Chad SME Competitiveness and Global Value Chain Upgrading Diagnostics with Focus on Opportunities in the Domestic and Regional Markets
Acknowledgements

This report was commissioned by the World Bank’s Extractives-Led Local Economic Diversification (ELLED) Program, a knowledge program that supports inclusive growth in mineral- and hydrocarbon-rich countries through innovation, long-term competitiveness, and regional synergies.

This report investigates the potential for leveraging the oil and gas industry to accelerate the diversification of the Chadian economy. It is complemented by detailed background analyses, presented in PowerPoint format.

The report complements an earlier World Bank publication, Chad Petroleum Sector Diagnostic Report (2019), which contains a detailed analysis of the oil and gas sector in Chad.

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The team would like to thank the Extractives Global Programmatic Support, a multidonor trust fund administered by the Energy and Extractives Global Practice of the World Bank, for their financial support.

Comments were received from Ifeyinwa Uchenna Onugha, Senior Private Sector Development Specialist, Milaine Rossanaly, Senior Private Sector Development Specialist, and Francois Bertone, Senior Water Resources Management Specialist.

Editorial support was provided by Aarre Laakso.

Our special thanks go to Israel’s Ministry of Energy, Israel Innovation Authority, University of Haifa, Israel Institute of Technology (Technion), Energean, Noble Oil Services, Delek Drilling, Prisma Photonics, Ham-Let (Advanced Control Technology), Israel Shipyards, Fieldbit, and RWL Water for their time and cooperation. Our thanks also go to Gil Shaki for his insights on the oil and gas industry and for organizing such fruitful meetings.
Abbreviations and Acronyms

AI       Artificial Intelligence
AFD      Agence Française de Développement
AFDB     African Development Bank
ANIE     Agence national des Investissements et des Exportations
ARCEP    Autorité de Régulation des Communications Electroniques et des Postes
CAGR     Compound annual growth rate
CEMAC    Central African Economic and Monetary Community
CNPC     China National Petroleum Corporation
CNPCIC   China National Petroleum Corporation International Chad
EITI     Extractive Industries Transparency Initiative
ELLED    Extractives-Led Local Economic Diversification
GDP      Gross Domestic Product
HSE      Health Safety & Environment
IMF      International Monetary Fund
INSTA    Institut National des Sciences et Techniques d’Abéché
IP       Intellectual Property
ITIE     Initiative pour la Transparence dans les Industries Extractives
OECD     Organisation for Economic Cooperation and Development
OFS      Oilfield Services
OPIC     Overseas Private Investment Corporation
OTRT     Office Tchadien de Régulation des Télécommunications
ML       Machine Learning
MPE      Maison de la Petite Entreprise
SCADA    Supervisory Control and Data Acquisition
SDG      Sustainable Development Goal
SDI      Spatial Development Initiatives
SHT      Société des Hydrocarbures du Tchad
SNE      Société Nationale d’Electricité
SRN      Société de Raffinage de N’Djamena
SSA      Sub Saharan Africa
STE      Société Tchadienne des Eaux
STEM     Science, Technology, Engineering, and Mathematics
TOTCO    Tchad Oil Transportation Company
UPM      Université Polytechnique de Mongo
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What does this report aim to do?

This study aims to explore ways in which key competencies of the oil and gas industry could be leveraged to support the diversification of the Chadian economy. The analysis focused on identifying opportunities and prioritizing core competencies in specific segments of the oil and gas value chain where economic activities have the potential to grow and increase cross pollination, which can be achieved through policy reforms or the provision of public and private inputs.

It seeks to achieve increased growth and employment creation through improved diversified products and services. Owing to its explanatory nature, this report must be seen as a high-level review of different opportunities—of potential options—that Chad could seize to catalyze its efforts in economic diversification. As such, it is not a guide to securing private sector investment or implementing reforms. It was prepared in a short period of time combining desk research, in-country stakeholder consultations, interviews with experts, and building on the accumulated knowledge from several value chain studies. Its findings are intended as background for discussion with the authorities with the aim of identifying a shared assessment of needs and priorities.

Who is this report aimed at?

This report is intended for use by World Bank management and technical staff to inform the design of potential technical assistance and advisory programs, as well as the preparation of sector engagement strategies. It may also be useful for Chad’s Ministry of Petroleum and Mines, Ministry of the Economy, Development Planning and International Cooperation, and other government entities to help them identify potential development paths and reform needs.

What methodology was used to prepare this report?

The methodology chosen for the project consists in the formulation of a development approach through strategic segmentation and gap analysis. This program followed a sequence of steps to identify analytical outputs and potential actions to be undertaken by both public and private stakeholders.

Identifying businesses in the global oil and gas industry prone to spillovers. The analysis of the global oil and gas sector focused on three main businesses pertaining to the global oil and gas value-chain: (a) exploration, (b) production, and (c) transportation. The global markets for exploration, production and transportation were classified into strategic segments that reflect not only the combination of products and services offered but also the users and markets served.

Mapping the ideal value chains for each business. Based on a review of industry literature, an ideal value chain mapping was conducted for each of the three activities listed above. The ideal value chain mapping was based on:

- An assessment of the business models needed to participate in the segment-specific activities;
- The evaluation of generic strategic options to determine advantages and disadvantages; and
- Key success factors (the characteristics a company needs to be profitable in the relevant segment).

These business models, generic strategic options, and key success factors were used to determine the ideal value chain for each segment and contrast this analysis with Chad’s current ecosystem. Therefore, for each value chain, we identified the strategic segments in which Chad is positioned today. We also monitored Chad’s performance in these segments (relative to regional and global competitors) and compared it to the “ideal value chain” for these segments. We then highlighted, for
each of the value chains, activities that could enable Chad to capture more value and create employment.

Within this framework, special emphasis was placed on discussing opportunities for creating inter-sectoral linkages to support economic diversification, job creation, and sustainable growth. The study hypotheses were refined through interviews with multiple experts who either work for development organizations or are technological and engineering specialists. A virtual study tour was also undertaken to identify lessons learned from the development of the oil and gas ecosystem of Israel, which provides a great business case of a nation that managed to leverage cross-industry linkages to activate a new and vibrant value chain.

During the project, local interviews with the main public agents that participate (directly or indirectly) in the national hydrocarbon value chain were performed. The objective of this component was to integrate the actors’ perspectives on the Chadian ecosystem and identify strategic programs related to economic development, as well as the diverse successes and challenges faced by institutions and private actors in the current context. However, due to the travel restrictions associated with the COVID-19 pandemic, these meetings were held virtually.

How is this report structured?

This report is organized in two main chapters as follows:

- In chapter 3, a review of the current trends in the oil & gas industry sheds light on the ongoing discussion about the role of the industry in achieving the Sustainable Development Goals. The industry could do many things to support this call to action, but the recognition of three core competencies within the oil and gas value chain—the capacity to extract and manage geospatial data, the capacity to handle and treat water, and the capacity to combine and share different types of infrastructure and logistics—provides an interesting view on how to contribute to sustainable development.
- In chapter 4, the study identifies several opportunities for Chad to harness these unique capabilities of the oil and gas value chain. The main proposal is to test this approach by running a geospatial analysis pilot project. The outcome of this effort should lead to spatial development initiatives leveraging water management and infrastructure sharing.

Executive Summary

Extractive industries are essential to the economy of Chad. The country became an oil producer in 2003 and has since relied on revenues from oil exports to support economic growth. The oil boom of the early 2000s enabled the country to increase per capita GDP from $220.8 in 2002 to $660.2 in 2005, thereby narrowing the income gap with sub-Saharan Africa. However, various episodes of national and regional insecurity have hampered hopes of raising growth to a faster and more sustainable pace. More importantly, continued dependence on oil and the inability to take advantage of long-term growth drivers (human capital, capital accumulation, institutions and governance, competition and innovation for productivity) have left the economy less diversified, less competitive, and more vulnerable to exogenous shocks.

Although the government was a crucial actor in many sectors of the economy through a policy of targeted public expenditure, its interventions have not been able to promote competition and private sector growth as much as necessary. Since 2014, the GDP coming from non-oil activities has
been significantly lower in Chad than in any other oil exporting country from CEMAC\(^1\) or from sub-Saharan Africa (IMF, 2019).

Chad’s low GDP growth is explained by the interaction of three major constraints that contributed to undermining major growth drivers such as trade or investment, keeping Chad from increasing its economic potential. These constraints were (a) regional insecurity, notably with Boko Haram’s presence most strongly felt around Lake Chad, (b) an inability to tap into oil revenues to push fiscal reforms and economic resilience, and (c) a lack of openness of the national market towards private investors that deprived Chad of significant benefits and growth dividends (World Bank Group, 2018). Under the influence of these combined factors, Chad has found itself trapped in the vicious circle of a heavily oil-dependent economy, incapable of finding its way out of the “growth labyrinth” through diversification.

**Unique capabilities of the oil and gas industry**

Analysis of the oil and gas global value chain identified three unique industry capabilities. They are core competencies that have the potential to create cross-industry linkages and spillover effects: advanced data management, water management, and shared infrastructure and logistics.

**Developing geographic synergies through advanced data management**

Geological information and data repositories developed for petroleum exploration can become a valuable input for the design of land use strategies. Using this information and the advanced capacity of the oil and gas industry to process complex databases, allows a precise vision of cross-sector opportunities and robust land management planning. Chad can capitalize on the use of this georeferenced information, but a coordination effort between institutional actors, operators and exploration companies is essential.

**Developing economic synergies through water management**

Water management companies are now the fastest growing segment of the oil and gas industry. The emergence of these companies with a different business model was mainly triggered by stricter regulations, technological advancements, and pressure on costs, but the know-how of these companies could be applied to tackle the perennial problem of water scarcity and water management in most sub-Saharan countries. To achieve this goal, four conditions must be met:

1. Ad-hoc regulation determining the uses of produced water and the application (or not) of additional treatments;
2. Capitalizing on the knowledge developed by the most technology-intensive areas of the industry, tapping first and foremost into its advanced engineering and problem-solving capacity;
3. A selection and sizing of the technologies to be developed determined by the local natural characteristics (geology, hydrology, topography); and
4. Reasonable operating costs.

**Developing communication and logistics synergies through shared infrastructure**

Energy efficient and reliable, pipelines offer multiple advantages over other modes of transportation. They are environmentally friendly when it comes to moving fluids over long distances, and they have seen their security levels improve thanks to the increasing integration of AI and IoT in their design (AI embedded SCADA\(^2\)). Therefore, it is possible to take advantage of existing pipelines using the shared infrastructure model. This means using installed pipelines, at marginal cost, to bring

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\(^1\) Central African Economic and Monetary Community

\(^2\) Supervisory Control and Data Acquisition.
utilities (electricity, fiber optics, and water) to the benefit of mostly rural communities scattered across a country.

This type of infrastructure sharing needs proactive government policies at certain critical stages in the management of oil projects. The government must ensure the deployment of a set of best practices:

1. Impose separation between the operator and the infrastructure;
2. Establish a strong regulatory framework to ensure shared use;
3. Encourage the Build / Operate / Transfer (BOT) model helping the transition after a period of use of 15 to 30 years; and
4. Set up an aspirational shared-infrastructure framework.

Opening new paths for diversification: the power of knowledge

Harnessing the oil and gas ecosystem as an enabling tool for integrated development requires the implementation of a set of actions based on geospatial information. They are a basis for the identification of potential spatial development initiatives and a source of informed decision-making processes.

Today there is no operating geospatial data repository in Chad. The geospatial information provided by the oil and gas operators is neither stored electronically nor capitalized upon for spatial planning in the country. The goal of this pilot is to contribute to the creation of the national data management facility, starting from areas where data has already been collected by oil companies, and enriching such data to account for other sectors and factors required to support land use strategies.

The first potential outcome of the pilot should be a spatial development initiative leveraging water management. Its objective would be to encourage and promote the beneficial use of produced water for irrigation through the identification of investment opportunities in agriculture.

The second potential outcome should be a spatial development initiative leveraging infrastructure sharing and logistics sharing. It would aim to develop shared infrastructure in identified areas through an investment promotion plan.

If the previous pilot activities are successful, other actions could be carried out to capitalize on the unique competencies of the oil and gas industry. The following areas could be considered: establishing regulatory frameworks conducive to water management; development of local water management specialists in Chad; design of an aspirational shared-infrastructure framework; and reinforcing Chad’s STEM capacity in geospatial analysis and advanced data management.

What further analytical work is needed?

The main project to be developed is a pilot fostering better land use and management in two selected oil- and gas-producing provinces (North and South). This study would trigger potential projects in land use, leveraging water management, and cross-sector infrastructure sharing and logistics sharing. A special task force for the implementation of this pilot should be organized to coordinate all involved stakeholders and to make decisions regarding the series of outcomes to be deployed.
1 Trends in the oil and gas value chain and the advent of three competencies

The extractives industry is being challenged to move beyond its traditional business scope and contribute positively to the sustainability of the world’s economy. Sustainable exploitation of natural resources is required to meet numerous Sustainable Development Goals (SDGs), such as ensuring the availability and sustainable management of water and sanitation for all (SDG 6), promoting decent work and economic growth (SDG 8), investing in infrastructure (SDG 9), taking climate action (SDG 13), and conserving life on land (SDG 15) (OECD, 2019). Therefore, the oil and gas industry is going through a worldwide discussion on the opportunities and challenges generated by the SDGs and how to combine them with their core business activities. For instance, in the report “Mapping the oil and gas industry to the SDGs: An Atlas” (UNDP, IFC, IPIECA, 2017), the main conclusion was the following: “The oil and gas industry has the potential to contribute to all 17 SDGs. With careful planning and implementation, the oil and gas industry has the opportunity to contribute across all SDGs, either by enhancing its positive contributions or by avoiding or mitigating negative impacts” (International Monetary Fund, 2017). The study goes through an array of possibilities listing all the activities that the oil and gas ecosystem could perform to help meet the SDGs.

Furthermore, the ongoing crisis in the industry is accelerating changes in the current business model. The COVID-19 pandemic has disrupted economic activity worldwide, fostering a sharp decline in end-use spending on energy and resulting in investment cuts in the energy sector. Also, the 2020 oil price shock, starting as a price war between Russia and Saudi Arabia, ended up in negative oil prices in the USA (a “perfect storm” combining weakened demand, unbridled production, and an exhausted storage capacity). Even though some recovery in prices is foreseen, they are still far from pre-pandemic levels.

As a contribution to this vital discussion, this study focuses on three exceptional competencies within the oil and gas industry as a powerful tool to foster sustainable development. The competencies—advanced data management, water management, and shared infrastructure—were identified through the analysis of the oil and gas value chain at the global level. These three unique capabilities have the potential to create cross-industry linkages and spillover effects. These three competences are described below, combining secondary data from documentary research and primary data compiled during interviews of sectoral experts, be they managers, geologists, or investment specialists in oil infrastructure.

1.1 Advanced Data Management

Until the recent past, large volumes of data remained unused and impossible to process, but now that storage and computing capacity have improved, new opportunities are opening for faster data processing and interpretation. Analytic teams have flourished, and AI solutions are trusted: analysts who are neither geologists nor geophysicists are doing the data gathering and problem solving.

Today, advanced data management in oil and gas consists in the collection and interpretation of geospatial data. It has several benefits (Figure 1.1). For instance, Petroleum Geo-Services (PGS) is a company that offers seismic services that help oil companies find oil and gas reserves offshore worldwide; its multi-client library is known for quality and coverage. Product offerings span from
survey planning and data acquisition, through advanced imaging, to reservoir analysis and interpretation. In one of PGS’ recent newsletters, the issue about machine interpretation is highlighted: “The true challenge for AI is to solve problems that humans solve intuitively; problems that are usually hard to describe in a formal way, where it is therefore hard to give instructions on how they should be tackled” PGS article (March, 2020).

This growing capacity for information production and interpretation could collate the geospatial data used for exploration with the socio-economic data of a defined region. The goal of such an effort would be to push the frontiers of knowledge, innovation, and technology to improve land use and economic planning. Geospatial analysis is a tool already used by governments to coordinate the spatial impact of various economic sectors (transport, agriculture, population density, etc.), in order to generate land-use planning based on multilayered spatial information. In many countries, however, data remains unexploited for policy making and economic development. A scientific knowledge of the endowments and assets of a region combined with human-related information could create value by prioritizing development opportunities and connecting local activities to global value chains.

**Advanced data management lays the foundation for spatial planning and allows sustainable use of land and resources.** The data acquired by oil companies can be used as the first layer of an integrated spatial management system. Such an approach looks for cross-discipline and cross-sector planning that seek to produce an amplified, lasting impact on people’s lives. These policies would be based on an open IT environment allowing for (a) the collection and processing of high-quality earth and socio-economic data and (b) the exchange of these two kinds of data between different interoperable applications. This “big data” approach would form the basis of a more sustainable objective-based growth, guaranteeing new business opportunities for the country. Data management capabilities developed by the petroleum sector can therefore help design “smart public policies” also referred to as “integrated development projects” (United Nations, 2020). The map in figure 1.2 shows an example of how the marine cadastre in the USA is made out of different layers of information and allows advanced data management.
The opportunity to build a new role for E&P data management capacities exists mostly at two levels:

1. Collaborating on the management of historic data (provided by the operators and other geospatial sources); and
2. Actively participating in the creation of a dynamic repository integrating new sources of data as it is produced.

As a conclusion, Chad can benefit from knowledge extrapolated from its oil and gas activities to shape its land management planning. To get the most out this approach, an advanced dialogue between institutional actors, operators and exploration companies is essential.

1.2 Water Management

Produced water is by far the largest volume by-product stream associated with oil and gas exploration and production (Oil & Gas Equity, 2017). Water is produced in large quantities and plays an important role in the profitability of oil and gas production wells. Because the water has been in contact with the hydrocarbon-bearing formation for centuries, it has some of the chemical characteristics of the formation and the hydrocarbon itself (figure 1.3). It may also include water from the reservoir, water injected into the formation, and any chemicals added during the drilling, production, and treatment processes. Produced water can also be called “brine”, “saltwater”, or “formation water” (Colorado School of Mines / Advanced Water Technology Center, 2020).
The total volume of produced water is significant, and for every barrel of oil, at least three barrels of produced water are produced. In 2014, around 200 million barrels of water were produced every day across the world by on-shore fields, compared to around 90 million barrels per day for off-shore production (figure 1.4). In contrast, global oil production was around 88 million barrels per day, giving an average water-to-oil ratio of 3.0 (Science Direct, 2020). Approximately 21 billion barrels of produced water are generated each year in the United States from about 900,000 wells. This is equivalent to a volume of 2.4 billion gallons per day (Colorado School of Mines / Advanced Water Technology Center, 2020), which is the estimated daily freshwater used by 8 million people in the USA (United States Environmental Protection Agency, 2020).

The management of produced water plays a significant role in the profitability of oil and gas production wells. The cost of managing produced water is a significant factor in the profitability of oil and gas production (Oil & Gas Portal, 2020). The total cost (ranging from less than 1 cent/barrel to more than $5/barrel) includes:

- The cost of constructing treatment and disposal facilities, including equipment acquisitions;
- The cost of operating those facilities, including chemical additives and utilities;
- The cost of managing any residuals or by products resulting from the treatment of produced water;
• Permitting, monitoring, and reporting costs; and
• Transportation costs.

Once the cost of managing produced water exceeds the value of the hydrocarbon produced from the well, the well is usually shut down (Colorado School of Mines / Advanced Water Technology Center, 2020).

**Stricter regulations, technological advancements and pressures on costs have triggered the emergence of new companies with a different business model.** This new business model typically involves gathering produced water from the oil field, storage, treatment, and transport to final use. Companies involved in water management are now the fastest growing segment of the oil and gas industry (World Oil Magazine, 2019). The water management market size is projected to grow from $11.7 billion in 2019 to $21.4 billion by 2024, at a Compound Annual Growth Rate (CAGR) of 12.9% during the forecast period (BusinessWire, 2020).

**Existing technologies and treatment processes allow turning almost any produced water into fresh water.** They depend on the chemical composition, volume, and flow of the produced water. This powerful capacity capitalizes on the knowledge developed by oil and gas technical staff over the years: most of the new companies have been created by former oil and gas technicians, while the first clients are usually the former operators for which these technicians used to work. Services are provided on a case-by-case basis determined by the unique local geological characteristics of the area of extraction.

**Regulation plays a fundamental role in the development of water management in a country.** It determines the potential usages of produced water, and therefore, the need for further treatment and disposal. It creates incentives for the development of new companies and services. Associated costs are high but are being contained as demand increases due to environmental concerns in developed economies, giving way to the consolidation of the sector.

**The know-how of these companies specialized in water management can therefore be transferred and applied to tackle the perennial problem of water scarcity and management in most sub-Saharan countries.** To achieve this goal, four conditions must be met:

1. Ad-hoc regulation determining the uses of produced water, and the application (or not) of additional treatments;
2. Capitalizing on the knowledge developed by the most technology-intensive areas of the industry, tapping first and foremost into its advanced engineering and problem-solving capacity;
3. A selection and sizing of the technologies to be developed determined by the local natural characteristics (geology, hydrology, topography); and
4. Reasonable operating costs.

**Chad has the opportunity to develop, from its experience in oil extraction, produced water management capacities that allow it to use this resource productively (for example in agriculture) and in the future, provide water management services in the region.** The know-how necessary for the correct provision of water management can positively converge with the urban wastewater treatment system, and even, at the infrastructure level, synergies between both can be explored.
1.3 Shared Infrastructure

Infrastructure sharing is defined by the process of identifying ways to capitalize on the infrastructure and facilities needed and financed by the extractive sector. Pipelines offer multiple advantages over other modes of transportation: they are energy efficient and reliable, and they are environmentally friendly when it comes to moving fluids over long distances. Since the 1990s, pipelines have been combined with optic-fiber cables because there are practically no safety or technology impediments to their association. Both “pipes”—whether they carry energy or information—are buried in the same trench, making the construction works needed for these infrastructures relatively simple from a technological point of view, cost-contained, and quickly completed (Figure 3.5). The embedding of pipelines with optical networks popularized the idea of cross-infrastructure sharing. Also, over the past five years, pipelines have seen their security levels increase thanks to the increasing integration of AI and IoT in their design (AI embedded SCADA3).

In developing countries, infrastructure sharing can be used for the broader benefit of the national and regional community. According to the Africa Infrastructure Country Diagnostic conducted by the World Bank, sub-Saharan Africa faces an annual infrastructure funding gap of US$31 billion; shared-infrastructure can be a part of the answer to this challenge. Therefore, leveraging oil-sector-related investments through shared use can help narrow the gap in public infrastructure funding.

In a business-as-usual context, every extractive development project sees the prospective operator and the national government in silos. On the one hand, oil and gas companies assume expensive infrastructure development expenses; on the other hand, the national government has to find solutions to fill in the infrastructure gap from which the country suffers, a task that is all the more complex as financial resources are scarce.

Infrastructure shared use allows bridging these two types of actors and their respective goals and constraints. It can deliver the following powerful results:

- Economies of scale, because every incremental unit of distance covered has a decreasing marginal cost; and
- Economies of scope, because one single development project brings two or more categories of services closer to the end customers.

It is possible to take advantage of existing pipelines using the shared infrastructure model. This means using the installed pipelines, at marginal cost, to bring utilities (electricity, fiber optics, and water) to the benefit of mostly rural communities scattered across the country. The less strategic and risky an infrastructure is, the easier it will be for the operators to share it. For that reason, telecommunications networks are the most amenable to sharing, followed by water and power.

The public-private-partnership model is at the core of shared infrastructure practices, but it needs to be complemented by a set of specific actions. Figure 1.5 describes the main phases of shared infrastructure.

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3 Supervisory Control and Data Acquisition
It is worth noting that very few business cases exhaustively address every phase of the process for infrastructure sharing in the oil and gas industry. However, partial good practices have been documented. One is the case of the Basrah Gas Company, one of the largest flare reduction projects in the world. Started in 2013, it is a living example of what PPPs can bring to countries needing to leverage their oil and gas value-chain, foster economic development, and further their population’s well-being:

- It is a joint venture established between the Iraqi Government, Shell and Mitsubishi;
- It was designed to enhance Iraq’s investment in its natural gas resources;
- It has turned Iraq form a net importer to a net exporter of LPG;\(^4\) and
- In 2018, it produced enough gas to generate 3.5 GW of electricity—enough to power three million homes.

Within the specific context of Chad, shared use could be an interesting approach only if significant economies of scale or scope are identified. The extra capacity should not be too costly, and there

\(^4\) Liquified Petroleum Gas

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\*Figure A.1. The phases of shared-used implementation\*
should be a substantial market for that marginal low-cost capacity. Shared use also relies on proactive government policies at certain critical stages in the management of oil projects. To make infrastructure shared use a viable option, the government must ensure a solid geospatial analysis along with the deployment of a conducive set of good practices (Table 1.1).

Table 1.1 Good practices for the shared use of infrastructure in oil and gas

<table>
<thead>
<tr>
<th>#</th>
<th>Good practice</th>
<th>Done in Chad?</th>
<th>Barriers to change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The government can incentivize shared use of extractive industry-related infrastructure by requiring a separation of ownership between the operator and the infrastructure.</td>
<td>✔</td>
<td>The Kome-Kribi pipeline was owned by the consortium (Exxon, Chevron, and Petronas), with the governments of Chad and Cameroon having a stake of 3%. The Djarmaya refinery and pipeline are 60% owned by CNPC and 40% by the Government of Chad.</td>
</tr>
<tr>
<td>2</td>
<td>In the case of user-concessions (by which the user also owns the infrastructure) a strong regulatory system is needed to guarantee shared use and ensure that the infrastructure is designed with additional capacity to accommodate shared use.</td>
<td>✘</td>
<td>In times of cheap oil, bargaining power favors oil and gas operators.</td>
</tr>
<tr>
<td>3</td>
<td>All user-concessions should be granted on a Build–Operate–Transfer (BOT) basis so that, after a contractual period of 15 to 30 years, the infrastructure is transferred to the host government.</td>
<td>✔</td>
<td>BOT period is 35 years in Chad.</td>
</tr>
<tr>
<td>4</td>
<td>All mining/energy companies should be encouraged to include shared use considerations in their infrastructure planning.</td>
<td>✘</td>
<td>Clearly define shared use. Operators’ BATNA is painless.</td>
</tr>
<tr>
<td>5</td>
<td>To help this planning effort, a ten-year aspirational shared-infrastructure framework can be a useful tool that would indicate the infrastructure necessary for national development.</td>
<td>✘</td>
<td>Institutional coordination is crucial.</td>
</tr>
</tbody>
</table>

A structured and inclusive public-private dialogue is needed.

Source: own elaboration

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5 Best alternative to a negotiated agreement
2 Chad’s opportunities: Harnessing the unique capabilities of the oil and gas industry to open new paths for diversification

This chapter proposes a range of actions aimed at creating a basis for the identification of spatial development initiatives and a source for an informed decision-making process. It is a practical approach to capitalize on Chad’s unique oil and gas competencies and support a sustainable development strategy. A selection of pilot projects and strategic options can be deployed in specific regions to test their potential for impact. They are described below.

2.1 Geospatial Analysis Pilot Project

The pilot is intended to demonstrate that the advanced data management capacities of the oil and gas industry are a source of geospatial knowledge which is key for policy making. The goal is to contribute to the creation of a national data management facility, starting from areas where data has already been collected by oil companies, and enriching such data to account for other sectors and factors required to support land use strategies. The geospatial information provided by the oil and gas operators today in Chad is neither stored electronically nor capitalized for spatial planning, thus this pilot would be established in two selected oil- and gas- producing provinces (in the North and the South) and would trigger potential spatial development initiatives leveraging water management and cross-sector infrastructure-sharing and logistics-sharing. It would also allow to guide better decision-making for Government authorities in matter of land use and integrated development options.

To this end, the recommended first step to set up a land use strategy, the government could request to the oil and gas companies to transfer the existing electronic geological records that are available to a single data repository. This information has mainly been produced in Southern and the Northern regions of the country, hence it is convenient to start the pilot in those areas. Then in a second step, once this historic E&P data is stored, other layers of information could be added (Figure 4.1). Those different layers of information need to be managed and analyzed to become a policy making tool.

Two main activities would be prioritized:

- Collaboration with oil and gas companies established in the North and South to improve the management of historic exploration and production data (provided by the operators and other geospatial sources); and

- Creation of a cross-sector live data repository integrating new data as it is produced. Such data can encompass but are not limited to water-related data, population, food and agriculture-related data, energy and extractive-related data and climate-related data.

A good example for land uses and management can be found in the Strategic Spatial Planning project that was achieved by Dobbin International in the province of Cabo Delgado in Mozambique to achieve sustainable development. (Dobbin International, 7 December 2015). Figure 2.1 shows an example of the land use maps produced by this project. The project resulted in the creation of new capacities in strategic planning process, an iterative process by which investors, decision-makers and stakeholders can review thematic scenarios to tweak the strategy and action plan if conditions change.
Thus, the tool allows for improved land use and management by the authorities in the Province. The objectives of the project were contained in four points:

- Identify new, innovative sustainable development patterns in the selected region.
- Implement geospatial analysis based on natural resource endowments and other economic assets.
- Build a multi-sector and systematic strategy and investment action plan to attract investors and partners to create broad-based socio-economic growth.
- Create synergies amongst main investors, decision-makers and stakeholders (Government, IFIs, NGOs and the private sector) for spatially targeted investments.

Figure A.1. Land-use analysis map in Cabo Delgado

The suggested geospatial pilot is a necessary first step to leverage the other two core competencies of the industry. It is only after a detailed geospatial analysis that solid spatial development initiatives (SDI) can be foreseen. Thus, in the following pages, two potential SDI related to water management or shared infrastructure are described as an outcome of the previous geospatial analysis pilot.

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6 An SDI seeks to increase the viability of inherent economic potential through the coordinated and synergic configuration of unrealized economic projects and the infrastructure projects necessary to realize them within a specific geographical area. The developmental potential of such large projects is further enhanced through the “deepening” (project linkages) and densification (provision of feeder infrastructure) of the SDI. Before an SDI is implemented in a selected area, a thorough and comprehensive concept study has to be undertaken in order to identify and assess at prefeasibility level the economic potential (usually high-rent resources) and whether they can support (service) the provision of the requisite infrastructure. (PAD Spatial Development Planning Technical Assistance Project, Mozambique, WB, 2010)
2.2 Potential outcome 1: Promotion of a spatial development initiative leveraging water management

The goal of this SDI is to encourage and promote the beneficial use of produced water for irrigation through the identification of investment opportunities in that field. The stakeholders involved would be large operators, local companies and the academia.

As mentioned above, the spatial planning process results in the development of multiple and interdependent sectoral scenarios. These are not separate plans in stand-alone sectors, but rather representations of how a specific theme such as agriculture can be supported by all the additional activities (or investments) needed to achieve a positive result.

For example, in a spatial planning project funded by the World Bank in Guinea, hydrology and access to water was one of the ecological resources analyzed. The study provided important information on characteristics of the subsoil that can control the movement or storage of groundwater. The bauxite plateau is potentially at high risk of pollution seeping into aquifers, so modeling lineaments and hydrology helped to understand water availability while revealing the potential implications of upstream pollution. In this project, the agriculture scenario not only focused on agricultural crops or the development of agricultural infrastructure, but also considered certain aspects examined in other themes that contribute to agricultural success, including investments such as restoration of elevation watersheds to preserve water sources, or rehabilitation of roads useful for transporting agricultural products.

The case of the Nimr field in Oman is another illustrative example of project for the use of produced water to replace freshwater. Since 2011, approximately a third of the produced water generated at the Nimr field – some 100,000 cubic meters per day – have been sent for treatment to a purposely built reed bed (wetlands) facility, operated on behalf of Petroleum Development Oman (PDO) and Shell by the environmental services company Bauer Nimr. The water treated by the reed beds is used for drilling new wells, which saves pumping clean water from shallow aquifers. Since the start-up of the Nimr reed beds facility, PDO has been able to shut down five of the twelve high pressure pumps that are used to dispose produced water from the field into deep-lying aquifers. PDO estimates that the energy saved as a result could add up to the equivalent of around 23 billion cubic feet of gas over a 10-year period.

Finally, the example of the pilot project in Meta Region Colombia illustrates the use of produced water for farming. US company Fluence provided the Meta Region with a high-recovery produced water treatment and desalination system, with the goal of reuse for irrigation. The multistage, fully automated plant was designed to accommodate approximately 4,000 m³/h (or 500,000 barrels per day) of treated produced water. This technology allows to irrigate a plantation of more than 1000 Ha of African palm tree for palm oil production.  

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7 This example is worthy of note as it demonstrates the maturity of the technologies used. However, the choice of tree essence - palm trees – is not to be considered as a best practice. In the case of Chad, a better informed choice of crop should be defined by the geospatial analysis.
2.3 Potential outcome 2: Promotion of a spatial development initiative leveraging infrastructure-sharing and logistics-sharing

The goal of this SDI is to develop shared infrastructure in identified areas through the set-up of an investment promotion plan. The stakeholders involved would be large operators, local companies and the academia. The SDI should showcase precise points where logistics and infrastructures can be shared on the province’s territory to the benefit of the rural population’s economic development. It should also specify how oil and gas operators and other investors could reach underserved communities.

The link of spatial planning and infrastructure in the oil and gas industry could be illustrated with the example of Sanborn. It is a US company expert in mapping and visualization services designed to support best practices for all aspects of oil & gas infrastructure management. Sanborn products and services enable improved land management, efficient asset management and alignment of information for oil & gas industry companies. This helps companies to cost-effectively manage key assets and infrastructure. Figure 2.2 shows an example of a planimetric map of oil and gas infrastructure.

Figure A.1 Example of mapping of shared infrastructure (Sanborn)

Source: The Sanborn Map Company, Inc.  
https://www.sanborn.com/mapping-for-oil-gas-industries/  
(accessed October 20, 2020)

In the short term, the pilot project presented here should be coordinated to test this integrated development approach and eventually encourage investment promotion activities. If the pilot has positive outcomes, other policies and projects targeting those core competencies of the oil and gas ecosystem could become a priority. The following activities could be undertaken in parallel and should be carried out under the supervision of a specific task-force involving key Chadian institutions.

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Figure A.1 Example of mapping of shared infrastructure (Sanborn)  
https://www.sanborn.com/
2.4 Other potential outcomes

Establishing regulatory frameworks conducive to water management

Chadian water regulation does not characterize produced water composition nor regulate further beneficial use of it. The two main steps of this pilot project are the identification and characterization of produced water; and the establishment of a regulatory framework for produced water for beneficial use.

Development of local water management specialists in Chad

It is necessary to champion the emergence of water professionals capitalizing on the experience consolidated within the oil and gas industry. If the previous pilot projects show positive economic and social impacts, there will be an opportunity for the development of different types of water services such as i) water management; ii) water treatment; and iii) water disposition. The main goal of this pilot project is to stimulate the emergence of water specialists in Chad, leveraging from oil and gas experience with a regional scope. The stakeholders involved could be the International technology providers, operators (large and small), local suppliers of engineering-related services and potential clients (agricultural sector, and other depending on the pilot’s results).

Design of an aspirational shared-infrastructure framework

First, the Chadian Government should lock key prerequisites at national level for successful cross-sector infrastructure-sharing. The goal is the identification of existing demand for new services in the country to facilitate the attraction of investors. The necessary actions to undertake are a national geospatial analysis to identify and map sizable underserved rural population clusters presenting potential for infrastructure and logistics shared-use, and the completion of the liberalization process of telecoms, electricity and water markets. These measures facilitate the emergence of solid industrial partners to negotiate with.

Second, the Chadian Government could extract and replicate lessons from successful cross-sector infrastructure-sharing initiatives. For instance, lessons from the Doba pipeline project could be extracted as a basis to improve institutional coordination. In the Doba pipeline, six pairs of optical fibers were laid along the sub-segment Mbéré-Komé which is part of the pipeline linking the Doba basin with Cameroon. Table 2.1 summarizes the main lessons that can be learned from the project.

<p>| Table 2.1 Shared use lessons from the Doba pipeline |
|---------------------------------|---------------------------------|
| <strong>Engineering aspects</strong>         | <strong>Legal aspects</strong>               |
| <strong>Negotiate early with operators:</strong> The OTRT (Chadian Office of Telecoms Regulation) signed a convention with Exxon in 2002. Works started in 2009. Exxon later retroceded to the Chadian State the 6 optical fibers deployed for 300 million FCFA. | <strong>Expand the regulator (OTRT that became ARCEP in 2015) responsibilities to the regulation of optical fibre network:</strong> Its main duties are 1) promoting the establishment of shared-infrastructure and 2) managing the licensing of optical fibres to infrastructure operators. |</p>
<table>
<thead>
<tr>
<th><strong>Appoint expert support to cover the technological aspects.</strong> To control the technological intricacies of the works the OTRT contracted French company AZTELCO in 2009.</th>
<th><strong>Appoint a company to take care of the infrastructure</strong> (separate from the service operators, such as Sotel). Company Sudatchad is now responsible for the technical, commercial and financial management of the fibre optic network.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Think regional integration.</strong> The Government invested in connecting the country to the landing points of major international networks of submarine optical cables (SAT3, WACS and NCSCS). These are located in Cameroon.</td>
<td><strong>Lift or loosen governmental restrictions</strong> to freely access the internet. To be profitable, communication infrastructures must allow new usages likely to support social and economic development (education, micro-banking, among others).</td>
</tr>
</tbody>
</table>

Source: own elaboration

**Reinforcing the STEM capacity in geospatial analysis, water management and shared infrastructure**

In the long term it is necessary to mobilize government, operators and national educative institutions and coordinate a joint effort towards capacity building in STEM. The goals of this pilot are to develop local specialization and engagement of local oil and gas companies with universities and to avoid brain drain to neighboring countries while attracting Chadian specialized diaspora.

**The work done in the East Mediterranean could be considered as a reference.** Under the leadership of the University of Haifa a consortium of seven universities and three governmental research institutes, was constituted in Israel. It was established to address an unprecedented array of scientific, technological, economic, security, and environmental challenges and opportunities resulting from the rapid development of the Eastern Mediterranean offshore. It is worth noting that Noble Energy and other oil and gas companies were actively engaged in this project.

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9 Science, technology, engineering, and mathematics
3 Conclusion

The identification of key capabilities of the oil and gas ecosystem is a powerful source to open new paths for diversification in Chad. Three unique competencies were identified in this report: advanced data management, water management, and shared infrastructure.

1. Chad can benefit from advanced data management capacities in the oil and gas industry to shape the land management planning for the country. There is an opportunity to collaborate in the management of historic data (provided by the operators and other geospatial sources) and by nurturing a dynamic data repository which integrates new sources of data as they are produced. In order to take the most out this information and to successfully free up geographic areas of potential sustainable growth, a solid spatial planning and high-level public private dialogue is necessary.

2. With respect to water management, the know-how of specialized companies could be transferred and applied to tackle the perennial problem of water scarcity and water management in the country. However, in order to achieve this goal, the following conditions must be considered: ad-hoc regulation determining the uses of produced water, and the application (or not) of additional treatments; capitalization on the knowledge developed by the most technology-intensive areas of the industry (tapping into its advanced engineering and problem-solving capacity); selection and sizing of the technologies to be developed determined by the local natural characteristics (geology, hydrology, topography); and reasonable operating costs.

3. Cross-sector infrastructure-sharing can become an effective instrument of development if there are significant economies of scale and if there is a substantial market for that marginal low-cost capacity. It also relies on proactive government policies at critical stages. To make infrastructure shared-used a viable option, the government must ensure the deployment of a conducive set of good practices (establishing a separation of ownership between the operator and the infrastructure); a strong regulatory system to guarantee shared-use and ensure that the infrastructure is designed with additional capacity to accommodate shared-use; all user-concessions should be granted on a Build–Operate–Transfer (BOT) basis so that after a contractual period of 15 to 30 years, the infrastructure is transferred to the host government, among others). Beyond pipelines, the shared-infrastructure model can be applied and opportunistically adapted to every type of facility and/or equipment deemed fit for sharing and effective in furthering the socio-economic development of the population. Finally, to help this planning effort, a ten-year aspirational shared-infrastructure framework can be a useful tool that would indicate the infrastructure necessary for national development.

For proper selection and implementation of projects related to the three aforementioned competencies it is essential to possess reliable geospatial data sets allowing enhanced land planning and land management. This is the reason why the main component deriving from the present study would take the form of a pilot project in geospatial analysis. The pilot should be established in two selected oil- and gas-producing provinces (one in the North and one the South) and should focus on facilitating two essential outcomes: the implementation of spatial development initiatives in water management and/or in shared infrastructure. The pilot would also serve to guide the Government of Chad in matter of land use and integrated development options.

As a concluding remark, it is important to observe that in order to successfully capitalize on the findings of this study, it is advisable to establish an inter-governmental task-force involving key
Chadian institutions. In the short term, the pilot project presented above should be coordinated to test this integrated development approach and eventually encourage investment promotion activities. If the pilot has positive outcomes, other policies and projects targeting those core competencies of the oil and gas ecosystem could become a priority. Further institutional efforts could be coordinated into a general framework allowing an integrated development for Chad. Potential members of the inter-governmental task-force could be: the Ministry of the Economy, Development Planning and International Cooperation; the Ministry of Petroleum and Mines; the Ministry of Energy; the Ministry of Finance and Budget; the Ministry of the Environment and Fishes; the Société des Hydrocarbures du Tchad (SHT); the Société Tchadienne de Eaux (STE); the National Agency for Investments and Exports; and the Ministry of Infrastructure and Transport.
Overview of the Chadian oil and gas ecosystem

A.1 The Industry in Chad

Production in decline but still a potential for development

In Chad, the production today was 132,000 barrels per day in 2019, and before the current crisis it was expected to rise to 200,000 per day by 2025. There is heavy oil in the south and light oil in the Lake Chad Basin, there are also some natural gas findings in the North (World Bank Group, 2019).

There are proven and unexplored deposits which constitute a promising potential for the country:
- Proven oil reserves of 1.5 billion barrels of oil, of which only 40% has been exploited, in 2018.
- Unexplored conventional resources of 40 billion barrels and 40 TCF of natural gas.
- Several petroleum discoveries have been made in recent years by CNPCIC, PetroChad, OPIC, and United Hydrocarbon.

Pipeline achievements

Completed in 2003, the Chad-Cameroon pipeline is an asset that contributed to the economic acceleration for both countries. It stimulated the growth of local companies working in civil & topographic works, basic logistics, land clearing, supply of equipment and food. Chad is a landlocked nation. Most of its oil exports are transported by a pipeline that goes from the village of Kome (Chad) to the port of Kribi (Cameroon). The Kome-Kribi pipeline construction began in October 2000, commissioned by a consortium made of three oil companies (Exxon, Chevron, and Petronas) and the World Bank. The pipeline was owned by the consortium, with the governments of Chad and Cameroon maintaining a combined stake of 3% in the project. The 1,090 km long pipeline was completed in 2003 and connected three oil fields in southern Chad with a floating production storage and offloading vessel located in the Atlantic off the coast Cameroon, 22 km from Kribi. Completed a year ahead of schedule, it created 13,000 jobs in Chad and led to over $400 million in infrastructure improvements. However, NGOs have denounced several oil spills as being harmful to local Cameroonian communities and have criticized government officials for not doing much to prevent them. In 2008, the World Bank ended its involvement in the pipeline after Chad finished repaying its loan. The World Bank specified that the Chadian government had failed to redirect revenue from the project to the earlier agreed upon goals: reducing poverty and developing infrastructure.

Another example is the Koudalwa-Djarmaya pipeline completed in 2011. It transports crude oil to the country’s first refinery, allowing it to supply the capital city in fuels and lubricants. This pipeline is the first major energy passage from South to North Chad. It is 311 km long with a diameter of 16 inches, a pressure of 10MPa.

China’s largest energy producer, China National Petroleum Corp (CNPC), began work to build a major oil pipeline in southwestern Chad in 2009. It completed work in just 20 months. The pipeline is operational since 2011. It transports crude oil from the village of Koudalwa – Bongor Basin (fields of Ronier & Mimosa) - to the Djarmaya refinery (40 km north of N’Djamena). It has a crude oil transport capacity of 1,000,000 T/year that can go up to 3,000,000 T/year. Its usual production capacity is 20,000 barrels per day. However, the relationship with the Chinese operator has not been smooth. Oil spills and environmental regulations violations by CNPC who was fined $1.2 billion. There are multiple price disputes between CNPC and the Chadian government leading to frequent closures of the refinery.
A.2 Chad’s oil and gas ecosystem

This section describes the market agents in the ecosystem, both the set of ‘core’ firms, and a number of other private firms that may be necessary to help move the industry into more attractive segments. These market-based actors are depicted in typified form in the Ecosystem Mapping below (World Bank Group, 2018). In a globalized economy, activities in each value chain are spread across national and international boundaries rather than being concentrated in a single location. This geographically scattered nature of value chains, means that the capacity to appropriate value from a specific industry is determined by which activities are performed rather than the type of industry per se. Activities are marked in yellow or blue in figure A.1 according to whether they are fully present or lacking in Chad.

Figure A.1 Chad’s key activities in the oil and gas value chain

Source: own elaboration

Chad’s oil and gas ecosystem has developed many key activities in the oil and gas Global value chain (see parts of the chain in yellow color). Chad possesses diverse players (figure A.2) in:

- Supporting activities, of which: Training & academia, Supporting Governmental institutions, Associations, Logistics services, Norms & certification, Regulation, HSE.
- Core activities, of which: the OFS, Exploration, Development and Production, Transport & stock, Distribution.
- End markets, of which: Electricity, Industrial, Transport and Petrochemical.
The main stakeholders that were identified in Chad’s oil and gas ecosystem are distributed by category as shown below.

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<thead>
<tr>
<th>Supporting activities</th>
<th>Training and Academia</th>
<th>Governmental institutions</th>
<th>Associations</th>
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Source: own elaboration
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<td>SRN - Société de Raffinage de N’Djaména</td>
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</tbody>
</table>

The value chain map was established on the basis of our interviews with advanced buyers and leading players internationally, plus interviews with firm and institutional actors in Chad. The international interviews permitted the team to construct an ‘ideal’ value chain for serving the new segments, while the Chadian interviews permitted the team to assess the current status of Chad’ capabilities in each activity in the value chain.
A.3 Conducting local stakeholders’ interviews

In the process of the study our team refined their hypotheses through multiple local stakeholders’ interviews.

Interviews with the government

Ministère du Pétrole, des Mines et de l’Energie

<table>
<thead>
<tr>
<th>Org. Name</th>
<th>Ministère du Pétrole, des Mines et de l’Energie</th>
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<tbody>
<tr>
<td>Activity</td>
<td>The Ministry of Petroleum and Energy is responsible for the design, coordination, implementation and monitoring of government policy in the primary and secondary energy sector.</td>
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Main contact

<table>
<thead>
<tr>
<th>Name</th>
<th>Mr Adoum MAHAMAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Email address</td>
<td><a href="mailto:adoumah@gmail.com">adoumah@gmail.com</a></td>
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<td>Function</td>
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<tr>
<td>Date of the ITW</td>
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Ministère de l’Economie et de la Planification du développement

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<td><a href="http://www.mepd-td.org/index.php/fr/">http://www.mepd-td.org/index.php/fr/</a></td>
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<tr>
<td>Activity</td>
<td>Responsible for the design, coordination, implementation and monitoring of the Government’s policy on planning, research and resource mobilization.</td>
</tr>
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Main contact

<table>
<thead>
<tr>
<th>Name</th>
<th>Mr Abdoulaye SENOUSSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Email address</td>
<td><a href="mailto:abdoulaye.senoussi@mepd.gouv.td">abdoulaye.senoussi@mepd.gouv.td</a></td>
</tr>
</tbody>
</table>
**Interviews with private companies**

### SOTRADA

**Org. Name**: SOTRADA  
**Activity**: La Société Tchadienne de Traitement des Déchets et d’Assainissement as its name indicates deals with the treatment of wastes and the sanitation of water.

**Main contact**

**Name**: Mr Brahim ZEBE KEBGABE  
**Email address**: zebe.technologie84@gmail.com  
**Function**: Director Marketing & communications  
**Date of the ITW**: 25 JUN. 2020

### Schlumberger

**Org. Name**: Schlumberger Tchad (OFS)  
**Webpage**: https://www.slb.com/  
**Activity**: They provide a range of industry products and services, from exploration through production, and integrated pore-to-pipeline solutions that optimize hydrocarbon recovery to deliver reservoir performance sustainably.
### Main contact

<table>
<thead>
<tr>
<th>Name</th>
<th>Mr David TOGUY</th>
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<tr>
<td>Email address</td>
<td><a href="mailto:DToguy@slb.com">DToguy@slb.com</a> / <a href="https://www.linkedin.com/in/david-toguy-09381a15/?originalSubdomain=fr">https://www.linkedin.com/in/david-toguy-09381a15/?originalSubdomain=fr</a></td>
</tr>
<tr>
<td>Function</td>
<td>Group Managing Director - Chad &amp; NEA</td>
</tr>
<tr>
<td>Date of the ITW</td>
<td>30 JUN. 2020</td>
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### Org. Name

<table>
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<th>COMECA</th>
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<td>Webpage</td>
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<tr>
<td>Activity</td>
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### Main contact

<table>
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<tr>
<th>Name</th>
<th>Mr Christophe TIGALBAYE</th>
</tr>
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<tbody>
<tr>
<td>Email address</td>
<td><a href="mailto:comecasarl@yahoo.fr">comecasarl@yahoo.fr</a></td>
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<tr>
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<td>Founder &amp; Director</td>
</tr>
<tr>
<td>Date of the ITW</td>
<td>15 JUL. 2020</td>
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In this section of the document, we apply a ‘strategic segmentation’ for the industry. The segmentation is ‘strategic’ in that it focuses on markets (demand side) and on the solutions – products and their complimentary services – provided to those markets (supply side). This method contrasts with a conventional approach to segmentation which divides an industry by product category. In doing so we aim to identify the attractiveness of various segments, and their broad requirements for entry, survival and growth.

The attractiveness of each segment is determined by global conditions (such as the evolution of substitutes, rivals, suppliers, buyers, and minimum efficient size of production). It is necessary to take a global view in doing the strategic segmentation as it allows to understand the rules of the game for every new player in each segment, in the world in general and in Chad in particular.

It is worth noting that in this study, the analysis of the three core competencies within the oil and gas value chain is meant to point out which activities and specialized knowledge could be leveraged by the Government of Chad. Therefore for this particular case, the value chain gap analysis is not used to stimulate the creation of new private entrants locally, but the comparison of the global value chain with the local value chain is a tool to highlight those areas where supporting institutions, and government in particular, could become a more active counterpart and use this knowledge as a basis for policy making.

### B.1 Identification of existing business segments in exploration

We can identify a new business segment in exploration activities which integrates sustainable development variables to the benefit of the public sector (governmental institutions). This is the segment A3 which corresponds to the business of Advanced Data Management. In Segment A3 the public sector collects timely and reliable data. It will then manage this data in order to provide a foundation for accountable scientific knowledge prone to support informed decisions and evidence-based policy (Advanced Data Management for integrated development).

![Figure B.1. Strategic Segmentation of the exploration activities](source: own elaboration)
Segment A3 – Advanced Data Management - implies and allows:

- Understanding and mastering the interactions between earth systems (geosphere, atmosphere, hydrosphere, biosphere) and socio-economic systems (demography, economy, land-use).
- Building “smart policies” based on dynamic and precise information.

Managing a continuous and open exchange of high-quality data sourced from the private sector (segment B3) aiming at integrated development for the country.

In the following figures, we compare the ideal diamond and the ideal value chain with the local value chain in Chad. The goal is to extract the areas in which the ecosystem in Chad could be improved and leverage the data management knowledge of the oil and gas industry.

**Figure B.2 Ideal Diamond for Advanced data management**

- Enhanced inter-ministerial cooperation (limited bureaucracy and transparent policy).
- Strong IP framework.
- Creation of a National Geological Survey.

- Political stability.
- Locally available STEM talent.
- Complete data repository of untapped resources: extractive resources (minerals, oil & gas deposits) combined with other resources (water, agriculture, etc.).

**Legend**

- **Advanced Data Management characteristic**
- **Common characteristic**

- New entrants in the oil & gas ecosystem.
- Open innovation mindset and quick technological adoption.

- End-customers universal, sustainable and affordable access to services.
- Access to a data repository is demanded by companies and civil society.

**Figure B.3 Ideal value chain for Advanced Data Management in exploration as a basis for integrated development**

**Preventive Support Institutions: R&D, Training, Regulatory Bodies**

- Establishment of an integrated development framework.
- 1st Phase Data collection and analysis.
- 2nd Phase Data collection and analysis.
- Definition and sanction of the project.
- Building of facilities and development drilling.

**Oil & Gas Services, Technical & Financial Assistance, Equipment Transport and Logistics**

- Source: own elaboration
B.2 Identification of existing business segments in oil and gas extraction

When it comes to extraction activities, the most attractive segments are segments B2 and B3. They correspond to the business of Water Management with B3 being the most sophisticated and better option as it involves complete treatment and re-use of the water that was produced through the oil production process.

Figure B.5 Strategic Segmentation in oil and gas extraction globally

<table>
<thead>
<tr>
<th>Segment</th>
<th>Oil (produced water)</th>
<th>Oil + fresh water</th>
<th>Water (fresh)</th>
<th>Deep water extraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drilling (x,y,z point)</td>
<td>A1 Traditional</td>
<td>X</td>
<td>C1 Deep</td>
<td></td>
</tr>
<tr>
<td>Vertical well</td>
<td></td>
<td></td>
<td>groundwater</td>
<td></td>
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<tr>
<td>Vertical+ horizontal</td>
<td></td>
<td></td>
<td>extraction</td>
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<tr>
<td>Multilateral well</td>
<td></td>
<td></td>
<td>segment</td>
<td></td>
</tr>
<tr>
<td>Completion and waste disposal</td>
<td>A2 Water management</td>
<td></td>
<td>C3</td>
<td></td>
</tr>
<tr>
<td>Completion and water treatment</td>
<td>A3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: own elaboration
Segment B3 – Water Management - implies and allows:

- Enhancing the profitability of the oil extraction phase.
- Turning waste-waters into a valuable source of clean water for the further development of agriculture in water-deprived countries.
- Reaffirming the social license of oil and gas players by lowering the ecological footprint of the extractive sector.

In the following figures, we compare the ideal diamond and the ideal value chain with the local value chain in Chad. The goal is to extract the areas in which the ecosystem in Chad could be improved and leverage the water management knowledge of the oil and gas industry.

**Figure B.6 Ideal Diamond for Water Management**

- Enhanced inter-ministerial cooperation (limited bureaucracy and transparent policy).
- Strong IP framework.
- Strategic planning regarding treatment and use of produced water.
- Political stability.
- Locally available STEM talent.
- Clear rule of law regarding final disposal and beneficial use of produced water.

**Legend**

<table>
<thead>
<tr>
<th>Common characteristic</th>
<th>Water Management characteristic</th>
</tr>
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<tbody>
<tr>
<td>End-customers universal, sustainable and affordable access to services.</td>
<td>New entrants in the O&amp;G ecosystem.</td>
</tr>
<tr>
<td>Further awareness of SDGs</td>
<td>A network of specialized water management companies operating in the country.</td>
</tr>
<tr>
<td>Goal 7: Ensure access to water and sanitation for all.</td>
<td>More local companies open to develop consortiums and joint ventures with international firms.</td>
</tr>
<tr>
<td>A strong agriculture sector demanding treated produced water for irrigation.</td>
<td>Specialized high-tech companies.</td>
</tr>
<tr>
<td>Selected regions demanding highly treated produced water for human consumption.</td>
<td>Start-up support ecosystem in place.</td>
</tr>
<tr>
<td>R&amp;D capacity aligned with private sector needs</td>
<td>Access to capital (venture, financial institutions, accelerators).</td>
</tr>
<tr>
<td>Access to capital (venture, financial institutions, accelerators).</td>
<td>Active academia open for collaboration and entrepreneurship related to water management.</td>
</tr>
</tbody>
</table>

Source: own elaboration

**Figure B.7 Ideal value chain of produced water management**

Support institutions: R&D, Training, Regulatory Bodies, and Associations

Source: own elaboration
B.3 Identification of existing business segments for transportation infrastructure & logistics

Looking at the transportation and logistics sector, we identified a comparatively more attractive segment (C2). In this segment the business consists in sharing infrastructure and logistics capacities in order to turn private investments dedicated at productive equipment into public-private efforts establishing synergies between both sides.

On the one hand private companies acting in the extractive industry will be given to operate and strengthen their bonds with the country’s authorities and population. On the other hand, the host country will be given to develop new cost-effective and practical solutions replying to unmet needs among the population.
Segment C2 – Shared-use infrastructure - implies and allows:

- Leveraging the infrastructure and equipment that the oil and gas operators erected for their operations with a view to extend existing or new services to unserved populations, mostly in matter of water, power and telecommunications.
- Tapping into potential economies of scale and/scope through bundling infrastructure (laying optical fiber in the same trench as a pipeline for instance) and through mutualizing services (sharing the loading of a fleet of trucks or instance).

In the following figures, we compare the ideal diamond and the ideal value chain with the local value chain in Chad. The goal is to extract the areas in which the ecosystem in Chad could be improved and leverage the know-how of sharing infrastructure the oil and gas industry.

Figure B.10 Ideal Diamond for Shared infrastructure

Figure B.11 Ideal value chain of shared infrastructure in oil and gas

Source: own elaboration
B.4 How should the ecosystem change to serve the new segment?

In this section, we compare the oil and gas industry ecosystem in Chad to the ideal ecosystem using the Porter Diamond\textsuperscript{10}. This tool allows to focus on potential areas to better leverage the core competencies of the oil and gas industry in Chad. The following pages summarize of the main findings.

\textbf{Figure B.13 Ideal Diamond for Chad}

\textsuperscript{10} The Porter Diamond is used to highlight four main attributes that define a competitive ecosystem: demand conditions, factor conditions, related and supporting industries, and strategy, structure, and rivalry. Such facets are often used in the theoretical literature as a framework to describe a nation’s competitive advantage in the international market.
Factor conditions conducive to the development of Advanced Data Management, Water Management and Shared Infrastructure

- The government in Chad is stable, despite the Boko-Haram disturbances around the lake.
- The education system in Chad is weak, 62% of women and 36% of men between the ages of 15 and 49 have no formal education. Only 15% and 37% of them have secondary or higher education, respectively. Most Chadians who seek higher education have to study abroad (Cameroon, Senegal, Morocco, France, Canada, etc.), but they usually do not return to their country.
- Chad has a proven petroleum system, with large basinal areas for further exploration, however, it is necessary to create a complete data repository of untapped resources: extractive resources (minerals, oil and gas deposits) combined with other resources (water, agriculture, etc.)
- A reliable transport infrastructure is needed in Chad as it is currently poor, and the cost is high.

Rivalry conditions conducive to the development of Advanced Data Management, Water Management and Shared Infrastructure

- Semi-specialized SMEs (Geyser, Senev, Sotrada, Comeca, Aboussimbil) need to quickly adopt technology and be open to developing consortiums and joint ventures with international companies.
- Very few companies have the capacity to move into water treatment services in the future.

Demand conditions conducive to the development of Advanced Data Management, Water Management and Shared Infrastructure

- In Chad, there is low access to services. For example, only 12% of the population has access to electricity and only 2% has access to the internet.
- Chad’s landlocked location and lack of infrastructure contribute to high prices for utilities.
- The vision for the future is to ensure access to water and sanitation for all and ensure access to affordable, reliable, sustainable and modern energy. Chad is just starting being equipped in renewable energy facilities, for example:
  - The “Desert to Power” project is financed with a €18m AfDB loan to build a 32MW solar PV plant & storage facility.
  - Water company (STE) will run a solar power plant in the city of Abéché.

Support conditions conducive to the development of Advanced Data Management, Water Management and Shared Infrastructure

- In Chad there are organizations and associations that support businesses. For example: La Maison de la Petite Entreprise.
- There are supporting institutions for water management: UPM (Université Polytechnique de Mongo) and INSTA (Institut National des Sciences et Techniques d’Abéché).
- Access to capital (venture, financial institutions, accelerators) needs to be strengthened.
- It is necessary to encourage companies to share infrastructure, currently there are few companies that share infrastructure (Exxon + Sudatchad). There are new players in solar energy, (Aboussimbil, Private Infrastructure Development Group, Smart Energies International).

Government conditions conducive to the development of Advanced Data Management, Water Management and Shared Infrastructure

- Need of greater inter-ministerial cooperation (limited bureaucracy and transparent politics).
- In Chad, there are no data repositories of geographic and geologic data to enhance the long-term decision-making process.
- According to the World Economic Forum indicator on quality of infrastructure and IMF data on the quality of investments, Chad has some of the lowest scores in the world for investment and infrastructure quality (energy, electricity, transport and telecommunications).
- There is a lack of planning regarding the future role of produced water as a source to combat water scarcity. Need for a national territorial development scheme.
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International Monetary Fund. (2017). Mapping the oil and gas industry to the SDGs.


UNDP, IFC, IPIECA. (2017). Mapping the oil and gas industry to the SDGs: An Atlas.


