



SOUTH AFRICA

TOWARDS AN EQUITABLE TRANSITION TO A LOW-CARBON, CLIMATE-RESILIENT ECONOMY

THE ILLUSTRATIVE PEOPLE'S ENERGY PLAN

The world is undergoing an energy revolution in response to the climate crisis, and we must shift away from fossil fuels.

HOW SHOULD SOUTH AFRICA PLAN FOR OUR ENERGY FUTURE?

South Africa, and other developing nations, must deliver societal returns to provide a good life for our citizens. This is often portrayed as being at odds with environmental needs, but the reality is that a just and rapid transition to a low-carbon economy can deliver economic growth and reduce inequality, while avoiding locking in negative environmental and economic impacts.

Robust planning for the energy system that underlies this transition over the next 25 years will unlock key opportunities for the nation's development. Although mandated by the 2008 Energy Act, South Africa has not yet produced an integrated energy plan. A key shortcoming in the government's draft integrated energy plans to date is the failure to consider the benefits and trade-offs of a transition to net zero, despite this being a long-term commitment by South Africa and a necessity for realising a competitive and growing low-carbon economy. Informed decision-making about the rate and affordability of this transition cannot be achieved without modelling it for comparison with other scenarios.



The Illustrative People's Energy Plan (IPEP) project, coordinated by WWF South Africa, looked to provide an example of good practice for developing an integrated energy plan. It included key scenarios, broad stakeholder engagement, transparency in process, models and outcome, and expert elicitation of underlying assumptions.

WHAT MUST AN INTEGRATED ENERGY PLAN CONSIDER?

According to the National Energy Act 34 of 2008: The Integrated Energy Plan (IEP) must deal with issues relating to the supply, transformation, transport, storage of and demand for energy in a way that accounts for:

- a) security of supply;
- b) economically available energy resources;
- c) affordability;
- d) universal accessibility and free basic electricity;
- e) social equity;
- f) employment;
- g) the environment;
- h) international commitments;
- i) consumer protection; and
- j) contribution of energy supply to socio-economic development.



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ENERGY SCENARIOS

Since the future is unknowable, we must work on scenarios that describe the different energy needs of different developmental and policy scenarios.

Each scenario is designed to deliver a consistent energy supply, building the system iteratively, year-on-year, based on cost minimisation, but with different additional scenario goals.

Comparing the outcomes of the scenarios enables society and government to accurately assess the impacts of these goals in terms of growth, employment, environmental impact, energy adequacy and social desirability.

Using SATIMGE* energy-economy modelling, the IPEP scenarios were divided into three sets:

- **Set 1 – Reference:** The first set represents a simple, least-cost, optimised model based on extant policies from 2020, with and without a limit to reach net zero CO₂ emissions by 2050.
- **Set 2 – Policy:** The second set explores the impacts of various policy levers, including full implementation of the Department of Mineral Resources and Energy's Gas Master Plan, a large green hydrogen industry, the Department of Transport's Green Transport Plan and improved energy efficiency measures across the economy.
- **Set 3 – Ideal:** This set visualises an idealised energy future that was workshopped with many stakeholders. It includes sensitivity tests to examine additional impacts of certain elements. This scenario demonstrates what a future energy scenario could look like based on a series of goals, aspirations and priorities indicated by stakeholders, and then shows different energy pathways to reach that future.

The Ideal Energy Scenario is not meant to be an alternative IEP and is by no means a comprehensive model representation of all the key issues facing the current and future energy system. It also does not purport to represent a unanimous view among all stakeholders or the wider public of what would constitute an ideal energy system.

* SATIMGE stands for South African TIMES Integrated Model with General Equilibrium. It is a specific scientific, energy-economic model used for policy analysis in South Africa.

THE MODELLING SYSTEM

The University of Cape Town's Energy Systems Research Group did the modelling work.

Their SATIMGE* model links a detailed energy model with an underlying economic model.

This approach helps us to understand the energy supply/demand impacts across different sectors and can also explore the economic impacts of the energy system.

The model does have some limitations, though:

- It considers average household income in three separate income bands but cannot track detailed household-level economics.
- It is not spatially explicit, so grid expansion and investment are tracked by internal factors. It therefore assumes some movement of people to follow job opportunities.
- Some especially important environmental impacts are tracked using proxies, such as air pollution health impacts (tracked using energy pollution outputs), water constraints (energy system water inputs) and land conversion impacts (area used for energy infrastructure).



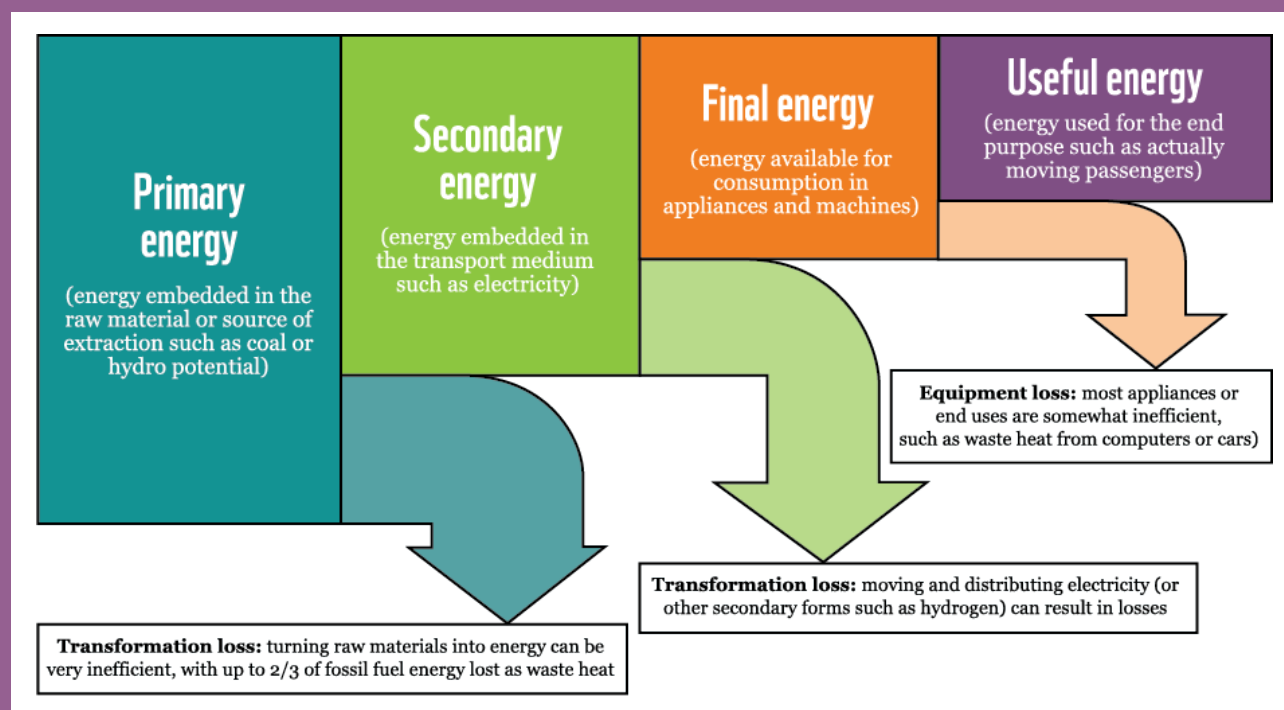
PRIMARY ENERGY AND FINAL ENERGY

Energy in the economy takes different forms. “Primary energy” is the energy embedded in raw materials – fossil fuels, renewables or nuclear.

Many forms of energy then undergo transformation into another form: photovoltaics (PV) to electricity, while coal may deliver heat to an industrial process, or to generate electricity for other uses. Each conversion results in energy loss (for instance, car motors are rarely more than 35% efficient), and there are also losses in transportation of both fuels and electricity.

The final energy is the energy consumed at the end point and used to deliver a service (for cars, this would be transportation). Energy systems with fewer conversion steps and direct electricity generation and consumption require much less primary energy to provide the same level of final energy.

The Ideal Energy Scenario has far lower losses between primary and final energy than the reference scenario because of electrification using renewables and has a lower final energy demand due to energy efficiency investments.



THE IDEAL ENERGY SCENARIO

In addition to minimising cost and ensuring energy provision, the Ideal Energy Scenario encompasses the following key elements:



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IS THERE A ROLE FOR CARBON CAPTURE AND STORAGE?

Carbon capture and storage (CCS) is a pipeline technology to remove carbon dioxide from the atmosphere into permanent storage.

Despite huge investments over a quarter-century, total global removals are just slightly more than Medupi Power Station's 2024 CO₂ emissions.

There is little evidence that CCS will grow fast, and it is likely to remain costly (optimistic estimates put it at US\$100/tCO₂e by 2050), so including it at scale in planning runs the risk of locking in emissions. CCS will likely never be able to support coal and long-term fossil fuel generation because of the huge costs entailed.

The Ideal Energy Scenario minimises use of CCS by shifting away from all sources of emissions but still included it for some critical GHG-emitting products (cement, steel and backstop power generation during long low-wind and low-solar periods) for which there is no current alternative.

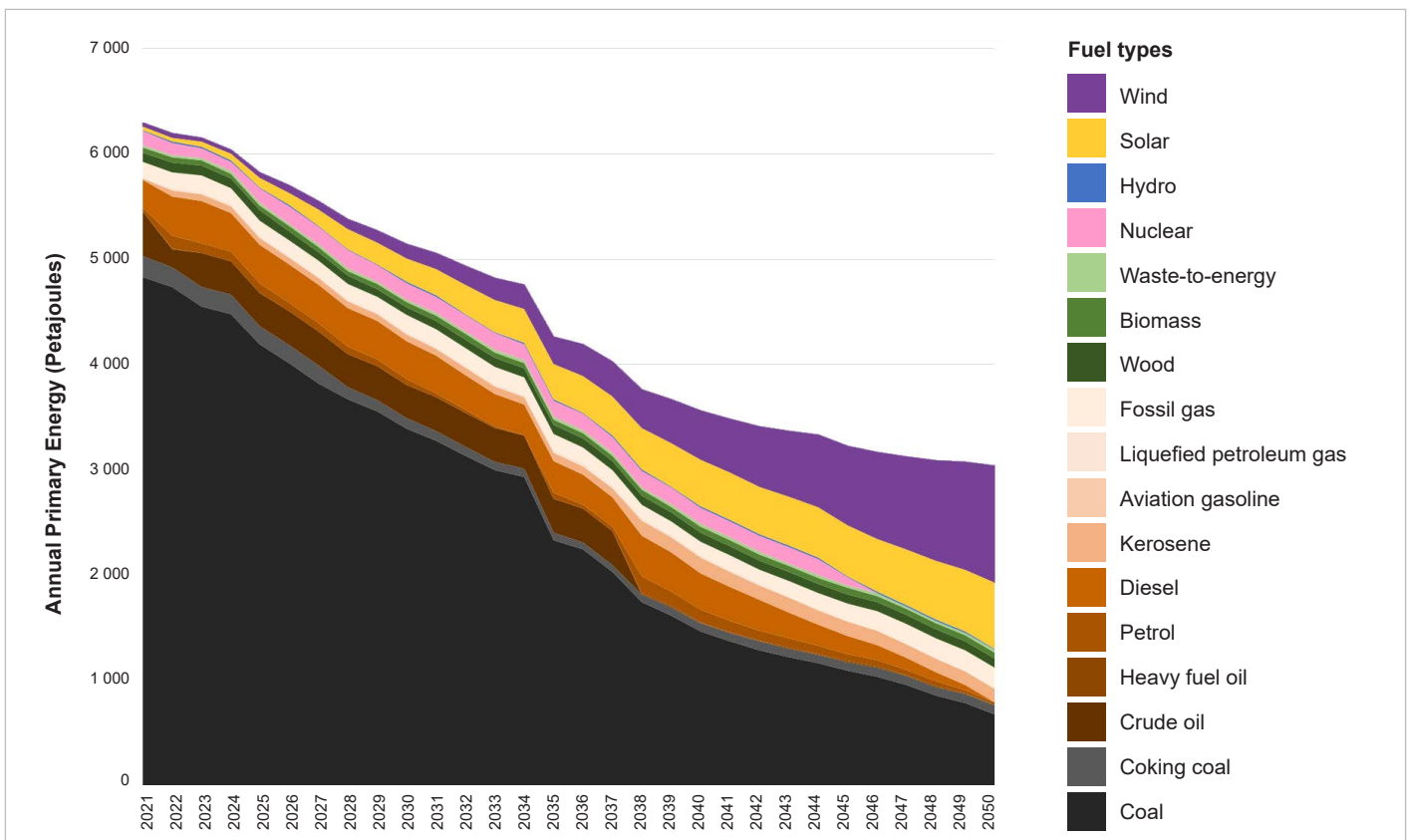
A no-CCS version of the Ideal Scenario did not achieve net zero by 2050, although it did limit emissions to below the 8 GtCO₂e target, and performed better on most measures (including growth and employment) than the reference scenario.

Other long-term energy storage options, such as power-to-liquids and cement alternatives, may become viable in time, so CCS might be seen as a proxy for these technologies.



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PRIMARY ENERGY SUPPLY FOR THE IDEAL ENERGY SCENARIO: TOWARDS 2050



IDEAL ENERGY SCENARIO MODELLING OUTCOMES

The Ideal Energy Scenario shows a marked transformation in the energy system, including:

- **A rapid and sustained shift away from fossil fuels**, with coal, oil and gas use declining significantly over time. Elevated levels of electrification are seen in all sectors.
- **Substantial energy efficiency improvements across all sectors**, particularly households, commerce and industry. These are modelled through a combination of structural change and the adoption of efficient technologies, as well as widespread electrification. The results suggest existing energy efficiency policies could be significantly expanded to drive greater sustainability (in terms of both emissions and cost savings).
- **An electricity system dominated by renewable energy**, primarily wind and solar PV. These are deployed in both centralised grid-scale form and distributed configurations such as rooftop PV, which has considerable potential for improving household energy access. No new nuclear capacity is added, and gas plays a limited role as a backup and peaking resource. A sensitivity analysis shows that, where conditions might allow for a nuclear build programme, it would still have a negative effect on overall economic growth due to “crowding out” of other economic investments by the high nuclear capital costs.
- **Costs remain manageable.** While total energy system costs increase in absolute terms, these costs don’t differ significantly from the Reference Scenario (set 1). Greater investment is required in the power sector – the key driver of decarbonisation towards net zero – but enhanced energy efficiency in industry and transport will result in comparative savings. Improved household energy access will nevertheless result in final energy demand that is lower than in other pathways, due to structural efficiencies in transport and household sectors. Electrification of energy end uses, particularly in industry and transport, provides significant gains in energy efficiency.
- **Employment nearly doubles between 2025 and 2050**, despite imposing climate mitigation constraints. Whilst this growth in economy-wide employment is 1.5% lower than the reference scenario, incorporating localisation measures into the clean electricity value chain results in more jobs in the energy sector.



WHAT YOU NEED TO KNOW: KEY POLICIES TO BE INCLUDED IN AN IEP

Universal, affordable and clean energy is essential for human wellbeing and inclusive economic development and should be at the heart of national energy policy. Below are key points we should be advocating for in a draft IEP:

1. EXPAND AND INTEGRATE ENERGY ACCESS FOR BETTER SOCIAL OUTCOMES

A just energy transition requires a fundamental rethink of how South Africans access energy. The FBE policy provides only 50kWh per household, far below the minimum level of consumption required to meet basic needs.

The model shows that increasing the FBE allowance to about 200kWh and providing solar water heaters can provide energy security and access to services for low-income households with only a marginal increase in electricity costs. The health benefits of shifting away from solid fuels (coal and biomass) and the freeing up of household incomes to cater to other basic needs can yield developmental benefits.

Integration of standards and administrative reforms at the local government level to ensure accurate targeting of FBE is critical. In addition, standardising and subsidising household energy efficiency measures and enforcing appliance efficiency standards can yield returns for low-income households.

2. UNLOCK INDUSTRIAL EFFICIENCY GAINS

Current energy efficiency policies have limited uptake and often benefit well-resourced firms without leveraging large-scale change, and the National Energy Efficiency Strategy (DME, 2008) has lapsed without being updated.

The model shows that large shifts in energy within industry can improve energy efficiency and reduce emissions whilst still yielding strong economic growth. However, strong policy engagement will need to drive this change.

Incentives such as the Section 12L tax rebate for energy efficiency should enable small and medium businesses to access them, alongside expanded support programmes. Minimum energy standards and sector-specific targets should be developed in consultation with industry, and the National Energy Efficiency Strategy should be revised.

3. SHIFT TO HIGH-DENSITY, EQUITABLE PUBLIC TRANSPORT

The government's approach to green transport focuses primarily on private electric vehicles. This approach does not address the reality for low-income South Africans, who depend on public and non-motorised transport, and are extremely vulnerable to fuel price variability.

A significant shift to high-density transport modes – bus rapid transport (BRT), passenger rail and electrified paratransit taxis – opens the door for broader access for most people to jobs, education and services.

Reduced traffic would decrease commuting and increase productivity, whilst the reduction in reliance on imported fuels would improve energy security.

The increased costs of public infrastructure development would be offset by reduced expenditure on road maintenance and would also simplify the electrification of transport, reducing expenditure on charging infrastructure.

4. ACCELERATE ELECTRIFICATION WITH A LOCALISED VALUE CHAIN

South Africa has made only limited progress despite a commitment to reaching net-zero CO₂ emissions. The employment challenges of realising a just transition from coal is exacerbated by energy shortfalls. However, the Ideal Energy Scenario has demonstrated that ambitious climate mitigation targets can support strong economic growth and employment even while moving to an electricity system dominated by renewable energy.

Electrifying industry, transport and households improves efficiency of the energy system, and ambitious localisation results in robust growth in the energy sector despite the decline in coal-sector jobs. The Gas Master Plan should be directed by IEP and long-term decarbonisation goals, not the other way around.

RECOMMENDATIONS: INTEGRATED ENERGY PLANNING PROCESSES

During the development of the IPEP, stakeholders and planners highlighted key elements of an integrated energy planning process for government to consider. These should be essential elements of the national IEP to ensure a robust outcome endorsed by South African citizens. We should all understand how the IEP should look:

1. THE IEP SHOULD BE USED TO ALIGN FRAGMENTED POLICIES

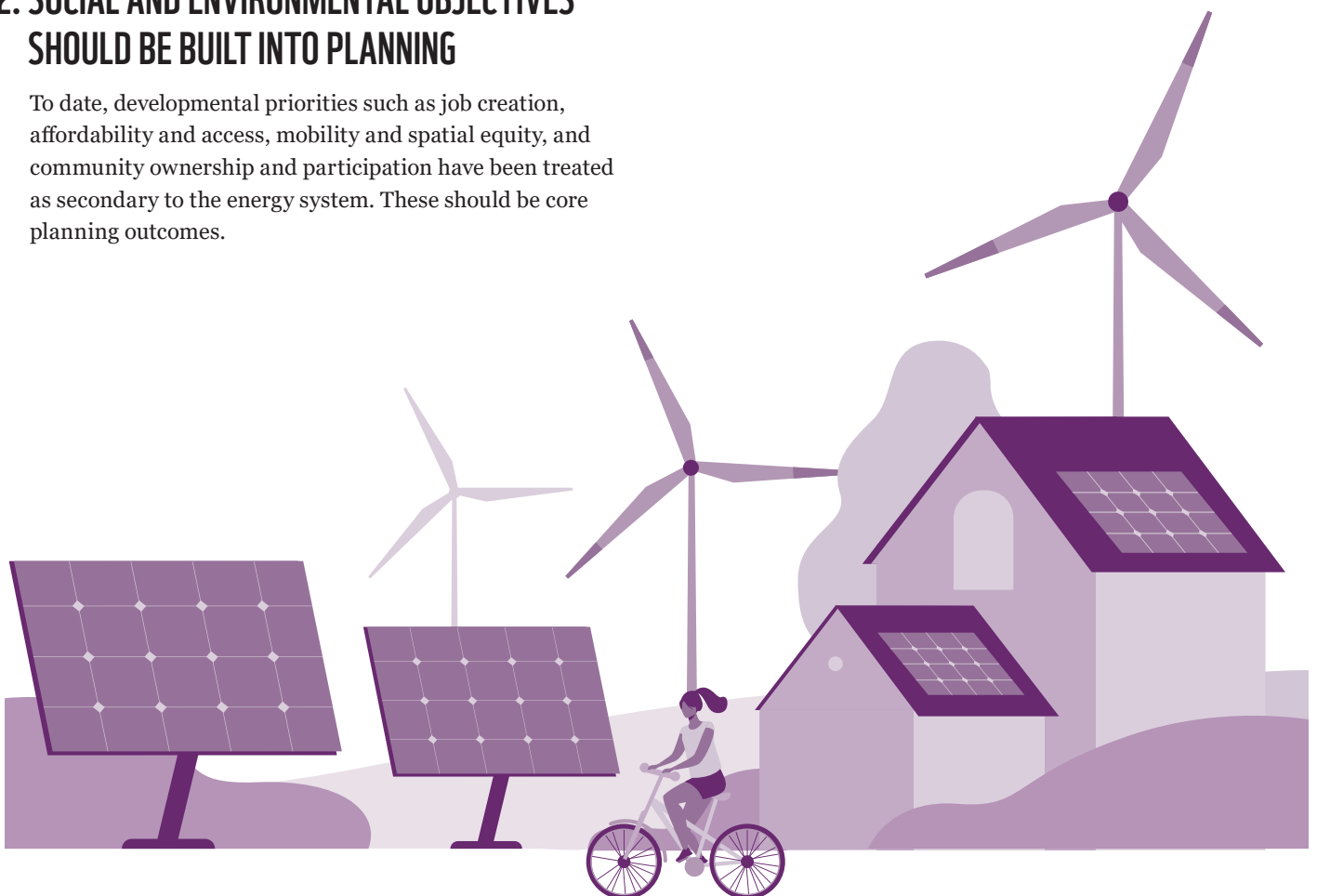
The current energy policy landscape has many overlapping but uncoordinated frameworks and sector-specific plans that risk conflicting at basic levels. The role of an integrated energy plan is to ensure the alignment of sector-specific plans with each other and with broader developmental and climate goals, stakeholders, and then shows different energy pathways to reach that future.

2. SOCIAL AND ENVIRONMENTAL OBJECTIVES SHOULD BE BUILT INTO PLANNING

To date, developmental priorities such as job creation, affordability and access, mobility and spatial equity, and community ownership and participation have been treated as secondary to the energy system. These should be core planning outcomes.

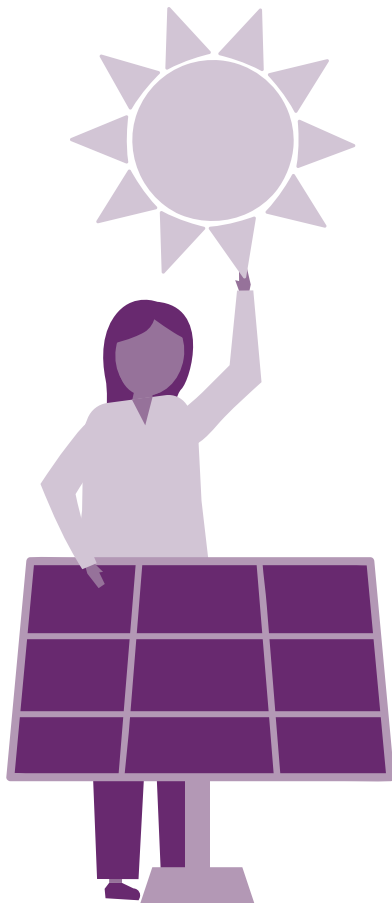
3. STAKEHOLDER ENGAGEMENT, TRANSPARENCY AND CLEAR REPORTING SHOULD BE INTEGRAL

The legitimacy and effectiveness of the IEP depend on meaningful, early and continuous engagement with civil society, labour, industry, local government and vulnerable groups, among others. From the outset, participation should shape the objectives, scenarios and trade-offs that underpin the plan. Transparent processes and accessible reporting are vital. All assumptions, data sources, methodologies, and limitations should be publicly documented, and decision-making criteria must be clear.



4. WE NEED A ROBUST, TRANSPARENT ENERGY PLANNING DATA SYSTEM

Reliable data is foundational to effective planning. Yet even the most aggregate data, such as the national energy balance, contains gaps, inconsistencies and errors. This undermines modelling, decision-making and public trust. In the IEP process, there should be a publicly accessible system for accurate, routine data collection, verification and updating. This process should foster standards for data transparency and accountability to enable independent verification and continuous improvement.



6. THE IEP MUST BE A LIVING DOCUMENT

Rapid changes in technology costs, energy prices and global commitments have shifted the realities of how energy is produced and consumed. Ensuring the relevance and credibility of an IEP requires annual updates, in line with the National Energy Act. Energy planning must reflect a rapidly changing world and the impacts of energy technologies.

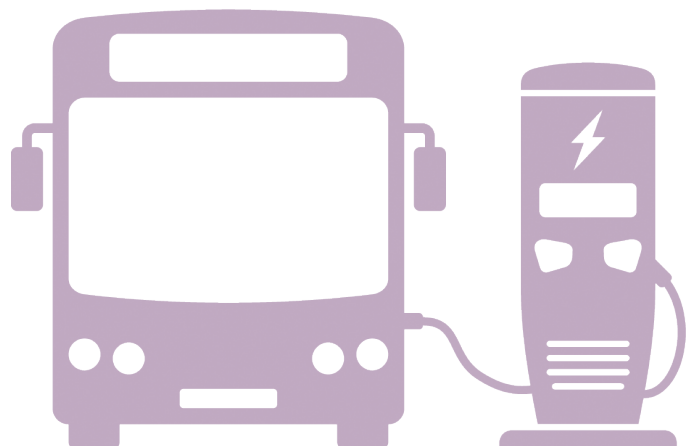


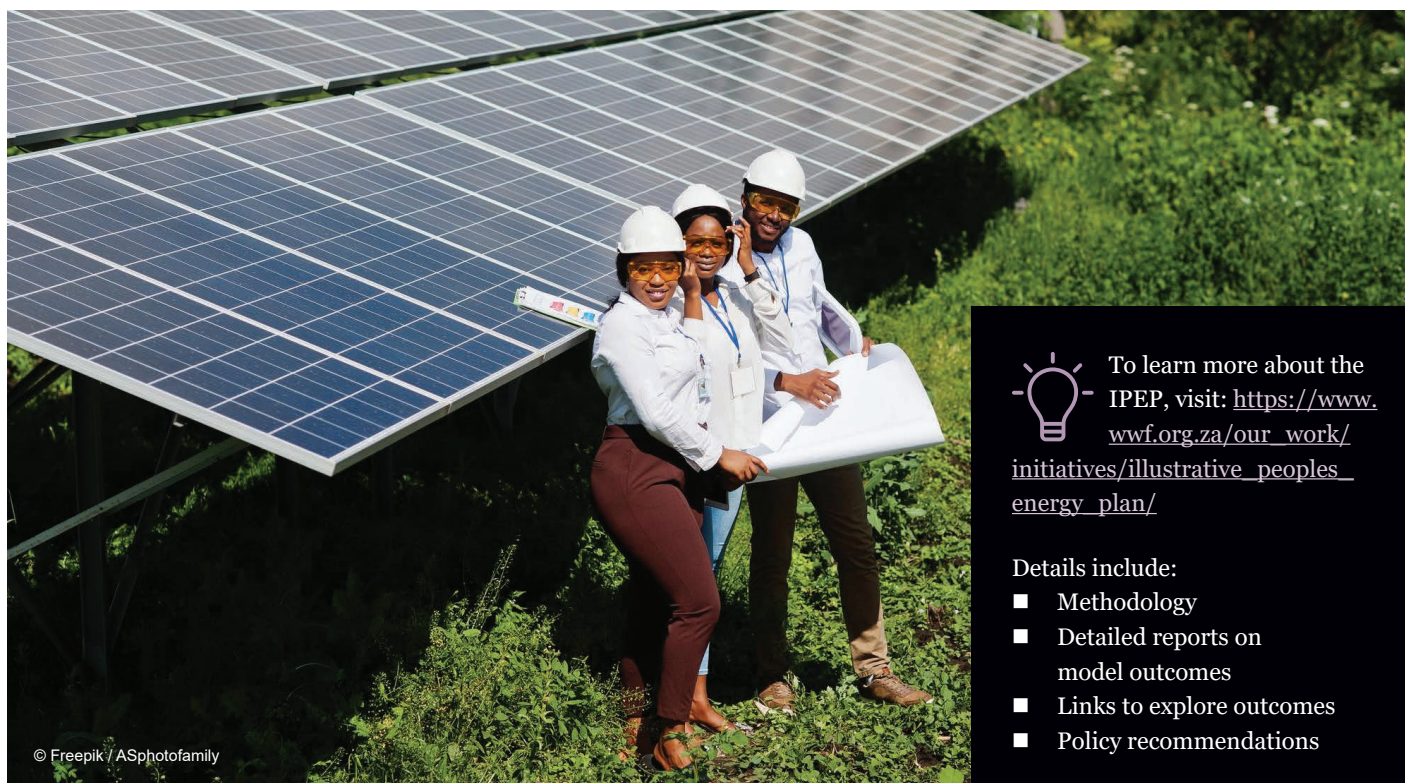
5. WE SHOULD RECOGNISE THE LIMITS OF MODELLING

While models like SATIMGE are essential for scenario analysis, they cannot account for many of the critical dimensions of a just energy transition. For example:

- a. Social impacts, governance quality, land-use conflicts, detailed environmental externalities and community ownership among other considerations which are not fully captured;
- b. The spatial costs of infrastructure like rail and bus lanes are highly localised.

These non-modellable dimensions must be addressed through parallel strategies, including participatory planning, social policy design, spatial planning and environmental justice frameworks.





REFERENCES

- Crompton, R., Young, B. & Hahn, T. 2024. An Analysis Of South Africa's Petrochemicals And Basic Chemicals In The Context Of South Africa's Energy Transition Focusing On Sasol's Secunda Coal-To-Chemicals and-Liquids Facility. Johannesburg, South Africa: Trade and Industrial Policy Strategies.
- DME. 2008. National Energy Efficiency Strategy of the Republic of South Africa. Pretoria, South Africa: Department of Minerals and Energy. Available: https://www.gov.za/sites/default/files/gcis_document/201409/32342908.pdf.
- DoE. 2016. Integrated Energy Plan. (Government Gazette 1430). Pretoria, South Africa: Government of South Africa.
- DoEE. 2025. Integrated Resource Plan 2025. Pretoria, South Africa: Department of Electricity and Energy. Available: <https://www.gpwnline.co.za/government-gazettes-2/> [2025, October 29].
- DoEE, DTIC & DSTI. 2025. South African Renewable Energy Masterplan (SAREM). An inclusive industrial development plan for the renewable energy and storage value chains by 2030. Pretoria, South Africa: DoEE,DTIC,DSTI. Available: https://www.gov.za/sites/default/files/gcis_document/202506/south-african-renewable-energy-masterplan.pdf [2025, November 05].
- DoT. 2019. Green Transport Strategy for South Africa (2018 to 2050). Pretoria, South Africa: Department of Transport, Government of South Africa.
- DTIC. 2023. Electric Vehicles White Paper. DTIC. Available: <https://www.thedtic.gov.za/wp-content/uploads/EV-White-Paper.pdf>.
- Ledger, T. & Rampedi, M. 2022. Hungry for electricity. Johannesburg, South Africa: Public Affairs Research Institute. Available: <https://pari.org.za/wp-content/uploads/2022/09/Hungry-for-Electricity-Digi-19092022.pdf> [2023, April 03].
- RSA. 2008. National Energy Act (Act 34 of 2008). V. 521 (Government Gazette no. 31638). Pretoria: Republic of South Africa.
- WWF. 2023a. Opportunities in South Africa's Solar PV Value Chain. (Fact Sheet). Cape Town, South Africa: WWF South Africa. Available: https://wwfafrica.awsassets.panda.org/downloads/wind_energy_value_chain_factsheet.pdf?41662/wind-energy-fact-sheet [2024, February 22].
- WWF. 2023b. Opportunities in South Africa's Wind Energy Value Chain. (Fact Sheet). Cape Town, South Africa: WWF South Africa. Available: https://wwfafrica.awsassets.panda.org/downloads/wind_energy_value_chain_factsheet.pdf?41662/wind-energy-fact-sheet [2024, February 22].



TRANSPARENT, ACCOUNTABLE AND INCLUSIVE ENERGY PLANNING CAN INFORM SOUTH AFRICA'S TRANSITION TO 100% RENEWABLE ENERGY BY 2050.

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Lasting positive outcomes for people and nature in the places where we work and from priority environmental challenges we focus on.

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