Annex J: South Africa Country Study

Contents

Executive summary

South African GHG emissions are ranked around 15th in the world, with 522 MtCO_2e in 2016. Most (84%) are from the energy sector, most (60%) of these are from electricity generation, and most (88%) electricity comes from burning coal, making the carbon intensity of the country's electricity (0.96 kg CO_2/kWh) the highest in the world. The biggest opportunities for GHG emission reduction therefore lie in the energy sector.

South Africa (SA) is committed to an emission *peak* and *plateau* in 2025-2035 and a *decline* thereafter and has been developing various plans and strategies to put this 'PPD' strategy into effect. Factors that constrain mitigation strategy, however, include a strong policy commitment to social equity in a highly unequal country, and a legacy of coal-based energy systems with which powerful interests remain aligned and upon which much employment still depends.

Ageing generating infrastructure and deteriorating performance at the highly-indebted state electricity provider Eskom contributed to inadequate electricity supplies in the 2000s and 2010s. Black-outs therefore combined with policies to increase equity and reduce GHG emissions, to stimulate efforts to bring renewable energy (RE) into the national grid. This has been achieved rather rapidly by global standards.

After an early experiment with feed-in tariffs (FITs) in 2009-2010, which were vetoed as unconstitutional because uncompetitive, the focus switched to competitive auctioning of power production contracts with the national supplier Eskom. This attracted investment by independent power producers (IPPs) and a number of auctions were organised in 2011-2015 through the Renewable Energy IPP [Procurement] Programme (REIPPP).

The REIPPP system induced 34 wind, 45 solar PV and 13 other RE investment projects to supply over 6 GW of electricity. More recent signings bring the total of 17.7 GW of wind energy and 8.2 GW of solar PV to be installed by 2030, raising the contribution of RE to 34% of total electricity production. This is an explosive growth in RE by any standards, and the Danish contribution to it was helpful in at least two ways:

- **The Wind Atlas (WASA) project**, Phase I of which pioneered wind resource mapping in 2009-2011, helped stimulate interest in wind-based FIT projects, and later informed and encouraged wind-energy bidders in the early REIPPP auctions. Phase II of WASA helped consolidate the credibility of South African wind investments and the national skills base in that area (see Annex e).
- **The technical assistance (TA) to Eskom component of the Danish Energy Partnership Programme (DEPP) Phases I and II**, which helped resolve the many technical difficulties involved in integrating variable RE electricity flows into the national grid. This is an essential capability within any power system that was originally designed to handle steady flows of power from conventional generators, yet now has to accommodate RE at scale (see Annexes f & g).

Other Danish-supported efforts were much less effective and included:

- **The energy-efficient housing project**, which dragged on for more than a decade and achieved almost nothing for various reasons (see Annex c).
- **The smart-metering project at the Department of Energy** (DoE, now Mineral Resources and Energy, DMRE), a project that paralleled DEPP Phase 'I', which was poorly designed and eventually cancelled (see Annex d).
- **The technical assistance (TA) to DoE/DMRE component of DEPP Phases 'I' and II**, which aimed to support the development of policies and strategies to promote the introduction of EE and RE technologies. This was only patchily effective in Phase I, and by Phase II the relationship between DMRE and Danish partners had become ineffective (see Annexes f & g).

None of the projects established clear baselines and performance monitoring and reporting were often inadequate, so it is hard to establish the contribution of these programmes to either capacity building or to GHG emission reduction. It is nevertheless clear that Danish mitigation efforts in SA had mixed levels of effectiveness, from which several lessons can be taken:

- on the potential importance of innovation, but also the costs of failing to keep on innovating and adapting in light of new conditions as they arise;
- on the utility of political economy analyses to support project design before investing in attempted change;

- on the need for partnership building based on shared priorities, common interests, mutual respect and good communications before capacity building is attempted; and
- on the need for a shared understanding of what building the capacity of staff and institutions means, and what it involves in practice.

Points of alignment between the 2016 NDC and the Danish mitigation interventions in SA at design level were limited to the energy sector. The relationship between DEA and DoE/DMRE was ineffective during DEPP Phases 'I' and II, and this inhibited progress in the areas of RE policy and regulatory development and EE. But that with Eskom was more fruitful in the area of integrating RE into the grid, and there was also direct and indirect progress associated with WASA in attracting investment into the RE (wind) generation sector, thus contributing to the NDC's energy decarbonisation investment goals. DEPP Phase III will continue the effective arrangement with Eskom on RE integration, and a promising engagement with the IPP Office has been added that responds to current needs and requests from the South African side. But continued reliance on DMRE in the area of sector planning remains a risky feature of the design.

1. National context of mitigation efforts

1.1 Overview of socioeconomic conditions

South Africa (SA) is over 1.2 million sq. km in area and has a climate influenced by the dry interior of Africa and the oceans on both sides, modified by the Drakensberg range. The resulting diversity of climatic zones include the 'Mediterranean' zone in the far south-west, the dry desert in the far north-west, and the moist sub-tropical zone in the east. These are becoming unstable, and "the adverse effects of climate change have been a stark reality for South Africa for many years [with projected] further trends of marked temperature increases, rainfall variation and rising sea levels as well as an increased frequency of severe weather events." (GoSA, 2016: 3).

The administrative capital[1], Pretoria, is on the highveld plateau, in Gauteng province which also accommodates the main coal seams (along with Mpumalanga province) and gold fields, the city of Johannesburg, and a third of the country's population. The major social transition within SA was the end of the apartheid system and the extension of civil rights to members of all 'races'[2] in 1991. Legacies of the earlier regime include highly-inequitable distributions of land ownership and wealth, which continue to favour 'whites' and which post-apartheid governments have tried to correct through cautious structural reforms, generous welfare measures and constitutional protections. Key social and economic indicators as they stood in 2019 are given in Table 1.

Table 1: South Africa: Human Development Indicators, 2019

[1] For historical reasons there are two other capitals: the legislative capital at Cape Town in Western Cape province, and the judicial capital at Bloemfontein in Free State province.

[2] 'Race' is a scientifically meaningless term but is often used to highlight supposed correlates of ethnic difference in SA, including a political distinction between 'black' (broadly meaning indigenous African, but excluding the aboriginal San who were the victims of an earlier genocide) and 'white' (broadly meaning people of European descent).

1. Human Development Index (HDI, rank of 189 countries)	113
2. Life expectancy at birth (years)	63.9
3. Expected years of schooling (years)	13.7
4. Gross national income per person (2011 PPP USD)	11,756
5. Inequality-adjusted HDI (raw HDI = 0.705)	0.463
6. Gender Development Index (GDI)	0.984
7. Employment to population ratio (% ages 15 and older)	40.6
8. Internet users, total (% of population)	56.2
9. Total population (millions)	57.8
10. Skilled labour force (% of labour force)	51.2
11. Corruption Perceptions Index (CPI, rank of 198 countries)	70

Sources: (items 1-10) http://hdr.undp.org/en/countries/profiles/ZAF (items 1-10); www.transparency.org/en/cpi/2019/results/zaf (item 11).

1.2 South African GHG emissions

At 522 $MtCO_2e$, South African GHG emissions are ranked around 15th in the world. Most (84%) are from the energy sector, of which the power generation sector contributes 60% (Figures 1 & 2; Table 2). Eskom's coal power stations, with a total nominal capacity of 37.4 GW, generate around 88% of South Africa's electricity. It is this sector that offers the biggest opportunities for GHG mitigation. The carbon-intensity of South Africa's electricity (0.96 kg CO_2/kWh) is the highest in the world.

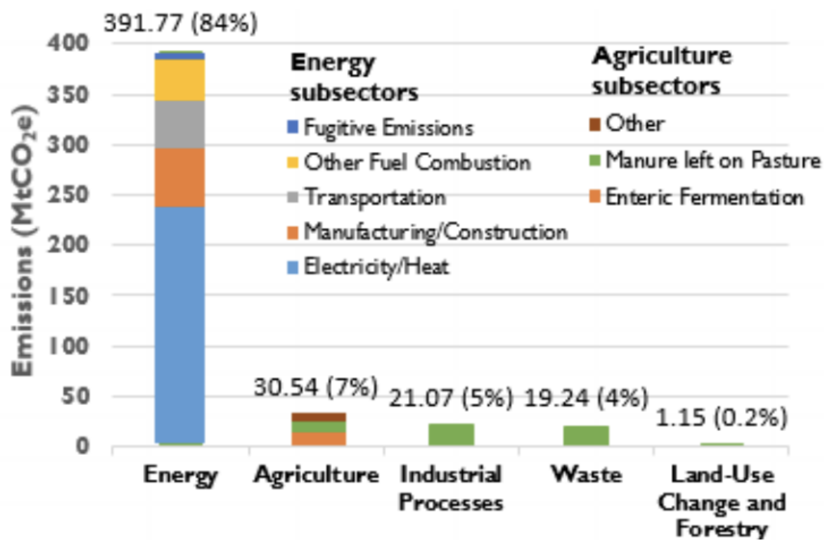


Figure 1: Breakdown of South Africa's GHG emissions per sector (Source: GoSA, 2020).

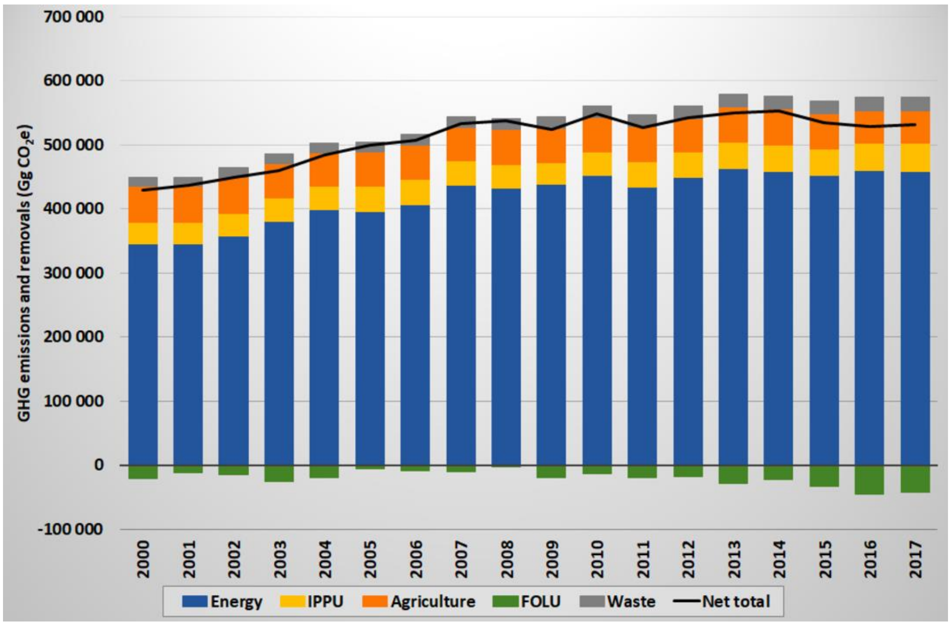


Figure 2: Trends in South Africa's GHG emissions per sector (Source: GoSA, 2020).

Table 2: GHG emissions, sinks, sources and changes in South Africa

GHG emissions	Unit	2016 data
Total GHG emissions	$MtCO_2e$	522.1
Per-person GHG emissions	tCO_2e	7.48
Land-use change & forestry sources/sinks	$MtCO_2e$	1.1
Electricity & heat sources	$MtCO_2e$	279.9
Agriculture sources	$MtCO_2e$	29.6
Transport sources	$MtCO_2e$	55.4
Waste sources	$MtCO_2e$	24.0
Manufacturing & construction sources	$MtCO_2e$	50.3
Industry sources	$MtCO_2e$	20.4
Fugitive emissions	$MtCO_2e$	2.7
Other fuel combustion	$MtCO_2e$	12.7
Buildings	$MtCO_2e$	21.2
Aviation & shipping sources	$MtCO_2e$	13.8
Energy intensity	kWh per unit GDP in 2011PPP USD	2.27
Carbon intensity	kg/kWh	0.33
GDP per person % change since 1990	Δ%	26.8
Consumption emissions per person % change since 1990	Δ%	6.9

Source: https://ourworldindata.org/co2/country/south-africa?country=~ZAF

1.3 South African climate policies and strategies

At the UNFCCC CoP in Copenhagen in 2009, SA made its first, voluntary, climate change mitigation commitment, for emissions to rise to a peak before plateauing and declining, and its first formal policy in this area was a White Paper on National Climate Change Response Policy (MoE, 2011). It contains general principles, such as that South Africa will contribute its fair share to global efforts and will undertake climate change mitigation actions mindful of development priorities. The country's broad mitigation approach can be summarised as follows:

- carbon budgets for large emitters with annual limits on emissions;
- sectoral emission allocations referred to as 'desired emissions reduction outcomes' in the White Paper, but now renamed 'Sectoral Emissions Targets';
- market/fiscal instruments such as the carbon tax; and
- an overall emissions trajectory benchmark range, peaking in 2025, plateauing until 2035 and then declining, which will guide long term strategies, informed and modified by the latest science. This is therefore often called the 'PPD scenario'.

The National Development Plan, also released in 2011, made a commitment to transition the country to a low-carbon economy. South Africa also signed and ratified the Paris Agreement in 2015, under which its first Nationally Determined Contribution (NDC) statement (GoSA, 2016) merely contained previous PPD commitments. The current updating process is expected to result in more ambitious mitigation targets.

The Department of Environment, Forestry and Fisheries (DEFF, formerly Environmental Affairs) has made slow progress in establishing a complete 'mitigation system' for actions and reporting on GHG emissions, and this still requires the Climate Change Bill to be passed by Parliament. When this is done, the Climate Change Act will provide a legal basis for setting compulsory carbon budgets for large emitters, sectoral emission targets, and revising the PPD strategy. It will also give statutory powers to the Presidential Climate Change Coordinating Commission that was approved by cabinet in September 2020 along with a national Low Emissions Development Strategy. The aim of all these measures is to ensure a 'just transition' to a new low-carbon future while improving the circumstances of the most vulnerable groups.

Greatest potential mitigation impact is offered by the Integrated Resource Plan, which allows for expanding electricity generation and an increasing share of RE in the least-cost mix (see Section 1.4). There are also energy efficiency (EE) programmes (with various degrees of effectiveness), the carbon tax (set currently at a low level), tax incentives (such as 12L in the tax code, which provides for accelerated depreciation for EE and RE investments), a Green Transport Strategy (which lacks an explicit implementation strategy) and a Green Industrialisation Strategy (which is still being drafted).

Planned carbon budgets have the potential to restrict emissions from large industries, but they are difficult to set administratively and there is little evidence that DEFF will have the political authority to implement them in full. Nevertheless, carbon budgets do contain useful elements of reporting and information disclosure, and ultimately will have the effect of making action plans to cut emissions mandatory. As indicated above, the electricity sector, dominated by the power generation assets of Eskom, offers the best opportunity for deep decarbonisation commitments and actions.

1.4 Recent developments and opportunities in the energy sector

South Africa's voluntary commitments to curb GHG emissions in 2009 found expression in the country's electricity planning processes, and the Integrated Resource Plan of 2010 incorporated RE options for the first time. Early attempts to procure grid-connected RE, through feed-in tariffs (FITs) published by the electricity regulator (NERSA) were unsuccessful, largely because the contracting framework was never finalized. The FITs were superseded by renewable auctions from 2011 after a state legal opinion that administratively-set FITs would not be able to meet the constitutional standard of public procurements being "fair, equitable, transparent, competitive, and cost-effective" [Section 217 of the Constitution of South Africa]. A number of successful renewable auctions have since been held, attracting more than USD 14 billion of investment in close to 100 projects totalling more than 6 GW (Table 3).

Table 3. Outcomes of REIPPP Auctions

		Wind		Solar PV		Other	
Auction	**Year**	**MW**	**No**	**MW**	**No**	**MW**	**No**
BW1	2011	649	8	627	18	150	2
BW2	2012	559	7	417	9	64	3
BW3	2013	787	7	435	6	235	4
BW3.5	2014	0	0	0	0	200	2
BW4a	2015	676	5	415	6	30	2
BW4b	2015	686	7	398	6	0	0
	TOTAL	**3,357**	**34**	**2,292**	**45**	**679**	**13**

Source: IPP Office (www.ipp-renewables.co.za).

After a successful start, the RE auctions were interrupted during the 4th bid window as a result of growing resistance from coal-related interests. The national power utility (Eskom) delayed signing power purchase agreements (PPAs) for over two years. Political economy factors within the ruling African National Congress (with constituencies dependent on the coal sector, including miners, power station workers, and new 'black' mining capital) began to contest the energy transition towards renewable energy. State capture and corruption grew under the 2009-2018 Zuma presidency, facilitated by disruptions in leadership such as those induced by frequent changes in ministers (e.g. there have been no fewer than seven energy ministers since 2010).

Under President Ramaphosa there has been progress towards greater policy transparency and certainty. Bid window 4 PPAs were signed in 2018 and an updated IRP 2019 has been published, which envisions a total of 17.7 GW of wind energy and 8.2 GW of solar PV installed by 2030, raising the contribution of RE to 34% of electricity production.

Eskom's performance has deteriorated over the past decade; the average energy availability factor of their power stations is now as low as 66%. Some of the coal power stations are over 50 years old and 11 GW will need to be decommissioned by 2030. Eskom also has high levels of debt, mainly as a result of investments in two new 'mega' coal power stations (Medupi and Kusile), both being way over budget and time. Two further coal IPPs were planned in recent years but sponsors and banks withdrew, and it is unlikely that another coal power station will be built in SA. New power generation capacity will have to come from private investments in IPPs and will be mostly a combination of solar, wind, and energy storage.

A roadmap for Eskom's future was approved by cabinet in October 2019, which details plans for breaking up Eskom (currently responsible for generation, transmission and distribution) and creating an independent transmission system and market operator that will create a transparent and fair platform for procuring new, least-cost power generation (i.e. mainly RE).

South Africa has a highly regulated energy sector. The Electricity Regulation Act empowers the energy minister to make Section 34 determinations on how much power should be procured from which resources, when, by whom, and sold to whom. In late 2020 the Minister made a new determination for the procurement of a further 6.8 GW of solar and wind energy, and a 5th REIPPP auction was expected to be held, perhaps with annual auctions thereafter.

A South African Renewable Energy Master Plan is under development and Renewable Energy Development Zones have been promulgated, which will facilitate Environmental Impact Assessments and transmission planning. Small-scale embedded generation is also taking off, with about 1.3 GW of solar PV already installed, although this sector also faces regulatory impediments. Nevertheless, many mines, large industries and commercial enterprises are submitting applications for generation licences and it is likely investments in distributed generation will accelerate.

1.5 Broader development challenges

South Africa has entered a major energy transition from its dependence on coal to an energy mix with a large and growing share of RE. The transition is sustainable in economic terms, since unsubsidised solar and wind energy are now the cheapest sources of grid-connected power, and solar PV is also becoming financially attractive for self-generation. But the transition is now being contested as stakeholders in the coal sector see their interests threatened. Investing in a 'just transition' is needed to relieve social consequences by mitigating costs to coal miners, workers in coal power stations, and the communities that depend on them. This would have to involve re-training for new employment, crowding new investments into the coal belt in Mpumalanga, and various social support programmes. Although the 'just transition' idea was accepted into the political discourse in SA during 2020, to be meaningful it now needs a substantive, coherent and coordinated response.

The energy transition will also need to accommodate South Africa's broader development challenges, since the country has one of the most unequal economies in the world with 20% of people possessing nearly 70% of national income. These inequalities generally still reflect the racial legacies of apartheid (see Section 1.1), and despite 26 years of inclusive democracy, and substantial investments in education, health, social support, housing, and infrastructure services, not enough progress has been made in reducing these inequalities (NDC, 2011). Poverty and unemployment levels remain unacceptably high. Nearly half of South Africans live below the national upper-bound poverty line (which is currently around USD 70 per person per month). With the CoViD pandemic, unemployment has risen to above 30%. The REIPPP system includes clear rules to ensure that bids have at least 40% local content and include a contribution (typically around 3.5%) to social improvements ('upliftment') in the area of construction.

South Africa has made impressive progress in widening access to electricity. At the end of apartheid, fewer than 40% of households had access to grid-based electricity; now the figure is around 88%, even though at least 20 million people have been added to the population. The resulting growth in demand exceeded growth in generation capacity, leading to power shortages and steep rises in electricity prices, which have more than doubled over the past decade (Figure 3). Affordability challenges are reflected in increasing levels of electricity non-payment and theft, despite free basic electricity provisions for poor households (although these are only for 50 kWh per household per month, which is barely enough to power lights and a television).

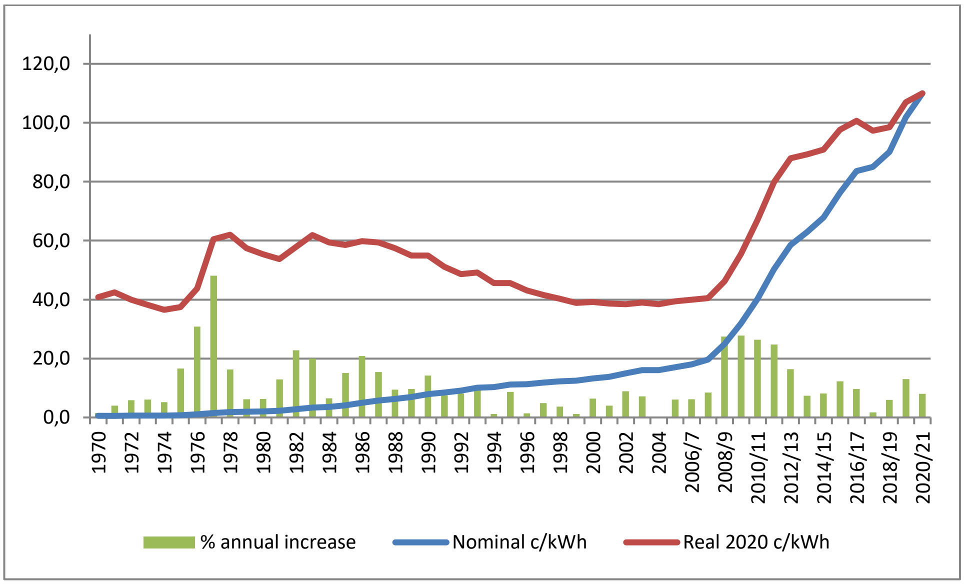


Figure 3: Average Eskom electricity prices

(**Sources**: Eskom Annual Reports summaries in Eskom, 1992, 2002, 2007; Stats SA update).

Given these social and economic development challenges, there is a huge need to build capabilities in the state to ensure better delivery of services. While the private sector and parts of state-owned enterprises (such as the System Operator within Eskom) have qualified and capable personnel, they are not always exposed to global frontiers in technology and business model innovations, and there remain huge gaps in capabilities in key parts of the state, including DMRE, NERSA and the IPP Office.

Although SA is classified as an Upper Middle-Income Country by the World Bank, based on per-person GDP, this conceals a highly skewed distribution of income, consumption, access to affordable services, and education and skill levels. Most South Africans and most of the places where they live would more realistically be classified as 'low-income', with conditions and challenges typical of developing countries. Development partnerships would help, but as is often the case internationally, those state institutions (and populations) that are most in need of assistance are those which are least capable of managing development partnerships and cooperation to their own advantage. This is a key challenge for Danida assistance going forward: where and how to be involved in facilitating an unprecedented and just energy transition.

1.6 South Africa's Nationally Determined Contribution

At the UNFCCC CoP 15/2009 in Copenhagen, South Africa pledged to deliver GHG emissions that would be 34% lower than business as usual (BAU) levels in 2020 and 42% lower than BAU levels in 2025. The 2011 National Climate Change Response Policy White Paper outlined policy instruments to be used in achieving these reductions which would include a carbon tax, SETs for sectors, company-level carbon budgets, as well as regulatory standards and controls for specifically identified GHG pollutants and emitters.

In its Nationally Determined Contribution (NDC), South Africa states a commitment "to addressing climate change based on science and equity" (GoSA, 2016: 1), and to capping emissions in 2025-2030 in the range 398-614 $MtCO_2e$[3]. It will use five-year periods of implementation at the national level, starting with 2016-2020, and focused on developing and demonstrating a mix of policies and measures to meet the South African Cancún pledge, and the periods 2021-2025 and 2026-2030 for the NDC. The anticipated level of effort is to enable GHG emissions to peak between 2020 and 2025, and to plateau for approximately a decade before declining in absolute terms thereafter.

The NDC stressed however that SA is heavily dependent on coal, with several old and inefficient coal-fired power plants that are nearing the end of their design life, as well as being reliant on a significant proportion of its liquid fuels being generated from coal[4]. Therefore, in the short-term (up to 2025), the NDC notes that SA faces significant rigidity in its economy and any policy-driven transition to a low-carbon and climate-resilient society must take into account and emphasise its overriding priority to address poverty and inequality. The mitigation strategy therefore highlights EE in general and especially in the industrial sector for early mitigation gains, while also contributing to

[3] The actual wording of the NDC is less clear: "South African emissions by 2025 and 2030 will be in a range between 398 and 614 Mt CO2eq, as defined in national policy. This is the benchmark against which the efficacy of mitigation actions will be measured."

[4] This is in part a legacy of the apartheid era, when petroleum imports were at times subject to international sanctions, and the first coal-to-oil plant in SA was opened in 1955 at Sasolburg in the Free State.

increased employment. The South African NDC should be understood in the context of these and other national circumstances.

South Africa's 2020 Biennial Update Report to the UNFCCC (GoSA, 2020) documented key sectoral actions and measures to implement the policy instruments and achieve the targets. These include an RE programme implemented through the REIPPP, an EE programme including tax incentives, a bus rapid transport system, a National Waste Management Strategy, and a Green Transport Strategy. The annual emission reductions from these measures were estimated at 96 $MtCO_2e$ in 2012, growing to 119 $MtCO_2e$ in 2015. The NDC is currently being updated, in light of social, economic and technological changes since 2015, and also in consideration of planning goals (such as reducing poverty and inequality) as modified by the unexpected CoViD pandemic which has hit SA particularly badly with 1.5 million cases and nearly 50,000 deaths so far recorded.

2. The Danish portfolio with South Africa

2.1 Overview of the portfolio

Danish-South African cooperation dates to the 1991-1994 transition to democracy. Projects aimed to meet Danish cooperation objectives in climate change and development, in line with Danida's Strategic Sector Cooperation priorities, including water resource management, urban planning, RE[5] and EE. In addition, Danida's mitigation initiatives in SA aimed to promote a sustained partnership between two countries, and something similar was also attempted in the areas of gender, human rights, peace and security, and youth participation. Danish and South African cooperation priorities are aligned in terms of low carbon development (Table 4), particularly as outlined in the National Development Plan (2013) and the NDC (GoSA, 2016). A timeline of Danish interventions in South Africa is given in Figure 4. This extends back to 2003 in order to contextualise the origins of the later work, and to situate the interventions in the political economy trajectory of the country.

Table 4. Danish-funded projects and programmes evaluated in South Africa

Title	Reference	Abbreviation	Timeframe	Budget (DKK million)
Energy Efficient Housing in the Low-cost Housing Sector in South Africa (Annex c).	#104.Sydafrika.1. MFS.60	Joe Slovo SWH	2003 - 2018	13.70
Support to SANEDI to develop smart metering systems at the Department of Energy (Annex d).	#104.G.15-20, part of #104.G.15.19	SM Pilot	2012 - 2014	0.46

[5] The Darling Windfarm was established in the Western Cape with Danish assistance starting in 1997, and later adopted as a national RE demonstration project.

Wind Atlas for South Africa (WASA) I (Annex e).	#104.Sydafrika.76	WASA I	2009 - 2012	10.00
Danish Support to Renewable Energy Development (Annex f).	#104.G.15-19	DEPP 'I'	2013 - 2015	40.00
Danish Energy Partnership Programme (Annex g).	#2017-18831	DEPP II	2017 -2020	18.19

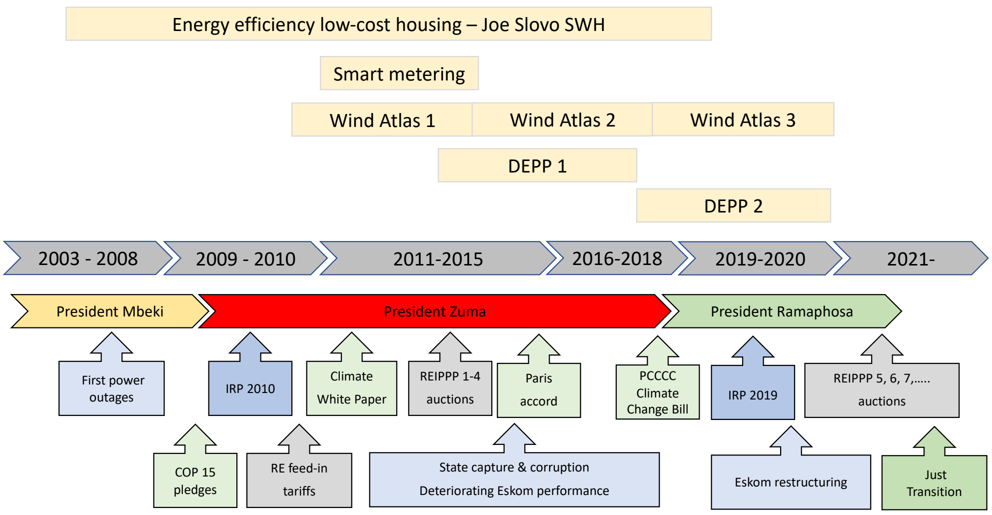


Figure 4: Timeline of Danish-funded Climate Mitigation Projects/Programmes in South Africa (2003-2020)

2.2 The energy-efficient housing project

This project was designed to test EE applications and use the results to support the updating of building codes. Much went wrong in implementation and the three-year project eventually lasted for about 14 years. It resulted in the installation of low-cost solar water heaters in the Joe Slovo settlement in Cape Town but had no influence on national policies or practices.

2.3 The Wind Atlas for South Africa (WASA) project, Phase I

This 2009-2012 initiative was undertaken with Danish and UNDP/GEF support. It involved the erection of a number of wind masts in the Western and Eastern Cape to verify data from meso-scale wind modelling and produced a numerical wind atlas which could support micro modelling (and extreme wind modelling) to assist in the location and design of wind farms.

2.4 Danish Support to Renewable Energy Development ('DEPP I')

Danish Support to Renewable Energy Development had three components that operated in 2013-2015. These focused respectively on technical assistance (TA) to the Department of Energy (DoE, later renamed DME, including the energy-efficient housing and smart metering projects listed separately in Table 2), WASA Phase II, and TA to Eskom. The initiative is usually called DEPP 'I' because it was followed by the Danish Energy Partnership Programme (DEPP II) in 2017-2020, which also had the themes of TA to DoE/DMRE and to Eskom (see Section 2.5).

a) Technical assistance to the Department of Energy (DoE)

The aim here was to develop policies and strategies for the efficient introduction of RE and EE technologies, through three sub-components.

- **The EE sub-component** sought to revise the National Energy Efficiency Strategy (NEES), organise an EE awareness campaign, develop a centralised smart metering management and monitoring system, and conduct a study to identify, assess and design market-based economic incentives for energy efficient appliances. The updated NEES was never finalised or published due to poor stakeholder relationships. The smart-metering initiative, which included efforts to install Danish meters in the DoE offices, was mostly divorced from parallel and more advanced efforts to develop a national standard for smart metering and did not engage Eskom and major municipalities which were already rolling out their own smart meters in an effort to improve the management of electricity revenue.
- **The RE sub-component** was used to develop a Renewable Energy Data and Information Service (see http://redis.energy.gov.za/), to improve capacity and competency on grid codes, and to integrate RE within municipal utilities. It also provided support for the establishment of the South African Renewable Energy Training Centre, which trained a number of wind energy technicians. Eskom's grid code has been enhanced in recent years through the incorporation of RE. It is unclear what progress was made with municipalities, although the SA Local Government Association now seems favourably inclined towards RE.
- **The climate change sub-component** centred on an EE school pilot project and a carbon tax offset programme with training of officials, neither of which left a trace in the record.

b) Role of the WASA

The second component of DEPP 'I' was directed towards further development of the wind atlas. Thus, WASA Phase II extended the work to further areas in the Eastern Cape, Free State and KwaZulu Natal. In the period between DEPP 'I' (end 2015) and DEPP II (start 2017), WASA was further extended to the Northern and North Western Provinces. WASA helped build appreciation that SA has a globally competitive wind resource, and with WASA in place SA moved rapidly from a single demonstration wind farm of only 5 MW to 34 wind farms totalling 3,357 MW. But the role of WASA in this transformation may be less decisive than it appears. The FIT regime in 2009-2011 had resulted in no wind investments but had catalysed the interest of developers who began putting up their own wind measurement masts. Thus, wind RE sites were being located ahead of the first WASA data being published. The REIPPP auctions in 2011-2014 then greatly accelerated the wind energy industry in SA.

Some wind energy developers (mostly local, some international) indicated that they found WASA data valuable, especially in later REIPPP rounds, to verify data from their own masts and their long term wind resource modelling for P50 and P90 bankability studies, and also to locate new sites for later auction rounds. They also found WASA-SAWEA workshops useful in building capacity to use modelling and siting software. But other wind developers, investors and equipment manufacturers, reported that they did not use WASA at all and relied on their own data. So, the WASA process had some but not a huge influence. It did however involve strong cooperation between RISØ/DTU in Denmark and the University of Cape Town's CASG research unit, the CSIR and the South African Weather Service. This support helped build capacity and sustained interest within South African institutions in the area of wind data and modelling.

c) Technical assistance to Eskom

The third component of DEPP 'I' provided TA to Eskom aimed at enhancing internal capacity to address the challenges involved with integration of RE in power supply. Eskom distribution operating units were engaged on the status of network operation performance and supervisory control and data acquisition (SCADA) systems in general, and in relation to operation of RE plants embedded in the distribution network. With regard to the integration of RE into the electricity grid at the transmission level, the programme focused on the requirements for Eskom ancillary services/reserves with increasing levels of RE penetration. This created the foundation for the subsequent Danish Energy Partnership Programme (DEPP II), through which Energinet, DTU/RISØ and other Danish partners provided further support to Eskom.

2.5 The Danish Energy Partnership Programme (DEPP II)

a) Support for DMRE on energy modelling and planning

Support for the Department of Mineral Resources and Energy (DMRE, formerly DoE) was planned around the development of a less carbon intensive electricity sector in line with the Integrated Energy Plan (IEP) and Integrated Resource Plan (IRP) for the electricity sector. It sought to work with DMRE to develop more comprehensive energy planning capabilities but was unsuccessful and the relationship between the DMRE and Danish partners became ineffective. It proved impossible to embed an advisor within the department, and DMRE staff refused to share any planning data or outputs with the Danish partners. Hence nothing was achieved, but it should be noted that DEPP II coincided with the height of state capture and corruption during the final years of the 2009-2018 Jacob Zuma presidency. This context may well have affected the cooperation environment in the energy sector, as it included frequent changes of senior staff and the disruption of planning processes by an arbitrary and politically-driven insistence that nuclear energy be included, even though it was in none of the least-cost plans. These disturbances highlight the vulnerability of aid programmes to factors of political economy which must, therefore, be adequately monitored and understood.

b) Support for Eskom in the integration of renewable energy

The other component of DEPP II focused on support for Eskom's System Operator in integrating a growing share of renewable energy. Work programmes included issues around flexibility and ancillary services, forecasting renewable energy output, and modifications to the grid code to include renewable energy and battery storage options. Of note was work supported by various consultants, including on energy modelling with EA Energianalyse, thermal power flexibility with Cowi, stochastic planning for RE integration with DTU, and activities related to RE integration at distribution level with Cowi and Sweco. These efforts were much more successful than those at DMRE. Eskom staff defined their needs and helped manage and orientate the nature of support provided. Solid relationships were built and there seems to be consensus that capacity was built with useful and valuable outputs and outcomes.

2.6 Danish Interventions in relation to NDC commitments

Points of alignment between the 2016 NDC and the Danish mitigation interventions in SA at design level were limited to the energy sector, reflecting Danish competencies (Table 5). Although the alignment in this sector was strong on paper, in practice the relationship between DEA and DoE/DMRE was ineffective, which inhibited progress in the areas of RE policy and regulatory development and EE. But the relationship with Eskom was more fruitful in terms of integrating RE into the grid, and direct and indirect progress was associated with WASA in attracting investment into the RE (wind) generation sector, thus contributing to the NDC's energy decarbonisation investment targets, and hence to the key NDC goal of plateauing emissions in 2025-2030.

Table 5: NDC mitigation commitments and Danish interventions in South Africa

Commitments in the NDC (GoSA, 2016)	Response in the form of Danish interventions
NDC goal: Peak, plateau and decline (PPD) is a GHG emissions trajectory range after mitigation. The starting point for PPD considered here is 2020 year end, and the goal is set at 2025-2030 with a plateau at 398-614 $MtCO_2e$.	A contextual starting point for justifying all interventions since 2016.
NDC coverage 1: Economy-wide, all sectors. [page 7].	The Danish interventions included a project on housing and efforts to promote energy strategy and EE, and otherwise focused on integrating wind power into the grid and facilitating wind investment through WASA. Promoting RE has economy-wide significance.
NDC coverage 2: Six greenhouse gases (GHGs), with a material focus on three GHGs: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). [page 7].	An impact indicator of DEPP II was tCO_2e emissions reduced (MFA & MCEU, 2017a), but MFA (2019: 7) notes that this "is very difficult to apply to the interventions on DEPP II.", so it was

	not in practice measured or reported. No Danish efforts targeted CH_4 or N_2O.
NDC strategic measure 1: Policy instruments under development include a carbon tax, desired emission reduction outcomes for sectors, company-level carbon budgets, as well as regulatory standards and controls for specifically identified GHG pollutants and emitters.	The interventions at DoE/DMRE under DEPP 'I' & II were partly aligned to supporting policy and regulatory development.
NDC strategic measure 2: Increased disaggregation over time will be enabled through the introduction of mandatory GHG reporting domestically, no later than 2016, with regular reporting to the UNFCCC.	GHG monitoring or reporting was not targeted.
NDC strategic measure 3: Agriculture, forestry and other land use (AFOLU) are included as one of the major IPCC categories. Considerable uncertainty in AFOLU emissions is noted, as is the intention to reduce uncertainty over time.	AFOLU sector mitigation was not targeted.
NDC strategic measure 4: Equity applies to mitigation, adaptation and support for both.	Danish development policy is strongly rights-based, and DEPP programming documents (e.g. MFA & MCEU, 2017b) confirm that rights, gender, equity, etc. were prioritised, but the topics are not prominent in intervention documents.
NDC sectoral target 1: significant investment in achieving agriculture, livestock, soil and land restoration targets.	AFOLU sector mitigation was not targeted.
NDC sectoral target 2: significant investment in achieving forestry and wetland targets.	AFOLU sector mitigation was not targeted.
NDC sectoral target 3: significant investment in achieving energy decarbonisation goals (e.g. USD 3 billion per year to expand REIPPP; USD 349 billion to decarbonise electricity supply by 2050).	There was significant direct and indirect progress through WASA and associated publicity and capacity building in attracting investment into the RE (wind) generation sector, thus contributing to energy decarbonisation investment goals.
NDC sectoral target 4: Carbon Capture and Storage (CCS) - 23 $MtCO_2$ from coal-to-liquid plant.	Development of CCS was not targeted.
NDC sectoral target 5: Electric and hybrid vehicles as a sectoral mitigation target (close to one USD trillion foreseen to 2050).	Development of electric/hybrid vehicles was not targeted.
NDC sectoral target 6: significant investment in achieving waste management targets.	Waste sector mitigation was not targeted.
Other NDC priority: implement NDC 2016.	SA has been a member of the Danish-funded NDC Partnership since 2016, with the Department of Environmental Affairs as its focal point. Its database for South Africa records 18 initiatives on mitigation and adaptation

	(https://ndcpartnership.org/good-practice-database#navi).

3. Lessons learned

3.1 Energy-efficient housing and smart metering

These two small projects were entirely disconnected from the policy developments and actions reviewed above. The first dragged on for many years before a final decision was taken to spend remaining funds to pay for solar water heaters in a single settlement. Contrary to its original intention, no broader housing energy efficiency measures were implemented, and there was no replicability and no impact on national efficiency or solar water heating standards or practices. Likewise, the smart-metering project was disconnected from national policy, standards, strategy and implementation initiatives. Inappropriately, it insisted on the use of Danish technology, despite other systems being rolled out by Eskom and the metropolitan councils. Both projects are examples of what not to do in development cooperation.

3.2 Wind Atlas for South Africa

This was founded on the idea that wind energy had real potential to contribute solutions in the broader energy context in SA. It built on an earlier wind energy demonstration project and was set up in a period when the electricity regulator had published RE FITs, and wind energy developers were beginning to look for suitable sites for wind farms. The FITs were later abandoned and replaced by the successful REIPPP system, but wind energy continued to grow quickly. As noted in Section 2.4(b) it is hard to draw a direct line of attribution between WASA and investment in wind energy, but it worked well with local institutions. It was also well connected with the broader industry, in particular SAWEA which helped disseminate results and organise capacity building and training programmes. Most interviewees acknowledged the value of this project.

3.3 DEPP Phases 'I' and II

The record of these two larger interventions is mixed. There is little evidence that either was connected with broader national policy initiatives at the time. There was no formal link with the environment ministry, and the relationship with the energy ministry and DoE/DMRE became dysfunctional. In hindsight, DEPP 'I' activities with DoE appear to be a set of small, *ad hoc*, opportunistic interventions, some of which achieved modest outputs, while others did not. None of the planned outputs or outcomes of DEPP II activities with DoE/DMRE were achieved. This was a difficult political period, however, with senior individuals at the department who were reluctant to respond to RDE recommendations. Meanwhile the project itself was unresponsive to new developments in the electricity sector, including the design and implementation of auctions, plans to expand electricity generation, discussions around restructuring Eskom, and the further development of climate change mitigation legislation, policies and strategies.

On the other hand, the TA provided by Energinet to Eskom's System Operator, geared around building systems, operating practices and codes to integrate a growing share of renewable energy, appears to have been successful, with evidence of useful outputs and outcomes, including on capacity building. The irony, when comparing outcomes of cooperation with the DoE/DMRE and with Eskom is that those who were most in need of assistance were generally also those with the least capacity to manage and receive assistance effectively. Cooperation with Eskom was by far the more successful, in part because of the professionalism of Energinet, but also because Eskom had adequate capacity to define its needs and the nature of the cooperation.

3.4 Implications for DEPP Phase III

The problems arising in DEPP 'I' and II have not deterred the development of DEPP Phase III in SA, which envisions the following three engagements.

- **With DMRE and the IPP Office**, directed towards (a) building capacity at DMRE "to apply modelling tools until they can assess and introduce low-carbon pathways into SA's national energy system planning and policy development processes"; and (b) supporting the IPP Office "in the areas of spatial planning, grid planning and connections, industry reform, market design and more effective auctioning processes thereby attracting further private investment in renewable energy supply" (MFA & MCEU, 2020a: 18). The idea is that these organisations make distinctive contributions, and both are needed to create an enabling environment that attracts greater RE investment. Previous problems at DMRE are acknowledged but are attributed to "the new government and reorganization of the ministries" (*ibid.*, Annex 2: 12), and future problems are not anticipated since "High level meetings have taken place between the Danish Ambassador and the Minister in which the Minister expressed great commitment to the cooperation and pledged to ensure smooth implementation going forward" (*ibid.*: 14).
- **With Eskom**, where DEPP III will work with the Eskom Strategy office, the Transmission Division, Generation Division and Distribution Division, and a knowledge management platform will be developed "to inform high level strategic decision makers based on international experience and concrete approaches in a shift to market-based solutions" and a long-term advisor embedded, allowing "grid planning and integration of variable renewable energy sources from transmission to distribution level [to] be strengthened so that the stochastic nature of variable renewable energy sources can be accommodated without compromising grid stability" (*ibid.*: 19). A key approach is to work with the **System Operations Division of Eskom**, to tackle regulatory frameworks, operational procedures and flexible options in the power system to accommodate safely a rising share of electricity from variable renewable energy sources (i.e. a continuation of DEPP II work).

Thus, DEPP III will involve more partners than DEPP II, and is generally far more ambitious. Assurances in the Programme Document notwithstanding, the evaluation notes the issue of relying on DMRE cooperation, while recognising that it must be involved and observing that the addition of the IPP Office is appropriate since its auctions are key to accelerating the shift away from coal to solar and wind. Capacity was lost in the IPP Office when the auctions were suspended in 2015-2018, so well-directed support to help rebuild this capacity could be very useful. Further support to the strategy and planning division of Eskom also makes sense, as Eskom's new leadership has signalled a refreshingly bold vision for the utility, including the need to decommission old coal power stations and to accelerate investment in RE IPPs. Exposing the Eskom leadership and executive team to international best practices in decarbonisation will be valuable, although there are countries (e.g. Poland) that have more experience in transitioning from coal than Denmark.

It should also be noted that the South African DEPP III is part of a DEPP process that now involves applying a uniform template in multiple other countries, including China, Vietnam and México (MFA & MCEU, 2020b). This model is based on a change process involving TA and coordinated climate diplomacy with the Danish MFA. It promotes low-carbon development in partner countries, including by building their institutional capacity, and co-developing analyses, policy reforms and regulations, all in support of the NDCs and SDGs 7 and 13. Other aims include the effective integration of RE into national grids and improving EE in industrial sectors and buildings through enhanced regulation.

This model is ambitious, being based on the idea that an actor with a limited range of technical offerings and few resources can exert strategic influence and provide useful technical support across the whole energy sectors of much larger national partners. To be effective this would require precise matching of partner needs, expectations and capabilities in every case. There is also the challenge that every society being different, using a standard model raises the question of how well it has been (or indeed can be) adapted to local conditions and needs. Aside from better political economy monitoring and reporting, as noted in Section 2.5(a), flexible and responsive assistance is needed that is open to knowledge from many sources, and especially during a disruptive energy transition. The necessary flexibility should be built into the approach, suggesting that a TA facility might actually be a better model than a pre-determined programme.

4. Conclusions

4.1 Design and performance

Of the Danish mitigation interventions reviewed here, the design scores (for logic and plausibility), and the performance scores (for impact, effectiveness and efficiency), both fall into two groups (Table 6). The well-designed and well-performing interventions were WASA Phase I and the Eskom component of DEPP Phase II. The others were all weakly designed/performing (DEPP 'I') or extremely weakly designed/performing (energy-efficient housing, smart metering, and the DMRE component of DEPP II). These findings are essentially the same as reported in the text above.

Table 6. Design and performance scores for mitigation interventions in South Africa

Project	Design	Impact	Effectiveness	Efficiency
EE housing (Annex c).	1	2	1	1
Smart metering (Annex d).	1	1	1	2
WASA 1 (Annex e).	5	5	5	5
DEPP 'I' (Annex f).	3	3	3	3
DEPP II (Annex g).	DMRE: 1 Eskom: 5	DMRE: 1 Eskom: 4	DMRE: 1 Eskom: 4.5	DMRE: 1 Eskom: 5
Mean	**2.7 (n = 6)**	**2.7 (n = 6)**	**2.6 (n = 6)**	**2.8 (n = 6)**
Description	**weak**	**weak**	**weak**	**weak**

4.2 The South African energy transition

Economy-wide energy transitions are complex and hard to plan and control in detail, and South Africa's is also occurring in a changing political-economy landscape. By remaining engaged in the right ways and being willing to make bold decisions to cull and change activities as needed, Denmark could make an early difference to outcomes in one of the most carbon-intensive economies in the world. Its efforts to promote decarbonisation and a just transition, however, would be greatly strengthened by better political economy awareness, stronger links with local government and knowledge-holding institutions, greater responsiveness to national priorities and initiatives, and more flexibility than it has demonstrated in the past.

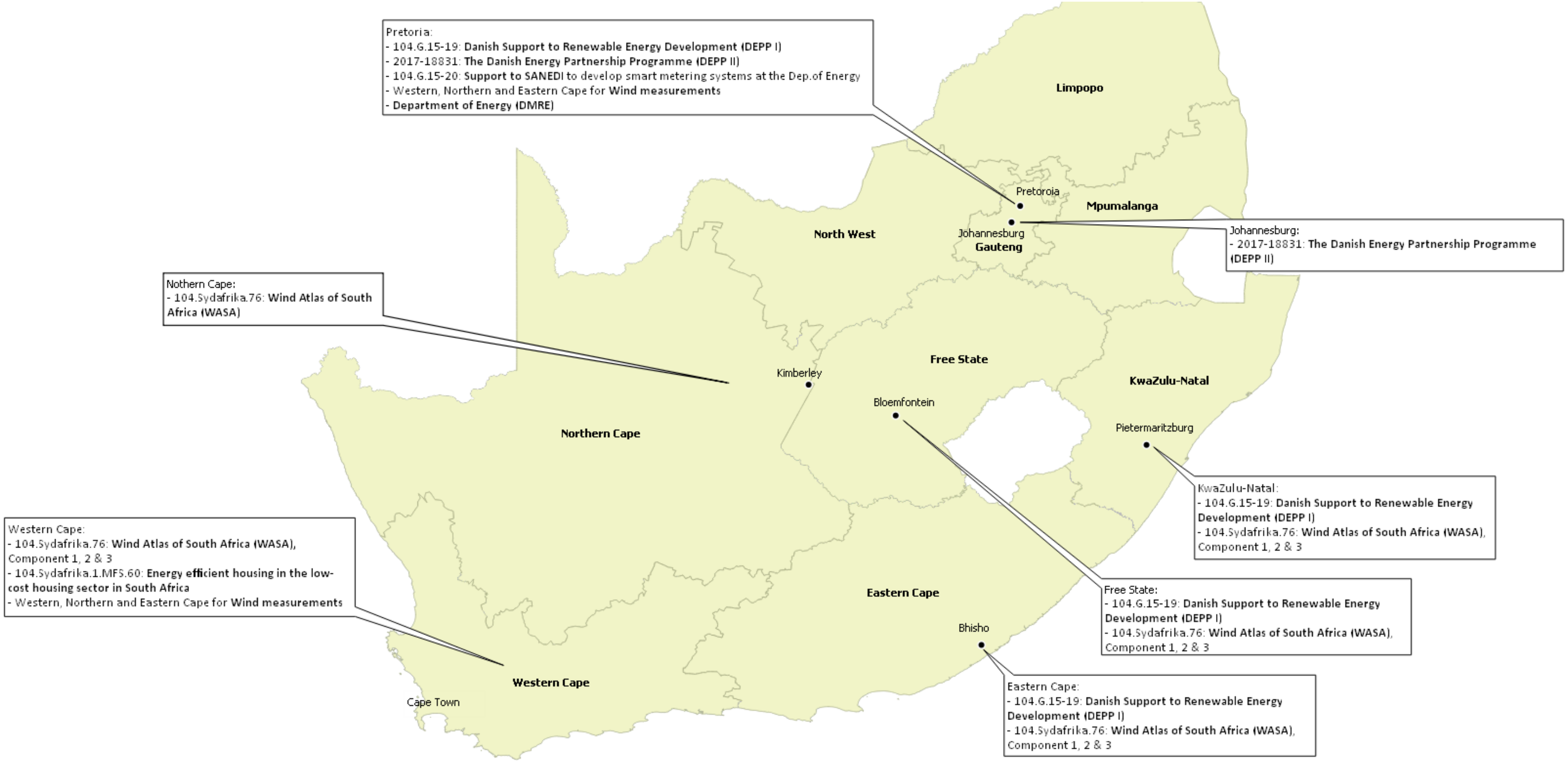
Overall, Danish support in South Africa in 2013-2020, with some notable exceptions, was not optimally designed or executed. All too often there was insufficient appreciation of related activities in the energy sector, resulting in missed opportunities for greater impact and replication. There was also often a lack of serious consideration given to broader socio-economic and political issues, including corruption, and the ways in which they spill over into the climate mitigation and RE spaces. In terms of project design, the assessment here indicates flaws, ranging from a limited consideration of the political economy context to a lack of comprehensive stakeholder analysis and engagement, particularly in terms of engaging with project partners on the policy relevance and usefulness of the proposed interventions. And, as mentioned, there were poor practices in establishing baselines, monitoring and evaluation, and reporting systems. This hampered the ability of the evaluation to obtain a clear sense of specific activities, whether planned or implemented.

There were also some successes, however, most notably when projects were well connected to broader developments in the energy sector (for example, WASA) or where TA needs were clearly defined and long term, respected professional relationships developed between the cooperation partners (for example, Eskom's System Operator and Energinet). On the other hand, it could also be asked whether Eskom actually needs Danish grant support. At a time of rapid energy innovation and transition it is clearly beneficial for Eskom staff to be exposed to new international experience and providing assistance to a well-developed institution with capable and professional staff is an easy and attractive way to accelerate innovative change, but such investments would need to be justified in terms of their contribution to a just transition in a highly unequal society.

Annex a: Information sources for the South African country study

Process of country study development		
All country studies were developed according to the note in Annex a of Annex H.		
Persons and institutions consulted in the South Africa country study		
Institution	**Relevance**	**Interviewee, role, contact, date**
Sustainable Energy Africa	Annex c: Energy-efficient housing	**Peliwe Jubase** (peliwe@sustainable.org.za), 29 Oct 2020.
Sustainable Energy Africa	Annex c: Energy-efficient housing	**Mark Borchers**, correspondence.
W. Cape Housing Devt Agency	Annex c: Energy-efficient housing	**Bruce Malgas** (bruce.malagas@thehda.co.za), 26 Oct 20.
Joe Slovo Committee	Annex c: Energy-efficient housing	**Mzwanele Zulu**, 26 Oct 20.
Plumbing Industry Registration Board	Annex C: Energy-efficient housing	**Lea Smith** (lea@verconsult.co.za), 29 Oct 20.
SANEDI	Annex d: Smart metering at DoE	**Minnesh Bipath**, 27 Oct 20.
GreenCape	Annex d: Smart metering at DoE	**Bruce Raw**, 12 Oct 20.
Vestas SA	Annex e: WASA I	**Flemming Schlier**, 28 July 2020, 30 Oct 20.
Redcap	Annex e: WASA I	**Mark Tanton** (mark@red-cap.co.za), **David Nichol**, 27 Oct 20.
Windlab	Annex e: WASA I	**Peter Venn**, 29 Oct 20.
Biotherm	Annex e: WASA I	**Jassandra Nyker**, 16 Nov 20.
Mainstream Renewable Energy	Annex e: WASA I	**Johan Stander**, 2 Nov 20.
SANEDI	Annex e: WASA I	**Andre Otto**, 5 Nov 20.
CSIR	Annex e: WASA I	**Eugene Mabille**, (emabille@csir.co.za), 2 Nov 20.
CSAG, UCT	Annex e: WASA I	**Chris Lennard**, 9 Nov 20.
RISØ/DTU	Annex e: WASA I	**Andrea Hahnmann**, **Niels Mortensen**, **J. Hansey**, 4 Nov 2020
SAWEA	Annex e: WASA I	**Ntombifuthi Ntuli** (pntuli@csir.co.za), 4 Nov 2020
Consultant	Annex e: WASA I	**Johan Van der Berg** (former SAWEA), 3 Nov 2020
Consultant	Annex e: WASA I	**Karen Breytenbach** (former Chief IPP Office), 5 Nov 2020
Krier Group	Annex f: DEPP 'I'	**Flemming Schlier** (Advisor Vesta SA, Director), 28 Jul 20
DEA	Annex f: DEPP 'I' & Annex g: DEPP II	**Eric Bjorklund** and **Steffen Ronsholt**, 9 Nov 20
Danish Embassy	Annex f: DEPP 'I' & Annex g: DEPP II	**Maleepile Moseki**, **Jorgen Erik Larsen**, 16 Nov 20.
DMRE	Annex f: DEPP 'I'	**Noma Qase**, 5 Nov 20.
SARATEC	Annex f: DEPP 'I'	**Sven Pietrangeli**, 13 Nov 20.
Energinet	Annex g: DEPP II	**Knud Johansen**, 22 Oct 20.
Eskom System Operator	Annex g: DEPP II	**Siju Joesph**, **Gavin Hurford**, **Target Mchunu**, 13 Nov 20.

Annex b: Map of South Africa with key project locations



Annex c: Energy-efficient, low-cost housing

Part A: Basic data

A1. Project number & name. 104.Sydafrika.1.MFS.60: Energy Efficient Housing South Africa.

A2. Interviews. See Annex a, persons and institutions consulted relevant to Annex c.

A3. Dates & financial data. Duration: Apr 2003 – Dec 2018 (extended from 3 years to 15 years). Budget: DKK 13.7 million. Disbursement DKK 13.15 million.

A4. Location(s). Pretoria (administrative capital) (Department of Human Settlements)

Joe Slovo informal settlement in Langa, Cape Town (housing construction)

A5. Partners. Original: (a) Dept of Housing (now Human Settlements, DHS), project host and chair of the Steering Committee. (b) South African Bureau of Standards (for building regulations – listed in the Project Document but no evidence of participation). (c) National Treasury (for subsidies for housing construction – listed in the Project Document but no evidence of participation). (d) SALGA (for negotiating and coordinating initiatives for and with municipalities - listed in the Project Document but no evidence of participation).

Since 2010: (a) Dept of Housing (now DHS). (b) Western Cape Provincial and Municipal Human Settlements Departments. (c) The Joe Slovo community. (d) The Sobambisana Construction Consortium (for building works). (e) SEA (Sustainable Energy Africa) Consulting NGO (to oversee implementation in 2011-2013). (f) RDE Pretoria: funding and member of the Steering Committee.

Part B: Purpose and relevance

B1. Purpose. The **Development Objective** was: "Tested technologies and the initiation of a process resulting in a regulatory framework for mainstreaming of energy efficiency in the low-cost housing market" **Original objectives** (MFA, 2003: ii): (a) Awareness of regulators, local authorities, private sector, practitioners and low-income consumers. (b) Adequate information sharing and dissemination. (c) Affordable technologies developed, selected, piloted, evaluated in low-cost houses and prepared for large-scale dissemination. (d) Regulatory framework for energy efficiency in low-cost houses in place. **Revised objectives** (DHS, 2010: 11): (a) To inform national housing policy of feasible, beneficial options which improved the sustainability of low-income housing, using Joe Slovo 3 and 3000 houses as demonstration. (b) To provide the residents of Joe Slovo with more healthy, comfortable, lower cost, more resource efficient houses. (c) To build the capacity and inform key players involved in delivery of low-income housing regarding the implementation of sustainable options.

B2. Relevance to partners.

South Africa: SA has an energy-intensive economy, high levels of poverty and inequality, including a housing crisis. Adoption of energy efficiency and optimised use of renewable energy resources in the country is important for sustainable economic growth and the development of the country as a whole. Further, DOH is responsible to provide millions of South Africans with housing as well as affordable electricity (MFA, 2003: 11).
Denmark: Already engaged supporting SA with the transition from coal-based energy provision towards greener energies thus reducing GHG emissions. Contribution to more energy efficient housing would in the longer run contribute to reduced CO_2 emissions from this sector. The relevance of the Project remained valid throughout the extended project implementation period.

B3. Relevance to MDGs/SDGs. SDG 7: Affordable and Clean Energy.

B4. Relevance to NDC mitigation commitments. In line with the NDC commitment to reducing net GHG emissions.

B5. Relevance to mitigation. The **original project** was relevant under the 'enabling framework' criterion of Incentives & Regulations (IR), by improving housing regulations in favour of energy efficiency. The **revised project** was relevant under the 'practical actions' criterion of Mitigation Technology (MT), by installing solar water heaters.

Part C: Narrative overview

The project was designed to contribute to a healthier and more comfortable living environment, lower carbon emissions, and lower energy costs per individual household in low-income housing in SA. The intention was to test energy efficient technologies, to support standardisation processes to uplift the building design nationwide and contribute to mass roll-out of energy efficient low-cost housing. A minimum of 1,500 low-income houses were to be included in the efficiency upgrades and tests. The project was not implemented as designed, however, and in 2008 it was decided to focus all interventions in the low-cost housing development, Joe Slovo in Cape Town, without prior testing and without systematic monitoring before being rolled-out to a large number of houses.

But South African housing construction works in a different timeframe than that described in the project document and it works without possibility to halt construction while waiting for test results. There were also no funds to purchase land and build the houses outside the existing South African processes where funds for the land and houses comes from the Ministry of Finance. So, the design was further altered to focus on: (a) Increased roof overhang on northern face of house; (b) Increased window area on north face of house; (c) Pergola on north face of house; (d) Increased roof pitch; and (e) Ventilation blocks above doorways. The project committee agreed to have these options costed (DoH, 2008: 2). All these ideas were later dropped for unknown reasons, and 2012-2013 documents show that the technology support was to be focused towards installation of solar water heaters only. In a parallel effort, energy efficient light bulbs were installed.

In 2013 it was agreed to transfer an amount 1.2 million ZAR to pay for an external consultant to manage the project. (DOH, 2013: 3). "As earlier challenges associated with the installation of solar water heaters, it was therefore decided by the PMU that there be a shift in attention away from installation processes to focus on meeting the remaining objectives of the project.

This shift has required a change in the attendance which had mainly comprised of technical and on-site managers but will be replaced by members who will focus on the documentation of lessons learnt, the areas of emphasis for dissemination to municipalities and the manner that dissemination will take place. Until recently, dissemination was to have taken place through written documents made available on the internet. In the light of the more pressing situation where retrofitting of several thousand of solar water heaters within the ESKOM roll-out has caused substantial structural damage to houses in several municipal areas, the Danida PMU is rather considering writing up lessons that will address best practice of the physical installation and maintenance and which may be presented in workshops to municipalities. A brainstorming workshop will take place before the July PMU meeting to take the discussion further." (DOH: 2013; 2)

After numerous redesigns of the Project, and several study tours and workshops, parts for 2,800 Solar Water Heaters (SWH) were finally delivered for a new low-cost housing complex in the Joe Slovo Settlement. The agreement to stop delivery of SWH seems to have been dropped, and the idea to write up lessons did not materialise. It is not clear exactly how many of the 2,800 SWH were paid for by MFA as both the Swiss SDC and the French AfD also contributed to the project. (DHS, 2019: 3). Further changes to the original design include the dropping of the idea to package the interventions as carbon credits, which had been conceived as a way to test a way finance energy efficient low-cost housing through the credit system (*Ref: Department of Housing Progress Report 3Q 2014).*

Work in the Joe Slovo settlement was also delayed, including by court cases brought by informal settlers who were to be forcibly removed from their homes to make space for the construction of low-cost housing for other people, since those living in shacks were not necessarily eligible for low-income houses. Moreover, people living in the informal settlement in Langa benefitted from an easy commute to the city and to the nearby work and trading areas of Pinelands and Epping, so were reluctant to make way for new developments. (*Ref: Department of Housing Progress reports 2016 and 2017*).

Part D: Design quality

D1. Theory of change. The original Project Document argued that SA is faced with challenges that include high carbon emissions from coal-based electricity generation, a short-fall in electricity supply, and poor living conditions for millions of people. After the collapse of the apartheid regime the new government promised all citizens access to affordable housing and basic services such as water and electricity. Houses designed for comfort and minimal electricity use were seen as helpful in this context. Moreover, testing energy-efficient designs and input technologies would yield information that could be used to update building standards. The Department of Housing (DoH) was believed to be able, acting in concert with other agencies (such as the DTI and the Housing Departments of Provincial and Local Governments), "to ensure the mainstreaming of energy efficiency in the regulation of the low-cost housing market" (MFA, 2003: 41), thus affecting the design and construction of some 200,000 low-cost homes annually (MFA, 2003: 27). The revised Project Document argued that using SWH will lead to reduced use of electricity to heat water, which would offer homeowners a monetary saving and also lead to reduction in GHG emissions.

D2. Assumptions underlying the theory of change.

<u>Reconstruction of original assumptions</u>.

Assumption 1: that the testing of new low-cost housing designs will lead to useful amendment of building standards.

Assumption 2: that the new building standards will be adopted and applied through the public low-cost housing sector.

Assumption 3: that large numbers of new buildings designed and built according to the new standards will result in significantly reduced electricity consumption.

Assumption 4: that reduced electricity consumption in the domestic housing sector will result in reduced GHG emissions.

Reconstruction of revised assumptions.

Assumption 1: that by safely and cost-effectively meeting needs for hot water, SWH will significantly replace use of electricity.

Assumption 2: that reduced demand for electricity will lead to reduced GHG emissions.

D3. Plausibility of assumptions and links.

The **original project design** was weak in failing: (a) to allocate resources to establish a management unit within the DoH; (b) to explain how people unfamiliar with the processes described would be able to drive them forward; (c) to explain how to operate expensive interactive processes between informal communities, provincial governments and the national government that did not exist in 2003; (d) to include TA to engage with the regulatory process: and (e) to respond to the realities of housing construction in South Africa.

On the last point, the building sector is dominated by groups such as the Builders Association and the Plumbing Association, which participate in the committees where building standards are developed. The informal sector is also involved in the construction of houses and their knowledge and standards are not linked to the formal processes. The entrepreneurs mentioned in the project design are not involved in any regulatory work. Each municipality has a building control officer who is responsible to check that all constructions are compliant with regulations. These often lack transport, staff and other resources to the extent that inspections at single unit constructions seldom happen. Moreover, South Africa faced increased political tensions and increased corruption during the mid-2000s, including at municipal level, and corruption scandals in the low-cost housing sectors are evidence to this point. The design failed to anticipate and mitigate corruption, while the budget was unrealistic, and the risks not properly assessed. Nevertheless, the theory of change was at least straightforward and its assumptions plausible except for the last one, which needs to be qualified. While the reduction of electricity use as a result of the adoption of energy efficiency and solar water heaters would result in reduced GHG emissions (as South Africa's electricity system is highly carbon-intensive), the low-income residential sector's contribution to total national electricity demand is very small, and often people bath in cold water only hence the potential GHG savings would be small.

The revised project design was supported by an action plan that focused on delivering SWH in Joe Slovo Settlement. The Steering Committee met several times annually, but did not discuss any aspect of training, engagement and replicability, or the assumed link between electricity saved and GHG emissions reduced, made no plan to monitor installation or use of SWH, and had weak community engagement. Its main task was to assign responsibility for installing SWH, and Sustainable Energy Africa (SEA) was recruited to oversee this process. Meanwhile, the new design failed to acknowledge problems with relocation of informal settlers from the land intended for the establishment of the Joe Slovo Settlement, and it also failed to anticipate the problems that would arise when it emerged that the Danish budget was insufficient to provide SWH for all houses. There were no quality control measures to ensure that only certified installers worked on the sites and only certified SWH were used. There were no efforts to replicate actions, no baselines and no monitoring of energy savings (except for a tiny, non-representative sample, with inconclusive results). The 2013 progress report notes that the PMU considered stopping all installations because of widespread problems with low-cost SWH, but no action was taken.

D4. General quality of the project design.

The original project design was compromised by serious flaws but possessed some logical coherence, while the revised project design had no redeeming features. A project that sought to impact national policies and practices on energy efficiency and low-cost solar water heating, to build capacity, demonstrate good practice and disseminate results, achieved none of these objectives. There was an entirely ineffectual engagement with those stakeholders responsible for national policy and standards in this area. Weak understanding of the social system that the intervention was targeting led to weak design and conflict that destabilised implementation, and corrections were poorly designed, managed and implemented. **Score**: 1.

Part E: Evidence for mitigation performance

E1. Direct effectiveness. None.

E2. Indirect effectiveness. None.

E3. Net GHG emission reductions Marginal. The original plan to convert energy savings to Carbon Credits was scrapped and there was no monitoring of saving in GHG emissions.

E4. Impact effects. A site visit found that Joe Slovo residents appreciate electricity savings as a result of having SWH. The revised project had no monitoring, no reporting, and no replication plan. The lack of arrangements for training SWH installers also undermined potential impact. **Score**: 2.

E5. Sustainability effects. With no attempt at replication, no training, no standard-setting and no sharing of lessons, sustainability was negligible. **Score**: 1.

E6. Efficiency issues. A 12-year delay in a three-year project based on weak design with no monitoring is an object lesson in how not to do anything. **Score**: 1.

E7. Capacity building issues. There was no attempt to build capacity among installers of SWH, the designers of houses or the regulators of house construction. **Score**: 1.

E8. Baseline and monitoring arrangements. None.

E9. Overall conclusion on mitigation performance. This was a small project with a small budget, and it should never have been allowed to drag on for almost 15 years. The original purpose had some merit but the project was 'too little and too late' to make an impact. The revised approach of installing non-compliant SWH in a settlement beset by conflict further indicates a failure of due diligence and risk assessment. **Overall score**: 1.

Part F: Other aspects of design and performance

F1. Unintended consequences. The Project contributed to worsening living conditions among the people who used to occupy the Joe Slovo land. These were forcefully moved to land much further from any work. The Danish support contributed to a trend towards using uncertified plumbers, installers and SWH. This was counter-productive to the original design that aimed to demonstrate best standards for energy-efficient housing. In addition, the project was counter-productive to initiatives (supported among others by the SDC, GIZ and driven by the National Association of Plumbers in South Africa) to ensure that all installations of hot water systems came with a reference number, a quality mark and a system to protect consumers in case something went wrong (reference: pirb.co.za).

F2. Other performance issues. The revised design failed to insist on use of qualified plumbers and SHW that complied with regulations. Non-compliant SWH were typically cheaper and not resistant to frost, while some lacked overflow valves and were prone to boiling, with 40-70% of customers expressing dissatisfaction with their SWH installations, according to the Sustainable Energy Society of Southern Africa ombudsman (IoL, 2013: 1).

The budget was insufficient to cover all houses. To avoid riots additional funding was sourced from the SDC among others.

Annex d: Smart Meter Piloting at the Department of Energy

Part A: Basic data

A1. Project number & name. 104.G.15-20 Support to SANEDI to develop smart metering systems at the Dept of Energy.

A2. Interviews. See Annex a, persons and institutions consulted relevant to Annex d.

A3. Dates & financial data. Duration: Sep 2012 - Jan 2014 (18 months). Project budget: DKK 0.462 million. Project commitment partly not specified (Climate Envelope).

A4. Location(s). South Africa, Pretoria.

A5. Partners. (a) SANEDI: project manager. (b) Ea EnergySystem (Denmark): contractor. (c) Dept of Energy (DoE): to use its own building to test and demonstrate the public building smart metering business case, and to DoE undertake the baseline audit. (d) Danish embassy: Partner. (e) DEA: Executing Partner. No other stakeholders or external partners were involved, despite Eskom and municipalities being described as key potential beneficiaries.

Part B: Purpose and relevance

B1. Purpose. To facilitate the roll-out of smart electricity meters in South Africa, by (a) supporting the development of appropriate regulations, and (b) building capacity at DoE to demonstrate the benefits of having done so (*EA Energy Systems Inception report*). This purpose should be seen in the South Africa context of widespread load shedding since 2008, theft from electricity networks and irregularities in billing systems based on manual meter readings.

B2. Relevance to partners.

South Africa: The *National Response to South Africa's Electricity Shortages* (GoSA, 2008) identified 'smart' metering (i.e. the use of electricity meters that can be read and controlled remotely by the electricity utility) as a medium- to long-term measure for increasing system security through improving billing, monitoring demand remotely and providing greater opportunities for putting energy efficiency measures into effect. The Department of Energy published Regulation 773 of the Energy Regulation Act for electricity reticulation services in the Government Gazette of 18 July 2008 which required that all consumers with a monthly consumption of 1,000 kWh or more must have a smart metering system and be on a time-of-use tariff by 2012. But this deadline has not been achieved.

Denmark: the chief attraction was the opportunity to test and develop markets for Danish technology, in line with the Green Climate Strategy at the time the project was formulated.

B3. Relevance to MDGs/SDGs. No significant contribution.

B4. Relevance to NDC mitigation commitments. The project is presented as being in line with South Africa's commitment to overall reduction in GHG emissions. Smart meters can contribute to more efficient billing, but they are also expected to improve energy efficiency through time-of-usage metering, greater consumer awareness of how energy is used, inducing energy savings and load shifting. Bi-directional meters also facilitate net-metering and the use of solar home systems. Interviewees suggested, however, that the main drivers of this were revenue management, improved billing and collections and reduced electricity theft, rather than reduced GHG emissions, and there was no evidence of direct relevance to the NDC.

B5. Relevance to mitigation. Possibly relevant to Research & monitoring (RM) through monitoring results and behavioural changes in the DoE and national influence, but with no implementation there are also no results relevant to mitigation.

Part C: Narrative overview

South Africa had (and still has) a problem with theft of electricity, non-payment for electricity and irregularities in the reading-reporting of consumption figures from the electricity meters. With a view to improve billing and thus revenue for the utility – and municipalities that sell electricity - the purpose of the project was to test how smart meters work in a South African setting with a view for mass scale roll out. The intention was to test the meters at two floors in the Department of Energy. The idea was to use an identified Danish company to install the smart meters and show-case the technology. The Project was stopped during implementation by the DoE as they felt the project was too late to deliver any useful results – the regulations were already in place and smart meters were already rolled out by many municipalities.

Part D: Design quality

D1. Theory of change. Use of smart meters is integral to the national Power Conservation Programme, and this has a number of aims including reducing GHG emissions indirectly by reducing unnecessary/wastage-related demand for electricity produced by burning coal. GHG emissions can be reduced if the production of coal-based electricity is reduced. Reducing of theft, losses and unpaid usage of electricity will lead to reduction in GHG emission as less coal-based electricity will be produced. Nation-wide installation of smart meters will help monitor and thus manage unintended losses.

D2. Assumptions underlying the theory of change.

Assumption 1. Installing smart meters as required by law can be encouraged and enabled by correcting the national regulatory framework and demonstrating how useful they are.

Assumption 2. Installing smart meters as required by law will reduce wastage of electricity.

Assumption 2. Reducing wastage of electricity will reduce GHG emissions.

D3. Plausibility of assumptions and links.

Assumption 1. Irrelevant, since: (a) smart meters were already being installed and used by distributors and private companies in SA, many municipalities had already installed smart meters whilst Eskom was already carrying out the Load Management Pilot Project in households in Gauteng, Cape Town and eThekwini and had implemented the Demand Market Participation programme, which was based on smart meter technology; (b) regulations since 2008 already required smart meters to be installed; (c) the design failed to address the fact that electricity bills for public buildings are paid by a central unit, so the departments occupying buildings cannot respond to smart meter signals, so the idea of using such departments to pilot-test smart meters was flawed; and (d) the project was not integrated into other relevant national initiatives such as the South Africa Smart Grid Initiative (SASGI) and Eskom's development of the national smart-meter standard NRS049.

Assumption 2. Plausible, if users are able to understand and respond to the signals from smart meters.

Assumption 3. Not fully plausible without other measures. The main motivation for smart meters in South Africa is utility revenue management and additional EE awareness campaigns and tariff regimes would have been necessary to encourage energy savings.

D4. General quality of the project design. The objectives were compromised by a lack of alignment with ongoing smart meter regulatory and implementation initiatives in SA during the same period. At the time, a number of metros were rolling out smart meter programmes. In addition, in 2012 SASGI was set up at SANEDI, made-up of industry stakeholders within the Electricity Distribution Industry, and was consequently granted EUR 20 million from the EU. Its main objectives were to draw on industry expertise, develop a Smart Grid vision for the industry, undertake a number of pilot programmes in municipalities and create a platform for knowledge sharing, although not all of these objectives have since been accomplished. In order to achieve economies of scale, smart metering needs to be procured at the national, rather than local government level, and the national power utility Eskom emerged as the appropriate partner for this role. Organisations such as GreenCape worked with Eskom to create the national standard NRS 049, Part 2 of which offers smart-metering specifications. The Danish initiative on smart metering did not connect with or impact any of these national initiatives. Absence of links with the national EE initiative places the project in a vacuum of context and without plausible arguments why some additional smart meters would be expected to have any impact. Potential regulatory contributions are described out of context with the existing regulatory drafting and promulgation processes. **Score**: 1.

Part E: Evidence for mitigation performance

E1. Direct effectiveness. None.

E2. Indirect effectiveness. None.

E3. Net GHG emission reductions: None.

E4. Impact effects. None. Smart meters were already in use in SA, and this plus serious design flaws suggest that there was no delivery at all. **Score**: 1.

E5. Sustainability effects. None. Smart meters were already in use in SA, and this plus serious design flaws and absence of any implementation results suggest that there was nothing to be sustained. **Score**: 1.

E6. Efficiency issues. The intervention was obsolete when it was designed/approved, had no engagement with or support from DoE, and was stopped during implementation by the DoE as they felt it was too late to deliver any useful results. Aborting a flawed project is a management response that is more efficient than allowing it to continue. **Score**: 2.

E7. Capacity building issues. None. The project was stopped before it could produce any results and no capacity building actions were implemented. **Score**: 1.

E8. Baseline and monitoring arrangements. None.

E9. Overall conclusion on mitigation performance. None. **Score**: 1.

Part F: Other aspects of design and performance

F1. Unintended consequences. Weakly designed interventions undermine confidence in the quality of the partnership and attempts to implement them unilaterally can damage the partnership in other ways too.

F2. Other performance issues. Even though the project was originally requested by the DoE, it is not clear how it survived discussion with the DoE and Danish partners. National consultants were asked to explore this question forensically.

Annex e: Wind Atlas for South Africa, Phase I (WASA I)

Part A: Basic data

A1. Project number & name. 104.Sydafrika.74 Wind Atlas for South Africa (WASA I).

A2. Interviews. See Annex a, people and institutions consulted relevant to Annex e

A3. Dates & financial data. Duration: 2009-12. Funding sources for capacity building activities: (a) Component 1 (UCT national climatology centre) financed by Danida/RDE; (b) Component 2 (CSIR national wind measurements) financed by UNDP/GEF; (c) Component 3 (CSIR wind modelling) financed by UNDP/GEF); (d) Component 4 (South African Weather Service, for extreme wind measurement) financed by Danida/RDE; (e) Component 5 (capacity building at SANERI for national documentation and information centre for wind) financed by Danida/RDE. Funding amounts: (a) UNDP: ca ZAR 5 million; (b) Danida: ca DKK 10 million (DKK 7 million for components 1 and 4, and DKK 2.7 million for Component 5).

A4. Location(s). South Africa, Western, Northern and Eastern Cape for wind measurements, the cities Cape Town, Stellenbosch, Pretoria for host organisations' locations.

A5. Partners. (a) UCT as host, national climatology centre. (b) CSIR as host, national wind measurements. (c) SAWS as host, institutional capacity for wind modelling. (d) SA National Energy Research Institute (SANERI) as host, national documentation and information sharing regarding wind energy. (e) RISØ DTU: Danish partner.

Part B: Purpose and relevance

B1. Purpose.

Through capacity development and research cooperation to develop and employ numerical (modelled) wind atlas methods and to develop capacity to enable long term planning of large-scale exploitation of wind power in SA, including dedicated wind resource assessment and siting tools for planning purposes (MFA, 2008a, b).

B2. Relevance to partners.

South Africa: facilitating investment in renewable energy contributes to the national goal of decoupling economic growth from GHG emissions.

Denmark: promoting wind energy in South Africa is in line with national commitments to reduce GHG emissions, while potentially supporting the aim of promoting export of Danish green technologies.

B3. Relevance to MDGs/SDGs. MDG 7 (environmental sustainability). SDG 7 (affordable and Clean Energy).

B4. Relevance to NDC mitigation commitments. Contribute to South Africa´s commitment to reduce GHG emissions.

B5. Relevance to mitigation. Enabling frameworks: Incentives & regulations (IR) - "remove barriers to or encourage ... investment in reducing GHG emissions" [in this case, by offering knowledge-based incentives].

Part C: Narrative overview

From 2007 South Africa faced an enduring electricity supply crisis while in 2009 announcing that its carbon emissions would rise to a plateau and then decline. The 2010 Integrated Resource Plan included an allocation of solar and wind energy as part of the least-cost energy mix. An RE FIT regime was tried, but the contracting framework was never finalised, and no investments resulted. In 2011, SA initiated the Renewable Energy Independent Power Producers Programme (REIPPP) which has run a number of auctions for large, grid-connected solar and wind energy projects. Relieving the shortfall in electrical power required immediate actions and RE was attractive because it can be brought on stream faster than coal-burning power stations. Early assessments of the wind regime in SA indicated that there was good potential for establishing large-scale wind farms. However, the country had limited technical expertise relevant to accurate wind-measurements for wind farming or wind modelling. Accurate knowledge of the wind regime is essential for investments in wind power. A 2003 study commissioned by the Danish-funded Capacity Building in Energy Efficiency and Renewable Energy [programme] found that wind atlases for SA were too inaccurate to support proper investment planning, but this could be corrected with a network of measurement masts. Experience during the 1990s had shown that microscale-adjusted mesoscale modelling and ground-truthed wind atlases could support accurate deployment of wind turbine generating capacity at national scale. A 2004 study by the African Development Bank also found that SA had abundant wind resources.

Based on the Danish experience where different research institutions work together with the private industry and the Government to create an environment with access to high quality data and knowledge about the available wind resources, this programme was designed as a partnership capacity development initiative between SA and Denmark. The first phase of the programme covered the Western Cape and parts of the Northern Cape and Eastern Cape provinces (10 wind measurement masts). Masts were generally 62 m tall, and the first 10 masts were installed by August 2010 with website data available soon thereafter. The WASA I wind atlas was launched in July 2013. In this same period, REIPPP launched a series of auctions that resulted in around USD 14 billion in investment in more than 100 projects (of which around a third are wind energy). Influenced by progress from the starting point in 2008 when South Africa only had one demonstration wind farm, until 2020 when South Africa had 33 registered wind farms with a total installed capacity of 3,125.5 MW (commissioned or under construction - www.sawea.org.za) the initial desk study of this project hypothesised a causal relationship between the WASA and the rapid growth of wind power investment. This was tested in depth and the actual relationship between events was found to be more complex than originally thought. It was concluded that although WASA I was a helpful step for a potential wind industry in SA, it was not a sufficient one. Interviews revealed that most wind energy developers had located their own sites for REIPPP round 1 auctions, which occurred before the WASA 1 atlas had been published in full. Also, interviews suggested that local wind energy developers (and some international developers) used WASA to verify their own long-term wind energy assessments and, in later auction rounds, were steered to new areas with good wind resources. There were also probable but unquantifiable effects on the financing credibility of wind investments. The study concluded that design of the WASA project and its overall mitigation effectiveness were very good.

Part D: Design quality

D1. Theory of change.

South African policies include reducing GHG emissions, diversifying energy supply, and developing human capacity to support the emerging renewable energy industry. The mapping of wind resources was inadequate to attract or support investment planning in the wind sector, because wind energy had not been mapped in sufficient windy areas or at the height of modern turbine hubs. This is essential as the energy production of a wind turbine depends on wind power and the turbine's efficiency, which is a function of the wind speed at hub height. Since wind power is directly proportional to the cube of wind velocity, so a doubling of wind speed will result in an eight-fold increase in wind power, making the accurate prediction of hub-height wind velocity essential to justify the placement of each wind turbine. Meso wind modelling, verified and supported by a numerical wind atlas and then micro modelling, helps to optimise the location and siting of wind farms, A Wind Atlas would therefore act as a door-opener to accelerate investment in wind energy.

D2. Assumptions underlying the theory of change.

Assumption 1: that relative to alternatives such as coal-fired electricity, wind power development offers a quick way to relieve power shortage.

Assumption 2: that investment in wind power was inhibited by a lack of accurate knowledge on the distribution of wind energy at hub height.

Assumption 3: once a Wind Atlas is available to present information on wind resources in a way that is meaningful to potential investors, then more wind power investment proposals will be made.

D3. Plausibility of assumptions and links.

It is plausible that wind power development is faster than most conventional electivity systems, including coal-fired power stations (Assumption 1), based on experience of energy sector development using diverse technologies. It is plausible that investment opportunities in wind power had not been noticed due to a lack of accurate information, that wind resource data at hub height and in high potential areas were correctly identified as an important data gap (Assumption 2), and that once this had been corrected then additional investment proposals would be generated (Assumption 3).

There are a number of potential constraints on wind-power investment, however, none of which affect the usefulness of an accurate wind atlas since they only apply to those seeking to use the information to create profitable businesses. They are nevertheless listed here and include: (a) reluctance by local capital providers to support renewable energy investments, which had no track record in South Africa; (b) reluctance of Eskom to accept competition by independent wind power producers and to sign power purchase agreements with them; (c) reluctance of stakeholders with interests in the coal industry to tolerate the growth of a sector that will undermine those interests; (d) reluctance by regulatory and planning officials familiar with coal-based electricity to learn about a new class of technology; and (e) reluctance by land-owning communities (in a country whose major historical preoccupation is competition over land) to accept the establishment of wind farms on their land without adequate, freely-agreed compensation including participation in revenues.

In addition, a number of other factors might influence investments in wind farms, including: (a) multiple wind farms in an area may overload transmission line capacity (as happened later in the Eastern Cape); (b) disputed land ownership can prompt chronic vandalism, theft and unrest (especially if people are resettled to make way for a wind farm); (c) shortage of labour skills, political instability, and exchange rate fluctuations that may make local coal cheaper to use than wind technology; and (d) a suitable procurement and contracting framework for wind energy. These factors would need to be considered in the context of a much broader effort, coordinated by government, to create an enabling environment for wind energy investment in SA, especially the last factor, as it was only when the REIPPP auction programme began that serious investments in wind energy became possible.

D4. General quality of the project design.

The design was sound, the proposed activities appropriate to the aims, and the allocation of responsibilities and the governance structures were all clear, although there are questions on the depth of analysis used to support the design. **Score**: 5.

Part E: Evidence for mitigation performance

E1. Direct effectiveness. The estimation of direct mitigation effectiveness must rest on evidence that more installed wind power resulted with the WASA than would have been the case without it. Interviews yielded the following insights: (a) Most wind energy developers had located their own sites for REIPPP round 1 auctions, which occurred before the WASA 1 atlas had been published in full. (This does not, however, exclude influence from potential investors being aware of the WASA data stream well before then.) (b) The interest of most of these developers had been sparked by the previous feed-in tariff regime (from 2009-2011). The developers had put up their own masts and had started environmental impact assessments and were ready to bid in the first auctions. (c) Local wind energy developers, and some international developers, used WASA to verify their own long-term wind energy assessments and, in later auction rounds, were steered to new areas with good wind resources. (d) Other international developers, however, indicated that they did not use WASA at all, and relied on other data sources. This offers a mixed picture on the influence of WASA, and it is also the case that the successful outcome of efforts to promote wind investments in SA would probably not have been obtained without a credible and bankable procurement and contracting framework, in practice and in particular the REIPPP auctions. Only some of the rapid progress in the sector can therefore be directly attributed to WASA. How much would depend on the unquantifiable effect of ostentatiously creating a data stream and a 'buzz' around wind power opportunities in 2009-2011. **Score**: 4.

E2. Indirect effectiveness. Nearly all interviewees indicated that WASA has put SA on the map as a country with globally competitive wind resources. WASA data also fed into IRENA RE resource maps. The capacity built at the CSIR, UCT and SAWS, in collaboration with RISØ/DTU has also survived. These are important indirect effects, by making potential wind (and other RE) investments credible to financing institutions and offering the reassurance of IRENA endorsement and the presence of technical expertise in SA. **Score**: 5.

E3. Net GHG emission reductions Not estimated, predictively modelled or tracked.

E4. Impact effects. Any significant effectiveness in a developmental system involving directional policy, legislative, technological and investment changes must be assessed as having equally-significant impact. **Score**: 5.

E5. Sustainability effects. Any significant effectiveness in a developmental system involving near-irreversible policy, legislative, technological and investment changes must be assessed as having equally-significant sustainability. From 2008 to 2020, the wind energy sector grew from one demonstration project in the Western Cape to over 3,000 MW installed capacity. While not discounting the influence of other factors including the Darling demonstration project, and the REIPPP auctions in particular, WASA 1 had a timely role in supporting this. Having become so well established, the change to wind energy now seems irreversible despite opposition from coal industry interests. Research collaboration between Denmark and SA is well developed, with its own momentum as researchers have developed contacts, reputations and habits of cooperation within the binational group and beyond. **Score**: 5.

E6. Efficiency issues. The June 2014 Project Closure Report states that all activities were implemented, results achieved, the budget spent and performance meetings hosted and reported as planned. On the other hand, the project did not establish any system to monitor how project results contributed to the objective. **Score**: 5.

E7. Capacity building issues. There is ample evidence of sustained knowledge sharing between RISØ-DTU and South African institutions (UCT, CSIR etc.). The project also contributed to building capacity among local private developers and investors. **Score**: 6.

E8. Baseline and monitoring arrangements. None.

E9. Overall conclusion on mitigation performance. WASA I was an enabling investment that might have paid for itself in mitigation terms through leverage effects on political-policy-legislative action, willingness to invest, and potential return on investment in renewable energy due to efficiency gains. Actual effectiveness cannot be assessed without estimates of these effects**.** Overall mitigation performance is marked down because the project failed to monitor and document its impacts relative to its stated objectives. **Score**: 5.

Part F: Other aspects of design and performance

F1. Unintended consequences. The strong focus on wind measurements without attention to other factors relevant to investment in wind farms may have delayed the commissioning of wind farms in the long run. Early support for a wind industry forum/network would have been beneficial, but the RDE and wind industry did establish SAWEA in collaboration with like-minded development partners and investors.

F2. Other performance issues. WASA 1 made a remarkable input towards building capacity in general and among academia in South Africa and has thus contributed significantly to the establishment of academic fields related to wind energy at the CSIR and universities in SA.

Annex f: Support to Renewable Energy Development (DEPP 'I')

Part A: Basic data

A1. Project number & name. 104.G.15-19 Danish Support to Renewable Energy Development in South Africa (DEPP 'I').

A2. Interviews. See Annex a, people and institutions consulted relevant to Annex f.

A3. Dates & financial data. Duration: Jan 2013 to Dec 2015 (of which the Inception Phase lasted three months, although the appraisal team recommended six months). Budget: Component 1 (TA to the DoE): DKK 19.00 million; Component 2 (WASA II): DKK 12.00 million; Component 3 (TA to Eskom): DKK 7.75 million; Programme management: DKK 1.25 million; Total: DKK 40.00 million (from MFA Denmark).

A4. Location(s). Components 1 and 3: Pretoria. Component 2: WASA II (a wind atlas for areas not covered by WASA 1, in Eastern Cape, KwaZulu-Natal and parts of Free State).

A5. Partners. Executing Partner: DoE, SA National Energy Development Institute (SANEDI) and Eskom. Implementing contractors: (a) SA Council for Scientific and Industrial Research (CSIR), (b) University of Cape Town Climate Systems Analysis Group (UCT CSAG), (c) SA Weather Service (SAWS) and (d) Technical University of Denmark Department of Wind Energy (DTU Wind Energy - 'RISØ DTU').

Part B: Purpose and relevance

B1. Purpose.

Development objective: Decoupling economic growth from GHG emissions.

Overall objective: Increased deployment of low-carbon technologies, in particular energy efficiency and renewable energy, in the energy sector.

Immediate objectives at component level:

Component 1 (TA to the DoE): "Development of an energy policy that will result in GHG mitigation in South Africa". This is a continuation of capacity development support to the DoE in 2001-2005, followed by support for Energy Efficiency monitoring in 2007-2010.

Component 2 (Wind Atlas South Africa 2): "The national potential of wind power for displacing power generation using fossil fuels is documented and used for the development and implementation of future investments in wind-based electricity generation". This is a continuation of the WASA 1 project.

Component 3 (TA to Eskom): "GHG mitigation through planning and technical integration of RE generation in South Africa". This is the first time that MFA has worked with Eskom in this way.

B2. Relevance to partners.

South Africa: "South Africa will build the climate resilience of the country, its economy and its people and manage the transition to a climate-resilient, equitable and internationally competitive lower-carbon economy and society in a manner that simultaneously addresses South Africa's over-riding national priorities for sustainable development, job creation, improved public and environmental health, poverty eradication, and social equality" (MoE, 2011: 11).

Denmark: "The [Growth and Employment] Strategy provides the framework for efforts to foster sustainable, economic growth and creation of decent jobs and outlines the main principles and priorities for instruments that directly engage the Danish business community in fostering growth and employment. This includes high prioritization of the development of partnerships and investments that can expand the use of green technology and contribute to increased food security" (MFA, 2013: 4).

B3. Relevance to MDGs/SDGs.

SDG 7: Affordable and Clean Energy, since it is assumed that greater wind energy supply will help meet demand in affordable and reliable ways.

SDG 13: Climate Action (mitigation), since it is assumed that greater wind energy supply will lead (one way or another) to fewer fossil fuels being burned.

B4. Relevance to NDC mitigation commitments. DEPP 'I' was underway during the lead-up to the Paris Agreement, and involved institutions and actions that would have been expected to help shape and inform the NDC commitments. Certainly, the aim of decoupling economic and GHG growth is in line with the mitigation goal of the Paris Agreement, and the Agreement specifically allows countries to follow their own paths in achieving it.

B5. Relevance to mitigation.

- DEPP 'I' was intended to contribute to MT through greater adoption of energy efficiency and renewable energy, hence substituting for coal-intensive electricity.
- DEPP 'I' was relevant under the 'practical actions' criterion of **Capacity Building** (CB), by training and engaging government officials with issues of wind-energy mapping, energy planning, safe integration of wind energy into the national grid, and minimising transmission losses.
- It was also relevant under the 'enabling frameworks' criteria of **Research & Monitoring** (RM) by studying wind energy resources, by organising knowledge relevant to the exploitation of wind energy, and by establishing a wind-research centre and arrangements for technical collaboration between South African and Danish institutions on wind measurement and the integration of wind energy in the national grid.

Part C: Narrative overview

In 2011, South Africa embarked on a series of REIPPP auctions for large grid-connected solar and wind energy projects, giving rise to new challenges on how to securely integrate these variable resources in the system and to ensure that RE plants would be able to connect with the grid in an optimum way. DEPP 'I' was therefore designed around three themes: (a) to provide technical assistance to DoE on policy development and strategic planning for EE and RE (b) to further develop a wind atlas and database, so that it covered all remaining areas that looked likely to possess significant wind energy resources (including modelling, measurement, applications for wind resource assessment, workshops, and publication of results); and (c) to provide technical assistance to Eskom on integrating RE into the electricity supply (including the development of decision support tools to maximise mitigation effects through planning and technical integration).

The plans for Component 1 (support to DoE/DMRE) changed during implementation. A long term adviser was eventually embedded in the department and activities included pre-energy audits of public buildings, a revised and updated NEES (never finalised or published), pilots for energy efficiency incentives, support for SARETEC to train wind energy technicians, a Renewable Energy Data and Information Service, proposals to NERSA for revisions to the Grid Code to incorporate RE, municipalities trained on the integration of RE, training and support for LEAP energy model, a carbon-offsets administration and reporting system. While these interventions responded to DoE/DMRE's needs, the outputs were not taken up and used by the department as expected. They were largely disconnected to the most significant development in the sector at the time - the launch of the REIPPP RE auctions.

Component 2 supported WASA II in extending the areas covered by wind measuring masts, and Component 3 supported Eskom in setting up an RE support group and developing decision support tools for integrating RE and for capacity building.

Part D: Design quality

D1. Theory of change. Reconstructed rationale. Decoupling GHG emissions from economic growth can be achieved through increased use of low-carbon technologies across the energy and industrial sectors. This can be done through interventions at policy, research and implementation level related to planning and increased role for RE in the power mix, to optimising decisions on where to invest in wind energy and how to integrate fluctuating wind power into the electricity network safely, without damaging systems or causing outages.

D2. Assumptions underlying the theory of change. Reconstructed assumptions.

Assumption 1: that increased use of low-carbon technologies across the energy and industrial sectors is necessary and sufficient to decouple GHG emissions from economic growth.

Assumption 2: that the specified interventions to improve planning to harmonise RE investment with other plans and priorities will enhance social and economic performance.

Assumption 3: that the specified interventions to improve technical capacity will be adequate to ensure safe and effective integration of wind energy to the national power mix.

D3. Plausibility of assumptions and links. Assessment of reconstructed assumptions.

Assumption 1 is plausible provided that the focus was on supporting impactful EE interventions or accelerated investment in RE. The REIPPP programme led to a rapid fall in prices with the potential for RE to ultimately be the cheapest source of new generation. However, DEPP 'I' was largely disconnected from this initiative and focused instead on a number of small initiatives, especially those in the DoE. Not explored in the design was the issue of strong economic ties between the coal industry and political decision makers; a stakeholder analysis could have provided early warning of potential problems.

Assumption 2 is in principle plausible, since RE development has impacts as older technologies are replaced (see Part G) and new business opportunities and therefore sources of potential inequity (from private wealth creation), unemployment (from new demands on labour) and displacement (from new distributions of work opportunities) arise, all of which can be understood, anticipated, planned for and to some extent compensated.

Assumption 3 is plausible, as the positive attributes and pitfalls of the RE technologies involved, and the measures needed to ensure safe and effective integration of wind energy, are all well known, as are the best ways to transfer skills and develop managerial systems.

General comments. The reconstructed logic and assumptions are implied rather than explicit in the programme documents, which address risks and assumptions at a superficial level and fail to address key issues that may delay a transition to a low carbon economy. Other weaknesses include: (a) That DoE/DMRE was expected to allocate adequate resources despite not having done so in previous engagements. It might have been better to assume that DoE lacked capacity, and to focus on remedial measures (for example by financing the employment of additional junior staff until the department could take over the payroll cost, or else by broadening the collaboration to include other public and/or private institutions with greater capacity to absorb the technical input). (b) That there was little reflection on other issues that affect investments in wind farms, in particular the procurement and contracting framework such as the REIPPP auctions. The transition to a low carbon energy sector is a complex process and this complexity is not reflected in the design.

D4. General quality of the project design. The design addresses some specific barriers to the low-carbon transition but ignores many others. The interventions (especially those in the DoE) had clarity and strength in their basic concept but were flawed in design, weak in implementation, and perverse in some of its adjustments. It was fortunately timed, however, in that WASA II could build on the early success of WASA I, and the Eskom component could build on early Danish support for the System Operator. Attribution of mitigation contributions is not possible without baselines and monitoring arrangements. **Score**: 3.

Part E: Evidence for mitigation performance

E1. Direct effectiveness. None, as a capacity-building/research & monitoring intervention.

E2. Indirect effectiveness. Component 2 (WASA II) raised the profile of SA as a wind energy location, and Component 3 assisted in developing a long-term relationship with Eskom in building its capacity to integrate renewable energy. **Score**: 4.

E3. Net GHG emission reductions: None.

E4. Impact effects. See D1, D2, E2 and E5-8. Facilitating energy efficiency interventions and the rapid growth of the wind energy sector in an otherwise coal-dependent country by any means, even imperfect ones, is likely to have multiple impacts including positive ones on reduced net GHG emissions. But the absence of a plausible capacity development strategy, missing baseline and monitoring arrangements, delivery and efficiency failings, and a lack of attention to key barriers and weaknesses in social and institutional contexts, means that net positive impacts are likely to be far lower than might otherwise have been achieved. **Score**: 3.

E5. Sustainability effects. Echoing the conclusions of a progress meeting in January 2015, Danida (2016) recommended that DEPP activities should be integrated into the DoE, Eskom and Sanedi work plans in a sustainable way. Other findings: (a) that activities in Component 1 had low sustainability, that funds had been used for study tours and training without their utility being assessed, and that opportunities had been missed due to lack of a dedicated DoE coordinator; (b) that Component 2 was likely to deliver expected outputs and results were being used by other departments to zone wind farms; and that (c) Component 3 had progressed well, yet training and capacity building had not been packaged as business input for Eskom to implement. These findings are consistent with the observations on design in Part D: that the project was suffering from the lack of an institutional capacity assessment, a capacity strategy, and ways to correct known staffing difficulties at the DoE. **Score**: 3.

E6. Efficiency issues. The DEPP inception report (SA & Denmark, 2013) made no changes to Components 2 or 3, but Component 1 was adjusted away from strategic planning for RE integration and toward installation of smart meters in public buildings (see Annex d), even though the installation of smart meters is a trivial matter compared to policy, optimised energy planning, and integration of wind energy. The 2015 Progress Report (DoE, 2015) highlighted the following: (a) that Component 1 suffered from delays in a number of activities including the RE status report and the carbon offset programme; (b) that Component 2 had also been delayed but had since progressed and a request for an extension had already been made; and (c) that Component 3 was also reporting delays and the anchoring of the component within Eskom had been changed. Delays meant that total expenditure was only about 5% of the overall programme budget, against an expected expenditure of around half by that stage in the programme. The programme received a no-cost extension, and the 2018 Completion Report (DoE, 2018) noted that some activities were achieved but some were delivered without involvement of the South African partners. **Score**: 3.

E7. Capacity building issues. There was no evidence of an assessment of institutional weaknesses, of plans to address them, or of the outcomes of training or other measures to correct them. DoE (2018: 7-8) claimed that "the programme has brought a significant change to the department in terms of capacity building in the areas of energy efficiency, renewable energy, climate change, energy planning, wind measurement and grid integration of renewable energy. It produced important outputs like the NEES [although in 2020 this has still not been finalised or published – and it should be noted that similar support was provided and claimed to be successful by SDC around 2010 and by the IEA around 2012], the Carbon Offset Administration System, Wind Atlas of South Africa, Eskom System Adequacy Report, Energy Demand Modelling Tool for the Commercial Sector, etc. However, it was not fully aligned with both the strategic and annual performance plans of the partners especially, the DoE, and this often led to a situation where the resources were too stretched and thus limited the expected output. The main challenge is sustainability of the component activities." **Score**: 3.

E8. Baseline and monitoring arrangements. The Programme Document stipulated that baselines and monitoring systems were to be established and progress reports issued, but did not make them goals of the inception phase. The resulting absence of baseline assessments and detailed monitoring arrangements then constrained navigation and management.

E9. Overall conclusion on mitigation performance. The intervention had clarity and strength in its basic concept but was flawed in design and weak in implementation. WASA I had already provided support for the wind industry, however, so these weaknesses were obscured by rapid growth and change in the sector. Mitigation contributions cannot be attributed without baselines and monitoring arrangements. **Score**: 3.

Part F: Other aspects of design and performance

F2. Other performance issues.

Coherence. There were few explicit links with other development partners, although UNDP collaborated in an EE incentives pilot under Component 1, as well as support for SARETEC and also WASA II (DoE, 2018).

Cross-cutting themes. The Programme Document made strong references to poverty alleviation and the high youth unemployment in South Africa and referred to GoSA's plans to use the RE sector to generate around 50,000 local jobs. Seen in this context it is significant that not a single socio-economic study was undertaken under DEPP 'I'. In the absence of WASA II coverage of Mpumalanga, there was no opportunity to explore opportunities to absorb re-trained labour from closed coal mines in the provincial wind industry.

Partnerships. Component 2 seems to have enhanced collaboration between South African and Danish wind research institutions.

Annex g: The Danish Energy Partnership Programme (DEPP II)

Part A: Basic data

A1. Project number & name. 2017-18831: Danish Energy Partnership Programme Phase II (DEPP II) (South Africa)

A2. Interviews. See Annex a, people and institutions consulted relevant to Annex g

A3. Dates & financial data. Duration: Jul 2017 – Oct 2020. Budget: DKK 18.19 million, managed by the SA Department of Energy (DoE, now DMRE). Component 1 (DoE) DKK 10.29 million; Component 2 (Eskom) DKK 5.16 million; Contingencies DKK 2.74 million.

A4. Location(s). South Africa: Pretoria and Johannesburg (with nationwide coverage through policy and technology).

A5. Partners. **DoE/DMRE**, responsible for modelling and developing scenarios, reflecting the policy options of the government (MFA, 2019). **Eskom**, the state-owned power utility with a mandate to generate, distribute and sell electricity. (c) DEA, Energinet, and others.

Part B: Purpose and relevance

B1. Purpose. The **Programme Objective** was to support SA's "transition to a less carbon-intensive electricity production including through expansion of RE generation" (MFA & MCEU, 2017a: 24), relating "to [4/8] key objectives of the [Integrated Energy Plan, IEP], namely ensuring the security of supply; minimising the cost of energy; diversifying supply sources and primary sources of energy; and minimising emissions from the energy sector" (MFA & MCEU, 2017a: 5). Two development engagements were envisioned. **Engagement 1 (Energy Sector Planning with DoE/DMRE)** aimed to improve "recurrent planning processes and attached inputs [by ensuring] more consolidated data, forecasts, peer reviewed assumptions and additional long-term policy and policy implementation scenarios for a less-carbon intensive electricity sector including through the expansion of RE-generation capacity." (MFA & MCEU, 2017a: 24). **Engagement 2 (RE Integration into the National Power System of SA with Eskom)** aimed to enhance "power system ability to integrate the RE generated in a cost effective way." (MFA & MCEU, 2017a: 26).

B2. Relevance to partners. For **South Africa**, DEPP II was in line with national policy statements for increased integration of RE and to pursue low-carbon development within the electricity sector. For **Denmark**, DEPP II was in line with Denmark's international commitments towards global reductions of GHG emissions.

B3. Relevance to MDGs/SDGs. SDG 7: Affordable and Clean Energy. SDG 13: Climate Action (mitigation).

B4. Relevance to NDC mitigation commitments. South Africa's NDC commitments focus on achieving a peak, plateau and decline in economy-wide GHG emissions within a range of values, to be achieved through various means, including "the introduction of mandatory GHG reporting domestically, no later than 2016" (GoSA, 2016: 7). DEPP II is potentially in line with the general trend of the NDC commitments.

B5. Relevance to mitigation. DEPP II was relevant under the 'practical actions' criterion of **Capacity Building** (CB), by training and engaging government officials in energy planning, safe integration of wind energy into the national grid, and minimising transmission losses.

Part C: Narrative overview

DEPP II followed Support to Renewable Energy Development in South Africa (DEPP 'I') which had a number of design and implementation problems, but efforts to correct them seem not to have worked and weaknesses remained. **Engagement 1** depended upon an effective LTA being embedded within DoE/DMRE, but this was not done and collaboration with the DMRE effectively broke down. Thus, DEPP II demonstrated few impacts on either the IEP or the 2019 electricity component of the revised Integrated Resources Plan (IRP). **Engagement 2** focused on RE integration into the power system, mainly with the Eskom System Operator in three areas: system flexibility and auxiliary services, forecasting renewable energy and improvements to the grid code to incorporate renewable energy and battery storage. Technical assistance was provided by personnel from Denmark's Energinet, DTU/RISØ and others, and this partnership was largely regarded as successful.

Part D: Design quality

D1. Theory of change. GoSA is committed to promoting RE as a way to relieve power shortages while reducing net GHG emissions but integrating RE safely and effectively presents technical and regulatory challenges of a sort that Denmark has the expertise to overcome. The intervention relies on the success of two interventions:

- With DoE/DMRE: "DoE will get better data input for modelling and more comprehensive capacity to utilize modelling tools. This will lead to robust modelling results, either consolidating present or suggesting revised implementation pathways for achieving the policy objectives of the Government. For this eventually to lead to changes needed, if any, of the enabling environment for investments in RE generation, again depends on actual policy making as well as other factors beyond this [development engagement], not least the wider political and economic context." (MFA & MCEU, 2017a: 8-9).
- With Eskom: "The Danish system operation paradigm with a high share of fluctuating RE in the grid offers the technical insights and experience that can facilitate the changes needed in order for Eskom to efficiently integrate increasing shares of RE as more RE-generation capacity comes online in the future." (MFA & MCEU, 2017a: 9). The intervention relies for its

D2. Assumptions underlying the theory of change.

Assumption 1: that GoSA will retain its commitment to climate change mitigation and RE as reflected in key planning documents and resource allocations to responsible institutions.

Assumption 2: that DoE/DMRE will be able to absorb and use effectively guidance offered through LTA deployment and other means (STA, study tours) on the development of modelling capacity, and use it to influence policy and regulation in support of RE development and integration.

Assumption 3: that Eskom will be able to absorb and use effectively guidance offered through a peer-to-peer relationship with the Danish Transmission System Operator (i.e. Energinet) and other means (STA), on the integration of RE into the national grid.

Assumption 4: that improved modelling and policy/regulation by DoE, coupled with improved RE integration by Eskom, will lead to an increased share of RE in the national electricity supply.

D3. Plausibility of assumptions and links.

Assumption 1 is compromised by GoSA interest in promoting nuclear, hydroelectricity and clean coal. This was interpreted as a potential barrier to RE development and identified as a serious risk in the Programme Document, to be offset by "modelling scenarios showing benefits on integrating renewable energy and long-term sustainability." MFA & MCEU (2017a: 12-13)

Assumption 2 is compromised by weaknesses previously seen in working with DoE/DMRE. This was identified as a significant risk in the Programme Document, to be offset by "DoE engagement with participation at Deputy Director General level" (MFA & MCEU (2017a: 13).

Assumption 3 is plausible, in view of the success of previous collaborations between Danish and SA research groups, and between Danish partners and Eskom's System Operator.

Assumption 4 is plausible but compromised by potentially conflicting policies (Assumption 1) and an unproven relationship with a key partner (Assumption 2).

D4. General quality of the project design. The Programme Document is clear, and the intervention makes sense as described, but 3/4 assumptions were clearly compromised. Moreover, the DEPP II formulation mission had no access to senior management at the DoE, making the level of interest in a key partner organisation questionable. **Score**: 3.

Part E: Evidence for mitigation performance

E1. Direct effectiveness. None, as this was a capacity building intervention.

E2. Indirect effectiveness. **DoE/DMRE**: there were no outputs or outcomes (**Score**: 1). **Eskom**: the intervention improved Eskom capacity to integrate higher shares of variable RE into the grid (**Score**: 5). See E4.

E3. Net GHG emission reductions. No evidence.

E4. Impact effects. **DoE/DMRE**: See E5. **Score**: 2. **Eskom**: Interviews with Eskom's System Operator staff have indicated strong support for and appreciation of the TA provided by Energinet in moving towards more flexibility and improved auxiliary services, improved forecasting for renewable energy and modification of the grid code to incorporate provisions for the integration of renewable energy and battery storage. While Energinet operates within a very different power market, Eskom staff were explicit in defining their needs and how Energinet could best support them. As the share of renewable energy grows on the grid, the technical challenges will be become more complex on managing variability and creating complementary flexible resources to balance the system. The long-term Danish support to Eskom has created a solid foundation from which to build further capacity. **Score**: 5.

E5. Sustainability effects. **Context**: The key assumption of the intervention was validated by "recent policy statements from the South African Government [that] underline the strong support at the highest national level for increased integration of renewable energy and to pursue a low carbon development within the electricity sector." (MFA, 2019: 3). The role of GIZ and other "well-funded" development partners all engaged with promoting RE in SA was noted by (MFA & MCEU, 2017: 6, 13), and this and other factors (such as a growing SA wind sector) make it hard to attribute this policy consolidation to any particular influence. **DoE/DMRE**: "There are very few staff resources available in the Planning Branch of DoE, and several positions of modelling experts are vacant. Training in modelling without adequate and qualified staff seems unsustainable and it would be simpler for DoE to hire the right staff or, if that is difficult, to continue building this capacity outside the department, e.g. in a research institution. Furthermore, the limited support from the DoE management to the programme brings the issue of country co-ownership into question. It was mentioned by several that the formulation process gave rise to discord and that some of the good faith from earlier cooperation may have been lost already from the beginning of DEPP II." (MFA, 2019: 7). **Score**: 2. **Eskom**: "Potential transformative impact of the collaboration with Eskom ... [with at least 2/4 outputs being] well targeted to Eskom's work on integrating RE at the distribution level and developing grid codes for the integration of batteries on the grid ... the technical assistance from DEPP II will remain relevant on all four outputs and will contribute to GoSA's increased priorities to RE." (MFA, 2019: 7). **Score**: 5.

E6. Efficiency issues. **Overall**: The signing of the DEPP II partnership agreement was delayed for over a year, suggesting a lack of priority for South African partners, reasons for which should have been (but were not) definitively established. **DoE/DMRE**: The critically-important posting of an LTA to DoE proved to be impossible. The MTR refers to a "lack of buy-in from DoE management" and suggests relocating the LTA to a different institution. It further observes that "The efficiency of the programme in DoE is affected by participation of the same individuals at two levels of the management structure, i.e. in the management group and in the implementation groups. The consequence is that people involved in direct implementation oversee their own work and performance as members of the management group." (MFA, 2019: 6). **Score**: 2. **Eskom**: Collaboration with the Eskom System Operator was effective. **Score**: 5.

E7. Capacity building issues. **DoE/DMRE**: As with DEPP 'I', there is no evidence of institutional weakness assessments or agreed capacity transition plans at institutional or individual level in DEPP II. There is likewise no evidence of improved capacity based on training, although training in Denmark was well received by those who participated. **Score**: 2. **Eskom**: "Eskom is a very committed partner on [DEPP II]. ... Two technical workshops (operational flexibility at TSO level and at the thermal power plant level) have been completed, and Eskom staff has been trained at Energinet in Denmark. One planning workshop on medium- and short-term forecasting has been held and two Eskom experts are to be trained by Energinet in Denmark. A technical planning workshop on integrating renewable energy at the distribution level was held in October 2018 and the strategy and methodologies for the planned training sessions were finalised in February 2019, with activities to start in the 2nd half of 2019. In preparation of the work on developing grid codes for Battery Energy Storage Systems (BESS), a technical planning workshop was held October 2018, developing a detailed work plan op to June 2019, which includes workshops in April and May 2019. Further planning of the work in the last year of DEPP II (e.g. on Demand Connection Code) is undertaken." **Score**: 4.

E8. Baseline and monitoring arrangements. The impact indicator for DEPP II is given as the contribution of the programme to tCO_2e emissions reduced (MFA & MCEU, 2017: 24). The DoE/DMRE outcome of increased capacity for modelling and policy development has undefined baselines described in terms of the position at the start of the programme, and a number of monitorable features (data disaggregated, technology catalogues, long-range policy-implementation scenarios, roundtables/seminars). The Eskom outcome of enhanced ability by the power system to integrate RE has well-defined baselines for operational themes (balancing fluctuating supply and demand, and improved forecasting), with training baseline described as the position at start of programme. all with monitorable features (operating tools, financial incentives, hourly forecasting based on weather models, change in operational strategies as a result of training). Links to the impact indicator are extremely indirect.

E9. Overall conclusion on mitigation performance. **DoE/DMRE**: With almost no direct or indirect mitigation effectiveness, and with very weak impact, sustainability, efficiency and capacity building effects, **Score**: 1. **Eskom**: with good indirect effectiveness, impact, sustainability, and efficiency, and moderate capacity building effects, **Score**: 4/5.

Acronyms and abbreviations (South Africa)

AFOLU	Agriculture, forestry and other land use (sector, see also LULUCF).
BAU	Business as usual.
BUR	Biennial Update Report.
CCS	Carbon Capture and Storage.
CSIR	Council for Scientific and Industrial Research.
CSAG	Climate System Analysis Group at the University of Cape Town.
CPPP	Community Public Private Partnership.
DEA	Danish Energy Agency.
DEFF	Department of Environment, Forestry and Fisheries
DEPP	Danish Energy [Agency] Partnership Programme.
DHS	Department of Human Settlements
DKK	Danish kronor
DMRE	Department of Mineral Resources and Energy
DoE	Department of Energy
DoH	Department of Housing
EE	Energy efficiency.
FIT	Feed-in tariff
FOLU	Forestry and other land use
GCF	Green Climate Fund.
GHG	Greenhouse gas
GoSA	Government of South Africa.
IEA	International Energy Agency
IPP	Independent Power Producer
IPPU	Industrial Processes and Product Use
LEAP	Long Range Energy Alternative Planning (model)
LULUCF	Land use, land-use change and forestry (sector, see also AFOLU).
MFA	Ministry of Foreign Affairs of Denmark
MKL	Department for Multilateral Cooperation & Climate Change (MFA Denmark)
MRV	Monitoring, reporting and verification.
MTR	Mid-term review
NDC	Nationally Determined Contribution (to Paris Agreement goals).
NEES	National Energy Efficiency Strategy
NERSA	National Energy Regulator of South Africa
PIRB	Plumbing Industry Registration Board
PMU	Project Management Unit
PPA	Power purchase agreement
PPD	Peak, plateau, decline [in GHG emissions]
PV	Photovoltaic.
RDE	Royal Danish Embassy (Pretoria)
RE	Renewable energy.
REIPPP	Renewable Energy Independent Power Producers Programme
RISØ/DTU	National Laboratory for Sustainable Energy, Danish Technical University
SABS	South Africa Bureau of Standards.
SALGA	The South African Local Government Association
SANEDI	South African National Energy Development Institute.
SANERI	South African National Energy Research Institute.
SAREM	South African Renewable Energy Master Plan
SARETEC	South African Renewable Energy Technology Centre.
SASGI	South African Smart Grid Initiative
SAWEA	South African Wind Energy Association.
SAWS	South African Weather Service.
SCADA	Supervisory control and data acquisition.
SDC	Swiss Development Corporation.
SEA	Sustainable Energy Africa (a consulting NGO).
SET	Sectoral Emissions Target.
SME	Small and medium enterprise.
SSC	Strategic Sector Cooperation.
SWH	Solar water heater.
UCT	University of Cape Town.
UNFCCC	United Nations Framework Convention on Climate Change.
WASA	Wind Atlas of South Africa.

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