

***Effect of Digital Transformation on Demand and Supply in
Gas Market in Egypt***

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1- Abstract:

New digital technologies combined with data-driven insights can transform operations, boosting agility and strategic decision-making. The Oil and Gas industry has spent trillions of dollars in recent decades building large infrastructures – including offshore projects, land development fields, and complex networks of pipelines and refineries – all with a view to meeting the world's energy demand.

The objective of this thesis is to explore the digital initiatives within large O&G companies to develop insight into which strategic platforms and methodologies are providing realized value, adopting new digital platforms and workflows for digital infrastructure and approach to understanding the breadth of digital influence in O&G. The research is considered a quantitative one the researcher draws data from the primary sources of data provided by **(EGAS)** which is published in its annual reports and the required disclosures, the Secondary data is crucial and of vital importance for any researcher

because it allows the researcher to know what has been done in the area of interest and the procedures that are used to come out with those findings.

The thesis gives a message that the data should be standardized, examined and linked on a centralized, flexible and scalable digital platform, meeting current needs and future growth of Bien Dong POC initiative. It involves considerable costs as this necessitates investment in IT as well as engineering initiatives. The production and operation outputs can be measured with different well openings through well test activities and at the outputs of the oil and gas processing systems. Being able to accurately calculate the production output at different well openings and across the entire production network is extremely important for oil and gas field management and operations to maximize economic potential of the reservoir.

Keywords: Digital Transformation- Natural Gas industry- strategic decision-making- data management

الملخص:

ساعد التحول الرقمي الى خلق مرونة نحو تحول العمليات واتخاذ القرارات الاستراتيجية. أنفق قطاع النفط والغاز مليارات الدولارات في العقود الأخيرة على بناء البنية التحتية بما في ذلك المشاريع البحرية وحقول البرية والشبكات المعقدة من خطوط الأنابيب والمصافي - كل ذلك بهدف تلبية الطلب العالمي على الطاقة. الهدف من هذه الرسالة هو اكتشاف المبادرات الرقمية داخل شركات النفط والغاز الكبيرة بهدف تكوين صورة متكاملة حول الأنظمة الأساسية والمنهجيات الاستراتيجية التي توفر قيمة محققة، من خلال اعتماد منصات رقمية جديدة وتقييم اداء سير عمل للبنية التحتية

الرقمية ونهج لفهم اتساع التأثير الرقمي في قطاع النفط والغاز. يعتبر البحث كميًا حيث يستخلص الباحث البيانات من المصادر الأولية للبيانات المقدمة من الشركة المصرية القابضة للغازات الطبيعية (إيجاس) والمنشورة في تقاريره السنوية والإفصاحات المطلوبة، وتعتبر البيانات الثانوية حاسمة وذات أهمية حيوية للباحث لأنها تتيح معرفة ما تم القيام به في مجال الاهتمام والإجراءات المتبعة للخروج بتلك النتائج.

خلصت الرسالة الى أهمية توحيد البيانات وفحصها وربطها على منصة رقمية مركزية ومرنة وقابلة للتطوير والتحديث، وتلبية الاحتياجات الحالية والنمو المستقبلي لمبادرة Bien Dong POC والتي تتطلب توفير تكاليف ضخمة حيث ان المبادرة تتطلب الإستثمار فى مجال تكنولوجيا المعلومات وكذلك المبادرات الهندسية وهى ما تشكل الجزء الأكبر من التكلفة. يمكن قياس مخرجات الإنتاج والتشغيل عند رأس الآبار من خلال أنشطة اختبار الآبار وفي مخرجات أنظمة معالجة النفط والغاز. تعد القدرة على حساب ناتج الإنتاج بدقة عند رأس الآبار وعبر شبكة الإنتاج بأكملها أمرًا بالغ الأهمية لإدارة وعمليات حقول النفط والغاز لزيادة الإمكانيات الاقتصادية للخران.

الكلمات المفتاحية: التحول الرقمي - صناعة الغاز الطبيعي - اتخاذ القرارات

الاستراتيجية - إدارة البيانات

2- An overview:

When Egypt became an importer of gas in 2015 it was a shock to the global gas market, as although the political and economic problems in the country were clear, it was nevertheless a surprise when surging gas demand overtook stagnant indigenous production.

As with so many countries in the MENA region, the key problem has been low subsidized gas prices that have encouraged rapid demand growth, and in this paper takes a close look at gas demand and splay across the Egyptian economy and concludes

that it will continue to grow, despite the best efforts of the government to reform the domestic gas market (Elshazly,2018).

It would seem that the best they can hope for is slow demand growth, but this may be enough to return the Egyptian gas market to balance thanks to new policies to encourage upstream development.

The researcher describes in detail the steps put into place that have led, to the discovery of the giant Zohr field and to a number of other important new finds which will transform Egypt's gas supply and demand balance over the next few years.

However, although this change should allow Egypt to end gas imports in the next year or so, and could even see exports recommence, the real significance of this paper for the global gas market is the question of how long this new situation can last (Mohamed,2022).

a number of domestic reform issues which need to be addressed if the balance of the Egyptian gas market is to be maintained, and he points out that there is a significant risk that the country could easily slip back to becoming an importer again if the government does not address a complex set of issues in the reform process, not the least of which will be the unwinding of subsidies.

Egypt has the resources to be at least self-sufficient in gas if it can address demand side issues in its economy and has the infrastructure available to become an LNG hub for the East Mediterranean region if it can optimize its sources of supply (Hafezi,2020).

Its success or failure in these endeavors can have an important bearing on the balance of the European and global gas markets, and this paper makes a key contribution to the understanding of this vital topic (Indupurnahayu,2021).

Egypt is considering the third-largest natural gas producer in Africa, following Algeria and Nigeria. Egypt operates the Suez Canal and the Suez-Mediterranean (SUMED) Pipeline, which are important transportation infrastructure in international energy markets.

Egypt is a large regional player in both the upstream and downstream sectors of the oil & gas industry. Egypt's gas production has soared in the last five years, due to several major finds in the West Nile Delta and returns Egypt to net exporter status, whilst oil production loiters around 600kb/d.

Egypt's growing middle class is boosting demand for both gas and refined fuels. In addition, the boom in the spot price for gas across Europe and Asia in 2021 is contrast to 2020 and Egypt has benefitted from its timely restarting of operations at its LNG facilities in early 2021, sending several cargoes each month.

We forecast the strong performance to continue into the end of 2023, which we also expect to be a peak year for natural gas production.

3- Research problem

New digital technologies combined with data-driven insights can transform operations, boosting agility and strategic decision-

making. The Oil and Gas industry has spent trillions of dollars in recent decades building large infrastructures – including offshore projects, land development fields, and complex networks of pipelines and refineries – all with a view to meeting the world's energy demand.

The ability to capture and interpret data, and then take effective action while minimizing risks to employees and the environment, lies at the heart of how the industry operates.

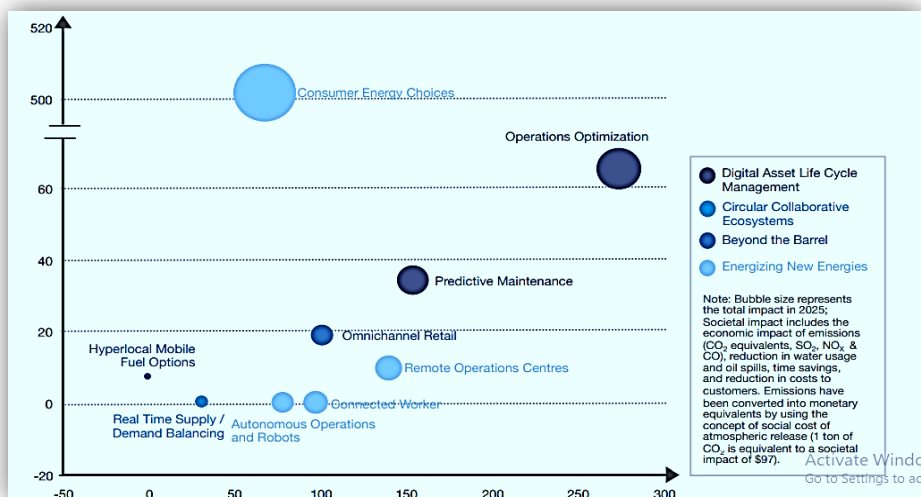
The use of technology and core physical infrastructure, such as sensors and automation in the upstream, midstream and downstream areas of the industry, have made this approach to operations possible.

Figure (1) Potential Value of Digital Initiatives and Technologies in Oil and Gas, for the Industry and Society.

Value at stake (\$ billion, 2016-25)

Societal impact (\$ billion)

Industry impact (\$ billion)



4- Research Questions:

Based on the underlying problem presented above, the study attempts to answer the following research questions:

1. What are the current digital investments and digital trends employed in the O&G industry?

2-How does this current digital state compare to the future digital vision? 3-What are the critical organizational and technical system barriers to achieving the transformation to impactful business digitization?

4-Is the O&G industry currently mixed up in a productivity paradox where investments are directed only toward “getting to digital” and fail to contribute to added business value?

5- Is there a framework that can more effectively evaluate the business value and alignment of a digital initiative with respect to how it integrates with an organization’s culture, competency, capability, and vision?

5- Research Objective:

The objective of this thesis is

- ❖ To explore the digital initiatives within large O&G companies to develop insight into which strategic platforms and methodologies are providing realized value.
- ❖ Adopting new digital platforms and workflows for digital infrastructure ‘
- ❖ Platform development, employee development (competency and culture), external competency resources, administration, and temporary productivity decline during transition and rollout.
- ❖ Platform integration, sensor integration, complex algorithms, and data management.
- ❖ Immense amount of energy and investments is directed toward “getting to digital” that is leading to tangent projects that fail to achieve a return on investment and deviate business models away from the optimal path .
- ❖ Approach to understanding the breadth of digital influence in O&G is outlined below.

6- Research Hypothesis:

A.H1: There is a significant positive relationship between digital transformation and demand in gas market in EGYPT.

B.H1: There is a significant positive relationship between digital transformation and supply in gas market in EGYPT

7- Significance of the Study:

The research derives its significant in general of the importance of the use of:

Technologically-driven and digital transformation is taking place in almost all types of activities. In the current scenario, no one can think about the world's functionality without the presence of technology-based development.

Almost each and every activity that a man is performing in this 21st century from waking up to going to the bed, whatever activity comes in between these two points of time consists of different types of technological-based gadgets, software, instruments, etc.

For making the whole lifestyle of human being much easier, productive and efficient. Technology is the future, as we all already know and understand very well.

But, in what possible way we are using our current technology is not at all the end in terms of it, as there is no concept available in terms of boundaries when we consider the functionality and coverage area of technology. Along with new and modern

technology the changes also taking place in the field of the digital world.

The digital world is mainly consisting of the power of digitization of different types of activities and functions which are directly and indirectly related to the human functions and the mechanism which are related to the human activities.

As the network and internet advancement taking places in achieving the target of fast pace of processing data, all other activities which were performed by the human in terms of their daily and official activities such as documentation, communication, transportation, businesses, industries, and all other activities are directly transformed and advanced with the introduction of the new era of advanced technologies.

Technological development is also taking place in the oil and gas industry. The oil and gas industry are one of the biggest industries in the whole world. No, any single nation can think about their functionality without the presence of proper oil and place fulfillments.

8- Research Methodology:

- Research Type:

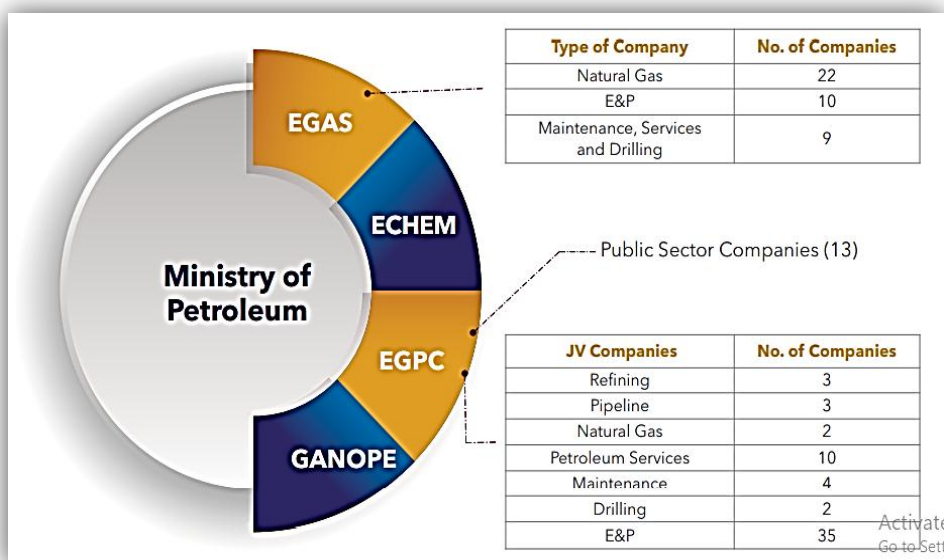
The research is considered a quantitative one the researcher draws data from the primary sources of data provided by (EGAS) which is published in its annual reports and the required disclosures

- Population and Sample:

Ministry of petroleum and mineral Resource (mop).As of 2018, there were 818,788 people working in the Public sector, 240,000 of whom are working in the oil and gas sector.

Under the petroleum ministry's umbrella are the five main holding companies- Egyptian General Petroleum Corporation (EGPC), Egyptian petro-chemicals holding company (GANOPE), and Egyptian Mineral Resource Authority (EMRA)- which oversee around 145 companies' public sector oil and gas companies have long suffered from misallocation of human capital, overstaffed.

Figure (2) Research Population



The top management representatives include: Chairperson, Vice chairperson, Chief Executive Officer, Managing Director and Board Members of the company.

➤ **The total population size for the following reasons:**

1. Top management representatives are most knowledgeable individuals about the companies' operational and strategic activities.

2. They have the most expertise and knowledge in terms of operation and direction of the firm.

3. Sources of Data Collection For the purpose of achieving the research objectives, there are two main sources from which data is collected by the researcher in this research.

i. Primary Sources of Data Collection:

Primary data of this research is obtained from the company top management through the distribution of questionnaires during the empirical work. It is developed according to the number of scales which have been previously used in previous studies.

A survey is a method of primary data collection based on communication with the research population or a representative sample of it.

The questionnaire used in this research is the self-administered questionnaire. Self-administered questionnaires are distributed to the respondents in hard copies.

ii. Secondary Sources of Data Collection:

Library or documentary research means collecting secondary data which can be found in company records, library, internet and other documents.

Literature obtained from secondary sources regarding entrepreneurial orientation is reviewed to identify factors that cause differences in performance and competitive advantage in various sectors.

Secondary data is crucial and of vital importance for any researcher because it allows the researcher to know what has been done in the area of interest and the procedures that are used to come out with those findings.

9- Recommendation:

In my opinion, natural gas is a cheap resource of energy and it is a valuable product that must be directed to profitable industries such as petrochemical or fertilizers as it will be more useful and add-value for natural gas.

Moreover, products of petrochemical or fertilizers have high and stable prices not fluctuated prices such as natural gas.

10- Limitations and Future Research:

The work performed in this thesis addressed the O&G digital transformation from a high level systems perspective, with a focus on drilling and completion design and operations.

Digital success and connectivity create a powerful competitive advantage for organizations and, thus, financial

information for integration and resulting realized value was difficult to uncover.

Information was gathered through the outward lens of news outlets, interviews, and available industry articles, where it was sometimes difficult to differentiate the advertised rhetoric and the actual value.

Additionally, there was no hands-on involvement or experience with the managing or integration of digital platforms in an O&G organization.

Future research should be focused on disclosing the financial value associated with the adoption of different digital techniques across the O&G value chain.

The financial value can be compared with the presented ranking methodology with respect to buy versus build, alliances, partnerships, standardization, and open source approaches.

Developing a profitability correlation to the different benefit attributes of a digital platform would be a powerful tool to help guide how organizations invest in their digital transformation. The proposed methodology can be applied to digital initiatives that have adopted within organizations to determine how well the organization's digital strategy aligns with the initiative, and this can be tracked with resulting successes or failures.

The methodology can be used to rank digital tools, but a limitation is that it has not been thoroughly evaluated with in-

depth analysis over a sufficiently large sample of digital initiatives.

Finally, future research should be directed to performing a more detailed review of the available O&G digital tools and applications.

This thesis approached the problem from a holistic systems perspective with a broad boundary of investigation. However, additional research into the specific details of the digital platforms and tool offerings with respect to the attributes outlined in the ranking method would provide more insight on the value-added functionalities.

This information can help to create a more accurate O&G digital roadmap with the inclusion of critical benefit attributes. Digital tools, attributes, and the respective performance can be

Correlated to better understand the trends and the direction in which the industry is heading.

11- Conclusions:

Digital transformation is a large-scale business shift. The opportunity for the overall digital transformation is driven by large database of oil and gas field operations, and advanced management tools by companies.

The scope of Bien Dong POC's digital transformation project is to lay out foundations for a digital platform that can be leveraged to deliver digital services.

All data will be standardized, examined and linked on a centralized, flexible and scalable digital platform, meeting current needs and future growth of Bien Dong POC. It involves considerable costs as this necessitates investment in IT as well as engineering initiatives.

The production and operation outputs can be measured with different well openings through well test activities and at the outputs of the oil and gas processing systems. Being able to accurately calculate the production output at different well openings and across the entire production network is extremely important for oil and gas field management and operations to maximize economic potential of the reservoir.

In addition, incorrect forecasting of yield can lead to false reservoir estimates and make erroneous decisions about well exploitation regime.

The construction of non-parametric reservoir models based on pressure and temperature data has proven to be a valid and cost-effective solution the "Production Performance Monitoring" (PPM) process has been successfully implemented in Bien Dong POC.

The PPM goal is to create automated workflows to improve productivity, data and process management methodology, and data standardization.

The components of this solution consists of (1) building a monitoring infrastructure system of operational activities; (2) collecting and storing real-time data; (3) standardizing the

production activity and allocation process; (4) tracking and evaluating allocation results automatically; and (5) building The digital transformation programmed has exploited important opportunities through the timely application of digitalization and mine dynamics analysis to promote capture and create high value in oil and gas operations.

With collected data converted into decisive information, Bien Dong POC has safely, effectively and continuously operated production over the years.

Future forecasts, management reports such as asset monitoring, production performance diagnostics and production optimization are performed accurately and promptly for investors and stakeholders.

However, this short statement would not do justice to the considerable efforts deployed by all the relevant stakeholders in launching Egypt's hydrocarbon activities, bringing on-stream, in record time, several new gas supply projects and boosting indigenous production.

It would also ignore the fact that the answer is based on current publicly available data and information on both the supply and demand sides.

Very shortly the Egyptian natural gas market will be balanced again, and gas exports may resume by the end of this decade or beginning of the next one.

Meeting the needs of the domestic gas market has been one of the key objectives and priorities of the Egyptian government.

This target is about to be achieved and a balanced market could possibly be sustained until at least the early 2020s, based on the above-mentioned assumptions.

It should be noted that some of the past gas consumption could be considered as repressed or rationed demand. As more gas supplies become available, but at higher or much higher prices, how would this demand adjust to the continuous reform of domestic energy prices and a significant reduction of energy price subsidies?

Egypt's future natural gas demand profile will depend on a number of factors. In addition to the country's economic growth prospects, the key drivers of gas demand growth are future movement of domestic gas prices, especially for gas supplies to the power sector, and adequate availability of natural gas infrastructure capacity to meet existing and potential expansion of gas demand in new areas/regions.

A lot of effort is focused on developing alternative energy sources of electricity generation, but it will take longer than ten years to diversify the energy mix and to reduce significantly the level of gas-fired generation and therefore Egypt's total gas demand.

The review of gas demand by sector of use shows that natural gas demand in Egypt will continue to grow, but at a slower pace compared to the last two decades' growth rate.

There is a need to focus not only on the yet-to-find gas resources to develop additional gas supplies and balance the market over a longer period, but also to pay further attention to the country's energy demand side.

Without the full implementation of consistent and integrated energy demand-side management measures, Egypt could be exposed again to a gas supply surplus/deficit cycle.

One of the key driving factors of all these measures is the reform of the domestic energy pricing structure, specifically for gas and electricity prices.

A new domestic gas market law and its executive regulations were issued in August 2017 and February 2018, respectively.

Although its full implementation and the liberalization of the gas market will take a long time to achieve and the fact that a number of implementation questions remain to be clarified, this new gas law is definitely a very important step forward in the reform of Egypt's natural gas sector.

The Egyptian government has already initiated courageous energy price reform measures with some positive affects in terms of restrained demand by some energy-intensive sectors of the economy.

The government has also stated repeatedly its commitments to implement further reforms. However, it will continue to face challenges with regard to the price subsidy and payment problems of the gas-to-power chain. Fully addressing these issues will take some time, possibly beyond this paper's time horizon,

as it involves a complex combination of sensitive social, economic and political factors.

The timing of the full resumption of Egyptian gas exports, the level of these exports and how long the exports will last, are crucial issues that are continuously raised within and outside Egypt.

Based on current, publicly available supply and demand data and information, Egypt is unlikely to regain its past.

Natural gas export position. The export window could last no more than a few years and export levels will decline quickly. However, there is the question of how the government will continue to monetize its gas resources, especially its additional gas supplies.

Subject to its existing contractual gas export commitments, should it capture additional rent through further domestic gas monetization (petrochemicals and industries) or mainly through exports or a combination of the two? Under a commercially viable energy pricing structure, such questions would be easier to address.

But, it is difficult to justify the continuation of energy price subsidies to domestic gas monetization projects, both economically and financially.

Egypt holds a central position in East Mediterranean gas developments.

It has been promoting the option of becoming a natural gas export 'hub' to export gas from its own fields and also from neighboring East Mediterranean gas producing sources.

In order to achieve such a regional energy integration scheme, Egypt and its neighbors will have to surmount daunting obstacles related not only to geopolitical and territorial disputes, but also to address difficult commercial, contractual, and inter-governmental agreement constraints in the currently challenging international gas markets.

It is important to stress that the issue of gas market reform cannot be looked at in isolation from other energy subsectors, especially power.

There is a critical need to reduce the heavy dependence on natural gas to generate electricity. As indicated above, Egypt's power sector is likely to continue to rely mainly on natural gas as a generating fuel for a long period of time.

To shorten this period and reduce gas demand, it will have to intensify its efforts to develop a diversified mix of energy sources.

This objective is supported by the government and international financial institutions through the launching of a series of renewable energy projects that will contribute to this diversification effort.

Finally, by the end of next decade, and most probably beyond 2030, Egypt's energy portfolio could be transformed with non-hydrocarbon sources of energy capturing an increasing share of the country's electricity generation mix.

This could potentially release some additional supplies of natural gas for export, but by then Egypt will be facing international gas

export markets that could be radically different from today's, especially in Europe under a decarbonization agenda.

12- References

Thesis:

- Dmitrievsky, A.N., Eremin, N.A., Stolyarov, V.E. Current Issues and Indicators of Digital Transformation of Oil and Gas Production at the Final Stage of Field Operation (2021) *SOCAR Proceedings*, 2021, pp. 1-13.
- Elshazly, M., Khodeir, S. Legislative reforms in the Egyptian energy sector to liberalize the natural gas market (2018) *Journal of World Energy Law and Business*, 11 (4), pp. 354-359.
- Hafezi, R., Wood, D.A., Akhavan, A.N., Pakseresht, S. Iran in the emerging global natural gas market: A scenario-based competitive analysis and policy assessment (2020) *Resources Policy*, 68.
- Henriqson, E., Rodrigues, F.S., Werle, N.J.B., Lando, F., Trancoso, R.S., Fogaça, L.B. Resilience and Digital Transformation Challenges in Oil and Gas Integrated Operations (2022) *Contributions to Management Science*, pp. 19-38
- Indupurnahayu, Setiawan, E.B., Agusinta, L., Suryawan, R.F., Ricardianto, P., Sari, M., Mulyono, S., Sakti, R.F.J. Changes in demand and supply of the crude oil market during the covid-19 pandemic and its effects on the natural gas market (2021) *International Journal of Energy Economics and Policy*, 11 (3), pp. 1-6.
- Jia-Man Li a, b , Xiu-Cheng Dong a, b, Qin-Zhe Jiang a, b , Kang-Yin Dong, Urban natural gas demand and factors analysis in China: Perspectives of price and income elasticities (2022), School of International Trade and Economics, University of International

Business and Economics, Beijing, 100029, China, Petroleum Science (19) pp420-440.

- Mohamed Sabry, "Egypt to overhaul hydropower plants amid Nile dam crisis," Al-Monitor, September 22, 2021. "Aswan High Dam, River Nile, Sudan, Egypt," Water Technology, accessed February 3, 2022.
- Zhang, J., He, R., Zou, X., Li, Z., Yang, X. Digital transformation of China's natural gas marketing business in the new pattern (2021) *Natural Gas Industry*, 41 (9), pp. 169-177.

Reports:

- IEA analysis based on EIA (2022), Weekly Working Gas In Underground Storage; GIE (2022), AGSI+ Database; IEA (2022), Monthly Gas Data Service.
- International Renewable Energy Agency, Renewable Energy Outlook: Egypt, October 2018."Egypt Power Report: Q1 2022," Fitch Solutions Country Risk & Industry Research, November 2021. "Electricity," Arab Fund for Economic & Social Development, accessed February 1, 2022. "Electricity Interconnection Projects," National Electrical Power Company (Jordan), accessed February 1, 2022.
- Jennifer Gnana, "Explainer: what is the Arab Gas Pipeline and why it matters," The National News, September 8, 2021. "Repairs to Arab Gas pipeline should be completed by end-Feb, Lebanese minister says," Reuters, December 29, 2021.
- U.S. Energy Information Administration, International Energy Statistics database, accessed January 27, 2022.

Conferences:

- Abramov, V.M., Burlov, V.G., Shevchuk, O.I., Shilin, M.B., Chusov, A.N.Digital transformation of geo-information support for large gas projects in Arctic (2021) *IOP Conference Series: Earth and Environmental Science*, 808 (1),
- Abramov, V.M., Burlov, V.G., Shevchuk, O.I., Shilin, M.B., Chusov, A.N.Digital transformation of geo-information support for large gas projects in Arctic (2021) *IOP Conference Series: Earth and Environmental Science*, 808 (1), art. no. 012047, .
- Akhunov, R.R., Akhunova, L.R., Marichev, S.G., Nizamutdinov, R.I.Russian oil and gas regions during the COVID-19 crisis and their digital transformation (2021) *R-Economy*, 7 (3), pp. 179-191.
- Alsaeedi, A.A.A.S., Elabrashy, M.M.M., Alzeyoudi, M.A., Albadi, M.M., Soni, S., Isambertt, J., Tripathi, D.UAE's first end to end standardized workflow-based digital transformation in a giant gas producing asset - Lessons learned and way forward (2021) *Proceedings - SPE Annual Technical Conference and Exhibition*, 2021-September, .
- Arango, F.O., Ramírez, J.C., Rosellón, J.The effects of natural gas market reforms in Mexico on its prices, sales and foreign trade [Los efectos de las reformas del mercado de gas natural en México sobre sus precios, ventas y comercio exterior](2021) *Contaduria y Administracion*, 66 (3),
- Arbogast, J.E., Defaye, C., Lotero, I., Gopalakrishnan, A., Roba, T., Kontopoulos, A.Smart manufacturing in industrial gas production: A digital transformation (2020) *Smart Manufacturing: Applications and Case Studies*, pp. 333-385.
- Ginanjar, M., Yusim, S.Integrated production forecast evaluation in a complex gas market system - A multidiscipline approach to optimize gas supply-demand in South Sumatra PSC Block, Indonesia(2019) *Society of*

Petroleum Engineers - SPE/IATMI Asia Pacific Oil and Gas Conference and Exhibition 2019, APOG 2019, .

- Koliopoulos, T.K.Digital Transformation Utility for Landfill Gas Emissions and Safety of Infrastructures: Risk Management Public Health Policy for Safe Community Health Tourism's Infrastructures at Post COVID-19 Era (2021) *International Conference on Engineering Management of Communication and Technology, EMCTECH 2021 - Proceedings.*
- Kusuma, J., Artana, K.B., Dinariyana, A.A.B. Market Analysis of Natural Gas Supply and Demand in East Java Province to Enable a Sustainable Scenario Using System Dynamics Simulation (2020) *IOP Conference Series: Earth and Environmental Science*, 557 (1), art. no. 012041

Articles:

- Berge, J.Digital transformation and IIoT for Oil and gas production (2018) *Proceedings of the Annual Offshore Technology Conference*, 2, pp. 1204-1213.
- Bieser, J.C.T., Hilty, L.M.Indirect effects of the digital transformation on environmental sustainability: Methodological challenges in assessing the greenhouse gas abatement potential of ict(2018) *EPiC Series in Computing*, 52, pp. 68-81.
- Bin Azmy, I.H., Azmi, A.B., Sulaiman, M.S., Yusop, O.B.M. Digital Transformation in Oil and Gas Industry: Developing an OSDU Third-Party Application (2021) *7th International Conference on Engineering and Emerging Technologies, ICEET 2021, .*
- Boute, A., Fang, M.M.China's textbook approach to regulatory reform of the natural gas market(2022) *Utilities Policy*, 76, art. no. 101369, .

-
- Broadstock, D.C., Li, R., Wang, L. Integration reforms in the European natural gas market: A rolling-window spillover analysis (2020) Energy Economics, 92, art. no. 104939, . Cited 2 times.
 - Burns, K., Houghton, T. An investigation into dynamics, elasticity and asymmetry for residential natural gas markets (2020) Handbook of Energy Finance: Theories, Practices and Simulations, pp. 157-181.
 - Caluri, L., Jianu, M., Cerioli, P., Silvestri, G.B. Open innovation as enabling paradigm to empower digital transformation in oil & gas organizations (2019) Society of Petroleum Engineers - Abu Dhabi International Petroleum Exhibition and Conference 2019, ADIP 2019, .
 - Chai, J., Zhang, X., Lu, Q., Zhang, X., Wang, Y. Research on imbalance between supply and demand in China's natural gas market under the double-track price system (2021) Energy Policy, 155, art. no. 112380, . Cited 7 times.
 - Chukuigwe, N., Ikiensikimama, S., Okafor, I. Digital transformation of the standing and Katz compressibility factor chart for natural gases (2020) Society of Petroleum Engineers - SPE Nigeria Annual International Conference and Exhibition 2020, NAIC 2020, .
 - Chukuigwe, N., Ikiensikimama, S., Okafor, I. Digital transformation of the standing and katz compressibility factor chart for natural gases (2020) Society of Petroleum Engineers - SPE Nigeria Annual International Conference and Exhibition 2020, NAIC 2020, .
 - Dagoumas, A.S. An ex-ante market monitoring and regulation mechanism for market concentration in electricity and natural gas markets (2021) Mathematical Modelling of Contemporary Electricity Markets, pp. 349-412.
 - Ding, A. A state-preference volatility index for the natural gas market (2021) Energy Economics, 104, art. no. 105625, .

-
- Dmitrievskiy, A.N., Eremin, N.A., Stolyarov, V.E. Digital transformation of gas production (2019) IOP Conference Series: Materials Science and Engineering, 700 (1), art. no. 012052, .
 - Dmitrievsky, A.N., Eremin, N.A., Stolyarov, V.E. Current Issues and Indicators of Digital Transformation of Oil and Gas Production at the Final Stage of Field Operation (2021) SOCAR Proceedings, 2021, pp.
 - Feijoo, F., Sankaranarayanan, S., Avraam, C., Siddiqui, S.A. Mathematical Models for Evolving Natural Gas Markets (2021) International Series in Operations Research and Management Science, 301, pp. 359-386.
 - Flaksman, A.S., Kokurin, D.I., Khodzhaev, D.K., Ekaterinovskaya, M.A., Orusova, O.V., Vlasov, A.V. Assessment of prospects and directions of digital transformation of oil and gas companies (2020) IOP Conference Series: Materials Science and Engineering, 976 (1), art. no. 012036, .
 - Panayiotou, N.A., Stergiou, K.E., Stavrou, V.P., Psaltakis, M.N. Digital Transformation of the Process of the Connection of New Users in the Natural Gas Network utilizing CRM system and Industry 4.0 technology (2020) Proceedings - 2020 6th International Conference on Mechanical Engineering and Automation Science, ICMEAS 2020, art. no. 9356891, pp. 14-18.
 - Ganz, K., Kern, T., Gunther, M. WEGA and MInGa - Considering regional transmission capacities for global gas market models (2020) International Conference on the European Energy Market, EEM, 2020-September, art. no. 9221880, .

- Geng, J.-B., Chen, F.-R., Ji, Q., Liu, B.-Y. Network connectedness between natural gas markets, uncertainty and stock markets (2021) *Energy Economics*, 95, art. no. 105001, .
- Geng, Z. Russian energy strategies in the natural gas market for energy security (2021) *International Journal of Energy Economics and Policy*, 11 (2), pp. 62-66. Cited 3 times.
- Ginanjar, M., Yusim, S. Integrated production forecast evaluation in a complex gas market system - A multidiscipline approach to optimize gas supply-demand in South Sumatra PSC Block, Indonesia (2019) *Society of Petroleum Engineers - SPE/IATMI Asia Pacific Oil and Gas Conference and Exhibition 2019, APOG 2019*, .
- Günther, M., Fallahnejad, M. Analysis of NCG prices under different shapes of oil price recovery with a worldwide gas market model (2020) *Handbook of Energy Finance: Theories, Practices and Simulations*, pp. 301-316.
- Hafezi, R., Wood, D.A., Akhavan, A.N., Pakseresht, S. Iran in the emerging global natural gas market: A scenario-based competitive analysis and policy assessment (2020) *Resources Policy*, 68, art. no. 101790, . Cited 8 times.
- Henriqson, E., Rodrigues, F.S., Werle, N.J.B., Lando, F., Trancoso, R.S., Fogaça, L.B. Resilience and Digital Digital Transformation Challenges in Oil and Gas Integrated Operations (2022) *Contributions to Management Science*, pp. 19-38.
- Indupurnahayu, Setiawan, E.B., Agusinta, L., Suryawan, R.F., Ricardianto, P., Sari, M., Mulyono, S., Sakti, R.F.J. Changes in demand and supply of the crude oil market during the covid-19 pandemic and its effects on the natural gas

-
- market(2021) International Journal of Energy Economics and Policy, 11 (3), pp. 1-6
- Jiang, H.-D., Xue, M.-M., Dong, K.-Y., Liang, Q.-M. How will natural gas market reforms affect carbon marginal abatement costs? Evidence from China (2021) Economic Systems Research, . Cited 7 time.
 - Kamel, S. The role of digital transformation in development in Egypt (2021) IBIMA Business Review, 2021, art. no. 911090, Wanasinghe, T.R., Trinh, T., Nguyen, T., Gosine, R.G., James, L.A., Warrian, P.J. Human centric digital transformation and operator 4.0 for the oil and gas industry (2021) IEEE Access, 9, art. no. 9509417, pp. 113270-113291.
 - Katysheva, E., Tsvetkova, A. Economic and institutional problems of the russian oil and gas complex digital transformation(2019) International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM, 19 (5.3), pp. 203-208.
 - Koliopoulos, T.K. Digital Transformation Utility for Landfill Gas Emissions and Safety of Infrastructures: Risk Management Public Health Policy for Safe Community Health Tourism's Infrastructures at Post COVID-19 Era(2021) 2021 International Conference on Engineering Management of Communication and Technology, EMCTECH 2021 - Proceedings, .
 - Komlev, S.L., Chapaikin, D.A. Contracted gas volume as factor of price formation on natural gas markets (2020) World Economy and International Relations, 64 (5), pp. 84-92.
 - Kushzhanov, N.V., Dashqin, M. The digital transformation of the oil and gas sector in kazakhstan: Priorities and problems (2019) News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences, 3 (435), pp. 203-212.

- Kusuma, J., Artana, K.B., Dinariyana, A.A.B. Market Analysis of Natural Gas Supply and Demand in East Java Province to Enable a Sustainable Scenario Using System Dynamics Simulation (2020) IOP Conference Series: Earth and Environmental Science, 557 (1), art. no. 012041, . Cited 1 time.
- Li, Y., Chevallier, J., Wei, Y., Li, J. Identifying price bubbles in the US, European and Asian natural gas market: Evidence from a GSADF test approach (2020) Energy Economics, 87, art. no. 104740, .
- Makhovikov, A.B., Katuntsov, E.V., Kosarev, O.V., Tsvetkov, P.S. Digital transformation in oil and gas extraction (2019) Innovation-Based Development of the Mineral Resources Sector: Challenges and Prospects - 11th conference of the Russian-German Raw Materials, 2018, pp. 531-538. .
- Maslennikov, A.O. World and regional natural gas markets after covid-19 (2020) World Economy and International Relations, 64 (10), pp. 74-83.
- Perifanis, T., Dagoumas, A. Price and volatility spillovers between crude oil and natural gas markets in Europe and Japan-Korea (2020) International Journal of Energy Economics and Policy, 10 (5), pp. 432-446. Cited 1 time.
- Medzhidova, D. Energy transition and asset specificity transformation of the European gas market [Энергопереход и трансформация специфичности европейского газового рынка] (2021) International Organisations Research Journal, 16 (3), pp. 1-30.
- Metawa, N., Elhoseny, M., Mutawea, M. The role of information systems for digital transformation in the private sector: a review of Egyptian SMEs (2021) African Journal of Economic and Management Studies, .
- Neal, S., Timko, G., Krenek, D., Hickman, D. A look at how the digital age continues to transform the gas compression industry (2019) 2019 Annual GPA Midstream Convention, pp. 317-325.

-
- Nester, D.C.Digital transformation for oil & gas investors (2021) World Oil, 242 (3), pp. 19-23.
 - Pogoretsky, V., Talus, K.The WTO panel report in EU-energy package and its implications for the eu's gas market and energy security (2020) World Trade Review, 19 (4), pp. 531-549. Cited 1 time.
 - Pouliasis, P.K., Visvikis, I.D., Papapostolou, N.C., Kryukov, A.A.A novel risk management framework for natural gas markets(2020) Journal of Futures Markets, 40 (3), pp. 430-459.
Roberts, R.Digital: Why an effective master data strategy is key to digital transformation in oil and gas(2020) Hydrocarbon Processing, 99 (8), .
 - Rubaszek, M., Szafrank, K., Uddin, G.S.The dynamics and elasticities on the U.S. natural gas market. A Bayesian Structural VAR analysis (2021) Energy Economics, 103, art. no. 105526, .
 - Rubaszek, M., Uddin, G.S.The role of underground storage in the dynamics of the US natural gas market: A threshold model analysis(2020) Energy Economics, 87, art. no. 104713, . Cited 3 t
 - Rubino, AThe political economy of Euro - Mediterranean cooperation in the gas market: The role of domestic stakeholders and the European Commission (2021) Resources Policy, 70, art. no. 101883, .
 - Sadlier, A., Jerry, J.Implementing the real-time data environment for the oil and gas digital transformation(2019) Offshore Mediterranean Conference and Exhibition 2019, OMC 2019.
 - Schewe, L., Schmidt, M., Thürauf, J.Structural properties of feasible bookings in the European entry–exit gas market system(2020) 4OR, 18 (2), pp. 197-218. Cited 5 times.
 - Schwele, A., Ordoudis, C., Pinson, P., Kazempour, J.Coordination of power and natural gas markets via financial instruments (2021) Computational Management Science, 18 (4), pp. 505-538. Cited 1 time.

-
- Shaik, F., Abdullah, A., Klein, S. Digital transformation in oil & gas - Cyber security and approach to safeguard your business (2017) World Petroleum Congress Proceedings, 2017-July, .
 - Yang, J., Du, J., Yang, Y., Fan, S. Research and practice on digital transformation of the oil and gas industry [(2021) Shiyou Xuebao/Acta Petrolei Sinica, 42 (2), pp. 248-258. Cited 4 times.
 - Zeynalli, A., Butdayev, R., Salmanov, V. Digital transformation in oil and gas industry (2019) Society of Petroleum Engineers - SPE Annual Caspian Technical Conference 2019, CTC 2019,.
 - Zhang, J., He, R., Zou, X., Li, Z., Yang, X. Digital transformation of China's natural gas marketing business in the new pattern (2021) Natural Gas Industry, 41 (9), pp. 169-177. Cited.
 - IEA analysis based on CQPGX (2022), Nanbin Observation; EIA (2022), Natural Gas Consumption; Enagas (2022), Natural Gas Demand; ENTSOG (2022), Transparency Platform; EPIAS (2022), Transparency Platform; PPAC (2022), Gas Consumption.