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INDUSTRIALISATION AND SUSTAINABLE GROWTH

A BENCHMARKING PAPER ON THE ROLE OF INFRASTRUCTURE IN ECONOMIC DEVELOPMENT AND PROMOTING AN INCLUSIVE LOW-CARBON FUTURE IN SOUTH AFRICA

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Abstract

This paper establishes the importance of social infrastructure in an economy with respect to economic development, social inclusion, and the transition to a low-carbon future. The approach of this paper is to establish a theoretical basis for the importance of infrastructure in improving wellbeing and providing a foundation on which green development can occur. This paper is pragmatic and attempts to benchmark South Africa against Germany and Japan in terms of the amenability of infrastructure where such comparison is possible. The key infrastructure of electricity is identified. This paper finds that South Africa's electricity production emissions exceed those of Germany and Japan, although the country supports a smaller economy and population. Furthermore, South Africa is still overly reliant on fossil fuel sources of power generation and its production and distribution of electricity is inefficient which results in losses. Financing of renewable energies lags behind Germany in absolute terms but fare well against Germany as a percentage of national GDP. This paper finds that South Africa must prioritise the diversification of energy sources, improve energy losses, and invest more in renewables to lay the foundation upon which the economy can transition to an inclusive low-carbon future.

About the author

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1. Introduction

This paper will look at the strategic role that infrastructural can play in terms of unlocking industrial potential in new and existing sectors while also fostering inclusive development and the transition to a low-carbon economic development future in South Africa. This paper argues that important linkages exist between infrastructure and economic growth, infrastructure and inclusivity, and infrastructure and opportunities for low-carbon social and economic development. Furthermore, this paper will assess the progress that South Africa is making in terms of electricity generation and adaptation to renewable sources of power generation with regard to comparison with Germany and Japan.

Consequently, this paper argues that government spending on infrastructural renewal and upgrading can generate opportunities for short- and long-term job creation (and social inclusion) as well as have a knock-on effect on the economy in terms of promoting investment and private enterprise along sustainable avenues for supporting the transition of South Africa to a low-carbon future. The selection of electricity is important because this sector underpins the rest of the economy and sustainability in the production of electricity can promote input sustainability in other industrial sectors.

Consequently, this paper is premised on the idea that public infrastructural spending on key infrastructures can help steer the trajectory of private enterprise and the economy as a whole toward inclusive economic growth and a low-carbon future. This paper will argue that is relationship, borne out by theory, is true and that South Africa must do more in terms of upgrading its electricity infrastructure for encouraging enterprise, employment, social development, and private enterprise engagement with greening the economy and lowering the carbon-intensity of the economy.

Finally, this paper will highlight the leadership role that government can play by ensuring the provision of adequate infrastructural spending and by creating an economic climate that encourages the private sector to invest in new economic opportunities and engage with low-carbon alternatives for the enabling of the long-term transition to a sustainable, just, and forward-looking economy.

2. Structure and Methodology

The structure of this paper will assist in telling the story of infrastructure and the transition to a low-carbon economy amid the need for inclusive development. Section 3 will consider how infrastructure upgrading supports economic development in general. Section 4 will argue that well-designed integrated infrastructure supports private enterprise, job creation, and inclusive development. Section 5 will argue that appropriate infrastructure can guide the transition to a sustainable low-carbon economy. Section 6 will benchmark South Africa and compare how infrastructure spending on renewable energy in South Africa compares to other countries. Section 9 will discuss the renewable energy policy environment in South Africa and the programmes that support it. This paper will conclude in Section 8 and give recommendations in Section 9 on how to improve outcomes.

The approach of this paper is two-fold. Sections 3 to 5 will assess the relationship between infrastructure and economic development and inclusivity on the one hand, and how this can facilitate the transition to a low-carbon economy that is sustainable, just, and forward-looking on the other. These discussions will approach the topic at the theoretical level and assess the prerequisite conditions for such linkages to take effect in the economy. Section 6 will assess the second aspect of this paper and attempt to benchmark the status of South Africa’s renewable energies against other countries. This comparison will assess the magnitude and financing on infrastructure in terms of GDP. Section 7 will frame the benchmarking in the context of the South Africa policy/programme climate.

This comparison will gauge the benefit of infrastructural spending on the economy in terms of its effect on inclusive economic development, and aligning economic growth and opportunities with the objective of promoting the transition to a low-carbon economy. The methodology of this paper will reinforce the aims of this paper by helping to explain how infrastructural spending relates to inclusivity, economic growth, and greening the economy. The focus will allow for an assessment of how infrastructural spending can specifically focus outcomes toward inclusion and sustainability.

This approach will be pragmatic and employ abductive reasoning in that it will rely on inference to the best available evidence. This will entail a back and forth movement in the discussion between theoretical expectations about the socioeconomic effects of infrastructure upgrading on the economy, the status of infrastructure spending, and the real-world outcomes of this spending, especially with regard to social inclusion and the transition to a low-carbon future. The premise of this paper is that improved infrastructure, that is also sustainable, can create opportunities for enterprise and economic growth, which support job creation, social development, and the greening of the economy.

3. Infrastructure and Economic Development

Infrastructure is defined as the “basic physical systems of a business or nation [including] transportation, communication, sewage, water and electric systems” (Investopedia, 2017). In addition to networks of road, rail, telecoms, pipelines, cables, equipment, and information technology, infrastructure includes certain networked services such as waste collection and processing, education, and healthcare. Indeed, the word infrastructure refers to the systems beneath (i.e. infra) the structure of the economy. In this sense, infrastructure supplies the foundational aspects of the built environment necessary to economic transactions and the process of economic development.

These infrastructural aspects of the built environment often possess certain aspects that make their provision by the private sector difficult. This is because they often require massive initial outlays of capital investment (i.e. alternators, telecoms, pipelines, cables etc.). Regardless, (Esfahani and Ramirez, 2003) find that economic growth in response to upgrading of infrastructure networks and services recoups or even exceeds the cost of provision. Furthermore, they are open to the problem of free riders (i.e. transport networks), and due to the presence of positive externalities are not invested in at the optimal level by private individuals (i.e. education, healthcare, policing, courts etc.).

Nevertheless, these physical networks and services are vital to the functioning of society and business operations. The provision of electricity, the infrastructure under investigation in this paper, underpins the functioning of most other sectors of the modern economy, public or private. This is a crucial aspect of renewable energy provision as intermittent sources like wind and solar PV require implementation and use of additional technologies for storing electricity in order to maintain supply (Kramer and Haigh, 2009). Therefore, this further complicates the transition to a low-carbon future because of the differences of renewable energy with traditional electricity generation infrastructure.

Infrastructure facilitates economic development by providing an enabling environment for entrepreneurship, business operations, market entry, and information gathering and transmission (Audretsch et al., 2015). Moreover, green infrastructure in the urban context that supplies ecosystem services can improve ecological outcomes and the health and mental wellbeing of people and workers (Tzoulas et al., 2007). Consequently, the infrastructural hardware of an economy may be likened to the life-support systems of the body. Indeed, they facilitate the flow and accumulation of knowledge, the industrial process of production and manufacturing, the movement of goods and services, the defence of key assets, the making of informed choices that safeguard the existence of economic activity and society, and provide for the physical and mental wellbeing of people.

More to the point, good public infrastructure encourages the entry of new and innovative firms into the marketplace as it reduces the sunk costs involved in the start-up of businesses (Audretsch et al., 2015). Indeed, good functional public infrastructure better facilitates the movement of information, resources, capital, equipment, and workers in the modern world. Telecoms and the internet allow for the freer movement of knowledge; roads, rail, and ports allow for the movement of people and goods; education and healthcare services produce healthy competent stores of labour, and electricity production supports most other processes and services in the economy. As a key input in the production processes of goods and services, efficiency and sustainability in the production of electricity affects the sustainability and carbon-intensity of the entire economy and renewable energies are key here to the transition away from fossil fuel based power to a low-carbon future.

Infrastructure maintenance and upgrading underpin the functioning of the market system by promoting efficiency, minimising information asymmetries; fostering greater competition among firms by promoting a level playing field; and compensate in markets where private provision would not take place at the optimal level due to market failures. This is particularly true of renewable energy technologies where initial adaptation is costly and there is an incentive to remain in fossil fuels. Other infrastructural services that uphold the rule of law through the courts and policing ensure a secure operating environment for businesses by protecting against theft and infringement of property rights.

4. Infrastructure and Inclusive Development

Infrastructure relates to inclusive social development and social cohesion in several ways. Indeed, it is "well recognized that civil infrastructure systems are essential in providing the range of services generally considered necessary to support a nation's economic wellbeing and quality of life" (Little, 2005, p. 263). In a modern economy, the free movement of people and information is vital to the functioning of markets as it allows workers to commute between home and work and information about economic opportunities and transactions to be easily disseminated throughout the economy.

This is particularly pertinent in South Africa due to the Apartheid-era segregation of urban spaces along racial and class lines, which means that workers are often resident far from business hubs and industrial activity. Thus, affordable and integrated public transport is key to maximising opportunities for inclusive development in South Africa going forward. Furthermore, access to reliable means of communication is also key to including people in the information economy and mobile phones play a significant role here, especially in the African context, with millions living in informal settlements.

Moreover, the provision of electricity, water, and wastes services is important to the mass inclusion of people in the economy as it provides opportunities for dignified, secure, and sanitary living. Public healthcare and education of a decent standard help to develop human capital stores and provide businesses, entrepreneurs, and government, with a skilled, capable and healthy workforce, which can be employed productively in the economy. When combined with capital investment in plant and equipment, this can improve overall total factor productivity and enhance competitiveness.

In general, developed physical infrastructure promotes accessibility and connectivity within and among countries. This makes logical sense as improved infrastructure reduces the spatial and temporal gaps in urban spaces as well as the divide between urban economic centres and rural areas where opportunities for employment may be dependent on linkages to upstream power generation as well as downstream processing facilities in the large industrial zones and metropolitans. In the regional context, greater connectivity also improves outcomes for specialisation and trade.

Developed public infrastructures, including transport and information networks, promote inclusivity by enhancing connectivity and linkages among people. This allows workers to find and access suitable employment. Furthermore, such infrastructure promotes the realisation of economic opportunities for entrepreneurs because it aids in the entrepreneurial decision and promotes start-up activity. This positive effect of infrastructure development on promoting entrepreneurial activity is particularly true of broadband technology on high-tech sector start-ups (Audretsch et al., 2015). This works by reducing the cost barriers associated with market entry and start-up. Furthermore, better communication infrastructure facilitates an exchange of information that promotes the identification of new economic opportunities and avenues for exploiting these. This allows entrepreneurs to take advantage of economic opportunities because it improves access to information, resources, labour, and markets, and comprehensive social services develop human capital and promote social cohesion.

Better more sustainable electricity generation provides people with an amenity essential to modern life and the need to save time and make use of modern technologies, which improve living standards while safeguarding the environment. Indeed, functional infrastructure, and especially green infrastructure, also promotes social cohesion by providing social and environmental services that improve living conditions in the built environment and help to level the playing field between different social classes and promote holistic wellbeing by reducing pollution and leakages of waste material.

5. Infrastructure and the Transition to a Low-Carbon Economy

Infrastructure can lead the way toward the transition to a low-carbon economy. Indeed, electricity production, which is a form of infrastructure, is often produced by the public sector and is a major source of emissions in many industries. Consequently, renewable energy production and more efficient use of fossil fuels in the production of electricity in itself can lower national emissions dramatically. This can have a knock-on effect in the private sector by encouraging manufacturers and other businesses to become more efficient in their use of energy in their production processes. Moreover, investment by state players in the renewable energy sector can help lower the cost of implementation and promote private sector buy-in, which promotes low-carbon energy production.

In this vein, investment in renewable energy technologies and production is vital to promoting the sustainability of many other industries. Indeed, the NDP highlights the mining and minerals sector, which is highly electricity-intensive, as a key beneficiary of renewable energy (electricity) production which would help the industry reduce its CO_2 emissions profile (National Planning Commission, 2011).

Moreover, renewable energy technologies reduce overall emissions and thereby help mitigate against the effects of climate change despite the fact that their manufacture and installation requires a higher use of material inputs than more traditional power generation technologies (Hertwich et al., 2015).

Furthermore, infrastructure like roads, storm water drains, and plumbing systems present massive opportunities for water conservation and prudence in the use of water. Indeed, water used for bathrooms and kitchens could be piped-in separately to conserve resources in water sanitation processes. In this way, potable water should not be used for irrigation or to flush toilets. Such a distinction could be possible in the built environment to preserve drinkable water and minimise wasteful processing of water resources for use in functions where less processed water would suffice.

Moreover, modern technologies present opportunities to generate electricity and collect water within the built environment such as solar power generation capacities designed into roads, bridges, and dams. Greater reliability, affordability, and connectivity of the public transport networks can also reduce emissions (and congestion) by getting cars off the road and people into busses and trains. Improved educational services can make people more conscious of the environment and promote ecologically friendly lifestyle practices. Public waste disposal systems that make sorting household garbage compulsory could reduce the demand for landfill sites and promote recycling efforts.

Infrastructure spending on new technologies that are expensive can help sweeten the pill for the private sector who may have a perverse financial incentive to continue to support cheaper dirtier technologies rather than adapting to renewable energy alternatives. Nevertheless, successfully decoupling greenhouse gas emissions from infrastructure investment can pave the way to developing a virtuous cycle of low-carbon economic growth (Kennedy and Corfee-Morlot, 2013). Public buy-in can thus promote private buy-in and achieve the requite scale requirements for further advances to be made and for these innovations in green technologies to become more cost-effective and enticing.

Better more integrated infrastructure like the greater use of rail can also reduce the emissions and wear-and-tear on roads associated with road freight and facilitate the movement of raw materials and agricultural produce from rural locations to urban spaces for processing and distribution. Advances in telecoms infrastructure, including drones, satellites, and infrastructure embedded with sensors for data gathering can help improve monitoring of the natural environment, the status of ecological encroachment, identify the industries that are responsible, and guide problem-solving solutions.

Improved law enforcement infrastructure (including policing and the courts) can enhance monitoring of those individuals and companies that commit infractions against the regulatory frameworks that are in place to protect the natural environment. Regulation at the legislative level can also guide and inform the transition to a low-carbon economy going forward. It can encourage industries to minimise their carbon emissions, improve efficiencies in their use of natural resources, manage their water use, operate responsibly within the locus of their operations with regard to natural habitat, and minimise their negative impact on biodiversity loss and the long-term health of ecological life-support systems.

Furthermore, green infrastructure in the built environment can provide environmental services in a similar way to how traditional infrastructure currently provides social services. Indeed, the examples mentioned above all imply infrastructure taking on a function in the ecology of the built environment. Renewable power generation designed into the landscape can reduce dependence on fossil fuels and mitigate against heat island effects in dense urban areas. Appropriate collection and processing of storm water run-off can help safeguard water resources and remove impurities resulting in similar outcomes produced by the systems of natural ecology, albeit through industrial or technical processes.

In a similar vein, adaptation to renewable energy technologies requires a non-traditional approach to investment and planning of infrastructure development. This is because technologies such a solar PV and wind are location dependent and are influenced by changes in sunlight, and wind direction and speed (Bridge et al., 2013). Furthermore, adaptation to such technologies, for private buy-in purposes especially, may not be common to the behaviour of entrepreneurs or business people in a country.

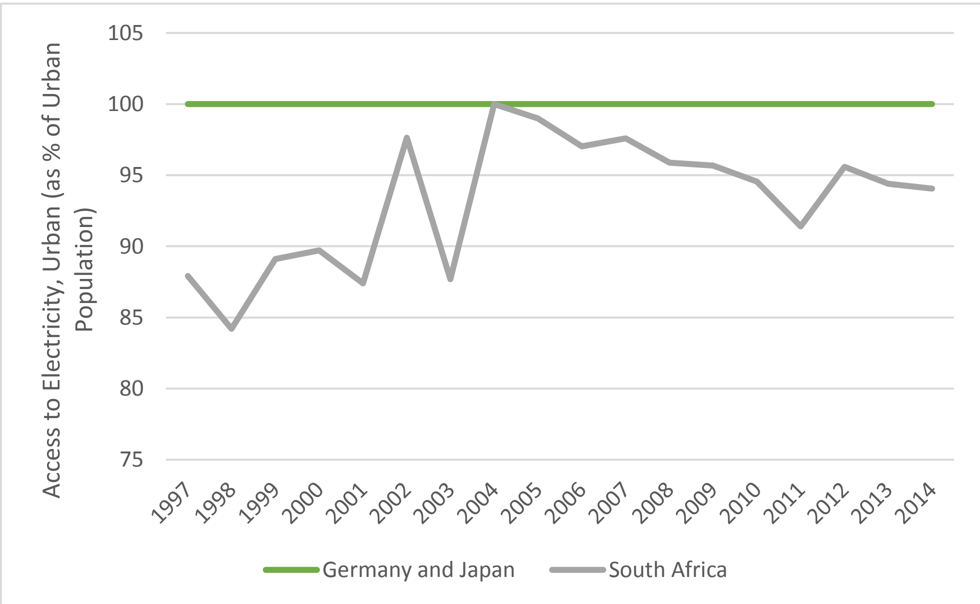
6. Case Study: Comparison of Infrastructure and Infrastructure Spending in Renewable Energy Generation in Germany, Japan, and South Africa

In this section, this paper will attempt to benchmark the state of one key infrastructure, that of electricity, in South Africa against that of Germany and Japan. These countries are considered because South Africa aims to pursue a similar style of industrialisation as Germany and Japan through the use of industrial policy and co-ordinated economic development. Furthermore, Germany is considered a leader in green infrastructure and adaptation to low-carbon technologies, and Japan represents a major advanced economy of the East Asian type with a need to transition to a low-carbon economy.

6.1 Access to Electricity

Figure 1 below shows access to electricity in urban areas (as percentage of urban population) for Germany, Japan, and South Africa. Evident from the graph is that Germany and Japan enjoy 100% access to electricity in urban areas. South Africa made significant gains between 1997 and 2004, however, access to electricity in South African urban locales between 2004 and 2014 has declined.

Figure 1: Urban Access to Electricity

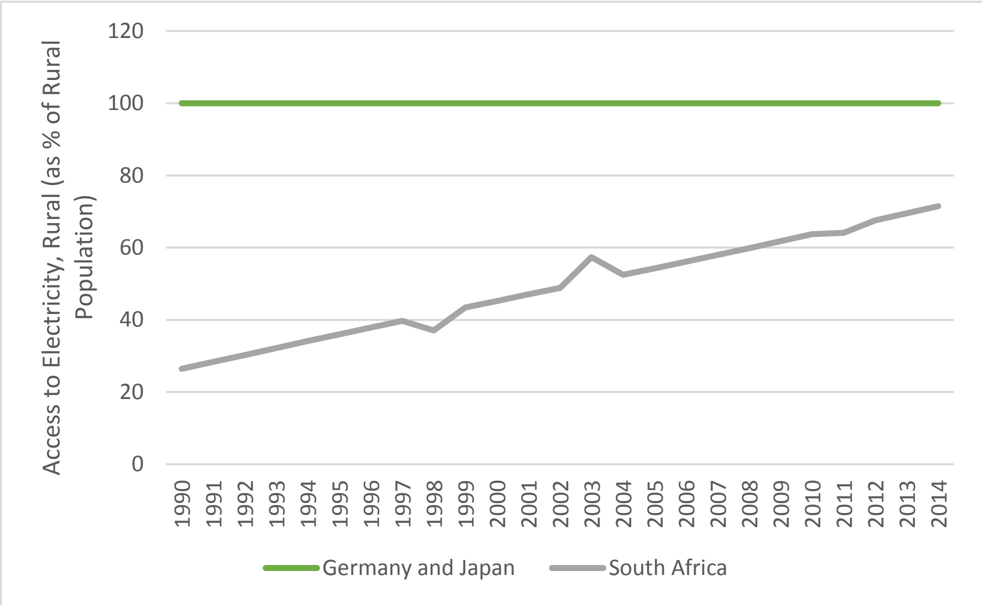


Source: (World Bank, 2017a)

Figure 2 below shows access to electricity in rural areas (as percentage of rural population) for Germany, Japan, and South Africa. Evident from the graph is that Germany and Japan enjoy 100% access to electricity in rural areas. South Africa has been making steady process toward greater level of electrification in rural areas between 1997 and 2014. This decline in access is most probably due to increasing trends toward urbanisation and the inability of infrastructure to keep pace with demand.

Moreover, the need for South Africa to generation more electricity is clear to ensure increased access to this key infrastructure, which improves human development and supports conditions for dignified living. Furthermore, the two graphs demonstrate an urban-rural inequality gap in terms of electricity access in South Africa. This situation means that electricity infrastructure in South Africa is not serving one of its cores functions by ensuring connectivity within the economy across time and space.

Figure 2: Rural Access to Electricity

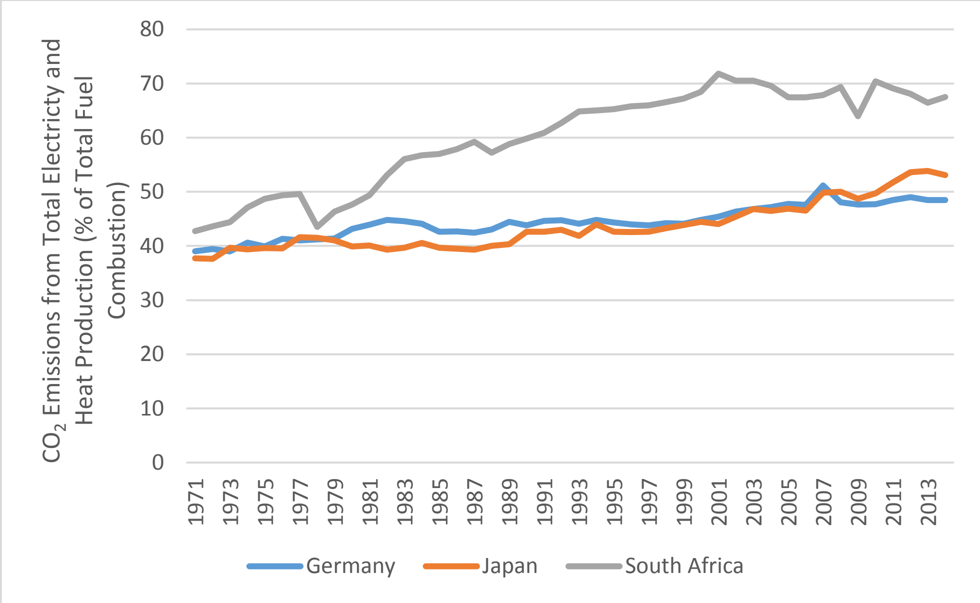


Source: (World Bank, 2017b)

6.2 Electricity Emissions, Energy Sources, Efficiency, and Consumption

Figure 3 below shows CO_2 emissions from the production of electricity in Germany, Japan, and South Africa. In absolute terms South Africa fairs badly against Germany and Japan. This is because it supports a smaller economy and a less populace country while emitting more. Indeed, South Africa experienced dramatic growth in emissions from electricity production between 1977 and 2001. Between 2001 and 2014 the rate of emissions in South Africa has cycled around with a slight trend toward declines, but emissions have risen again in 2013 and 2014. Germany experienced declines between 2007 and 2008 and now emissions from electricity production seem to have plateaued. Japan has experienced slow growth in electricity production emissions between 1981 and 2011 with recent declines between 2012 and 2014. Figures 4-6 below will unpack these observations further.

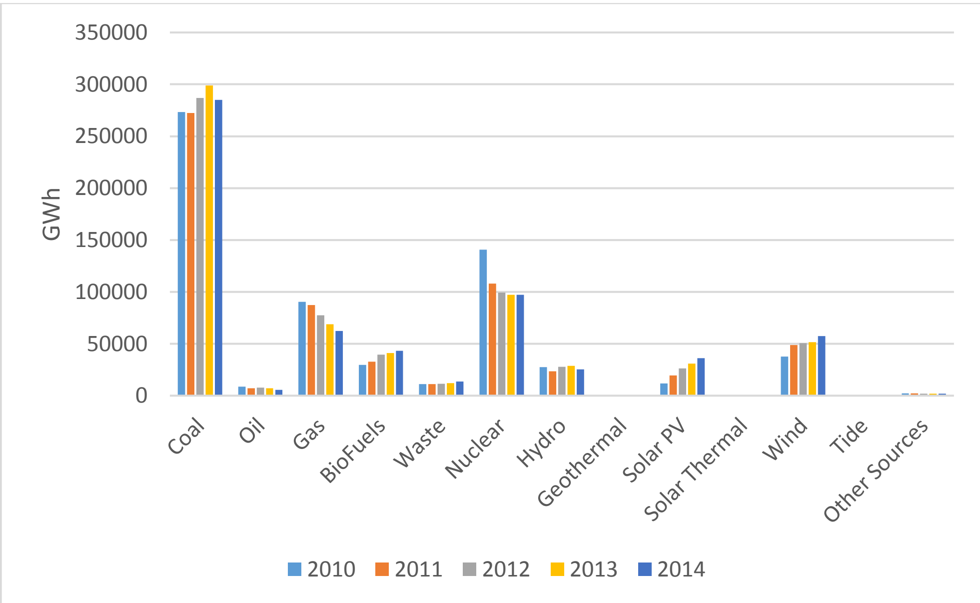
Figure 3: Electricity and Heat CO_2 Emissions in Germany, Japan, and South Africa



Source: (World Bank, 2017c)

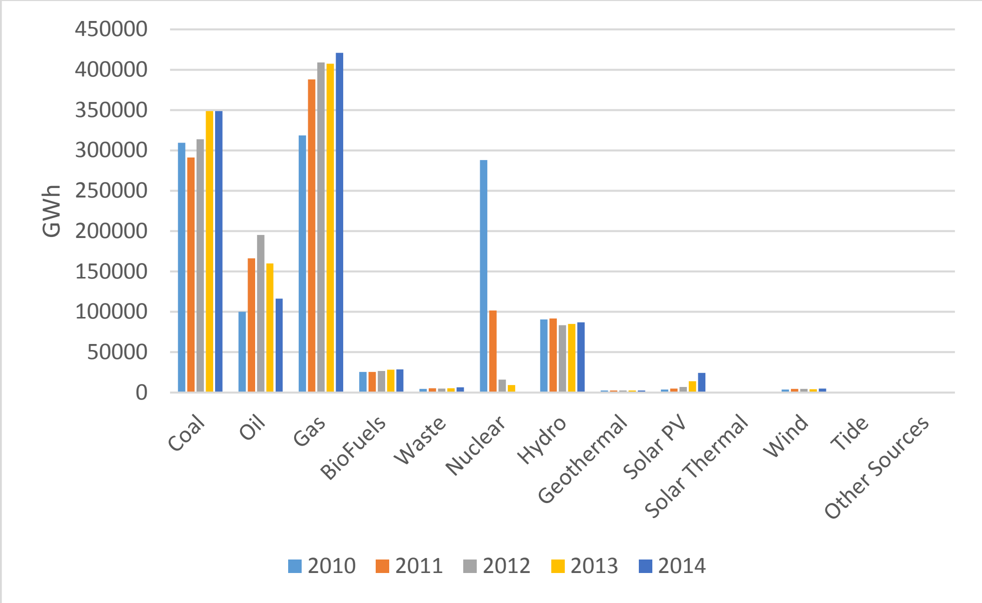
Figures 4-6 below show the baskets of electricity generation by source for Germany, Japan, and South Africa. These figures reflect domestic production and do not account for imports or exports of electricity to or from other countries. Figure 7 below shows the electricity lost in the production of distribution of electricity in the three countries. Figure 4 demonstrates that in Germany the relative reliance on different power generation sources is moving in favour of renewable energy. Indeed, between 2010 and 2014 biofuels, waste, solar PV, and wind reliance all increased. Germany is still heavily reliant on coal for electricity generation with only recent declines between 2013 and 2014, while reliance on oil and hydro appears steady, and the production of nuclear energy is declining.

Figure 4: Basket of Electricity Generation Sources in Germany



Source: (International Energy Agency, 2014)

Figure 5: Basket of Electricity Generation Sources in Japan

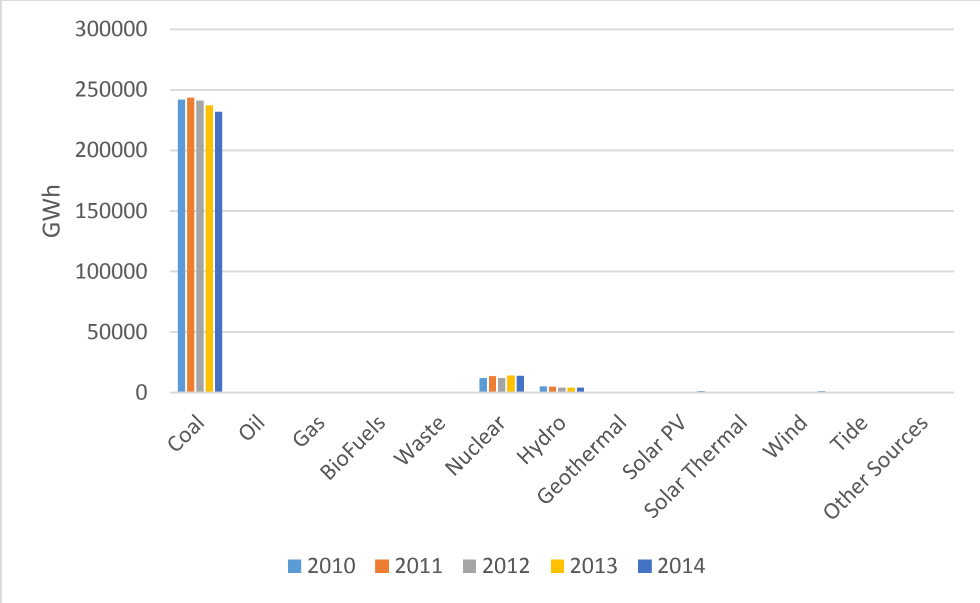


Source: (International Energy Agency, 2014)

Figure 5 above demonstrates that for Japan the basket of electricity generation sources is less reliant on renewable energy than Germany, but still with some positive trends toward developing renewables. Indeed, production, although limited, is steadily increasing for biofuels, waste, solar PV, and wind. However, the country is still heavily reliant on coal and gas for electricity generation and this reliance increased between 2010 and 2014. Nuclear energy production decreased over this period, while hydro remained somewhat constant, and electricity from oil spiked upwards in 2012 and has declined again between 2012 and 2014. This can be explained by Japan's need to shift away from nuclear energy in the wake of the Great East Japan Earthquake of 2011. Concerning though is that fossil fuels seem to have made up the difference in terms of satisfying Japan's energy needs.

Figure 6 below shows the energy generation basket for South Africa. Immediately evident is the unbalanced skewing toward coal for electricity production, although this is declining. Renewables such as biofuels, solar PV, and wind have been steadily increasing between 2010 and 2014. Regarding the contribution in terms of GWh, renewables are still too small for them to be significant. Reliance on nuclear has slightly increased, while electricity from hydro has declined slightly. More to the point, the target of 20 000 MWh produced from renewables by 2030 as laid out in the (National Planning Commission, 2011) seems a far-off and inconsequential goal given comparison with other countries.

Figure 6: Basket of Electricity Generation Sources in South Africa

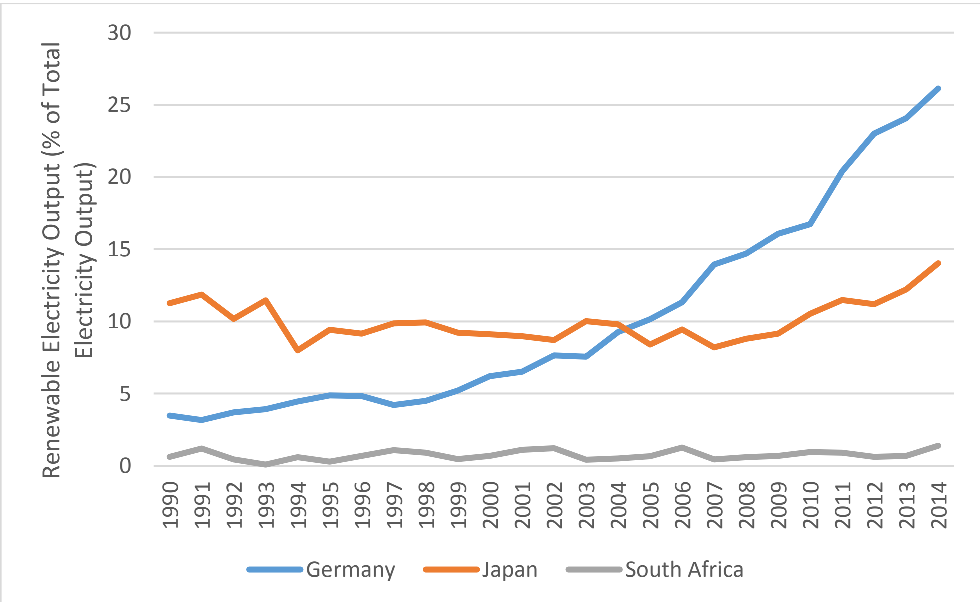


Source: (International Energy Agency, 2014)

Moreover, comparing the absolute figures of domestic electricity production for Germany, Japan, and South Africa, there have declines in output for both Japan and South Africa. Japan's electricity production appears to have stabilised between 2012 and 2014, while South Africa's shows a trend toward steady declines. By contrast, Germany's production of electricity has fluctuated over this period, but without demonstrating a trend to increase or decrease between 2010 and 2014.

Regarding South Africa's standing relative to Germany and Japan in terms of electricity production, the country is not faring well. Germany shows an excellent spread of reliance on fossil fuels and renewables with definite progress toward green sources of electricity. Japan is less developed in terms of renewables, however, it does show progress toward developing reliance on biofuels, waste, solar PV, and wind. By contrast, South Africa electricity production infrastructure shows a heavy reliance on coal and investments in and spending on renewables are not making a big enough impact in terms of satisfying the power requirements of the country (discussed below in sub-Sections 6.3 and 6.4).

Figure 7: Renewable Electricity Output in Germany, Japan, and South Africa

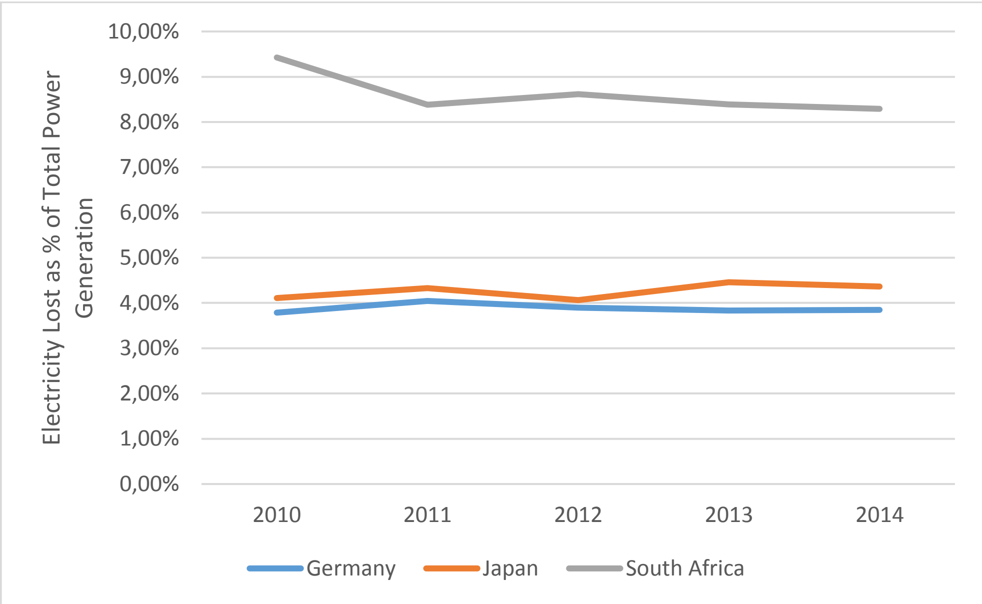


Source: (World Bank, 2017d)

The realities observed in Figure 4-6 are confirmed by a look over a longer time period in Figure 7. Indeed, Germany has outpaced Japan in its production of renewable electricity taking the lead among the three countries in 2004. Japan experienced declining contributions from renewable electricity between 1993 and 2007, but has since started to produce more electricity from renewable sources. Meanwhile, South Africa's position relative to the other two countries is poor and the trend seems to be plateauing with minor fluctuation down after the financial crisis and a recovery starting in 2013.

Furthermore, this distribution of electricity sources and the overreliance on coal by South Africa evidently has worse implications when looking at energy efficiency levels by country (i.e. electricity losses from the production and distribution of electricity in Germany, Japan and South Africa).

Figure 8: Lost Electricity as Percentage of Total Power Generation by Country



Source: (International Energy Agency, 2014)

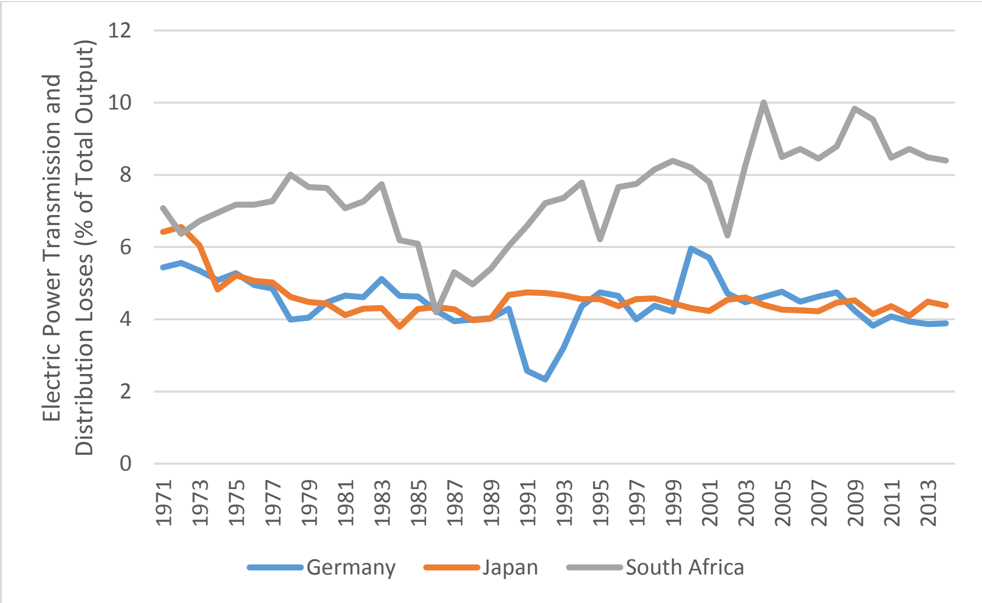
Figure 8 above shows the electricity lost in the production and distribution of power for Germany, Japan, and South Africa as a percentage of total domestic electricity production. The graph shows that South Africa is much more inefficient in terms of power losses than Germany and Japan. Indeed, South Africa loses about double (i.e. around 8%) the amount of electricity produced through its production and distribution infrastructure (compared to Germany and Japan at around 3% and 4%, respectively).

This situation bodes badly for South Africa in terms of benchmarking it against Germany and Japan. This is because not only does South Africa rely more heavily on fossil fuels for electricity production, a key national infrastructure, it wastes on efficiency in this production through losses from power plants and the grid. This suggests that South Africa's power network needs attention in terms of infrastructure upgrades not only to prioritise more renewable sources of electricity, but to increase the efficiency of the power grid so that resources used in the production of power are used optimally.

This picture of electricity losses by country is confirmed by a look over a longer time period in Figure 9 below. The graph shows that Japan has been becoming steady more efficient between 1990 and 2014. Meanwhile, Germany and South Africa experienced increased inefficiency during the early

2000s, but both countries have now made progress toward increased efficiency in the transmission and distribution of power. Nevertheless, South Africa is still significantly more power inefficient.

Figure 9: Electricity Losses as Percentage of Total Output

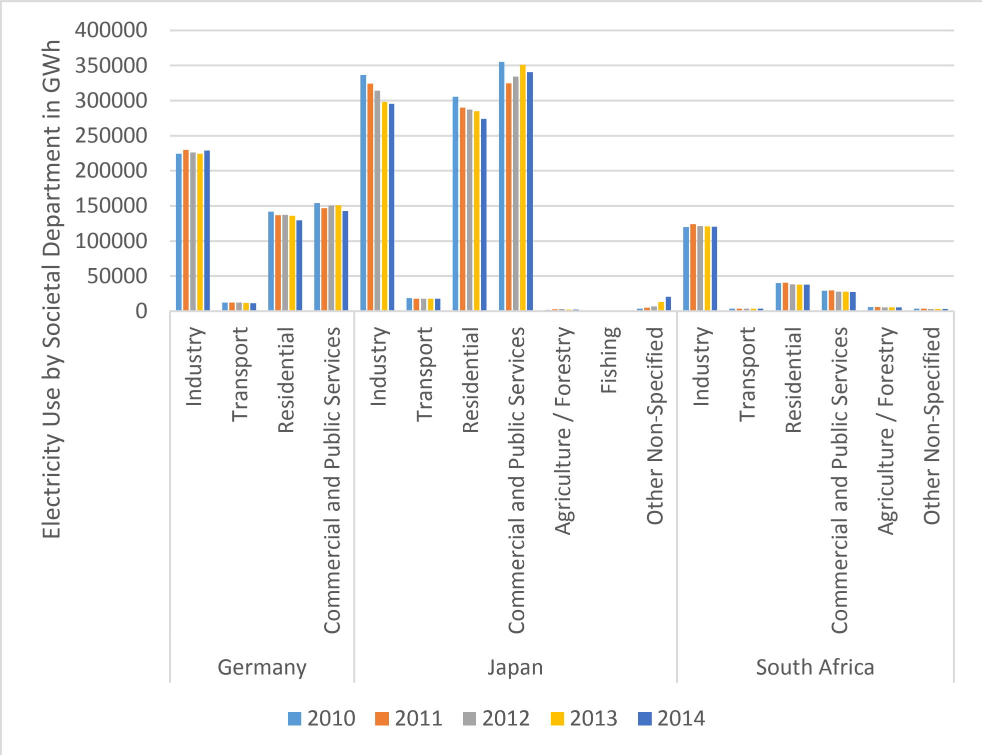


Source: (World Bank, 2017e)

The picture of electricity in Germany, Japan, and South Africa is made more interesting by a comparison of consumption figures in GWh in Figure 10 and as a percentage of total consumption by country in Figure 11. Figure 10 shows that Germany and Japan are more electricity-intensive economies with significantly higher rates of usage by "transport", "households", and "commercial and public services". Evident however, is that across all three countries with the exception of "commercial and public services" in Japan, electricity usage by societal department has been decreasing. What is more, this could be indication of improved energy efficiency on the consumption side of the equation.

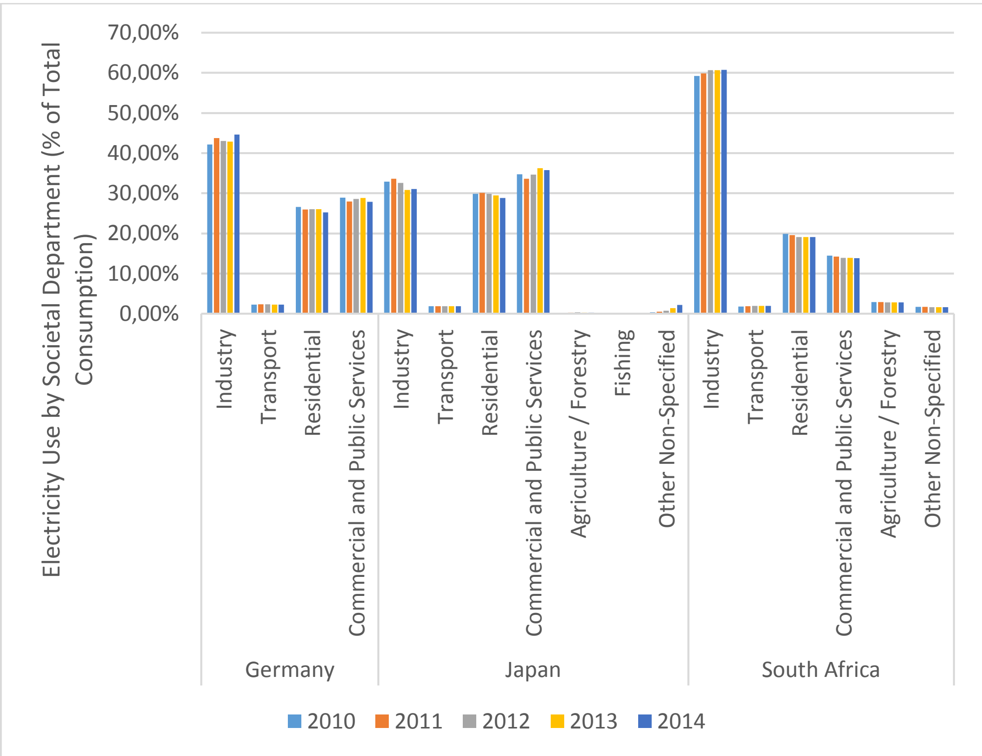
Regardless, the situation is even more interesting when looking at societal departments by percentage of total national consumption in Figure 11. In this case, "industry" in South Africa seems to be more energy intensive relative to Japan with Germany in the middle range of intensity, which suggests that a transition to renewable electricity would have a greater impact on the South African economy in terms of lowing emissions and promoting a low-carbon future for industry in the country.

Figure 10: Electricity Use (in GWh) by Societal Department



Source: (International Energy Agency, 2014)

Figure 11: Electricity Use (as Percentage of Total Consumption) by Societal Department



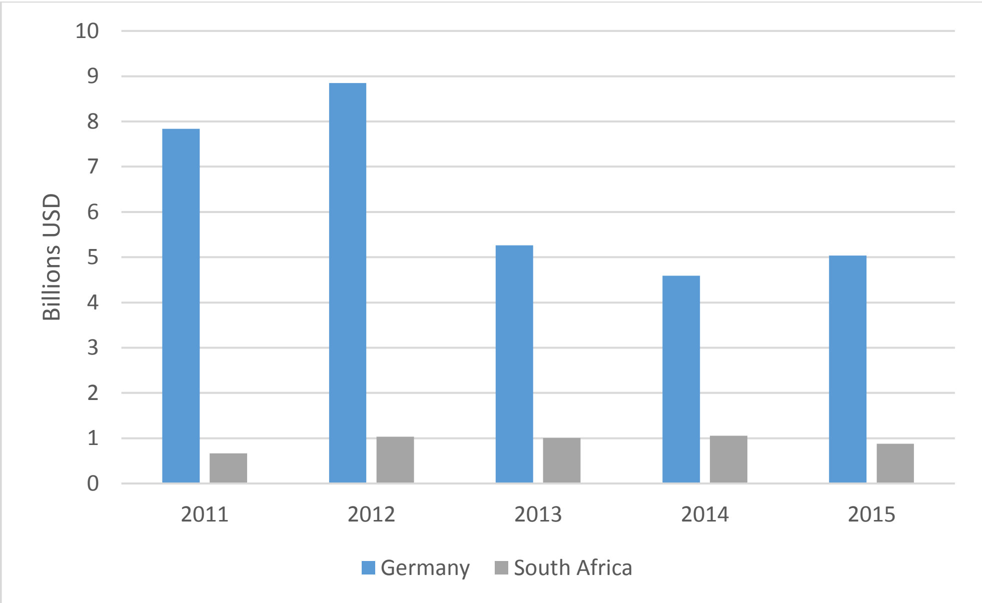
Source: (International Energy Agency, 2014)

6.3 Renewable Energy Development Finance

Regarding development finance for renewable energy sources this paper now compares financing for Germany and South Africa. Comparison with Japan was not possible as the Development Bank of Japan (DBJ) reports on infrastructure and green initiatives, but does not single out renewable energy. Figure 6 below shows the absolute financing of renewable energies by Kreditanstalt für Wiederaufbau (KfW) (Germany) and the Industrial Development Corporation (IDC) (South Africa) in current USD.

Evident from Figure 12 is that Germany's financing of renewable energies is far above that of South Africa. Furthermore, South Africa's financing grew from 2011 to 2014, but has recently declined in absolute terms. Germany's financing increased between 2011 and 2012, but then shrank dramatically in 2014, and has recently increased in 2015. Considering that South Africa is way behind Germany in terms of its basket of sources of electricity it is noteworthy that Germany is still spending massively on renewable energies and that South Africa is lagging behind in term of production and investment.

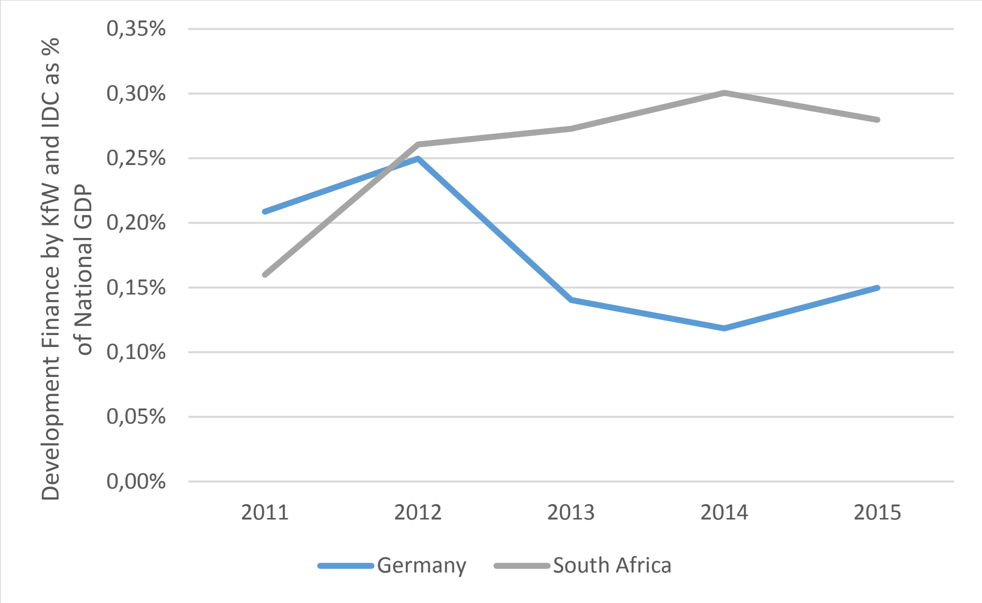
Figure 12: Development Finance by KfW and IDC in Renewable Energies



Source: (IDC, 2015; KfW, 2015)

Figure 13 below shows this development financing by KfW and the IDC on renewable energies as a percentage of national GDP. The trend here is different compared to the absolute figures. Indeed, South Africa's contribution to financing of renewable energies via the IDC as a percentage of national GDP grew steadily between 2011 and 2014 and has recently declined in 2015. Whereas Germany's (via KfW) increased between 2011 and 2012, declined markedly between 2012 and 2014, and has increased again in 2015. In terms of this benchmarking measure, South Africa is doing better than Germany and shows that there is definitely initiative to get renewable energies up-and-running.

Figure 13: Development Finance by KfW and IDC as Percentage of National GDP

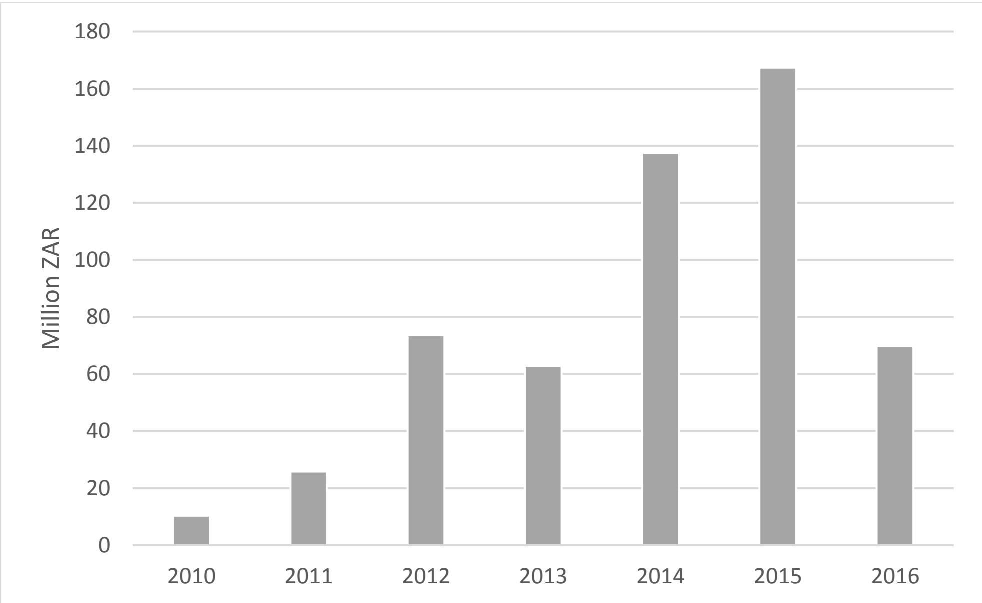


Source: (IDC, 2015; KfW, 2015; World Bank, 2017f)

6.4 Government Spending on Renewable Energy Infrastructure

Figure 14 below shows the allocation in the South African National Budget to renewable energies. The graph shows that expenditure on this item grew substantially between 2010 and 2015 with a slight dip in 2013. However, expenditure on renewable energies halved in 2016. Noteworthy, is that expenditure by national government is far less than that of the IDC in Figure 12. This demonstrates that the South African government is not taking a leadership role in this area, which is unfortunate.

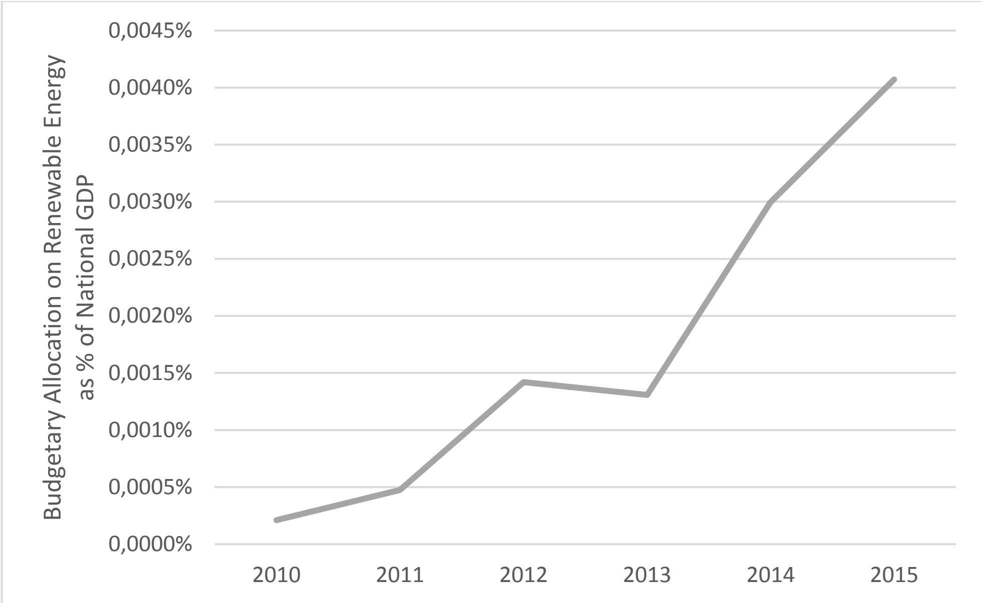
Figure 14: South African National Budget Allocation on Renewable Energies



Source: (National Treasury, 2017)

Figure 15 below shows the data in Figure 14, South African government spending on renewable energy, as a percentage of South African GDP. Figure 15 shows that government spending on renewable energy has increased as a percentage of GDP between 2010 and 2015, but that this is a very small percentage of national GDP. The story in the graph is one of the situation improving, but that the contribution by the South African government to renewable energy seems rather insignificant to make an impact on the country's reliance on coal-based electricity production.

Figure 15: South African Government Spending on Renewable Energy as Percentage of GDP

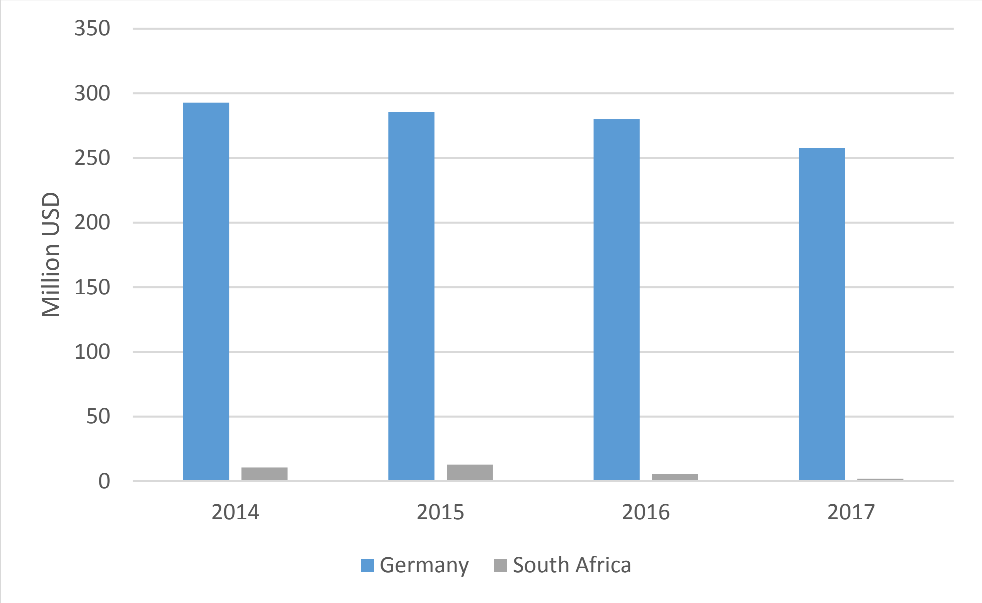


Source: (National Treasury, 2017; World Bank, 2017f)

Comparison with Germany and Japan was challenging as English language translations of national budgetary allocations in these two countries appear rudimentary and do not always specifically identify allocations to spending on renewable energy sources. Nevertheless, some limited comparison with Germany was possible. Figure 16 below shows spending on developing renewable energies infrastructure in Germany and South Africa in USD. Evident from the graph is that Germany again spends significantly more on developing renewable energy sources than South Africa. Moreover, in both countries spending on renewable energies is declining in absolute terms.

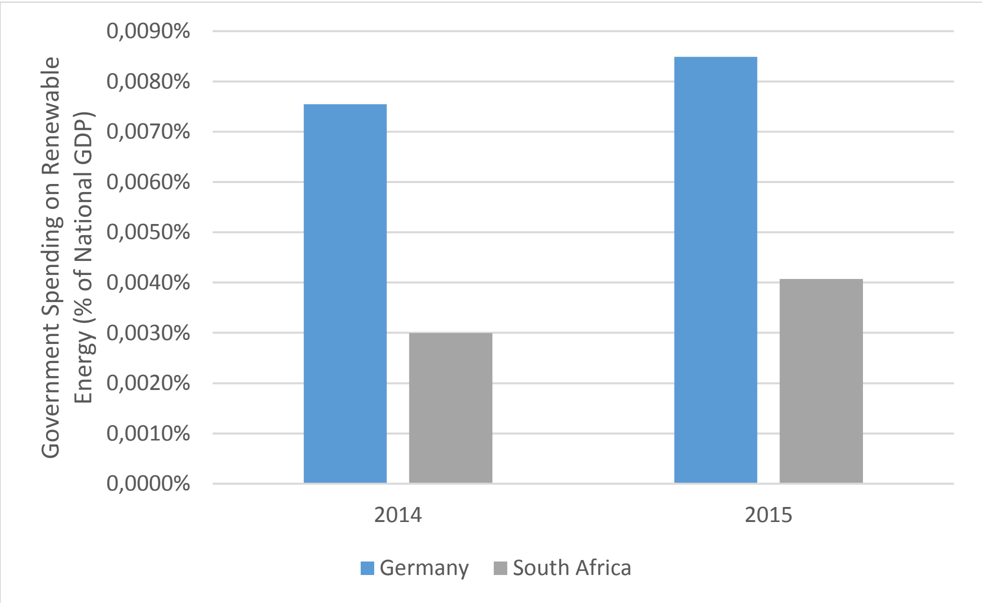
Figure 17 below shows the data from Figure 16 as a percentage of national GDP. The results are somewhat different in this case as Figure 17 demonstrates that South Africa is not faring as badly as the picture painted in Figure 16. Indeed, South Africa spending on renewable energies by this measure was about half that of Germany's in 2014 and 2015, and furthermore, as a percentage of GDP both countries' spending on this budget item increased. This suggests that the declines in spending are due to the global economic downturn and not to a change of priorities away from renewable energies.

Figure 16: Government Spending on Renewable Energy in USD



Source: (BMWi, 2017; National Treasury, 2017)

Figure 17: Government Spending on Renewable Energy as Percentage of National GDP



Source: (BMWi, 2017; National Treasury, 2017)

7. Renewable Energy Policy in South Africa

The picture in Section 6 appears at first glance disappointing. Indeed, South Africa still has ways to go in terms of improving its electricity infrastructure. The country needs to improve access to electricity in urban and especially rural areas; diversify its sources of electricity generation away from coal and toward renewable energy sources; improve efficiency in the transmission and distribution of electricity to optimise the use of natural resources; and commit more development and government financing to the project of developing renewable electricity infrastructure in South Africa.

The current spending patterns on renewable energies by the IDC and the South African national government are not sufficient for the transition to a low-carbon economy via renewable energy production. This is because the transition to sustainable energy necessitates a vibrant implementation and adaptation to renewable energy technologies in order to not disrupt the supply of electricity and to facilitate the transformation of electricity infrastructure networks which use different specifications to traditional fossil fuel based electricity production technologies and networks (Roelich et al., 2014).

Consequently, renewable energy infrastructure cannot be seen as an augmentation to the economy, but rather the transition to a sustainable supply of electricity requires a transfusion of one of the life-blood systems of the country's economy. Green infrastructure must crowd out fossil fuel based energy production and for this to occur rampant and aggressive efforts are required to instigate the change.

What is more, in the absence of dynamic policy action there is a danger that a lock-in effect will occur. Indeed, current fossil fuel based electricity production technologies can only be replaced by industry and policy-makers through an aggressive roll-out of renewable energies because it necessitates the overhauling of the transmission and distribution system that links electricity to the economy. This is crucial if transition to a low-carbon future is to be effective and result in a reduction in CO_2 emissions.

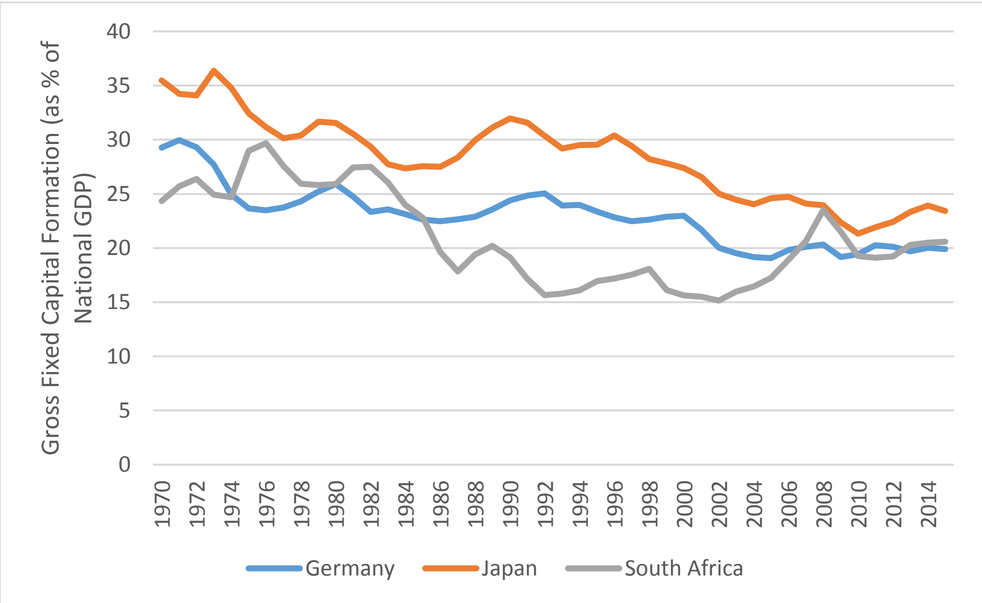
Moreover, investment in renewable energies present opportunities for inclusive development through job creation opportunities, increasing the supply of electricity to ensure more people have access to dignified living, fostering the development of upstream manufacturing centred around the development and installation of renewable energy technologies, and by ensuring that the natural environment and the climate are safeguarded. Furthermore, renewable energy and upgrading the electricity infrastructure to reduce power losses will enhance the energy efficiency and sustainability of all other sectors and public services that rely on electricity as a key input in the production process.

Therefore, the greening of electricity generation in South Africa is a key and primary step required to green the entire economy and initiate the transition to a low-carbon future. Indeed, currently our electricity production is too carbon-intensive and the country still has ways to go in terms of economic development. It is crucial that South Africa head down a sustainable path in pursuing development and long-term economic growth, which is supported by a decreased reliance on coal-based electricity.

Both the New Growth Path (NGP) and the National Development Plan (NDP) identify renewable energy development and production as key to the transition to a low-carbon economic future in South Africa. Indeed, the NGP sees a doubling of electricity capacity by 2030, 33% of which coming from renewable sources (EDD, 2011, p. 28). In pursuit of this goal the NGP see government collaborating with Development Finance Institutions (DFIs) and State-Owned Enterprises (SOEs) to upgrade electricity infrastructure in the country (EDD, 2011, p. 56). Nevertheless, the NDP highlights the issue of high capital-intensity costs related to the start-up of renewable power generation facilities for electricity and their limited contribution to the national grid (National Planning Commission, 2011, p. 45). The NDP aims to procure 20 000 MWh worth of renewable electricity production, import electricity from the region, de-commission 11 000 MWh worth of coal-based power stations, and encourage investments in energy-efficiency (National Planning Commission, 2011, p. 46).

Indeed the need for greater regional integration on the energy front was raised in the NGP regarding the need develop infrastructure and manufacturing capabilities in the region to support the renewable energy sector (EDD, 2011, p. 57). On the domestic front, the NDP states that South Africa has missed a generation of capital investment in infrastructures, including, electricity. Indeed, capital investment fell from 30% of GDP in 1980 to 16% by the early 2000s (National Planning Commission, 2011, p. 44). Therefore, according to the NDP, gross fixed capital formation must increase to 30% of GDP by 2030 and public sector investment being 10% of GDP for infrastructure improvements to deliver public services (National Planning Commission, 2011, p. 44). Figure 18 below shows that currently gross fixed capital formation for Germany and South Africa is around 20% of GDP while that of Japan is around 24% of GDP. South Africa's position has strengthened since the early 2000s, but recently plateaued.

Figure 18: Gross Fixed Capital Formation as Percentage of National GDP



Source: (World Bank, 2017g)

On another positive note, the commencement of the South African Green Fund, with a total budget of 1.1 billion ZAR, under the auspices of the Department of Environmental Affairs, and administered by the Development Bank of Southern Africa, there is a renewed focus on developing renewable energies including off-grid and mini-grid generation capabilities (DEA, 2016). This clearly shows that there is government initiative behind reinforcing South Africa's energy needs through the development of renewable electricity infrastructure. To date, the Fund has approved financing of projects in "energy efficiency" (to the values of 12.3 million ZAR), "energy efficiency and demand size management" (to the value of 50.8 million ZAR), and "renewable energy" (to the value of 204 million ZAR), among others, representing 0.0035%, 0.0145%, and 0.0581% of 2014 national GDP respectively, which is comparable to the levels of investment in the National Budget (SA Green Fund, 2014).

Regarding the improvement of electricity efficiency in the country, the Department of Energy (DOE) has the "Sub-Programme 2.4: Electricity, Energy Efficiency and Environmental Policy" (DOE, 2016, p.

60). This aims to improve the management of electricity demand; provide universal access to electricity; improve efficiency in the transmission and distribution of electricity through infrastructure upgrades; and safeguard electricity supply by encouraging greater competition in the electricity production market through the entry of independent power producers (IPPs) and the supply of capital for electricity infrastructure. The DOE spent 6.667 million ZAR on this programme in 2015 (DOE, 2015a). This represents 0.0021% of 2015 national GDP, which is comparable to national expenditure.

Furthermore, the DOE has "Sub-Programme 6.1: Energy Efficiency", which aims to advance "energy efficiency in South Africa by planning and coordinating initiatives and interventions that are focused on developing and improving the energy efficiency market which ensures the integration and coordination of energy efficiency initiatives and interventions with relevant associated institutions" (DOE, 2016, p. 113). In the 2015 Report no finance was allocated to this programme (DOE, 2015a).

The DOE also has the "Sub-Programme 6.2: Renewable Energy". This aims to promote the integration of renewable energy into "South Africa's mainstream energy supply by planning and coordinating initiatives and interventions focused on the development and improvement of the renewable energy market" (DOE, 2016, p. 115). Furthermore, in partnership with local and international institutions, it integrates and coordinates renewable energy initiatives and interventions. The Department spent 4.913 million ZAR on this programmes in 2015 (DOE, 2015a). This represents 0.0013% of national GDP, which is comparable to expenditure by national government like with Sub-Programme 2.4.

In another vein, there is the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP), which aims to increase South Africa's supply of renewable energy, encourage foreign investment in the renewable energy sector, and create more competitive pricing in the energy marketplace. This is the fastest growing renewable energy programme of its kind in the world and it is the leading infrastructure development programme in South Africa (DTI, 2016a). As of October 2016, REIPPPP had resulted in 6 376 MWh of electricity procured from 102 renewable energy IPPs in six rounds of bidding (DTI, 2017, p. 15). In addition, all projects (comprising 51 IPPs) from the first two rounds of bidding are operational providing 2 738 MWh of electricity generation capacity have been connected to the national grid. Furthermore, the REIPPP has resulted in total investments worth 194.1 billion ZAR, including 53 billion ZAR (27%) from foreign investors. According to IPAP 2017/18 – 2019/2020, REIPPPP has created 28 484 job years[1] and generated 256.2 million ZAR in socio-economic development contributions and 80.5 million ZAR in enterprise development contributions (DTI, 2017).

The first three bidding round of REIPPPP have resulted in socially inclusive outcomes. Indeed, for the 62 project represented black South Africans have a 30% shareholding of which 11% is held by local communities (DTI, 2016b). Furthermore, local content in these projects amounted to 49% and 111% of planned employment, which together promote local economic development, capacity building in support industries, and social upliftment through earned incomes for local community workers.

Evidently, South Africa is making progress on encouraging the development of renewable energy supply through its strategy of relying more on private buy-in than through state-led investment. Moreover, the competitive bidding process of REIPPPP is in-line with founding policy papers concerning renewable energy in South Africa, including, the White Paper on Energy Policy (1998), Renewable Energy White Paper (2003), and the National Climate Change Response Policy White Paper (2011). This is because the approach does not burden the state with the need to support expensive subsidisation programmes, but rather seeks to instigate reforms through private investment.

[1] A job year is defined as follows: 1 job year = 1 job for 1 year.

Moreover, the REIPPPP process, and the IPPs generally under the auspices of public procurement, improve several market conditions in the electricity supply marketplace. These benefits include, the diversification of the electricity supply basket through the private sector buy-in and a crowding-in effect, the encouraging of new skills and approaches to renewable energy technologies, crosscutting investment in infrastructure, and increased competition over product and pricing (DOE, 2015b, p. 67).

This piecemeal approach to the transition to clean energy is also in-line with the Integrated Resource Plan for Electricity 2010-2030 (2010), to encourage development of South Africa's electricity infrastructure, secure energy supply, and plan for the country energy needs going forward in-line with the socioeconomic objectives set out in the NDP. This includes obtaining electricity from renewable energy sources that integrate localised electricity supply, including small-scale operations, to augment the supply and ensure electricity security and improved energy efficiency of the national grid. The Plan also aims to integrate electricity in the region better with several renewable energy sources identified.

Consequently, although the data point in Section 6 paint a dismal picture in absolute terms, the policy and programmes discussion frames South Africa's transition to a low-carbon economy in a more positive light. Indeed, South Africa is still a developing country with other budgetary commitments including to social welfare spending, the need for broad-based economic development, and the expansion of several key infrastructure services to cater for the majority of South Africans in an era of democracy and equal opportunities. Indeed, the benchmarking exercise should not be taken as implying that South Africa should be where Germany and Japan are today. Instead, the exercise actually demonstrates that South Africa is doing remarkably well on the transition to renewable energies given it other broad socioeconomic commitments and it upper-middle income status.

Also noteworthy is that the transition to renewable energies is challenging for any country. Indeed, in the wake of the 2011 Great East Japan Earthquake and the need to close operation at all nuclear power plants in Japan, the data in Section 6 demonstrates that Japan has relied on coal- and oil-based electricity production to satisfy its energy requirements for it large industrialised economy.

8. Conclusion

This paper has established the important relationship between infrastructure in an economy, economic development, social inclusion, and the transition to a low-carbon future. In terms of benchmarking South Africa against Germany and Japan, several obstacles are noteworthy. Firstly comparing green infrastructure is complicated by its inclusion in infrastructure in general and other green initiatives. Second, different countries have different reporting standards in terms of how they report spending on green-related endeavours. Third, language in the reporting of spending was a challenge as English language translations seem to have not been as comprehensive as their German and Japanese language equivalents. Finally, there is not a clear separation of terms between climate, the green economy, and green infrastructures, which presented challenges for evaluation.

Nevertheless, this paper has attempted to benchmark South Africa against Germany in terms of one key infrastructure, that of electricity, which is considered important to the transition to a low-carbon future while also realising social inclusion. By various measures, South Africa appears to be carbon-intensive both in terms of its electricity generation and overly reliant on coal. However, some positive progress is being made and renewables are steadily growing and receiving development finance. Furthermore, the policy environment in South Africa is supportive of the strategy to achieve the transition to renewable energy through policies and programmes that support private sector buy-in.

9. Recommendations

- South Africa must lower its CO_2 emissions from the production of electricity, as the economy is currently highly carbon-intensive in terms of electricity production.
- South Africa must lower its reliance on coal as a source of electricity generation.
- South Africa must diversify its basket of electricity generation sources.
- South Africa must prioritise the development of renewable energy sources so that these contribute GWh (not merely MWh) to the national grid.
- Infrastructure upgrades are required in South Africa in the production and distribution of electricity to minimise power losses and the wastage of inputs such as coal in the generation of electricity.
- South Africa must continue to invest more in renewable energies to better enhance the diversification of the basket of electricity generation sources.
- The South African government must prioritise investment in renewable energies better and continue to increase the allocation in the national budget.
- South Africa must consider a dual approach to transitioning to renewable energies in that it should continue to encourage private buy-in but provide greater leadership from national government in terms of financing renewable energy to instigate radical, dynamic, and transformational progress.

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