

Turning points for sustainability transitions: Institutional destabilization, public finance and the techno-economic dynamics of decarbonization in South Africa

Author: Dr David R Walwyn

Affiliation: Department of Engineering and Technology Management, University of Pretoria

Email: david.walwyn@up.ac.za

Mail Address: The Department of Engineering and Technology Management, University of Pretoria, Private Bag X20, Hatfield, Pretoria 0028, South Africa

Physical Address: Room 2-18, Engineering 2 Building, Hatfield Campus, University of Pretoria, Pretoria, South Africa

Abstract

Existing socio-technical systems tend to be intransigent to change. Decarbonisation, on the other hand, is an imperative, leading to an obvious conflict between the need for, and highly effective resistance to, change. Moreover, the abandonment of fossil fuel-based technologies in favour of more sustainable alternatives will require substantial reallocation of government's operational expenditure, particularly in countries like South Africa with high per capita greenhouse gas emissions and low per capita income. In this article, it is argued that reallocation will require more than niche experimentation and destabilisation of the present socio-technical regime. Based on a study of South Africa's budget processes, it is concluded that change will only occur when four separate pre-conditions converge, namely a rapidly growing environmental problem capable of leading to civil unrest, a supportive and recently developed policy framework, decreasing techno-economic costs for its solution, and strong political support from an effective ministry or minister. Turning points for transition, although infrequent, can be reached through strategic attention to these pre-conditions. A modified Kingdon multiple streams approach, which introduces the additional dimension of techno-economic feasibility, is proposed as a useful framework for anticipating when and how to act in order to mobilise sufficient public resources for decarbonisation.

1. Introduction

The decarbonisation of energy and other systems is essential for the transition to a low-carbon future [1]. Many countries have committed to binding targets for greenhouse gas (GHG) emissions, including the attainment of net zero emissions by 2050 [2]. The Paris Agreement is clear on what countries need to achieve in terms of such emissions, and over what time period these Nationally Determined Contributions (NDCs) must be realised [3]. However, the costs of decarbonisation have not been similarly specified in the agreement. Individual countries are only now beginning to fully understand and quantify what investment will be required to reach the NDCs, and how these funds might be secured.

Some initial assessments have been reported in the literature [4-7]. For the United Kingdom, it has been estimated that the plan to reach net zero GHG emissions by 2030 will cost \$1.3 trillion or \$3,571 per metric tonne (MT) carbon dioxide equivalent [8]. A similar value has been estimated for the United States of America, where the cost of replacing fossil fuels in the energy sector is estimated at \$4.7 trillion or \$2,666 per MT carbon dioxide equivalent [9]. These values can be more easily comprehended by firstly calculating a total cost based on the present carbon emissions, then annualising this cost by assuming that the transition to low-carbon will take place over a 30-year period (2020 to 2050), and finally expressing the annual cost as a proportion of gross domestic product (GDP). The normalised costs of decarbonisation for the United Kingdom and the United States of America are estimated at 1.3% and 2.3% of GDP respectively, whereas for South Africa the value is about 12%.

The issue of cost will be particularly acute for South Africa [10]. It is an upper middle-income country, heavily dependent on coal as a source of both electricity and liquid fuel [11, 12]. Decarbonisation of the energy sector will be a formidable undertaking, whose solution is made more difficult not only by the extent of the economic disruption and social dislocation that may result, but also by the constrained resources with which to address the issue [13, 14]. A similar conclusion about the limited readiness of South Africa for a low-carbon future has been reached by the World Economic Forum, which has placed the country in the 114th position out of 115 countries based on the Energy Transition Index [14, 15].

Already South Africa has been criticised for its insufficient progress towards the attainment of the country's NDC targets [16]. There is concern about its renewable energy programme, including ongoing delays [17], a poor outcome relative to the intended targets for economic development [18], and general deficiencies in the implementation of off-grid solar home systems [19-21]. The government has also significantly alleviated the impact of a recently introduced carbon tax, and is failing to adequately resource the realisation of its NDCs [10]. Moreover, the COVID-19 pandemic has caused a massive shock to the economy, reducing tax revenue collection by 20% and cutting at least 6% from the GDP [22]. In short, the South African government appears unwilling and increasingly unable to resource its low-carbon transition.

The issue of public sector resource allocation is critical for sustainability transitions. Budget decisions within governments have direct and often irredeemable consequences. Once such decisions are made, the resultant allocation of funds allows some programmes to be pursued and compels others to be halted. Although there are several publications on green financing within South Africa, such as its broader challenges and necessary design features [23] and the role that public financial intermediaries have already played in the country's energy transition [24], there have been no specific studies on how to mobilise and reorient government expenditure for sustainability transitions, and particularly the decarbonisation of its energy sector.

The unique contribution of this paper is its analysis of budget processes, leading to the proposition that four preconditions should be met before a significant reallocation of government's operational budgets, in support of decarbonisation, can be achieved. Notably, in addition to the three factors of problem, policy and politics, which are central to Kingdon's Multiple Streams Approach (MSA) and are already well-described [25], the techno-economic value of the proposed solution must be addressed. The analysis in this paper seeks not only to support its claim for the four streams approach, but also to recommend ways of dislodging lock-in and re-directing government expenditure.

The study was exploratory in its approach. It drew on interviews with ex-government officials, examples of previous re-allocations and government documents relating to the budget process. Its objective was to identify the causal factors that could lead to profound changes in these budgets, and then to present these factors as preconditions that should be concurrently fulfilled. In its analysis, the study uses a theoretical framework which combines MSA [26] with historical institutionalism [27], as explained in the second section. The third section presents the relevant background on South Africa's budget processes. The methodology, results, discussion and conclusions follow in Sections 4, 5, 6 and 7 respectively.

2. Theoretical Framework

Kingdon's MSA postulates that change happens at single points in time or 'policy windows', when a number of causal chains or streams converge [25, 26]. Typically, the three streams comprise of the problem itself, a relevant policy framework and the political process through which change can be realised. MSA further stresses the importance of policy entrepreneurs, who must attempt to couple

the three streams through process of power brokerage and manipulation of problem contexts [28]. MSA specifically acknowledges the complex and chaotic nature of policymaking, and the difficulty of operating within an environment of ambiguity, irrationality and unpredictability [25]. Changes in policy are seen in MSA to emerge spontaneously and stochastically, and can be missed by policy entrepreneurs due to the absence of well-developed policy solutions [29].

MSA's emphasis on windows of opportunity and convergence is also a central aspect of historical institutionalism, which refers to windows of opportunity as critical junctures and convergence as a process of conjuncture [30]. Historical institutionalism emerged in the 1980s as a means of conceptualising and theorising how reform takes place at the meso-level, introducing such terms as path dependence and self-reinforcing processes, whose identification are critical to understanding and hence overcoming intransigence to transition and change. It adopts a longitudinal approach, perhaps over several decades, the analysis of which is used to identify the relationships of lock-in and dependence that comprise the socio-technical landscape [27].

The hierarchies of micro, meso and macro, as developed within historical institutionalism, have become widely accepted and applied in the sustainability transitions literature [31, 32], as exemplified by its adoption of the multi-level perspective (MLP). The latter defines the three levels as the socio-technical landscape, consisting of government policy and inter/national systems, the socio-technical regime and the niche level, the latter including firms and networks of individual actors. Although arguably a simplification of the broad diversity of individuals, collectives, organisations and systems, this layered hierarchy is fundamental to an understanding of transition, and how different processes take place within each level. In much of the MLP literature, change is considered to begin through niche innovations and policy experimentation, undertaken by an array of minor actors. The efforts of these actors may eventually become aligned and sufficiently powerful to destabilise an extant socio-technical regime, which has been well-established at the meso-level over a long period [33].

A possible weakness of this model in the context of a developing country is the extent to which agency is possible within a highly resource-constrained political system. Indeed, in the wider debate about structure vs agency, it can be argued that individuals and small networks of actors are disempowered by the broader structural context. It is precisely this consideration which makes the use of historical institutionalism, with its focus on the meso-level, as a highly relevant analytical framework for a country such as South Africa. Although operating as a democracy, it is clear that the societal environment in South Africa still acts as a major constraint on the micro-level actors, given the low level of education and human capability [34]. Furthermore, the highly rigid approach of the pre-1994 system of apartheid resulted in an extensive entanglement of the technological systems and the state, creating an almost irreversible degree of lock-in [35].

In some senses, historical institutionalism is about theories of continuity, providing an explanation for why regimes remain stable, even though they are contested, rather than why they change. In order to address this gap, Roberts and Geels [36] supplemented the insights of historical institutionalism with those of MLP as a means to further develop a theory of change. In their analysis of conditions for politically accelerated transition, informed by two case studies in the United Kingdom, they argue that conditions for change must include both a weakening of the socio-technical regime, which they refer to as a push factor, and a strengthening of niche actors, which they label as a pull factor. Following the insights from historical institutionalism, in which major policy change arises from struggles for power at the meso-level, they conclude that at least one mechanism of change is a macro- or landscape level shock. This severely disrupts the incumbent regimes and allows the emergence of niche actors as a new socio-technical system [36].

In summary, historical institutionalism has two specific advantages when used to understand sustainability transitions, firstly its focus on meso-level institutions and policy regimes, and secondly

the recognition that power struggles between political collectives or groups over scarce resources lie at the centre of politics and are critical to policy change [36, 37]. Institutional structures and arrangements, typically referred to as a political community or polity, engage in power struggles through the process of politics. In this sense, historical institutionalism is more appropriate in understanding South Africa's budget processes and has been used in this study. It is argued that important decisions relating to resource allocation, which have the capacity to alter the course of socio-technical systems, are the consequence of conjunctures taking place at critical moments. Such turning points have a low probability of occurrence, given the dominant approach to policy stability and lock-in.

The state can play an important role in transitions, either through exogenous changes at the level of the socio-technical landscape, or by strategic and planned initiatives to change the institutional environment [38]. It is precisely the issue of the role of the state, and how it can be internally directed, that is the subject of this article. The study considers the separate roles of the Executive, the Administration and the Legislature. The nature of the power balances between these three arms is explored by analysing their relative roles with respect to a core public sector process, namely the allocation of funds from the national fiscus to individual departments. An overview of this process, as it normally takes place, is presented in the next section.

3. Background on Budget Processes

The adoption of South Africa's new Constitution in 1996 necessitated a comprehensive reform of the management of public finances, including its budget procedures. The latter were amended in several respects, such as strengthening the link between policy and budget allocations, the introduction of systems to address fragmentation and lack of clarity, and measures to improve transparency and re-establish fiscal stability [39]. Although the new processes were more top-down, the changes improved the alignment between post-1994 priorities and actual public expenditure [39].

A core feature of the revised budget process was the introduction of the Medium-Term Expenditure Framework (MTEF), which was intended as the means by which Government could ensure budget stability and predictability while allowing changes "at the margin" [39, p3], thereby managing the "tension between competing policy priorities and budget realities" [40, p49]. The MTEF was positioned as a first step in the "wider overhaul of the budgetary process, emphasising transparency, output-driven programme budgeting and political prioritization", that provided the link between the "technical preparation of budgets and the need to reflect political priorities in expenditure plans" [41 p1]. Its key features include rolling baselines, which are the core budgets for each department and are substantially unchanged within a single MTEF, and a contingency reserve, which is intended to cover unforeseen expenditure.

A detailed review of the timeline for the budget process is not possible in this article. In summary, the process is initiated by a Cabinet Lekgotla, which takes place in February to March of each year (see Figure 1). At this meeting, the Cabinet reviews the macroeconomic and fiscal policies, and the extent of the required budget cuts, or the additional funding that may be available for new priorities. These changes are then incorporated in a set of MTEF budget guidelines [42], which are issued to the various national departments and provinces.

In response to the guidelines, the departments prepare budget proposals, which are then submitted to National Treasury, where they are consolidated into an overall budget estimate. Based on the alignment between the estimates and the guidelines, National Treasury provides feedback and, if necessary, requests revisions from the departments. The adjusted budgets are then assessed in the Ministers' Committee on the Budget (MINCOMBUD) Technical Committee (MTEC), which is composed

of senior officials from National Treasury (NT), the Department of Planning, Monitoring and Evaluation (DPME), the Department of Cooperative Governance (DCoG) and the Department of Public Service and Administration (DPSA).

MTEC then prepares recommendations for MINCOMBUD and Cabinet regarding budget allocations in the MTEF, taking into account government priorities, funding available, exchange rates, alternative funding sources and the division of revenue amongst the three spheres of government [42]. Once MINCOMBUD has approved the budgets, the Minister of Finance tables the Medium-Term Budget Policy Statement in Parliament (in October of each year), following which preliminary allocation letters are issued to the Departments. At this point, there are a number of steps associated with the updating of the Estimates of National Expenditure (ENE) data, which are completed by the end of November of each year. In the final stage, Cabinet approves the final allocations under the MTEF to the departments (November/December), and the Minister of Finance tables the final budget in Parliament (February of the following year).

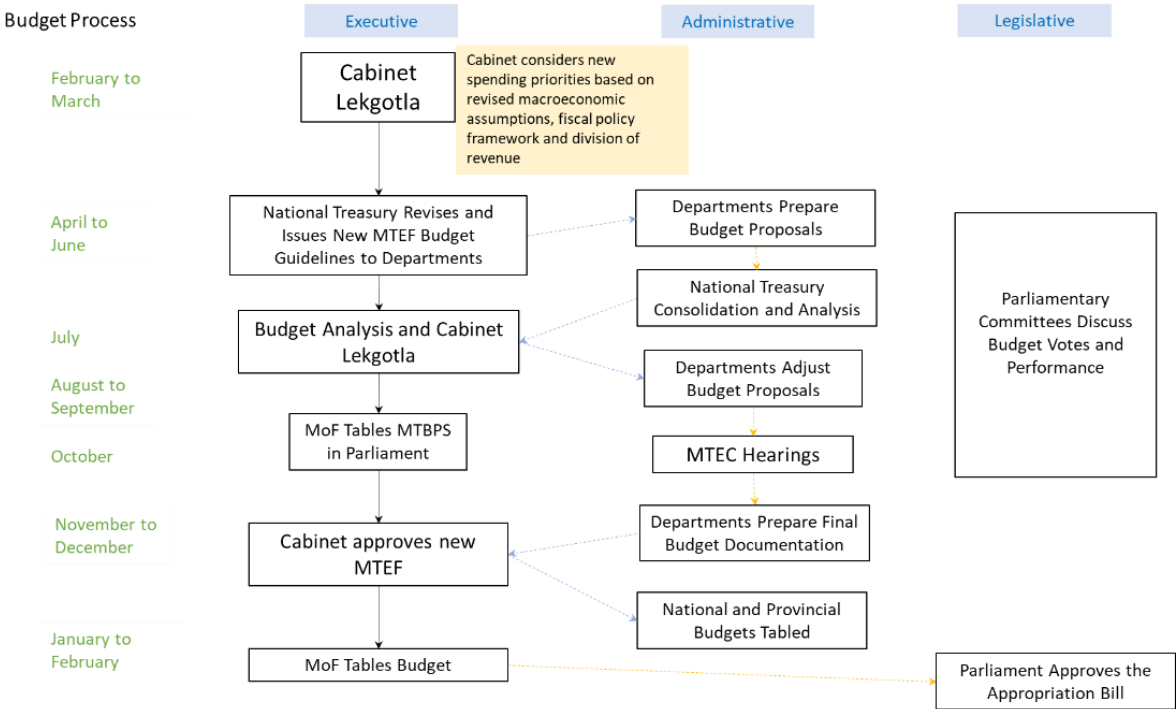


Figure 1. Overview of the budget process

The whole process intentionally reinforces a central design principle of the post-1994 reforms, namely the establishment and maintenance of a stable public finance environment, otherwise stated as a predictable expenditures and policies [39]. One effect of this approach is that it severely limits the available funding for new policies or initiatives and reinforces a pattern of lock-in or pathway dependence within the budget allocations. However, there are two mechanisms through which small amounts of money can be sourced for new policies, if there is sufficient political support. Before the estimated income is divided between the different departments and spheres of Government, a contingency reserve is ‘top-sliced’ and retained by National Treasury for emergency needs or novel policy instruments. This reserve provides a level of flexibility to the budget allocations, although, as shall be discussed later, it is a small amount relative to the demand for new funding from the various departments.

The other mechanism, known as virement, involves the shifting of funds from one subdivision of a Budget Vote to another. There are a number of restrictions to this practice, including the requirement that it may not exceed 8% of the total allocation in the source subdivision (from which the funds are taken), that it may not involve the shifting of funds from capital to recurrent expenditure and that it cannot be used to increase remuneration without special approval from National Treasury.

Clearly, expenditure predictability and budget stability are important objectives, especially in respect of financial markets and the cost of borrowing. However, both elements act against the needs of transition or change, particularly where the change has a significant cost or budget implication. The prospects of sufficient allocations for major new policy directions are limited by the MTEF and the system weakens the role that government can play in enabling such changes. This imbalance has led to the growing realisation by South Africans that reform can only take place in response to external pressure, widespread protest, and even violence.

The 2015/2016 student protests regarding “free” higher education are an illustration of this perspective. Provoked by a statement from the Department of Higher Education and Training (DHET) on transformation in higher education [43], the students embarked on nation-wide protests, demanding that promises of free education be fulfilled. After a number of incremental changes, President Zuma finally announced on 16 December 2017 that higher education for the poor and working class students would be free [44].

The President’s decision was taken against the advice of National Treasury, especially since it ran counter to the agreed budget processes and mechanisms [45]. Moreover the impact was profound; funding for the National Student Financial Aid Scheme (NSFAS), the primary vehicle for the implementation of the new policy, a ‘mere’ R7.2 billion in 2015/16, increased to R40 billion in 2021-2022 [46], as shown in Figure 2. Certainly, in respect of this decision, it can be concluded that the Executive directed, the Administration was out-manoeuvred and the Legislature side-lined. The intent that such decisions should be the outcome of evidence-based information and a collective consensus between the three arms, as stipulated by a range of policy documents, was over-ruled.

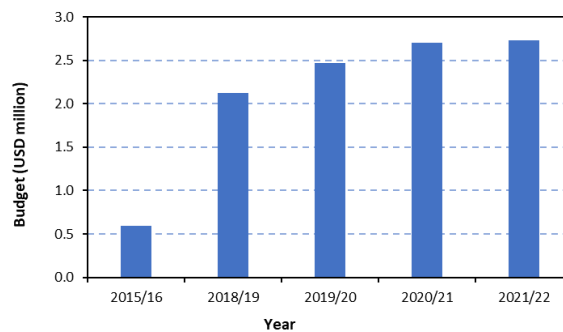


Figure 2. Budget allocations to the NSFAS

Thus, issues of policy conflict and priorities are often resolved through a political process which may relate to the power or influence of key positions within the Executive arm of Government (Cabinet), or to the ability of the operational and legislative arms to determine the expenditure allocations. Despite such processes being of critical importance to an understanding of how decisions on resource allocation are made, there is little published research in South Africa on this topic. As illustrated by the earlier example of the NSFAS, budget re-allocations are possible and do take place. Accelerated sustainability transitions, as will be necessary for the timely implementation of the Paris Agreement, will require significant government investment, especially in new systems of transport and energy. To disregard or overlook these outlays under the pretext of lacking the necessary funds, appears

disingenuous. It is a matter of priority and policy, and of avoiding the disruption of existing, exclusive institutions [47].

In summary, the analysis of budget processes leads to the following propositions about how change, and in particular realignment to operational budgets in favour of sustainability transitions, could take place.

- For change to take place, the problem must be highly visible, a coherent and aligned policy framework must be in place, the solution should be affordable, it must require a political intervention, and failing to act must have severe consequences (such as social unrest).
- The dynamics of each aspect are the problem must be accelerating in its severity; the solution must have falling cost implications; the window of change is generally very brief, opened by the sway of politics and rising popular dissent; and the political response must be rapid and effective.
- The simultaneous convergence of these four aspects, described as a process of conjuncture resulting in a turning point or critical juncture, is essential for change to take place.

In order to explore the validity of these propositions, a research project, involving a series of interviews over an 18-month period, was designed and initiated. The overall objective of the study, as already noted in the introduction, was to identify the factors that can lead to profound changes in government expenditure, and hence how greater priority can be mobilised for the support of sustainability transitions. Further details of the research method are provided in the next section.

4. Research Methods

The research followed a qualitative, inductive and exploratory approach with a purposive sampling strategy [48]. The population consisted of ex-members of National Treasury, and other departments, who had occupied senior positions within Government in the recent past, including Director-General, Deputy Director-General and Chief Director, and had more than 5 years' experience of budget processes in the public sector. Approval of the project by the Faculty Ethics Committee was subject to two explicit conditions, namely that only ex-members could be interviewed and the responses had to be anonymised. The latter is a standard requirement and was fulfilled by following the normal procedures. However, the former condition added lengthy delays to the project due to the difficulty in identifying suitable respondents meeting the two criteria of having *recently* left a *senior* post in Government.

Altogether, six interviews were completed. The respondents were interviewed using a semi-structured questionnaire in order to understand, primarily, how policy priorities are assessed and balanced within the public sector. The questionnaire was divided into four separate sections, with the first section covering the participant's view on the role of the state with respect to the environment and how this is presently being fulfilled, followed by three sections on the process of budget allocations and determination of funding priorities, the resolution of cases involving competing priorities, and general recommendations on accelerating support for sustainability transitions, respectively.

In each case the interviews were recorded, transcribed and then analysed using ATLAS.ti. The coding structure was developed based on the research questions, with the coding groups covering the core questions of role, examples of policy conflict, the determination of priorities, details of the budget process, moments of change and lessons for sustainability transitions.

It is acknowledged that the small sample size limits the external validity or generalisability of the results [48]. The credibility and exclusivity of the data is, however, robust in that the respondents had all occupied senior positions and accumulated more than fifteen years of experience in budget processes within the public sector. Although there were differences in perspectives, mostly there was agreement on the main determinants of the central question that this article seeks to address, namely how to influence such budget processes. As a result, it has been possible to extract a set of useful insights from the data.

5. Results

5.1 Origin of conflicting priorities (environment and the role of the state)

As mentioned earlier, South Africa faces a huge decarbonisation challenge. Its electricity sector is the most carbon intensive of all the G20 countries, it has a bankrupt power utility without resources to finance its normal operations, let alone decarbonisation, and it has a high level of unemployment, which places even more pressure on the imperative for a just transition [49]. The global decarbonisation imperative will place huge financial pressure on state income. It has been estimated that the cumulative impact on South Africa of a low-carbon transition, referred to as the ‘transition risk’ will be \$120 billion, which includes the loss of export revenue, and the loss of local markets for coal and liquid fuels [14].

In addition, South Africa will need to invest in new energy infrastructure, the extent of which can be illustrated by considering investment cost normalised for GDP. Using data for carbon emissions and GDP data from the World Development Indicators database [50], and assuming that the average investment cost will be \$2,500 per MT of carbon, it is calculated that South Africa must source \$44 billion, or 12% of the GDP to finance the transition, as shown in Figure 3. It is clear from this comparison that the cost of decarbonisation will be more acutely experienced by countries with lower GDP and higher carbon emissions. For instance, Iran, Russia, India and Saudi Arabia have high relative GHG emissions and can expect a larger cost, normalised to GDP, than other countries.

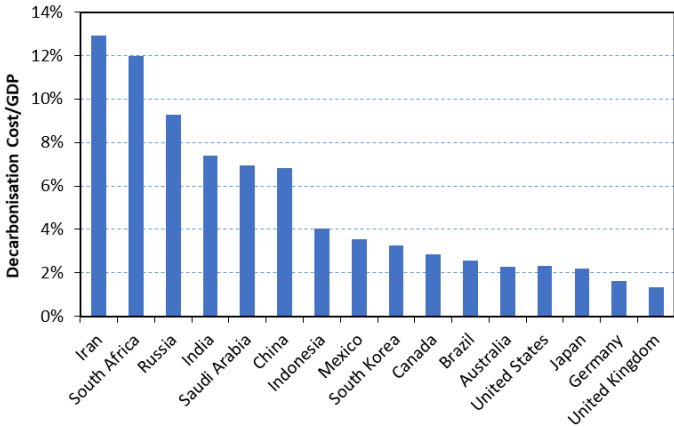


Figure 3. Estimated investment cost of decarbonisation as a proportion of GDP
 Source: This study and World Development Indicators [50]

The combined impact of this investment cost and the transition risk, which represent a major challenge to the South African government, has a number of budgetary implications. As will be the case in many countries, the public sector will be required to implement mitigation strategies, such as the retraining of mining sector employees, introduction of new policy instruments to support the renewable energy sector, changes to legislation, interim approaches to reduce the impact of revenue

changes on municipalities, measures to build resilience to climate change, programmes in research and development focussed on the necessary diversification of the economy and the remediation of environmental damage from fossil fuel usage.

Although several departments will be affected by transition risk, this study has looked specifically at the Department of Environment, Forestry and Fisheries (DEFF), which has overall responsibility for environmental management and is represented at Executive level by the Minister and Deputy Minister. The department has an annual budget of about \$500 billion, an amount which has not changed much over the last seven years, and under the Medium-Term Expenditure Framework allocations is projected to stay at a similar level in the immediate future (see Figure 4).

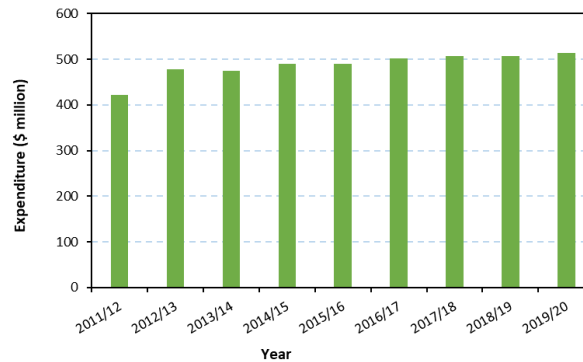


Figure 4. Budget allocations to the Department of Environment, Forestry and Fisheries

Allocations to the department were considered by the interviewees to have grown from a low base, with the department being one of those to have benefitted from the growth in overall government revenue over the period 2003 to 2008. Opinions as to the adequacy of the present budget in meeting the department’s responsibilities were mixed, although it was generally considered that the major constraint was not funding, but capacity to deliver. This sentiment is not echoed by the present Minister, who indicated a need to leverage the resources of other sectors in order to ensure that the department could deliver on its present mandate [51].

The respondents agreed that DEFF’s role is to ensure the protection and preservation of the environment, or in broad terms ‘environmental sustainability’, and that this role was being fulfilled through the combined actions of regulation and enforcement. However, it was noted by the respondents that the department’s efforts can be compromised by the very nature of public policy, which is to represent a broad range of interest groups, and the diversity of government’s activities, some of which can impinge on the environment and have direct environmental costs.

For instance, the granting of coal mining or fishing licenses was cited as an example of the tension between protection of the environment and economic development. In the case of fishing licenses, the desire to ensure the economic livelihoods of small fishing enterprises was considered to have led to over-harvesting of fish stock, with subsequent depletion, and in some cases collapse, of fish populations. Similarly, the granting of additional coal mining licenses as a means of transforming the sector, or the use of pesticides to control malaria, had led to significant degradation of the environment in the affected areas.

It can also be argued that environmental protection through restrictions on mining and other resource extraction activities can be justified economically, and that defining sustainability vs. development as a dichotomy is unproductive and misleading. Longer term economic development is about environmental sustainability, a perspective which is expressed by the present Minister, Barbara Creecy, who stated [51]:

"What I want to bring to this portfolio is the understanding that caring for the environment, caring about climate change and threats to biodiversity may well be an emotional concern for some people, but 2-million South Africans are directly dependent on our natural resources."

It is clear that conflict between the mandate of DEFF and other departments arise on a regular basis, and that in some cases, the DEFF is successful in preventing decisions leading to adverse environmental impacts. Although no clear pattern emerged from the discussions, the interviewees were questioned about how such tension was managed, and, typically, which areas were prioritised. The results of these questions are presented in the next section.

5.2 Determination of priorities and resolution of conflicts

Disagreements on government choices are generally resolved through the existing policy framework, which forms the blueprint for government action. However, in ambiguous situations, where proponents of each position can find relevant policies in support of their perspectives, decisions are taken based on the power of coalitions, politics, the charisma of individuals and the strength of lobby groups.

Such decisions often take place in the Executive, which, in the view of one respondent, is a forum with weak environmental representation, given that there is one Minister of Environmental Affairs, but five or six Economic Ministries, and eight or nine Social Ministries. In order to ensure a positive result for the environmental portfolio, it is therefore essential that the Minister attempts to build an alliance with other ministries and civil society, and is then able to depend on this alliance in supporting a particular issue. As noted by one respondent:

[19:51] *"A flat-footed Environment Ministry that refuses to play the politics that is required ain't going to get anywhere."* (Respondent 2)

The choice of alliance partners is one of several important components in the construction of such a coalition. It was indicated that likely partners for environmental issues included the security cluster (defence, police, justice) and one or several of the cross-cutting departments (finance; foreign affairs; public service and administration; and planning, monitoring and evaluation). It was noted that the former was often supportive of longer-term perspectives as a means of averting social unrest and international conflict.

Apart from being a forum in which the environmental mandate is outnumbered, the Executive is also a constitutional body which lacks a referee, particularly if the President does not assume at least some responsibility for non-partisanship. This one-sidedness is especially relevant in decisions relating to the construction of infrastructure or the expansion of one of its public enterprises, where the government acts as both the regulator and the player, and may too easily be able to bend the rules in its favour, or make a trade-off, as described by one respondent:

[9:24] *Government always has to make trade-offs between various sectors and importantly with respect to the environment it is constantly making trade-offs between environmental and economic/social objectives, and really that is its function. So, it is not just a regulator of the environment. In regulating the environment, it balances multiple competing objectives I think that is just the hierarchy of decision-making that it needs to do (follow).* (Respondent 2)

It is not clear how such a hierarchy of decision-making is established, other than that it is political and highly contextual. A propensity for persistent and patient negotiation is an important prerequisite for the Minister of Environment, Forestry and Fisheries, especially in pursuing a pro-environment agenda which may be perceived as anti-employment or economic growth. In the next section, the respondents' comments on how such agendas have evolved, and particularly the reasons for any successes, are discussed.

5.3 The politics of critical junctures

During the interviews, several incidents of decisions relating to significant policy changes were discussed, including the implementation of the sugar tax, the introduction of plastic bag regulations, the proposed carbon tax and the reforms on student fees. In the earlier discussion on historical institutionalism, it is argued that such moments of change require, inter alia, strong political support.

One important strategy for obtaining this support, which emerged from the discussions, is the inclusion of revenue collection, which predictably secures agreement of arguably the most powerful government department, the Department of National Treasury. According to the respondents, the ability to extract additional fiscal revenue accounts for the relative ease with which changes such as the sugar tax were introduced, compared to other policy initiatives. The respondents noted, however, that even in the case of additional tax revenue, obtaining consensus from the Executive always required a great deal of finesse.

[12:09] There were moments where we basically won our case, (such as) the Plastic Bag Regulations. It was a huge hoo-ha with Trade and Industry at the time, a massive lobby launched by the chemicals and plastics industries, which we won, but it was won ... after a very serious battle and that needed ... you know that needed some fancy political footwork by the then Environment Minister. (Respondent 2)

The nature of this 'footwork' is central to this study, but inevitably the most elusive aspect to define. It depends on the issue, the context, the personalities, the relevant institutions, the affected sectors, and a number of other factors. It is what distinguishes an effective from an ineffective Minister, a progressive from an intransigent or reactionary administration. The respondents noted that in government change generally takes place with difficulty, if at all. The processes and systems are designed to maintain the status quo, perhaps for important reasons. Policy stability, particularly macro-economic, is both a desire and a goal in governments, and change, especially when it is driven by narrow political interests outside of established governance processes, can be damaging to countries and economies.

Such momentum in government action is reflected acutely in budget allocations. The respondents commented that these allocations are mostly unchanged from one year to the next, giving little flexibility to the Executive in being able to implement new initiatives. For instance,

[5:50] "... every now and then there are some shifts, but those shifts might be fairly significant in the context of one particular department, but I'm not sure that they are significant in the context of an entire sector and usually those shifts are either ... I don't think that they are ever more than maybe 5% of any government's allocation from one year to the next." (Respondent 4)

In other words, there is no new money within treasury and budgets remain substantially unchanged from one year to the next. Moreover, the re-allocation of funds from one budget line to another,

within the rules of virement, is tightly controlled and requires National Treasury approval. Individual line managers are able to re-allocate unspent funds within a programme or line item, such as from one project to another, but these changes are relatively minor and cannot be applied to the funding of new initiatives. The challenge for the funding of sustainability transitions is, therefore, to persuade government departments to redirect their existing budgets over time, and mainstream the sustainability development goals in their daily practices.

This challenge is recognised by DEFF as being central to its mandate and it engages regularly with other departments on the need to include such goals with some success. For example, the establishment of the Biodiversity Centre of Excellence by the Department of Science and Technology (now the Department of Science and Innovation), the creation of the Green Fund and the implementation of the Renewable Energy Independent Power Producers Procurement Programme were mentioned by the respondents as resulting from such inter-departmental discussions.

There is one important exception to the overall situation of budget stasis, which is the power afforded to the President of South Africa. Although not explicitly stated in the Constitution or the legal system, it appears that the President is able to circumvent the standard budget processes, as happened in the example of the student fees crisis of 2015 [43]. The appropriateness of this use (or abuse) of power was questioned by a respondent:

[35:33] *“you know if the politicians don’t accept the institutional rules of the game, then it is very easy for them to wreck the institutions. ... there has to be a basic acceptance, a collective acceptance that this is the rules and this is how you do things. If people don’t accept that, they can just wreck institutions very, very easily.”* (Respondent 3)

In summary, the interviewees concurred on the budget situation as being highly constrained with the opportunity of finding new funding to support sustainability transitions (in pursuance of the sustainability development goals) as being not just remote, but impossible. The redirection of existing funds is the only option, although the budget process is ill-suited to such changes and in general only incremental adjustments over a long period are possible. The implication of these results for sustainability transitions are discussed in the next section.

6. Discussion

Decarbonisation of South Africa’s energy sector is largely a problem for the state. More than 45% of the country’s carbon emissions derive from the fleet of coal-based power stations owned and operated by the state-owned power utility, Eskom [52]. Replacement of these facilities with renewable energy alternatives will require significant new finance. Given its present financial circumstances, Eskom itself is highly unlikely to be at the forefront of this reinvestment and the reform of the electricity sector. As already noted, the utility is deep in debt, and embroiled in a series of technical and political crises which severely constrain its ability to raise finance from capital markets or the state [53].

This outlook suggests that much of the investment finance for the energy transition will be provided by the non-government sources. However, government will be required to provide financial support for a range of operational activities, including energy research and development, retraining workers affected by the energy transition, building of capacity to manage energy markets, and incentives to support local manufacture of renewable energy equipment. Such funding will be mostly additional to the existing budgets of government departments, and will require either new funding or the re-allocation of budgets from other activities.

The likelihood of new funding is minimal. Government finances, already stretched to the limit before COVID-19, are now in a highly-borrowed predicament, with the level of government debt rising to 80% of GDP in the 2020/2021 financial year [54]. The re-allocation of monies from other expenditure items within the operational budgets will be an imperative if government funding for decarbonisation and the energy transition is to be made available. The premise of this article has rested on the assumption that high-level decisions for such changes reflect not only the extent of the need to fulfil each department's public mandate, but also the strength or weakness of the interdepartmental power relationships. An understanding of these dynamics is therefore critical to the implementation of emergent and experimental policies within government, such as policies to support decarbonisation, sustainability transitions and the transformation of socio-technical systems.

This study has intimated that the budget process affords limited opportunity for negotiations on departmental budgets. However, there are points in the process, referred to as windows of opportunity, when such changes are possible if a number of preconditions have been met. The concept of a window of opportunity is by no means unique. As already outlined, it is shared by both MSA and the multi-level perspective; the latter focuses on the two streams of regime destabilisation and niche consolidation, whereas MSA requires the conjuncture of problem, policy and politics. The South African context supports both approaches, but identifies the fourth precondition of an affordable solution.

Conditions in developing countries are frequently resource-constrained, implying that regime changes lead to extreme changes for the affected parties. As a result, the conflict can be more apparent, the outcomes more divisive and the moments of change take place more unpredictable. In other words, the higher financial stakes determine the nature of the struggle and the resultant change, should it occur. The critical junctures or windows of opportunity are less frequent, more contested, require more significant alignment of interest groups and are characterised as strong conjunctural processes.

The pre-conditions for these windows of opportunity are also different. It is argued here that one further stream is required, namely favourable techno-economic value or improvements in the benefit to cost ratio of the potential solution, as exemplified by the introduction of the sugar tax. This amendment to the MSA is essential to understand how change can emerge, and hence to engineer or accelerate sustainability transitions. Furthermore, each of the four streams needs to be characterised based on its dynamics or rates of change. The four streams are now discussed in more detail.

6.1 The problem (regime destabilisation)

Policy changes rarely seem to take place in response to opportunities. Politics is a domain that appears to be mainly reactive, and often takes the form of crisis management. Given the multiple demands on the public sector, and the huge scale of the issues, this reactivity is perhaps not surprising. One general precondition for policy change seems to be clear: there must be a shared understanding of a clearly defined problem for such changes to be considered.

The mere existence of a problem is also not on its own sufficient; policy windows are more likely to open when the problem is both growing in scope and the rate of growth is accelerating, to the extent that it is mobilising extensive political support outside of Government, most notably in civil society with its ability to mobilise civil unrest. The power of civil society to destabilise the landscape depends on the extent of mass mobilisation and public support for a particular issue, and the degree to which this support is able to gain momentum within nation states. Government may then act to repress or outlaw civil society protest, as happened repeatedly under Apartheid South Africa [55].

The inclusion of regime destabilisation as a necessary step in the processual framework of this model is also part of the MSA and also the multi-level perspective. Examples of such changes include the occurrence of pandemics, the environmental crisis, the advent of widespread road transport and the rise of wheat mono-culture [36].

6.2 The policy framework (institutional reform)

Opinions on how to change a dominant regime have been offered by many authors. Milton Friedman, well known for the development of stabilisation policy, surprisingly had a perspective on how to change a socio-technical regime. He considered that only a crisis produces change, and that the most important pre-condition was to be well-prepared [56, p ix].

This requirement of being well-prepared is partly captured in the theories of policy experimentation and strategic niche management [57, 58]. These argue that transition requires initial experimentation with new approaches, some of which may fail, but the successful interventions may eventually gather sufficient momentum to result in changes at the meso level. Importantly, there are no clear predictors of success with early experiments, and policy frameworks may themselves not achieve the desired outcomes. It is therefore critical that such interventions be accompanied by a transparent and insightful monitoring and evaluation framework, which can inform whether the policy should be continued, strengthened or withdrawn.

6.3 The techno-economic value (benefit/cost improvement)

The stream of techno-economic value refers to the perceived cost benefit ratio of a public policy or intervention [59]. Such analyses are a legislative requirement within the South Africa public service, and are typically framed with questions such as “what is the value for money?” or “what is the cost/benefit ratio?” [60]. Cost/benefit analysis is used as a means of informing budget decisions based on the economic viability or socio-economic benefit of a particular intervention. There are multiple approaches to the analysis, including the use of standard financial techniques such as discounted cash flows, net present values, internal rates of return and payback periods [61]. Mostly, the analysis requires the monetisation of the resultant social welfare and economic benefits of the intervention, the sum of which are then compared to the overall costs.

Measurement of the net social welfare is complicated by the large variety of possible benefits, the relative value of each intervention and the prediction of its impact. Although costs are mostly explicit and relatively straightforward to calculate, the quantification of benefits is subject to assumptions on critical issues such as the contribution of energy to the quality of life, or the magnitude of the social discount factor, or the value of possible externalities (such as an improvement in the quality of the natural environment) which are associated with a particular intervention. Some of these limitations can be avoided by applying cost/benefit analysis only as a comparative technique. In this way, the same assumptions apply to all the options being reviewed, and allow for the selection of the most cost-effective alternative amongst a portfolio of analogous projects.

A useful example of how the techno-economic value can influence resource allocation decisions is the case of the declining cost of renewable energy technologies. Although the cost of electricity from photovoltaic panels and onshore wind turbines was, prior to 2019, generally more expensive than energy obtained from fossil fuels, this situation has now reversed and renewable energy technologies are now consistently cheaper [62], due mostly to improved manufacturing efficiencies and greater production capacity within the sector [63]. The lower levelised cost of energy has been an important influence on the planning of national energy systems and the decisions to incorporate higher levels of renewable technologies within such systems [17].

As for the problem stream, a positive impact on social welfare is not a sufficient condition; the benefit should have, at least, the prospect of growth. In other words, the potential savings should be increasing, or the cost of implementation should be decreasing, as indicated in the example of renewable energy technologies.

6.4 The politics (engagement with the realpolitik)

Accepting the validity of the normative process that policy determines strategy, strategy determines operational plans and operational plans drive budget allocations, it is reasonable to assume that budget allocations match the overall policy framework. However, Government as a punctualised actor is in fact not a single entity; it is a loose agglomeration of multiple actors with overlapping but also conflicting policy objectives. For instance, industrial policy may contradict environmental policy, fiscal policy may oppose energy policy, health policy may conflict with trade policy, and defence policy may act against science and technology policy.

In terms of decarbonisation, and the likelihood that departments of the environment will be able to secure funds from the national fiscus in support of decarbonisation, it is clear that attention to the politics is critical. For South Africa, which faces a 530 million metric tonne per annum decarbonisation challenge with limited ability to raise the necessary resources, this aspect of the environmental campaign will be vital. Using the estimated value of \$2,666 per MT carbon dioxide equivalent, the decarbonisation cost for South Africa will amount to \$1,472 billion, or 12% of GDP over a 30-year period (2020 to 2050). In comparison, the decarbonisation costs for the United Kingdom will be 1.3% of GDP, as previously indicated in the introduction.

South Africa, therefore, has limited options in addressing the decarbonisation challenge, other than to consider budget reallocation. The issue of securing resources to support sustainability transitions, and particularly public funding, is also highlighted in the literature on technological innovation systems, where resource mobilisation is identified as one of several critical functions for the establishment of systems to support such transitions [64]. Technological innovation systems as a conceptual model for transition is also a processual framework and in its discussion of resource mobilisation, it is argued that this function needs to be sufficiently covered from the early stages in the development of a new system.

Identifying resource allocation as an important part of the overall transition process is in itself insufficient in supporting the transition. It is equally important to understand the source of the funds and how they can be secured. Public funding is critical in such transitions since the initial stages will be characterised by high levels of risk and limited participation from private funders. However, public budgets are subject to intense competition from other priorities including health, security, education and infrastructure, and the prospects of successfully lobbying for the re-direction of public funds from existing portfolios are severely restricted.

This article has argued that such moments do exist, but in resource constrained setting such as South Africa, they occur only within narrow windows of opportunity characterised by an escalating problem, the adoption of a recent policy framework, the prospects of an improving benefit to cost ratio, and a willingness to engage in realpolitik. Previous studies have concluded with a number of policy recommendations for low-carbon transitions including the need for dynamic policy mixes dealing with demand- and supply-side instruments, a focus on politics in addition to policy, and active steps to phase-out existing technologies in addition to supporting niche-innovation [65]. The results of this study suggest a number of more specific recommendations for resource-constrained countries as follows.

Public-Funded Low-Carbon Transitions

Low-carbon futures are unlikely to be realised without public funding. As is argued in the case of public-funded research and development, such transitions will be subject to market failure and under-investment in the absence of public support. It is therefore important that government establish dedicated funding for sustainability transitions, in the same way that they have created budgets for industrial development or energy infrastructure. Developing the structure and rationale for these budgets is an important step towards securing the actual funding.

Critical Junctures

In resource-constrained settings, it will be hugely challenging to secure funds without re-allocation from existing portfolios, the prospects of which are unlikely on a daily basis. However, there will be windows of opportunity or critical junctures, which will arise when there is alignment between an escalating problem, a supporting policy framework and a rising benefit to cost ratio. An appreciation of such moments, and a mechanism for recognising their opening, is an important insight of this study.

Creating the Alliances

Although leadership and agency are critical, engaging in politics is more than individual action. All actors, but especially politicians and senior public servants, need to enter into relationships with each other, and with civil society, labour and advocacy organisations. In the final decision on budgets, the most important factor may not be the strength of the evidence for the intervention, but the strength of the alliances which are willing to support the re-allocation proposal.

7. Conclusion and Recommendations

In addition to an overall cultural change, transitions to sustainability in South Africa, and perhaps other countries, will require new programmes and projects within government. Importantly, these programmes will require new funding. However, the prospects for this are severely limited by the present situation of decreasing government revenues and the overall path dependence of budget allocations. The lack of new funding will hinder such transformation and requires the development of new strategies.

This research has sought to define the main components of the budget process in South Africa and hence develop a strategy to overcome funding limitations for necessary and important operational programmes. It concludes that the conjunction of four streams is key to successful changes in budget allocations, namely a growing problem, preferably accelerating, a recently developed policy framework, a strong techno-economic justification whose prospects likely to become more attractive, and a strengthening political stream consisting of powerful alliances able to drive budget changes through the Executive.

These conclusions align with the insights of historical institutionalism, which include the supposition that change takes place as a result of contestation, and at the meso level, the destabilisation of the existing socio-technical regime combined with significant challenge from an alliance of niche players. This result implies that sustainability transitions in South Africa will require highly strategic leadership of the environmental portfolio, which can direct the processes of conjuncture and act at critical moments in order to effect transformation. In particular, this leadership needs to sharpen the arguments for public funding to support sustainability transitions, develop the necessary budget structure, learn to recognise critical junctures or windows of opportunity, and network with power actors willing to support budget re-allocations.

References

- [1] P. Johnstone, K.S. Rogge, P. Kivimaa, C.F. Fratini, E. Primmer, A. Stirling, Waves of disruption in clean energy transitions: sociotechnical dimensions of system disruption in Germany and the United Kingdom, *Energy Research & Social Science* 59 (2020) 101287.
- [2] A. Rathi, These countries have committed to a net-zero emissions goal - could it solve the climate crisis?, 2019. <https://www.weforum.org/agenda/2019/07/the-growing-list-of-countries-committing-to-a-net-zero-emissions-goal>. (Accessed 19 December 2019).
- [3] UNFCCC, FCCC/CP/2015/L.9/Rev.1: Adoption of the Paris Agreement., UNFCC, Paris, France, 2015, pp. 1-32.
- [4] K. Akimoto, F. Sano, B.S. Tehrani, The analyses on the economic costs for achieving the nationally determined contributions and the expected global emission pathways, *Evolutionary and Institutional Economics Review* 14(1) (2017) 193-206.
- [5] P. Enkvist, T. Nauc ler, J. Rosander, A cost curve for greenhouse gas reduction, *McKinsey Quarterly* 1 (2007) 34.
- [6] J.P. Weyant, Costs of reducing global carbon emissions, *Journal of Economic Perspectives* 7(4) (1993) 27-46.
- [7] C.C. Jagemann, Essays on the economics of decarbonization and renewable energy support, Universit t zu K ln, Germany, 2014.
- [8] J. Pickard, UK net zero emissions target will ‘cost more than  1tn’, 2019. <https://www.ft.com/content/036a5596-87a7-11e9-a028-86cea8523dc2>. (Accessed 19 December 2019).
- [9] D. Shreve, W. Schauer, Deep decarbonisation requires deep pockets, Wood Mackenzie, Edinburgh, 2019, pp. 1-9.
- [10] B. Parr, M. Swilling, D. Henry, The Paris Agreement and South Africa’s Just Transition, in: Melbourne Sustainable Society Institute (Ed.) Melbourne, 2018.
- [11] M.B. Ting, R. Byrne, Eskom and the rise of renewables: Regime-resistance, crisis and the strategy of incumbency in South Africa's electricity system, *Energy Research and Social Science* 60 (2020).
- [12] L. Baker, Renewable energy in South Africa's minerals-energy complex: a ‘low carbon’ transition?, *Review of African Political Economy* 42(144) (2015) 245-261.
- [13] M. Swilling, J. Musango, J. Wakeford, Developmental states and sustainability transitions: prospects of a just transition in South Africa, *Journal of Environmental Policy & Planning* 18(5) (2016) 650-672.
- [14] M. Huxham, M. Anwar, D. Nelson, Understanding the impact of a low carbon transition on South Africa, Climate Policy Initiative, London, 2019.
- [15] World Economic Forum, Energy Transition Index, 2019. http://reports.weforum.org/pdf/etriv19-2019/WEF_ETRIV19_2019_Profile_ZAF.pdf. (Accessed 6 May 2020).
- [16] M. den Elzen, T. Kuramochi, N. H hne, J. Cantzler, K. Esmeijer, H. Fekete, T. Fransen, K. Keramidias, M. Roelfsema, F. Sha, Are the G20 economies making enough progress to meet their NDC targets?, *Energy policy* 126(11) (2019) 238-250.

- [17] T. Bischof-Niemz, T. Creamer, South Africa's Energy Transition: A Roadmap to a Decarbonised, Low-cost and Job-rich Future, Routledge, Abingdon, 2019.
- [18] M. Davies, M. Swilling, H.L. Wlokas, Towards new configurations of urban energy governance in South Africa's Renewable Energy Procurement Programme, *Energy Research and Social Science* 36 (2018) 61-69.
- [19] D. Conway, B. Robinson, P. Mudimu, T. Chitekwe, K. Koranteng, M. Swilling, Exploring hybrid models for universal access to basic solar energy services in informal settlements: Case studies from South Africa and Zimbabwe, *Energy Research and Social Science* 56 (2019).
- [20] C.G. Monyei, A.O. Adewumi, K.E.H. Jenkins, Energy (in)justice in off-grid rural electrification policy: South Africa in focus, *Energy Research and Social Science* 44 (2018) 152-171.
- [21] A. Kumar, R. Ferdous, A. Luque-Ayala, C. McEwan, M. Power, B. Turner, H. Bulkeley, Solar energy for all? Understanding the successes and shortfalls through a critical comparative assessment of Bangladesh, Brazil, India, Mozambique, Sri Lanka and South Africa, *Energy Research and Social Science* 48 (2019) 166-176.
- [22] A. Visser, Covid-19: SA will need R3.4trn to recover, 2020. <https://www.moneyweb.co.za/mymoney/moneyweb-tax/covid-19-sa-will-need-r3-4trn-to-recover/>. (Accessed 8 September 2020).
- [23] C.P. Naidoo, Relating financial systems to sustainability transitions: Challenges, demands and design features, *Environmental Innovation and Societal Transitions* In Press (2019) 1-21.
- [24] C. Naidoo, Transitioning South Africa's finance system towards sustainability, in: N. Mohammed (Ed.), *Sustainability Transitions in South Africa*, Routledge, Abingdon, 2019, pp. 1-20.
- [25] N. Zahariadis, The Multiple Streams Framework: Structure, Limitations, Prospects, in: P.A. Sabatier (Ed.), *Theories of the Policy Process*, Westview Press, Boulder, 2007, pp. 65-92.
- [26] J.W. Kingdon, *Agendas, alternatives, and public policies* 2nd edition, New York: Addison, Wesley, Longman, 1995.
- [27] K. Thelen, Historical institutionalism in comparative politics, *Annual Review of Political Science*, 1999, pp. 369-404.
- [28] H.E. Castro, Advancing HTA in Latin America: The Policy Process of Setting up an HTA Agency in Colombia, *Global Policy* 8 (2017) 97-102.
- [29] F. Kern, K.S. Rogge, Harnessing theories of the policy process for analysing the politics of sustainability transitions: A critical survey, *Environmental innovation and societal transitions* 27 (2018) 102-117.
- [30] P. Pierson, T. Skocpol, Historical institutionalism in contemporary political science, in: I. Katznelson, H. Milner (Eds.), *Political Science: State of the Discipline*, W.W. Norton, New York, 2002, pp. 693-721.
- [31] J.-P. Voss, B. Bornemann, The politics of reflexive governance: challenges for designing adaptive management and transition management, *Ecology and Society* 16(2) (2011) 9.
- [32] F.W. Geels, Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study, *Research Policy* 31(8-9) (2002) 1257-1274.

- [33] J. Schot, F.W. Geels, Niches in evolutionary theories of technical change, *Journal of Evolutionary Economics* 17(5) (2007) 605-622.
- [34] OECD, *OECD Economic Surveys; South Africa*, in: OECD (Ed.) OECD, Paris, 2017.
- [35] M. Scerri, *The evolution of the South African system of innovation since 1916*, Cambridge Scholars Publishing, Newcastle, 2009.
- [36] C. Roberts, F.W. Geels, Conditions for politically accelerated transitions: Historical institutionalism, the multi-level perspective, and two historical case studies in transport and agriculture, *Technological Forecasting and Social Change* 140(3) (2019) 221-240.
- [37] P.A. Hall, R.C. Taylor, Political science and the three new institutionalisms, *Political studies* 44(5) (1996) 936-957.
- [38] P. Johnstone, P. Newell, Sustainability transitions and the state, *Environmental innovation and societal transitions* (2017).
- [39] A. Fölscher, N. Cole, South Africa: Transition to democracy offers opportunity for whole system reform, *OECD Journal on Budgeting* 6(2) (2006) 1-37.
- [40] National Treasury, *Medium Term Expenditure Framework*, in: National Treasury (Ed.), *Medium Term Budget Policy Statement*, South African Government, Pretoria, 1999, pp. 49-61.
- [41] National Treasury, *Introduction*, in: National Treasury (Ed.), *Medium Term Budget Policy Statement* 97, South African Government, Pretoria, 1997, pp. 1-3.
- [42] National Treasury, *2019 Medium Term Expenditure Framework: Technical Guidelines*, National Treasury, Pretoria 2018.
<http://www.treasury.gov.za/publications/guidelines/2019%20MTEF%20Technical%20Guidelines.pdf>. (Accessed 11 June 2019).
- [43] E. Bitzer, E. De Jager, The views of commerce students regarding “free” Higher Education in South Africa, *South African Journal of Higher Education* 32(4) (2018) 12-36.
- [44] A. Areff, D. Spies, Zuma announces free higher education for poor and working class students, 2017 24.com, Johannesburg <https://www.news24.com/SouthAfrica/News/zuma-announces-free-higher-education-for-poor-and-working-class-students-20171216> (Accessed 12 July 2019).
- [45] L. Donnelly, M. Letsoalo, B. Macupe, T. Tshwane, Zuma ignored treasury, NEC on higher education, 2017 Mail & Guardian, Johannesburg <https://mg.co.za/article/2017-12-17-00-zuma-ignored-treasury-nec-on-higher-education/> (Accessed 7 May 2020).
- [46] T. Kahn, Jacob Zuma’s promise of free higher education honoured, 2019 Tiso Blackstar Group, Johannesburg <https://www.businesslive.co.za/bd/national/2019-02-20-zumas-promise-of-free-higher-education-honoured/> (Accessed 12 July 2019).
- [47] M. Ramos-Mejía, M.-L. Franco-Garcia, J.M. Jauregui-Becker, Sustainability transitions in the developing world: Challenges of socio-technical transformations unfolding in contexts of poverty, *Environmental Science & Policy* 84 (2018) 217-223.
- [48] B.K. Sovacool, J. Axsen, S. Sorrell, Promoting novelty, rigor, and style in energy social science: towards codes of practice for appropriate methods and research design, *Energy Research & Social Science* 45 (2018) 12-42.

- [49] Climate Transparency, Brown to green: The G20 transition to a net-zero emissions economy, Climate Transparency, Berlin, Germany, 2019, p. 2018.
- [50] World Bank, World Development Indicators, 2020.
<https://databank.worldbank.org/source/world-development-indicators>. (Accessed 6 May 2020).
- [51] C. Keeton, Bringing a climate of change, 2019 Times Live, Johannesburg
<https://www.timeslive.co.za/sunday-times/news/2019-07-28-table-talk--bringing-a-climate-of-change/> (Accessed 21 August 2019).
- [52] Eskom, Integrated Report, Johannesburg, 2019.
- [53] L. Baker, J. Phillips, Tensions in the transition: the politics of electricity distribution in South Africa, *Environment and Planning C: Politics and Space* 37(1) (2019) 177-196.
- [54] BusinessTech, South Africa sees government debt exceeding 100% of GDP, 2020.
<https://businesstech.co.za/news/finance/409345/south-africa-sees-government-debt-exceeding-100-of-gdp/>. (Accessed 1 September 2020).
- [55] A. Habib, State-civil society relations in post-apartheid South Africa, *Social Research* (2005) 671-692.
- [56] M. Friedman, *Capitalism and Freedom*, University of Chicago Press, Chicago, 1982.
- [57] L. Husain, Policy experimentation and innovation as a response to complexity in China's management of health reforms, *Globalization and Health* 13(1) (2017) 54.
- [58] J. Schot, F.W. Geels, Strategic niche management and sustainable innovation journeys: theory, findings, research agenda, and policy, *Technology Analysis & Strategic Management* 20(5) (2008) 537-554.
- [59] M. Florio, *Applied welfare economics: Cost-benefit analysis of projects and policies*, Routledge, Abingdon, 2014.
- [60] Department of Planning Monitoring and Evaluation, *Socio-Economic Impact Assessment System Guidelines*, Department of Planning Monitoring and Evaluation, Pretoria 2015.
<https://www.dpme.gov.za/keyfocusareas/Socio%20Economic%20Impact%20Assessment%20System/SEIAS%20Documents/SEIAS%20guidelines.pdf>. (Accessed 8 May 2020).
- [61] C.S. Park, G. Kim, S. Choi, *Fundamentals of Engineering Economics*, 3rd Edition ed., Pearson Education, Harlow, 2013.
- [62] IRENA, *Renewable Power Generation Costs in 2018*, International Renewable Energy Agency (IRENA), Abu Dhabi, 2019.
- [63] D.R. Walwyn, A.C. Brent, Renewable energy gathers steam in South Africa, *Renewable and Sustainable Energy Reviews* 41(1) (2015) 390-401.
- [64] M.P. Hekkert, R.A.A. Suurs, S.O. Negro, S. Kuhlmann, R.E.H.M. Smits, Functions of innovation systems: A new approach for analysing technological change, *Technological Forecasting and Social Change* 74(4) (2007) 413-432.

[65] F.W. Geels, B.K. Sovacool, T. Schwanen, S. Sorrell, The socio-technical dynamics of low-carbon transitions, *Joule* 1(3) (2017) 463-479.