

POSSIBLE DECARBONISATION ROADMAP FOR SOUTH AFRICA

RES4AFRICA FOUNDATION

AGENDA

1. SETTING THE CONTEXT
2. DECARBONISATION ROADMAP FOR SOUTH AFRICA
3. ANNEXES

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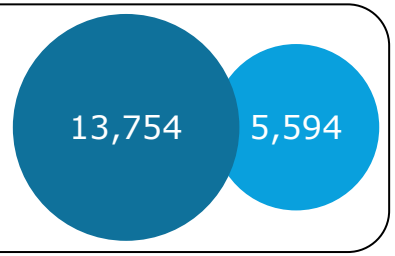
1.
SETTING THE CONTEXT

South Africa is one of the most important economies in Africa and therefore is key in driving the continent's transition

SOUTH AFRICA OVERVIEW

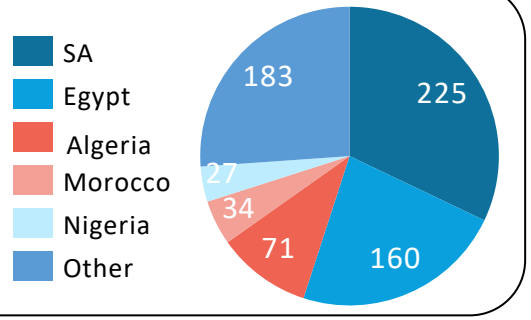
GDP per capita
[PPP current international $ in 2019]

SA is a developing Country whose GDP per capita is higher than Africa average and is the only African **member of the G20**



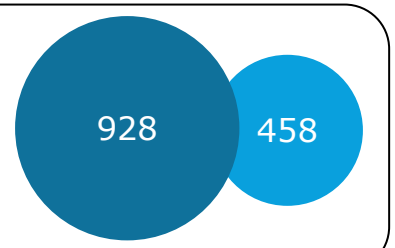
Electricity Demand
[TWh in 2019]

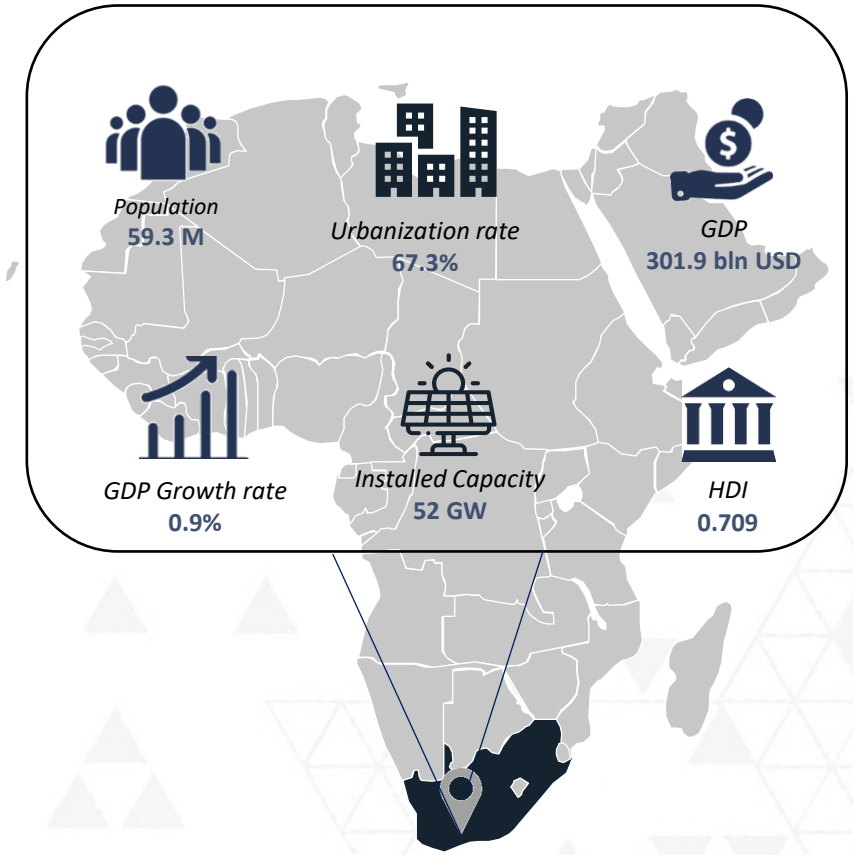
SA is the **largest electricity market in the continent**, the decarbonisation of its power sector could give a substantial contribution to the growth of a sustainable economy in Africa



Emission intensity of the power sector
[gCO2/kWh in 2019]

SA's **emission intensity** is more than **double the G20 average.**

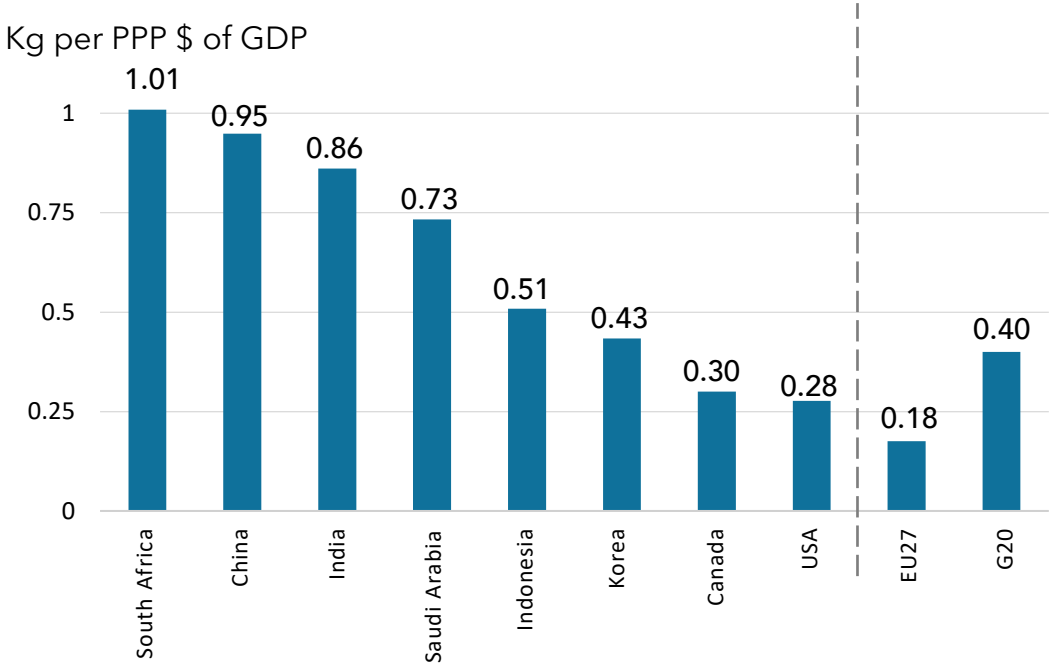




Source: IEA, Climateanalytics, StatisticsTimes | PPP: Purchasing Power Parity

South Africa has the most carbon intensive economy among the G20, mainly due to massive use of coal in the industry and power generation sectors

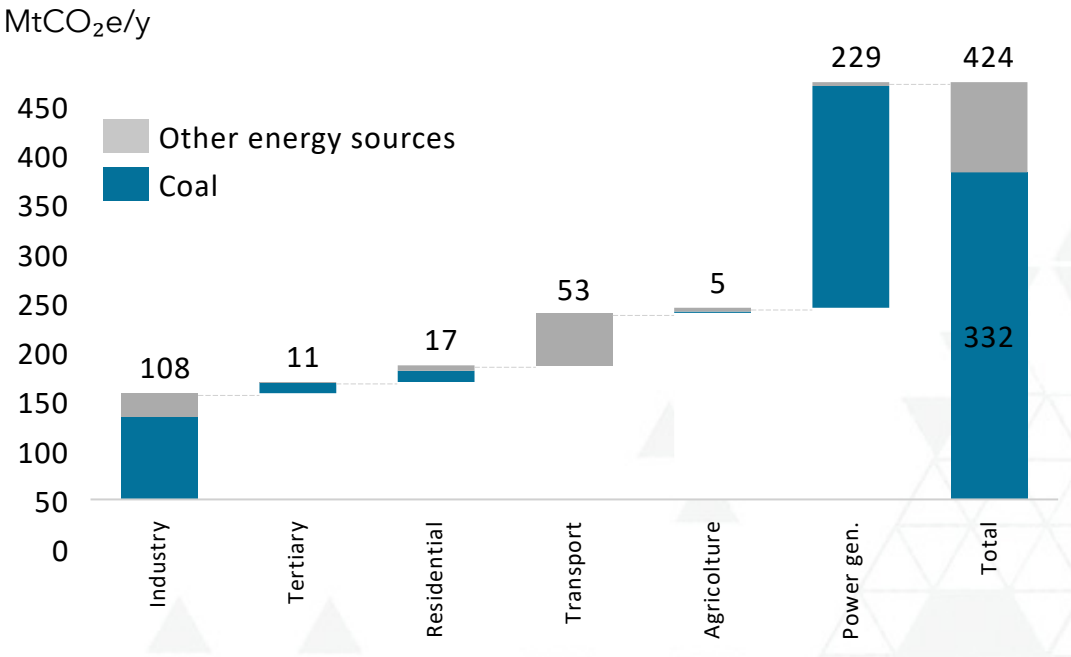
CO2 EMISSIONS IN 2018[1]



South Africa is ranked as the worst G20 carbon performer

SA has still not been able to decouple its economic growth from its impact in terms of carbon emission

SOUTH AFRICA'S EMISSIONS BY SECTOR AND SOURCE IN 2018



Over 50% of South Africa's emissions come from the power generation sector, which is dominated by coal plants

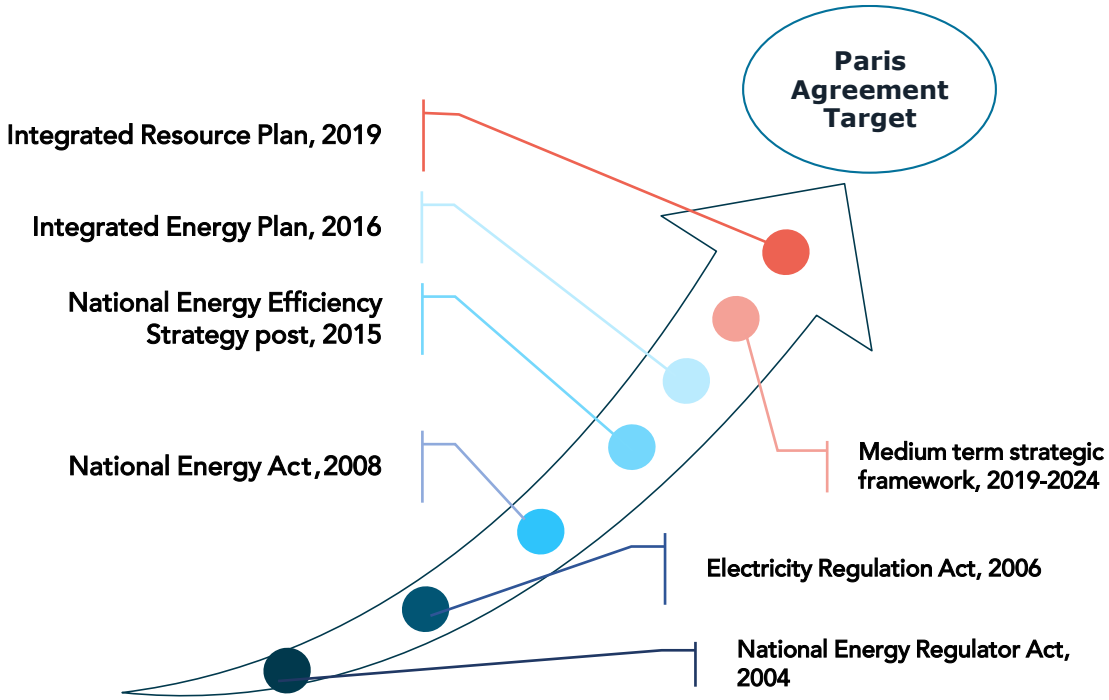
Coal is also the most dominant energy source in all other main sectors (particularly industry), other than the transport sector

Source: IEA, World Bank | PPP: Purchasing Power Parity

Notes: 1) Countries have been selected among G20 based on their relevance and fossil fuel dependency

Over the years, the South African Government has tried to face future issues related to GHG emissions by adopting decarbonisation initiatives…

POLICY ROADMAP



COMMENTS

In order to respect international agreements on climate change, several initiatives have been adopted over the last two decades in order to reduce GJG emissions:

- National Energy Acts in early 00's set the rules to build an integrated approach to face the decarbonisation issue
- In Oct 2015, SA deposited its first NDC[1] with the UNFCCC[2], committing to keeping national GHG emissions within a range from 398-614 Mt. CO2-eq by 2030
- To reach the declared target, the energy plan (IRP) foresees:
  - the **decommissioning of coal-fire power plants** (roughly 11MW by 2030 and 35MW by 2050)
  - the reduction of coal dependence in electricity generation (to 55% in 2030 and 11% in 2050) via a **planned renewables procurement**
- Since the first NDC proved to be insufficient to meet international targets, SA has declared an **updated NDC with a 2030 target range of 350 - 420 Mt CO2eq**

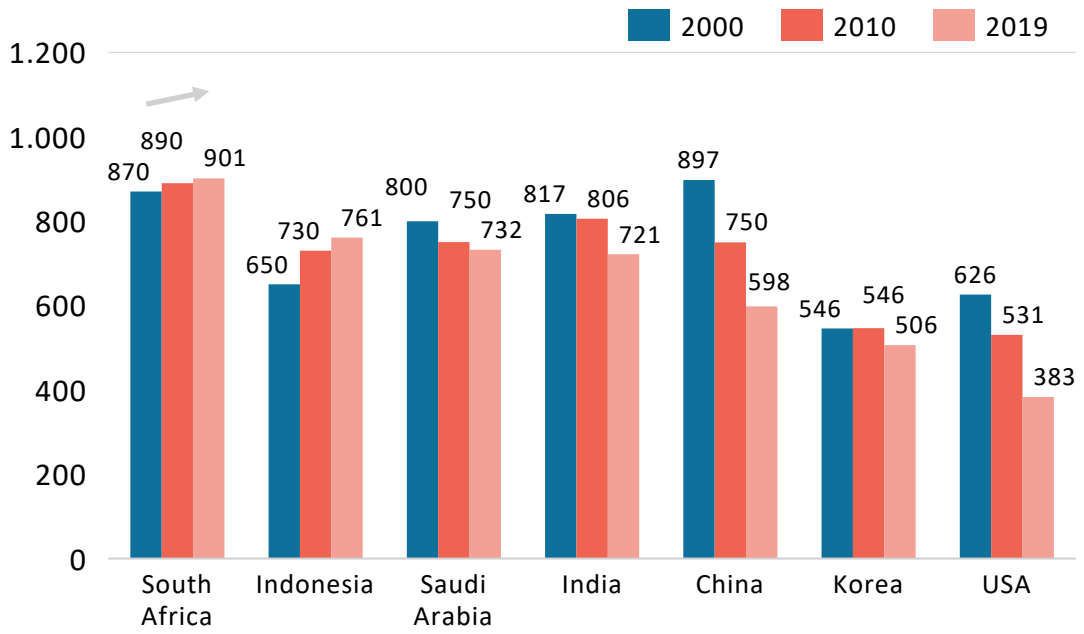
Notes: 1) NDC: National Determined Contribution;

2) UNFCCC: United Nations Framework Convention on Climate Change

...but, despite these efforts, South Africa is not on track to respect the 1.5°C target and, in contrast to G20 countries, power carbon intensity is still rising...

EMISSION INTENSITY TREND IN THE POWER SECTOR[1] 2000-2019

gCO2/kWh

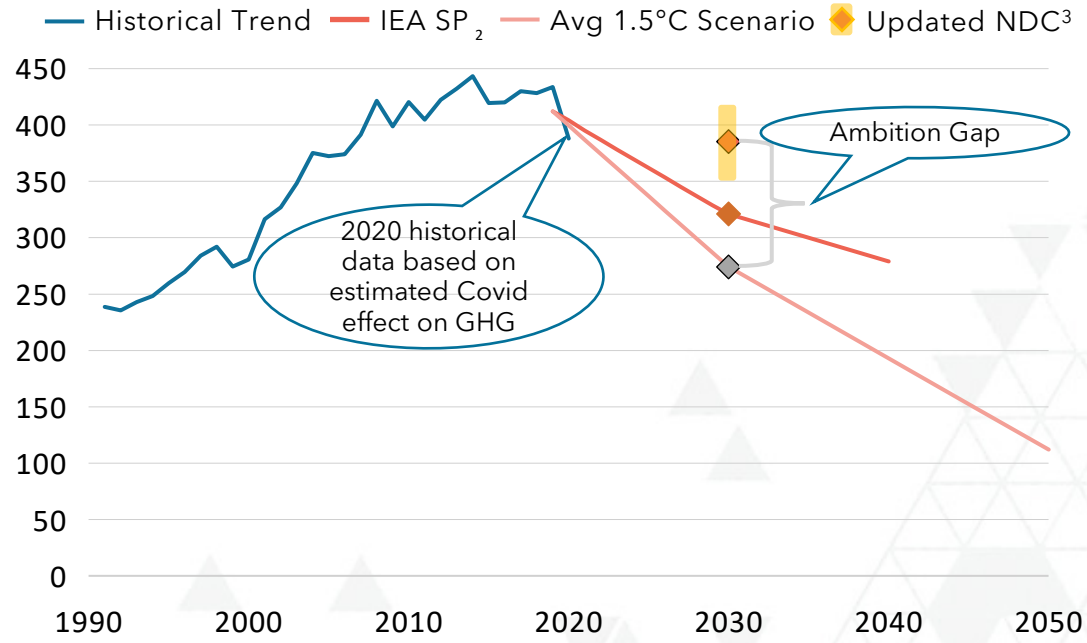


The majority of the countries have been able to reduce the emission intensity of their power generation sector, switching from coal to less carbon intensive fossil fuels and increasing the share of RES

SA's countertrend is explained by continuous **investments in the fossil fuel sectors** dominated by coal plants

GHG EMISSIONS FOR DIFFERENT SCENARIOS

$MtCO_2e/y$



Despite the country's commitment to follow global energy transition pathways, neither South Africa's **updated NDC** nor its **IEA stated policies (SP) scenario** (based on current policy) will lead to the necessary GHG emissions for staying within the 2030 **1.5°C Paris Agreement target** [4]

Source: IEA, World Bank, Climateanalytics
Notes: 1) Countries have been selected among G20 based on their relevance and fossil fuel dependency 2) IEA SP: Stated Policy 3) NDC refers to the last updated 2030 GHG target stated by SA government 4) 1.5°C target has been estimated based on fair share average of Climate Analytics projections

…risking to miss out on the attractiveness for “greening” investments and a just and sustainable future

GREEN FINANCE AND RELATED OPPORTUNITIES

Green Finance tools can be summarized as follows:

- ***Public and private green investment*** *in environmental goods and services*
- ***Public policies*** *that encourage environmental-related projects*
- ***Financial instruments*** *for green investments and* ***structured green funds***

NEW OPPORTUNITIES

ENERGY

- Less dependence on fossil fuel imports
- Lower energy cost
- Reduced death rate due to air pollution

MARKET CREATION

- Reduced unemployment rate
- Increased attractiveness for foreign investors
- Diversify the economy

TRANSPORT

- Modernize the sector
- Improved vehicles efficiency
- Increased access to public transport

BUILDING

- Reduced environmental impact
- Lower energy cost
- Modernize old public infrastructure

Source: Climateanalytics

CONSEQUENCES OF MISSING GREEN TRANSITION

ECONOMIC GROWTH

Since investments will switch from fossil fuel based technologies towards greener ones, SA will face rising difficulties in attracting investors if it fails to follow the energy transition, negatively affecting GDP and causing an economic downturn

COMPETITIVE POWER

In failingg to meet its decarbonisation targets, SA would fall behind in modernising its economy, losing competitive advantage over countries more committed to sustainability

SUSTAINABILITY

SA will miss the opportunity to embrace a Just Transition to an equal and ecologically sustainable economy that promotes working condition improvement and qualified job creation as well as a reduction of carbon intensity

South Africa should catch the opportunity of the decarbonisation process, focusing on each relevant sector




Power Generation


Transport


Residential


Tertiary


Industrial


Agriculture

1. How could a decarbonisation path look like up to 2050 and in the interim transition phase to 2030?

2. What are the advantages of more ambitious transition pathways?

3. Which is the potential roadmap South Africa could follow to go further with its climate ambitions?

2. Decarbonisation Roadmap for South Africa

Through the assessment of policies and future decarbonisation scenario impacts, a potential roadmap for South Africa has been designed

STUDY APPROACH

1

Policy framework analysis

Scenario development started from the analysis of current government policies, identifying the main policy levers and related technologies

- *NDC targets/actions*
- *Integrated Resource Plan 2019*
- *Green Transport Strategy*
- *National Energy Efficiency Strategy*

2

Scenario building

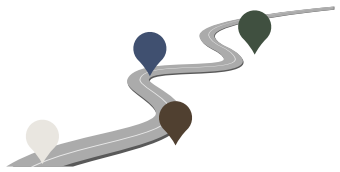
Decarbonized scenarios were developed combining government policy levers with additional technological levers (e.g.: electrification) in order to reach more ambitious decarbonisation targets

1. *Policy Scenario*
2. *Green Development*

3

Potential Roadmap for SA

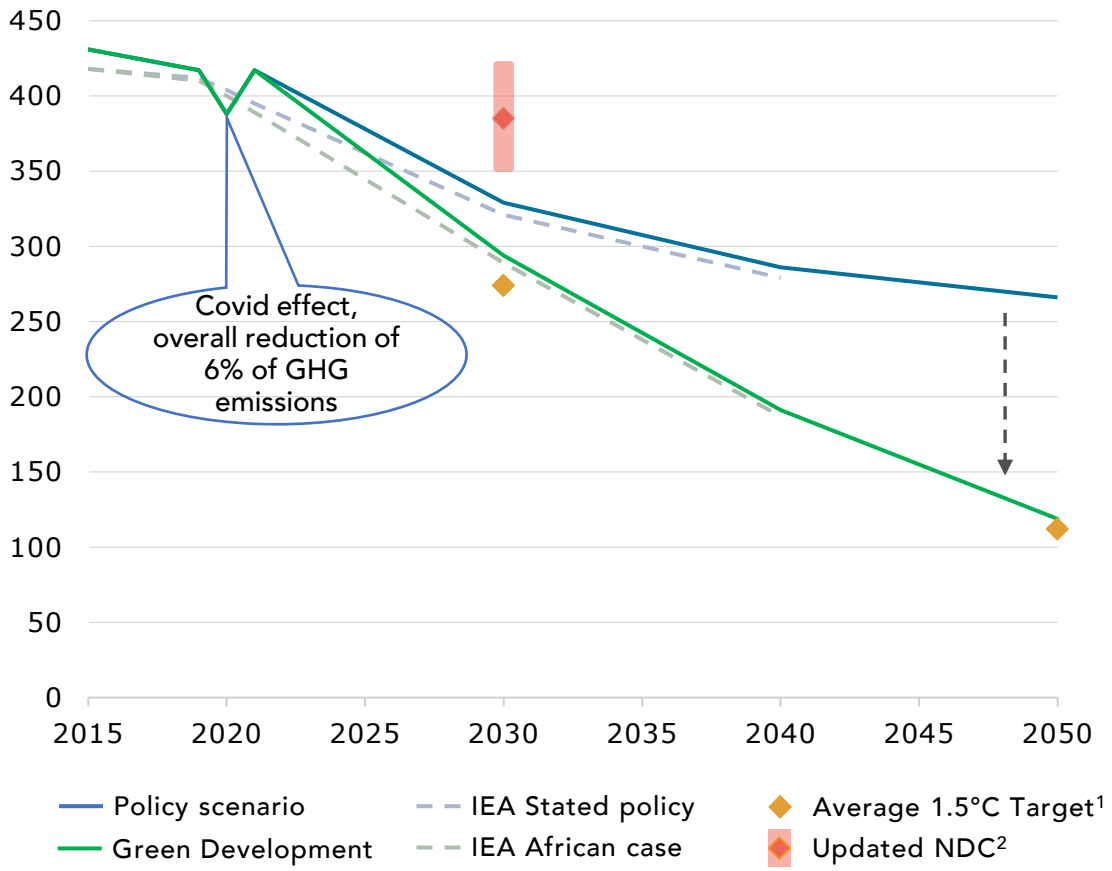
Scenario building resulted in the identification of ways to reinforce policy levers and the definition of incentives to strengthen existing technology penetration and ensure the effectiveness of existing technology penetration and ensure the effectiveness of decarbonisation targets



Current Policies should be strengthened to hit the 1.5°C target

ENERGY RELATED GHG EMISSIONS

$MtCO_2eq$



1

- **Policy Scenario (P),** based on NDC targets, current policy framework, and on IEA SP scenario, **is not aligned with the 1.5°C emission reduction targets** neither in the short- nor the mid-to-long- term[3]:
  - -24% vs -36% by 2030
  - -38% vs -74% by 2050
- If South Africa wants to meet Paris Agreement targets, it needs to explore a **more aggressive scenario**

2

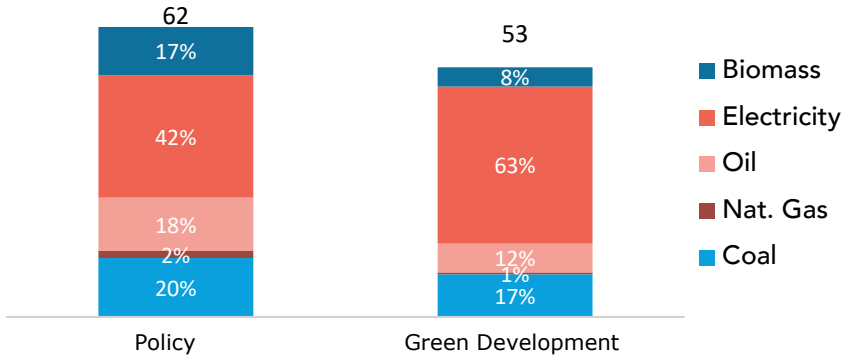
- **Green Development scenario (GD)**, driven by more ambitious policies and implementation of additional technological levers, is **aligned with the 1.5°C emission reduction targets[3]:**
  - -32% vs -36% by 2030
  - -72% vs -74% by 2050
- Both **P** and **GD** scenarios show a slightly more conservative evolution (especially in the short term due to Covid impact) respectively compared with **IEA SP and AC scenarios[4],** used as **benchmarks** to calibrate regulatory and technological levers
- **COVID impact** had a **double effect**:
  1. GHG emissions reduction in 2020 due to economy negative economic growth
  2. Short-term higher GHG emissions resulting from a delay in policy implementation

Notes: 1)1.5°C target has been estimated based on fair share average of Climate Analytics projections 2) NDC refers to the last updated 2030 GHG target stated by SA government 3) With reference to 2015 GHG emission level 4) SP: Stated Policy AC: Africa Case

RES generation, electrification, and energy efficiency are the transition's pillars …

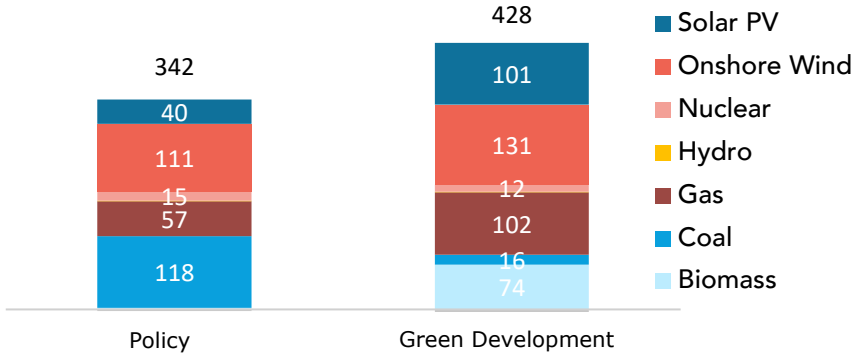
ENERGY CONSUMPTION PER TYPE OF FUEL BY 2050

MTOE



GENERATION MIX BY 2050

TWh



SECTORS ELECTRIFICATION

	Industry	Tertiary	Residential	Transport
P	45%	53%	54%	8%
GD	68%	78%	78%	42%

ENERGY INTENSITY REDUCTION[1]

	Industry	Tertiary	Residential
P	0.6%	0.5%	0.8%
GD	1.3%	2.3%	1.1%

RES SHARE ON GENERATION MIX

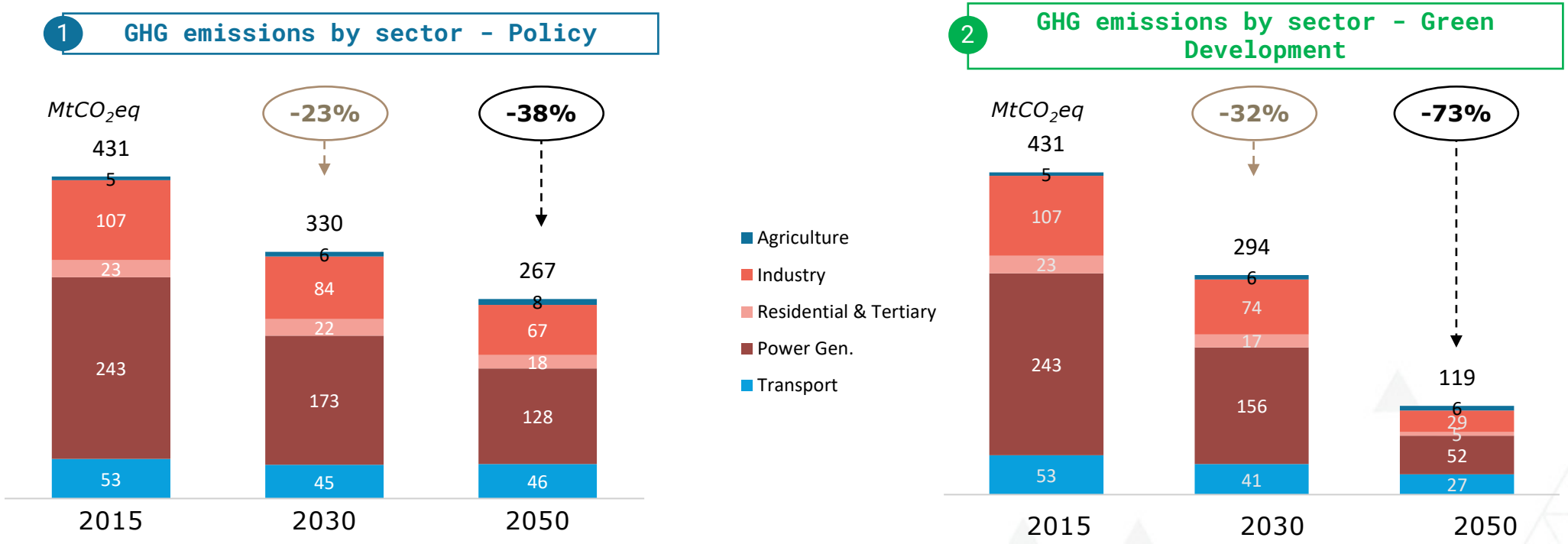
P	45%
GD	72%

- Power sector modelled to **ensure system flexibility and reliability**
- **System flexibility is provided by a diversified portfolio of technologies** reducing the share of coal on total capacity and generation in the decarbonized scenarios
- Complementary **flexible technologies are BESS, Hydro Pumped Storage** and **biomass plants**

P Policy GD Green Development Industry Tertiary Residential Transport

Notes: 1) Annual average energy intensity reduction;

…having a material impact in GHG emissions reduction especially for the Power Generation, Industry and transport sectors…



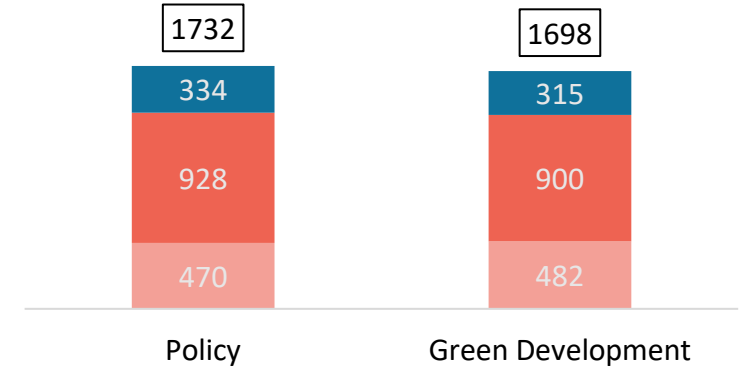
- Green Development scenario leads to a higher reduction of total GHG emission both in 2030 and 2050 (11% and -55% respectively) when compared to Policy Scenario
- Key sectors for a more aggressive decarbonisation pathway (GD) are:
  - Power Generation: Coal phase out is the main driver behind GHG reduction and, whilst in the Policy scenario it will continue to represent almost 50% of total GHG in 2050, in the Green Development scenario emissions are mainly related to Gas plants
  - Industry: Electrification and energy efficiency led to a reduction of the GHG contribution of manufacturing and mining sectors
  - Transport: higher spread of electric vehicles (EVs) has been forecasted thanks to the implementation of more ambitious policies, whilst in Policy scenario low spread of Evs was at the basis of a steady GHG emissions trend of the transport sector

…and leading to economic advantages compared to Policy scenario already significant in the short term and even increasing in the long term horizon

ILLUSTRATIVE[1]

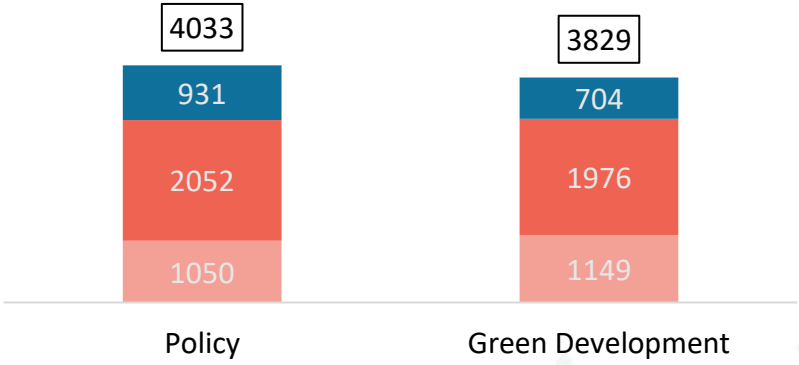
FULL ECONOMIC COST - CUMULATED - 2030

B$



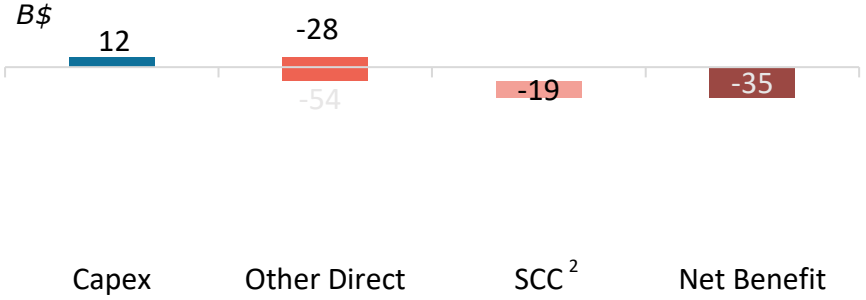
FULL ECONOMIC COST - CUMULATED - 2050

B$



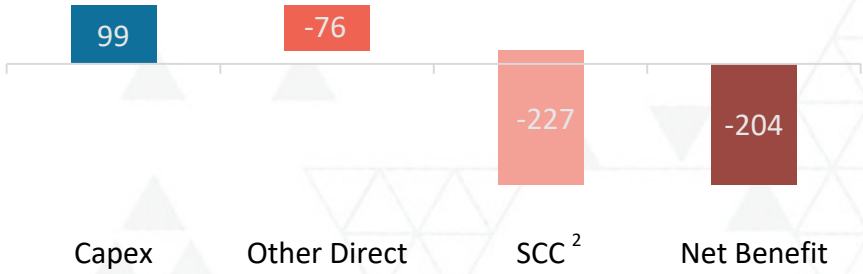
FULL ECONOMIC COST DELTA - 2030

B$



FULL ECONOMIC COST DELTA - 2050

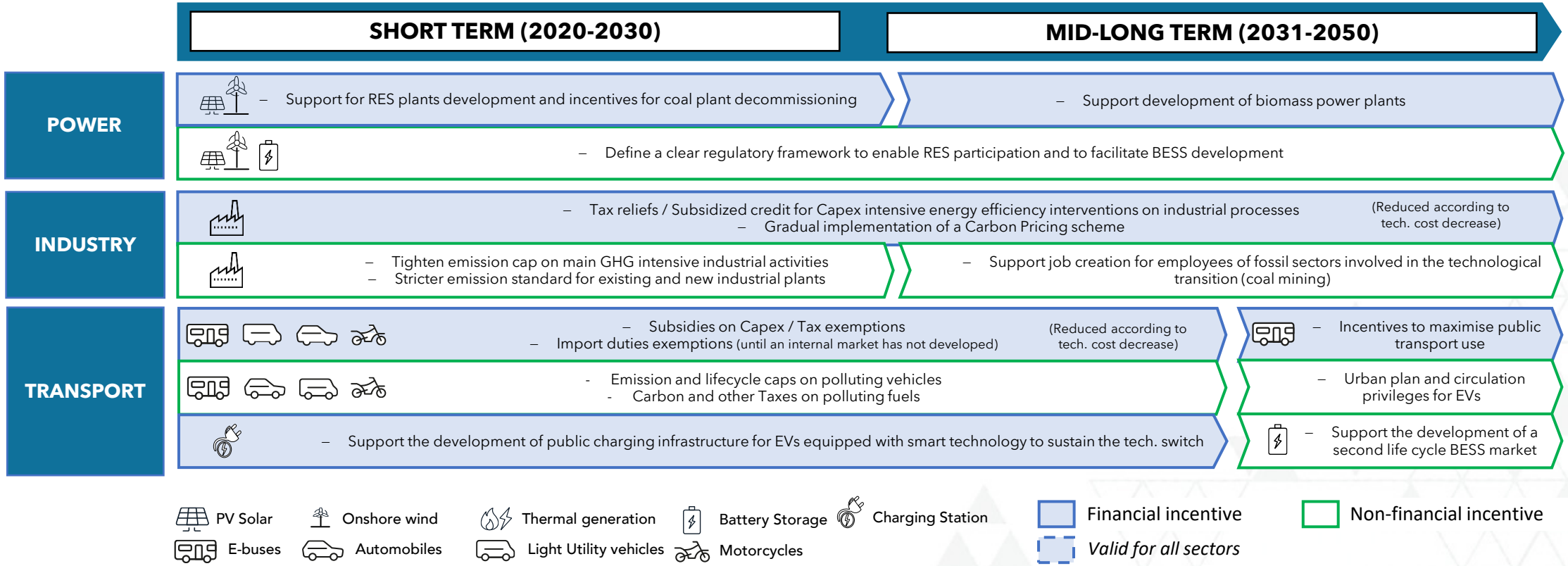
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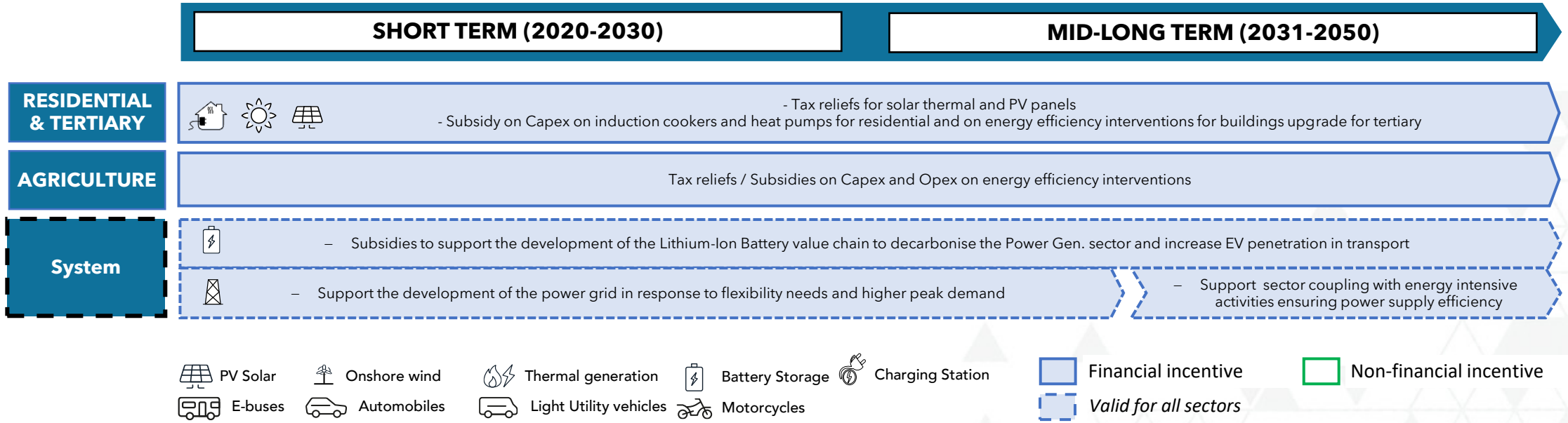
GD presents higher capex due to implementation costs of electrification and energy efficiency technologies, lower Other Direct costs thanks to reduced commodities cost and energy savings, and lower SCC linked to reductions in GHG emissions

Notes: 1) Results of the Social & Cost analysis here reported should be considered as average values of a wider range of + /- 20%, detailed results will require a deeper analysis on commodities, capex and opex of technologies involved; 2) Social cost of carbon based on US benchmark

Financial and non-financial policy measures sustain the more ambitious decarbonisation path for key sectors, balancing short and long-term dynamics



Financial and non-financial policy measures sustain the more ambitious decarbonisation path for key sectors, balancing short and long-term dynamics (continued)



South Africa should tighten current Policies to meet Paris Agreement target, but could also explore further levers towards 2050 net zero emission

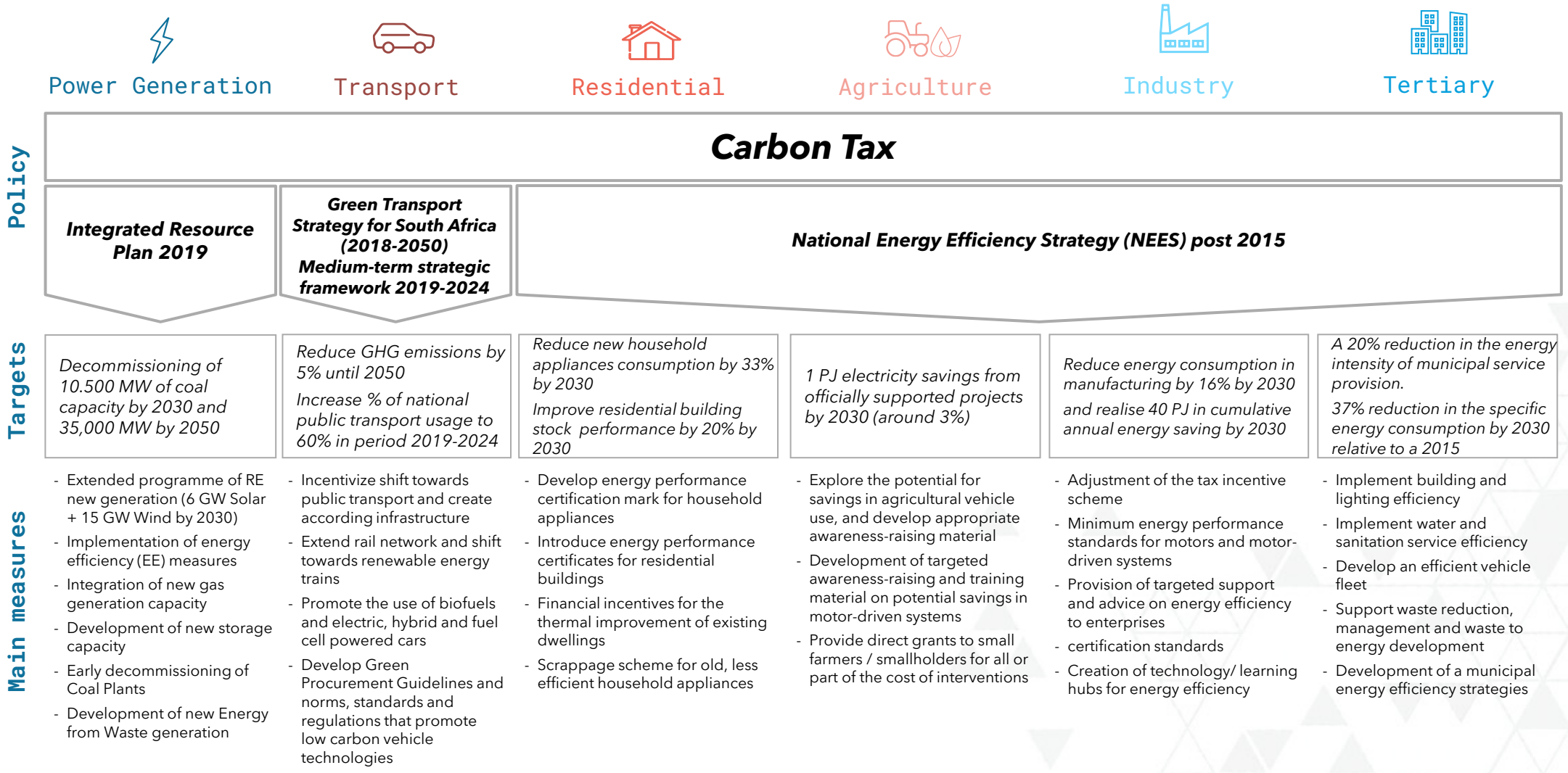
- High dependence on coal has led **South Africa** to become the **worst carbon performer among G20 Countries**. This fact has increased interest in the adoption of decarbonisation measures, bringing the South African Government to define specific programs aimed at reducing emissions.
- However, the Policy scenario, based on **current policy framework**, **is still far from the Paris Agreement GHG emissions target** and this could cause South Africa to lose attractiveness and miss development opportunities
- To benefit from the advantages of the transition process, South Africa should accelerate the decarbonisation trend by **tightening current Policies towards more ambitious targets** in all the relevant sectors, through the implementation of financial and non-financial measures
- The **Green Development scenario,** based on the adoption of such measures, allows the removal of existing barriers that hinder decarbonisation levers such as **electrification, energy efficiency and RES penetration** and leads to GHG emission level by 2050 (119 MtCO2eq) **aligned with 1.5°C Paris Agreement target**

- To achieve a net zero emission in 2050[1], a lever not addressed in these scenarios could be explored: **Green Hydrogen**
- Green Hydrogen could further reduce GHG emissions either for those **hard-to-abate industrial sectors** in which electrification could not be used as a decarbonisation
- However, before considering hydrogen as a feasible lever, its economic convenience for South Africa should be analysed further

Notes: 1) Updated NDC declared by South Africa government sets net zero emission level as 2050 target

3.
Annexe 1: Policy Framework Analysis

Latest government policies focus on a massive phase out of coal power plants alongside initiatives across all the other sectors

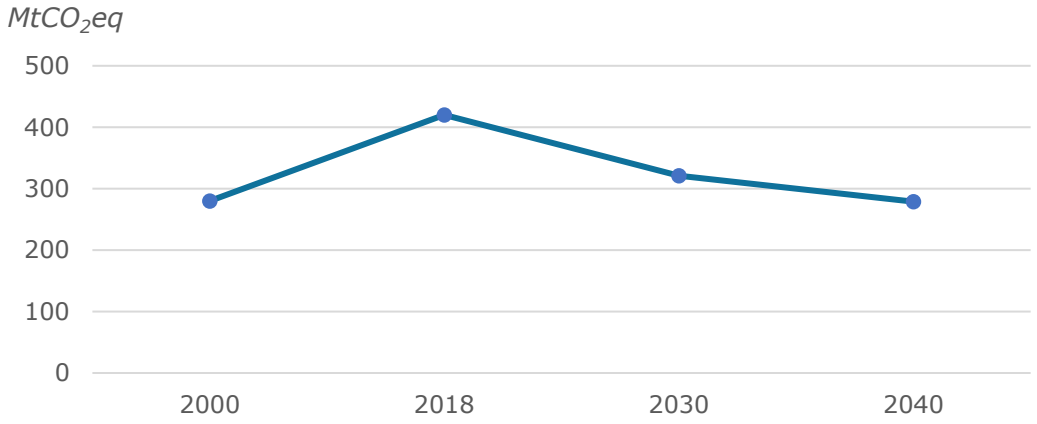


More details on current policy framework will be provided in the slides of the following section, with a focus on each relevant sector

4.
Annexe 2: Scenario Build and Analysis

IEA SP scenario develops the government targets envisaged by IRP which represents the official drive for decarbonization until 2040

GHG EMISSION ($MtCO_2eq$) BY IEA STATED POLICY SCENARIO



Macroeconomic assumptions	2000	2018	2030	2040
GDP ($2018 Billion, PPP)	491	789	1010	1348
Population (Million)	46	57	66	71
Share of population with access to electricity (%)	77%	95%	100%	100%
Share of population with with access to clean cooking (%)	56%	87%	90%	93%
CO_2 emissions (MtCO2eq)	280	420	321	279

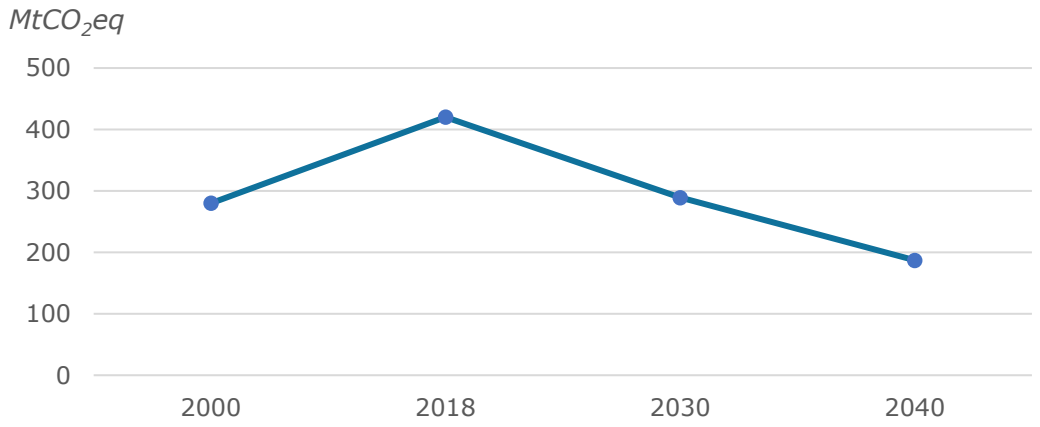
IEA: International Energy Agency; SP: Stated Policy; AC: Africa Case

COMMENTS

- IEA has developed a scenario **on the trajectory of GHG emission from the energy sector of South Africa**. The following scenario is based on the ongoing regulatory framework. To achieve the results expected there needs to be a cumulative investments of more than $200 Billion
- **Power Generation targets:**
  - The National Development Plan 2030 envisages that adequate investment in energy infrastructure will promote economic growth and development
  - Decommission 35 GW (of 42 GW currently operating) of coal-fired power capacity and supply at least 20 GW of the additional 29 GW of electricity needed by 2030 from renewables and natural gas
- **Industrial development targets:**
  - Secure primary steel production capability and support the downstream steel sector
  - Automotive Masterplan 2020: raise domestic vehicle production to 1% of global output including increasing the share of hybrid electric vehicles to 20% by 2030
- **Cumulative investment needs by scenario, 2019-2040: 216 billion $ (2018)**, with renewables and electricity networks accounting for the majority

Compared to IEA SP, IEA African Case scenario envisages further GHG emission reductions mainly by higher penetration of renewables and gas

GHG EMISSION ($MtCO_2eq$) BY IEA AFRICA CASE SCENARIO



Macroeconomic assumptions	2000	2018	2030	2040
GDP ($2018 Billion, PPP)	491	789	1174	1600
Population (Million)	46	57	66	71
Share of population with access to electricity (%)	77%	95%	100%	100%
Share of population with with access to clean cooking (%)	56%	87%	100%	100%
CO_2 emissions (MtCO2eq)	280	420	289	187

IEA: International Energy Agency; SP: Stated Policy; AC: Africa Case

COMMENTS

- IEA has developed a special scenario **on the trajectory of GHG emission from the energy sector** of South Africa. The following scenario **is based on Agenda 2063**, in which African leaders set out their vision for the future growth and development of the continent
- **Key Assumptions**
  - The economy could double in the Africa Case (AC) with less primary energy demand compared to today by increasing the share of renewables and gas in the energy mix
  - In the AC, the role of coal in South African industry and power generation is already decreasing, while that of gas and renewables is increasing
- **Cumulative investment needs by scenario, 2019-2040: 214 billion $ (2018),** more in gas production, but overall efficiency improvements moderate the additional spending needs

Based on current policies and technology levers, scenarios have been compared to IEA SP and AC and evaluated against GHG emission targets

	1 Definition and calibration	2 Evaluation	3 Scenario results
P	• Policy scenario has been defined based on relevant South African policies • Assumptions on parameters have been made to reach the policy targets envisaged by IEA SP[1] when policy measures were not sufficiently exhaustive • IRP low projection of electricity demand has been used to calibrate the electrification rate among sectors	• The historical trend of the six sectors involved in the analysis has been used to forecast the evolution of final energy consumption • Energy efficiency, electrification rate and RES evolution are the main technology levers • Short term effect of Covid on main economic parameters has been accounted • Some policies have been fully implemented whilst, for other measures, a more conservative or ambitious approach has been used	• SA current policies would result in emissions reductions only in line with 3°C warming • Partial coal phase out, contained energy savings and reduced EV penetration are the main hurdles of the scenario • To successfully overcome the challenge of green transition a more ambitious scenario is required
GD	• Green Development scenario has been developed in order to meet the 1.5°C target • More ambitious assumptions on parameters have been made to be consistent with IEA AC[2] scenario	• The Policy scenario forecasted trend of the six sectors are is the basis of GD final energy consumption evolution • Energy efficiency, electrification rate and RES evolution are the main technology levers implemented with a higher level of ambition • Short term effect of Covid on main economic parameters has been accounted	• GD trajectory at 2050 is well aligned with the 1.5°C target • The high level Social Cost analysis performed on the two scenarios confirm that GD could bring a net reduction on full economic cost, despite higher investment cost • GD result to be slightly more conservative compared to IEA AC, with an average delta of 4 MtCO2e

Notes: 1) SP: Stated Policy 2) AC: Africa Case

The target of emissions reduction by 2050 for Transports has been largely overcome thanks to reduction of vehicle per capita and electrification



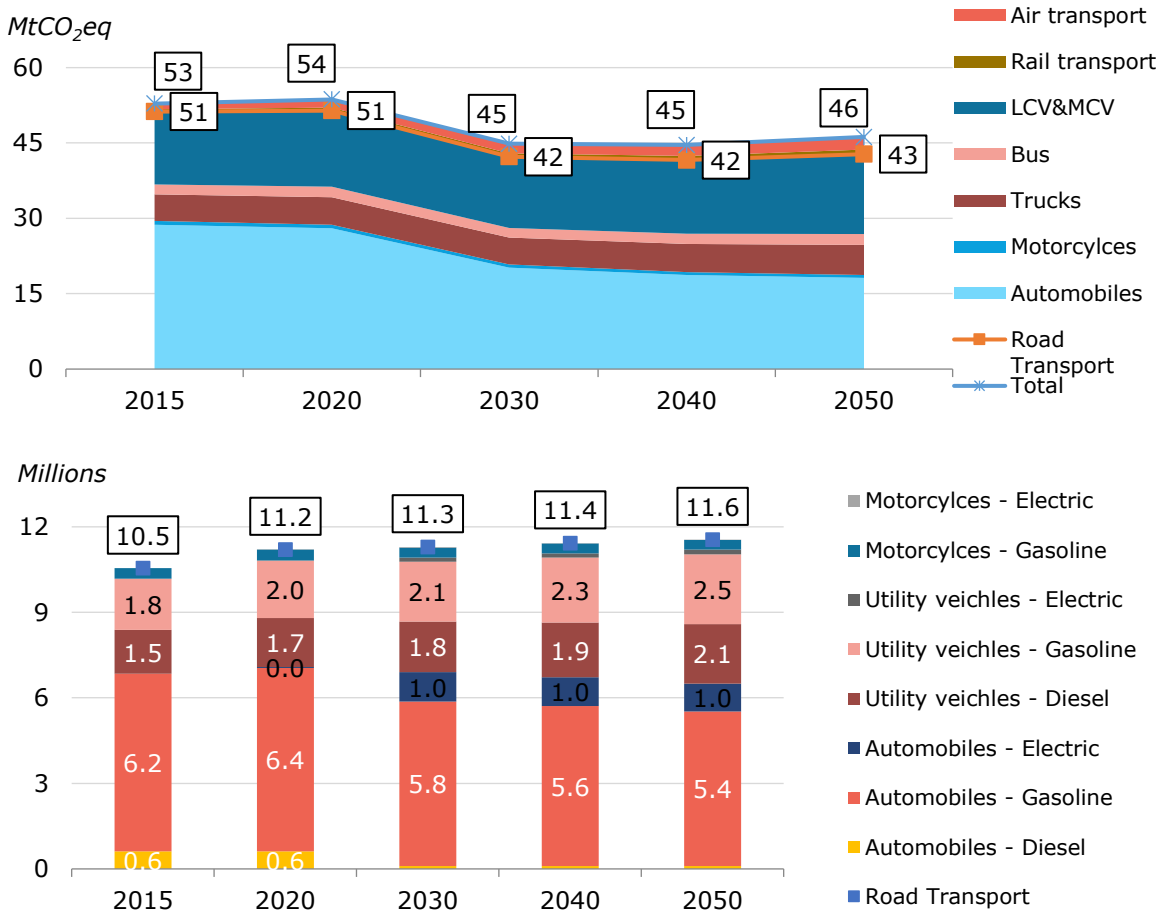
Policy implementation | Policy scenario results | GD scenario results | Implemented targets

Green Transport Strategy for South Africa (2018-2050)

		Policy Scenario	Green Development
GHG reduction	Reduce GHG emissions by 5% until 2050	Reduction of GHG emission from transport sector of 13% by 2050	Reduction of GHG emission from transport sector of 53% by 2050
Road Transport	A 20% reduction in the average vehicle energy intensity (measured in MJ/km) of the South African road vehicle fleet, relative to a 2015 baseline, by 2030	20% reduction of energy consumption per km replacing polluting vehicles with clean ones in 20 years for both diesel and gasoline	30% reduction of energy consumption per km replacing polluting vehicles with clean ones in 20 years for both diesel and gasoline
Road and Rail	Shift of passenger transport from private cars to public transport and eco-mobility transport (in 5 to 7 years)	23% reduction of vehicle per capita in 7 years and up to 2050 compared to 2015	30% reduction of vehicle per capita up to 2050 compared to 2015
	5% of the national and public sector fleet converted to CNG, biogas, biofuels, electricity in 7 years (from 2015)	EV penetration target for Automobiles, LCV, MCV Motorcycles and Buses by 2030	EV penetration target for Automobiles, LCV, MCV Motorcycles and Buses by 2030
	2% of annual increase in fleet converted to CNG, biogas, biofuels, electricity thereafter until 2025	EV penetration target for Automobiles, LCV, MCV Motorcycles and Buses by 2050	EV penetration target for Automobiles, LCV, MCV Motorcycles and Buses by 2050

Automobiles remain the main source of GHG emissions in 2050. EV and public transports are assumed to be the key drivers for decarbonisation

GHG EMISSIONS ($MtCO_2eq$) AND GROWTH OF TOTAL VEHICLES (MILLIONS) IN ROAD TRANSPORT



LCV: Light Commercial Vehicles; MCV: Medium Commercial Vehicles

METHODOLOGY

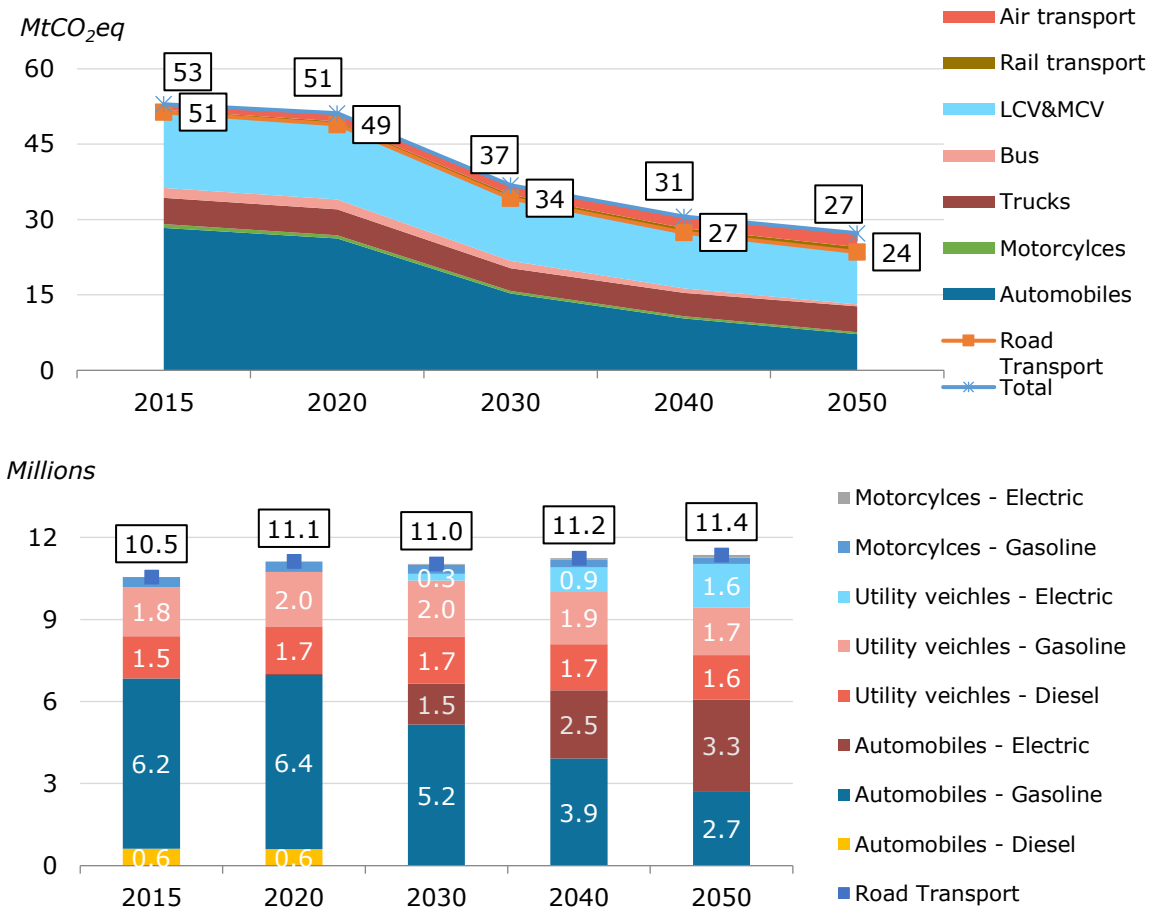
- A bottom-up approach has been adopted using the total number of vehicles and related consumption:
  - We focus on three categories of vehicles to reflect variety of road transport: Automobiles, Motorcycles and Utility vehicles (LCV&MCV, bus and trucks)
  - Future growth of automobiles and motorcycles has been estimated considering the reduction of vehicles per capita envisaged by national policies, while utility vehicles grow according to population
  - Electric and "clean" gasoline and Diesel vehicles are assumed to replace old gasoline and Diesel vehicles, proportionally over the years
  - Average fuel-consumption of vehicles is based on international benchmarks
- Growth of energy consumption of rail and air transport has been correlated to population growth
- As envisaged by national policies, an emissions reduction by at least 5% in 2050, compared with 2015, is achieved in this scenario

DATA SOURCE

- Department of Transport of South Africa , "Transport Statistics Bulletin", 2015
- SANEDI, "Quantifying the energy needs of the transport sector for South Africa: a bottom-up model", 2012
- IEA, "World Energy Balance", 2017
- DOE, "Forecast for Electricity Demand in South Africa (2017-2050)", 2017
- DOE, "Report on the potential energy efficiency measures", 2016

LCV & MCV will substitute automobiles as main source of GHG emissions in 2050 thanks to higher penetration of EVs in the automobiles segment

GHG EMISSIONS ($MtCO_2eq$) AND GROWTH OF TOTAL VEHICLES (MILLIONS) IN ROAD TRANSPORT



LCV: Light Commercial Vehicles; MCV: Medium Commercial Vehicles

Policy implementation | Policy scenario results | **GD scenario results** | Implemented targets

METHODOLOGY

- The same bottom-up approach explained for the Policy scenario has been adopted with some levers on which more ambitious targets have been considered:
  - Parameters correlated with the total population such as the growth of utility vehicles and the trend of energy consumption of rail and air transport result to be slightly higher than in the Policy scenario, due to the slightly higher growth rate of the population assumed
  - "Clean" gasoline and Diesel vehicles are assumed to replace old gasoline and Diesel vehicles by 2030, 4 years before than what forecasted in the Policy scenario
  - EV penetration targets have been strengthened, especially for automobilities (55% at 2050) and the public transport (buses – 80% at 2050)
- Compared to what was envisaged in the national policies target of emissions reduction by at least 5% in 2050, compared with 2015, in the GD scenario a 50% drop has been obtained

DATA SOURCE

- Department of Transport of South Africa , "Transport Statistics Bulletin", 2015
- SANEDI, "Quantifying the energy needs of the transport sector for South Africa: a bottom-up model", 2012
- IEA, "World Energy Balance", 2017
- DOE, "Forecast for Electricity Demand in South Africa (2017-2050)", 2017
- DOE, "Report on the potential energy efficiency measures", 2016

Transport – Implemented target values

Policy implementation | Policy scenario results | GD scenario results | Implemented targets

		Policy Scenario		Green Development	
REDUCTION OF ENERGY CONSUMPTION PER KM COMPARED TO 2015		-20%		-30%	
REDUCTION OF VEHICLES PER CAPITA BY 2050		-23%		-30%	
SHARE OF EVs VEHICLES by 2030	AUTOMOBILES	15%	10% of overall Road vehicles	23%	16% of overall Road vehicles
	MOTORCYCLES	4%		6%	
	LCV AND MCV	4%		6%	
	BUSES	4%		15%	
SHARE OF EVs VEHICLES by 2050	AUTOMOBILES	15%	10% of overall Road vehicles	55%	44% of overall Road vehicles
	MOTORCYCLES	4%		30%	
	LCV AND MCV	4%		30%	
	BUSES	4%		80%	

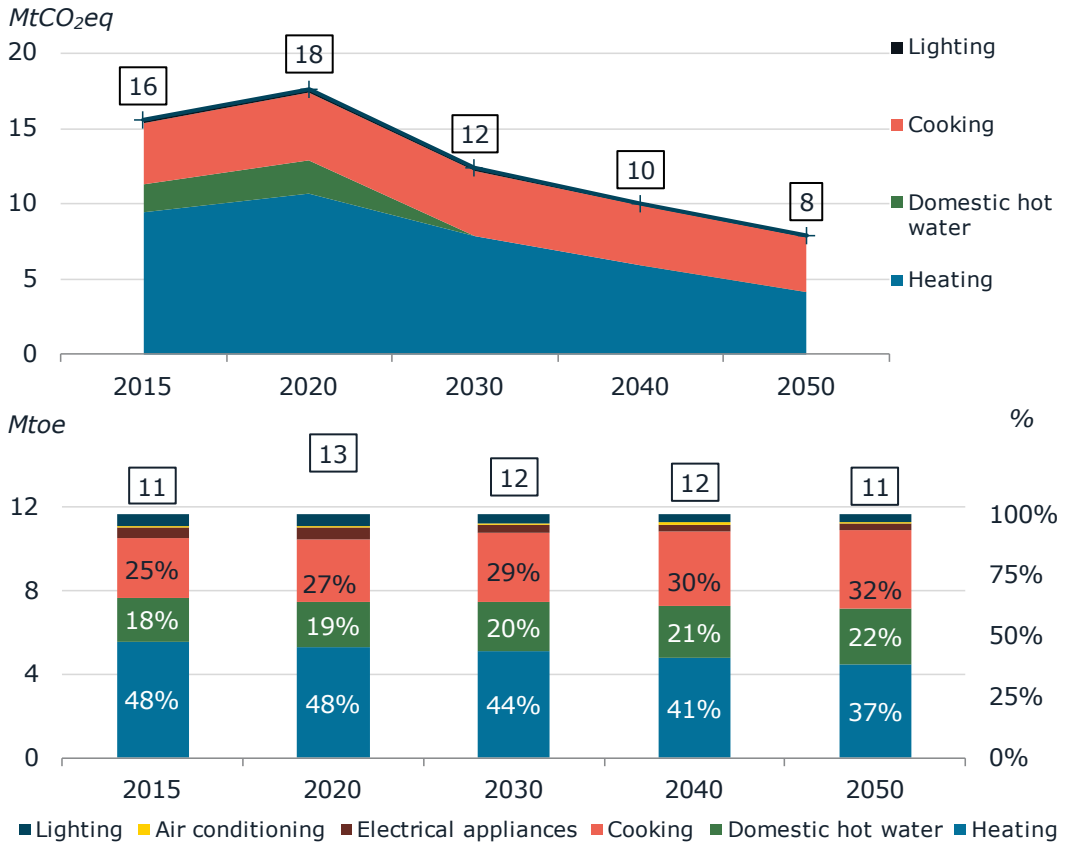
For the Residential sector, electrification and energy efficiency measures are expected to drive the decarbonization process

Policy implementation | Policy scenario results | GD scenario results | Implemented targets

EE Strategy post 2015		Policy Scenario	Green Development
Heating	20% improvement in the average energy performance of the residential building stock by 2030 relative to a 2015 baseline	Reduction of energy consumption for heating by 20% by 2030 linearly from 2022. Further reduction by 2050	Reduction of energy consumption for heating by 30% by 2030 linearly from 2022. Further reduction by 2050
DHW	A minimum of 50% of energy used for DHW must be met by sources other than electric resistance heaters. So by solar thermal collectors or heat pumps	Full technology switch to electrical appliances in face of Oil, Biomass, Coal and paraffine of which 50% of consumption met by solar thermal by 2030 and 75% by 2050	Full technology switch to electrical appliances in face of Oil, Biomass, Coal and paraffine of which 50% of consumption met by solar thermal by 2030 and 75% by 2050
Cooking	Population is rapidly moving from using wood/paraffin to electrical appliances	Technology switch to electrical appliances in face of Oil, Biomass and Paraffine	Technology switch to electrical appliances in face of Oil, Biomass and Paraffine
Household appliances	33% reduction in the average specific energy consumption of new household appliances purchased in SA by 2030 (2015 baseline)	Reduction of energy consumption by 33% by 2030 linearly from 2022 for Air conditioning, lighting and other electrical appliances. Further reduction by 2050	Reduction of energy consumption by 40% by 2030 linearly from 2022 for Air conditioning, lighting and other electrical appliances. Further reduction by 2050

These measures will have a huge impact on heating energy use which still represents the major source of emissions along with cooking

GHG EMISSIONS (MTCO2EQ) AND SHARE OF ENERGY CONSUMPTION BY FINAL USES (MTOE – %)



IEA: International Energy Agency

Policy implementation | *Policy scenario results* | *GD scenario results* | *Implemented targets*

METHODOLOGY

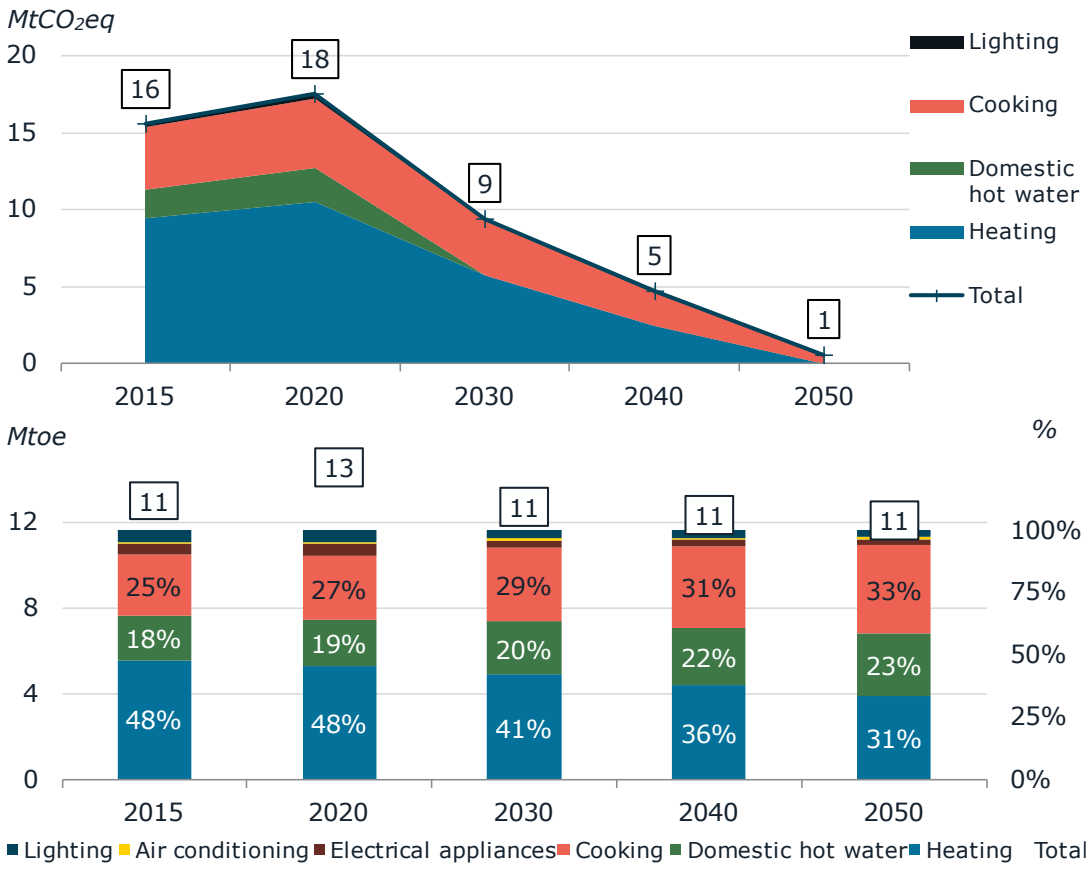
- We assumed an average energy consumption per household in 2015 based on IEA historical data and Statistics South Africa
- Final consumptions grow according to population
- Six final energy uses have been identified: Heating, Domestic Hot Water, Cooking, Electrical appliances, Air conditioning and Lighting
- Heating: as specified in national policies, we assumed an improvement of 20% in energy performance in 2030 compared with 2015 (CAGR equal to -1.5% until 2050 has been used). Besides, a reduction in use of solid fuels and biomass in favour of electricity source has been assumed
- Domestic hot water: as specified in national policies, we assumed the use of only electricity and solar thermal panels by 2030
- Cooking: a reduction in use of solid fuels and biomass in favour of electricity source has been assumed
- Electrical appliances, air conditioning and lighting: as specified in national policies, we assumed improvement of 33% in energy performance in 2030 compared with 2015 (CAGR/2 equal to -1.3% until 2050 has been used)
- We considered an initial final use share in household consumption based on South Africa benchmark and IEA historical data

DATA SOURCE

- IEA, "World Energy Balance", 2017
- DOE, "Forecast for Electricity Demand in South Africa (2017-2050)", 2017
- STATS SA, "General Household Survey", 2018
- ERC, "South African energy policies for sustainable development", 2005
- DME, "Energy Outlook for South Africa", 2002
- DOE, "Report on the potential energy efficiency measures", 2016

Energy efficiency measures and high level of electrification will drastically reduce GHG emissions from heating and cooking

GHG EMISSIONS ($MtCO_2eq$) AND SHARE OF ENERGY CONSUMPTION BY FINAL USES (Mtoe - %)



IEA: International Energy Agency

METHODOLOGY

The same assumptions adopted in the Policy scenario to forecast the trend of residential final energy consumptions have been adopted in the GD, moreover, same targets have been updated:

Heating: going further than what specified in national policies, we assumed an improvement of 30% in energy performance in 2030 compared with 2015 (CAGR equal to -2.3% until 2050 has been used).

Cooking: a reduction in use of solid fuels and biomass in favour of electricity has been assumed and at 2050 almost 95% of cooking demand will be represented by electricity consumption

Electrical appliances, air conditioning and lighting: more ambitious targets have been considered than what specified in national policies, we assumed improvement of 40% in energy performance in 2030 compared with 2015 (CAGR/2 equal to -3.3% until 2050 has been used)

DATA SOURCE

- IEA, "World Energy Balance", 2017
- DOE, "Forecast for Electricity Demand in South Africa (2017-2050)", 2017
- STATS SA, "General Household Survey", 2018
- ERC, "South African energy policies for sustainable development", 2005
- DME, "Energy Outlook for South Africa", 2002
- DOE, "Report on the potential energy efficiency measures", 2016

Residential – Implemented target values



Policy implementation | Policy scenario results | GD scenario results | Implemented targets

		Policy Scenario	Green Development
REDUCTION OF ENERGY CONSUMPTION FOR HEATING BY 2030		**-20%**	**-30%**
REDUCTION OF ENERGY CONSUMPTION FOR HEATING BY 2050		**-40%**	**-56%**
REDUCTION OF ENERGY CONSUMPTION FOR HOUSEHOLD APPLIANCES BY 2030	AIR CONDITIONING	**33%**	**40%**
	LIGHTING	**33%**	**40%**
	ELECTRICAL APPLIANCES	**33%**	**40%**
REDUCTION OF ENERGY CONSUMPTION FOR HOUSEHOLD APPLIANCES BY 2050	AIR CONDITIONING	**50%**	**57%**
	LIGHTING	**50%**	**57%**
	ELECTRICAL APPLIANCES	**50%**	**57%**
ELECTRIC TECHNOLOGY PENETRATION FOR DHW BY 2030		**100%**	**100%**
DHW CONSUMPTION FROM SOLAR THERMAL BY 2030		**50%**	**50%**
DHW CONSUMPTION FROM SOLAR THERMAL BY 2050		**75%**	**75%**

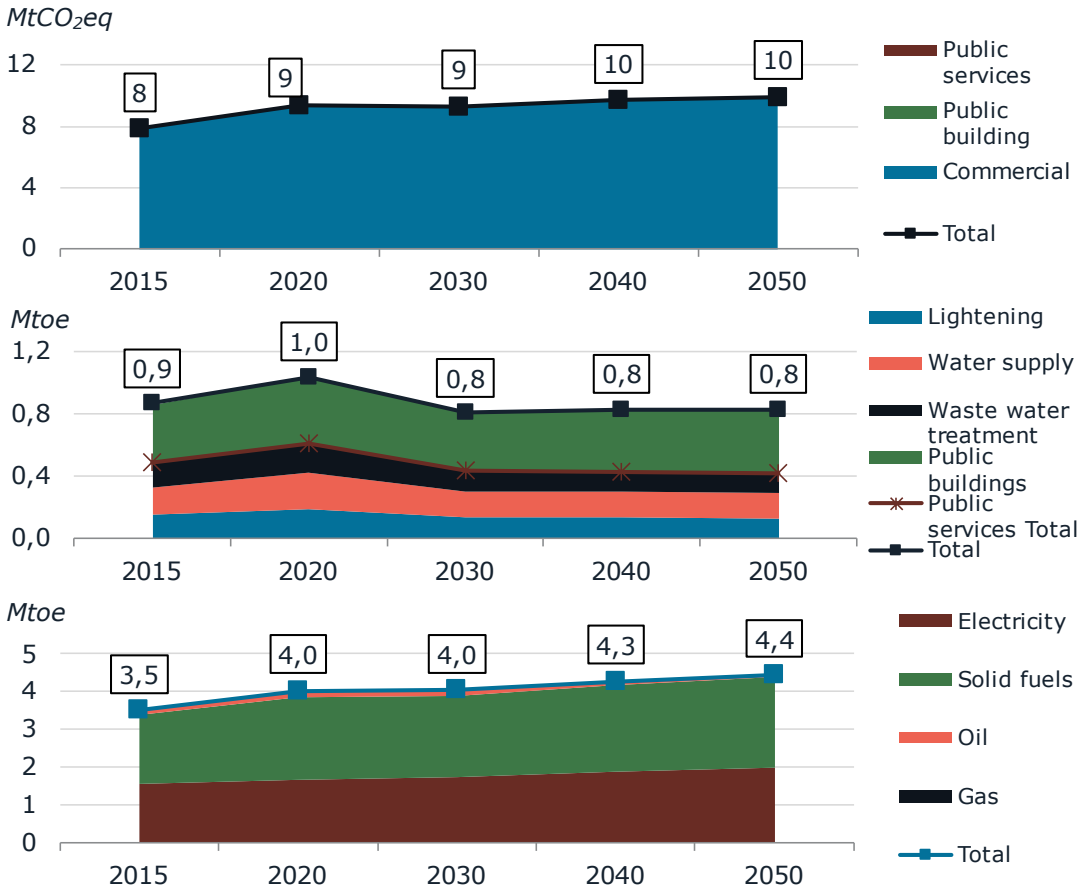
Policies for Tertiary sector envisage emissions drop due to energy efficiency measures, while our scenario also increases electrification in Commercial use

Policy implementation | Policy scenario results | GD scenario results | Implemented targets

		Policy Scenario	Green Development
EE Strategy post 2015	Public building	50% reduction in the specific energy consumption (measured as GJ annual energy consumption per m2 of occupied floor area) by 2030 relative to a 2015 baseline	Reduction of energy consumption of public buildings of 50% @2030 from 2022 linearly starting from baseline consumption evolution. 60% by 2050	Reduction of energy consumption of public buildings of 60% by 2030 from 2022 linearly starting from baseline consumption evolution. 70% by 2050
	Commercial	37% reduction in the specific energy consumption (measured as GJ annual energy consumption per m2 of occupied floor area) by 2030 relative to a 2015 baseline	Reduction of energy consumption of commercial sector of 37% by 2030 from 2022 linearly starting from baseline consumption evolution. 50%@2050	Reduction of energy consumption of commercial sector of 40% by 2030 from 2022 linearly starting from baseline consumption evolution. 60% by 2050
			Implementation of electrification rate for commercial buildings of 45% by 2050	Implementation of electrification rate for commercial buildings of 74% @2050
	Public services	20% reduction in the energy intensity (measured as energy consumption per head of population served) of municipal service provision. The specific services included are street lighting, traffic lights, water supply and wastewater treatment	Reduction of energy intensity (Mtoe/population) of public services (waste water treatment, street lighting, water supply) of 20% by 2030 and 30% by 2050	Reduction of energy intensity (Mtoe/population) of public services (waste water treatment, street lighting, water supply) of 20% by 2030 and 30% by 2050
		30% reduction in the fossil fuel intensity of municipality vehicle fleets (measured as total fossil fuel consumption by municipal vehicles per head of population served)	Implementation of 10% energy intensity reduction through EVs penetration in LCV and MCV for the transport sector	Implementation of 36% energy intensity reduction through EVs penetration in LCV and MCV for the transport sector

Population and GDP growths combined with the increase of electrification and energy efficiency measures will cause a static development of emissions

GHG EMISSIONS ($MtCO_2eq$) AND SHARE OF ENERGY CONSUMPTION BY PUBLIC AND COMMERCIAL SECTORS (Mtoe)



GDP: Gross Domestic Product; IEA: International Energy Agency

Policy implementation | *Policy scenario results* | *GD scenario results* | *Implemented targets*

METHODOLOGY

Final energy consumption of Commercial and Public sector are based on IEA historical data

As specified in national policies for commercial buildings, we assumed an improvement of 37% in energy performance in 2030 compared with 2015 (a cumulated improvement of 50% has been considered for 2050). Besides, a reduction in use of solid fuels and oil in favour of electricity sources has been assumed

Final uses for Public sector have been split into Public Building and Public Services (which includes Waste Water Treatment, Lighting and Water Supply)

According to data on major municipalities across South Africa, the public sector relies mostly on electricity sources both for buildings and services

As specified in national policies for the public sector, we assumed improvement of 50% in buildings energy performance in 2030 compared with 2015 (a cumulated improvement of 60% has been considered for 2050), while an improvement of 20% in services energy performance in 2030 compared with 2015 (a cumulated improvement of 30% has been considered for 2050)

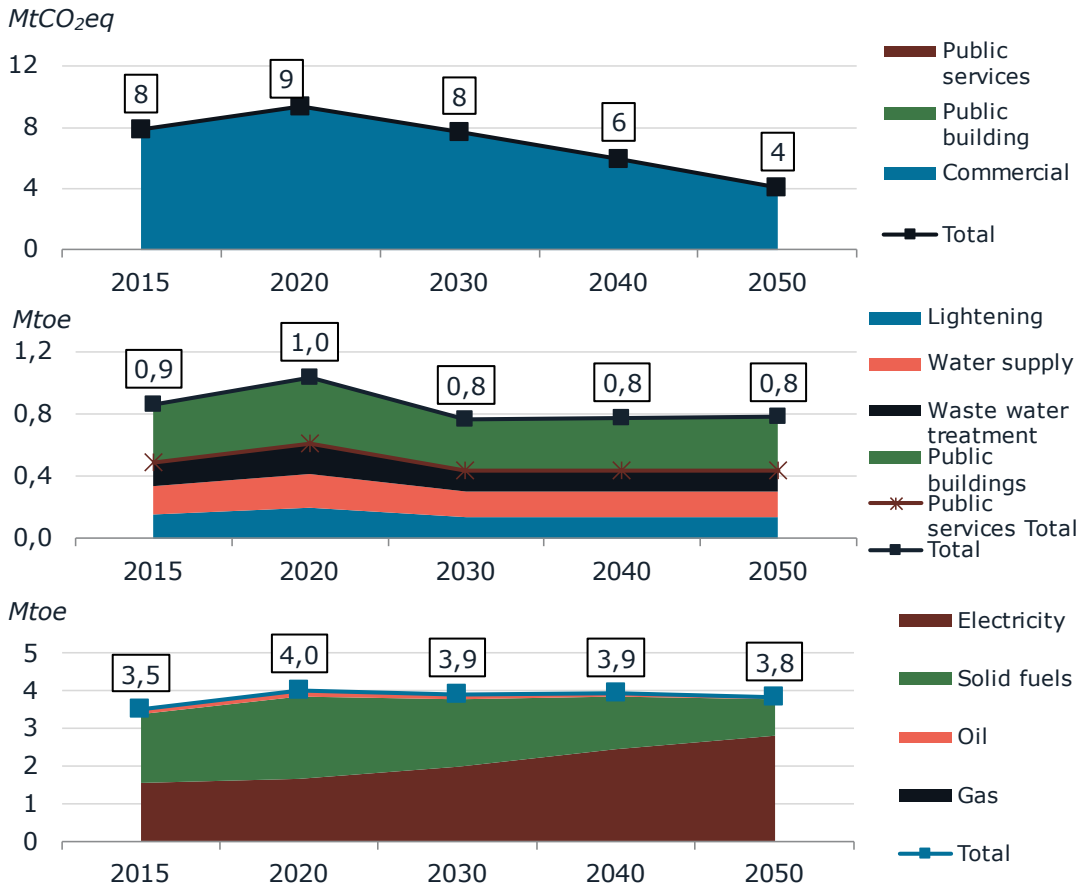
Growth of energy consumption for Commercial and Public Building sectors have been correlated to GDP, while Public Services is linked to population growth

DATA SOURCE

- IEA, "World Energy Balance", 2017
- SARB, GDP historical data at market prices (current, ZAR)
- DOE, "Forecast for Electricity Demand in South Africa (2017-2050)", 2017
- DOE, "Report on the potential energy efficiency measures", 2016
- SEA, "State of Energy in South African Cities", 2015
- SACN, "Modelling Energy Efficiency Potential in Municipal Operations", 2014

Increase of electrification and energy efficiency measures will cause a decline in GHG emissions from public and commercial sectors

GHG EMISSIONS ($MtCO_2eq$) AND SHARE OF ENERGY CONSUMPTION BY PUBLIC AND COMMERCIAL SECTORS (Mtoe)



GDP: Gross Domestic Product; IEA: International Energy Agency

Policy implementation | *Policy scenario results* | *GD scenario results* | *Implemented targets*

METHODOLOGY

- Final energy consumption of Commercial and Public sector have been estimated with the same methodology adopted in the Policy scenario, same targets have been updated:
- Higher targets than what specified in national policies for commercial buildings, with an improvement of 40% in energy performance in 2030 compared with 2015 (a cumulated improvement of 60% has been considered for 2050). Besides, higher electrification penetration rate has been adopted
- In the public sector, we assumed improvement of 60% in building energy performance in 2030 compared with 2015 (a cumulated improvement of 70% has been considered for 2050)
- Growth of energy consumption for Commercial and Public Building sectors have been correlated to GDP, while Public Services is linked to population growth (GDP and population growth rate has been calibrated based on IRP high scenario)

DATA SOURCE

- IEA, "World Energy Balance", 2017
- SARB, GDP historical data at market prices (current, ZAR)
- DOE, "Forecast for Electricity Demand in South Africa (2017-2050)", 2017
- DOE, "Report on the potential energy efficiency measures", 2016
- SEA, "State of Energy in South African Cities", 2015
- SACN, "Modelling Energy Efficiency Potential in Municipal Operations", 2014

Tertiary (Commercial & Public) – Implemented target values



Policy implementation | Policy scenario results | GD scenario results | **Implemented targets**

	Policy Scenario	Green development
REDUCTION OF ENERGY CONSUMPTION COMPARED TO BASELINE EVOLUTION FOR PUBLIC BUILDINGS BY 2030	**-50%**	**-60%**
REDUCTION OF ENERGY CONSUMPTION COMPARED TO BASELINE EVOLUTION FOR PUBLIC BUILDINGS BY 2050	**-60%**	**-70%**
REDUCTION OF ENERGY CONSUMPTION COMPARED TO BASELINE EVOLUTION FOR COMMERCIAL BUILDINGS BY 2030	**-37%**	**-40%**
REDUCTION OF ENERGY CONSUMPTION COMPARED TO BASELINE EVOLUTION FOR COMMERCIAL BUILDINGS BY 2050	**-50%**	**-60%**
REDUCTION OF ENERGY INTENSITY FOR PUBLIC SERVICES (MTOE/POPULATION) BY 2030	**-20%**	**-20%**
REDUCTION OF ENERGY INTENSITY FOR PUBLIC SERVICES (MTOE/POPULATION) BY 2050	**-30%**	**-30%**
ELECTRICITY PENETRATION TARGET IN COMMERCIAL BUILDINGS BY 2050	**45%**	**74%**

Policies for Industry sectors envisage emissions drop mainly due to energy efficiency measures, while our scenario will also increases electrification

Policy implementation | Policy scenario results | GD scenario results | Implemented targets

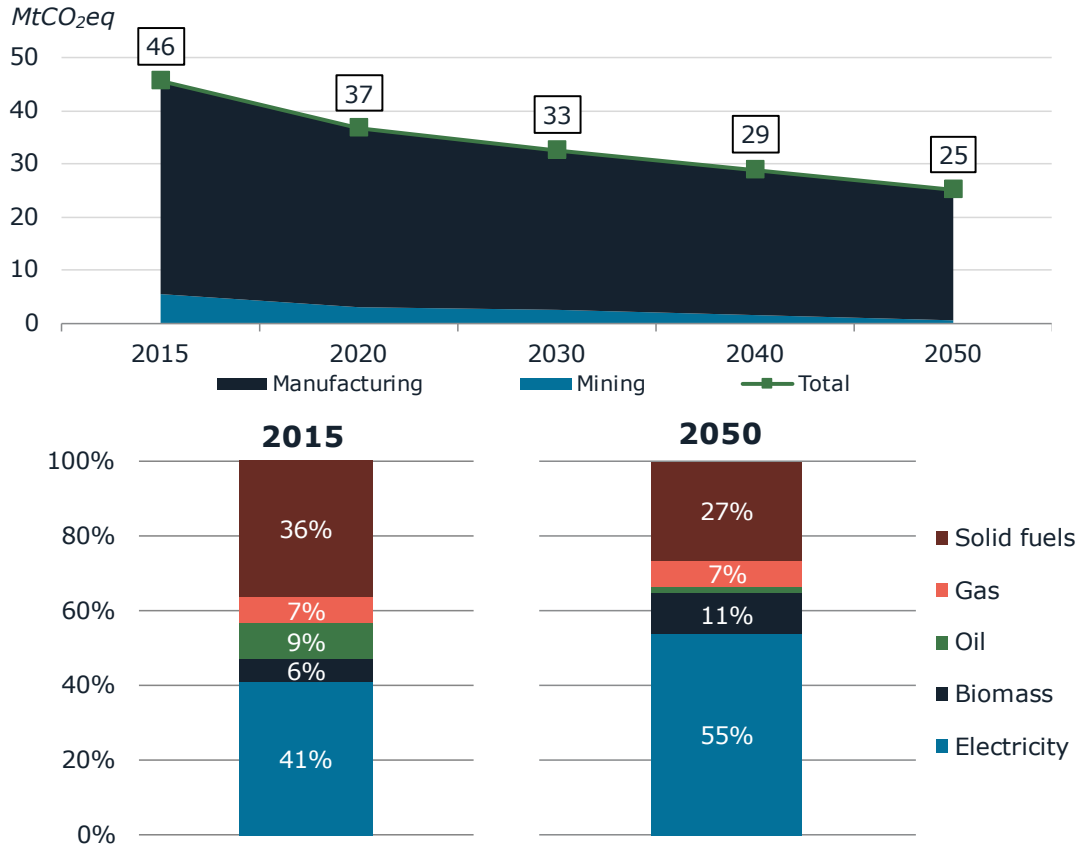
EE Strategy post 2015

		Policy Scenario	Green Development
GHG reduction	15% reduction in final energy consumption	-17% (Reached through policy implementation and additional Electrification measures)	-38% (Reached through policy implementation and additional Electrification measures)
Mining	40 PJ cumulative annual saving from energy efficiency interventions in mining by 2050	Reduction of energy consumption of mining sector of 40PJ by 2050 linear growth from 2017	Reduction of energy consumption of mining sector of 60PJ by 2050 linear growth from 2017
		Electrification target by 2050 in face of Oil and Coal	Electrification target by 2050 in face of Oil and Coal
Manufacturing	16% reduction in the weighted mean specific energy consumption of manufacturing by 2030	Reduction of energy consumption of manufacturing and other industry sector of 16% by 2030 starting from baseline consumption evolution. Linear growth from 2017.	Reduction of energy consumption of manufacturing and other industry sector of 20% by 2030 starting from baseline consumption evolution. Linear growth from 2017. 40% 2050
		Electrification target for manufacturing by 2050 in face of Oil, Coal, Gas and Biomass	Electrification target for manufacturing by 2050 in face of Oil, Coal, Gas and Biomass
		Electrification target for other industries by 2050 in face of Oil, Coal, Gas and Lignite	Electrification target for other industries by 2050 in face of Oil, Coal, Gas and Lignite

Both Mining and Manufacturing will see a rapid drop in GHG emissions, where the Manufacturing component still remains dominant

Policy implementation | **Policy scenario results** | GD scenario results | Implemented targets

GHG EMISSIONS ($MtCO_2eq$) AND SHARE OF ENERGY CONSUMPTION BY SOURCE IN 2015 AND 2050 (%)



IEA: International Energy Agency

METHODOLOGY

- IEA historical data on industry include Mining and Manufacturing energy consumptions
- The mining sector will see a decrease of 40PJ in final energy consumptions as envisaged by the national policies. Besides, a reduction in use of oil in favour of electricity source has been assumed
- For the manufacturing sector, as specified in national policies, we assumed an improvement of 16% in energy performance in 2030 compared with 2015 (same rate for the following years). Furhermore, a reduction in use of solid fuels in favour of electricity sources has been assumed
- Growth of energy consumption for the manufacturing sector has been correlated to population growth

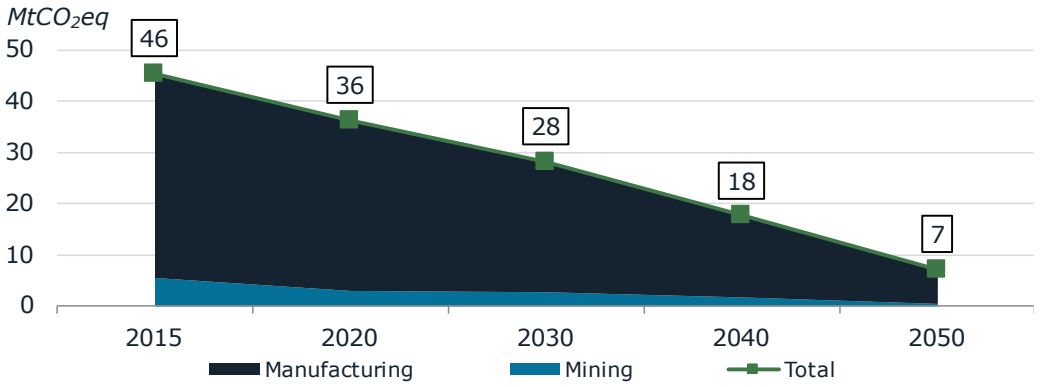
DATA SOURCE

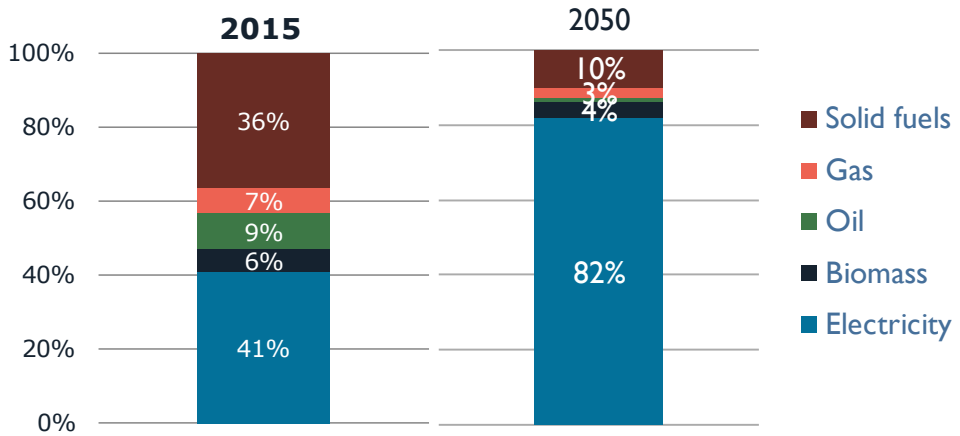
- IEA, "World Energy Balance", 2017
- DOE, "Forecast for Electricity Demand in South Africa (2017-2050)", 2017
- DOE, "National Energy Efficiency Strategy", 2016

Electrification is the additional lever towards the drastic reduction in GHG emissions in both mining and manufacturing, where the latter remains the dominant component

Policy implementation | Policy scenario results | GD scenario results | Implemented targets

GHG EMISSIONS ($MtCO_2eq$) AND SHARE OF ENERGY CONSUMPTION BY SOURCE IN 2015 AND 2050 (%)





IEA: International Energy Agency

METHODOLOGY

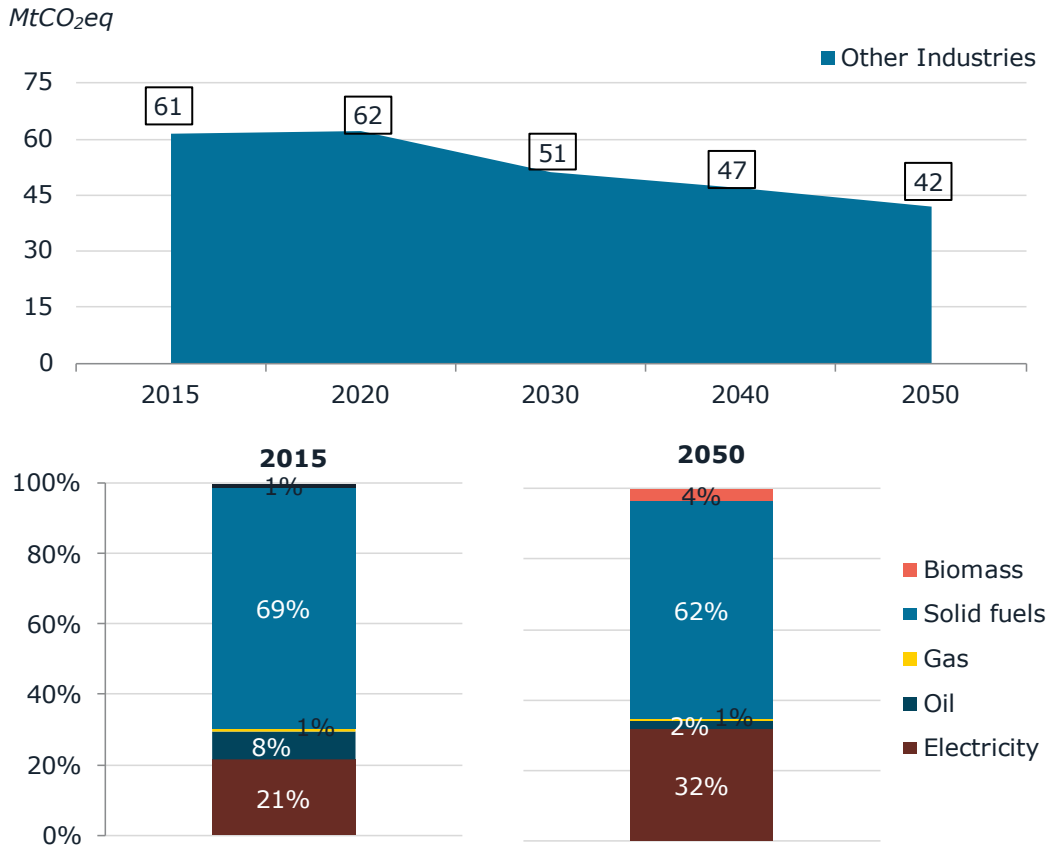
- In the Green Development scenario the IEA historical data adopted in the Policy for Mining and Manufacturing energy consumptions has been used, same targets have been updated with more ambitious goals:
- The mining sector will see a decrease of 60PJ in final energy consumptions (20 PJ more than what is envisaged by the national policies).
- For the manufacturing sector, we assumed slightly higher target than that specified in national policies, with improvement of 20% in energy performance in 2030 compared with 2015 (same rate for the following years till reaching 40% at 2050).
- Reduction in GHG emissions will be obtained also thanks to the higher electrification envisaged in the scenario: in the mining sector the share of electricity consumption will reach 94% at 2050, while in the manufacturing it will be 79%

DATA SOURCE

- IEA, "World Energy Balance", 2017
- DOE, "Forecast for Electricity Demand in South Africa (2017-2050)", 2017
- DOE, "National Energy Efficiency Strategy", 2016

Other Industries' development, being not covered by national policies, are assumed to follow similar trend of the Manufacturing sector

GHG EMISSIONS ($MtCO_2eq$) AND SHARE OF ENERGY CONSUMPTION BY SOURCE IN 2015 AND 2050 (%)



IEA: International Energy Agency

Policy implementation | **Policy scenario results** | GD scenario results | Implemented targets

METHODOLOGY

- Other industries sector includes industry activities not related to Mining and Manufacturing
- Considering lack of specific policies for this sector, policies envisaged for the manufacturing have been applied, while an increase of electrification in spite of solid fuels has been assumed, reducing its share from 69% in 2015 to 62% in 2050.

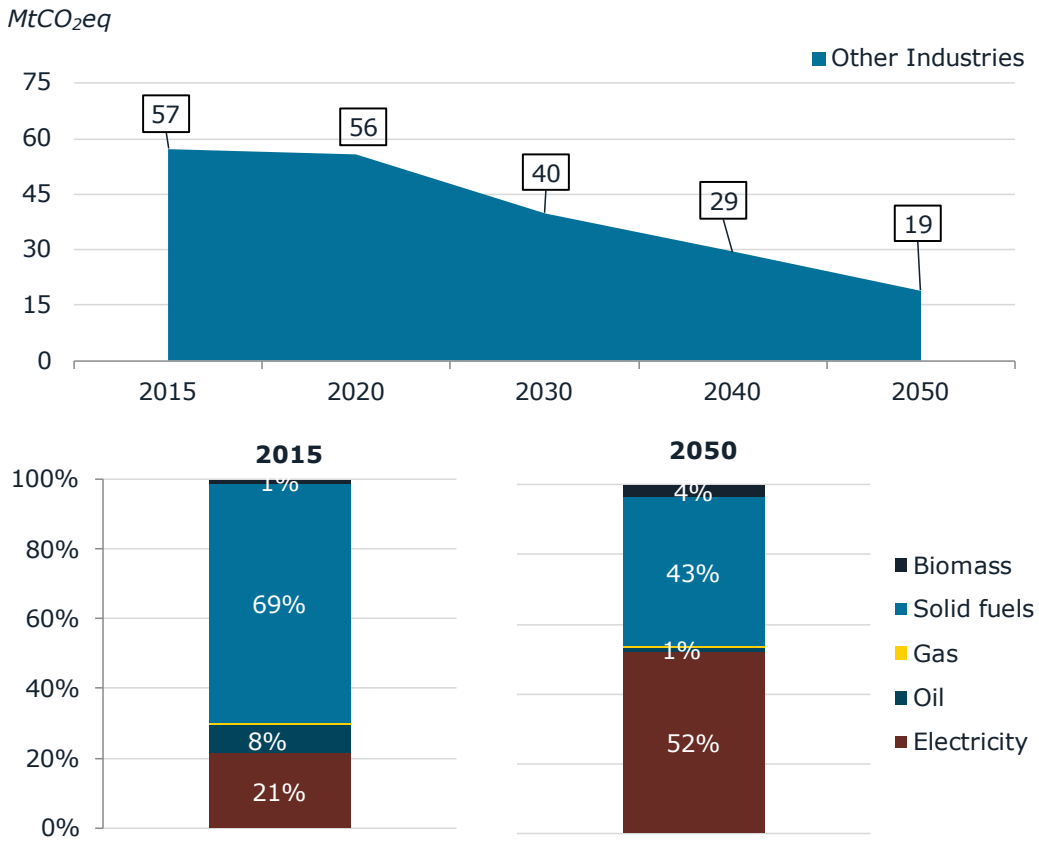
DATA SOURCE

- IEA, "World Energy Balance", 2017

Following the implementation of more ambitious targets in manufacturing sector, higher electrification leads to GHG emissions reduction for other industries

Policy implementation | Policy scenario results | **GD scenario results** | Implemented targets

GHG EMISSIONS ($MtCO_2eq$) AND SHARE OF ENERGY CONSUMPTION BY SOURCE IN 2015 AND 2050 (%)



IEA: International Energy Agency

METHODOLOGY

- Considering lack of specific policies for this sector, policies applied in the Policy scenario have been considered and updated with more ambitious targets with an increase of electrification in spite of solid fuels, reducing its share from 69% in 2015 to 43% in 2050.

DATA SOURCE

- IEA, "World Energy Balance", 2017

Industry – Implemented target values



Policy implementation | Policy scenario results | GD scenario results | **Implemented targets**

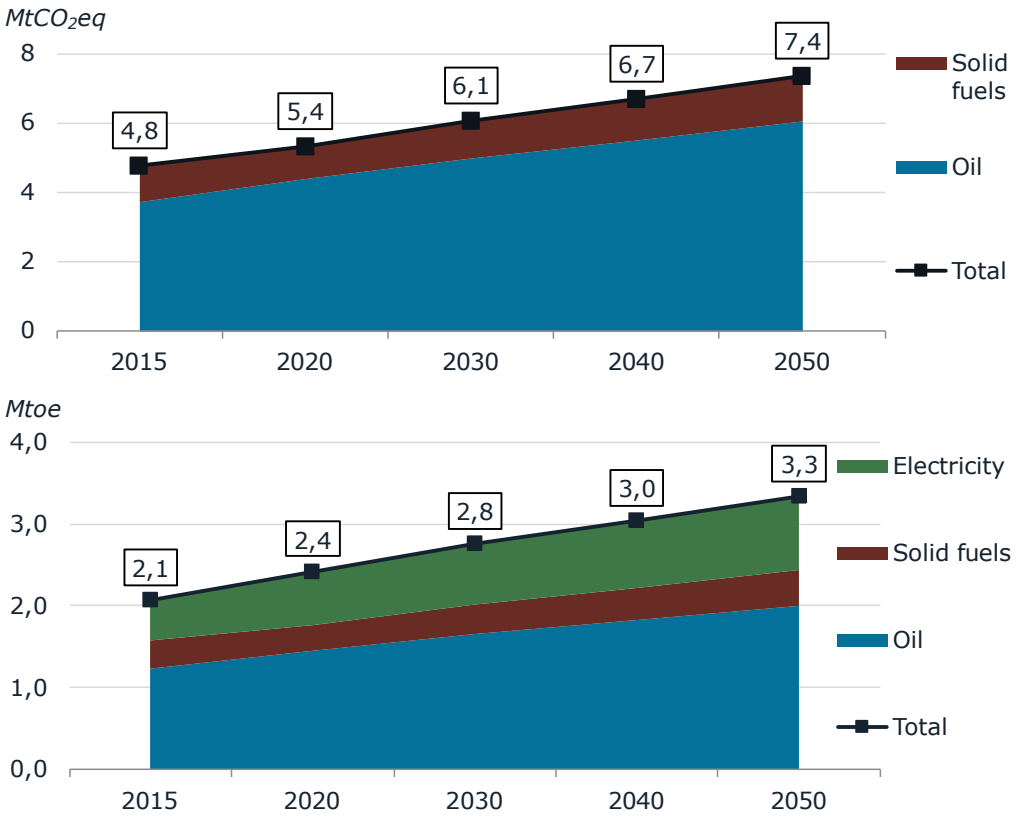
	Policy Scenario	Green Development
REDUCTION OF ENERGY CONSUMPTION MINING SECTOR BY 2050	**-40 PJ**	**-60 PJ**
REDUCTION OF ENERGY CONSUMPTION COMPARED TO BASELINE EVOLUTION FOR MANUFACTURING AND OTHER INDUSTRIES BY 2030	**-14%[1]**	**-18%[1]**
REDUCTION OF ENERGY CONSUMPTION COMPARED TO BASELINE EVOLUTION FOR MANUFACTURING AND OTHER INDUSTRIES BY 2050	**-16%[1]**	**-37%[1]**
ELECTRICITY PENETRATION TARGET IN MINING BY 2050	**94%**	**94%**
ELECTRICITY PENETRATION TARGET IN MANUFACTURING BY 2050	**48%**	**79%**
ELECTRICITY PENETRATION TARGET IN OTHER INDUSTRIES BY 2050	**33%**	**54%**

IEA: International Energy Agency 1) Evaluated as the average of the whole industrial sector

Lacking specific policies on GHG emission for Agriculture, energy mix is assumed to be constant, while consumption will increase with population

Policy scenario results | GD scenario results

GHG EMISSIONS (MTCO2EQ) AND SHARE OF ENERGY CONSUMPTION BY SOURCE (MTOE)



IEA: International Energy Agency

METHODOLOGY

- Final energy consumption of agricultural sector are based on IEA historical data
- Growth of energy consumption of agriculture sector has been correlated to population growth
- Fuel mix of agriculture energy consumption is assumed stable

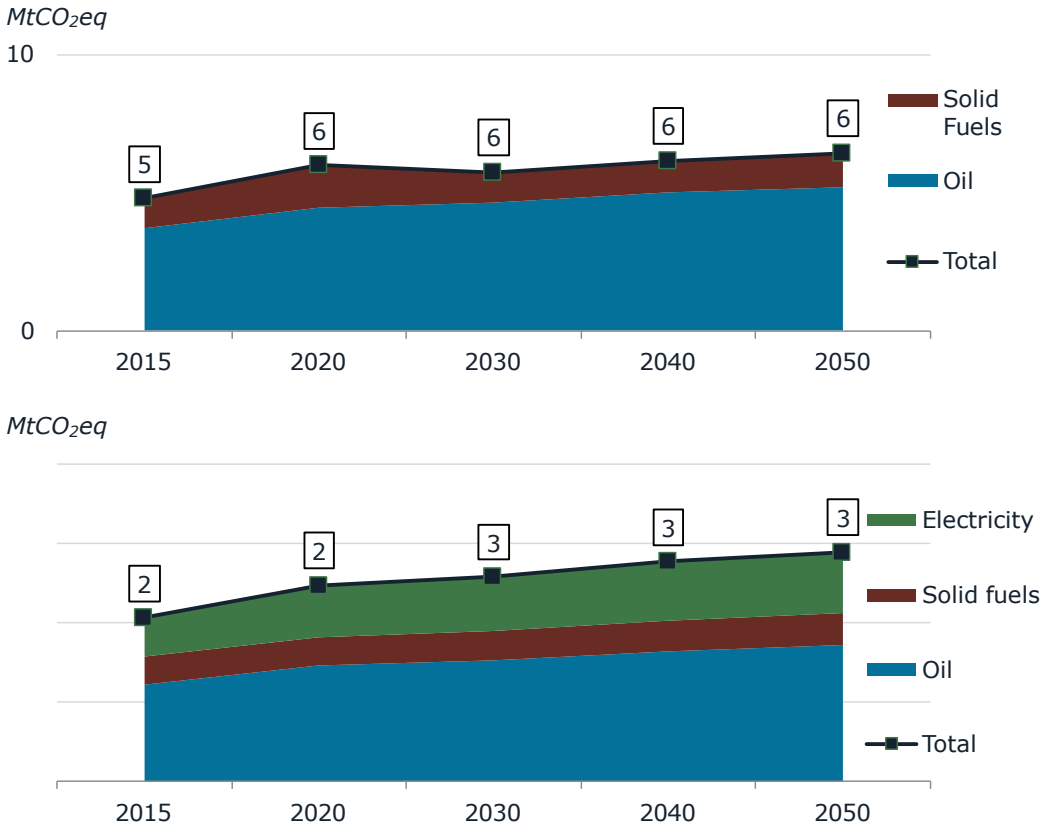
DATA SOURCE

- IEA, "World Energy Balance", 2017
- DOE, "Forecast for Electricity Demand in South Africa (2017-2050)", 2017

Energy mix for Agriculture is assumed to be constant whereas an energy efficiency target for 2050 has been assumed

Policy scenario results | GD scenario results

GHG EMISSIONS (MTCO2EQ) AND SHARE OF ENERGY CONSUMPTION BY SOURCE (MTOE)



IEA: International Energy Agency

METHODOLOGY

- Final energy consumptions of agricultural sector are based on IEA historical data as assumed also in the Policy scenario
- Growth of energy consumption of agriculture sector has been correlated to population growth, while 20 PJ of energy saving have been envisaged by 2050 in the agricultural sector
- Fuel mix of agriculture energy consumption is assumed stable

DATA SOURCE

- IEA, "World Energy Balance", 2017
- DOE, "Forecast for Electricity Demand in South Africa (2017-2050)", 2017

Considering the installed capacity scenario envisaged by the policies, we modelled the Power Generation sector

Policy implementation | Policy scenario results | GD scenario results

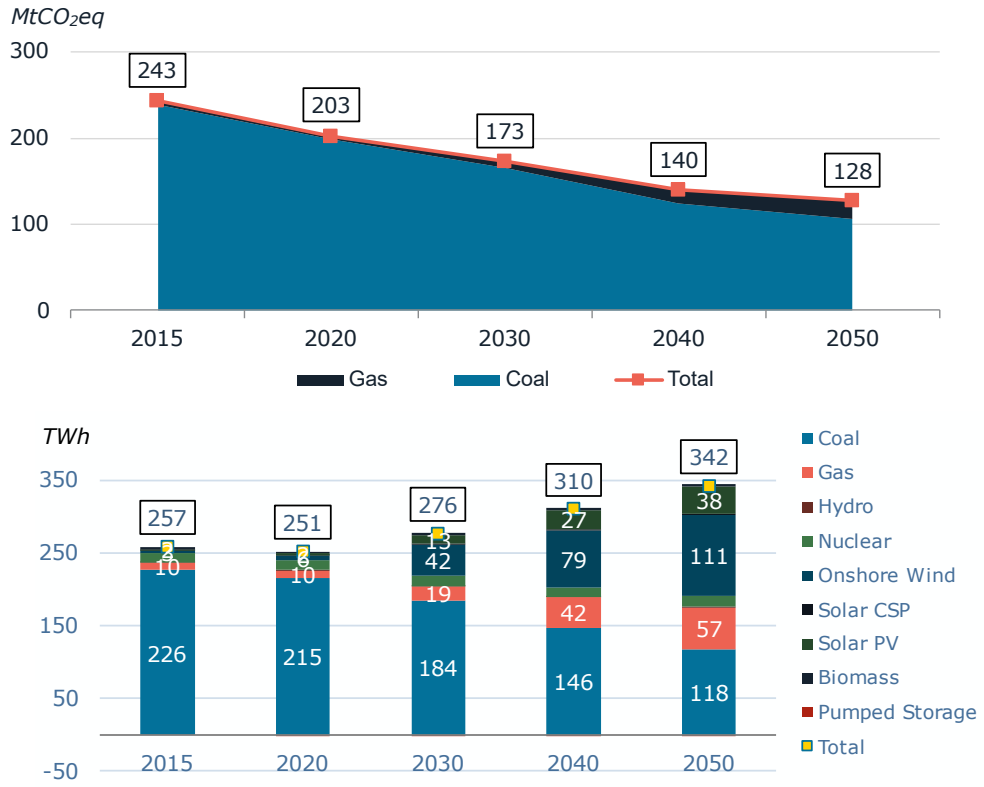
IRP 2019

		Target	Policy scenario	Green Development
Coal	Decommissioning of 10.500 MW of coal capacity by 2030	10-5 GW	11 GW	13 GW
	Decommissioning of and 35,000 MW of coal capacity by 2050	35 GW	35 GW	57 GW
Solar	Addition of 6,814 MW Solar PV by 2030	8.3 GW	✓	12.9 GW
Wind	Addition of 15,762 MW Onshore wind by 2030	17.7 GW	✓	18.7 GW
Nuclear	Extension of Koeberg Power Station design life of 20 years from 2024	1.9 GW	✓	✓
	Decision8:Commence preparations for a nuclear build programme to the extent of 2500MW (2050)	2.5 GW	✓	✓
Gas and Diesel	Integration of new gas generation capacity	6,8 GW	✓	30.6 GW

The model results show that the electricity sector will be more dependent on renewables and gas sources, even if coal still contributes to a large extent

Policy implementation | Policy scenario results | GD scenario results

GHG EMISSIONS ($MtCO_2eq$) AND GENERATION MIX (TWh)



METHODOLOGY

- Power generation sector has been modelled to optimize the generation mix subject to constraints that are: security of supply level and power plants profitability
- The generation mix shows a decline of coal generation, replaced by both renewables and gas generation
- Despite the shown decrease of generation by coal, its share is envisaged to remain high in 2050 (35%)

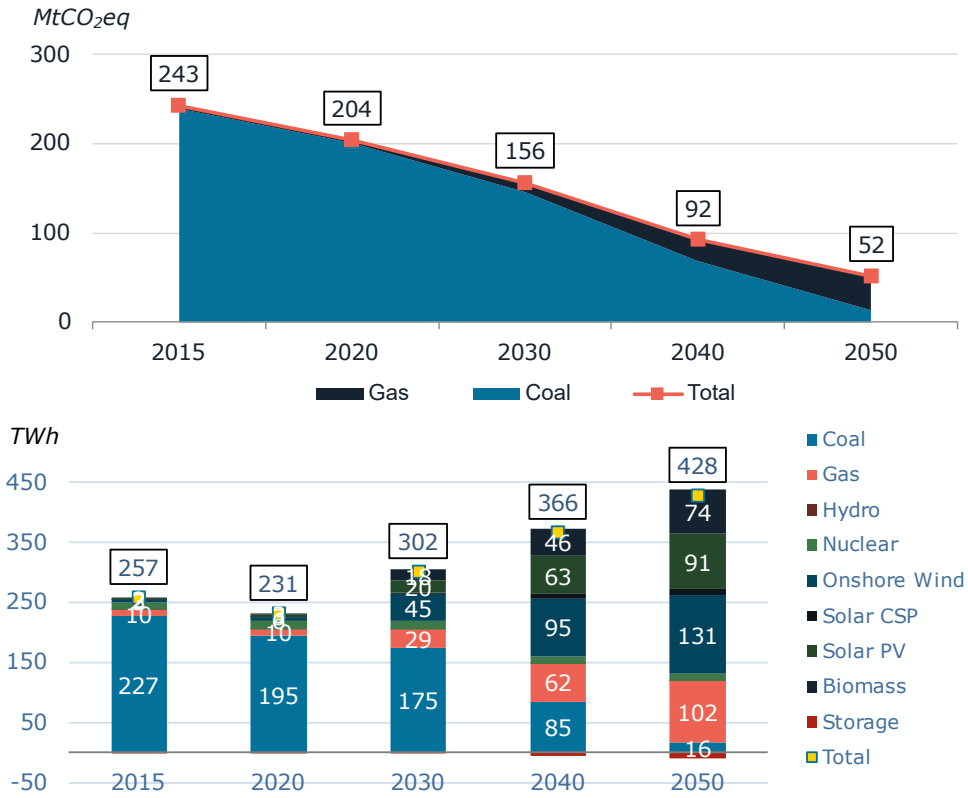
DATA SOURCE

- AFRY forecasts of South Africa final energy demand
- AFRY projections of South Africa fuel prices

CSP: Concentrated Solar Power; PV: Photovoltaic

The electricity sector will be more dependent on renewables and gas sources, while relevance of coal will be drastically reduced through coal plant decommissioning

GHG EMISSIONS ($MtCO_2eq$) AND GENERATION MIX (TWh)



CSP: Concentrated Solar Power; PV: Photovoltaic

METHODOLOGY

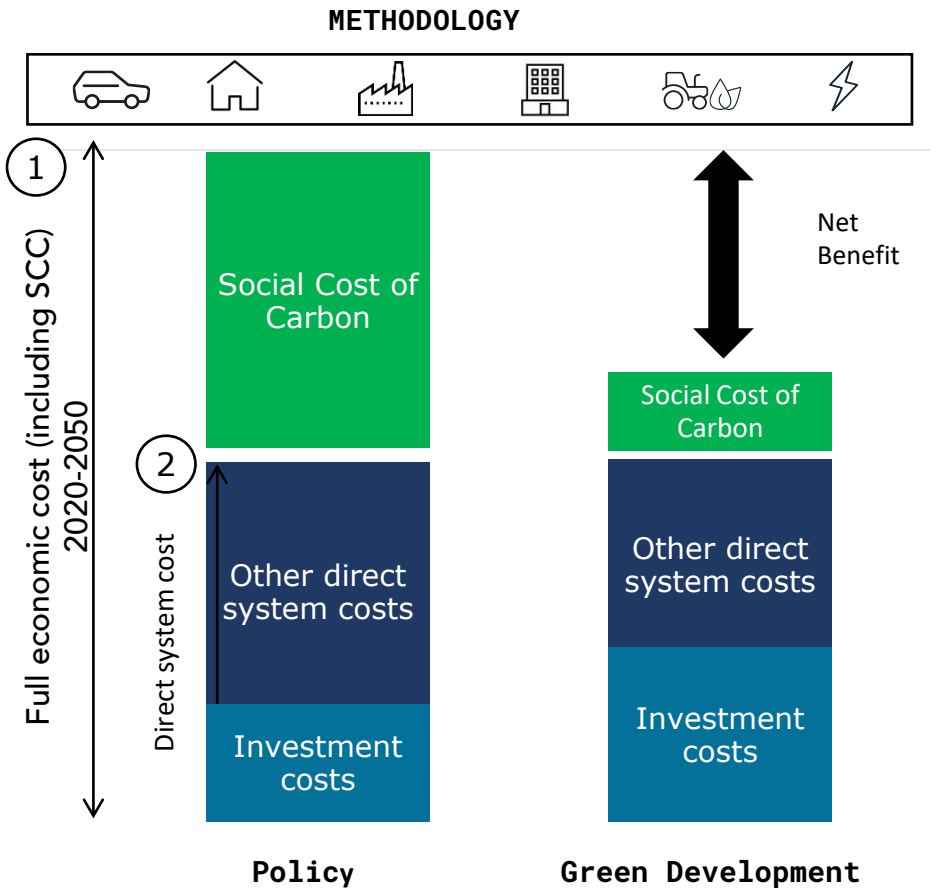
- Power generation sector has been modelled using the same approach adopted for the Policy scenario (optimization of the generation mix considering constraints like security of supply level and power plants profitability)
- The generation mix forecasted in the Green Development scenario is based on a stronger penetration of RES supported by development of BESS capacities to ensure the security of supply
- The results show an evident decline of coal generation, replaced by both renewables and gas generation

DATA SOURCE

- AFRY forecasts of South Africa final energy demand
- AFRY projections of South Africa fuel prices

A cost benefit analysis has been performed to identify technological levers and estimate the global economic benefit of modelled scenarios

ILLUSTRATIVE



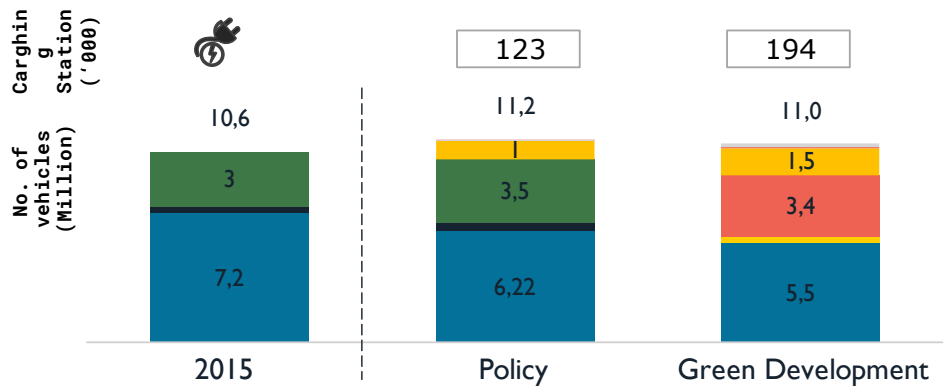
1
- The full economic cost is calculated as the sum of Direct system cost and Social Cost of Carbon:
  - Direct system cost includes the system expenditures (Capex, Opex, commodity costs and taxes) including infrastructure cost, and is calculated based on a LCOE analysis for each technology
  - Social Cost of Carbon represents the implicit cost of carbon emissions factoring in multiple impacts for the system including, among others, social and health costs
  - Decarbonised scenario lead to global economic benefits to the system whenever its full economic cost is lower than the Policy

2
- Even if decarbonised scenarios are cheaper in terms of full economic cost some financial policy measures could be needed in case of higher direct system cost and/or investment costs compared to Policy

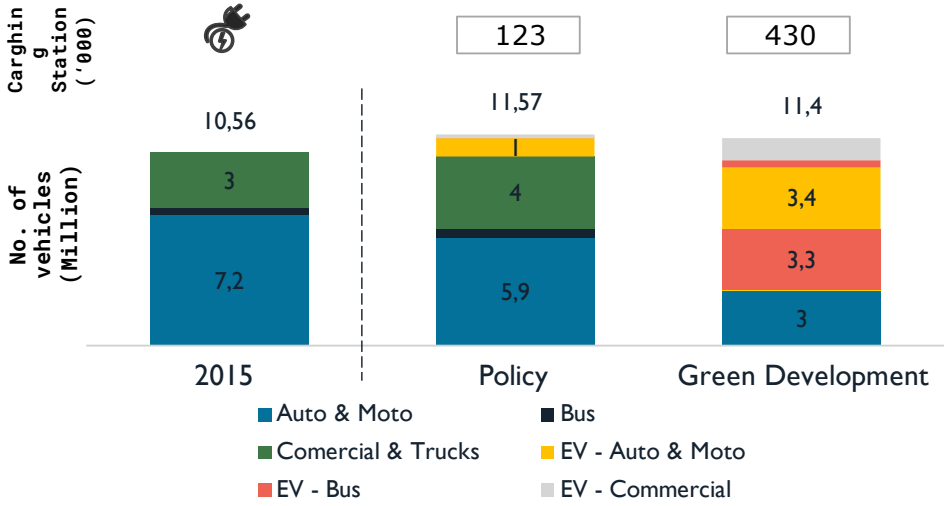
5.
Annexe 3: Detailed Potential Roadmap for South Africa

To reach the ambitious penetration of electric vehicles in the transport sector some barriers need to be mitigated by adequate policy recommendations

VEHICLES FLEET SHARE AT 2030 vs 2015



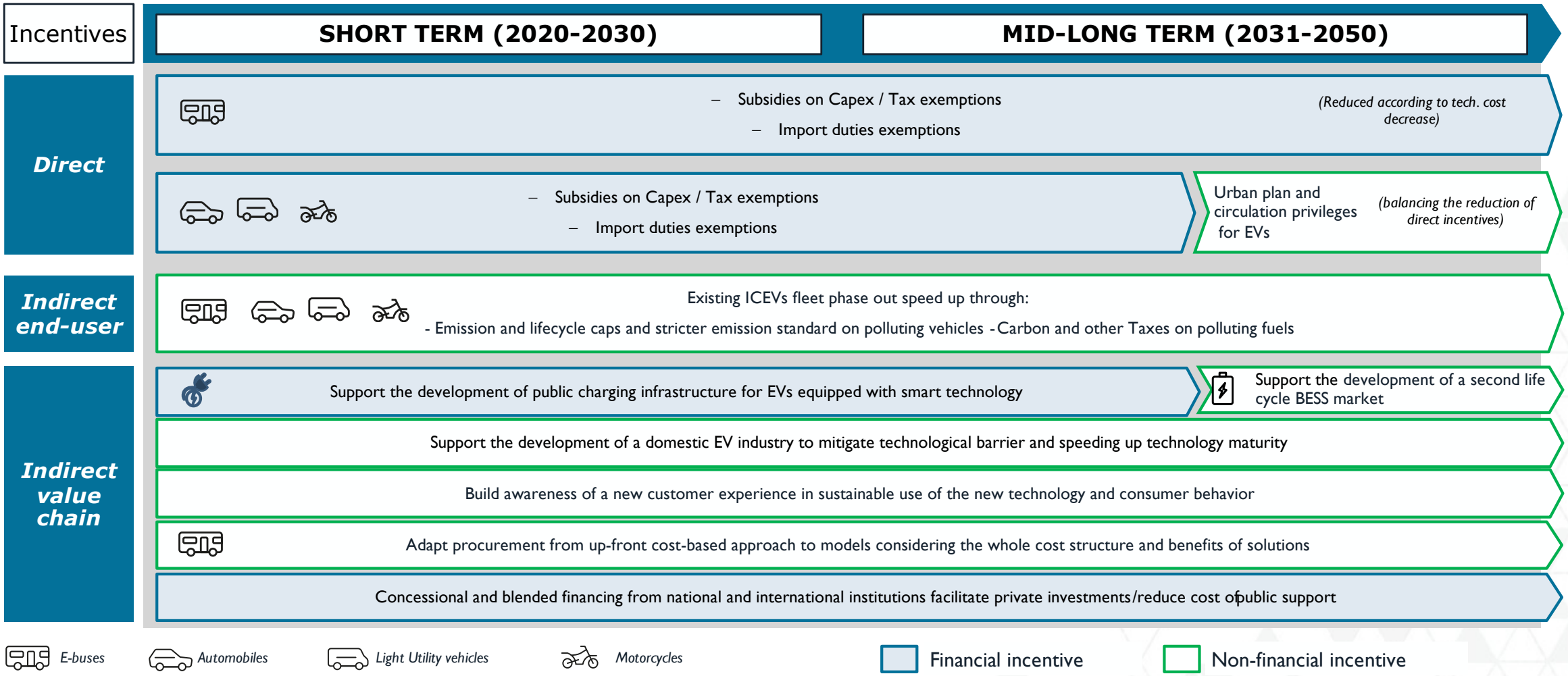
VEHICLES FLEET SHARE AT 2050 vs 2015



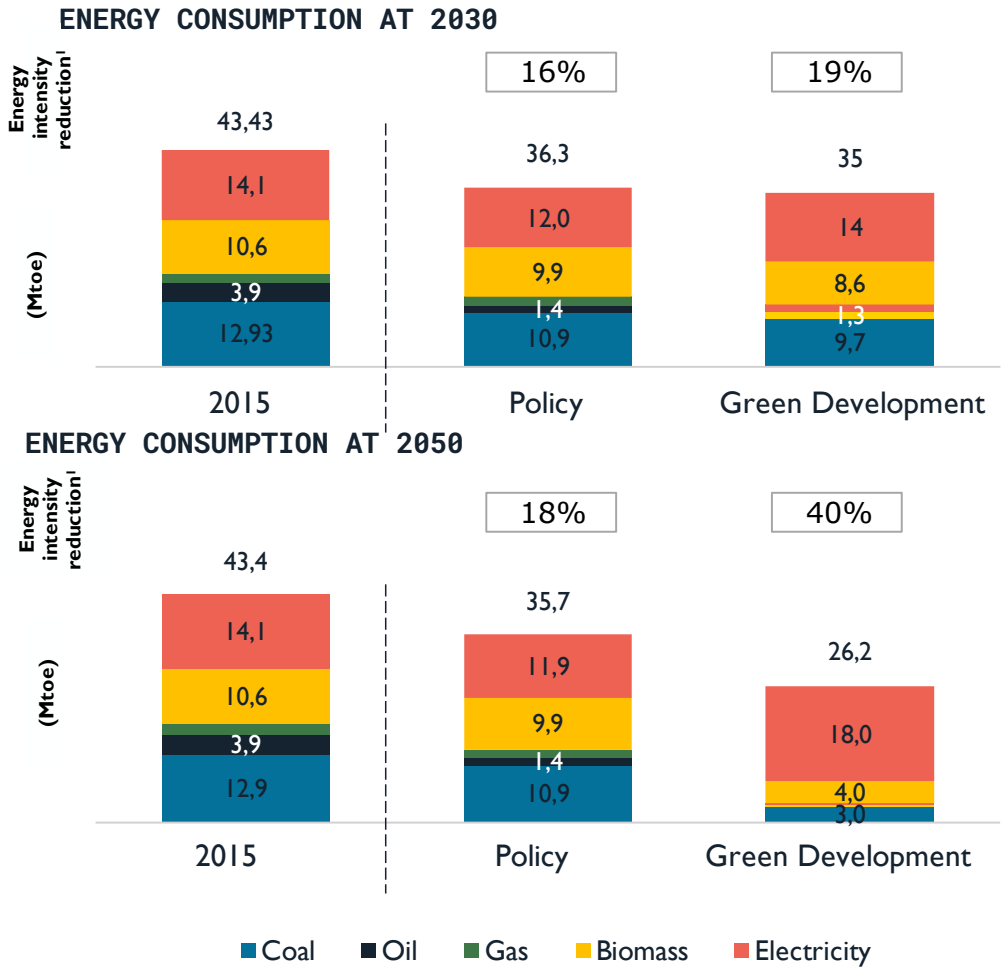
BARRIERS TO ELECTRIC MOBILITY DEVELOPMENT

- To decarbonise the transport sector, ambitious targets on EV penetration need to be reached
- Technology switch from fossil fueled mobility to electric mobility is hindered by some barriers:
  - Economic: EVs have higher upfront costs compared to ICEVs leading to higher investments on private sector side
  - Technical: lack of a developed charging infrastructure (n. of stations and smart technology endowment) and lack of a competitive BESS technology cost structure
  - Managerial: procurement and tendering models typically focus on up-front costs without considering the whole cost structure and benefits of EVs penetration
  - Financing: high up-front investment costs either for EVs or charging infrastructure and uncertainties about long term performances of BESS plus not mature marketplace limit EVs attractiveness for public and private investors
  - Behavioral: lack of people awareness either about low emission mobility efficiency benefits or about existing ICEVs fleet negative climate and environmental impact
- South African Government should develop an integrated electric policy approach to mitigate such barriers

EVs shall be sustained with financial incentives and a proper value chain development whilst stricter policies for ICEVs fleet phase out are needed



To reach the energy intensity reduction targets in the industrial sector energy efficiency investments need to be inventivised by adequate policies



BARRIERS TO ENERGY EFFICIENCY:

- To decarbonise the industrial sector, targets for energy intensity reduction through energy efficiency interventions need to be reached
- The introduction of energy efficiency measures will lead to energy savings for all the commodities used in the industrial sector
- The higher energy intensity reduction targets in the Green Development scenario lead to higher energy savings compared to Policy
- Energy efficiency development is however hindered by an economic barrier since EE interventions entail some upfront costs for end users
- Policy measures must be identified to mitigate the economic barrier

1) Overall 2015-2030/2050 percentage reduction of energy intensity

Energy efficiency shall be sustained in industry with some financial incentives and energy intensity and environmental obligations

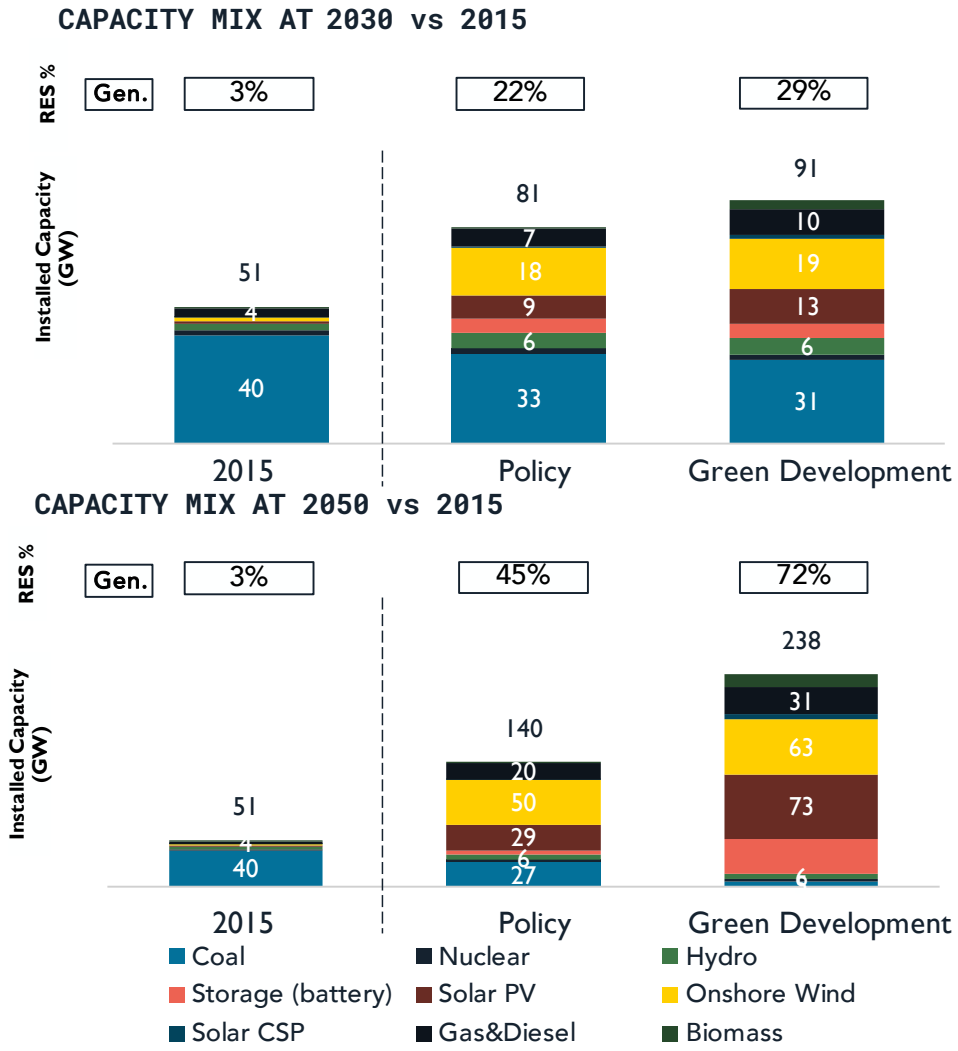
Incentives	SHORT TERM (2020-2030)	MID-LONG TERM (2031-2050)
Direct	– Tax reliefs / Subsidized credit from national institutions (e.g. funding programs and grants) for Capex intensive energy effiiency interventions on industrial processes (e.g. Compressed air, high performances CHPs, process heating)	*(Reduced according to tech. cost decrease)*
Indirect end-user	– Gradual implementation of a Carbon Pricing scheme in the industrial sector to boost the technological switching from fossil fuel as primary energy source towards an electrification of the main industrial energy intensive activities	Support new qualified job creation for employees of fossil sectors involved in the tech. transition (coal mining)
	– Tighten emission cap on main GHG intensive industrial activities and stricter emission standard for existing and new industrial plants – Increase industrial sector awareness either towards current technology climate and environmental impact or technology switching energy efficiency benefits	
Indirect value chain	– Define an "energy efficiency handbook" with clear standards and supporting measures for each intervention (e.g. performance evaluation methodology, investment coverage, type of subsidy) – Define standards for Energy Service Companies development	
	Define technical and environmental standards for industrial new builds that promotes reduction of energy intensity, electrification of consumption and emissions reduction	

Industry

Financial incentive

Non-financial incentive

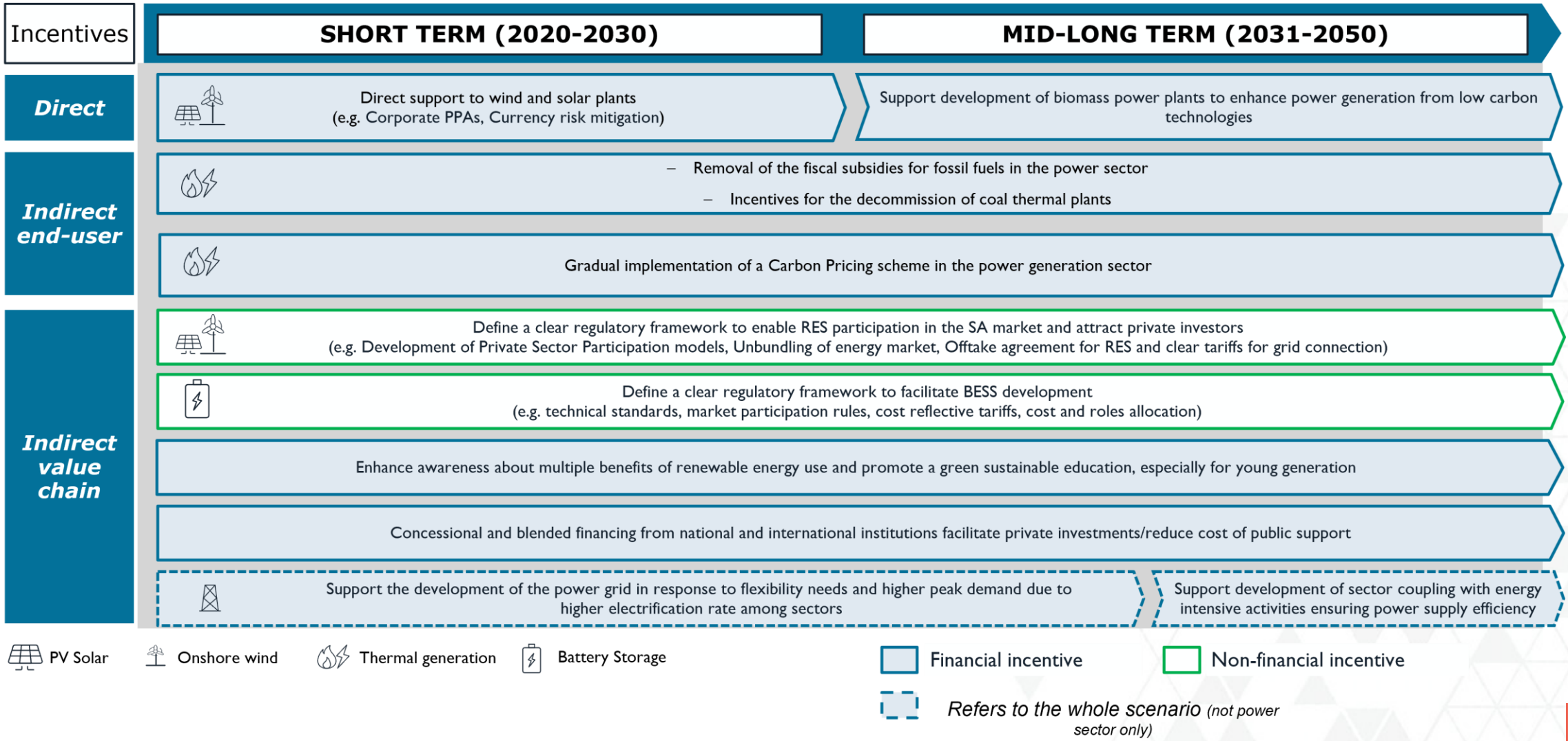
To reach the RES penetration targets in the power sector RES and Battery Storage need to be incentivised by adequate policies



BARRIERS TO POWER SECTOR DECARBONISATION:

- To decarbonise the power sector, ambitious targets on RES penetration need to be reached accompanied by battery energy storage system (BESS) development
- The development of RES is hindered by 3 main barriers:
  - Economic: due to limited local manufacturing capability most of the RE technologies used in South Africa are imported. Investments are subject to foreign exchange exposure, negatively affecting profitability
  - Technical: due to insufficient grid access, large areas of the country remain detached from the grid (15%), so an adequate grid enforcement is required
  - Regulatory: Presence of a government's own monopoly in the energy industry sector could create some difficulties in the development of a clear and favorable regulatory framework necessary to enable RES market participation and to attract private investments
  - Batteries are mainly hindered by regulatory barriers (presence of restrictions or lack of clarity around if and how storage can be used cross generation, transmission and distribution). Moreover, there are also market barriers including a lack of system services and uncertainty about the risk return profile of this emerging technology (limited data and analysis capabilities)
- Policy measures shall be identified to mitigate the identified barriers

National policies shall sustain investments to support RES penetration and coal plants decommissioning and provide a clear and favorable regulatory framework for RES and BESS



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