CSIR presentation to the Portfolio Committee on Mineral Resources and Energy

21 August 2019

science & innovation
Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA

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CSIR mandate

CSIR MANDATE

"The objects of the CSIR are, through **directed** and **particularly multi-disciplinary research** and **technological innovation**, to foster, in the national interest and in fields which in its opinion should receive preference, **industrial** and **scientific development**, either by itself or in **co-operation with principals** from the **private** or **public sectors**, and thereby to contribute to the **improvement of the quality of life of the people of the Republic**, and to perform any other functions that may be assigned to the CSIR by or under this Act."

(Scientific Research Council Act 46 of 1988, amended by Act 71 of 1990)

CSIR mandate unpacked

- Better utilisation of the resources of the Republic
- Manpower training to improve productive capacity of its population
- Improvement of technical processes and methods to improve industrial production
- The promotion and expansion of existing, as well as the establishment of new industries

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Vision and mission

VISION

We are accelerators of socio-economic prosperity in South Africa through leading innovation

MISSION

Collaboratively innovating and localising technologies while providing knowledge solutions for the inclusive and sustainable advancement of industry and society

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Our values

Excellence

We excel at R&D and industrial **innovation** solutions that address South Africa's challenges. We are unashamedly **passionate** about the **impact** we make and pursue **excellence** in every facet of CSIR life.

People-centred

We **care** about people – our impact through innovation aims to **improve lives.** We respect each other's **diversity**, and uphold the **dignity** of every person, regardless of **culture or belief system.** We treat our **stakeholders** the way we like to be treated.

Integrity

We value integrity – in ourselves and in others. We are **honest** and **fair** in how we work and how we engage the world around us. We respect the trust that our colleagues and our stakeholders place in us and commit to ethical decision-making, delivery and governance.

Collaboration

We are keen to learn from one another and **collaborate** across the organisation and with external partners, to ensure our work has the best chance to **innovate** a better future for South Africans.

Strategic objectives

Conduct R&D and localise transformative technologies and accelerate their diffusion

Collaboratively improve the competitiveness of high impact industries to support South Africa's re-industrialisation

Drive the socioeconomic transformation through RD&I which supports the development of a capable state

Build and leverage human capital and infrastructure

Diversify income, maintain financial sustainability and good governance

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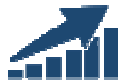
The strategic intent

Growth

- South African economy
- CSIR business



Sustainability

- Competitive advantage of SA enterprises
- Sustainability of the CSIR in a financially constrained environment

Impact

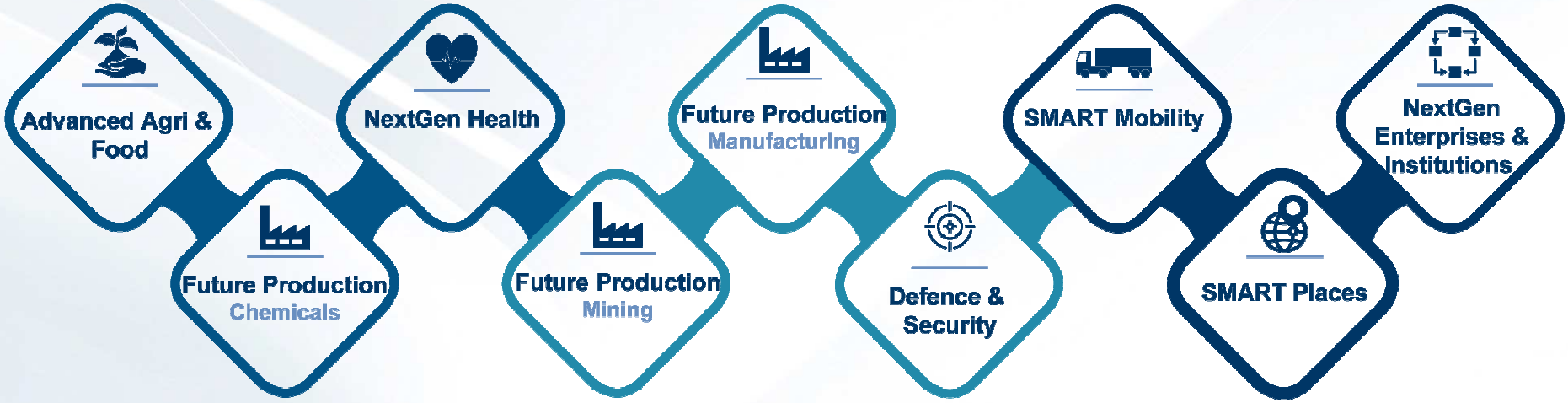
- Techn. Commercialisation: Industrial development
- Knowledge and Tech Support for a capable state

Relevance

- Innovation underpins sustainable industrialisation
- CSIR relevance and delivery on mandate

Technology - Sector Clusters

Positioned to drive SA's industrialisation



4IR Capability embedded in all clusters

Enabling capabilities

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CSIR Executive Management

Chief Executive Officer

Dr Thulani Dlamini

Executive: Project Synapse
(Acting) Group Executive: Chemicals, Agriculture, Food and Health

Dr Rachel Chikwamba

Group Executive: Legal, Compliance and Business Enablement

Adv Esmé Kennedy

(Acting) Chief Financial Officer

Ms Cheryl Howell

Group Executive: Business Excellence and Integration

Ms Khungeka Njobe

(Acting) Group Executive: Human Capital

Mr Andile Mabindisa

Group Executive: Mining, Manufacturing, Defence and Security

Dr Motodi Maserumule

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The CSIR in numbers

The CSIR is a science council, classified as a national government business enterprise.

IN NUMBERS:

Pretoria
Johannesburg
Durban
Cape Town
Stellenbosch

2 344
Total staff base

1 608
*SET base

62%
Black South Africans

36%
Female South Africans

320
Staff with PhDs

586
Staff with M-qualifications

536
Publication equivalents

319
Journal articles

19 New patents

50 New technology demonstrators

R2 534 m
Total income

31%
Grant Funding

R5.42 m
Royalty and licence income

+R126 m
Total investment in HCD

*Science, engineering and technology figures as at 31 March 2019

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Energy system and just transition challenges and opportunities

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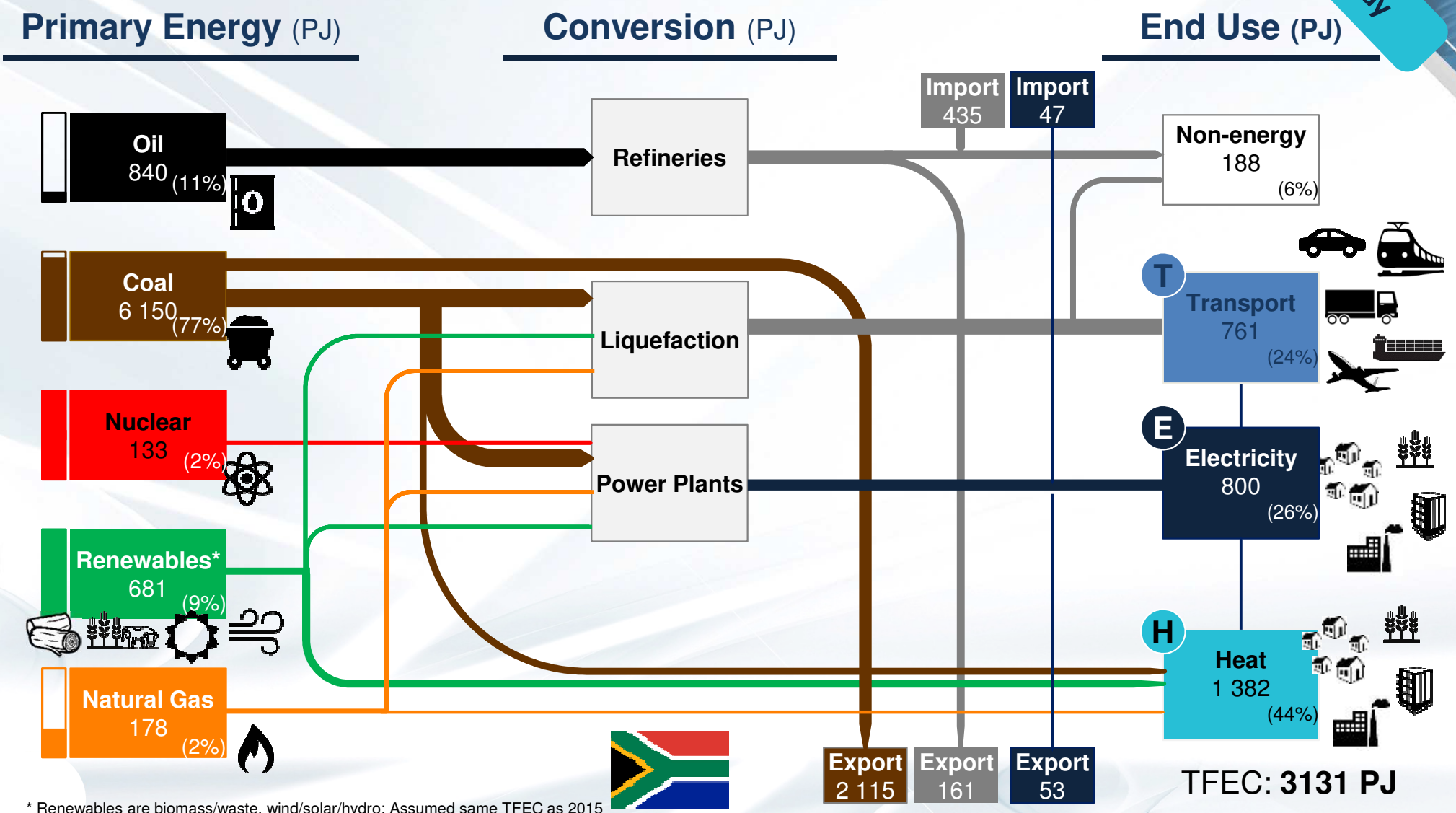
Energy supply is domestic and coal-dominated in South Africa but most oil and liquid fuels are imported for use in the transportation sector

Simplified energy-flow diagram (Sankey diagram) for South Africa in 2015 (PJ);

Today



* Renewables are biomass/waste, wind/solar/hydro; Assumed same TFEC as 2015

Sources: IEA; Eskom, CSIR analysis

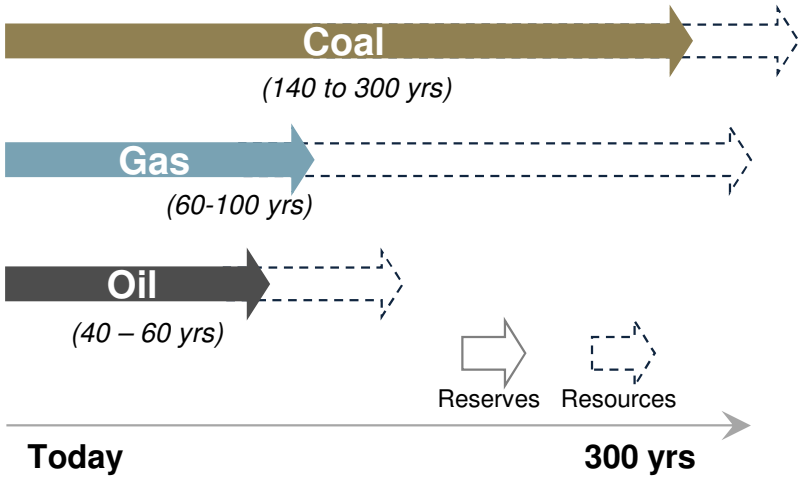
A range of challenges require decisive visionary leadership
Key pain points include…..

Trend	Challenge	Consequence
→	Aging and poorly performing coal-fired power stations	• Load shedding • Systemic risk of Eskom to the economy • Inability to meet increasing electricity demands associated with economic growth requirements • Reduced investor confidence • Escalating electricity prices impacting competitiveness of industry and affordability • Erosion of ability to sustain subsidies for the poor • Increasing outages (poor reliability of supply) • Grid defection (those that can afford to) • Increasingly constrained distribution grid • Liquid fuels importation negatively effects balance of trade and results in volatility (international oil prices and forex fluctuations) • High environmental impact (emissions and water consumption)
↓	Eskom liquidity and financial challenges	
→	Lack of policy certainty (delays Integrated Resource Plan, Integrated Energy Plan, Gas Utilisation Master Plan)	
↓	Growing infrastructure backlog	
↓	Primary energy challenges – increasing coal costs and dependency on single resource	
→	Delays and performance issues with new mega-build programs	
→	Dependency on imported liquid fuels	
↓	Failing municipal electricity distribution business model	

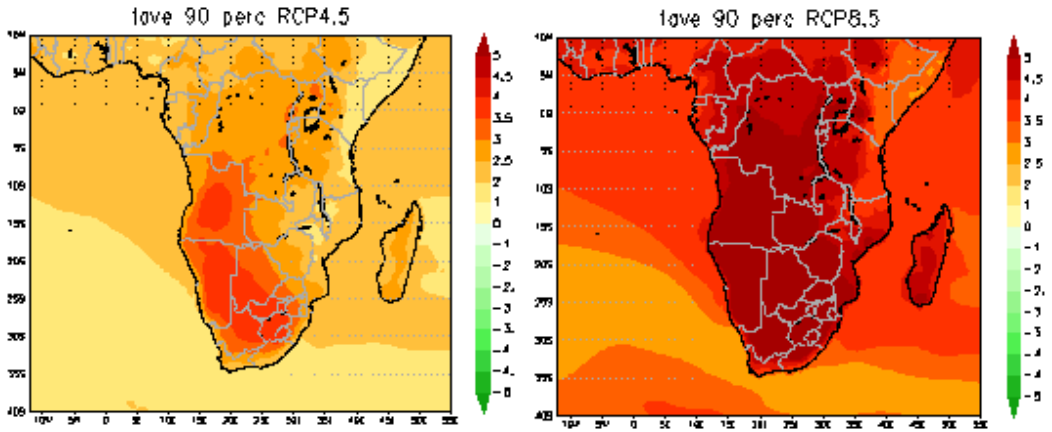
Two drivers require a global energy transition: Natural resources are finite and CO_2 emissions need to be capped

Needs to be considered in our local context and the National Development Plan

Resources are finite



CO_2 emissions need to be reduced



Price pressure

Regulatory/policy pressure

NDP Vision 2030

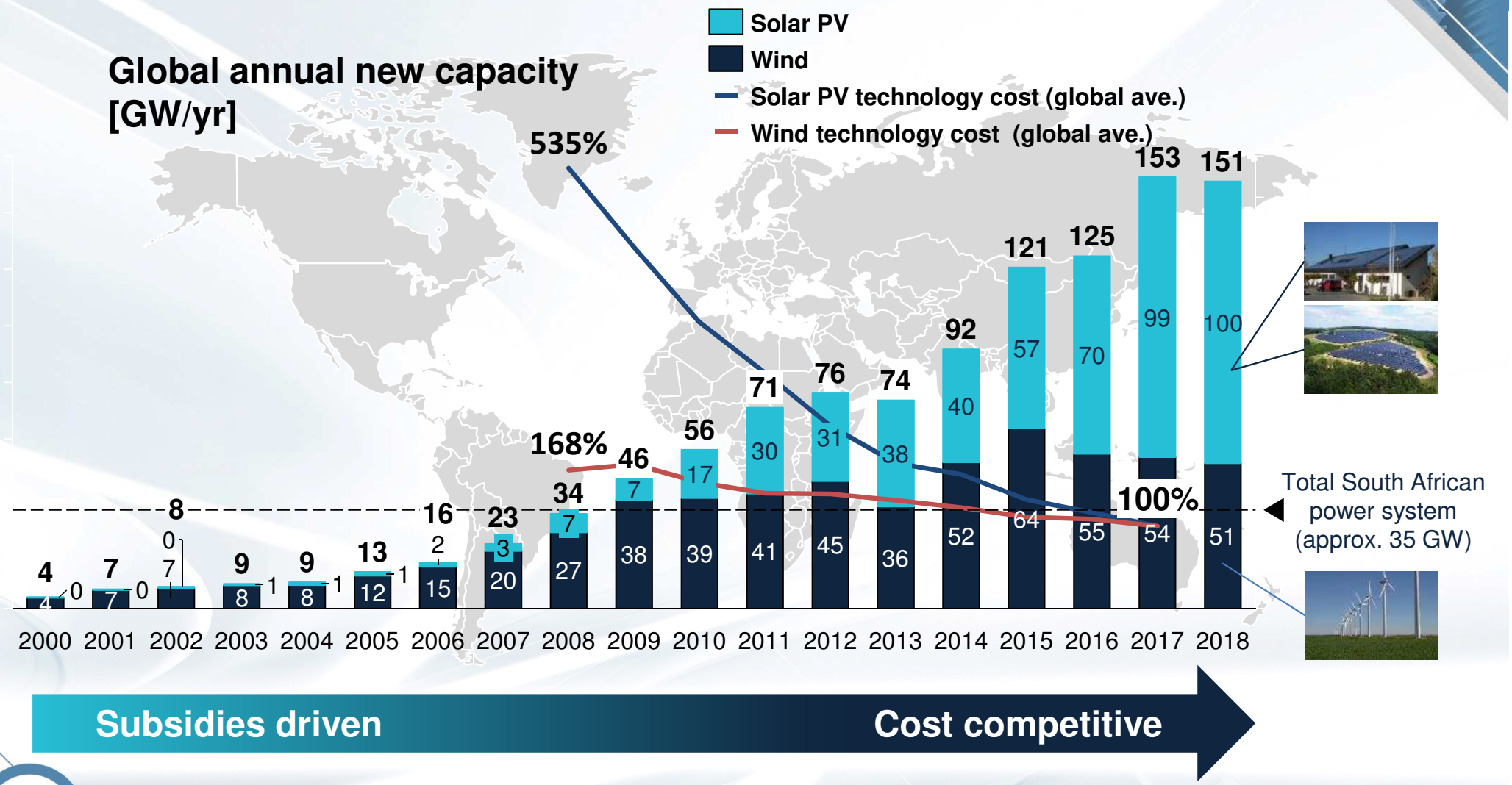
Reliable and efficient energy service at competitive rates, while supporting economic growth through job creation

Social Equity through expanded access to energy at affordable tariffs and through targeted, sustainable subsidies for needy households

Environmental sustainability through efforts to reduce pollution and mitigate the effects of climate change

Sources: WEC; BCG; CSIR analysis, National Development Plan

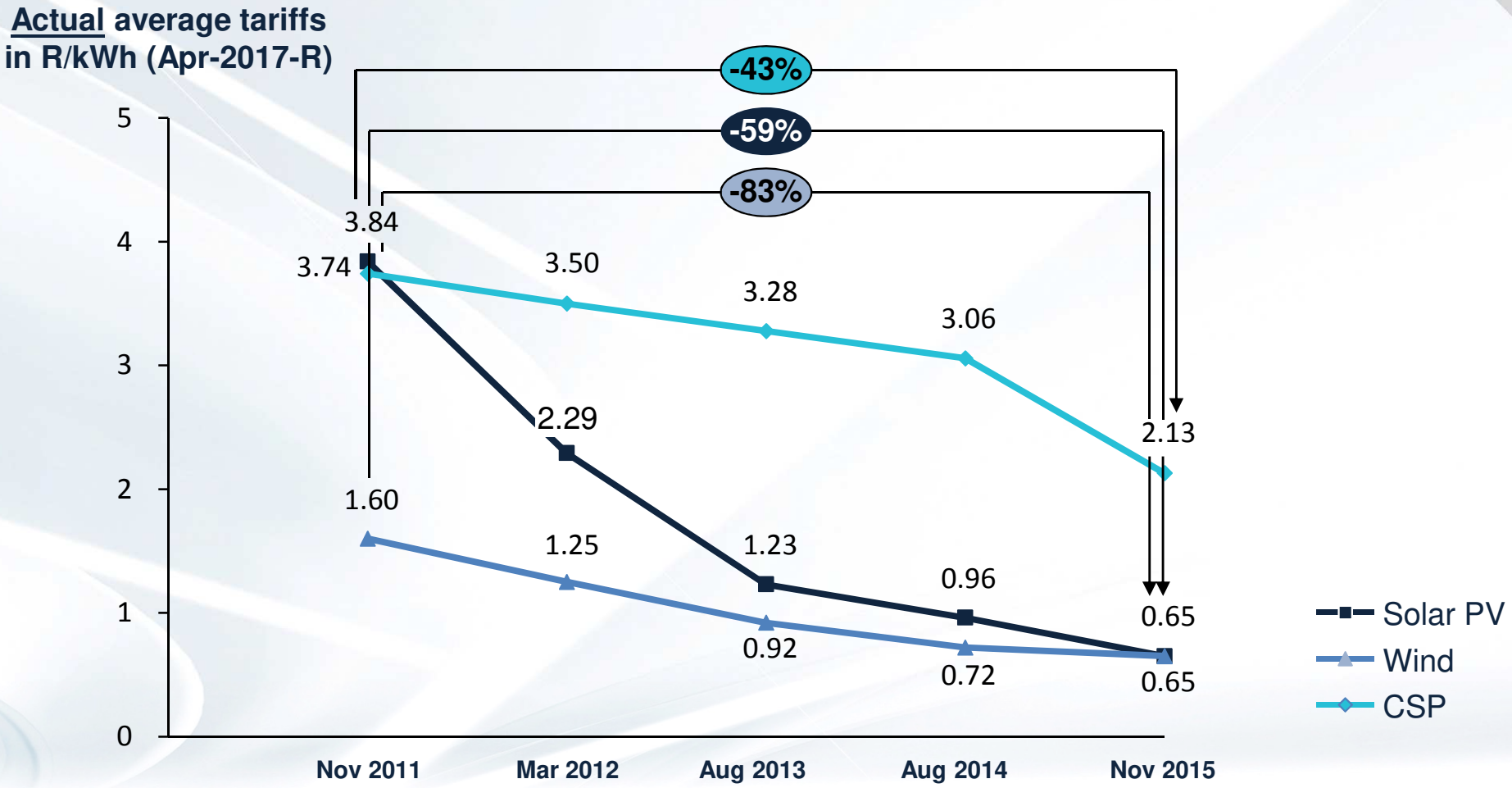
Renewable Energy globally: Significant cost reductions materialised in the last 6- 10 years (specifically for solar PV)



Sources: GWEC; IRENA; IEA PVPS; CSIR analysis

Actual tariffs: Reductions in tariff for new wind, solar PV and CSP

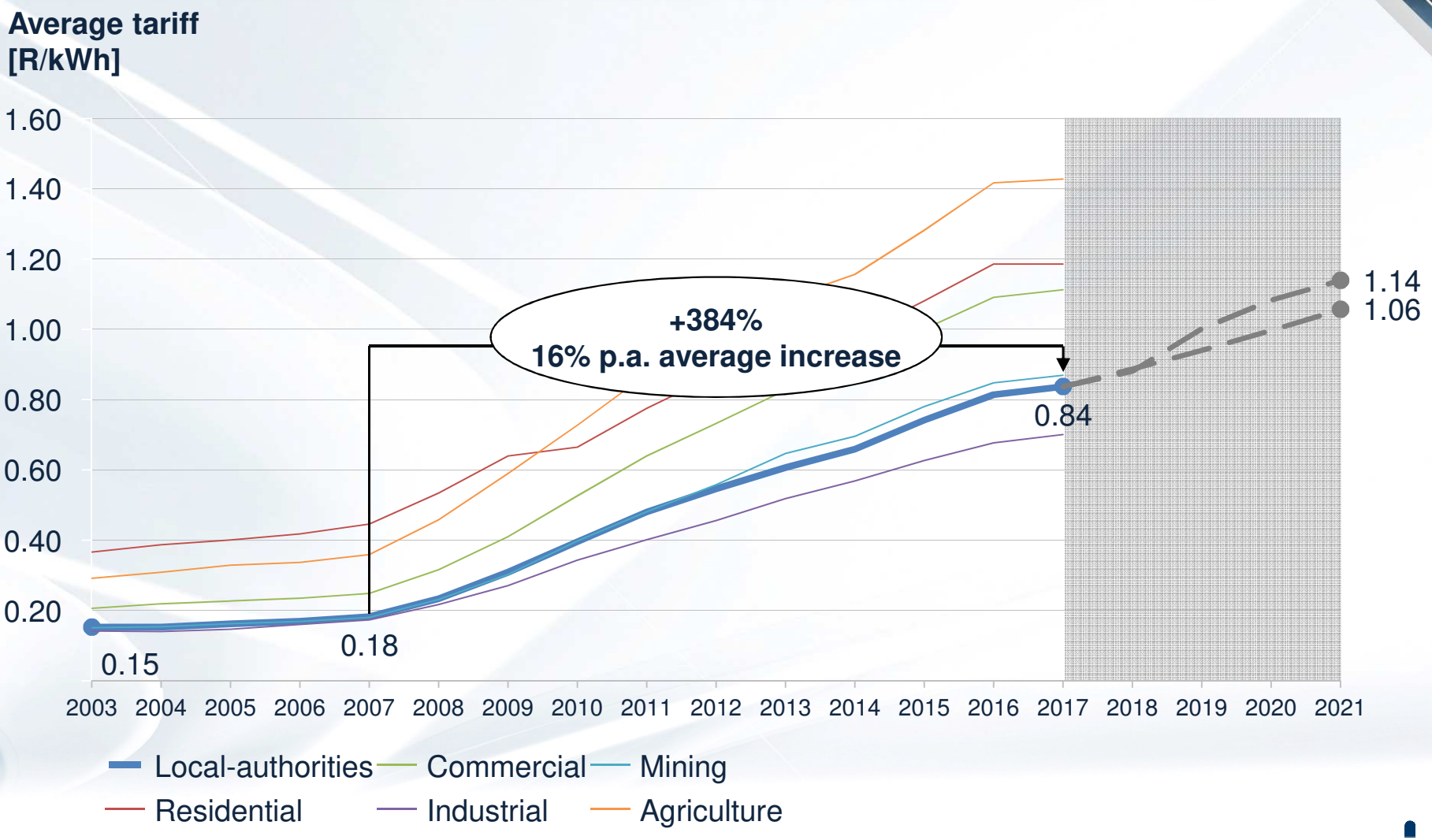
Results of Department of Energy's RE IPP Procurement Programme



BW1 → BW 4 (Expedited)

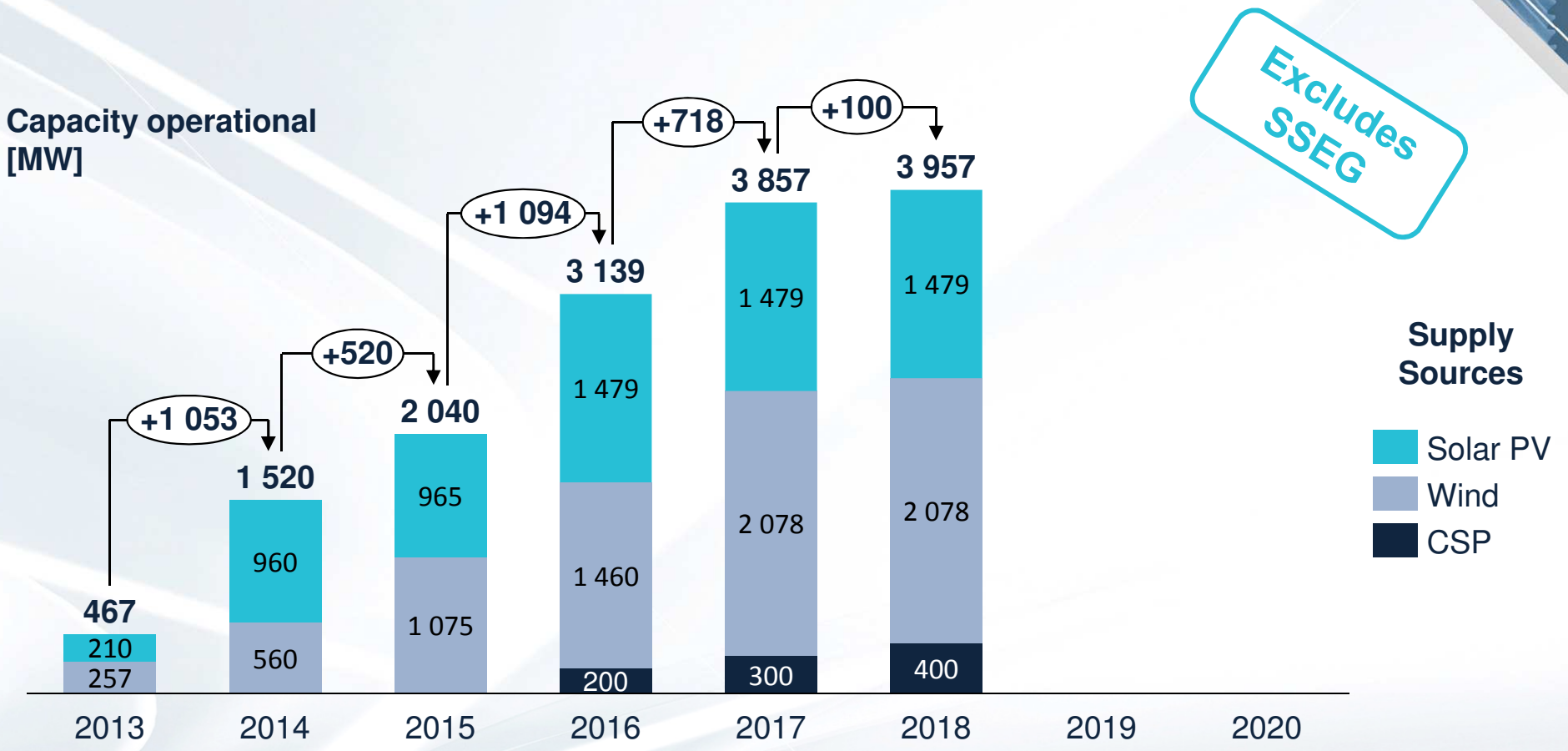
Sources: http://www.energy.gov.za/files/renewable-energy-status-report/Market-Overview-and-Current-Levels-of-Renewable-Energy-Deployment-NERSA.pdf; http://www.saippa.org.za/Portals/24/Documents/2017/Coal%20IPP%20factsheet.pdf; http://www.ee.co.za/wp-content/uploads/2017/10/New_Power_Generators_RSA-CSIR-14Oct2017.pdf; StatsSA on CPI; BW = Bid Window; Dates shown are the bid submission dates; CSIR analysis

In contrast electricity retail tariffs have increased substantially



NOTE: Future upper bound assumes average tariff aligned with Eskom MYPD4 application (2017/18-2020/21); Lower bound increases aligned with CPI (6% assumed)
Sources Eskom

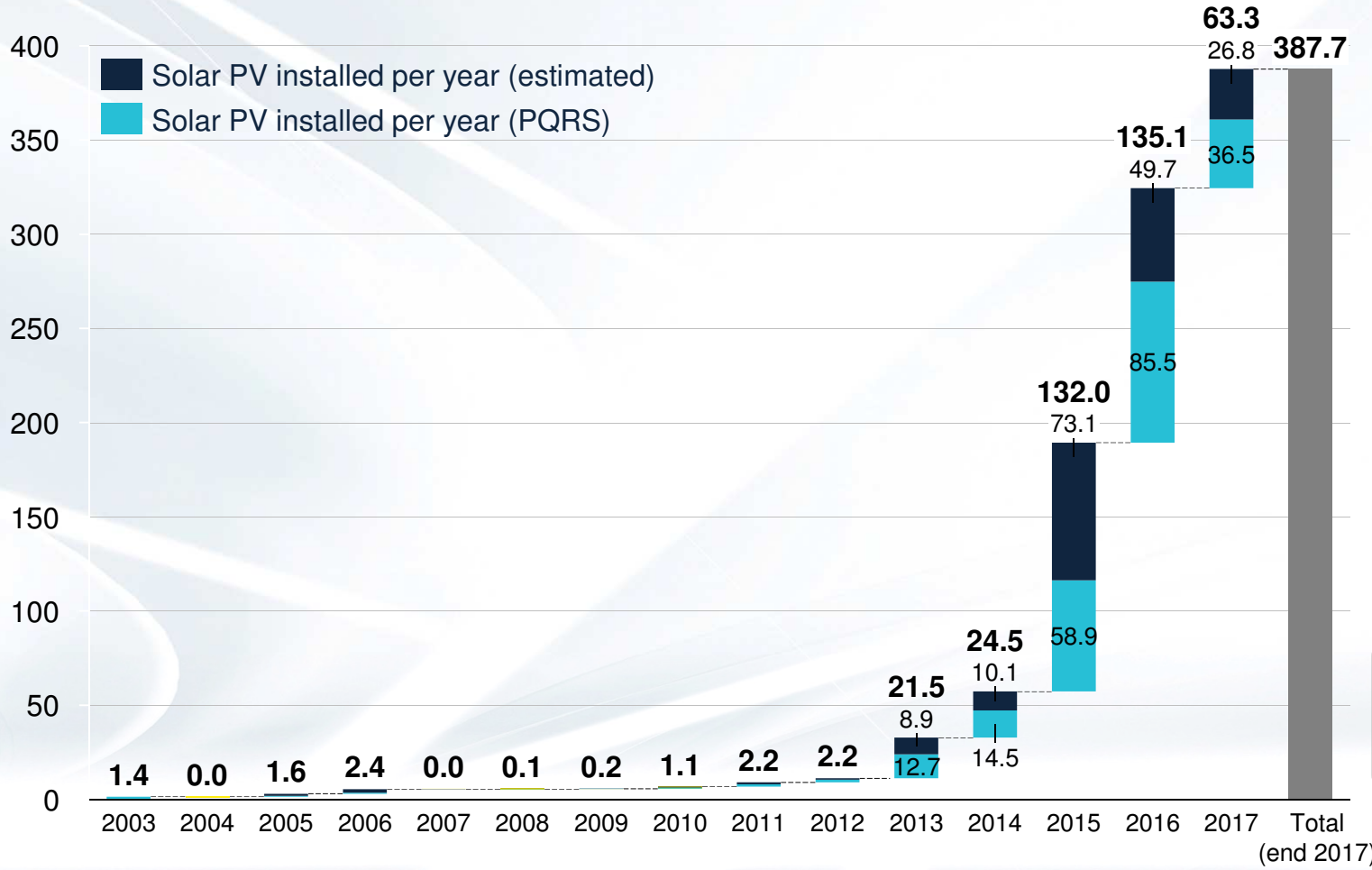
South Africa has steadily added utility-scale wind, solar PV and CSP (amongst others) from 2013-2017



Notes: RSA = Republic of South Africa. Solar PV capacity = capacity at point of common coupling. Wind includes Eskom's Sere wind farm (100 MW).
SSEG – Small Scale Embedded Generation
Sources: Eskom; DoE IPP Office

Small Scale Embedded Generation (SSEG) is growing (mostly solar PV)… quickly

Installed capacity (SSEG) [MWp]



… 0.5 - 0.7 TWh

… 0.2-0.3% of system demand

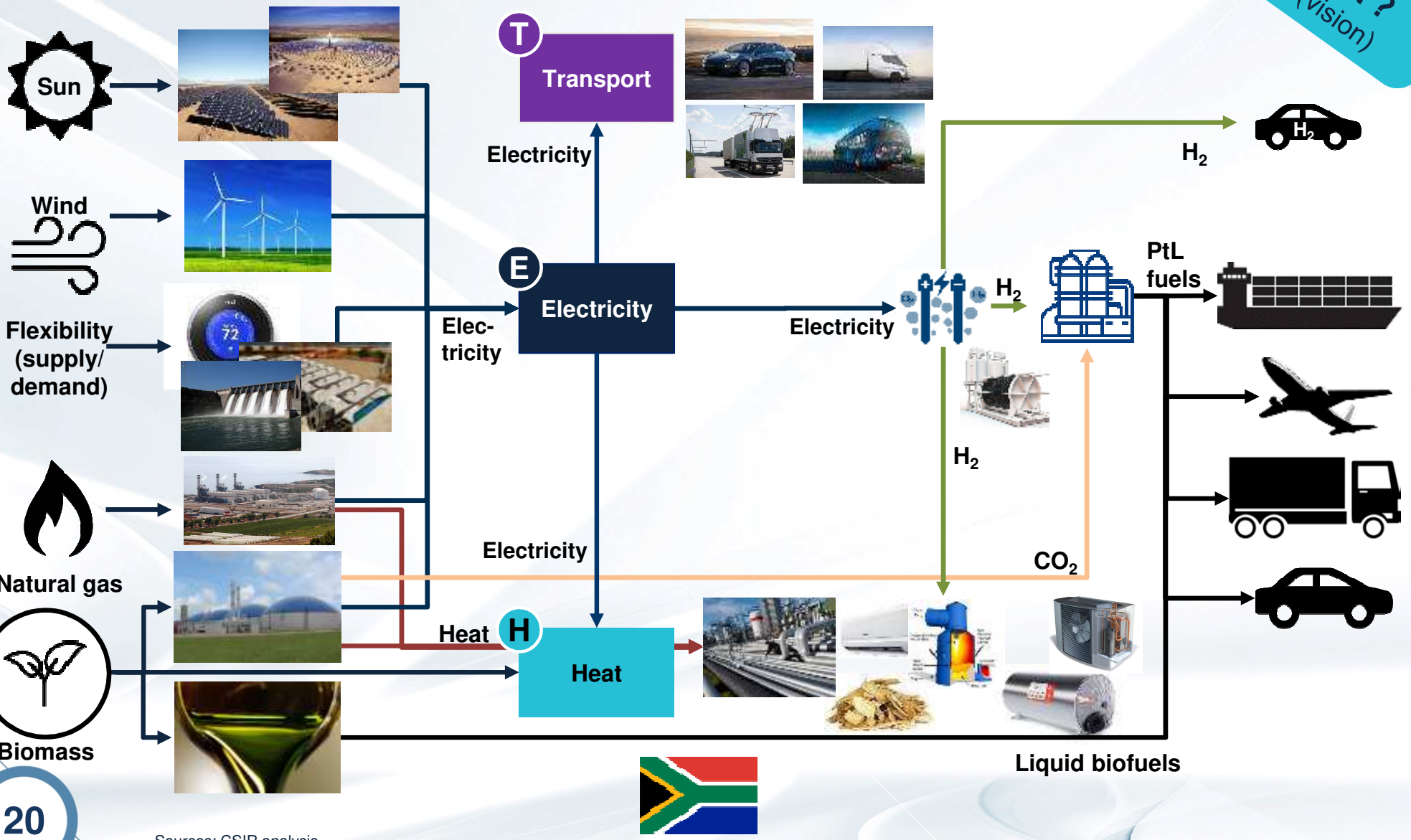
2018
Likely an additional 150–200 MW (at least)

Sources: PQRS SSEG database (adjusted)

Possible future: RSA's energy system based on electricity transitioning to decarbonisation based on predominantly renewables

Hypothetical energy-flow diagram (Sankey diagram) for South Africa's future energy system

20?? (vision)



Sources: CSIR analysis

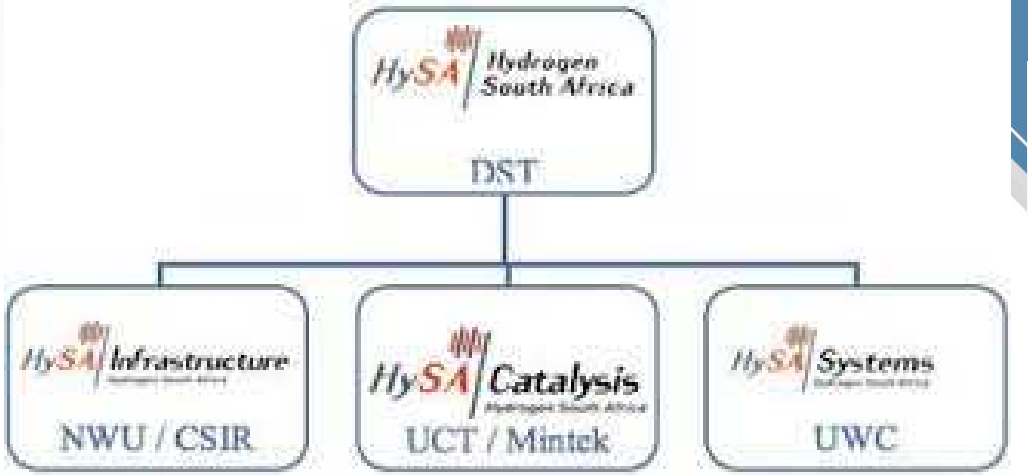
Underground mining operations will be early adopters of the new integrated energy system

Renewable energy will compliment traditional grid based power, with integrated thermal storage and hydrogen used in underground operations

Increasing energy cost negatively impacts on profitability and sustainability

Uncertainty of electrical power supply presents a significant safety concern

Uncertainty of future availability of reliable electrical power reduces investor confidence



BL Premium

BusinessDay

NATIONAL POLITICS COMPANIES ECONOMY BUSINESS

GOLD FIELDS

Gold Fields calls for fast-tracking of solar power at mines

BL PREMIUM

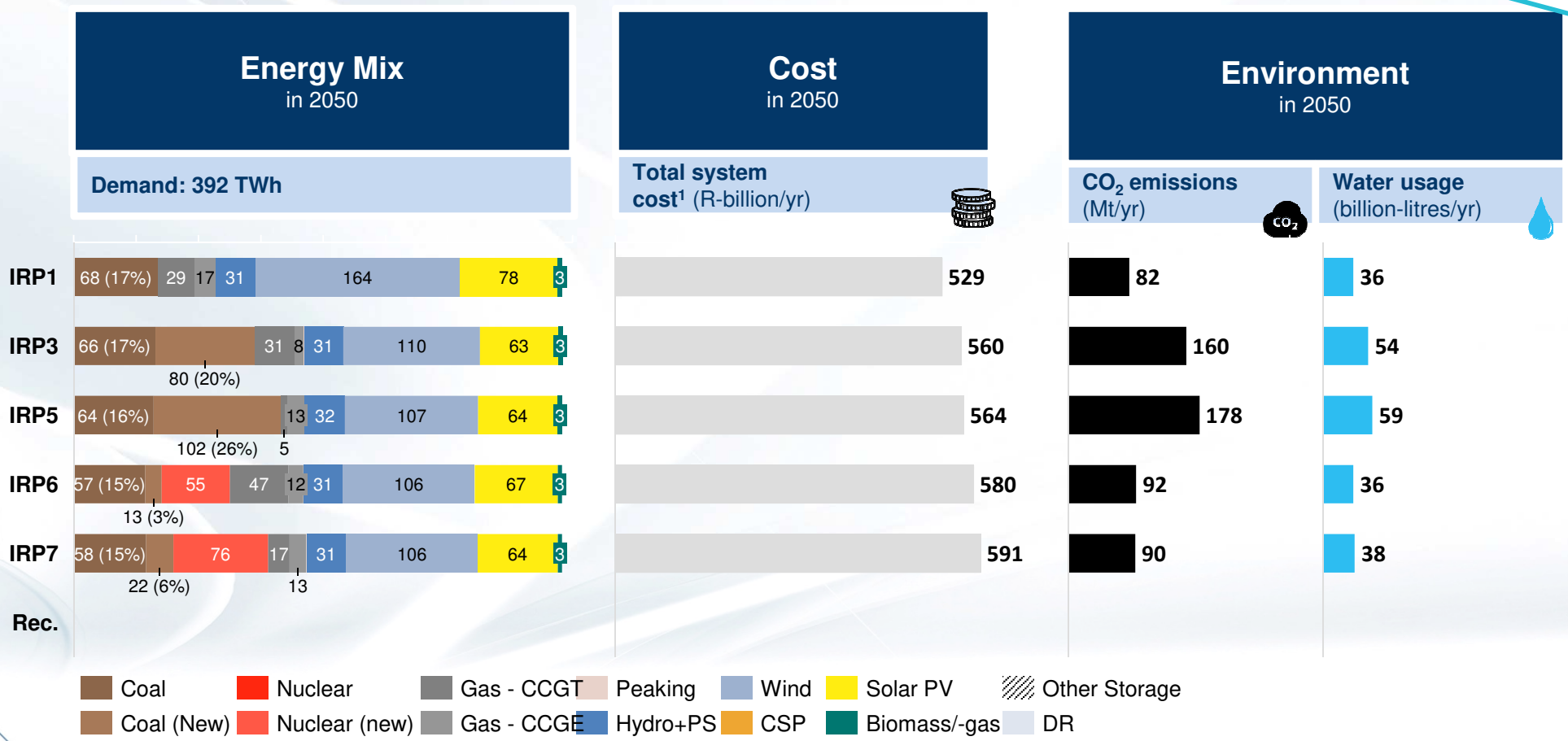
20 AUGUST 2019 - 05:10 *by* ALLAN SECCOMBE

By 2050 - Least-cost mix is 70% solar PV and wind, reflects a fundamental shift

As informed by DoE Draft IRP 2018 and validated by a number of independent studies

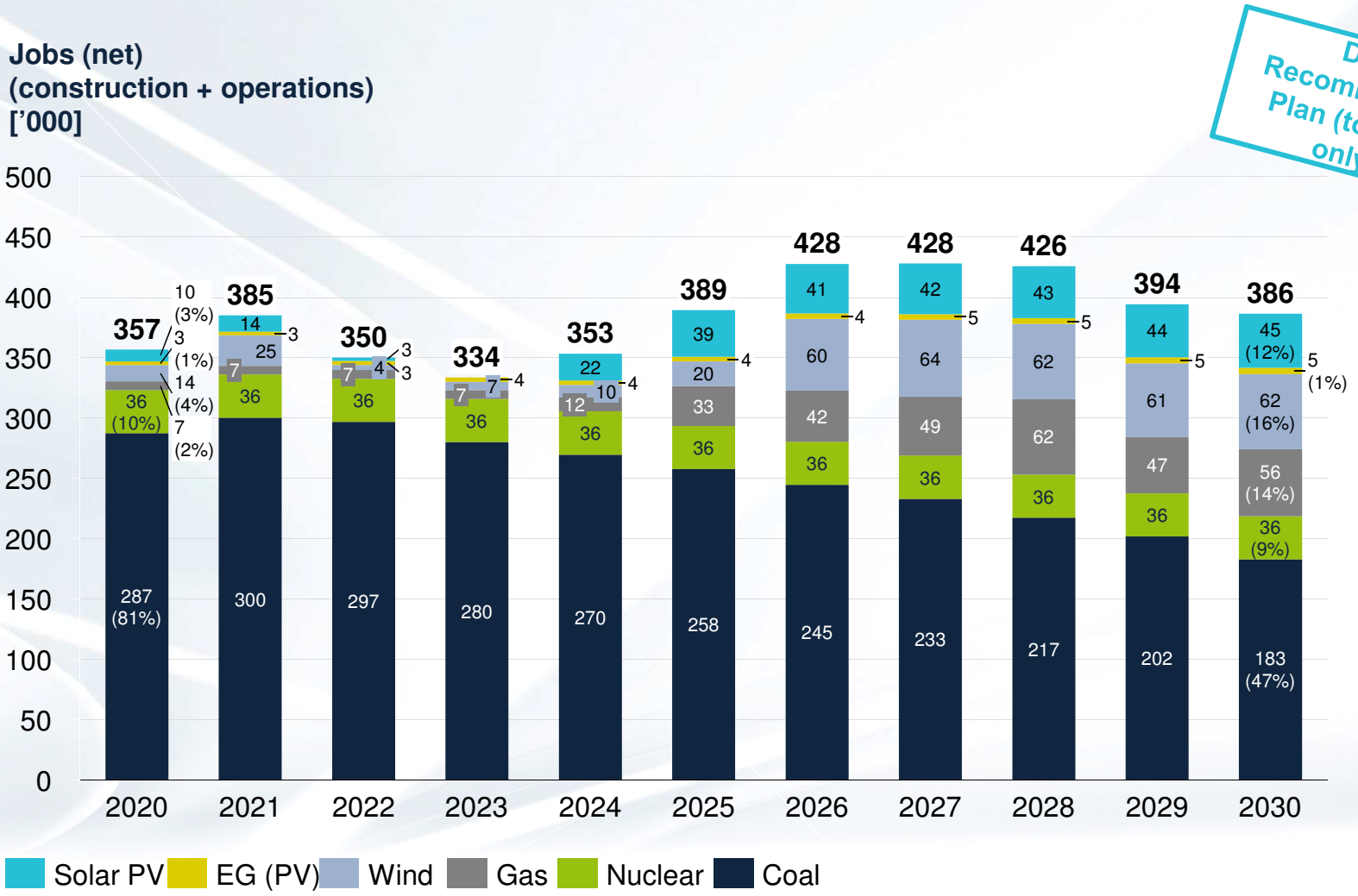
From Draft IRP 2018

2050



Sources: DoE Draft IRP 2018; Eskom on Tx, Dx costs; CSIR analysis; flaticon.com

DoE recommended plan in Draft IRP 2018: Net job decrease in coal of ≈100k but net gain overall as gas grows to ≈55k jobs towards 2030, RE contributes up to ≈110k by 2030



Sources: Draft IRP 2018; CSIR Energy Centre analysis
Note: Job potential includes direct, indirect and induced jobs; Nuclear is estimated based on existing experience at Koeberg (KPMG, 2017)

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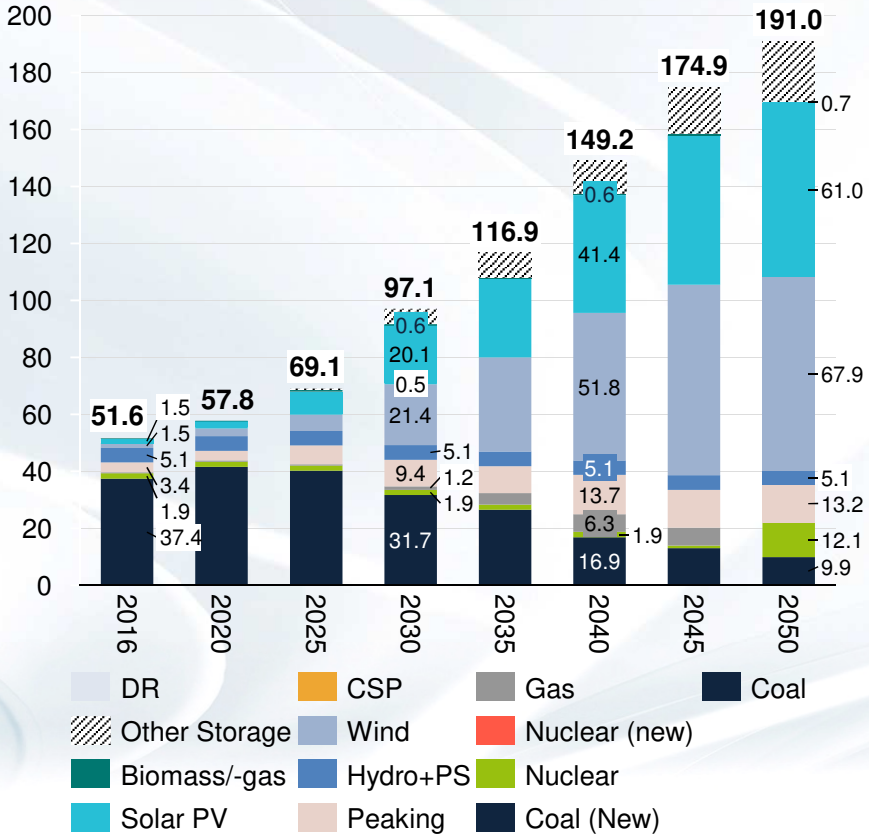
CSIR developed further scenarios to test the impacts of low coal fleet performance and reducing battery costs

Renewable energy, gas to power and battery storage dominate the future energy mix result in the cheapest and cleaner energy with substantially reduced water consumption

Risk-adjusted scenario - Low EAF (CSIR)

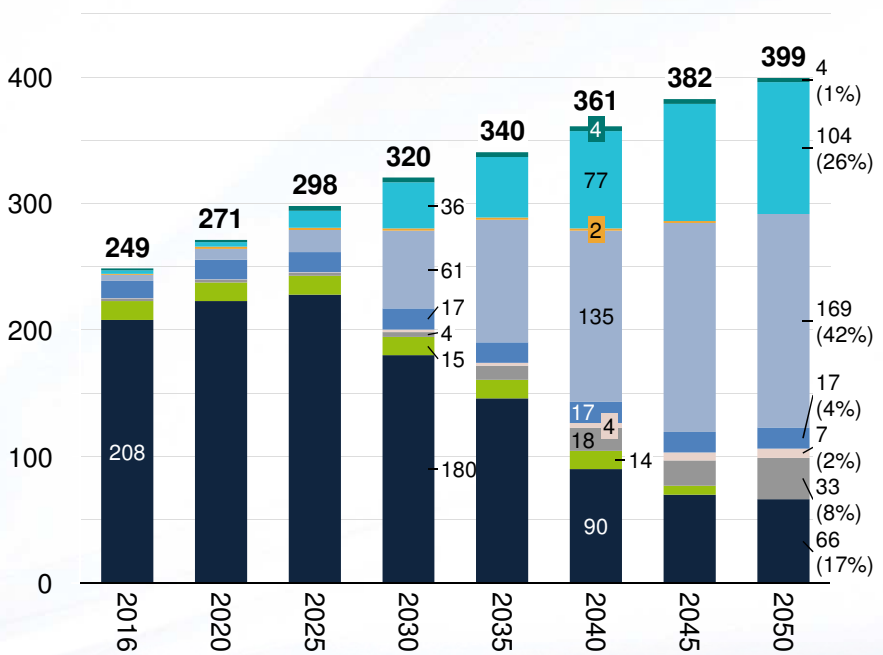
Installed capacity

Total installed capacity (net) [GW]



Energy mix

Electricity production [TWh/yr]



Demand: Median

First new-builds:

PV (2023)	*0.4 GW*
Wind (2023)	*0.2 GW*
OCGT (2023)	*1.9 GW*
Storage (2024)	*0.3 GW*

CSIR scenario is similar to DoE Draft IRP 2018 Least Cost scenario

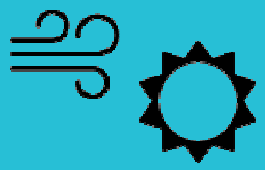
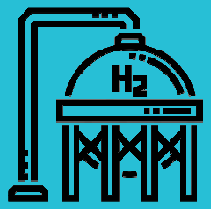
Sources: Draft IRP 2018. CSIR Energy Centre analysis

Transitioning to the future energy system will take time and presents opportunities – key aspects to consider

- **Cleaner (low-carbon) and least-cost are NOT in conflict**
- Transition to the future energy system **will be gradual** and **coordinated planning is required** to manage impacts and maximise benefits
- South Africa's massive opportunity (1) World-class solar/wind resource (in addition to coal) and (2) large land area enable low-cost renewable based electricity to becomes the primary carrier. Not just domestic use and increased energy security but also **EXPORT markets e.g. Hydrogen, Synthetic (carbon-neutral) fuels and chemicals**
- **Coal will play major role for many years to come**, with a decline expected after 2030 as linked to aging coal-fired power stations decommissioning plans. Coal will remain part of the energy mix even in 2050 (albeit <20%) with predominate use in industrial process heat
- Opportunities for new industries abound, however, the transition to these new industries (4IR – dominated) **will require new skills; capacity building will be key**

Energy transition presents opportunities for RSA

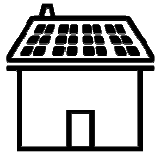
South Africa is well-positioned to be among regional and global leaders transitioning the energy system. Therefore strategic investment in R&D initiatives that speak to technology innovation and industrialisation is paramount

	Opportunities – a select few	Research and Development agenda
Wind & solar 	• Abundant and inexhaustible wind and solar energy resources • Even by 2050, RSA would not have used 10% of its exploitable wind and solar resources • Strategic global competitive advantage (excellent resource and available land)	• Planning and operating a power system with high share of renewables (stability/reliability) • **Technology localisation** (industry, jobs, SMMEs) • Energy storage (battery development and localisation) – **beneficiating local mineral resources**
Financing 	• Global finance available to decarbonise the energy system and make countries resilient to climate change effects	• **Opportunities to address present liquidity challenges** (Eskom and municipalities)
Hydrogen economy 	• Hydrogen a fuel source of the future • Local energy mix diversity, and possible export opportunity (Europe and Japan) • Reduce RSA balance of payments displacing imported liquid fuels • Platinum beneficiation in fuel cells and electrolysis	• **Determining the future role of hydrogen in the RSA energy mix** and end use applications and new industries including hydrogen as a feedstock for CO2 utilisation in the production of clean synthetic fuels • **Localisation and beneficiation** to supply the global hydrogen value chain
Circular economy 	• Valuation of waste	• Carbon dioxide utilisation • Fly ash-based geopolymer binders for **reduced cost building materials**

4IR at the core of industrialisation; Using IoT, Robotics, VR and AI to improve and enhance our way of life (productivity/efficiency)

The energy transitions needs to be just and requires the development of new industries and business models

South Africa is well-positioned to be among regional and global leaders transitioning the energy system. Therefore strategic investment in R&D initiatives that speak to technology innovation and industrialisation is paramount

	Opportunities – a select few	Research and Development agenda
Just Transition 	• New jobs in Gas, Storage and Renewables • Renewable energy manufacturing and deployment in coal regions • Net increase in jobs • Localisation and industrialisation of new technologies	• **Re-purposing aging coal-fired power stations** • **Labour migration and social plans** • **Economic sector diversification in coal regions** (e.g. special economic zones) • **Skills plans for new industries** (new skills and re-skilling)
Consumers Prosumers 	• Consumers participate in the provision of electricity (small scale embedded generation) • Off-grid and mini-grid electrification	• New business models for prosumers and the municipal utilities. Financial sustainability of new tariff structures and trajectories • **Democratisation of energy and opportunities for SMMEs** • **New tech for electrification Universal Access**
Utility business model 	• Change from a vertically integrated power utility business model • Entrance of new players in the Electricity Supply Industry (ESI)	• New energy markets with aggregators • Capacitate **infrastructure maintenance and creation** • **Ensuring the performance of existing (Eskom) fleet**
alternative/low-emissions mobility 	• Carbon neutral synthetic fuels • Battery and fuel cell Electric Vehicles for domestic and export markets • Reduce dependency on imported liquid fuels	• **Electrochemical technologies (batteries, fuel-cells) key to the future transportation system – localisation and industrialisation** • **Revenue opportunities & increased electricity sales**

4IR at the core of industrialisation; Using IoT, Robotics, VR and AI to improve and enhance our way of life (productivity/efficiency)

A just transition will have substantive positive impact

Deliberate choices will enable South Africa to transition from the present pain points and support the NDP

Impact	Social	Economic	Enviro
Net **increase in jobs**	✓	✓	
Reduced emissions and water consumption	✓		✓
Creation of new industries (Gas, Renewables, Electric Vehicles)		✓	
Lowest cost energy – longer term strategic advantage	✓	✓	
Export hydrogen and clean synthetic fuels		✓	✓
Increased energy security		✓	
Support universal access to energy	✓		
Flexibility to respond to changing economic growth and energy demand		✓	

Partnerships

Will require a collaborative and coordinated plan across multiple role players… some CSIR examples in the energy domain

Recommendations

Selected bed-rock factors require immediate attention

Recommendation	CSIR support	Progress
A **coordinated national approach**, plan and execution for the just energy transition	✓	
A **comprehensive integrated energy plan** (electricity, heat and transportation) that provides strategic decision making support	✓	
Restructuring Eskom and the broader Electricity supply industry	✓	
Develop **new municipal energy role and business model**	✓	
Focused **RDI in emerging technologies** (hydrogen, energy storage, renewable energy)	✓	
Analysis and **implementation plans** for a future electricity system with a high share of variable renewable energy	✓	
Developing industry and business models for **hydrogen and synthetic fuels** / **chemicals export**	✓	

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Mining Challenges and Opportunities

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Mining Industry Challenges

- **Occupational health and safety** needs to improve towards attaining Zero Harm objective
- **Economic viability** of many mining operations are threatened e.g. low commodity prices, increased cost
- **Productivity challenges** with mining **complex orebodies,** deeper and further from the shaft
- **Mine rehabilitation** requirements to ensure that the environmental impact is minimised both during mining as well as once mining activities have stopped;
- **Skills shortages** both from a technical as well as operational perspective;
- **Socio-economic issues** need to be addressed especially in the communities where mining operations are taking place;
- **Infrastructure** has to be reliable, cost competitive and efficient.

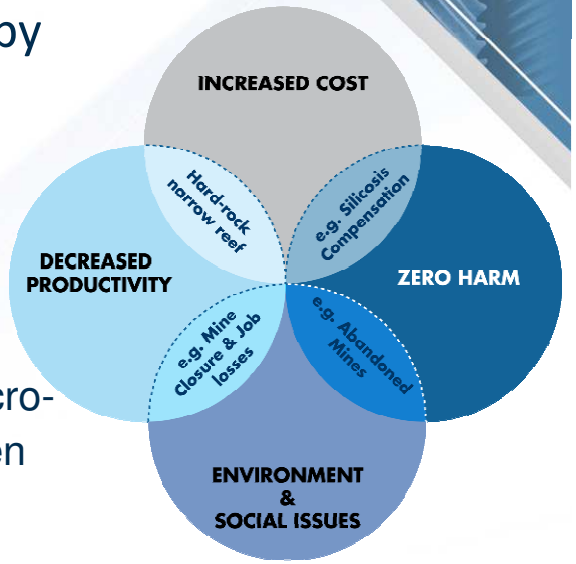
Requires an intervention from all stakeholders in the following areas:

- Improving **upstream and downstream linkages** between mines and the domestic capital-equipment sector through an effective **beneficiation** strategy on core minerals.
- Pursuing **social and community upliftment and development**, via access to the supply chain, with a particular emphasis on housing
- Supporting **increased exploration** activities, including by providing more detailed geo-scientific information to explorers
- Underpinned by strong **research, development and innovation** within the cluster, and
- Planning and implementing holistic mine modernization (systems thinking approach)

Challenges – Mineral extraction

The key ***pain points*** of the industry were identified and confirmed by all Mining Industry players as indicated below.

- **Safety statistics have attained a plateau.** Though safety has greatly improved from the 1990s, there has been no consistent reduction in the number of fatalities since 2016.
- **Increasing costs.** As mines go deeper, all cost components increase. Macro-economic factors, such as increasing labour and energy costs, also threaten the profitability of mines.
- **Decreasing productivity and poor efficiencies.** Mining activities rely on the synchronisation of a critical series of activities. Many of these activities are labour-intensive, time-consuming. The cyclical nature of the drill-and-blast process, and long travel times to working places, reduces productive time at the face, during which mines incur costs and generate no income.



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Mining sector opportunities

South Africa has an abundance of mineral wealth reserves (USD 2.5 trillion[1] and World #1 in PGMs, Chromium, Manganese, Titanium and Gold)

South Africa is ranked No 1 or 2 in the world for its resources of 9 out of 18 key minerals required for 4IR technologies [2]

South Africa mining attractiveness improved dramatically since 2017 - the Policy Perception Index showed a 21% improvement and South Africa's Mineral Potential is ranked as 20 out of 91 (Fraser Institute, 2018) [2]

Return to best practices in policy, legislation and regulation formulation coul… South African mining back in the top 25% of investment attracti…ene…s ranki… resulting in: [2]

- **Capital investment** increased by R 122 billion
- Create **additional 200,000 jobs** (direct and indirect)
- Profound **positive impacts** on mining supply chain, export earnings, ta… transforming of the sector

1. (www.south africa.info and CGS) 2. Minerals Council South Africa, 2019)

Mining RDI Opportunities

A unified approach to addressing the key challenges mineral extraction – the SAMERDI strategy – was adopted by stakeholders across the mining industry

A true Public-Private Partnership embodied in the establishment of the Mandela Mining Precinct, with the role of coordinating the implementation of the SAMERDI strategy in partnership with academia

Positioned to re-build mining research and development capability and capacity

Mining Industry challenges	CSIR's response
Occupational health and safety	Partnering with Mine Health and Safety Council in **occupational health and safety research** through its Centre of Excellence
Economic viability of mines	Participation in SAMERDI research programmes that will improve **efficiencies** and **productivity**
Mine rehabilitation	Solutions to **reduce environmental impact**
Skills shortages	**Skills training** leveraging unique mining research facilities
Socio-economic challenges	Hosting an initiative with mining companies and government to **identify socio-economic problems and develop solutions** e.g. in education, healthcare and economic development

Required support

- Unique national facilities that support the drive towards Zero Harm could unlock greater impact through:
  - Appropriate funding models for long-term sustainability
  - Increased awareness
  - Broader industry utilisation through appropriate regulations

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tion to the Parliamentary folio Committee

MANDELA MINING PRECINCT
MINDS FOR MINES

Activities at the Mandela Mining Precinct to address challenges in mining

Navin Singh

MANDELA MINING PRECINCT
MINDS FOR MINES

Collectively addressing crisis in mining

Mining in Crisis

Solution for the Sector

Solution: Advancing the mining cluster

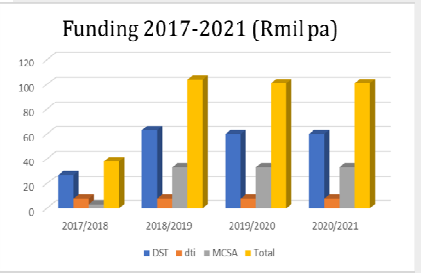
- Modernisation
- Maximise access to supply chain
- Focus on People-centric, Processes & Technology
- Build Manufacturing Capability
- SA R&D capacity and capability
- SA mechanised mining equipment

Extend the life of platinum and Gold Mines beyond 2025 & establish global leadership in narrow reef, hard-rock mining systems

Private Public partnership

mineral resources · science & technology · the dti · planning, monitoring and evaluation · OPERATION PHAKISA · MINERALS COUNCIL SOUTH AFRICA · MEMSA · Coaltech · SiMINE · SAMPEC · CSIR · GSSA · WITS UNIVERSITY · UNIVERSITY OF JOHANNESBURG

MANDELA MINING PRECINCT
MINDS FOR MINES



Establishment of the Mandela Mining Precinct

- *Situated at the place of original site of in Jhb, public -partnerships wit State, Industry, Research Partners (academia and science councils)*
- *In tribute to the legacy of President Mandela , of bringing people together to work on challenges, "MINDS FOR MINES" .*
- *The vehicle for a Healthy, Safe, Transformative, Innovative & Economically Viable mining industry .*
- *An enabler for creating technological solutions firstly for the benefit of the South African Mining Industry , then into SADC and ultimately into the rest of the African continent*

MANDELA MINING PRECINCT
MINDS FOR MINES

Reviving Mi g via R&D – *a strategy*

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

MINERALS COUNCIL SOUTH AFRICA

Public Private Partnership

SOUTH AFRICAN MINING EXTRACTION RESEARCH, DEVELOPMENT & INNOVATION STRATEGY" (SAMERDI)

"To **maximise** the returns of **South Africa's mineral wealth** through **collaborative, sustainable** *Research, Development, Innovation and Implementation of mining technologies in a* **socially, environmentally and financially manner** *that is rooted in the wellbeing of* **local communities and the national economy.**"

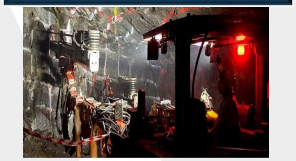
SAMERDI Strategy

Modernisation of mining

The Mine of Today
more from the same with the same
- Zero Harm
- Increasing efficiency by focusing on technologies, people and processes.

JOB PRESERVATION

The Mine of Tomorrow
using specialised locally manufactured equipment
- Zero Harm
- Efficacy gains
- Accessing orebodies that can't be mined conventionally

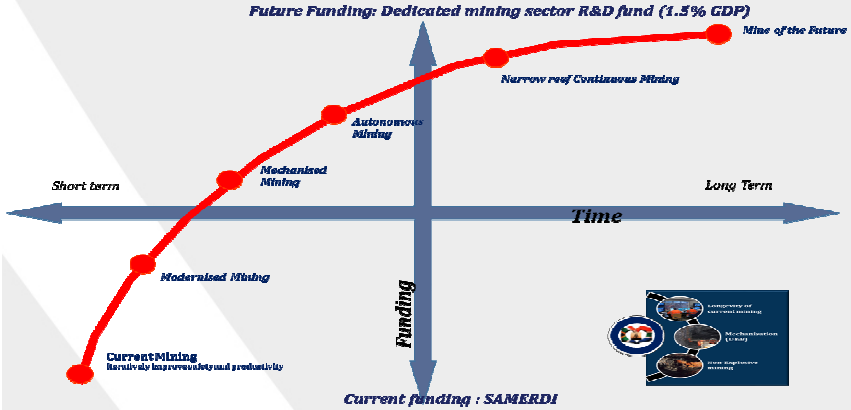


JOB CREATION

The Mine of the future
Mining only the reef, all of the time
- Zero Harm
- Zero Dilution
- Accessing orebodies even deeper orebodies

JOB CREATION

Vision 2030 for Mining Industry



CROSS CUTTING INITIATIVES		GAINS
Advanced orebody Knowledge	To see ahead of the face to find reef, structures (faults dykes)	• Safety
Real Time Information Management	The right information to the right person at the right time	• Production
Successful Application of technology Centred Around People	People centric solutions in dealing with changes to processes with(out) technology	• Efficiency

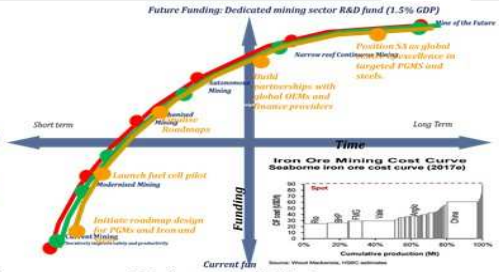
MANDELA MINING PRECINCT
MINDS FOR MINES

Mining as a dr[illegible]r for industrialisation

- **Positive impact on mining jobs (retention & creation)**
- **Mining Equipment Capability to SA mines and ultimately SADC**

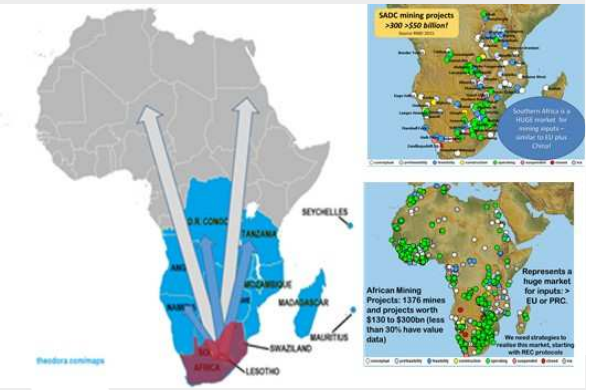
Revitalisation of Mining

Local Manufacturing Capability



Value Addition

Group	Jobs creation and retention	Multiplier	Time frame for success
Semi-skilled workers in unviable mines heading for closure/contraction	200k	10X	0-5y
Skilled miners (new mechanised mines)	100k	10X	5-10y
Skilled workers in the supply-chains (capital goods, consumables and services)	120k	10X	1-10y
Skilled and semi-skilled workers in downstream industries	TBD	10X	5-10y
Semi-skilled workers in agriculture & processing	10k	10X	2-5y



Significant opportunity in SADC and rest of Africa- market in Africa is larger than EU and PRC combined