SCIENCE POLICY RESEARCH UNIT

SPRU Working Paper Series

SWPS 2019-08 (May)

Multiple Regime Interactions, Conversion, and South Africa's Liquefied Natural Gas

Marie Blanche Ting

Energy Policy

Sustainable Development

Science and Technology Policy

Innovation and Project Management

Economics of Innovation

UNIVERSITY OF SUSSEX | BUSINESS SCHOOL

SPRU Working Paper Series (ISSN 2057-6668)

The SPRU Working Paper Series aims to accelerate the public availability of the research undertaken by SPRU-associated people, and other research that is of considerable interest within SPRU, providing access to early copies of SPRU research.

Guidelines for authors

Papers should be submitted to swps@sussex.ac.uk as a PDF or Word file. The first page should include: title, abstract, keywords, and authors' names and affiliations. The paper will be considered for publication by an Associate Editor, who may ask two referees to provide a light review. We aim to send referee reports within three weeks from submission. Authors may be requested to submit a revised version of the paper with a reply to the referees' comments to swps@sussex.ac.uk. The Editors make the final decision on the inclusion of the paper in the series. When submitting, the authors should indicate if the paper has already undergone peer-review (in other series, journals, or books), in which case the Editors may decide to skip the review process. Once the paper is included in the SWPS, the authors maintain the copyright.

Websites

UoS: **www.sussex.ac.uk/spru/research/swps**
SSRN: **www.ssrn.com/link/SPRU-RES.html**
IDEAS:**ideas.repec.org/s/sru/ssewps.html**

Multiple Regime Interactions, Conversion, and South African Liquefied Natural Gas

Marie Blanche Ting

Science Policy Research Unit (SPRU), University of Sussex, Brighton BN1 9SL, United Kingdom

Highlights

- Limited research on multiple regime interactions in sustainability transitions.
- Traced the co-evolution of an emerging interaction between established electricity and liquid fuels regime in South Africa.
- Regime rules are multipurpose tools, which can be repurposed, redirected, and reinterpreted, by regime actors.
- Multiple regime interactions can be characterised as repurposing existing normative, cognitive and normative rules in response to cumulative landscape and regime tensions over time.

Abstract

Increasingly it is recognised that regimes in transitions can promote niches rather than resist them. Using a combination of the Multi-Level Perspective (MLP) and institutional theory, this paper contributes to the transitions literature on multiple regime interactions, by providing a more nuanced understanding of why and how regimes interact over time. Using semi-structured interviews, the case study explored South Africa's development of its Liquefied Natural Gas (LNG) for power generation and industrial use together considered as the niche. The two regimes were the coal-based electricity and liquid fuels. This case study revealed the co-evolutionary nature of multiple regime interactions, through repurposing existing institutions in response to increasing landscape pressures and regime tension over time. However, repurposing of existing rules was neither spontaneous nor automatic but required a series of cohesive efforts for linkages between the two regimes. These efforts involved the ongoing interface between a broad base community with interests for the LNG niche, which over time provided a supportive environment in which to complement shared resources. Understanding multiple regime interactions, has potential implications on 'acceleration' of niche development, whereby new institutions are not necessarily created, but rather repurpose existing ones to serve new goals or interests. The paper also reflects on temporal policy overlaps aimed at sustainability transitions, whereby a policy instrument initially used for renewables could be co-opted by more powerful actors in a direction that may strengthen

a fossil fuel based system. Thus, special attention is needed on the relationship between the flexibility of some policy instruments and the dominant groups, which may leverage them for its own interests.

1. Introduction

This paper examines how multiple regime interactions enable the development of a niche, through a series of cohesive efforts in repurposing existing regime rules. Understanding multiple regime interactions is essential in transitions research; because it can counter the bias of bottom-up niche development (Geels, 2011), as well as standalone regime transformations (Papachristos et al., 2013, Raven, 2007, Sutherland et al., 2015, Konrad et al., 2008). Moreover, there is limited deliberation on the role of landscape pressures, and regime tensions on multiple regime interactions, which are indeed central to sustainability transitions research (Sutherland et al., 2015).

To examine multiple regime interactions, this research presents a case study on South Africa's development of gas-fired generation in the electricity system and industrial use. In 2015, South Africa introduced a gas independent power producers procurement programme (Gas I4P)[1], To procure 3.7 GW of liquefied natural gas (LNG) to power (DOE, 2016). At present gas contributes to around 3% to the country's primary energy mix, but there are indications that gas will feature more strongly in the future (DOE, 2018a). There are a diversity of drivers for pursuing gas including energy diversification and security to reduce the country's dependence on coal for electricity; as a means to reduce GHG emissions from electricity generation; as a potential to provide flexibility to the introduction of renewable generation into the electricity grid; and as an opportunity for regional trade within the Southern African Development Community (SADC) (DOE, 2016).

The research question is: What explains regime interactions in the course of developing South Africa's LNG for power and industrial use?

To answer this question, the case study uses the Multi-Level Perspective (MLP), whereby the two regimes are electricity and liquid fuels, and LNG for power and industrial use was considered a niche. As this paper aims to advance the concept of multiple regime interactions, the analytical work is based on analysing rule changes, which is expected to reveal different types of regime interactions. It is well known in transitions research that regime actors are not passive rule followers but are 'knowledgeable agents' that can reflect and engage in ways other than their taken for granted social rules (Geels and Schot, 2010, p. 34). Given that rules are informed by institutional theory, this research draws on the concepts of conversion, in which to observe the efforts employed by both regimes to develop a niche. Conversion was developed by institutional scholars, which is defined as repurposing or redirection of existing rules for new ends (Streeck and Thelen, 2005).

As later elaborated, existing rules between the two regimes were repurposed over time, as a response to pressures from landscape changes and regime tensions. As such viewed from a

[1] For consistency the Gas I4P, is used throughout the paper

multi-level perspective, increasing pressures from the landscape and the electricity regime influenced its search heuristics from a local to distant search in such a way that it gradually integrates more radical alternatives and exploration of new knowledge bases (Geels, 2014, p. 271). The South African case study demonstrated that to develop the LNG niche, several cohesive efforts of alignment between the electricity and liquid fuels regime became necessary. At first, the efforts involved repurposing an existing policy instrument, which was initially used for renewable energy from independent power producers procurement programme (RE I4P)[2], but later procured gas and coal also from independent power producers (IPPs). Then as the required technical and operational parameters needed for the LNG niche matured, so did the level of interaction between the two regimes. A series of activities had followed, which was premised on importing LNG for power generation, and LNG for industrial use. Therefore, a broad base of actors became part of the LNG development, which included national and local government, societal groups, finance, industry stakeholders, environment, and the research community. These served as a supportive and collaborative community on which repurposing of rules became conceivable. This paper argues that repurposing existing rules between regimes can provide insights for advancing the literature on multiple regime interactions, which in turn has implications on niche development. The paper concludes with some reflection on the implication that policy instruments may be vulnerable to co-option by dominant groups that could re-direct them away from sustainable transitions.

The paper proceeds as follows. Section 2 sets out the conceptual framework and gives due consideration to the critical concepts of the conceptual framework, which is a combination of the MLP with an institutional lens of conversion. Section 3 discusses the methodology used for the research; Section 4 provides an overview of South Africa's liquid fuels history, and electricity as regimes, describing how the multiple regimes emerged to create a favourable environment for the development of Gas I4P. Section 5 draws together the main findings in the paper and concludes in Section 6 with suggested contributions to empirical and theoretical research.

2. Conceptual framework

2.1 Conceptualising multiple regimes in transitions research

The notion of transitions is regarded as co-evolutionary changes between socio-technical systems, actors and social networks, and socio-technical regimes (Foxon, 2011, Geels and Schot, 2010). One of the most common frameworks used in transitions research is the Multi-Level Perspective (MLP). The MLP defines transitions which interface changes at three levels: innovative practices (niche experiments), structure (the regime), and long-term, exogenous trends (the landscape) (Geels and Schot, 2010). The MLP considers the interaction between all three levels in a given time as part of the process of transitions (Raven and Verbong, 2007). These three levels are regarded as functional relationships between actors, structures, and practices that are closely interlinked. Furthermore, the higher the scale level, the more aggregated the components and the relationships and the slower the dynamics are between these actors, structures and working practices (Grin, 2010).

[2] For consistency the RE I4P, is used throughout the paper

The regime tends to lock in processes, because of mutual interdependencies and alignment over time, such that path dependency and incremental change are likely (Smith and Raven, 2012). Where radical innovation does take place is in the form of protected spaces, so-called niches. Landscape change such as global trends or climate change concerns may exert pressure onto the regime resulting in destabilising effects, and for niches to develop. Transitions within the MLP frame start in socio-technical niches, diffuse and breakthrough due to the linkages between developments at multiple levels (Geels and Schot, 2010). The assumption is that as a niche matures; it scales up and diffuses, resulting in overthrowing the incumbent regime, eventually leading to either transformation or replacement of the dominant regime. However, there are other scholars who recognised that regimes also drive innovation at the niche level, depending on the economic opportunity (Berggren et al., 2015). For instance, in analysing hybrid electric powertrains, Berggren et al. (2015), noted that an incumbent, which drove innovation in a systemic, integrated approach, had good potential in scaling up niches such that technological applications had vertical integration, and broader market adoption. To elaborate, incumbents used existing knowledge resources to leverage the development of new technologies, applied innovation across a variety of market segments, as well as providing insights into performance requirements such as efficiency, functionality, and costs. In this way, the incumbent took advantage of existing resources to support and develop the technological niche.

Moreover, standalone regime transformations has been criticised given the interrelatedness of complex sociotechnical systems (Papachristos et al., 2013). As such, a few researchers have revealed various ways in which multiple regimes can interact, and these include: 1) competing with each other in order to fulfil similar societal functions; 2) complementary relations, e.g. a natural gas regime providing a steady source of supply to the electricity regime; 3) shared structural similarities as a result of which separate regimes merge into one; and 4) through spillover effects as a result of the transfer of rules to another (Raven and Verbong, 2007, Raven, 2007). Multiple regimes can also interact via 'functional coupling' such as input-output relationships (Konrad et al., 2008), or 'structural coupling' between infrastructures, for instance, telecommunications using electricity cables (Schot and Kanger, 2018). Konrad et al., (2008) asserted that multiple regime dynamics require consideration because socio-technical transformations often entail overlaps or shared boundaries across regimes such that producers and consumers have closer linkages. For example, Konrad et al. (2008) indicated from 1920 to 1990s closer multiple regime interactions with electricity, gas, water; sanitation and telecommunications had developed due to their structural (actors, infrastructures and institutions) similarities. Likewise, Geels (2011), argued that as niches mature there is a need to interact between two or more regimes, for instance, biofuels links with agriculture and transport, or battery powered vehicles links with transport and electricity.

The research on multiple regime interactions highlights the potential of 'accelerating' niche development through the efforts encouraged by regimes. This then offers an opportunity in understanding transitions as less bottom up, and could conceivably be realised through multiple regime interactions. One of the possible means to analyse multiple regime interactions is through the concept of rules, given that it forms a central coordinating and guiding features of regimes (Geels and Schot, 2010). Rules in the form of normative, regulative and cognitive provide the functional relationship between material resources, actors and organisational networks within the socio-technical regime (Genus and Coles, 2008, Kivimaa and Kern, 2016). This research expects that a focus on rule changes are likely to reveal the types of interactions between regimes. The next section discusses in further details the linkages between rules and the regime.

2.2 Socio-technical regime and rules

It is well recognised in transitions research, that the socio-technical regime is informed by institutional theory, whereby rules are embedded in structures that are both context and outcome of actions (Geels, 2004, Geels, 2011). These structures are established through semi-coherent alignment of normative (values, behavioural norms) cognitive (belief systems, perceptions, search heuristics), and regulatory rules (regulations and standards) (Geels and Schot, 2007). According to Geels (2014), regime actors could draw on their structures, through deliberate strategy, intentionality, and interpretation of rules. Therefore, the recognition is that regime actors are not 'cultural dopes', but are instead 'knowledgeable agents', that go beyond routine base actions, whereby learning, anticipation, and deviating from existing norms are conceived (Geels and Schot, 2010). More recently, Schot and Kanger (2018) have indicated that rules are exchangeable in a way that variations exist in scope (rules in single or multi-systems) and whether there are single rules or rule-set in multi-systems. This then allows for the possibility of understanding rules as transferable or negotiable by regime actors, in such a way that it could be redirected or repurposed for new goals. However, there is a lack of research, which operationalises the concepts of repurposing rules in regimes, which may provide useful insights into multiple regime interactions. Repurposing rules may also shed some light in accelerating transitions, as new institutions are not necessarily created but instead redirected towards new goals. It is for these reasons that the current paper sets its aims, in which repurposing rules are tested in South Africa's LNG development.

2.3 Rule-changes and institutional theory

Building on the ideas of rules, which are derived from institutional theory, a group of scholars have developed concepts to delineate four different types of rules changes, and these refer to drift, layering, conversion and displacement applied in political science research (Streeck and Thelen, 2005, Mahoney and Thelen, 2010). To elaborate: *drift* is when formal rules are deliberately held constant in the face of significant shifts causing their outcomes to change; *layering* when new rules are added alongside old ones; *conversion* is a redirection, or repurposing existing rules for new purposes, and *displacement* is the replacement of old rules with entirely new ones. I focus specifically on adapting conversion as it translates into a broader set of repurposed regime rules, which could reveal how shared resources are effectively used.

2.4 Conversion: Repurposing existing rules

Conversion defines institutions as 'multipurpose tools' (Hacker, 2015), and refers to the transformation of existing rules through redirection, reinterpretation and re-appropriation, depending on which political or economic force is powerful enough to control them in their favour (Streeck and Thelen, 2005, Hacker, 2015). Institutions are therefore subject to mediation and contestation over which functions and purposes they should serve. Moreover, the actors that were responsible for the creation of rules may be different from those who were in charged with shaping and operating them over time. Thus, it is likely that given enough time, the interpretation of rules becomes a variable, as various actors enact them in different ways. According to Hacker (2015), dismantling and creation of new institutions are often challenging because there are significant hurdles and barriers in collective action to do so. Therefore, conversion is a way of sidestepping these efforts by repurposing existing institutions into new directions or goals. The next section defines the rules, as they are understood in transition research, using these as a basis for the analytical framework.

2.5 Defining the rules

For this paper, I follow Geels (Geels, 2014, p. 267) description of 'industrial regime', which focuses on industry-specific institutions that guide the responses of firms in industries. The 'industrial regime' was used because of the ways in which, a regime could respond to specific interests, shared mindsets, cognitive frames, and industrial identity and mission (Geels, 2014).

For this paper, the following regime rules are considered, 1) cognitive 2) normative and 3) regulative rules. To elaborate on these rules, a description is further described below.

Cognitive rules refer to industrial mind-sets and cognitive frames, which influence interpretations, strategic choices and decisions (Geels, 2014, p. 267). Strategic responses can include mutual expectations, in a way that legitimises choices in specific configurations over others as well as the inclusion or exclusion of artefacts (Berkhout, 2006). Taken together, responses, and choices form shared mind-sets in industries, which contribute to cognitive inertia because actors tend to search for solutions within their own sphere of activity.

Normative rules refer to industry identity, values and mission. Here the normative institutions blind industries towards appropriate behaviour regarding social obligation or pressures to conform (Geels, 2014). The normative elements signal a societal purpose and expectations, which enables legitimacy and validity. An example of normative rules can include values placed on societal problems such as climate change or phase-out of coal.

Regulative rules refer to regulations, laws and standards, which are imposed on industries through governance mechanisms that facilitate actions in specific directions (Geels, 2014). Here the basis of legitimacy is through formal rules such as legislation and sanctions.

In the next section, the repurposing of rules according to a conversion lens is operationalised, guiding the analytical research.

3. Data and Methodology

In this case study, the analysis is on evolving interaction between the two regimes which led to the development of the LNG for power generation (Gas I4P) and LNG for industrial use, which established the Gas Industrialisation Unit (GIU). The two regimes are South Africa's liquid fuels and electricity. The LNG for power and industrial use are regarded as a niche. The period from 1998 to 2018 was considered, demonstrating how two regimes evolve into a closer relationship. The analytical period started in 1998 because South Africa's White Paper on Energy was implemented at this time, marking significant post-apartheid changes. Significant to this study, was the recognition that energy diversification away from coal (e.g. renewable energy, and gas) were needed. I argue that there is evidence to suggest the two regimes grew closer in interaction over time, due to landscape changes, as well as regime tensions. Therefore, the South African case study provides a useful example whereby multiple regimes could be examined using the regime concept of the MLP in combination with institutional change.

The fieldwork for this research was carried out between June and August 2015, and from March to July 2016. It included 20 semi-structured interviews, 13 of which are drawn upon in this paper, and were conducted in Pretoria, Johannesburg and Cape Town, and the United Kingdom (U.K.) with representatives from government, NGOs, the private sector, academia and think tanks (Table 1). Moreover, in February 2018, to supplement ongoing updates, a few follow up questions were posed to some interviewees. Furthermore, South Africa's integrated resources plan (IRP), a significant strategic directive from the DOE was updated in August 2018. The updated IRP had proposed a significant role of Gas I4P in the electricity sector up to 2030. Therefore, the analysis period covers gas developments up to August 2018, and as such a timely case study. The interview material was then triangulated through a systematic analysis of publicly available documents from South Africa's energy, and environment portfolio committee hearings, academic publications, and articles in the national press.

Table 1 : List of interviewees for this research outlining their respective positions

Respondent	Position	Interviews (date and location)
A	Director of oil and gas in a law firm	15 April 2016, Cape Town, South Africa
B	Vice President of South African Petrochemical company	4 May 2016, Johannesburg, South Africa.
C	Chief Advisor of Power System Economics in a State-Owned Entity (SOE)	5 July 2016, Johannesburg, South Africa.
D	Development Manager for an Engineering Procurement, Construction (EPC) and Project Development Firm	15 March 2016, Johannesburg, South Africa

E	Independent consultant that is part of the Gas Industrialisation Unit (GIU) task team	14 April 2016, Cape Town, South Africa
F	Senior manager in an oil and gas alliance organisation	19 April 2016, Cape Town, South Africa
G	Consultant for the independent power producers (IPP) office	10 March 2016, Johannesburg, South Africa
H	Senior academic on energy and infrastructure at a South African university	16 April 2016, Cape Town, South Africa
I	Representative of the IPP office	4 March 2016, Johannesburg, South Africa
J	Representative of the IPP office	30 October, 2015, Johannesburg, South Africa
K	Member of Business Unity South Africa (BUSA) energy task team	7 March 2016, Johannesburg, South Africa
L	Senior oil and gas government representative	31 March 2016, Pretoria, South Africa
M	Researcher based in a UK think tank	9 February 2018, U.K.

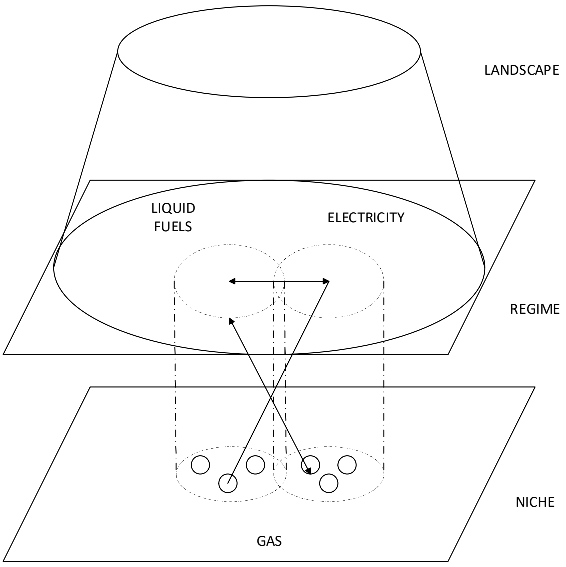
To operationalise the concepts of conversion, I first grouped the overarching regime rules according to selection pressures of cognitive, normative and regulative rules (as earlier stated in Section 2). I then constructed the analytical framework based on the regime rules unto conversion, by maintaining the definitions of repurposing existing rules. These operationalised concepts of conversion were the type of questions posed to interviewees. For conversion, examining displays of repurposing and redirection of existing rules from the two regimes, which enabled the development of the niche was important. For instance, repurposing existing infrastructure or the redirection of an existing set of skills or technical knowledge such that it caters to the niche, could be considered conversion.

Furthermore, along with cognitive rules, I examined ways in which industrial mindsets and strategic choices between regimes, are re-interpreted or re-appropriated. Similarly, in the normative rules looking for evidence of redirection in missions and identity to gain social legitimacy or support that could lead to the basis of change in social obligation or appropriation. Lastly, the two regimes could interact due to a repurposing of an existing regulative rule, which favours a niche through legislative means. In my analysis of semi-structured interviews, I did a manual coding to highlight regular themes outlined in Table 2.

Table 2: outlining the main regime rules used and related it to the concepts of conversion.

Regime rules	**Cognitive**	**Normative**	**Regulative**
Conversion	Reinterpretation of Industrial mind-sets	New missions identity, values	Repurpose existing policy instruments or goals

In summary, the analytical framework in this case study uses a combination of the MLP with an institutional lens of conversion (Figure 1).



Analytical framework

Multiple regime interactions

Two regimes: Liquid fuels and electricity

Using the lens of conversion to analyse an emerging closer relationship between the two regimes

The arrows between regimes and niche represent conversion

Figure 1: Depicting the analytical framework used in this study adapted from Sutherland et al. (2015).

4. Multiple regime interactions between liquid fuels and electricity regime

The analysis of the multi-regime interactions is divided into four periods. The discussion begins by describing the historical background of the two regimes, as a prelude to subsequent events. Followed with three sub-periods from 1998-2018, where the regimes started with minor interactions, but due to landscape changes, regime tensions, and a few process repurposing of existing rules, a closer interaction between multiple regimes emerged, resulting in the development of a Gas I4P.

4.1 Empirical background of the two regimes

At present, the country's primary energy mix consists of coal (60 %), crude oil (16%), biomass and waste (20%), gas (3 %), nuclear (2 %) (DOE, 2018b).

Liquid fuels regime

South Africa has more than forty years' experience in exploration for oil and gas, but this is somewhat overshadowed considering the dominance of coal. Nevertheless, the country has an existing well-established liquid fuels regime, primarily through a dominant incumbent called Sasol, an energy and petrochemicals company that was state-owned but now corporatised, and the state-owned national oil company, Petroleum Oil and Gas Corporation of South Africa (PetroSA). Together these two companies use Fischer Tropsch technology to convert gas to liquid fuels (GTL) as well as gas for industrial use. Sasol has an existing natural gas pipeline from Mozambique's Pande and Temane gas fields to South Africa (158 million GJ/year) and a 140 MW gas to power plant used entirely for its purposes (later elaborated in Section 4.2). Since the 1980s, Sasol has provided a methane-rich gas (CH_4) as a feedstock to the country's various energy-intensive industries (DOE, 2016, p. 16). In essence, South Africa's existing gas market follows Sasol's historical development. What needs to be appreciated is that in South Africa, Sasol uses gas mostly for its own purpose, with excess supply catering to a peripheral market. Similarly, while Sasol is among the country's largest coal producers, the bulk of this production is to supply its coal-to-liquids (CTL).

PetroSA has extensive oil and gas exploration, in the Bredasdorp basin located off Mossel Bay in the Western Cape Province (Figure 2) and in 1987 established a GTL plant called Mossgas (Burden, 1992, PASA, 2012). Currently, the Mossgas GTL plant consumes 42 million GJ/year (DOE, 2016). PetroSA provides five per cent of the country's liquid fuel needs (DOE, 2015). However, the basin is in decline, and the government has incentives to look for alternative gas supply to ensure the continued viability of the GTL plant.

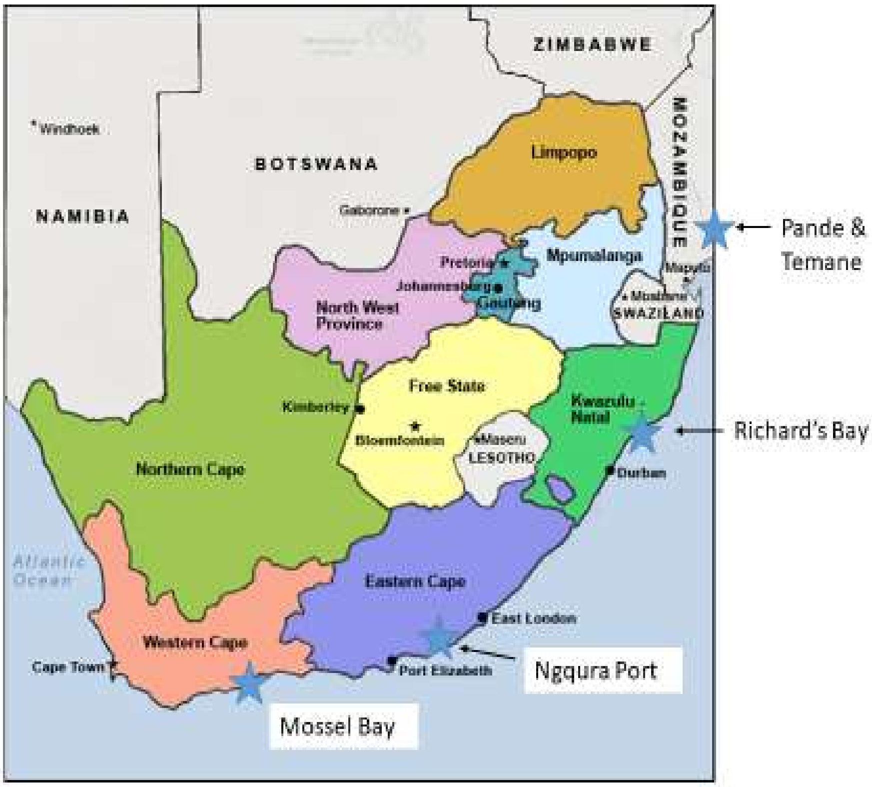


Figure 2: Map indicating Mossel Bay, Port Ngqura, Richards Bay in South Africa, with Pande and Temane gas fields in Mozambique

The main actors in South Africa's liquid fuels regime can be delineated according to upstream and downstream activities (Figure 3).

Upstream deals with exploration, which mostly falls under the legislative framework of the Minerals and Petroleum Resources Development Act (MPRDA) that is administered by the Department of Minerals and Resources (DMR). The Department of Energy (DOE) has substantial organisations under its responsibility, with the Central Energy Fund (CEF) a state-owned energy utility that has broad remits to ensure energy security. The CEF controls, PetroSA (state own GTL refinery), Strategic Fuel Fund (SSF), iGas (Mozambique to SA gas pipeline shareholder), and PASA (licensing agreements) (Transnet, 2016).

The Gas Act, 2001 administered by DOE and regulated under the National Energy Regulator of South Africa (NERSA), covers the **downstream regulatory framework**.

As later discussed, Eskom the state-owned utility for electricity generation uses diesel for peak load but has incentives to shift to gas as a cheaper alternative. Regarding gas pipelines, NERSA regulates these through state-owned entity, namely Transnet, as well as ports infrastructure through the Transnet Ports Authority (TNPA) (Transnet, 2016). For gas to industry, a newly formed, Gas Industrialization Unit (GIU) which deals with gas non-power use is an initiative by the Department of Trade and Industry (the dti) working closely with key players across the sector. In summary, the LNG socio-technical niche has an existing network which is amenable to co-opt for its development. For this research, the gas community which is actively pursuing the LNG is the South African Oil and Gas Alliance (SAOGA), Sasol, DOE, the dti through the GIU, although essential but less active are PetroSA and Transnet (Interview with a senior oil and gas government representative, Respondent L). Thus, it would seem that key actors mainly the DOE and the DTI with Sasol are present in the electricity and liquid fuels regime respectively to realise a gas economy in the country.

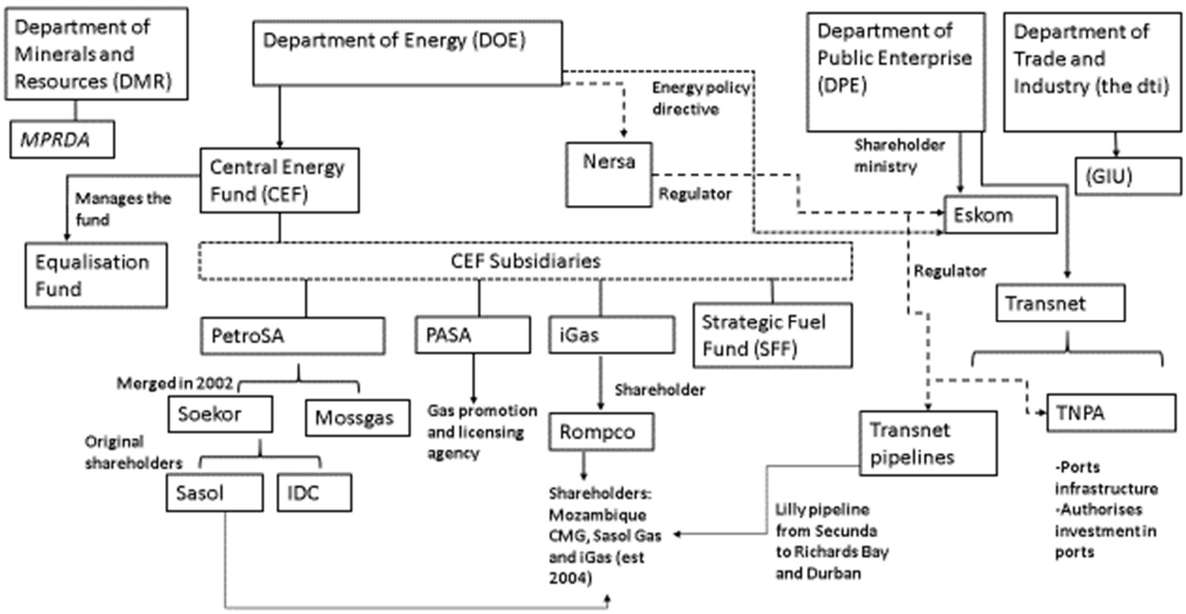


Figure 3: The main players of gas activities in South Africa

Electricity regime

South Africa's electricity system was primarily established to support mining and its associated energy-intensive industry in the early 1900s (Fine and Rustomjee, 1996, Ting, 2015). In 1923, South Africa established Eskom, a state-owned utility, which continues to function as a monopoly in 2018. As part of the state-led, industrial policy to support the mining sector considered vital for the country's economic development. The South Africa government ensured cheap coal, cheap electricity, government incentives, tax subsidies, and import substitution to foster the mining and energy-intensive industries (Makhaya and Roberts, 2013, Roberts and Black, 2009). Consequently, an energy-intensive user group (EIUG), mostly from mining and associated industries, are responsible for approximately 44% of electricity demand in the country (EIUG, 2015). The current state of the electricity sector is that Eskom holds a vertical monopoly responsible for a generation (>90%), transmission (95%) and distribution (>50%) (Eskom, 2015b). Eskom main consumers are municipalities, industry and mining, accounting for around 80% consumption (Figure 4). Eskom has an installed capacity of 37 GW (coal), 1.9 GW (nuclear), 1.4 GW (pumped storage), 0.6 GW (hydro), 2.4 GW (peaking stations with diesel) (Eskom, 2015b).

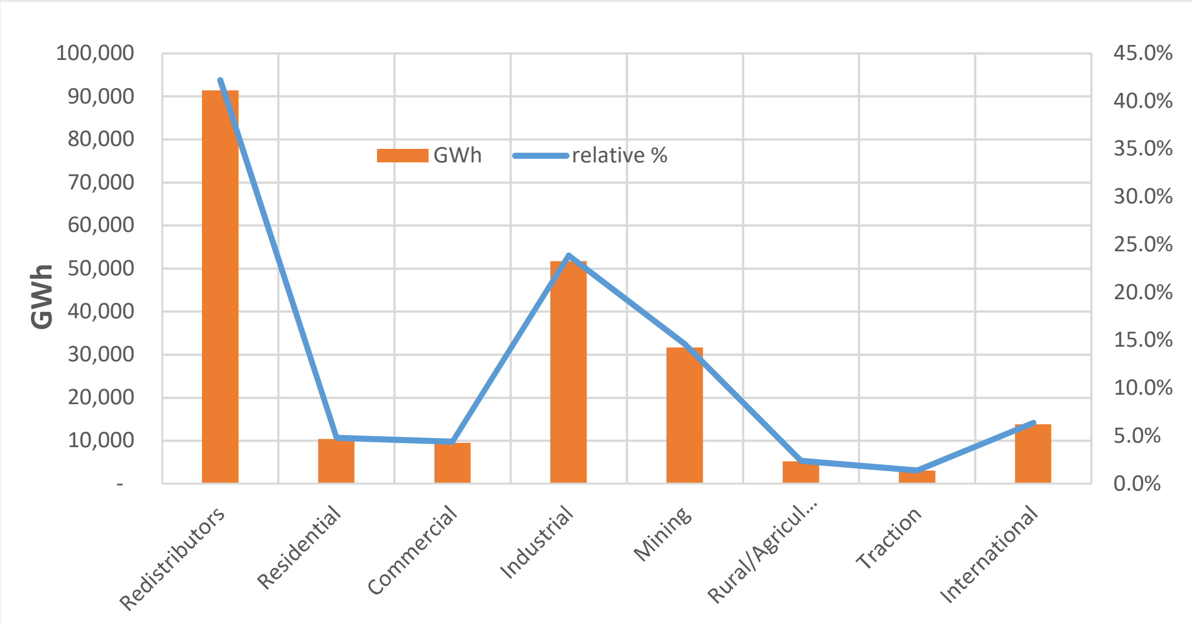


Figure 4: Eskom electricity consumption (GWh) relative to consumer use in percentage (NERSA, 2015)

There are three peaking generation Open Cycle Gas Turbines (OCGT) located in various ports in the country. These existing OCGTs are using diesel during peak demand, which is usually considered between 07:00 and 10:00 in the morning and 18:00 and 20:00 in the evening[3]. The

[3]Eskom,http://www.eskom.co.za/CustomerCare/TariffsAndCharges/Documents/Eskom%20Booklet.pdf

DOE has articulated that more economical use of gas instead of diesel is planned, to support the Gas I4P (as elaborated later in Section 4.3).

The OCGTs are currently located within an existing, well-established port hub along the country's coastline (Figure 2). For instance, in a town called Richards Bay located in the Kwa-Zulu Natal (KZN) province, there are established industries of an aluminium smelter, two titanium smelters, a paper mill and chromium smelter, as well as existing industrial demand for gas due to the Lilly Pipeline (DOE, 2016). In this port, there is a diesel-fired power plant called Avon, of which the DOE plans to convert into gas, with an installed capacity of 670 MW (Figure 5).

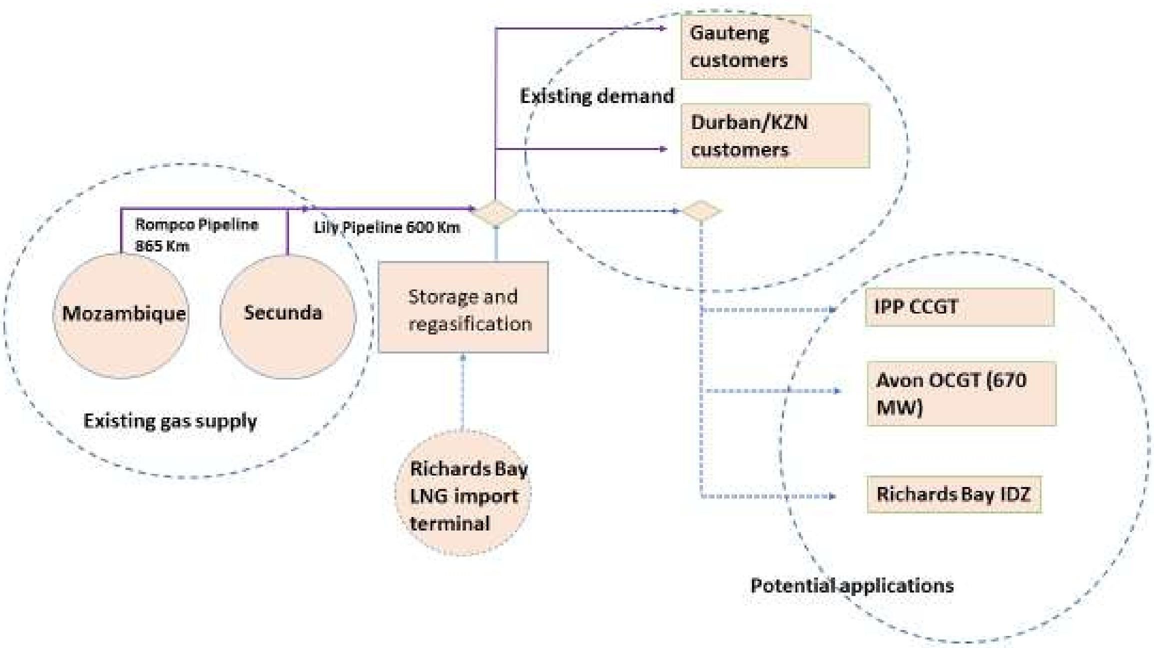


Figure 5: Kwa-Zulu Natal (KZN) potential LNG infrastructure development, adapted from Transnet (2015)

In a nearby port is Ngqura, located in the Eastern Cape Province of the country and is adjacent to a well-established Coega Industrial Development Zone (IDZ) (Figure 6). Coega is also home to considerable investment in renewable energy developments, especially wind farms (DOE, 2016). In this location, there is an operational OCGT plant called Dedisa with a capacity of 335 MW, and a further 350 km is Gourikwa (746 MW) in Mossel Bay (Figure 6). The plans here are to convert Dedisa peaking plant from diesel to gas firing, and the longer term is to establish either a GTL or a minerals beneficiation plant (DOE, 2016, p. 21).

Together these two ports have been selected by the DOE as the initial steps for the Gas I4P. The indication is the implementing the Gas I4P could be complemented by existing industrial activities, to build a business case in importing the LNG. Essentially, the infrastructure needed for LNG import has fundamental geographical requirements, preferably close to existing facilities that are amenable to gas and areas where the government could catalyse and sustain industrial activities.

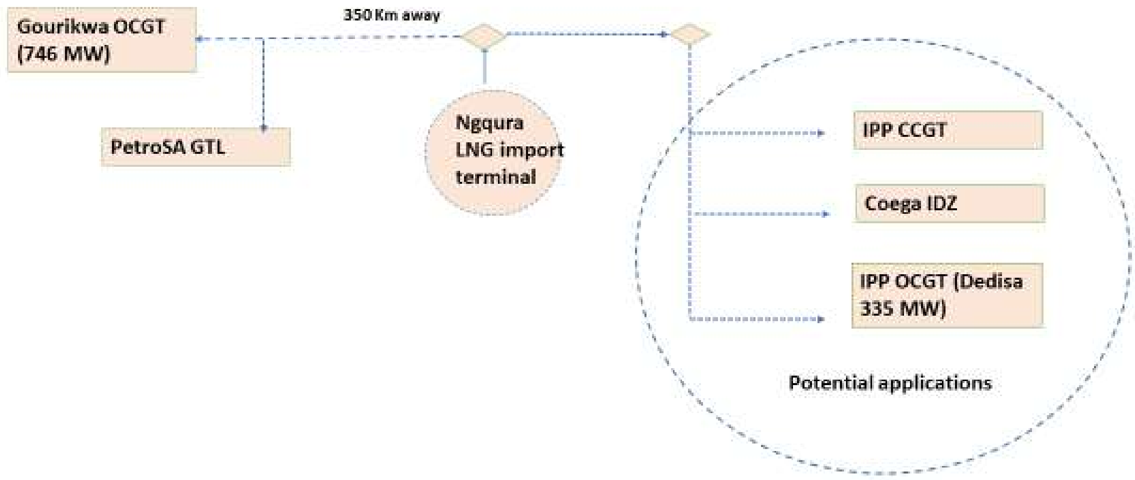


Figure 6: Coega potential LNG infrastructure development, adapted from Transnet (2015)

To sum up, South Africa's gas development is planned for electricity generation, industrial use, and export envisioned up to 2040 (DOE, 2016, p. 15). In the short-term, the DOE plans to import LNG to provide an 'anchor demand' for electricity generation, as the best way of catalysing the gas economy in the country (DOE, 2016). In the mid to longer term, the South African government, wants to establish a gas market by importing and stimulating regional trade within the South African Development Community (SADC), and domestic gas utilisation for industrial, commercial, transportation and residential use (DOE, 2016, Transnet, 2015). Ultimately, the longer-term vision is to provide an incentive for upstream players to invest in exploration, and production for shale gas in the Karoo region. In this way, South Africa could successfully monetise its indigenous energy reserves, particularly because the resource has similarities to an already existing established extractives base economy (DOE, 2016).

In the next section, an emerging closer relationship between the two regimes is discussed, starting from 1998 to 2005.

4.2 1998-2005: Energy sector reforms

In this section, the discussion is focussed on the significant reforms in the country's energy sector from 1998 to 2005. These include a landmark policy which signalled the recognition of natural gas as an option to diversify the country's energy mix, the introduction of private sector participation in electricity generation, the establishment of gas pipelines between Mozambique and South Africa, and several institutional changes. During this period, the liquid fuels regime expanded by establishing key infrastructure developments, while the electricity regime initiated two new coal plants. The two regimes had minor interaction at this point, but this period provided a contextual preamble to gas initiatives that subsequently took place.

In 1998, South Africa's White Paper on Energy provided a milestone policy, which signalled significant changes for both the liquid fuels and the electricity regime. In particular, the need to introduce independent power production against the country's monopoly system as discussed below, and the recognition of gas because of important discoveries in neighbouring countries Mozambique and Namibia (DME, 1998). Subsequently, in 2001, the Gas Act was implemented and established the development of gas infrastructure in the country through pipelines and the regulatory framework. This Act as later discuss has since been amended to adapt to gas developments over time. In 2002, the Mineral Petroleum Resources and Development Act (MPRDA) became operational, which provided remits for oil and gas exploration and production. At the same time, PetroSA was established, consolidating previously separate entities of Soekor and Mossgas.

In 2004, a gas pipeline between Mozambique and South Africa was established. Sasol as the dominant incumbent within a liquid fuels regime established an 865-km gas pipeline from Temane, Mozambique to Secunda in SA (Transnet, 2015). The Republic of Mozambique

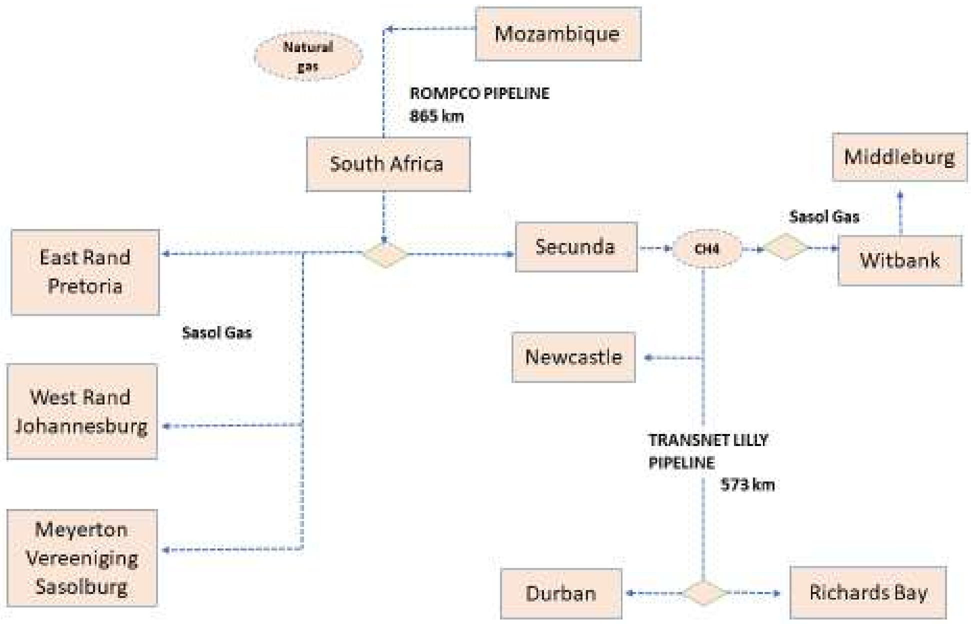


Figure 7: Key gas infrastructure in South Africa.[4] (DOE, 2016, p. 19)

Pipeline Investments Company (ROMPCO) is mostly owned by Sasol (50 per cent), the Mozambique government (25 per cent), and the South African state-owned Central Energy Fund (CEF) (25 per cent) (Transnet, 2016). However, it has been argued that the Rompco

[4] Ch_4 refers to a methane-rich pipeline.

pipeline does not create a real market in the country.[5] This is because the gas pipeline within South Africa (transmission and distribution) is owned and mostly used by Sasol for its plants in Secunda and Sasolburg (Figure 8). In 2017, Sasol imported 158 million gigajoules (MGJ) of natural gas, (DOE, 2016, p. 17, Sasol, 2018) used for its chemical plants and to generate power at an operational capacity of 140 MW (Sasol, 2018). The rest of the gas is routed to the province of KZN, through the Transnet Lilly Pipeline (See earlier Figure 2).

While over 90 per cent of the gas transported via the ROMPCO pipeline goes to Sasol, the establishment of the pipeline has nonetheless created demand to around 370 industrial and commercial customers via 530 offtake points (DOE, 2016, p. 17). Furthermore, the pipeline has prompted the DOE and the Department of Industry (DTI), to encourage existing industries that use LPG and diesel to switch to natural gas as soon as it becomes feasible to do so. These government departments had started to envision the gas industry in the country.

For the electricity regime, 1998, Energy White Paper predicted that demand would exceed supply by 2007 (DME, 1998). The DME[6] noted the following:

> "Although growth in electricity demand is only projected to exceed generation capacity around 2007, long capacity-expansion lead times require strategies to be in place in the mid-term, to meet the needs of the growing economy" (DME, 1998).

What followed from 1998 was a series of significant changes in the electricity regime and these include; a move towards cost-reflective tariffs, the corporatisation and commercialisation of the utility in 2001 (which started to pay dividends and taxes), a higher cost of capital (due to higher debt levels and weaker credit metrics) and a small potential role for gas for peak load in its Open Cycle Gas Turbines (OCGT) (DTI, 2013). As the electricity regime became under pressure to meet the electricity deficit, two new coal plants, namely Medupi and Kusile with a combined capacity of 9.5 GW were commissioned in 2005.

By 2004, the DME, ratified the National Energy Regulatory Act which was responsible for the national electricity regulatory framework. (DTI, 2013, p. 49).

Despite the 1998 White Paper on Energy intention for energy diversification, coal remained the dominant choice for electricity generation up to 2005. At this stage, the liquid fuels and electricity regimes had minor links due to Sasol own use of gas from Mozambique for power generation located in one of its operations at Sasolburg. Therefore, other than these links, the two regimes of interaction could be considered relatively minor. However, given that Sasol has demonstrated the use of gas for liquid fuels production and power generation, the potential for a closer relationship was evident.

4.3 2006-2012- Landscape pressure and regime tensions

During this period from 2006 to 2012, gas started to feature more strongly into South Africa's energy system. A few turning points had occurred; one was the substantial shale gas potential

[5] Respondent A

[6] The Department of Minerals and Energy (DME) split in 2009, forming separate Ministries. From 2009, the Department of Energy (DOE) became the primary energy policy Ministry.

reported by the United States Energy Information Agency (EIA), encouraging policymakers to include gas into the energy mix. Second, was natural gas discoveries in neighbouring Mozambique and Tanzania prompting potential regional trade. Thirdly, an electricity crisis in South Africa resulted in blackouts and load-shedding in 2008, pressuring the electricity regime to seek solutions. These three events were significant because both landscape changes and electricity regime tensions started to escalate.

Consequently, the electricity regime was forced to seek solutions externally to its own coal fleets. In this timeframe, the two regimes had started to interact, driven by the need to solve problems derived from regime tension and landscape trends. These are discussed accordingly.

In 2008, South Africa was cited to have one of the top ten technically recoverable shale gas resource in the world, with estimates at 390 trillion cubic feet (tcf) (EIA, 2013). The location for potential shale gas is in a semi-desert region called the Karoo, spanning approximately two-thirds of the country. (EIA, 2013). Although shale gas is not yet proven, the report by the EIA had catalysed significant interest, particularly with the government often articulating it as a game changer (DOE, 2016b, p. 24). From 2008, onwards gas had started to feature more strongly, and these were reflected in the DOE integrated resources plan in 2011.

Around the same time, from 2009 onwards, regional discoveries of gas near South Africa are raising interest amongst the national gas community. The most promising natural gas discoveries were discovered off the coast of Mozambique and Tanzania. The area called the Rovuma basin in Mozambique has garnered enormous interests in the Southern African gas community region (Ledesma, 2013, Symons, 2016). The Rovuma basin has potential natural gas reserves more significant than 100 tcf, with two main areas for exploration operated by US-based Anadarko and Italian company ENI (Ledesma, 2013). The Rovuma basin is a significant gas play, dwarfing regional gas discoveries elsewhere for instance in Namibia, Tanzania and Angola.[7]

Anadarko is planning to build two 5 MTPA (million tonnes per annum) liquefaction trains with an expected operational date by 2021 (DEDT, 2013, p. 34). As later described, neighbouring countries gas discoveries are part of the South African government's means to initiate a regional industrial trade.

By 2012, major national stakeholders in the South African gas industry were established, and these include the Southern African Qualification and Certification Committee for Gas, South African Oil and Gas Alliance (SAOGA) and Gas User Group (GUG), which represents 13 large domestic manufacturers (Ethekwini, 2015, p. 105). Based on a growing number of gas associated stakeholders, an indication is that an expansion of the gas community could contribute to shaping the ideas, opinions, as well as the practicalities needed to realise a gas economy in the country.

For the electricity regime, in 2008, a major electricity crisis demonstrated through blackouts, and load shedding had occurred (Ting and Byrne, 2019). The electricity regime tension had a destabilising effect, which prompted a search for solutions to the problem. During the electricity crisis, Eskom used (amongst other measures) costly diesel OCGTs to mitigate the shortfall in supply (Figure 8). Eskom reportedly operated the OCGT's at a load factor from 0.3%

[7] For comparison, technical gas reserves in Angola are around ten tcf, Namibia less than one tcf and South Africa offshore basin is less than one tcf.

in 2009/10 to 19% in 2013/14, instead of a typical peak load of up to 5% (Eskom, 2015b). Subsequently, Eskom had spent substantial operating costs to mitigate the electricity deficit (DEDT, 2013). A study indicated that running a peaker gas fired Close Cycle Gas Turbine (CCGT) on imported LNG as opposed to diesel at a load factor of 20% had less impact on the country's trade balance (DEDT, 2013, p. 50). This meant that the higher the load factor on a peaker plant that is running on diesel, the higher the imperative to replace it with LNG. Therefore, there was an incentive for using gas as a feedstock to offset the costs of diesel.

Using diesel during the time of crisis, it became apparent to the DOE, that this measure was a costly solution. At this point, it would seem that gas for power generation became an option because of the electricity crisis, and the potential regional natural and domestic shale gas. As often articulated during interviews gas provided benefits over diesel, such as affordability and the probable use between electricity and industry.[8]

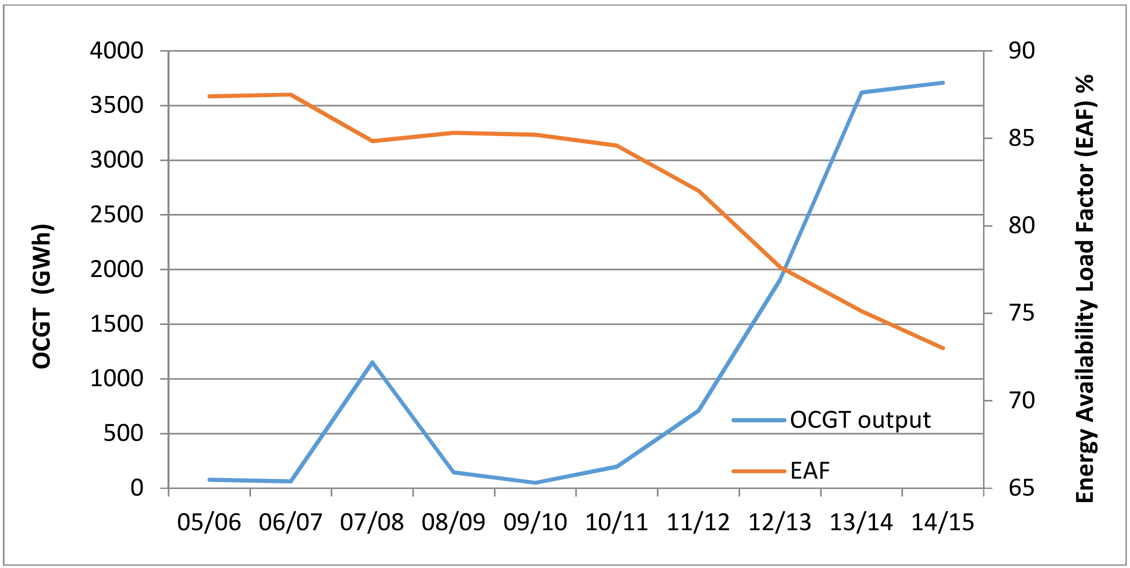


Figure 8: Eskom's use of diesel relative to its Energy Availability Factor (EAF)[9] (Eskom, 2015b)

Eventually, in 2011, as a response to the electricity crisis, the DOE ratified legislation called New Generation Capacity, under the Electricity Regulation Act (DOE, 2018b). The New Generation Capacity introduced the Renewable Energy Independent Power Producers Procurement Programme (RE I4P). This provided much needed private sector investment into the country's electricity generation. Despite significant delays and challenges to its implementation, the RE I4P later was in the first instance very successful, as a result of which the DOE decided to adapt the model in order to procure gas and coal from IPPs. From here, the policy instrument of introducing independent power producers became an essential policy tool for the Gas I4P.

[8] Respondent A, C, H.

[9] EAF measures plant availability, plus energy losses not under the control of plant management (external).

4.4 2013-2018 Emergence of multiple-regime interactions

From 2013 to 2018, gas development started to gain momentum driven by significant landscape trends that include increasing sophistication in LNG liquefaction, favourable gas prices that were conducive for import, and changes in LNG trade patterns favouring countries that wanted to import LNG. Moreover, in this period significant conversion changes were evident, particularly the repurposing of the RE I4P policy instrument used initially for renewable energy, later used for Gas I4P. Further, the plans for potential gas trade with Mozambique became formalised through the DTI critical industrial policy action plan (IPAP). Lastly, technological development of the gas niche became more specific, mainly outlining procurement under a bundled case, with floating storage regasification gas unit (FSRUs) as the preferred model (DOE, 2016, p. 23). The Gas I4P was often articulated to provide flexibility to the electricity grid, a suitable load follower to renewable energy intermittency, and provide less risk of stranded assets. Overall, the development of gas to power started to stabilise, resulting in the liquid fuels and electricity regimes to interact much closer compared to previous periods.

In this period, at the landscape level, three significant trends regarding LNG technologies raised interests in the gas community. These are increasing trends toward liquefaction of gas, bypassing the need for pipelines. Gas for a long time was unable to match the strength of the oil trade through marine transportation (Kumar et al., 2011, p. 4098). However, the relative advancement in liquefaction technology has enabled the possibilities to commoditise gas that bypasses sunk investments such as pipelines. Moreover, gas distribution through pipeline suffers from what is called maximum site specificity (Dorigoni et al., 2010). The higher the switching costs for alternative use of a fixed asset the greater the degree of specificity. This makes pipeline an inflexible asset, with a high emphasis on ties between buyer and producer (Dorigoni et al., 2010). In this regard, there is an expected growth of 46% in global liquefaction capacity by 2021, and these are mostly attributed to the United States (US) and Australia, as well as Russia, Malaysia, Indonesia, and Cameroon (IGU, 2016, p. 17).

Secondly, gas prices are changing from long-term to short-term contracts, which opens up to a competitive, spot market and attracting new buyers into the sector. Reportedly short-term (less than five years) LNG trade grew from 8% in 2005 to 29% in 2015 (IGU, 2016, p. 13). A South African study has shown that importing LNG at a gas price of $7 per MMBTU or less can compete with coal (Eberhard, 2015). Given the changing dynamics of global gas prices, it was articulated during interviews that South Africa could negotiate at this favourable price, depending on aggregated demand. [10]

According to one interviewee, that represents government and industry: "past gas volumes were based on oil indexations, but there are structural changes with producers. It is a good time [for SA] to be a buyer because there is a chance to capture good terms in the contract. Time frames are flexible; we are now looking at 5-year contracts". Because of these short-term contracts, countries planning to import LNG are in a better position to negotiate gas prices at favourable rates."[11]

[10] Respondent A, D, E, L

[11] Respondent A

From these sentiments, the implications of short-term trade and lower gas prices mean that the South African gas community believes they are in an excellent position to negotiate favourable contracts.

Thirdly, there are changes in LNG trade patterns, which means new market dynamics between traditional exporters and importers. According to the IGU (2014), "the emergence of new areas with tremendous [LNG] supply potential has been one of the most striking changes in the LNG industry in the last three years."

Overall the impact of these factors means a re-direction of LNG volumes to markets without established liquid gas trade (IGU, 2016, p. 14). Interviews with a representative from the private sector and government, articulate that due to global changes in LNG trade mainly in the shift of traditional exporters and importers, oversupply in the short term, and advances in liquefaction capacities, SA could take advantage of these changes.[12] The three trends were consistently iterated during interviews and used to justify gas developments in the country.

By 2015, due to the success of the renewable energy programme, the DOE repurposed the IPP policy instrument in what can be described as conversion, to procure various other technologies including coal, gas, and cogeneration.

As one interviewee noted: "The idea is that the IPP will handle the bidding process and try to replicate the renewable energy process and success." [13]

Thus, by 2015, the DOE announced the Gas I4P with procurement of 3.7 GW electricity generation (DOE, 2016). The Gas I4P was effectively formalised into the electricity sector, given the strong signal that the policy instrument had provided. According to interviewees, before 2013, scaling gas into a nationwide market has stalled in the past, primarily due to lack of 1) sufficient infrastructure, 2) industrial demand, 3) indigenous gas reserves, 4) clarity in government policies, as well as competing for dominance of liquid fuels and coal.[14] Therefore, gas has been in the background in the overall energy sector. However, with the Gas I4P, the DOE made clear indications that development would be close to an existing diesel-based electricity generation, as well as existing industrial development zones.

Moreover, during this period, the electricity regime had persistent problems, as the new coal plants were not commissioned in time, black outs were continuous, and electricity tariffs increased (Ting and Byrne, 2019). Consequently, the electricity regime grew with tensions over time and increasingly became a visible focal point for public discontent over their rights to civic services and delivery.

As was earlier outlined in Section 4.1, two sites selected for the Gas I4P, were Port of Ngqura (Eastern Cape Province) and Richards Bay (KZN). Both locations have gone through significant environmental impact assessments, and techno-economic feasibility studies to determine the best LNG terminals (DOE, 2016). Thus, there is an indication that the Gas I4P is taking advantage alongside an existing infrastructure development. Both Ports of Ngqura and Richards Bay have dedicated special economic zones, with incentives from local government

[12] Respondent A, F, J

[13] Respondent F

[14] Respondent A, D, E, F, G, I, J, M

to stimulate industrial development. In this way, the plans by the DOE to repurpose diesel base OCGT for gas use, as well as stimulating industrial demand was already in place.

The plans for Gas I4P implementation and site selection, made the technological requirement more specific, particularly as questions were being asked about the type of LNG plant to be established, provincial support, funding models, meteorological conditions and port configuration needed (Transnet, 2016). Likewise, there was a clear alignment that renewable energy and gas are complementary and compatible power generation sources.[15] Relatedly, an interviewee from the electricity regime stated that gas is the best option as a load follower to renewable energy intermittency, as it can be ramped up or down as needed.[16] Thus, there is an increasing awareness that to meet uncertain electricity demand, a modular, flexible generation, and fewer chances of stranded assets are needed, of which gas provides such an option. [17]

These sentiments seem to indicate that technological specification, and choices, were becoming explicit, with more precise direction for the implementation of the Gas I4P. Consequently, the DOE planned to convert existing OCGTs into dual fuel services that will enable it to use diesel and gas. This suggests that the DOE has started to re-purpose at least part of Eskom's fleet, and system requirements, which could favour the Gas I4P.

As the Gas I4P gained traction, the implementation of gas widened as potential feedstock for industrial process, commercial and residential cooking, and heating applications (DOE, 2016, p. 15). The typical alignment of expectations considering gas development is that it provides socio-economic benefits and can contribute to lowering Green House Gas (GHG) emissions (Eberhard, 2015). Here aspects of normative elements are evident, given that the Gas I4P is embedded in national development plans (electricity and industrialisation), which is argued to form a part of increasing social awareness and expectations that in turn could ultimately lead to legitimacy.

Moreover, related to cultural-cognitive elements, a prominent interviewee in the liquid fuels regime articulated noted the following:

> "gas, in essence, covers two things, commodity and energy security". [18]

From this sentiment, an indication is that shared industrial mind-sets have started to widen, as ideas and interpretations for gas applications were considered both in electricity and liquid fuels (DTI, 2018, p. 169). In a way, there was a belief that gas has a role in the electricity sector as well as in industries. As part of its expansion, by 2016, gas potential role beyond electricity was formalised. The country's annual Industrial Action Plan (IPAP) an important national industrial strategy document, followed by the establishment in 2017, a Gas Industrialisation Unit (GIU), illustrated this. The GIU includes members from Sasol, various government departments, and others. These are indications that existing normative elements between electricity and liquid fuels regimes have grown in interaction.

[15] Respondent A, C, F, K.
[16] Respondent C
[17] Respondent H, L
[18] Respondent B

According to Garth Strachan, the Deputy Director-General on Industrial Development at the DTI stated that[19]:

> "The vision of the GIU is to build on the momentum of gas to power development, using gas for scale up- and downstream industrialisation, and as one of the pathways to regional industrialisation"

Thus, beyond national plans for gas were intentions for intra-trade between the Southern African Development Community (SADC), particularly with the proximity of Mozambique (DTI, 2018, p. 168).

> "We are proposing the establishment of an Inter-State Natural Gas Committee to share learning for regional gas development and to prepare for the development of the wider gas economy" (2017).

Additionally, the DTI has identified industries that could align to gas developments. These are; iron and steel, mining and quarrying, petrochemicals, non-ferrous metals, non-metallic minerals, cement industry, power generation, fertilisers, and GTL (Mavuso, 2015). Thus, South Africa strategic imperative is to re-direct 'close at hand' capabilities into using gas as a long-term objective. Close at hand implying that existing capabilities such as those found in liquid fuels and associated industries, could benefit from the expansion of economic activities using gas. The strategy is to stimulate the multiplier effects of linkages in the gas value chain to build sufficient gas industrialisation.

As indicated in most interviews, the re-industrialisation of the country's economy could be realised through the initial catalytic start with the Gas I4P and later with industries. The belief is that gas could be the country's next commodity resource, as the country's mining future was uncertain and is on a decline. [20] Relatedly, some actors in the oil and gas community are pushing for a pivot of mining skills towards the upstream gas sector, as potential new ventures for the extractives industries. [21] The indications were that the skills required for drilling and exploring gas fields are deemed similar to those found in mining. These views are considered as examples of re-interpretation of industrial mind-sets as there is an interrogation of the continued relevance of mining in the extractives industry, given the massive potential of shale gas in the country.

By August 2018, gas was articulated by the latest country's integrated resources plan, to play a significant role in future electricity generation. The indications were that gas would contribute as much as 15% of the installed capacity mix by 2030 (DOE, 2018a). This seems to suggest at least to some degree to the energy policy makers that gas to power has the necessary fit, form and compatibility with the electricity system. Thus, with considerable future role of gas in the electricity regime, and the inclusion of gas in the country's industrial plans, these are instances of new missions, and beliefs, and would, therefore, illustrate a broader institutional change of conversion.

[19] DTI launches Gas Industrialisation Unit, https://www.engineeringnews.co.za/article/dti-launches-gas-industrialisation-unit-2016-05-16

[20] Respondent A

[21] Respondent F

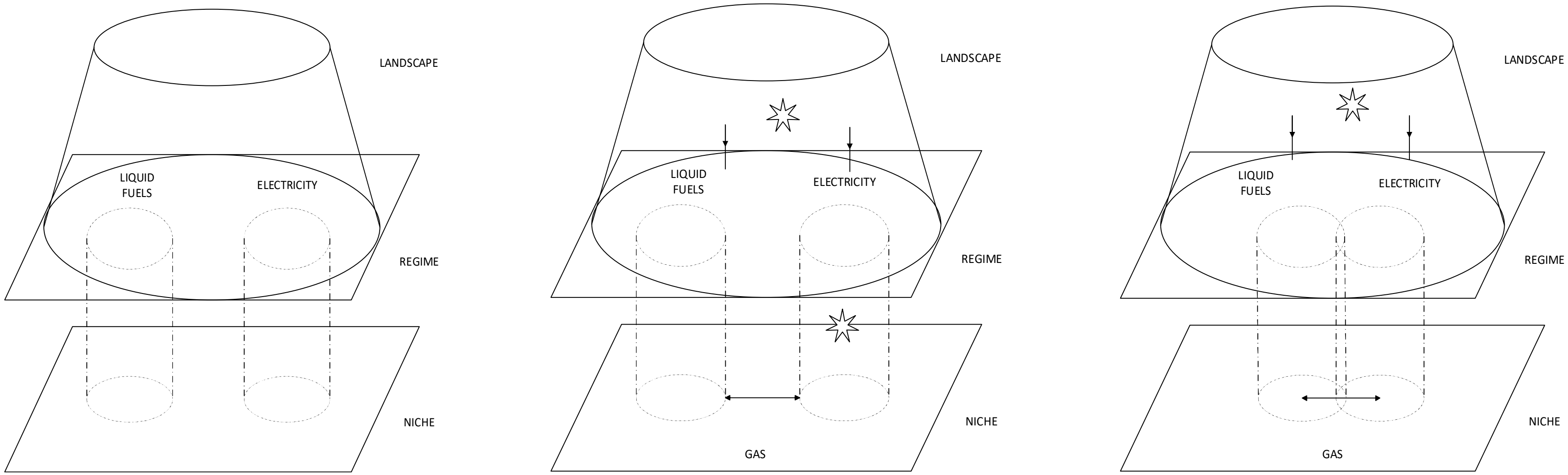
5. Discussion

Using a conversion lens, this case study revealed the co-evolutionary nature of multiple regime interactions, through repurposing existing institutions over time. Moreover, it was demonstrated that repurposing existing rules between the regimes, was in response to cumulative landscape pressures and electricity regime tension over time. This section discusses the main findings, which integrates each of the three period outlined followed by suggested contributions to empirical and theoretical research (Figure 9). Reflecting on the case study, the two regimes of electricity and liquid fuels grew in interaction through the repurposing of the cognitive, normative and regulative rules. The interaction between the two regimes was preceded by changes at the landscape and regime level. Thus the period from 1998 to 2012, provided a preamble as to why the regime interaction had later occurred. From 2012 onwards, the emergence of regime interactions featured more strongly.

For instance, in 2004, Sasol the dominant incumbent in the liquid fuels regime implemented a pipeline to import gas from Mozambique, catalysing a significant change on its operations, using gas as a feedstock for the GTL process and electricity generation. Although Sasol used the imported gas mostly for its own purposes, nevertheless the demonstration of the large-scale project had encouraged, and seeded ideas of the potential feasibility of a gas economy in the country, at least amongst the actors involved in both regimes. Around the same time, the electricity regime endured a series of changes, leading up to the commissioning of two new coal plants. Viewed from an MLP perspective, in the first period analysed, from 1998 to 2005, no significant landscape changes were observed, and both regimes had expanded. Therefore, without any evidence of 'cracks' or a window of opportunity at the landscape or regime level, at this stage, the two regimes had minor interactions.

In the second period (2006-2012), the first signs of changes started to appear, with potential shale gas in the Karoo region, further gas discoveries in Mozambique, and a significant electricity crisis. In addition, in this period there was evidence of an increasing number of gas-related stakeholders in the form of industrial alliances, users group, and associated policymakers. This community would provide a critical point of references whereby ideas, perceptions and interests are deliberated and serve as feedback loops. Overall, these developments prompted the search heuristics of the electricity regime to widen. At first, the solution was the introduction of a policy instrument that enabled the development of renewable energy in the country (Ting, 2019, Sovacool et al., 2018). This could be described as 'local search' as the adjustment was incremental as it maintained the structure of the regime (Geels, 2014). However, with sustained pressure onto the electricity regime, together with prior elements of infrastructure development by Sasol in the liquid fuels regime, conditions for gas development were apparent. In time, the constant blackouts by Eskom are what could be considered as a structural performance problem (Geels, 2014). This meant the electricity regime actors were prompted to question the foundational elements of the regime, and this, in turn, stimulated actions beyond structural constraints. Here, the electricity regime had eventually engaged in a 'distant search' (Geels, 2014, p. 271) because options for radical alternatives and new knowledge bases were explored. Given the need to seek major solutions, by the third period (2013-2018), a closer interaction between the two regimes became evident.

Figure 9: Regime interactions and niche development from 1998-2005 (adapted from Sutherland et al. (2015)



1998-2005

Minor interaction between the two regimes

Key developments

Liquid fuels regime expanded in 2004 a gas pipeline was established between Mozambique and South Africa.

Electricity regime expanded with two new coal plants

2006-2012

Minor interaction between the regimes

Key developments

Landscape pressures due to regional gas discoveries and a major shale gas potential was reported.

Electricity regime tension due to major crisis in 2008

*The stars explains the landscape pressure and the tension with the regime.

2013-2018

Emerging closer interaction between the regimes

Key developments

Major landscape trends of increasing liquefaction sophistication, changes in global gas prices, and LNG trade patterns

In 2015, Gas I4P was initiated by DOE, and in 2016, Gas Industrial Unit (GIU) was established by the DTI

Significant niche development

By 2015, the policy instrument for IPP that initially catered to the RE I4P was repurposed to procure other technologies, including gas. In time to implement the Gas I4P, the level of activities in technological choices became specific and robust, as was demonstrated by decisions in the type of LNG to be imported, selection of port sites, and conversion of existing OCGT plants into dual services, as well indication that gas would provide flexibility as a load follower to renewables. Therefore, as cognitive elements such as technical knowledge, operational processes, and funding mechanisms increasingly matured, so did involvement of a community of a variety of actors. These included national and local government, societal groups, finance, industry stakeholders, environment, infrastructure requirements, and the research community. This suggests that an infrastructure intensive project such as the LNG for power and industrial use, required the interaction of a broad base of actors, and these were found in both regimes. Moreover, the complementary characteristics between the coal-fired electricity and liquid regime enabled the corresponding shared mindset, with similar networks and interests mainly related to the extractives industry.

Relatedly the technological specificity of the LNG was amenable to modular and flexible implementation, provided fewer risks of stranded assets, which are likely to contribute to easier linkages between regimes, and portability amongst applications. There was also an indication that the LNG for power could offset the intermittency of renewables in the electricity grid, and provide prospects to develop a gas industry. Thus, another critical aspect that enabled interaction was the perceived opportunities for both regimes. For instance, the Gas I4P was reliant on LNG importation, the selection of ports meant that the associated local government with the nearby special economic zones had incentives to pursue the initiative. The ports that were selected had existing diesel OCGT plants, which were amenable to be repurposed into dual fuel services. Significantly, the proximity of existing established industries stimulated the national and local government to catalyse a gas value chain. It was demonstrated by the inclusion of gas into the national industrial plans governed by the DTI, which had resulted in the establishment of a dedicated GIU.

The GIU established a task force, including Sasol, various government departments, and other gas stakeholders. The perceived opportunities for gas industrialisation in conjunction with energy security resulted in shared interests amongst actors in both regimes, and thus facilitated ongoing interaction. The gas industrialisation industry had also motivated interests in regional trade with Mozambique, which is increasingly in line with an overarching industrialisation strategy with SADC. This means the plans for realising a gas economy in South Africa suggests an extensive development from a national, local and regional scale. As such, the outreach is broad with prospects for interfacing with a diverse community. Moreover, the opportunities provided by a gas economy prompted support from government and the private sector, particularly from the extractives industry, and would thus, likely be responsive to repurposing or complementing shared resources.

Furthermore, as there was a gradual expansion of shared industrial mindsets, maturity in technical knowledge, and societal expectations for the development of the LNG niche over time. These changes, in turn, gave credibility and legitimacy in support of the LNG niche, which led to the alignment of interests and formation of actor networks between the two regimes. What followed was that some actors started to articulate a change in beliefs in the extractive industries, whereby the country should be exploiting gas as the new commodity, due in part to the precarious condition of the mining industry. For instance, there was a suggestion that the established mining skills in the country could be re-directed towards exploring shale gas fields as those found in the Karoo region. Thus, together with changes in industrial mindsets at least in the extractives industry, and the inclusion of gas in the country's national development plans, this suggests that gas is increasingly embedded within normative goals in both regimes. As changes in core-beliefs, mission and identity are considered deeper forms of institutional change (Geels, 2014). This means that the emergence of linkages between the two regimes could possibly lead to enduring connection and greater configurational transformation (scope and depth) over time.

Lastly, the multiple regime interaction observed in this case study has implications for policies with the intention for sustainability transitions. It would seem that the prevailing actors in both regimes are centred on extractive base industries. Thus, the hopeful change for sustainability transitions, through the renewable IPP policy instrument, was vulnerable to co-option by powerful actors that already subsists within the system, and in this case, seems to strengthen the fossil fuel based system. Therefore, the underlying institutional settings in both regimes predicated on extractives base industries was likely to favour repurposing rules in order to pursue each other's interests. In line with Hacker (2015), who emphasised that rules are subject to re-interpretation depending on groups that may have the necessary resources to re-direct them according to their own benefit. In this way, the policy intent needs to pay attention to dominant groups that can navigate the direction under which transitions can unfold.

In conclusion, a close interaction between the electricity and liquid fuels regime was necessary for nurturing the LNG niche. After sustained structural performance problem experienced by electricity regime, it was later forced to seek a 'distant search' for solutions. Given that South Africa's has a well-established liquid fuels regime, with experience and infrastructure for importing gas from Mozambique and with Sasol a world leader in converting gas to liquid fuels, the prospect of LNG for power became an option.

6. Conclusion

The current MLP literature suggests that windows of opportunity either from the landscape or regime level provide spaces for niches to develop, eventually resulting in overthrow or displacement of a regime. However, this regular pattern of scale up from a niche to a regime could likewise develop through the support of multiple regime interactions. The literature on multiple regimes suggests that the process can be illustrated as complementary, symbiotic, or even competitive. These theoretical concepts while helpful in some context are limited and require a better explanation of why and how regimes interact over time. The evidence found in this research potentially reflects the limitations of engaging with the concepts of niche, regime and landscape in isolation, showing that at any point in time multiple layers of interactions are at play. There is, therefore, an interconnected co-evolutionary process that was enabled through repurposing existing institutions. The case study shows that multiple regime interactions can be characterised as repurposing existing rules as part of the efforts to drive innovation at a niche level.

Through a conversion lens, the regime interactions had enabled the repurposing of existing cognitive, normative and regulative rules. However, it is not evident in literature what the enabling conditions were for conversion to proceed. The empirical case demonstrated that repurposing rules were not automatic nor spontaneous, but instead cultivated over time, due to shared similar interests and perceived opportunities derived from the LNG niche. Moreover, a growing shared community, provided a reference for reflecting on ideas, concepts and feedback loops, enabled the linkages between the two regimes. These, in turn, led to a supportive environment both from government and from the private sector, particularly the well-resourced extractives industry. Lastly, an increasing alignment towards normative goals in both regimes has provided an encouraging setting for sustained interaction.

Finally, the current study is cognisant that the findings are drawn from a single case. However, the aim was to contribute to transitions literature on multiple regime interactions and thus open up for comparative research between similar types of infrastructure intensive initiatives.
Moreover, transitions researchers need to pay attention to the potential of shared boundaries and similarities between various regimes, such that multiple regimes are increasingly recognised and analysed.

Acknowledgements

This paper had greatly benefitted from comments, and guidance of the research topic from Lucy Baker, Rob Byrne and Matias Ramirez, Ralitsa Hiteva, Tim Foxon and Benjamin Sovacool. The author is grateful for the comment received by an anonymous reviewer and the support of the SPRU Working Paper Series (SWPS) editorial team. I also thank the Science Policy Research Unit (SPRU) for funding the Doctoral studies.

7. References

BERGGREN, C., MAGNUSSON, T. & SUSHANDOYO, D. 2015. Transition pathways revisited: established firms as multi-level actors in the heavy vehicle industry. *Research policy,* 44**,** 1017-1028.

BURDEN, P. L. A. 1992. Soekor, partners explore possibilities in Bredasdrop basin off South Africa. *South Africa, Oil and Gas Journal***,** 109-112.

DEDT 2013. Pre-feasibility report for the importation of natural gas into the Western Cape with specific focus on the Saldanha Bay-Cape Town corridor. *In:* (DEDT), D. O. E. D. A. T. (ed.). Western Cape, South Africa.
DME 1998. White Paper on the Energy Policy. *In:* ENERGY, D. O. M. A. (ed.). Pretoria: Department of Minerals and Energy.
DMR 2005. Gas Infrastructure Plan (GIP). *In:* (DMR), D. O. M. A. R. (ed.). Pretoria, South Africa.
DOE 2016. Independent Power Producer Procurement Office, Information Memorandum for New Generation capacity for the LNG to Power. *In:* OFFICE, I. (ed.). DOE.
DOE 2016b. Integrated Energy Plan (IEP). *In:* ENERGY, D. O. (ed.). Pretoria, South Africa: DOE.
DOE 2018a. Integrated Resources Plan *In:* ENERGY, D. O. (ed.). Pretoria, South Africa
DOE 2018b. South African Energy sector report. *In:* ENERGY, D. O. (ed.). Pretoria, South Africa.
DORIGONI, S., GRAZIANO, C. & PONTONI, F. 2010. Can LNG increase competitiveness in the natural gas market?(Report). *Energy Policy,* 38**,** 7653-7664.
DTI 2013. The dti electricity pricing report. *In:* INDUSTRY, T. D. O. T. A. (ed.). Pretoria, South Africa.
DTI 2018. Industrial Policy Action Plan (IPAP): 2018/19-2020/21. *In:* INDUSTRY, D. O. T. A. (ed.). Pretoria, South Africa.
EBERHARD, A. 2015. Harnessing African natural gas. A new opportunity for Africa's energy agenda? : Energy and extractives global practice, The World Bank.
EIA 2013. Technically recoverable shale oil and shale gas resources, an assessment of 137 shale formations in 41 countries outside the United Sates.: Energy Information Administration (EIA).
ESKOM 2015b. Eskom fact sheets, statistical table 1A, ten year technical statistics. *In:* ESKOM (ed.).
ETHEKWINI 2015. Natural Gas position paper *In:* MUNICIPALITY, E. (ed.). Durban, South Africa.
FINE, B. & RUSTOMJEE, Z. 1996. *The Political economy of South Africa: from Minerals Energy Complex to Industrialization,* London, C. Hurst London.
FOXON, T. 2011. A coevolutionary framework for analysing a transition to a sustainable low carbon economy. *Ecological economics,* 70**,** 2258-2267.
GEELS, F. 2004. From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory. *Research Policy,* 33**,** 897-920.
GEELS, F. 2011. The multi-level perspective on sustainability transitions: Responses to seven criticisms. *Environmental Innovation and Societal Transitions,* 1**,** 24-40.
GEELS, F. 2014. Reconceptualising the co-evolution of firms-in-industries and their environments: Developing an inter-disciplinary Triple Embeddedness Framework. *Research Policy,* 43**,** 261.
GEELS, F. W. & SCHOT, J. 2007. Typology of sociotechnical transition pathways. *Research Policy,* 36**,** 399-417.
GEELS, F. W. & SCHOT, J. 2010. The Dynamics of Transitions *In:* GRIN, J., ET AL. (ed.) *Transitions to Sustainable Development : New Directions in the Study of Long Term Transformative Change,.* Taylor & Francis Group,.
GENUS, A. & COLES, A.-M. 2008. Rethinking the multi-level perspective of technological transitions. *Research Policy,* 37**,** 1436-1445.
GRIN, J. 2010. Transitions to sustainable development : new directions in the study of long term transformative change. *In:* ROTMANS, J. & SCHOT, J. W. (eds.). New York : Routledge.
HACKER, J. S., PIERSON, P., THELEN, K., 2015. Drift and conversion: hidden faces of institutional change. *In:* MAHONEY, J. A. T., K. (EDS). (ed.) *Advances in comparative historical analysis.*: Cambridge University Press.
IGU 2014. International Gas Union (IGU), World LNG report

IGU 2016. International Gas Union (IGU), World LNG report.
KIVIMAA, P. & KERN, F. 2016. Creative destruction or mere niche support? Innovation policy mixes for sustainability transitions. *Research Policy,* 45**,** 205-217.
KONRAD, K., TRUFFER, B. & VOß, J.-P. 2008. Multi-regime dynamics in the analysis of sectoral transformation potentials: evidence from German utility sectors. *Journal of Cleaner Production,* 16**,** 1190-1202.
KUMAR, S., HYOUK-TAE, K., KWANG-HO, C., JAE HYUN, C., WONSUB, L. & IL, M. 2011. Current status and future projections of LNG demand and supplies: a global prospective.(Report). *Energy Policy,* 39**,** 4097-4104.
LEDESMA, D. 2013. East Africa Gas-potential for export, Oxford Institute for Energy Studies. Oxford Institute for Energy Studies (OIES).
MAKHAYA, G. & ROBERTS, S. 2013. Expectations and outcomes: considering competition and corporate power in South Africa under democracy. *Review of African Political Economy,* 40**,** 556-571.
MAVUSO, Z. 2015. *Gas based industrialisation vision hinges on sound policy, gas to power roll out* [Online]. Engineering news. Available: http://www.engineeringnews.co.za/article/gas-based-industrialisation-vision-hinges-on-sound-policy-gas-to-power-roll-out-2015-08-21-1 [Accessed 31 March 2016].
NERSA 2015. Consultation paper, Eskom cost of unserved energy methodology, Appendix B, Cost of Energy Model. . *In:* AFRICA, N. E. R. O. S. (ed.). Pretoria, South Africa.
PAPACHRISTOS, G., SOFIANOS, A. & ADAMIDES, E. 2013. System interactions in socio-technical transitions: Extending the multi-level perspective. *Environmental Innovation and Societal Transitions,* 7**,** 53-69.
PASA 2012. Petroleum exploration in South Africa, information and opportunities. *In:* AFRICA, P. A. S. (ed.).
PRESIDENCY 2017. Speech by the President Jacob Zuma on the occasion of the 37th SADC summit of Heads of State and Government.
RAVEN, R. 2007. Co-evolution of waste and electricity regimes: Multi- regime dynamics in the Netherlands (1969-2003). *Energy Policy,* 35**,** 2197.
RAVEN, R. & VERBONG, G. 2007. Multi-Regime Interactions in the Dutch Energy Sector: The Case of Combined Heat and Power Technologies in the Netherlands 1970–2000. *Technology Analysis & Strategic Management,* 19**,** 491-507.
ROBERTS, S. & BLACK, A. 2009. The evolution and impact of industrial and competition policies. *In:* ARON, J., KAHN, B. AND G. KINGDON (EDS) (ed.) *South African Economy Policy Under Democracy, OUP.*: Oxford University Press
SASOL 2018. Mind over matter, the Sasol story: A half century of technological innovation. John Collings.: Sasol.
SCHOT, J. & KANGER, L. 2018. Deep transitions: Emergence, acceleration, stabilization and directionality. *Research Policy,* 47**,** 1045-1059.
SMITH, A. & RAVEN, R. 2012. What is protective space? Reconsidering niches in transitions to sustainability. *Research Policy,* 41**,** 1025-1036.
SOVACOOL, B. K., LOVELL, K. & TING, M. B. 2018. Reconfiguration, Contestation, and Decline: Conceptualizing Mature Large Technical Systems. *Science, Technology, & Human Values***,** 0162243918768074.
STREECK, W. & THELEN, K. A. 2005. *Beyond continuity: institutional change in advanced political economies,* Oxford, Oxford University Press.
SUTHERLAND, L.-A., PETER, S. & ZAGATA, L. 2015. Conceptualising multi-regime interactions: The role of the agriculture sector in renewable energy transitions.(Report). *Research Policy,* 44**,** 1543.
SYMONS, K. 2016. Transnational spaces, hybrid governance and civil society contestation in Mozambique's gas boom. *The Extractive Industries and Society,* 3**,** 149-159.

TING, M. B. 2015. Historical review of the relationship between, energy, mining and the South African economy. . *In:* (EDS), M. E. A. (ed.) *Earth, Wind and Fire:unpacking the political, economic and security implicaitons of discourse on the Green Economy. Mapungubwe Institute for Strategic Reflection (MISTRA).* Johannesburg, South Africa Real African Publishers.

TING, M. B. 2019. *PhD on Socio-technical transitions in South Africa's electricity system.* SPRU, University of Sussex.

TING, M. B. & BYRNE, R. 2019. Regime-resistance and niche-challenges: battles over rule-changes in South Africa's electricity system (unpublished). University of Sussex

TRANSNET 2015. Natural Gas infrastructure planning. *In:* TRANSNET (ed.).

TRANSNET 2016. Natural Gas Infrastructure Planning. *In:* TRANSNET (ed.).

Recent papers in the SPRU Working Paper Series:

February

Specialisation, Diversification and the Ladder of Green Technology Development. François Perruchas, Davide Consoli and Nicolò Barbieri.

Engineering and Sustainability: Control and Care in Unfoldings of Modernity. Andy Stirling.

January

As Time Went By - Long Waves in the Light of Evolving Evolutionary Economics. Francisco Louçã.

Structural Changes and Sustainability. A Selected Review of the Empirical Evidence. Maria Savona and Tommaso Ciarli.

To What Extent is Inclusion in the Web of Science an Indicator of Journal 'Quality'? Diego Chavarro, Ismael Ràfols and Puay Tang.

Towards a *Taxonomy of Academic Misconduct: the Case of Business School Research*. Jeremy Hall and Ben R Martin.

Modelling the Evolution of Economic Structures and Climate Changes: A Review. Tommaso Ciarli and Maria Savona.

Suggested citation:

Marie Blanche Ting (2019). Multiple Regime Interactions, Conversion, and South Africa's Liquefied Natural Gas. SPRU Working Paper Series (SWPS), 2019-08: 1-30. ISSN 2057-6668. Available at: www.sussex.ac.uk/spru/swps2019-08

Science Policy Research Unit
University of Sussex, Falmer
Brighton BN1 9SL
United Kingdom

SPRU website: **www.sussex.ac.uk/business-school/spru**
SWPS website: **www.sussex.ac.uk/business-school/spru/research/swps**
Twitter: **@spru**

UNIVERSITY OF SUSSEX | BUSINESS SCHOOL