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The authors argue that Brazilian energy planning is not considering the long-term consequences of fossil fuel electricity generation. Renewable electricity options are dropping in price and investing in those technologies will reduce the risk to electricity systems.

The author notes that economic growth resulting from resource development can be enhanced if appropriate policies are in place. These policies need to recognize the existing local market conditions and pace progress in a way that supports continued development.

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Leapfrogging Natural Gas in the Energy Transition: More Renewables, More Technology and More Stranded Assets

Tatiana Bruce da Silva and Fernanda Delgado

To leapfrog means to jump over. In adopting a new technology, method or model, leapfrogging describes a fast change, which leads to the employment of more advanced processes without having to go through intermediate stages of development.

In the energy sector, leapfrogging occurs when a more technologically advanced energy solution is adopted, "skipping" one or more stages of development. One example of leapfrogging occurs in regions with low infrastructure resources. Regions in certain African or Asian countries do not have access to electrical energy due to the difficulty in installing transmission lines, which require significant investment that is not always possible or a priority.[1] With the emergence of distributed generation, especially solar photovoltaic, however, leapfrogging is taking place in electricity supply in these communities, as they have not previously experienced a centralized power grid in which consumers are connected to power plants through transmission lines. These communities are already in the next stage of development in the electricity sector, that of decentralized and renewable generation.

Another leapfrogging example comes with the advance of "modern" renewables.[2] In several locations, it is questioned whether the accelerated advancement of these energy sources would lead to leapfrogging in the global energy transition. Due to concerns with climate change, the world has been seeking to decarbonize its economies. In this process, natural gas is considered a "transition fuel" because of lower emissions of greenhouse gases compared to other fossil fuels such as coal or diesel. Therefore, greater use of natural gas is seen as an option in reducing emissions and, at the same time, satisfying the energy needs of the global population, as well as acting to better integrate intermittent and non-dispatchable renewable sources (solar and wind) to the energy matrix.

Due to economies of scale from greater production, however, the cost of new renewable technologies has fallen, contributing to a faster adoption rate.[3] This trend can be seen, for example, in the technologies for solar and wind energy and battery storage. According to data from the International Renewable Energy Agency (IRENA), since 2009, the cost of wind turbines has fallen by approximately one third, while the cost of solar PV modules was reduced by 80%. Consequently, between 2010 and 2016, the levelized cost of electricity[4] provided by these sources was reduced in a way that, even without subsidies, photovoltaic solar and onshore wind energy reached cost parity with traditional fossil sources in several markets. Consequently, renewables are, now, according to IRENA (2017), the first choice to expand, refine and upgrade electrical systems around the world, even in times of low oil prices in the international market.[5] Bloomberg New Energy Finance (BNEF) reports that the cost of lithium-ion batteries, used in electric vehicles and energy storage systems, has fallen by 79% since 2010 and is expected to decrease 67% more until 2030.[6]

Therefore, this article aims to analyze how the advent of renewable energy can contribute, in certain regions, to a leapfrog of natural gas in the energy transition: from coal and other more polluting fossil fuel energy sources straight to renewables. A decrease in the cost of renewable energy generation technologies will contribute to previously dominant sources becoming economically ineffective, or stranded assets.[7] Furthermore, the advancement of technology, regulation and business models will allow the intermittency of renewable sources to be integrated with the use of renewable energy portfolios and distributed energy resources, as we will analyze hereinafter.

Clean Energy Portfolios

Clean energy portfolios include renewable energy (including solar and wind) and distributed energy resources (DER, which include battery storage, electric vehicles, energy efficiency, demand response and distributed generation). According to a Rocky Mountain Institute (2018) study,[8] in some locations, combining these technologies already provides the same services, at competitive costs, as thermoelectric power plants fueled by natural gas. Furthermore, these clean energy

portfolios are balanced and diverse, combining emerging and mature resources, not limiting themselves to the exploration of only one technology. Thus, clean energy portfolios contribute to the diversification of the electric power matrix and, at the same time, enable electricity generation without greenhouse gas (GHG) emissions. Table 1 lists the options of resources included in these portfolios.

Table 1: Resource Options for Clean Energy Portfolios

Energy efficiency	Physical measures, software controls, or other strategies to reduce the amount of energy required to perform a given service (for example, thermal insulation and smart thermostats to reduce energy for heating and cooling).
Demand flexibility	Load controls to enable electricity consumption to shift through time (for off-peak hours) without reducing overall energy use or service quality (for example, smart charging of electric vehicles). Furthermore, technological advancements have increasingly allowed the use of demand response in providing flexibility and integration of renewable sources.
Variable renewable energy	Behind-the-meter and front-of-the-meter distributed and utility-scale solar photovoltaics (PV) and wind turbines that provide weather-dependent, non-dispatchable energy. Recently, however, the use of smart inverters has allowed these sources to provide flexibility and ancillary services to the power grid.
Battery energy storage	Dedicated battery storage assets, either in front of the meter or behind the meter, providing energy balancing and flexibility via controlled charging and discharging.

Source: *Rocky Mountain Institute*, 2018.

Through a model that estimates the lower cost resource portfolio that provides the same energy generation, capacity, reliability, flexibility, stability and system peak demand management as a thermal power plant that uses natural gas, in addition to considering capital expenditure and operational expenditure, clean energy portfolios are found to be more cost-effective than the construction of three natural gas plants in the United States.[9]

That being said, and considering that the technologies included in the clean energy portfolios are forecasted to develop increasingly faster in the coming years, which gradually reduces their costs, and that thermal power plants have a vast lifespan, the construction of these plants today brings a risk to investors because there is a non-trivial possibility that these investments become stranded assets. A similar case already happens in the electricity sector: with the technological advancement that allowed for economies of scale, natural gas has been replacing coal and even nuclear energy in some markets, causing power plants that use these two fuels to lose their competitiveness.[10] It is expected that, in the future, clean energy portfolios cause the same impact on natural gas.

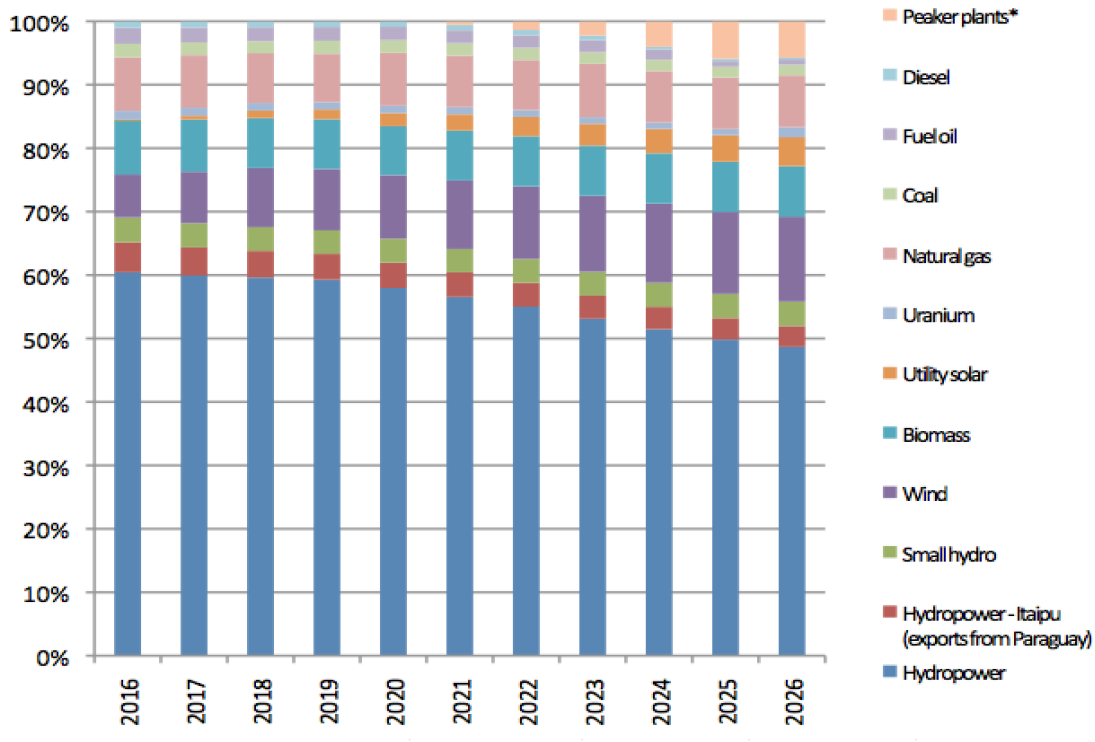
Therefore, the quicker the cost reduction of technologies involved in clean energy portfolios is, the faster natural gas loses its competitive edge. In this situation, natural gas will be leapfrogged in the global energy transition. Its usefulness in making up for the intermittency and lack of dispatchability of renewable sources will become obsolete. Furthermore, with the institution of carbon pricing, these thermal plants will be even more economically unviable.

What About Brazil?

This discussion is relevant to Brazil because the Brazilian electricity market is still highly regulated. To ensure predictability for investors, the cost of erroneous planning and, consequently, investment decisions in the electricity generation park are passed on to consumers, who do not have enough flexibility to choose a utility with more accessible rates.[11] Therefore, the decision to invest in natural gas power plants today must take into account how other technologies, which could potentially become less costly, are developing. Otherwise, Brazilians will consume electricity from inefficient stranded assets when there are other more cost-effective options available.

As of today, the Brazilian energy planner (Ministry of Mines and Energy) is not taking into account the increasingly downward trend in renewables' prices and how that might affect the power sector energy mix. The planning framework for the next ten years considers thermal plants as the "go to" power source when firm capacity and flexibility in power generation (peaker plants) are needed (Figure 1). Even coal is mentioned as an alternative if hydroelectricity becomes increasingly unreliable. Although clean energy portfolios already can provide the same services as thermal power plants at lower or equal costs in some markets, the Brazilian planner does not yet consider them as a resource.[12] Thermal power plants were hired in the last auctions and more are planned for the future.[13]

Figure 1: Evolution of Installed Capacity by Power Generation Source - Baseline Scenario



*Peaker plants can include open cycle thermoelectric plants, pumped-storage hydroelectricity, repowering of existing hydroelectric plants, batteries, and demand response.
Source: own elaboration based on data from EPE, 2018.

In addition, natural gas for power generation is expected to come from pre-salt oil exploration, whose production is increasing daily. According to PDE projections, oil production in Brazil is expected to reach the highest volumes by 2024, around 4.0 million bbl/day. This way, the information from PDE shows that energy planning in Brazil still considers investing in infrastructure that may become stranded assets in the near future. By locking in investments that have a chance of becoming increasingly uneconomical, the Brazilian consumer may end up paying unnecessarily for expensive energy.

Governments may be slower to capture these trends, but private companies are more attentive to them. Major companies in the oil and gas sector have been increasingly watching the growth in renewable energy and working to diversify their investment portfolios with the aim of reducing their specialization in fossil fuels and, thus, becoming providers of energy solutions as a whole (examples include the French company, Total, and the Norwegian Statoil, now called Equinor). In Brazil, Petrobras recently announced that it would resume investments in renewable energy, in partnership with Total. According to Petrobras, this decision is due to “the trend of a global economy that is increasingly becoming less carbon-intensive and, on the other hand, the great potential in Brazil for solar and wind energy generation.” [14]

Shifting to renewables will certainly have an impact on these companies' businesses. Diversifying later rather than sooner, however, will pose a much higher cost for these companies. Moreover, energy will still be demanded, coming from fossil fuels or renewables. Although some jobs are lost in the process, others are created.

In conclusion, price is the primary factor behind choosing an energy source, such that costs will be the main driver of the energy transition. Concerns over climate change drive regulation, which, in turn, leads to the development of technologies, not yet mature. Eventually, these technologies will achieve scale and become more accessible than current conventional fossil fuel resources, which may become stranded assets. Investing in energy portfolios highly specialized in fossil fuels, whose infrastructure has a long-lasting lifespan, will potentially cease to be the safest option, not only from an environmental point of view but also from an economic one. Governments, like the Brazilian one, must keep that in mind for their citizens' welfare.

About the Authors

Tatiana Bruce da Silva is Researcher at FGV Energia and Fernanda Delgado is Research Coordinator at FGV Energia.

Endnotes

[1]In Sub-Saharan African countries, the challenges of supplying electricity exist due to several factors, such as considerable investment costs, high levels of technical and non-technical losses, institutional inefficiencies, among others. The International Energy Agency reports, in a study, that decentralized renewables offer a solution at the lowest cost for ¾ of the additional electricity connections needed in the region. For more information, see: Attia and Shirley, 2018.

[2]Including solar power and heat, wind power, hydropower, ocean energy, geothermal power and heat, and modern bioenergy. (*REthinking Energy*, IRENA, 2017).

[3]The existence of government subsidies at the initial stage of technological development in renewable energy has been of the utmost importance in allowing them to reach scale. If society, represented by their elected governments, thinks it is valid to subsidize such technologies, due to the benefits they will bring, the subsidy is reasonable as long as, when economies of scale in producing these technologies are achieved, they be phased out.

[4]The levelized cost of electricity (LCOE), also known as levelized energy cost (LEC), is the net present value of the unit cost of electricity throughout the lifespan of a power-generating asset. Often, it is used as a proxy for the average price the market would need to pay so that the power-generating asset can break even throughout its lifespan. It is a first-order economic assessment of the cost competitiveness of power generation system that incorporates all costs through its lifespan: initial investment, operations and maintenance, fuel cost and capital cost. Source: IEA, 2010 (https://www.iea.org/publications/freepublications/publication/projected_costs.pdf)

[5]Bruce da Silva, T; Delgado, F.; and Weiss, M. Brazil: Climate Change Goals and Energy Choices. *Geopolitics of Energy*. Volume 40, Issue 3, March 2018.

[6]New Energy Outlook 2018, Bloomberg New Energy Finance.

[7]The decrease in technology costs rekindles the interest of big oil and gas companies in renewables. A similar trend happened in the 2000s. At the time, however, the interest was solely from the supply side, so companies invested because they considered renewables good business opportunities. With the 2008 crisis, though, these projects did not go forward and these companies lost interest in renewable energy. Nowadays, however, interest from the demand side for several reasons (environmental, regulatory, among others) is helping the adoption curve of renewable technologies reach a higher level of maturity, leading to economies of scale in their production, which contributes for them to become cheaper, thus competing with traditional fossil sources. For more details on technology adoption curves, see: Rogers, E. *The Diffusion of Innovations*. The Free Press, New York, USA, 5th edition, 2003; Schilling, M.A., Esmundo, M., *Technology S-curves in renewable energy alternatives: Analysis and implications for industry and government*. Energy Policy (2009); Shahan, Z. *Electric Car S-Curve Adoption by Country*. CleanTechnica (2017).

[8]Dyson, M.; Engel, A.; and Farbes, J. *The Economics of Clean Energy Portfolios. The Rocky Mountain Institute*, 2018. (RMI, 2018)

[9]The plants in the study are a combined-cycle combustion turbine thermal plant in the West Coast of the United States and two combustion turbines gas “peaker” plants in Texas and in the country´s Mid-Atlantic region.

[10]This is the case today in the United States. Even so, the federal government has been trying to extend the lifespan of coal and nuclear through subsidies. However, the Federal Energy Regulatory Commission (FERC) has stated that there is no reason for bailing out coal and nuclear energy in the country. For further details, see: St. John, J. “*FERC Commissioners Agree: No Grid Emergency Exists to Justify Coal, Nuclear Bailout*”. *Greentech Media*. 06/12/2018. Available at: https://www.greentechmedia.com/articles/read/ferc-commissioners-agree-no-grid-emergency-exists?utm_source=Daily&utm_medium=email&utm_campaign=GT

[11]The increasingly migration of big consumers to the liberalized power market is, in part, due to high rates charged to captive consumers in Brazil.
[12]Battery energy storage and demand response are mentioned in a sensibility analysis in the Decennial Energy Plan (PDE), the planning document for the decade 2016-2026. These resources are not, however, considered in the baseline scenario (Figure 1), which is assumed to be the most likely to happen in the period. Thermal power plants are seen as more feasible to become peaker plants due to the still high costs of batteries and regulatory difficulties in implementing demand side management in the country.
There is a discussion in the Brazilian energy sector on whether hydroelectricity must be used to provide firm energy and flexibility, thus allowing for capacity expansion to happen through wind and solar. Then, the power mix could become closer to 100% renewable. This possibility, however, is disfavored because the power mix is already very clean. Therefore, using thermal power plants is not considered to be a problem. What the planner fails to understand is that thermal plants may become stranded assets in a few years.
[13]Leilões de Geração, Agência Nacional de Energia Elétrica (ANEEL), 2018.
[14]https://oglobo.globo.com/economia/petroleo-e-energia/petrobras-vai-voltar-investir-em-energias-renovaveis-22871369

Local Content in Sub-Saharan Africa and Latin America
The Path Defined by Different Industrialization Experiences

Roger Tissot

Local content can be defined as the value that firms in extractive industries, such as mining or oil and gas production, generate in the economy through the procurement of local goods and services. The value is measured in terms of national direct and indirect jobs created and the commercial linkages and spillovers generated when local firms act as suppliers.

Countries that have discovered commercially viable oil and gas reserves in the last few years have made local content in upstream projects a central negotiating point with international oil companies (IOCs). Buoyed by high oil prices, policymakers in new producing countries sought to capture a larger "piece of the pie" in addition to revenues from the government-negotiated fiscal terms. These stakeholders also sought to carve out a portion of the foreign direct investment (FDI) flows for their domestic firms, especially in the construction phase of upstream projects.

For late entrant countries to industrialization such as Sub-Saharan Africa (SSA), local content is perceived as a key strategy for industrialization. Organizations such as the United Nations Economic Council for Africa (UNECA 2014) argue that commodity-based industrialization can offer the leverage that commodity-dependent economies need to industrialize. They argue "that Africa cannot industrialize by ignoring its commodities and therefore must make the most of its commodities to promote value addition, new service industries and technological capabilities" (Morries, Fessehaie 2014). As such, several petroleum producing SSA countries have developed comprehensive local content policies and strategies (Ramdoo 2015).

With a longer tradition of extractive industries, Latin America has approached local content policies differently. In Latin America, the policy has focused on increasing the market access of local suppliers and, except for Brazil, Trinidad Tobago and recently Mexico, the rest of the hydrocarbon producing nations have not developed comprehensive local content strategies. Regulation and legislation of what would constitute a local content policy are dispersed through different levels of the government legislative and executive bodies (Mushemeza, Okiira, Morales & Herrera 2017).

These fundamental differences between the SSA and Latin American approach to local content policies can be explained by their dissimilar experience in their industrialization efforts.

The Latin American Experience

Latin America adopted a state-led industrialization strategy in the early 1950s centred around import substitution policies and direct government intervention of key economic sectors. Import substitution policies consisted of high tariffs, quotas and trade barriers aimed at protecting domestic markets. In addition, the state participated directly in what they considered strategic economic activities such as oil, gas and electricity. The state-led industrialization strategy also

benefitted from the expansion of immigrants from Europe in previous decades, who brought with them skills, knowledge and institutions (including trade unions) (Ocampo 2013) and the disruptions caused by World War II limiting industrialized countries supply of manufactured products as they realigned their industrial production to the war effort. European migrants created new businesses and became merged with the social and political fabric of their host countries, creating a local entrepreneurial elite which supported the region's corporatist policies. Progress in education also resulted in the development of a skilled workforce.

A key feature of the state-led industrialization in Latin America was the creation of national oil companies (NOCs). By the early 1970s, almost every Latin American oil-producing nation had its own vertically integrated NOC. These companies facilitated the creation of a local technocratic elite and a skilled and semi-skilled unionized workforce. Public education institutions included in their curriculum diverse programs aimed at supplying these NOCs with skilled employees. Technical schools offered basic training programs such as welding, electricity, and in later years petroleum technicians. Public universities also developed programs in petroleum engineering or geology. Research institutions also emerged under the guidance and leadership of the NOCs. The personnel graduating from these institutions knew that they had at least a good opportunity for employment with the NOCs. The trilogy of NOCs, local business elite and education or research centers was significant in the development of local capacity, particularly in Brazil.

NOCs also acted as an anchor for local businesses eager to enter the petroleum supply chain. Several service suppliers, benefitting from their preferential access and superior market knowledge of the local business and political environment, were able to secure contracts from the NOCs. Some of these businesses eventually evolved into oil and gas exploring and producing companies or expanded their activities into neighbouring countries. However, the expansion of the local supply chain was highly dependent on the investment capacity of the NOC, which was also a function of the price of oil and limited by governments risk aversion, which preferred to use the NOCs revenues for their own current spending.

Despite high levels of inequality and bias against Indigenous and other minorities, "the state-led industrialization period was characterized by a prolonged, rapid and stable rate of economic growth, and social progress" (Ocampo 2013). However, the model had its flaws, particularly its inability to build a solid technological base. Latin America was unable to close its technological gap with the developed world. Public education suffered from budget limitations, and an overall weakening of public institutions as the region's macroeconomic problems increased in the late 1970s and early 1980s, particularly its growing fiscal deficits and external debt. The implementation of import substitution policies was also negatively impacted by weak governance and the excessive costs of moving import substitution from one phase – consumer products – to the others: intermediary and capital products. As NOCs budgets suffered from political meddling, limited budgets, and diversity of objectives, their capacity to support local industries – as anchors of demand for goods and services – also declined.

Following the collapse of the state-led industrialization strategies, Latin America engaged in market reforms in the 1980s and 1990s. Pro-trade and foreign investment policies were enacted by reducing trade barriers and privatizing state-owned assets. Collapsing oil prices forced governments to open their oil industry. Countries reduced the role of the NOCs as the exclusive operator, compelling them to compete with private companies. In some cases, NOCs were privatized and sold to foreign companies.

The entry of new international oil companies (IOCs) combined with lower spending by NOCs led to a decline of activity by local suppliers to the oil industry. IOCs activities did not translate into new opportunities for them. IOCs preferred to rely on their own supply chains whenever possible. However, strong unions, the existence of an already skilled workforce, and strict protective labour force legislation limited the ability of IOCs to import foreign workers except for senior level or highly complex technical positions. But even then, the high cost of employing an "expat" in most Latin American countries encouraged IOCs to rely on a large available local professional workforce. Politically it was also seen as beneficial to have most of the senior management in the host country to be local, as long as governments were also aligned with the market liberalization policies.

As commodity prices increased in the early years of the 21st century, the region reversed some of the market liberalization policies, opting for a combination of leftist, populist and "resource nationalist" ones. The focus was on income distribution, and rent capture from foreign companies, as opposed to industrialization strategies. However, NOCs experienced a "new lease on life," and as in the case of Brazil, local content policies were set up to favour local industrial activities emerging from the large oil discoveries made in that country. In other countries, the focus was on improving the ability of local suppliers to compete through the implementation of supply development programs such as in Argentina. Finally, in Venezuela, statist policies favoured the over expansion of the NOCs in many activities, while at the same time the political regime attacked the local entrepreneurial elite with disastrous results for the economy and social welfare of the population.

However, these policies are not free of criticism. In the case of Brazil, perhaps the only country with the most comprehensive local content policies in Latin America, the lack of a central strategic plan to gradually implement the reforms in accordance with the country's supply chain reality led to excessive costs and project delays. The policy's general objectives were quickly imposed without focused targets, and from the beginning, it lacked advanced metrics or indicators that could accurately measure results, apart from higher investments (which mainly came from government subsidies) (Narciso Filho 2015)." Facing growing cost overruns and corruption scandals that impacted several large Brazilian companies and Petrobras Brazil's NOC, the policy changed in 2017. Overall requirements became more flexible and more incentive-based.

In the case of Mexico, a country that nationalized the oil industry in the early 1930s, the government adopted local content policies following the opening of its oil industry in 2016. During the nationalization period, Mexico developed a service oil industry that was completely dependent on Pemex. As new IOCs entered the country, the government wanted to secure its local service industry's ability to compete with foreign service suppliers. However, the challenge is to ensure a balance between the need to keep competitive terms for IOCs against the desire to secure local suppliers' participation in the value chain.

Latin America did not use its large dependency on extractive activities to leverage an industrialization strategy as has been the case in SSA. The existence of a local entrepreneurial elite with strong political clout and an influential unionized workforce at the state-owned businesses, in particular, the NOCs, helped to create a legacy that was difficult to reverse even when policies were drastically changed. Labour legislation and strong unions limited any possibility of foreign workers to be employed in the industry, even in countries where unions were weakened. A relatively large pool of professionals and technical experts who developed their skills by working for the NOC, in addition to the creation of technical schools and universities offering training, also ensured strong support for a nationalistic labour legislation among the elites. Instead, as the region started to reconsider some of the impacts of market liberalization – in particular the process of de-industrialization – preference has been on improving the opportunities of the local business community to compete through supply development programs, and other strategies aimed at helping them to increase competitiveness. However, the use of legislation mandating a certain level or percentage of local procurement to be made by IOCs has been limited (and watered down) to Brazil, Trinidad Tobago and Mexico.

The Sub-Saharan Africa Experience

Africa industrialization efforts occurred later than in Latin America. During the colonial period, industrialization strategies varied depending on the country's colonial legacy of i) a settler (South Africa, Zimbabwe), ii) concession (Congo) or iii) peasant economies (Senegal) (Austin, Frankema, Jerven 2015). Settler colonies were the first to implement industrialization strategies by adopting import substitution policies. They achieved a certain level of industrialization, but one burdened by their own political contradiction. On the one hand they had a large black unskilled workforce for which the state did not make any attempt to educate and instead coerced to keep their wages low; on the other hand, their local businesses were burdened by a shortage of skilled workers and the high wages paid to the white population. Domestic products were sold at high prices to protect local firms. The domestic market was limited by the low purchasing power capacity of the large black population. In colonial Congo, industrial development emerged around large mining activities,

producing light consumer products for the mining, mostly white workforce. High transportation costs acted as a powerful barrier to imports. However, these early industrial developments eventually collapsed following the country's political turmoil and economic mismanagement of the Mobutu Sese Seko administration.

At the advent of independence, SSA countries were eager to implement import substitution policies. SSA was following the examples of Latin America and other emerging economies, expecting to close the industrial gap with the industrialized world by imposing high tariffs and other protective measures. Former peasant colonies saw this as an act of independence from their colonial masters. The objective was to achieve self-sufficiency on consumer products rather than securing global competitiveness via manufacturing exports.

The implementation of ISI strategies suffered from several challenges in SSA. First, following the struggle for independence, SSA was left with the detrimental legacy of racial discrimination on the socio-economic mobility and human capital development of native Africans. Forced labour programs were focused on supplying the mines and plantations with manual labour, while higher skilled jobs and management positions were exclusively reserved for whites. The colour bar was also strictly applied in education. Primary education was almost entirely left to Catholic and Protestant missionary schools. The few public schools in the larger urban centers would offer lower-grade secondary education to SSA children, but nothing more (Austin, Frankema, Jerven 2015). This legacy resulted after independence in a preference for bureaucratic posts by the tiny African educated minority eroded the creation of labour-intensive factories that could compete with imported products and limited the capacity of the state at administrating industrialization efforts.

SSA countries were also confronted with their own ethnic diversity, exacerbated by the arbitrariness of the boundaries set during the colonial period. It is common in SSA countries to have the largest ethnicity to include less than a third of the national population, and for another group, or even two others, to be almost as large. These levels of ethnic fragmentation into a few large ethnic blocs may be associated with higher levels of civil conflict. Rent seeking attitudes resulted in unhealthy competition between dominant ethnic groups for the limited resources of the state instead of focusing on long-term nation-building efforts. "In the worst cases, this has led to a 'tragedy of the commons' in which productive activities are taxed out of existence by groups which fear that if they do not do this themselves, their rivals will" (Easterly and Levine 1997).

In Latin America, a certain level of homogenous ethnic composition, favouring those of European descent, prevailed in almost all countries during the state-led industrialization period. This favouritism, rooted in deeply objectionable racist beliefs, still facilitated the creation of a local entrepreneurial class with strong political clout. On the other hand, SSA import substitution efforts failed to develop a local entrepreneurial elite, and the few local entrepreneurs were overrepresented by ethnic minorities from India and other Asian countries – and the white minority in the case of South Africa – causing social resentment and vulnerability to political exploitation as it was the case in Uganda during the Idi Amin mandate with disastrous consequences for that country.

Local entrepreneurs in SSA also failed to develop strong linkages with the local economy, often relying on their countries or ethnic origin for their supply chain. Government direct industrial intervention made the situation worse with ill-conceived projects with little regard to their integration with the local economy. Except perhaps for Nigeria, where state enterprises failed to promote a local entrepreneurial elite or foster the capacity of a technically-skilled and semi-skilled workforce through local education institutions. In fact, the allocation of state resources for skills development was often tied to local tribal preferences.

Contrary to Latin America, SSA's import substitution period was relatively short, and despite some successes in the manufacturing of foodstuffs, drinks, tobacco, textiles, shoes, clothing and paper (Mendez, Bertella, Teixeira 2014), its supply chains remained poorly integrated with the local economy. Local firms were burdened by high production costs due to overvalued currencies, lack of infrastructure and significant human resources limitations. To boost investments, governments offered tax incentives to foreign investors, but these efforts, in addition to limiting tax revenues, also increased trade balance deficits as factories remained highly dependent on imported intermediary and capital

equipment, failed to create linkages with the local economy and their final products were not destined for exports. High protection and heavy import dependency meant the African industry was poorly prepared for international competition. Its extractive sector was also highly dependent on foreign capital, technology and know-how.

SSA adopted market reforms in the 1980s following similar policy recipes as in Latin America, redirecting their efforts toward market-oriented strategies. As it was the case with Latin America, these policies improved the macroeconomic management of the countries, but also increased inequality and brought about a process of de-industrialization. Some countries achieved some successes, particularly in Ethiopia with its thriving agro-industrial flower business. However, SSA was ill prepared to compete with low-cost manufacturing activities from China. Similar observations can be made about the Latin America de-industrialization process. But the limitations in SSA were made worse by the inability of the region during its short-lived import substitution era to build a local entrepreneurial elite with strong political clout, lack of NOCs in most countries, and limitations of a unionized workforce at imposing nationalistic labour codes.

When commodity prices increased, SSA benefitted from strong growth as a massive flow of FDI concentrated in the extractive activities (mining and hydrocarbon), resulting in an economic realignment – which also occurred in Latin America – as commodity exporter – abandoning its industrialization efforts. However, contrary to Latin America, SSA did not have a strong legacy of union activism in the extractive sector, and except for a few countries, local NOCs were too weak or non-existent. Most countries lacked proper technical training centers that ensured a supply of local workers into extractive activities. IOCs relied overwhelmingly on an imported skilled workforce.

Contrary to Latin America, during the commodity price boom, SSA did not focus on nationalizing activities, but instead, it promoted higher rent capture by requiring IOCs to develop comprehensive local strategies that focused on training of a local workforce. Even if these are capital intensive activities, generating few jobs, it was important for SSA countries to ensure a strong presence in all the activities of the extractives production.

However, as the extraction sector increased, SSA started to develop local content comprehensive strategies, aimed at promoting industrialization. As such, in addition to jobs, the priority shifted to local supply development programs. However, SSA was too slow at building nationally, reaching technical schools and universities able to train a local workforce. By the time discoveries were made, the SSA workforce was ill prepared to capture most jobs, limiting their opportunities to low value-added activities replicating dependency on foreign workers by IOC and sub-contractors, reducing the pressure for the government to invest in technical training. SSA countries have addressed those limitations by including capacity building and technology transfer activities in their oil contracts.

Development of local supply has been negatively impacted by ill-conceived policies that focused on the nationality of the business owner as opposed to value creation of the business. This encouraged corruption through “frontage” local firms with no value creation, benefiting the politically well connected to the regimes. In Latin America, which also suffered from high levels of corruption, the destruction of value was associated mostly by allocating to local entrepreneurs’ contracts at inflated prices by the NOCs.

With the decline in commodity prices after 2014, the expectation was that local content policies would be abandoned to preserve SSA jurisdictions attractive to IOCs. However, even if policies were softened, and became more amiable to oil companies (Ovadia 2015), they have not been abandoned.

Local content remains a central industrialization strategy in SSA. SSA oil contracts require IOC to comply with the specific hiring of locals and the implementation of capacity building and training programs. However, many countries still lack credible nationally reaching technical programs that can lift the skills of their rapidly growing young population. Increasing focus on value-added, as opposed to nationality, when considering a supplier as a local one should also improve the development of local supply chains. However, if SSA expects to achieve a certain level of

industrialization out of their local content strategies, it is important that as several migrant entrepreneurs, particularly from China, set up business in SSA, they also localize their own supply chains and employ local workers. These entrepreneurs should be allowed to gain more political clout, as job creators and taxpayers, demanding more accountability from the regimes, instead of seeking special favours from it (tax exemptions, uncompetitive allocation of contracts).

Final Observations

Latin America and SSA share some similar economic characteristics due to the importance of extractive activities in their economies. However, SSA's late entry into industrialization made it more difficult to achieve. Except for a few cases (Nigeria, Angola), local NOCs were too weak or non-existent to play similar roles as Latin American NOCs played during the state-led industrialization period in the creation of a local entrepreneurial elite and a local workforce. Globalization of supply chains also limits their ability to develop local industrial activities. IOCs preference, whenever possible, is to operate with trusted suppliers that can meet stringent technical and environmental requirements and offer their products and services globally.

Both regions have suffered from a process of de-industrialization and commoditization of their export base after the end of their state-led and import substitution industrialization period. However, because Latin America was able to invest in local NOCs that were able to form through the years a skilled workforce and support a politically influential local entrepreneurial elite, the region did not need to rely on an imported workforce, and instead it has been exporting its technical expertise as numerous ex-workers from Latin American NOCs operating in SSA, the Middle East and other oil producing locations can testify. Those local businesses that were able to adapt and survive the market's structural reforms have grown more efficient. As such, policies aimed at improving local business competitiveness should be the priority.

In SSA, on the other hand, the focus should be on strengthening a local entrepreneurial elite – not based on nationality but instead on the creation of value locally – and by developing technical skills of their workforce by strengthening technical and trade schools. Although it is not guaranteed that establishing NOCs in SSA may play a similar role as Latin American ones did in that region's industrialization effort, relying on IOCs for supply development programs alone may not be enough. First, those IOCs have been operating for decades – almost as long as NOCs in Latin America – and their impact on local industrialization is negligible. Second, IOCs presence in a country is subject to their own strategies and can change anytime as market conditions evolve.

About the Author

Roger Tissot is an economist focused on local content policies and strategies for the Extractive Industry. He just completed a three-year assignment in Saudi Arabia, leading KAPSARC (King Abdullah Petroleum Studies and Research Center) local content research activities where he focused his research on East African countries. Roger started his career at the Canadian Energy Research Institute (CERI) where he specialized in Latin America's energy policy issues, including the role of national oil companies, and the evolution of petroleum fiscal models. He then worked for EnCana, a large Canadian oil and gas company in different functions such as Business Development and Government Relations. Following his work at EnCana, he joined PFC Energy (now IHS MARKIT) where he led activities related to country and above-ground risk analysis for international oil companies (IOCs). Roger has also worked as an independent consultant advising governments and oil companies. Roger is currently enrolled in the Ph.D. program at the University of British Columbia, holds an MA in Economics from Laval University (Quebec) and an MBA from the University of Calgary. He also obtained his CMA/CPA designation in 2014.

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Publisher: Canadian Energy Research Institute, #150, 3512 - 33 Street NW, Calgary, Alberta, Canada T2L 2A6
Telephone: (403) 220-2370; Fax: (403) 220-9579; Email: **mmurphy@ceri.ca**.

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