Frame: Skills for the Future Foresight* (Turin: ETF, 2014).

16 ILO, “Anticipating and Matching Skills and Jobs” (Guidance Note, ILO, Geneva, 2015).

17 ETF, European Centre for the Development of Vocational Training and International Labour Office, *Developing Skills Foresights, Scenarios and Forecasts. Guide to Anticipating and Matching Skills and Jobs, Volume 2* (Geneva: ETF, 2016).

18 OECD, “Strategic Foresight for Better Policies: Building Effective Governance in the Face of Uncertain Futures” (OECD, Paris, October 2019).

19 SENAI is a technical and vocational education training institution that provides vocational training and technological services for industry.

20 ILO and OECD, *Approaches to Anticipating Skills*.

21 Fernando Vargas (Coord.), *Skills Anticipation: The Transfer of the SENAI Prospective Model, Latin America and the Caribbean Outlook* (Montevideo: ILO and Cinterfor, 2015), 120.

stakeholders. The research findings highlight the necessity to rethink skills planning beyond the current paradigm and to adopt skills foresight and an extended understanding of skills anticipation to transform the TVET ecosystem.

TABLE 1 THE DIFFERENCE BETWEEN SKILLS PLANNING, SKILLS FORESIGHT, SKILLS ANTICIPATION AND SKILLS GOVERNANCE		
Category	Description	Key features
Skills planning	A traditional approach to planning for future skill needs	<ul style="list-style-type: none"> Relies on historical data and predictive models Often follows a top-down, expert-driven approach Over-reliance on quantitative data and forecasting methods
Skills foresight	A structured process for anticipating future skills needs to inform present-day decision-making	<ul style="list-style-type: none"> Emphasises imagining multiple futures Adopts broad-based participatory approaches Informs policymaking Fosters collaboration Enhances foresight capabilities Drives commitment to strategic visions Assists in making better decisions for present-day actions
Skills anticipation	The process of acting on skills foresight by building proactive responses to futures intelligence by means of experimentation and prototyping a variety of proactive ready-made policy options.	<ul style="list-style-type: none"> Experimentation and prototyping Developing proactive rather than reactive policy responses Embrace of a variety of approaches Collaborative approaches Relies on foresight intelligence
Skills governance	The process of putting in place institutional structures, operational processes and dissemination channels that may aid stakeholder interaction and policy reaction based on reliable labour market information signals by applying skills planning, skills foresight and skills anticipation	<ul style="list-style-type: none"> Adoption of participatory skills anticipation methods and tools Utilisation of skills foresight and anticipation for governing intermediary bodies Regulation of management, financial and non-financial incentives Dissemination through online or offline platforms for qualitative and quantitative analysis Monitoring and evaluating medium- to long-term impact of training programmes Reliance on reliable labour market information signals

Sources: European Centre for the Development of Vocational Training, “Next Generation Skills Intelligence for More Learning and Better Matching: Policy Brief, Skills Anticipation Trends, Opportunities and Challenges in EU Member States” (Policy Brief, CEDEFOP, Thessaloniki, 2023); CEDEFOP, “Skills Anticipation Methods and Practices: Identifying Emerging Technologies and Skill Needs for Policy” (Policy Learning Forum, Thessaloniki, June 14–15, 2018); CEDEFOP, “Understanding Technological Change and Skill Needs: Technology and Skills Foresight” (Practical Guide 3, CEDEFOP, Thessaloniki, 2021); European Training Foundation, CEDEFOP and International Labour Office, *Developing Skills Foresights, Scenarios and Forecasts. Guide to Anticipating and Matching Skills and Jobs*, Volume 2 (Geneva: ETF, 2016)

This policy briefing advocates the widespread adoption of SF, promoting participative, long-term holistic thinking to drive the essential systemic change needed for GHE prosperity. By examining the priority areas identified, the research provides a comprehensive understanding of skills challenges and potential innovations. The research also offers valuable insights into addressing the skills needs of South Africa's rapidly developing GHE and serves as a guide on adopting skills foresight and improving skills anticipation systems in the TVET ecosystem. This policy briefing calls for the development of a transversal skills commons for both the formal and the informal economy and for re-negotiating a new social compact on PSET strategies, thereby potentially fostering the growth of a thriving GHE.

Introducing skills foresight and anticipation in the TVET ecosystem

Various policy documents, including the [Just Energy Transition Implementation Plan](#), emphasise the crucial role of skills development in facilitating a just energy transition (JET) in South Africa, essential for establishing a local GHE. The JET Implementation Plan identifies various shortcomings in the current skills planning system, including the failure to accurately predict future labour market demands. This is primarily owing to the system's heavy reliance on input from employers to signal future labour market requirements, which is problematic as employers struggle to articulate their current needs, let alone anticipate future skill requirements. It is noted that even when employers do manage to identify skills gaps, translating these insights into actionable tasks proves challenging, making it difficult to determine education requirements beyond the immediate and short term.²²

The JET Implementation Plan recognises that this leads to a mismatch in timeframes between the immediate and emergent focus of skills gap analysis and the long-term strategies prioritised by education planning.²³ This misalignment poses a significant challenge in balancing short-term crises with long-term goals. This sentiment is echoed in the South African Energy Association's [Energy Skills Roadmap](#), which highlights that TVET colleges are falling short in providing relevant programmes that meet current and future solar energy demands, integral to the establishment of a GH₂ value chain.²⁴

While commendable steps have been proposed to address green skills development, the above-mentioned plans tend to align within the reigning economic growth paradigm. In this paradigm, skills development is geared towards prioritising economic efficiency, market fundamentalism and hyper-individualism at the expense of other important values such as workers' rights, environmental protection and social welfare, thereby eroding

22 The Presidency, Republic of South Africa, [Just Energy Transition Implementation Plan](#).

23 The Presidency, Republic of South Africa, [Just Energy Transition Implementation Plan](#).

24 South African Energy Association, [South African Energy Skills Roadmap 2023](#) (Pretoria: SANE, 2023).

social solidarity and community.²⁵ Critics argue that conceptualising sectoral reform based solely on skills provision is inadequate for contemporary South Africa. This sentiment was echoed by workshop participants, who emphasised the urgent need for new forms of economic development that innovatively tackle the pervasive issues ingrained within the current economic growth/skills development paradigm. The urgency of such reform was highlighted in discussions on the income potential offered by the establishment of a local GHE. Participants noted that, without deliberate reforms in place, the GHE could perpetuate the trend whereby only a privileged few benefit. Consequently, it is necessary to create education systems that support economic prosperity within societies dealing with market complexities beyond the traditional economic model.²⁶

The skills development system must consequently ensure that education contributes to the development of individuals and communities, which requires aligning curricula with the real-life concerns of community members. To attain this alignment, a comprehensive understanding of these needs is essential. Without it, there is a risk of maintaining the status quo by making only surface-level changes. This is the case in South Africa, where transformation efforts seem excessively reliant on providing skills training and meeting labour market demands, neglecting crucial aspects of human development and the imperative of reducing inequality through transformation.²⁷

Strategic foresight offers an important approach in this regard, as it fosters collaborative, futures-thinking discussions among diverse stakeholders, enabling governments and other entities to anticipate and navigate future trends and complexities. This ensures that long-term strategies capitalise on promising opportunities while addressing emerging challenges. By incorporating diverse perspectives and expertise, strategic foresight strengthens anticipatory governance and adaptivity, facilitating informed decision-making in uncertain environments.²⁸ This participatory futures-focused approach helps overcome the global trend of excluding significant stakeholders in education from actively participating in educational policy and planning. It also involves them in research and knowledge generation on climate change and its potential impacts on education.²⁹

Regarding SF, the focus extends beyond predicting future skills demand and trend analysis to enhancing the understanding of skills needs. This broader understanding is achieved by:³⁰

- emphasising the exploration of multiple possible futures;
- adopting broad-based participatory approaches;

25 S Ngcwangu, "Skills Development and TVET Policies in South Africa: The Human Capabilities Approach", in *Handbook of Vocational Education and Training*, eds. S McGrath et al. (Cham: Springer, 2019), 4.

26 South African Institute of International Affairs, *SADC Futures of Higher Education & TVET Strategic Framework, Unpublished Report* (Johannesburg: SAIIA, February 2023).

27 Felix Maringe and Ruksana Osman, "Transforming the Post-School Sector in South Africa: Limits of a Skills-Driven Agenda", *South African Journal of Higher Education* 30 (2016).

28 Global Centre for Public Service Excellence, *Foresight Manual: Empowered Futures for the 2030 Agenda* (Singapore: UNDP GCPSE, 2018).

29 UNESCO, *Reimagining Our Futures Together: A New Social Contract for Education*, Report (Paris: UNESCO, 2021).

30 SAIIA, *SADC Futures of Higher Education*.

- informing policymaking;
- fostering collaboration;
- enhancing foresight capabilities;
- driving commitment to strategic visions; and
- assisting in making better decisions for present-day actions based on future-oriented insights.³¹

A practical example of SF in action is the Russian Skills 2030 Foresight initiative, developed through collaboration between the Russian Ministry of Education, the Science Agency of Strategic initiative and the Moscow School of Management Skolkovo. This initiative generates foresight on skills for various sectors and adopts a comprehensive multidisciplinary and ecosystem perspective to understand impending challenges in education.³² In the South African context, this would involve establishing a foresight-oriented team among senior decision makers in the PSET sector. Such a team would explore potential futures in skills development and shape the future of green skills in the vocational sector. It would do this by engaging stakeholders through collaborative workshops, articulating longer-term skills needs, developing strategic plans and disseminating findings to inform policy and practice.

As such, it is recommended that the Department of Higher Education and Training (DHET) and the HRDC integrate SF to bridge short- and long-term perspectives on skills planning related to green skills in general and GH₂ skills specifically. This involves establishing a well-versed, foresight-oriented team within the DHET, tasked with proactively identifying potential future threats and opportunities related to developing green skills at the vocational level. Given that this team would complement the existing labour market intelligence research provided by the NSF, funding should be allocated accordingly by the NSF. This team should collaborate closely with the recently launched just transition labour research centre, which offers technical expertise in reviewing research and the implications for workers, analysing engagement with stakeholders and sharing South African and international experiences.³³

The establishment of this task team would serve as an auxiliary measure to the JET Desk, also located within the HRDC, as advocated by the JET Implementation Plan. To translate this foresight capacity into tangible resources, it is essential to make its findings publicly accessible via an online platform. This platform should fall under the purview of the Presidential Climate Commission, aligning with its exemplary work on the skills requirements of the just transition. Such an initiative would enable a broad range of

31 European Training Foundation, “Skills Foresight: Making Sense of Emerging Labour Market Trends” (Background Note, ETF, Torino, February 2017).

32 ILO and OECD, *Approaches to Anticipating Skills for the Future of Work*, Report (G20 Employment Working Group, Second Meeting of the Employment Working Group, Geneva, June 11–12, 2018).

33 Terence Creamer, “South African Unions to Launch Just Transition Labour Research Centre”, *Engineering News*, November 10, 2023.

policymakers to engage with the findings and integrate longer-term orientations into their policy advocacy efforts.

Improving skills anticipation in the TVET ecosystem

The South African TVET sector's lack of innovative responses has been attributed to a top-down governance model and the extensive centralisation of curriculum responsiveness overseen by the DHET.³⁴ Research participants signalled their extreme frustration with this state of affairs. They conveyed a need for improving the vocational system's responsiveness to rapid changes within the contextual environment. The concern is that failure to adapt to changes in these realms risks rendering the curriculum obsolete, diminishing students' employability and potentially jeopardising the programme's and institution's viability.³⁵

While the immediate impulse would be to advocate decentralising the system, the centralised oversight of curriculum content and assessment facilitates standardisation, thereby fostering trust in qualifications and their transferability. This dichotomy creates a well-noted tension between standardisation and responsiveness within TVET curricula, especially given rapidly evolving technological demands, such as those posed by the development of a localised GH₂ industry.³⁶

Proposed approaches aimed at alleviating this tension include the creation of hybrid centres of specialisation that improve collaboration and cooperation with industry partners in terms of developing much-needed green skills.³⁷ The JET Implementation Plan also mentions the establishment of skills development zones. These are conceived as localised learning hubs that foster local economic development.³⁸

Another approach involves implementing a centralised-decentralised model for TVET curricula, as advocated by Wedekind³⁹ and the OECD.⁴⁰ In this model, the curriculum is devised at the national level but allows for local adaptations and enhancements. This means that national curriculum guidelines are provided by authorities and further developed by institutions to suit local needs, with allowances within national curricula for

34 National Advisory Council on Innovation, *The Status of Innovation in the TVET Colleges: An Exploratory Study* (Pretoria: Department of Science and Innovation, August 2021).

35 V Wedekind, *Manual for Managing Curriculum Responsiveness* (Johannesburg: Department of Higher Education and Training, Centre for Researching Education and Labour, University of Witwatersrand, 2017).

36 TVET Research Programme, *Research Report on Curriculum Relevance and Responsiveness of selected NC(V) and NATED Programmes in TVET Colleges. Project 2.3* (Pretoria: DHET and National Skills Fund).

37 D Cloete et al., *The South African Green Hydrogen TVET Ecosystem Just Transition Strategic Framework*, Synthesis Report (Johannesburg: SAIIA, December 2022).

38 The Presidency, Republic of South Africa, *Just Energy Transition Implementation Plan*.

39 Wedekind, *Manual for Managing Curriculum*.

40 Simon Field, Pauline Musset and José-Luis Álvarez-Galván, *A Skills Beyond School Review of South Africa* (Paris: OECD Publishing, 2014).

institutions to incorporate local content and involve local employers in curriculum design.⁴¹ Wedekind argues that TVET lecturers could increase curriculum relevance through curricula enhancements and the provision of additional content to better align with local needs and demands. To support this, he suggests that the DHET play a central role in encouraging such initiatives.⁴²

The HRDC's synthesis report on TVET colleges emphasises the DHET's pivotal role in enabling TVET colleges to address their diverse local contexts. It suggests enhancing collaboration between the DHET and individual colleges, promoting mutual capacity development rather than unilateral decision-making. The report proposes establishing a dedicated unit within the DHET to spearhead the TVET partnership initiative, advocating a flexible 'bottom-up' strategy that encourages institutional innovation within established accountability frameworks.⁴³ The Human Sciences Research Council supports a similar approach, noting that the proliferation of bodies involved in quality assurance has become unsustainable. It argues for subsidiarity and accountability, advocating central monitoring of decentralised self-regulation.⁴⁴

While it is beyond the scope of this research to advocate a specific approach in resolving ineffective power dynamics within the TVET system, it becomes clear that the proposals listed focus on addressing industry needs, framed within current economic and political paradigms. These proposals lack anticipatory capacity that ensures the longevity of the system beyond the status quo. As proven by the COVID-19 pandemic, this lack of long-term, agile planning could have disastrous results, seeing as TVET colleges reported far greater disruption during the COVID-19 lockdown periods than any of their PSET counterparts.⁴⁵

It is therefore necessary to think beyond the current paradigms by envisioning both desired and undesired consequences of possible changes to the contextual environments within which the TVET system exists. Skills anticipation, building on the insights gained from SF, is uniquely equipped to address this challenge. Practically, this involves empowering local TVET decision makers to iteratively conduct experiments beyond the provided curriculum, aimed at advancing GH₂-related skills at the individual TVET level. The insights gained from these experiments and possible skills prototypes could then be shared with the DHET body responsible for green skills curricula oversight, contributing to the refinement and adaptation of educational programmes to meet emerging needs.

As such, it is imperative to promote skills anticipation to enhance the adaptability and responsiveness of the TVET sector for future green skills development related to the GHE. This promotion should permeate the system, with particular emphasis on individual TVET

41 TVET Research Programme, *Research Report on Curriculum*.

42 Wedekind, *Manual for Managing Curriculum*.

43 HRDC, *Strengthening and Supporting TVET Colleges for Expanded Access and Increased Programme Quality*, Synthesis Report (Pretoria: TVET Colleges Project, July 2014).

44 Vijay Reddy et al., *Skills Development Legislation as a Lever of Change to Reduce Poverty, Inequality and Unemployment* (Pretoria: Human Sciences Research Council, 2017).

45 Tamar Kahn, "COVID-19 Lockdown Hit TVET Students Hardest, Finds HSRC Survey", *Business Day*, June 14, 2021.

lecturers, who play a pivotal role in driving grassroots-level innovation. Fostering a culture of iterative innovation among students and colleagues at this level can drive creativity and adaptability, while implementing project-based learning enhances problem-solving skills.

To enhance the TVET sector's responsiveness and resilience, the DHET should offer futures literacy training for decision makers across the TVET ecosystem. Hosting collaborative workshops on SF and skills anticipation, involving decision makers at all levels of the TVET skills development ecosystem, would enable them to identify emerging skills needs and develop strategies for sectoral agility. This initiative should be led by the proposed DHET foresight task team and ideally result in local TVET decision makers engaging in iterative studies and experiments aimed at advancing GH₂-related skills beyond the confines of the current curriculum.

Focusing on the formal and informal development of a transversal skills commons

While the GHE holds promise, its comprehensive establishment is not guaranteed. Significant concerns include South Africa's geographic location and water constraints. Saldanha Bay, for example, is over 6 000 nautical miles away from northern Europe, exceeding the current shipping range for highly compressed hydrogen gas, which is limited to 4 000 nautical miles.⁴⁶ Additionally, the availability of fresh water is crucial in the GH₂ manufacturing process, posing a significant challenge in water-stressed countries such as South Africa. Consequently, GH₂ production will rely extensively on recycled non-potable water or desalinated seawater, resulting in additional costs and heightened environmental risks.⁴⁷

Given these challenges, there is a pressing need for transversal competencies⁴⁸ capable of ensuring green energy workforce resilience beyond the possible establishment of a local GHE.⁴⁹ Critical transversal competencies needed include digital proficiency, adept problem-solving capabilities, the ability to take initiative, autonomous learning abilities, cultural sensitivity, social acumen, creativity and critical thinking.⁵⁰

The UNESCO Strategy for TVET (2022–2029): Transforming TVET for Successful and Just Transitions highlights the potential role of TVET providers in providing learners with these much-needed transversal skills. The strategy advises TVETs to offer lifelong learning opportunities with tailored teaching approaches, flexible learning pathways and

46 Wim Naudé, "South Africa Must Beware of Falling Victim to Green Hydrogen Imperialism", *Daily Maverick*, December 11, 2023.

47 Lee Rondganger, "South Africa Commits to a Green Hydrogen Future, but Environmental Lobby Groups Are Gearing Up for a Fight", *iol*, October 17, 2023. Top of Form

48 Transversal competencies are versatile abilities that cut across various tasks, roles or contexts. Unlike job-specific skills, they can be applied in diverse situations and work settings.

49 Simon Whittemore, "Transversal Competencies Essential for Future Proofing the Workforce" (White Paper, Skilla Library, July 2018).

50 Whittemore, "Transversal Competencies Essential".

cross-sectoral integration, acknowledging the growing importance of micro-credentials, digital credentials and alternative forms of TVET accreditation.⁵¹ These alternative credentialing formats are particularly crucial for recognising informally acquired transversal competencies, thereby enhancing the resilience of South Africa's green skills sector.

South Africa has implemented various initiatives to develop skills related to the GHE. These include introducing renewable energy technology in the National Certificate: Vocational curriculum,⁵² creating occupational programmes such as the Photovoltaic Technician programme⁵³ and launching hydrogen fuel cell-related training programmes in collaboration with the Department of Science and Innovation (DSI), the Energy and Water Sector Education Training Authority and other partners.⁵⁴

These are all worthy efforts, highlighting growing recognition of the importance of employing adaptable qualification provision methods to impart the skills needed for a GHE to thrive. However, unfortunately they also reflect the uncoordinated nature of the greater PSET system. This translates into a lack of a clear focus on imparting long-term, future-oriented transversal green skills.

Skills provision for potential GHE workers will require significant adjustments in both curriculum substance and methodology. An adaptable South African skills development environment necessitates establishing a transversal skills commons. This entails leveraging peer-to-peer social connections within human networks, alongside technological infrastructure development to facilitate the dissemination and scaling up of these new skills-sharing networks. The concept suggests that a shared repository of versatile skills encourages communities to pool their resources; stimulates innovation in skills development through market mechanisms that serve community interests; and enables government backing for public platforms.⁵⁵ As UNESCO notes in its *Reimagining Our Futures Together* report, the theoretical potential of a knowledge or skills commons is boundless. Its richness and creativity emerge from the sharing and exchanging of ideas, the crossing of disciplinary borders in experimentation and the reinterpretation of existing knowledge to generate novel insights.⁵⁶

In the local context, establishing a Cross-Sectoral Advisory Board for Transversal Skills Development among senior decision makers would be highly practical. This board could comprise representatives of government, industry, academia and civil society, ensuring diverse perspectives. Their primary responsibility would be to oversee and coordinate efforts

51 UNESCO, *UNESCO Strategy for TVET (2022–2029): Transforming TVET for Successful and Just Transitions*, Discussion Document (Paris: UNESCO, 2021).

52 Kirsten Freimann and Gerda Magnus, "Skills for a Just Transition to a Green Future: Measuring the South African TVET System and Providing Input to Support Its Development" (International Research Conference on Skills for a Just Transition, Centre for Researching Education and Labour, University of the Witwatersrand, Johannesburg, May 11–12, 2023).

53 Freimann and Magnus, "Skills for a Just Transition".

54 DSI, *Hydrogen Society Roadmap*.

55 Cloete et al., *The South African Green Hydrogen*.

56 UNESCO, *Reimagining Our Futures Together*.

in developing transversal skills. This would involve conducting a comprehensive resilience assessment of current credentialing systems and the creation of a knowledge-sharing network or commons.

We propose that the Presidency, in collaboration with relevant stakeholders including the IDC, BUSA, NBI and DHET, establish a Cross-Sectoral TVET Advisory Board for Green Transversal Skills Development within the HRDC. This board would oversee transversal skills development efforts, conduct resilience assessments of credentialing systems, create iterative pathways to address barriers for marginalised individuals and establish a knowledge-sharing platform between stakeholders. Leveraging insights from the proposed HRDC foresight task team's work, the board would bridge the gap between formal and informal transversal skills recognition by prioritising practical and real-world learning experiences.

Re-negotiating a new social compact on PSET

The perception of TVET qualifications as being inferior to university degrees,⁵⁷ highlighted by research participants, can be attributed to several factors. These include insufficient industry engagement, deficiencies in work-integrated learning and a shortage of qualified personnel. These shortcomings exacerbate issues such as low student-throughput rates and limited progression opportunities.⁵⁸ As a result, TVET colleges are often viewed as a fallback option for students who are unable to secure admission to universities.⁵⁹

The National Plan for Post-School Education and Training 2021–2030 recommends targeted marketing initiatives to promote TVET colleges as premier post-school education and training providers.⁶⁰ While this is a positive step, it fails to fully address the wider societal disparities evident in the bias against TVET qualifications. Developing new approaches to improve societal recognition of vocational training's transformative potential is crucial.

UNESCO's International Commission on the Futures of Education presents a possible avenue for achieving this goal by arguing for a new social contract for education. This new social pact must rectify past injustices while charting pathways toward transformative futures. It must be underpinned by the right to lifelong education and a dedication to education as a public and shared asset to facilitate the creation of pathways towards sustainable futures that are socially, economically and environmentally equitable.⁶¹ The National Development Plan echoes this sentiment by highlighting the importance of establishing a social compact to address collective challenges.⁶²

57 Bongisipho Magcaba, "Perception of TVET Colleges Discouraging Student Enrollment", *SABC News*, January 30, 2023.

58 DHET, *National Plan for Post-School Education and Training 2021–2030* (Pretoria: DHET, September 2023).

59 Sizile Makola, Itu Dube and Ramodungoane Tabane, "Why TVET Colleges Are Not Attractive Places of Higher Learning for South African High School Learners?", *International Journal of Research in Business and Social Science* 12 (2023): 435–444.

60 DHET, *National Plan for Post-School*.

61 UNESCO, *Reimagining Our Futures Together*.

62 National Planning Commission, *Our Future – Make it Work: National Development Plan 2030* (Pretoria: NPC, 2012).

The National Planning Commission (NPC) recognises that definitions of a social contract may vary. However, there is broad consensus within South Africa that the most beneficial form would entail a core agreement among diverse societal stakeholders and the government, delineating the rights and responsibilities of each party.⁶³ This aligns with UNESCO's argument for a social contract related to education. It states that, as a societal undertaking, education encompasses a multitude of stakeholders in its management and oversight. It is imperative to incorporate a wide range of voices into policies and decision-making procedures, for which participatory futures approaches are ideally suited.⁶⁴

Current initiatives aimed at achieving a new social compact include the recently launched Social Justice M-Plan, which targets poverty elimination and reduced inequality, among other objectives.⁶⁵ While these efforts underscore the country's commitment to collective problem-solving and social progress, there remains a gap in strategic foresight-focused attention on addressing educational disparities, such as those between TVET and universities.

Strategic foresight, with its focus on participatory knowledge and collective intelligence development, could play a transformative role in shaping a new social compact for education. By adopting a participatory futures approach, the NPC could engage a wide variety of stakeholders in envisioning and co-creating a future-oriented education system. This approach, supported by adequate budget allocation, could offer new avenues for overcoming the poverty of imagination and building anticipatory capabilities to actively shape the future. As UNESCO argues, an ethos of collaboration, humility and foresight should permeate every aspect of our educational research agenda.⁶⁶

A practical example of using participatory foresight methods to foster change is the development of North Macedonia's National Development Strategy, which has a focus on societal mobilisation. This involves creating an enabling environment where stakeholders can develop a shared vision with institutional actors. The UN Development Programme organised so-called 'Dream Labs' – futures-thinking sessions where citizens and organisations/institutions help to shape shared societal goals by leveraging baseline data compiled across various societal fields. Thus far, 35 labs have been organised along this structure with more than 1 250 people taking part.⁶⁷

In the local context, this would involve initiating widescale participatory futures dialogues with a diverse range of stakeholders aimed at exploring the TVET system beyond its current confines. The focus should be on guiding the envisioning of numerous potential future trajectories related to the development of green skills at the vocational level. The proposed futures literacy labs should be readily accessible, potentially taking the shape of an online video-based forum developed by the DSI. Advocacy for their importance should rest with

63 NPC, *National Development Plan 2030*.

64 UNESCO, *Reimagining Our Futures Together*.

65 NPC, *National Development Plan 2030*.

66 UNESCO, *Reimagining Our Futures Together*.

67 Biljana Cvetanovska Gugoska et al., "Becoming Future Ready", UNDP North Macedonia, June 20, 2022.

SETAs, given their established presence on all TVET campuses nationwide. The findings of these labs can then be provided to the HRDC foresight task team, as recommended earlier, to form part of the anticipatory exercises aimed at improving policy development related to skills provisioning for the GH₂ sector.

In the context of the above, we argue for the adoption of participatory futures approaches, such as futures literacy labs, to facilitate the co-creation of a new social compact for PSET. This entails engaging a wide range of stakeholders in envisioning and shaping the future trajectory of vocational education, particularly focusing on addressing disparities between TVET and universities and enhancing green skills development. By initiating widescale participatory futures dialogues, funded by the NPC and implemented by the DSI and HRDC, we aim to foster collective problem-solving and co-create transformative pathways for the TVET system.

Conclusion

For South Africa to truly embrace innovative approaches in its pursuit of a GHE, it should end its reliance on traditional skills planning methods, which have proved inadequate to address the dynamic challenges presented by the rapidly evolving GH₂ sector. In essence, the success of South Africa's journey towards a GHE hinges on its ability to depart from conventional approaches and embrace foresight-based approaches and strategies. Future research needs to explore SF implementation in the formal and informal PSET ecosystem, seeking systemic innovations and implementation of transformative TVET programmes and policies. Through the incorporation of SF, South Africa can position itself as a significant player in the global transition to the GHE.

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Please note that all currencies are in US\$ unless otherwise indicated.

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