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The Role of Smart Infrastructure on Petroleum and Piped Gas Regulation Strategy Development in South Africa

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Abstract

This paper presents a discussion on the role played by smart infrastructure in facilitating petroleum and piped-gas regulation strategy development. The current regulatory framework for these two industries is relatively in its infancy with key challenges noted on the methodologies used to set or approve tariffs and to approve maximum prices. Numerous applications of smart infrastructure and smart technologies are discussed to show how such will aid improved tariff decisions by energy regulator regarding transportation of petroleum products *via* pipelines as well as loading and storage tariff regimes. A discussion is also presented on how smart software systems may be adopted in future to evaluate the economic impact of tariff decisions that have been made by the energy regulator in the past. Smart technologies have also been regarded as crucial in gas pricing strategy development and how such systems may be utilised by the energy regulator in pricing methodologies of natural gas in future. The need for smart technology through econometric software in benchmarking research in piped-gas regulation is indicated and discussed. The drive to refine regulatory practices in the petroleum and piped-gas industries may not yield the most desirable outcomes if not backed by smart systems and smart infrastructure. Hence, this paper contributes to such a discourse, discussing areas that can be improved significantly through the adoption of smart infrastructure to foster regulatory regimes for the petroleum and piped-gas industries that are more investor friendly without prejudicing interests of end-users.

Keywords: Energy regulator; Econometrics; Petroleum; Piped-Gas; Regulation; Energy industry

Introduction

According to the Royal Academy of Engineering (2012), smart infrastructure is a facility capable of responding intelligently to changes in its environment, including user demands and other infrastructure improve regulatory performance. The Smart infrastructure, alternatively referred to as smart systems, uses a feedback loop of data, which provides evidence for informed decision making. Such systems measure, analyses, monitors and may communicate findings for an informed decision making in a variety of operations, including regulatory frameworks [1].

Gaps have been identified and all the methodologies have gone under review since 2016 to improve the efficiency of regulatory instruments on both industries. However, more focus has been placed on mitigation measures to improve methodological and technical aspects that have either been challenged by key stakeholders or that have been identified as threats to regulatory certainty. So far, not much has been done to improve the existing infrastructure to facilitate the adoption of smart infrastructure or smart systems as the energy regulator seeks to improve on regulatory efficiency. Hence, this paper contributes to such a discourse, discussing areas that can be improved significantly through the adoption of smart infrastructure in a bid to foster regulatory regimes that are more investor friendly without prejudicing interests of end-users [2].

NERSA has undertaken various initiatives to refine regulatory practices and methodologies in its quest to become a recognised world-class leader in energy regulation. The drive to refine regulatory practices may not give sound outcomes if not backed by smart systems and smart infrastructure. In its Annual Performance Plan (APP), the energy regulator states unequivocally that, a key strategic objective is to establish and position NERSA as a credible and reliable regulator.

This is accomplished ensuring that systems, processes, procedures and resources are in place that will put NERSA to a position where policy makers are appropriately advised on any matter relating to the effective and efficient regulation of the electricity, piped-gas and petroleum pipelines industries. Smart infrastructure is instrumental towards the attainment of such goals. These goals ultimately cascade into the broader government objectives feeding into macroeconomic developmental goals of the country [3].

Regulation of petroleum and piped-gas industries pose challenges to the energy regulator as they are required to balance conflicting interests of licensees, investors, consumers/end-users and the policy makers. In the short run, the goals of the Energy Regulator are to implement and harmonise methodologies in a manner which promote synergy in terms how these two industries are effectively regulated. In the medium term NERSA develops comprehensive systems to improve on its processes. Long term goals are inclined to growth of presence in the regulatory fraternity while ensuring continuous improvement of applicable regulatory frameworks. Such long term goals require the adoption of smart infrastructure to enhance operational efficiency.

Overall, there is commitment by the Energy Regulator to continuously pursue advocacy for a regulatory regime with consequences. This has been a long term target beyond 2020 with NERSA aiming to continuously improve with a revised operating model while focusing on enhancing efficiency and performance orientation.

The electricity industry is also regulated by NERSA but issues around the implications of adopting smart systems and infrastructure in its regulation strategy development are beyond the scope of what is covered in this paper.

The rest of the paper unfolds with section 2 dwelling on the background covering the underpinning legislative framework upon which the Energy Regulator derives their mandate in regulating petroleum and piped-gas industries. Section 3 presents theoretical and conceptual caveats leading to contextualisation of 'smart infrastructure' as a relevant aspect in regulation strategy development by NERSA. The link between smart infrastructure and piped gas regulation strategy development is explored in section 4 while the role of such smart systems in shaping petroleum regulation strategy development is alluded in section 5. Concluding remarks with recommendations to NERSA and other energy regulators are presented in section 6 [4].

Literature Review

Background

The National Energy Regulator (NERSA), a public entity, is a schedule 3A institution established through the Public Finance Act, 1999. It was established on the 1st of October 2005 in terms of the National Energy Regulator Act, 2004 to regulate the petroleum pipelines industry as informed by the petroleum pipelines act, 2003 the electricity industry as informed by the electricity regulation act, 2006; and the piped-gas industry as espoused on the gas act, 2001. In executing its mandate, NERSA seeks to balance interests of investors as licensed entities and end user customers. The above stipulated statutory instruments used to regulate the three industries are backed by three levies acts and three facilitating acts. The three levies acts are the gas regulator levies act, 2002, the petroleum pipelines levies act and section 5B of the electricity act, 1987. In executing its mandate, three facilitating acts are instrumental namely the Public Finance Management Act (PFMA), 1999; the Promotion of Access to Information Act (PAIA), 2000 and the Promotion of Administrative Justice Act (PAJA). All the mentioned statutes anchoring NERSA's mandate are derived from the constitution of the Republic of South Africa [5].

The gas act stipulates that the Energy Regulator must regulate maximum prices of piped-gas, for distributors, in terms of section 21(1)(p), subject to the issuance of a license to trade in natural gas. The regulation of maximum prices of piped-gas is also subject to the determination that there is inadequate competition in the market space. Section 22 of the Gas Act contemplates that licensees may not discriminate between customers or classes of customers regarding access, tariffs, prices, conditions or service except for objectively justifiable and identifiable differences regarding such matters as quantity, transmission distance, longevity of contract, load profile and other distinguishing feature approved by the Energy Regulator. Section 28(3)(c) of the Petroleum Pipelines Act 2003 asserts that the tariffs set or approved by the energy regulator must enable the licensee to make a profit commensurate with risk. Section 4(6) of the Petroleum Regulations compiled in line with the petroleum pipelines act of 2008 stipulates the manner in which calculated allowable revenue has to be earned from the tariffs contemplated in sub-section (2) [6].

The mandate of NERSA, as enshrined in relevant legislation, entails the issuance of licences; setting and/or approving tariffs and prices; monitoring and enforcing compliance with licence conditions; dispute resolution including mediation, arbitration and the handling of complaints. NERSA is also responsible for gathering, storing and disseminating industry information as it also determines conditions of supply of electricity, petroleum products and natural gas. Its mandate also stretches to the setting of rules, guidelines and codes for the regulation of the three industries as well as setting applicable standards. NERSA has a mandate to be the registrar of import and production activities [7].

Hence, the National Energy Regulator Act combines the non-technical aspects of the electricity regulation act, gas act and petroleum pipelines act and repeals these provisions from the three Acts. The NERSA Act establishes the National Energy Regulator to administer all three Acts and related legal instruments. It was passed by parliament and operationalised on the 5th of September 2005. In exercising its mandate, NERSA must at all times display regulatory independence and observe key regulatory principles such as independence, accountability, integrity, transparency, efficiency, neutrality consistency and predictability. Among these principles is the notion of efficiency which stipulates that NERSA or the Energy Regulator should utilise resources at its disposal to pursue further its regulatory objectives by exercising objectivity and commitment to evidence-based strategies for improvement. To ensure regulatory independence, the Energy Regulator has developed regulatory mechanisms (i.e. policies, procedures, rules, guidelines and systems) that makes its decision making process to be open, transparent, credible, predictable, as well as making it accountable for its decisions. The systems that NERSA has put in place to regulate tariffs and maximum prices in the petroleum and piped gas industries are constantly reviewed. Smart infrastructure is a prerequisite to align these systems to international best practice in synergy with the 4th industrial revolution [8,9].

The status quo is that financial models prepared in Microsoft Excel are used to evaluate tariff applications in a bid to apply incentive regulation in both the petroleum and piped-gas industries. Cost of equity calculations in line with the Capital Asset Pricing Model (CAPM) are performed in excel as well as in Bloomberg. For example, the determination of the benchmark efficient entity in the computation of beta has necessitated the need for such smart infrastructure so that a more efficient estimate can be calculated. Smart infrastructure calls for the use of recently developed software that may perform the same functions to improve the accuracy of models in setting or approving maximum prices and tariffs. By so doing NERSA will be progressing in terms of following one of its fundamental principles that it ought to be efficient. Smart infrastructure enables the energy regulator to benchmark approved tariffs or maximum prices to tariffs or prices of jurisdictions and other regional markets around the world. The relevance of such smart infrastructure to regulation strategy development inclined to petroleum and piped-gas industries in South Africa cannot be understated [10].

Theoretical conceptual issues

As society move faster into the twenty-first century, demand for smart infrastructure assets has tremendously grown with high expectations on quality service delivery and productivity. This quest for more efficient infrastructure associated with the rise of Information Technology (IT) has led to the concept of 'smart infrastructure'. Relevant to the field of economic regulation and to the petroleum and piped-gas regulation in South Africa in particular, are the potential benefits that smart infrastructure will enable increased quality and value of service (on-demand use and flexible tariffs) [11].

The Royal Academy of Engineering (2012) has put forward four key principles as essential inputs to a sound smart infrastructure. First, they note that data are a core input and founding element of all smart technology. As smart infrastructure is rolled out into different areas of the global society, there will be a vast explosion of data generated and data ownership will become increasingly important to any regulatory regime. Therefore, smart infrastructure turns data into information, then subsequently into knowledge and value to society for fair and transparent regulatory protocols. Second, selective sampling of information, collation of data and analysis through robust mathematical models to guide tools for effective and optimal decision making for the benefit of regulatory institutions, industry, government and society at large. Third, infrastructure is purportedly smart if it is capable of giving feedback earmarked to improve systems and workflows to various regulatory dispensations. Hence, feedback within a smart system provides opportunities to increase performance of regulatory instruments. Fourth, smart infrastructure creates systems that ought to be adaptable to a spectrum of demands, conditions and technology development. In the long run, there are enormous gains in the production of smart systems capable of absorbing future technologies and future needs in regulatory environments [12].

According to Hagen, there is no agreed definition of smart infrastructure. Hence it is an ambiguous concept used in many applications to describe different sociotechnical settings. Weiss perceives smart infrastructure as 'the lens through which the future is seen'. Kadam notes that a smart infrastructure is an existing infrastructure that has been transitioned to a regime of major, positive changes in infrastructure service delivery due to the adoption of technological innovations. However, argues that the perspective indicated by Kadam espouses the link between the degree to which innovation ensues and the level of its smartness.

This stated that ICT solutions that can be regarded as smart infrastructure combine associated technologies which include information modelling, geographic information systems and Artificial Intelligence (AI). Such systems, as indicated are able to execute tasks and make decisions without human intervention. For instance, in the piped-gas or petroleum regulatory space, such systems entail a network of interconnected software that are able to assess financial viability of licensees before they can be issued with an operating or trading licence. They may also be able to assess financial information given by a licensee to calculate a pipeline tariff for transportation of natural gas or petroleum liquid fuels and conduct financial analysis of audited information for Regulatory Financial Reporting (RFR). In so doing, efficiency is enhanced as analysts will be able to present more accurate analysis in a wide range of regulatory submissions leading to better quality information useable by the Energy Regulator for decision making purposes [13].

Broadly, economic regulation of energy utilities calls for the development of smart infrastructure for economists to understand the extent to which smart grids can elasticise consumer demand to match the supply of petroleum fuels, natural gas or electricity.

Smart infrastructure and petroleum pipelines industrial regulation strategy development

NERSA regulates pipelines, marine loading facilities and storage facilities as regulation of the downstream value chain. Approved pipeline tariffs are a component of the transport cost per litre of diesel or petrol to the pumps and reflected in the final pump prices of these petroleum products. Storage tariffs approved do not feature in price regulation. The Department of Minerals and Energy (DMRE) is the other downstream regulator responsible for gazetting pump prices of diesel and petrol every second week of the month with support from the Central Energy Fund (CEF). Other regulators involved include the Ports Regulator of South Africa, the National Ports Authority (a regulator that is partially placed under Transnet-a commercial state owned enterprise) and the petroleum agency of South Africa.

DMRE uses the currently approved Durban-to-Alrode tariff which is set at 45.69 cents per litre of liquid fuel transported. This tariff is reflected through the pump price that is charged to consumers. As indicated by NERSA, section 28 of the Petroleum pipelines act requires that a tariff charged must be:

- Based on a systematic methodology applicable on a consistent and comparable basis.
- Fair.
- Non-discriminatory.
- Simple and Transparent.
- Predictable and stable.
- Such as to promote access to affordable petroleum products.

The Trended Original Cost (TOC) Tariff Methodology that is currently under review prescribes the rate of return regulation (incentive regulation) and the discounted cash flow techniques as suitable methodologies to arrive to a tariff. The tariff is set by determining the allowable revenue that the investor may be allowed to earn against projected volumes into their market space in order for them to make a profit commensurate with risk. The profit earned is a proportion of their regulated asset base which ultimately indicates the allowable returns on investment by the licensee. The Weighted Average Cost of Capital (WACC) is computed through the Capital Asset Pricing Model (CAPM) in a multi-factor framework. Regulatory precedence is that NERSA has been calculating components of WACC through Bloomberg regressions and financial models developed in Microsoft Excel.

However, modern approaches to the computations of these components require the adoption of smart infrastructure as smart technology to measure components such as the beta more efficiently and accurately. Smart infrastructure in the form of econometric software can be utilised in future using high frequency data to shift the regulatory regime towards the utilisation of sophisticated econometric models such as the Generalised Auto Regressive Conditional Heteroscedasticity (GARCH) models. Outcomes of such beta estimates in the South African context may then be compared against the standard Ordinary Least Squares (OLS) techniques and the Least Absolute Deviations (LAD) method to check for the most efficient estimator as argued by the Australian Energy Regulator. This may only be rendered possible with the adoption of smart infrastructure and associated smart technologies by NERSA in future [14].

Using smart infrastructure, it will be possible in future for the Energy Regulator to conduct macroeconomic impact assessment of tariff decisions that have been passed since 2011. Such infrastructure includes software programs that are capable of running Computable General Equilibrium (CGE) models in a static or dynamic fashion utilising Social Accounting Matrices (SAMs). CGE models are able to capture negative displacement or knock-on effects as well as positive gross multiplier effects emanating from tariff decisions considered exogenous stimuli to the broader macroeconomic environment. Thus, the CGE model is a macroeconomy-wide model that interconnects demand, production and income structures, analysed to show less than instantaneous responses by economic fundamentals given a price or tariff regime change subject to given supply constraints.

A SAM is an input-output model presented in a matrix form showing links between aggregated or disaggregated transactions taking place in an economy usually over a year. CGE modelling provides a theoretically consistent framework to assess welfare and distributional effects of policy changes or any other macroeconomic fundamentals such as petroleum tariff regimes in this instance. Both SAMs and CGE models may be used to assess impacts of competing modes of transporting petroleum products on their final prices with a view to evaluate the true effect of any tariff decision that the Energy Regulator has made in the past. Such an analysis is meant to derive policy lessons in future tariff decisions. Using smart infrastructure, it is imperative that a dynamic CGE for South Africa, as extended to the energy sector be used to simulate impacts of either pipeline, storage or loading tariff decisions to overall macroeconomic performance in the country. Such analysis cannot be conducted given the status quo of the current ICT system and there is need for the Energy Regulator to embark on a capacity building exercise.

Smart infrastructure may be instrumental in giving the Energy Regulator a turn-key solution by providing a composite platform upon which both SAMs and CGE models may be run to assess the impact of previously made tariff decisions. With a smart system, it will then be possible for the Energy Regulator to run calibrations while assigning values to the model's theoretical parameters. The SAM may then be maintained as a data source. There are numerous local and international studies that have demonstrated the application of CGE models in particular to examine energy policy implications and energy efficiency in addition to other applications such as those on carbon emission tax policies, economic and environmental policy implications among others. However, smart systems are required to cultivate such modelling culture as part of petroleum regulation strategy development to enable the energy regulator to evaluate tariff decisions over time and how they impact other policy objectives of the state.

Smart infrastructure and piped gas regulation strategy development

The creation of an integrated and competitive natural gas pricing strategy is an issue that has gained interest globally. Various econometric software programs as smart infrastructure plays a pivotal role as instruments of economic analysis required in gas pricing strategy development. In the absence of an integrated global gas market, regional markets have evolved at varying speeds in response to demand and supply-side factors among other market conditions. South Africa is an embryonic market and on a substitute-based pricing regime with prices of alternative fuels in the energy basket (coal, diesel, heavy fuel oil, liquefied petroleum gas and electricity) used as benchmarks. This has been an alternative methodology to the cost-pass through approach to the determination of maximum prices of both piped and compressed natural gas.

However, the application of the current methodology has resulted in a commercial dispute between the National Energy Regulator of South Africa (NERSA) and the Gas Users Group (GUG) leading to the Supreme Court of Appeal (SCA) judgement that the manner in which the pricing methodology is currently structured is irrational. The Constitutional Court has also made a determination on the same matter on the 26th of February 2019, emphasising the need to develop a pricing methodology that consider the marginal cost of natural gas production and supply. This commercial dispute has precipitated the need to review the methodology and to develop a new gas pricing strategy. Thus, the processes and procedures relevant in reviewing the methodology require the adoption of smart infrastructure to develop new gas pricing formulae [15].

Pricing of natural gas has evolved following maturity stages in each respective region with liberalised mature gas markets taking the lead with pricing regimes driven by demand and supply factors while those in the developmental stages adopt oil- indexation or substitute based pricing. The Henry Hub is the most liberalised, competitive and liquid gas market at Louisiana in the United States followed by other physical and virtual hubs such as the National Balancing Point (NBP) in the UK, the Title Transfer Facility (TTF) in the Netherlands, the Belgian Zeebrugge and the Germany Interconnect among others. The Asian Pacific block is growing with oil-indexation through long term gas contracts in Countries like China, Japan, Singapore and India, although spot trading of LNG has grown significantly. In Africa gas pricing is mainly driven through regulated dispensations as either cost of service, socio-political or bilateral monopoly. Long term contracts are still visible based on oil indexation or substitute-based pricing in North and Southern Africa. For instance, Algeria exports natural gas to Italy and Spain through a long term oil indexed gas pricing regime. More than 90% of natural gas to be exported by Anadarko from Mozambique to the Asian Pacific market will be through oil indexation. In the Americas, mainly in Brazil and Argentina, both oil-indexation and gas-on-gas competition dictate gas pricing strategy. Simulations leading to a new gas pricing formula require smart infrastructure to facilitate robust mathematical modelling on how gas pricing strategy for South Africa can be developed in future.

Quasi-oil indexation or quasi-hub indexation using both oil-indexation and hub referencing may be considered by the Energy Regulator, where smart infrastructure plays a pivotal role in modelling the new pricing formula. Illustrations can be presented on how econometric models are capable of providing solutions on the selection criteria of variables towards deriving a new gas pricing strategy for South Africa. Smart software facilitates robust analysis such as cointegration regression equations to establish optimal gas pricing formulae as such systems are based on the nature of the long run relationship between the price of natural gas and its determinants.

Discusssion

Econometric modelling enables the evaluation of candidate variables for possible inclusion in the new gas pricing equation. Such analysis optimally leads to the determination of weights that will reflect the relative importance of each variable in the gas pricing formula. For instance, Impulse Response Functions (IRFs) and Forecast Error Variance Decompositions (FEVDs) are suitable smart infrastructure to establish the relative weights of each potential variable in any proposed gas pricing equation. Both IRFs and FEVDs are run in econometric software and other smart platforms utilising Vector Autoregressive (VAR) time series models. These smart systems can be used by the Energy Regulator in future to interrogate the mathematical interaction of the chosen determinants of the natural gas pricing equation. This has not been used in South Africa as the current methodology has been developed on the basis of energy consumption patterns as reflected in the energy digest of 2008. The gas pricing equation has been expressed in the methodology as a linear function of prices of substitute fuels in the energy basket of South Africa expressed through the price indicators approach. The formula is currently stated as additive, although it is possible that it could be multiplicative. Smart econometric software will be able to interrogate the model to derive a more suitable mathematical structure of the gas pricing formula. Data can still be obtained from the same sources except in circumstances where new variables are identified [16].

With input data from the key suppliers of natural gas from the upstream, the energy regulator is subsequently able to utilise any smart infrastructure at its disposal to measure the marginal cost of supplying natural gas downstream. The determination of marginal cost will subsequently be made possible using smart infrastructure with potential to utilise linear programming tools of analysis, subject to upstream production constraints. Given that the mandate of the energy regulator is to approve the maximum price of the gas molecule, measuring marginal cost will foster a more objective way of defining total economic surplus in the natural gas market for South Africa. Such surplus is the difference between the maximum price approved by NERSA as a price ceiling and the marginal cost which is crucial to establish the price floor as a minimum price. The minimum price protects the interests of the natural gas supplier as the investor while the maximum price protects the interest of consumers of natural gas as end users as they may fall victim of exorbitant pricing by monopolistic firms. Therefore, it is the energy regulator's responsibility to ensure that such interests are balanced in the broader context of other important macroeconomic objectives. All such analysis is rendered possible only if the Energy Regulator is able to put smart infrastructure in place to enhance economic analysis that will be able to explore these issues for optimal decision making.

From time to time, the Energy Regulator has a responsibility of ensuring that prices of natural gas are aligned to prices of other jurisdictions and of other global markets. Therefore, there is need to conduct benchmark studies to check for alignment and test the global natural gas convergence hypothesis. Smart infrastructure through econometric software is needed to run statistical models that may be used to test for cointegration among natural gas prices in South Africa, jurisdictions in Continental Europe, the Americas, the Middle East and Africa and as well as from the Asian Pacific region. Smart systems are able to detect the presence of a sustainable long run relationship to confirm price convergence or divergence if no evidence of any cointegrating relationship among global prices is found from time series data. Such smart systems are a more effective monitoring tool that the energy regulator may use to evaluate comparability of the natural gas price regime against regimes of other regional markets.

Conclusion

Smart infrastructure plays a pivotal role in petroleum and piped-gas regulation strategy development in South Africa. In undertaking its mandate, the Energy Regulator ought to develop smart systems that ensure setting and/or approval of tariffs for pipeline, storage and loading facilities in the petroleum industry. In the piped-gas industry maximum prices are approved as well as transmission tariffs for piped-gas using methodologies and infrastructure that need upgrading over time. Given that the TOC Tariff methodology is due for a review for an improved regulatory framework, the energy regulator need to adopt smart ICT infrastructure that can enhance efficient estimation of components of the CAPM model. The methodology to approve maximum prices of piped-gas is also under review, making it incumbent for the regulator to utilize smart systems in an endeavour to craft a new methodology. Therefore, there is need to foster the development or adoption of smart infrastructure for an effective petroleum and piped-gas strategy development mission by the Energy Regulator of South Africa.

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