TRADE & INDUSTRIAL POLICY STRATEGIES

INDUSTRIAL DEVELOPMENT PROJECTS

BOREHOLE DRILLING RIGS

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December 2020

A contribution to South Africa's Post COVID-19 Recovery Plan: Tapping into new and unmet sources of demand to support the establishment of new companies, factories, value chains and employment opportunities

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INTRODUCTION

As South Africa responds to COVID-19 and aims to stimulate the economy and job creation post lockdown, an opportunity should not be missed to consider investing in new product markets which could increase the size and dynamism of the manufacturing sector. Such a package could contribute to arresting the current trend of deindustrialisation and shift the trajectory of the industrial base into new, sustainable growth areas and value chains. This would result in new factories, new downstream demand for primary and intermediate inputs, new export products, increased foreign exchange earnings, and importantly new direct and indirect long-term jobs.

Using the idea of "business *un*usual" TIPS economists have put together a Post COVID-19 recovery programme in South Africa that could provide the impetus to arrest the current trend of deindustrialisation and herald in the beginning of a new generation of industrial activity.

Seven initial projects have been identified. They represent a wide array of economic activity in the special purpose machinery, agro-industries, bioplastics, shipping, alternative fuel, biochemicals and automotive component manufacturing sectors.

This project looks at the production of 100% local content borehole drilling rigs specifically engineered for small and medium enterprise drillers to service increased investment in groundwater access in South Africa and the African export market.

For more information on this or other projects please contact Sandy Lowitt at 082 373 1150.

BOREHOLD DRILLING RIGS

PROJECT SUMMARY SHEET

TITLE	The production of 100% local content borehole drilling rigs specifically engineered for SME (small and medium enterprise) drillers to service increased investment in groundwater access in South Africa and the African export market.
LEAD DEPARTMENT	Department of Trade, Industry and Competition. Other Departments: Department of Human Settlement, Water and Sanitation; Department of Small Business Development.
PROJECT SUMMARY	The project in contextualised in terms of the National Water Resource Strategy's (NWRS) support for the further development of groundwater in meeting South Africa's water needs, and a proposed increase in water infrastructure investment as part of a post-COVID recovery package. The project is the production of 100% local content borehole drilling rigs. The rigs have been designed to be village level operated and maintained, meaning that they can be repaired and serviced even in remote areas. Parts and spares are readily available and are generic and standard. The project also incorporates the training of a new cohort of SME drillers and operators in support of an expanded groundwater industry both locally and in the rest of Africa.
APPROXIMATE BUDGET	R15 million to R20 million for an assembly facility. All locally produced parts to be outsourced to specialist engineering firms with a strong track record. R3 million to R5 million for institutes course development and accreditation through the Manufacturing, Engineering and Related Services Sector Education Training Authority (merSETA).
STAKEHOLDERS	• Current intellectual property (IP) holder and producer of the rig; • A black industrialist partner with business and especially export market knowledge; • Department of Small Business Development to assist in the development of the training institute and setup capital for SMEs; • MerSETA to approve training content; • Department of Human Settlements, Water and Sanitation to set regulations and processes for additional sustainable borehole development, and to ensure that contracts are given to drillers not briefcase companies with no experience; • The dtic to support capital equipment production of rigs and downstream inputs.
CAPITAL INVESTMENT	• Factory space to assemble drilling rigs (some manufacturing on certain parts) • Basic assembly equipment including milling machines, lathes, hoist, welding and other basic fabricator equipment.
OUTCOMES	• Job creation: Each new SME drilling company will employ at least 10 to 12 full-time workers. The assembly of the drilling rigs will employ between 20 to 40 people directly. Indirect jobs downstream will be created in the iron and steel sector, the plastic extrusion sector, metal fabrication sector, specialist engineering sector and piping and hose manufacturing sectors. In time, compressors can also be produced locally. • Entirely new export product and export revenue stream. Research suggests that Africa requires over 100 million boreholes to be drilled in the next 15 years. The proposed rig meets all international specifications, hence global organisations such as the World Bank, United Nations Children's Fund (UNICEF) and the Red Cross can be approached to source their rigs from South Africa. • Increased access to sustainable water supply.

The production of 100% local content borehole drilling rigs, specifically engineered for SME drillers to service increased investment in groundwater access in South Africa and the African export market.

Introduction

Infrastructure investment has dominated the government's thinking regarding a post COVID-19 recovery strategy. TIPS 2020; Water Research Commission 2020; and Green Cape 2020 have all written that investment in South African water and sanitation should form an important part of this package. They argue that such investment will positively contribute to: the protection of existing agricultural employment and livelihoods; enhance productive opportunities and livelihoods in unserviced and underserviced areas; reduce poverty and inequality; enhance the country's responsiveness to current and future pandemics; and stimulate industrial development. In terms of industrial development it is argued specifically that South Africa should roll out locally manufactured solutions that allow for: import substitution; strengthening of the country's global competitiveness; and the increase of exports. The proposed project meets all these industrial development goals while in addition facilitating local black SME mainstream economic opportunities in a growth sector through training and reduced barriers to entry.

Water scarcity is a major challenge in South Africa and elsewhere on the African continent. Freshwater exists in two forms: surface waters (lakes and rivers) and groundwater, which is water that soaks into the earth when it rains and is stored in underground cracks and chambers (called aquifers). Surface water accounts for only 3% of global fresh water supplies. Ninety-seven percent of global fresh water is groundwater. Ground water may discharge naturally at surface level in the form of springs, seeps and wetlands. Most commonly, however, groundwater is mechanically withdrawn by constructing and operating a well or a borehole.[1] Accessing groundwater is therefore seen as a central part of resolving water access in Africa.

Three hundred million Africans currently lack access to clean drinking water. UNICEF estimates that 67 million boreholes need to be drilled in Africa to meet the Millennium Development Goals related to accessing clean drinking water (UNICEF 2016). In Mozambique alone, it is estimated that 1 000 boreholes have to be drilled per year for 15 years to meet these goals (Dovi 2007). If groundwater access for industrial and agricultural use is also factored in, the required number of boreholes needed in Africa exceeds 100 million in the next 15 years.

A borehole is a narrow shaft drilled vertically into the ground for the purpose of extracting groundwater. Once the shaft is drilled, a casing is used to line the shaft to prevent it from caving in. A screen is then placed atop the shaft to prevent pollution of the borehole water and finally a pump is installed to raise the water to the surface for use. Pumps may be electric, solar or manual. To drill a standard water borehole (which varies anything from 50m to 200m depending on geological formation) a piece of specialised capital equipment known as a drilling rig is used (Standard Industrial Classification (SIC) 357).

Drilling rigs vary in size from massive rigs used to drill kilometre deep mine shafts to small portable rigs which can be pulled and positioned by a single person. In order to reach a reasonable depth for a standard water borehole, a drill rig needs a minimum weight (four tons) and a minimum torque (4 000 newton meters[2]). Currently there are no locally produced borehole drilling rigs that meet such

[1] UNICEF and the World Bank use the words well and borehole interchangeably.

[2] These standard specifications are set out by UNICEF and are adopted by most aid and development programmes internationally. As such, to access internationally funded projects in the rest of Africa the drilling rig needs to meet UNICEF standards.

specifications[3] and which are designed specifically for use in remote areas where access to parts, spares, and repair and maintenance services are hard to access. In addition, no local rigs meet the above specifications which are also reasonably priced in terms of the setup costs of a new SME drilling company.

The 100% local content drilling rig for which the IP has been registered has a key market differentiator in the fact that it is designed to be "village level operated and maintained". This means that the rig is simple to use and hence capacity can be ramped up more readily than with more complex rigs. In addition (and more importantly) a huge problem with borehole drilling in Africa is the difficulty in getting rigs serviced, repaired and maintained in remote settings. The project rig is designed specifically to be self-maintained by the driller and all parts are either standard and generic parts easily attainable across most countries (in hardware stores or from car dealerships), or locally produced in South Africa. There are no original equipment manufacturer (OEM) or imported parts in the rig itself.

The 100% local content of the drilling rig will catalyse demand along multiple value chains servicing the downstream activities of the capital equipment sector. Most demand will be for parts fabricated by specialist engineering firms (such as steel rods, braided high pressure plastic piping and chassis[4]). While the drilling rig is 100% local content, the other pieces of equipment required to drill a borehole (engine, motor, compressor, truck and some consumables) are not based on local content. It is possible that, if export demand for drilling rigs increases, market size will be sufficient to allow a second wave of import substitution when non rig parts and equipment (such as compressors or hammers) can begin to be produced locally.

The project to produce cost effective and technologically appropriate borehole drilling rigs is premised on the need for Africa (and South Africa in particular) to improve access to drinking and productive water by drilling into and extracting groundwater. The NWRS states that groundwater will play an increasingly important role in the supply of water in South Africa. To achieve increased usage of groundwater at scale will require a new and extended cohort of drillers of boreholes. As the individuals responsible for the design and building of the project rig are drillers themselves, the rig production company plans to also operate a training institution. In the institute prospective black, SME drillers from all over Africa can be trained on: placing a borehole; drilling a borehole; maintaining a borehole; and maintaining their drilling equipment. The project is thus an industrial production project as well as a capacity building project.

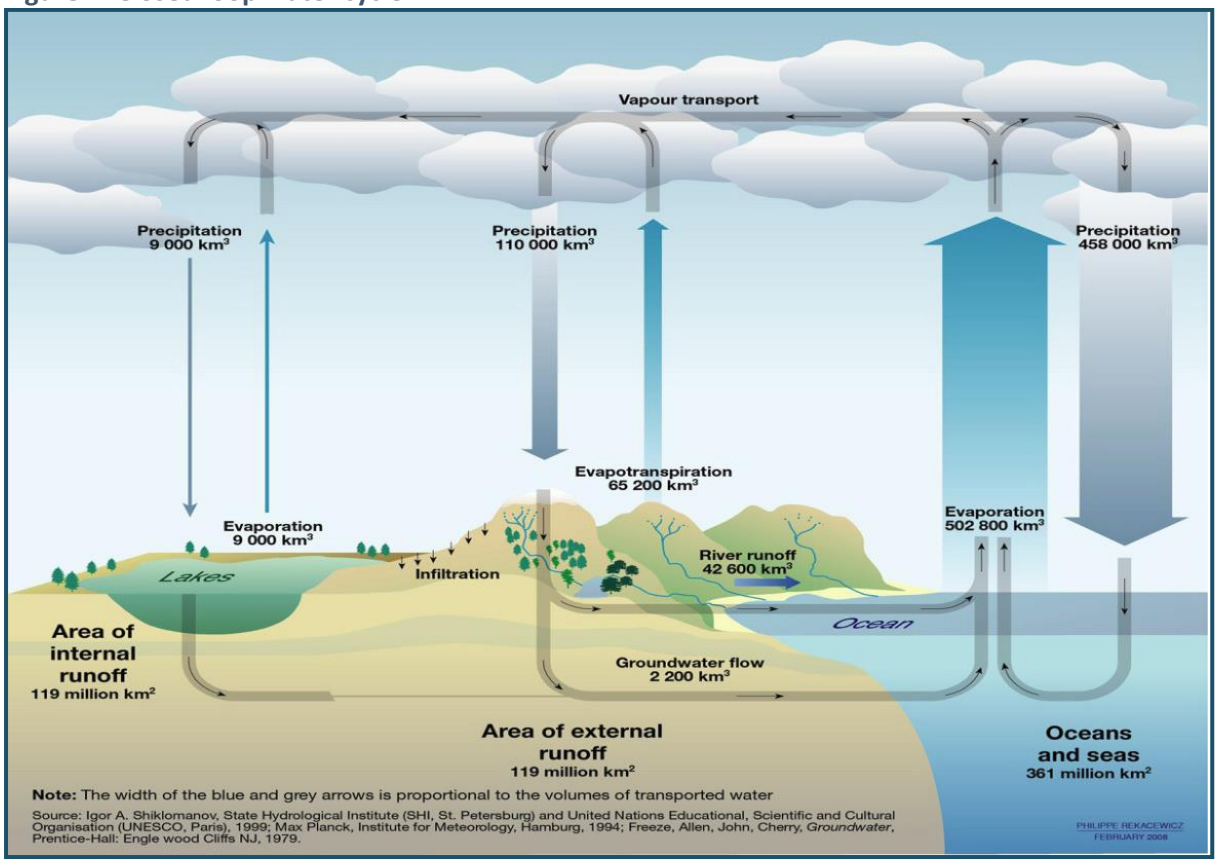
Groundwater and national policy

Groundwater is a renewable resource which operates in a closed loop system (Figure 1). Heat results in water evaporation from the land and water resources. As the water vapour rises, it cools and condenses to form clouds. When conditions are appropriate, the water in the clouds is released as precipitation (rain, hail, snow or sleet). This precipitation evaporates back into the atmosphere, infiltrates the ground to become soil moisture or groundwater, or runs off into surface water resources such as rivers, estuaries and wetlands. Plants take up water from the soil and transpirate some of it into the air, contributing to the return of moisture into the atmosphere, and back into the cycle of evapotranspiration and precipitation. As such groundwater is replenishable and sustainable.

[3] The local market is positioned towards larger drilling rigs. Smaller rigs imported from India and China are available but lack the weight and torque to be able to reach required depths to find water. Most locally produced rigs are attached to 10-ton trucks, making them expensive and ill-suited for remote access sites.

[4] The chassis is also known as the skid steer and is the wheels/tracks on which the rig sits. To date, most locally produced rigs are attached to imported skid steers – usually the well-known yellow bob cat.

Figure 1: Closed loop water cycle



Source: Department of Water, 2012

Ground water is the water that soaks into the soil from precipitation, rivers and lakes. It moves downwards to fill cracks and other openings in beds of sand and rock. A unit of rock with cracks and fractures that can yield a usable quantity of water is called an aquifer. The characteristics of aquifers vary with the geology and structure of the substrate and topography in which they occur. Generally the most productive aquifers occur in sedimentary geological formations.

Groundwater is usually: cheaper to access; more convenient; and less vulnerable to pollution than surface water. Globally groundwater is commonly used for public water supply (UNICEF 2016).

The 2012 NWRS states that groundwater in South Africa is an important resource for all sectors ranging from agriculture to domestic water supply. It states that groundwater will make greater contributions to the national water supply in years to come as surface water gets closer to the limits of its development and availability. Currently surface water in South Africa (rivers, lakes) accounts for 9 500million cubic meters of water per annum. It is estimated that groundwater of 7 500 million cubic meters per annum exists at a high level of assurance. Currently only 2 000 million cubic meters per annum of this groundwater is exploited (27%), leaving a substantial 5 500 cubic meters per annum available to supplement dwindling surface water in the future.

The NWRS thus argues that there is extensive potential available for the further development of groundwater resources; and that the development of this resource will be crucial for sustaining water security of small towns and villages as well as augmenting water supplies to larger urban centres and agriculture (Department of Water, 2012). To support this usage, development of the borehole drilling and borehole development sector will need to grow.

Borehole drilling

There are many types of drilling techniques. Each technique requires a different type of associated drilling rig. The most common method of mechanical borehole drilling in South Africa and the rest of Africa is known as percussion rotary air blast drilling (RABD). In RABD the drill uses a pneumatic piston-driven "hammer" to energetically drive a heavy drill bit into the rock. The drill bit has very hard buttons on the end made of tungsten carbide, which pulverise the rock as the hammer strikes the bit down against the rock. The drill bit is hollow. Compressed air sucks up the pulverised rock which is then blown up the outside of the drilling bit and collected at the surface. As the bit eats through the rock, rods are added above the hammer so that depth can be achieved. The bit, the hammer and the rods used in drilling are consumables and have a limited lifespan requiring regular replacement.

The drilling rig itself must provide the hammering motion to pulverise the rock, but also a rotating motion to create a round shaft. There are three crucial systems in a drilling rig. The first comprises an engine which drives hydraulic pumps to create high pressure hydraulic fluid which drives a motor. The motor turns the rods above the drilling hammer adding a rotating motion to the hammer like striking motion so as to produce the actual round shaft. This is known as the hydraulics of the drilling rig. Second the drilling rig needs to produce the hammer like up and down movement to fracture and break up the rock. This is achieved by connecting the rig to a compressor. The compressor pushes air down the rods and lifts the piston up and down to make the hammer move and to push up pulverised rock to the service. The third important function of a drilling rig is known as pullback power. This provides the power to pull rods back out of the hole once water has been reached. This pull back strength is created using the hydraulic power from the rig's engine. As such in engineering terms the hydraulic system of a rig is central to its operation and functionality. In this project, the hydraulic system is 100% local content and specifically devised to be easily operated and maintained even in remote areas. It is robust and high quality reducing downtime.

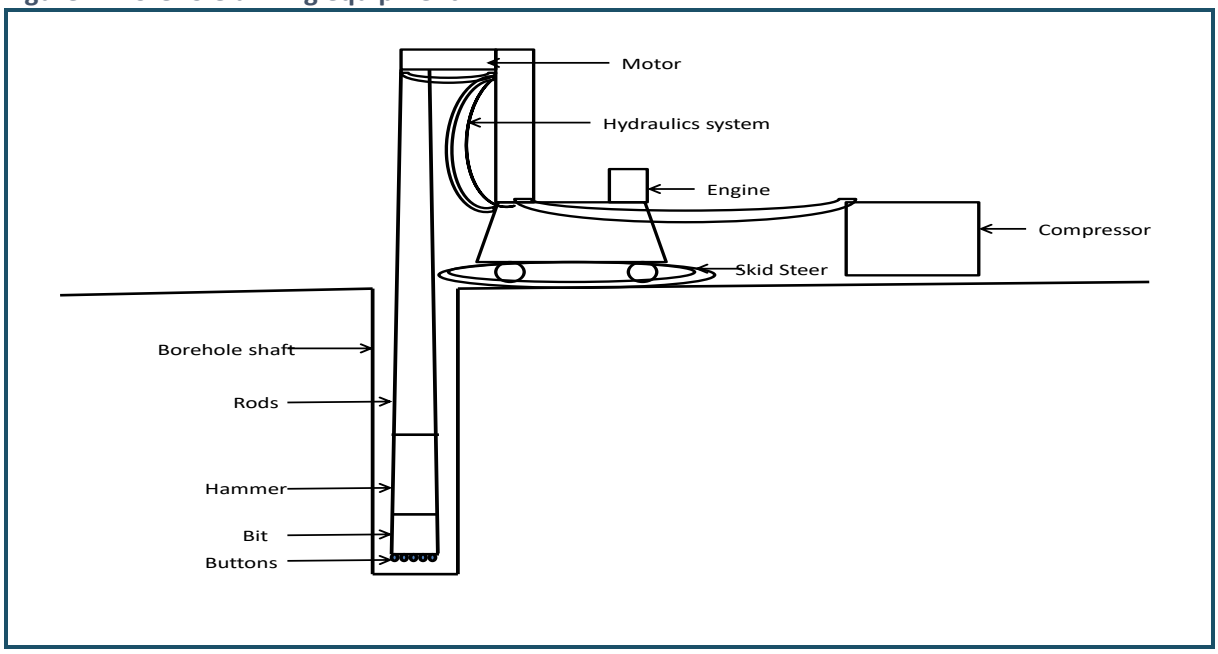
Inputs and value chain

Production of a drilling rig falls within SIC code 357 – the manufacture of special purpose machinery. The key components required for a drilling rig are: an engine, a hydraulic motor, a hydraulics system, a hammer, a drill bit, rods, piping metal, piping plastic, casings (metal and plastic[5]), bearings, nuts, bolts, hoses and skid steers (chassis upon which everything is attached). All of these inputs are locally produced excluding: the engine, the hammer and the drill bit. Engines are not currently made in South Africa, but Toyota engines are used as spares and are easily accessible in most African countries. The hammer is made of hardened steel and could in principle be manufactured locally, although currently no steel mills produce the grade of steel necessary to meet hammer specifications. Drill bits are imported because no-one in South Africa produced tungsten carbide buttons.

The downstream industries which would benefit from the production of local content driven drilling rigs would be specialised engineering firms, metal piping firms, plastic extrusion companies, plastic piping companies, hose manufacturers, rig engineers and skid steer manufacturers. Both the metal fabrication and plastics sectors would enjoy increased upstream demand.

[5] 8-inch steel casings and 6-inch PVC casings.

Figure 2: Borehole drilling equipment



Source: Author's own design

In addition to a drilling rig, a compressor and transport equipment are required to successfully drill a borehole. Compressors are crucial to the operation of a drilling rig and differ in size depending on their air pressure and movement of air per minute. Typically, to drill a standard borehole requires 21 bar of pressure and air movement of 850 cubic feet per minute. Compressors meeting these specifications are large and heavy weighting up to 6.5 tons. There are locally produced compressors which are also designed specifically to be village level operated and maintained. It would be beneficial for local drillers to have access to such compressors to complement their easy to maintain rigs. Unfortunately, South African compressors remain uncompetitive in price compared to Indian and Chinese imports. In the short run it is therefore likely that compressors for this project will be imported but local compressors could be produced to substitute imports if industry development and economies of scale occur.

Finally a drilling rig and compressor are useless unless they can be transported onto site. A drilling operation thus requires a truck (to carry the compressor and rods) and a trailer to pull the rig. Standard heavy duty trailers produced locally in South Africa can be used and a 4x4 10 ton truck with a double axle would be required for the compressor.

Capacity building and SME establishment

The United Nations and the International Red Cross reports on borehole drilling and development all raise the issue of increasing the standards of boreholes which have been drilled to increase functionality and decrease failure (which is currently at more than 26% across 20 surveyed African countries); increasing maintenance of boreholes and borehole pumps; and the need to manage groundwater resources to prevent over abstraction. To this end, the reports document a cross-cutting approach to groundwater development in a developing country including: establishing a strong institutional framework; collating and disseminating groundwater information; capacity building; project design, implementation and monitoring; dialogue awareness and financial investment (UNICEF 2016). They also both provide specifications and minimum standards for drilling, casing, water development, testing, and pumps.

Poor borehole drilling and development and borehole mechanical failures are attributed to: a lack of access to spare parts; a lack of basic maintenance; operation and management which is deemed

"too difficult"; and a lack of finance (UNICEF 2016). In the same year, the International Water Agency stated that "there are not enough appropriately skilled water professionals to support the attainment of universal access to safe drinking water and sanitation .... the developing world alone will need an additional 3.3 million professionals to achieve universal coverage"(IWA 2016).

Based on this inclusive and 360 degree approach to growing the groundwater development sector, the producers of the local content drilling rigs will offer a complete training course to newly established drilling SMEs in South Africa and abroad. This will cover all the aspects highlighted in the UNICEF standardisation of borehole drilling issues especially: how to site, drill, construct, develop, operate and maintain a borehole; and, how to operate, service, maintain and fix the drilling rig.

It is hoped that existing or new SME development programming can be leveraged to assist prospective drillers to enter the local groundwater development market. Current and future demand locally and across the rest of the continent is substantial and hence offers a new and sustainable growth opportunity. A new drilling SME could be established for approximately R3 million and would create sustainable direct employment for a minimum of 10 people. Indirect job creation through the value chain would also be supported.

Table 1: Start-up capital and consumable costs

ONCE-OFF COSTS	RANDS	
Drilling Rig	1 200 000	
Compressor	450 000	
10t truck (used)	450 000	
Heavy Duty Trailer	80 000	
	2 180 000	
Consumables		
Bit	7500	Replaced about every 1 000m of drilling
Rods	3 200	Each rod is 2m long – need at least 50 to drill a 100m borehole
Hammer	3 000	Usually replaced every 18 months

Source: Author's own calculations

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