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Expert Commentary

Navigating energy transitions: A comparative analysis of NOC's operational performance

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1. Introduction

A clear global megatrend is evident: world energy consumption is gaining momentum, driven by low-income countries seeking to improve their standard of living and overall quality of life. Projections from the latest edition of GECF Global Gas Outlook depict a striking picture, projecting a significant 20% increase in energy demand, rising from 14.9 Gtoe in 2022 to 17.9 Gtoe by the year 2050. This surge in energy demand can be attributed to various factors, including an anticipated global population rise of around 1.7 billion people, with substantial growth expected in Africa and Asia. Moreover, the global GDP is projected to double, surpassing USD 200 trillion. These demographic and economic shifts are set to reshape the global energy landscape significantly.

Nevertheless, this increase in energy consumption entails a negative externality of increasing greenhouse gas emissions(GHGs), contributing to global warming. According to a McKinsey (2020) report, the energy sector collectively contributes to three-quarters of GHG emissions. Specifically, the oil and gas industry alone is accountable for 16% of energy sector emissions and 12% of global emissions in 2020.

In this context, National Oil Companies (NOCs) stand as critical players in the pursuit of a sustainable future. On the one hand, according to analysis based on a dataset from Energy Intelligence, NOCs command over 70% of the world's oil and gas reserves, along with approximately half of the market share in the oil and gas industry. These enterprises are consolidating their position within the supply chain by acquiring a more significant share of oil product sales and refining capacity worldwide. Consequently, it is logical to assert that NOCs are set to play a vital role in supplying reliable and affordable energy to the world in the foreseeable future, thereby contributing to improving living standards and tackling energy poverty. Conversely, the combustion of fossil fuels supplied by NOCs, particularly oil and gas, leads to the accumulation of GHG emissions, further worsening global warming.

As the dominant players in the oil and gas industry, NOCs confront this complex challenge while facing mounting pressure from investors, consumers, and environmental and citizen groups, especially in OECD countries. Both governments and corporations are facing mounting pressure to respond to imminent developments associated with climate change. There is a growing call to reduce investments and

production in fossil fuels, which mainly constitute oil, gas and coal. Several governments have recently committed to net-zero emissions targets, prioritising the growing desire to decrease hydrocarbon (oil and gas) consumption in response to the demands of their electorates.

These actions are echoing across the oil and gas value chain, introducing uncertainties regarding future demand for oil and gas. This has prompted questions about the industry's future investment strategies and business models. Consequently, national and International NOCs (INOCs), as key players in the industry, are under pressure to monetise reserves that are at risk of becoming stranded, contend with the risk of enduring low prices, the dilemma of committing to new long-term investments, and the option of diversifying into new, low-carbon-intensive business models.

While these challenges are reshaping the existing oil and gas supply chain, NOCs, often endowed with significant skills, resources, and assets, are well-positioned to play a central role in addressing GHG emissions and driving the world toward inclusive and sustainable development. Traditionally linked with hydrocarbon production, NOCs possess distinctive opportunities to utilise their expertise and infrastructure to transition towards cleaner energy solutions, thereby fostering technological innovation. They have the potential to contribute to addressing the global energy and climate challenge by diversifying their portfolios, investing in low-carbon energy sources and renewable energy, and adopting technologies like carbon capture and storage. As we advance into the era of equitable, orderly and just energy transitions, the role of NOCs is expected to undoubtedly transform, positioning them as a vital element on the journey towards a sustainable and low-carbon energy future. Hence, this commentary conducts a comparative analysis of NOCs and IOCs' operational performance, leading to their role in the era of energy transitions.

The paper begins by highlighting future energy needs amidst population growth and the quest for improved living standards. It examines the potential role of NOCs by analysing their reserves, production, refining, and sales of oil and gas products. Conclusively explores strategies to mitigate increased greenhouse gas emissions while fulfilling energy demands and achieving climate targets.

2- NOC operational performance analysis

Driven by a profound aspiration to industrialise their economies and elevate living standards, oil-exporting countries embarked on a determined course of action, particularly following the nationalisation of their oil industries in the aftermath of World War II. Their paramount goal was to harness the full potential of their abundant natural resources, particularly oil, to attain economic progress and prosperity. In the wake of this nationalisation, these countries implemented strategic initiatives aimed at extracting the utmost advantage from their vast oil reserves. This drive was not only rooted in the pursuit of economic development but also in the aspiration to elevate their citizens' standard of living to unprecedented levels. Consequently, they embarked on comprehensive initiatives to maximise the utilisation of their oil resources. They undertook efforts to ensure that major oil companies operating in their territories negotiated agreements to explore and exploit these valuable resources. As a result of these negotiations, a significant turning point was reached after World War II when the famous 50-50 sharing formula was established (Fales, H., Smith, D.N., Frick, R.H., Carroll, J.S. and Lipton, 1973).

Following this development, oil-exporting countries began to nationalise the oil companies present in their territories. This move was driven by their desire to take control of the revenue and pricing mechanisms, ultimately leading to a balanced supply of oil for both exporting and importing countries. Recognising that IOCs, referred to as majors in this report, were instruments of foreign origin, governments in these oil-rich countries prioritised the establishment of NOCs.

The importance of NOCs grew exponentially owing to the rising demand for oil and gas, combined with more constrained supply conditions driven by geopolitical factors. These NOCs emerged as crucial players in the global energy landscape. This notable change in the oversight and management of oil and gas businesses on a global scale led to a remarkable transformation. The share of production controlled by IOCs significantly declined from 93% in 1972 (EKT Interactive, 2023) to less than 50% in modern times (RystadEnergy, 2021). This shift indicates the growing influence and dominance of NOCs, as well as the changing dynamics of the oil and gas industry worldwide.

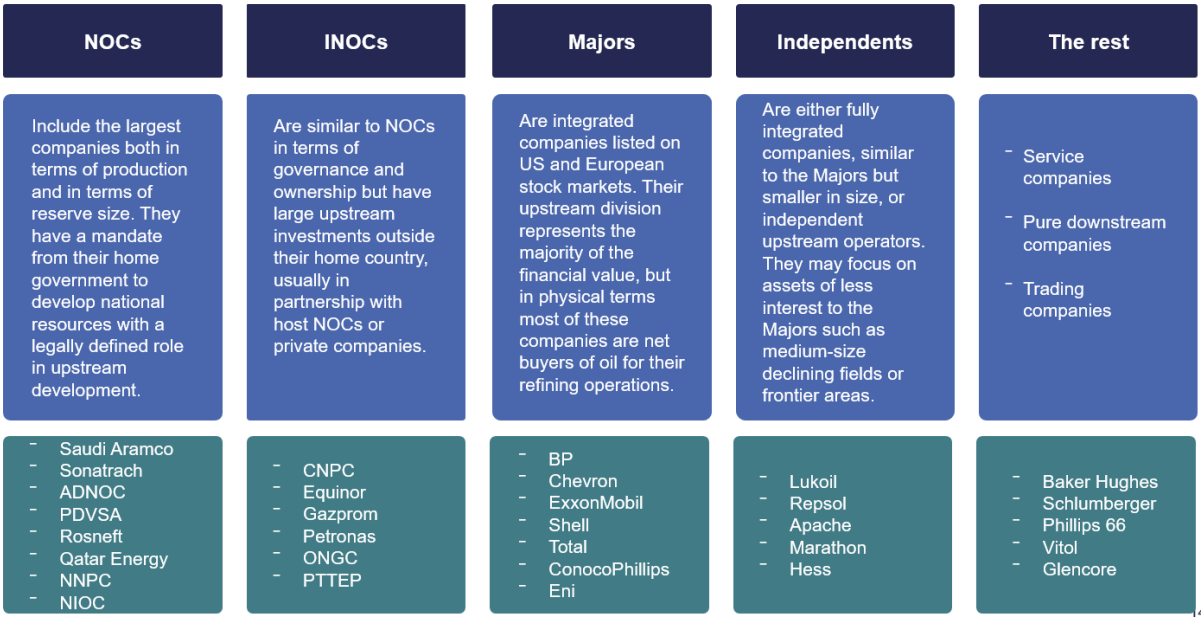
The ever-changing landscape of activities and strategies adopted by NOCs over the past decades, alongside the emergence and decline of new enterprises in the oil and gas industry, has posed challenges in categorising these companies. To maintain consistency and ensure clarity throughout this paper, we have opted to adhere to Rystad Energy's definition.

According to definitions of RystadEnergy and IEA, NOCs are companies that have a mandate from their home government to develop national resources, with a legally defined role in upstream development, e.g. NIOC, QatarEnergy, Basra Oil Co, Rosneft, Sonatrach, PDVSA, NNPC, etc. These companies play a significant role in the energy sector, as they manage a country's hydrocarbon reserves and contribute to its energy security and economic development. NOCs are prevalent in various countries around the world, each with its unique structure, objectives, and strategies, most at times in tune with the International NOCs (INOCs).

The INOCs maintain large upstream investments beyond their home countries, typically in partnership with host NOCs or private companies; these include Gazprom, Equinor, CNOOC, PTTEP, etc. Both NOCs and INOCs share similarities but differ from the oil majors. Majors, usually referred to as IOCs, are integrated companies listed on the United States and European stock markets. Their upstream division represents the majority of the financial value, e.g. BP, Chevron, ExxonMobil, Shell, TotalEnergies, ConocoPhillips and Eni.

Another category of companies known as Independents comprises fully integrated companies, similar to the Majors but smaller in scale, or independent upstream operators, e.g. Lukoil, Repsol, Marathon, Apache and Hess. A summary of definitions and examples is provided in Figure. 1. NOCs have intrinsically different objectives and responsibilities compared to the majors, and therefore, comparison between them is always complex, yet NOC operations and strategies can be drawn from majors and independents, especially in emission reductions as part of energy transitions.

Figure 1. Definitions and scope of oil and gas companies



2-1- Data sourcing

For the purpose of performance analysis of oil companies in this paper, a comprehensive dataset spanning two decades has been sourced from Energy Intelligence's top 100 global NOCs and IOCs ranking dataset. This dataset forms the basis for characterising historical and emerging trends in the production operations of oil and gas, as well as assessing aspects like reserves, production durations, and downstream activities such as refining and product sales.

The dataset encompasses a diverse range of variables, enabling a thorough analysis of the energy landscape over the period of 2000-2022. It includes a time series for operational and financial performance indicators of major oil and gas companies. The dataset is not limited to the upstream sector, and it also provides insights into downstream activities, offering data on refining capacities and oil product sales.

2-2- Insights into NOCs characteristics and resilience in energy transitions

The quantitative analysis illustrates that the nature of NOCs has undergone significant changes over time as they have attained greater control over their respective host country's national oil and gas assets and market shares. While their fundamental business focus remains unchanged, the characteristics of NOCs now reflect the

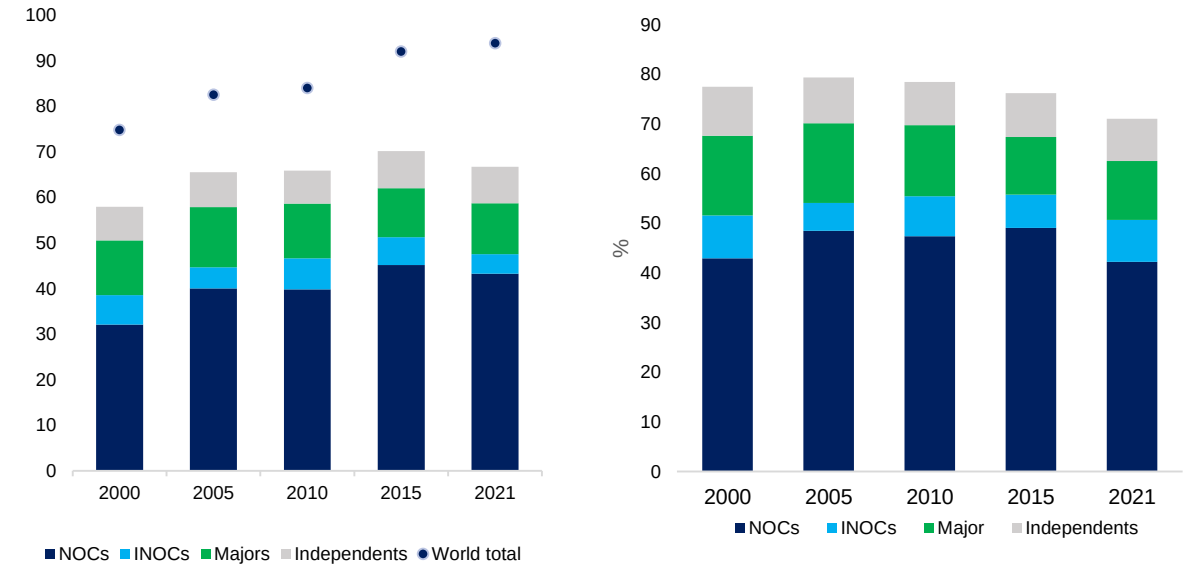
diverse and heterogeneous nature of their business portfolios. Below, we explore some of the common and distinctive traits exhibited by NOCs.

2-2-1- NOCs control on oil production

Over the past two decades, NOCs and INOCs have exhibited a remarkable trajectory in their oil production, showcasing a steadfast increase from nearly 38.5 million barrels per day (mbd) in 2000 to 47.5 mbd in 2021, as shown in Figure. 2. This growth can be attributed to their unwavering commitment to meeting the surging global oil demand during this period. Interestingly, despite the rise of independent and integrated oil companies, NOCs managed to retain their market dominance, consistently securing a substantial portion of the global oil market share. Despite the ascent of competitors, NOCs and INOCs sustained a share of 52% in 2000, which rose to 55% in 2010 before settling at 51% in 2021. In contrast, integrated oil companies witnessed a gradual erosion of their market share, diminishing from 16% in 2000 to 12% in 2021, thus underscoring the enduring influence of NOCs in the global oil production landscape.

During this evolving energy landscape, major oil companies, commonly referred to as the Majors, have undergone a strategic transformation in response to mounting pressures from climate change concerns and the urgent need for energy transitions. As environmental consciousness and regulatory mandates gained momentum, the majors navigated toward sustainable practices and diversified their energy portfolios, aiming to mitigate their carbon footprint. In this dynamic environment, NOCs emerged as a vital player in energy transition endeavours, fortified by their relative stability and resilience in the face of changing market dynamics. The Majors' strategic shifts inadvertently strengthened the relevance of NOCs in driving impactful energy transitions, as the latter's consistent production capacity and strategic positioning enabled them to navigate through the challenges of a rapidly changing energy landscape.

Figure 2. Oil companies' oil production level and global share evolution (mbd)

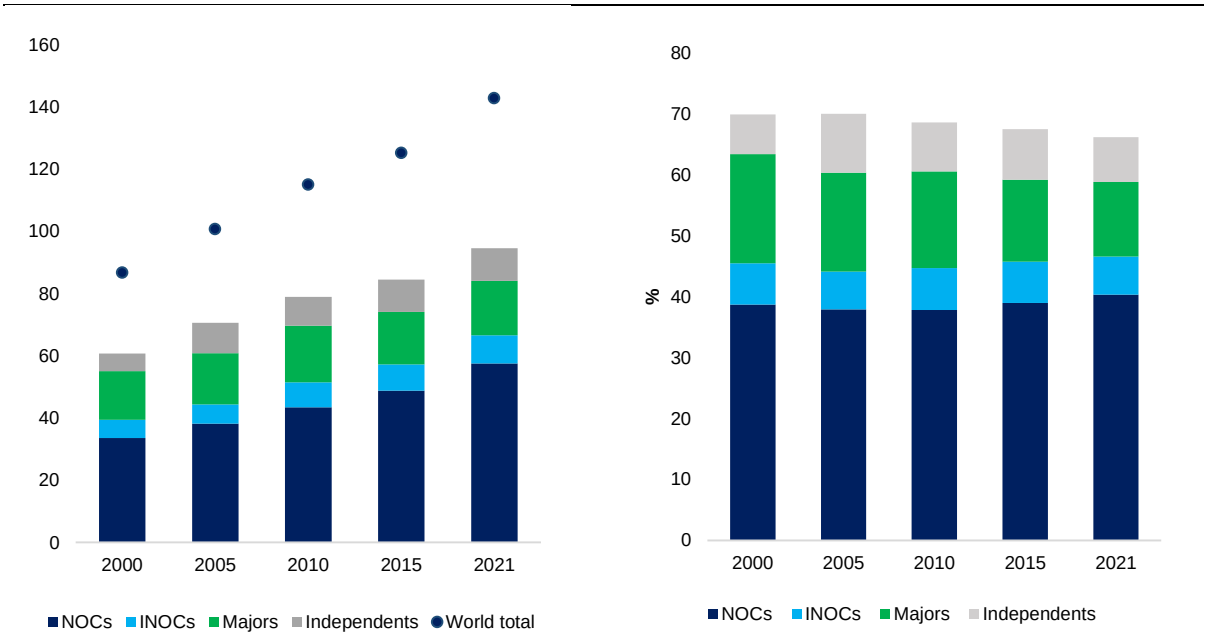


Source: Author calculation based on Energy Intelligence data (2022)

2-2-2- NOCs control on natural gas production

Natural gas occupies a strategic position, serving the dual purpose of meeting the global demand for affordable energy and aligning with environmental imperatives to facilitate energy transitions. This data's coverage period reveals a significant surge in natural gas production by both NOCs and major oil corporations (Majors), as shown in Figure 3, underlining their recognition of natural gas's pivotal role. NOCs and independent entities experienced a near-doubling of their gas production by 2021, escalating from 34 to 58 trillion cubic feet (tcf) and from 6 to 11 tcf, respectively. Meanwhile, the Majors followed a generally ascending trend, albeit at a slower pace than NOCs and independents, reflecting not only their limited control over reserves but also their adaptations to cope with global economic shifts and environmental regulations that have reshaped their business models.

Figure 3. Oil and gas companies gas production level and global share evolution (1000 bcf)



Source: Author calculation based on Energy Intelligence data (2022)

Throughout history, NOCs have historically dominated the global share of gas production, a pattern that has remained consistent even amidst the contemporary backdrop of energy transitions. This constancy can be attributed to the enduring significance of natural gas as an economical and environmentally friendly energy source. NOCs have held their ground, maintaining a share that evolved modestly from 45.5% in 2000 to 46.6% in 2021. In contrast, major oil companies saw a gradual decline in their share over the same timeframe, partly stemming from alterations in their business strategies. Nonetheless, the Majors have exhibited a steadfast commitment to retaining their natural gas portfolios, even as they strive to achieve net-zero goals by approximately 2050, underscoring their recognition of natural gas's role in the energy mix of the future.

2-2-3- NOCs oil reserves ownership

Over the past two decades, NOCs have consistently upheld their dominance in global oil reserves, maintaining control over nearly 70% of the world's oil reserves. This share has seen a gradual ascent, climbing from 67% in 2000 to 71% by 2021, effectively accounting for a total of 1.2 trillion barrels on a global scale, as shown in Figure 4. Concurrently, major oil corporations and independent entities have experienced some erosion in their oil reserves during this same timeframe. This decline can be attributed, in part, to the evolving landscape of business models, shifts in global economic trends,

and the ongoing energy transitions. This shift signifies the majors' potential shift towards diversification, potentially moving away from solely focusing on prospecting for new oil reserves.

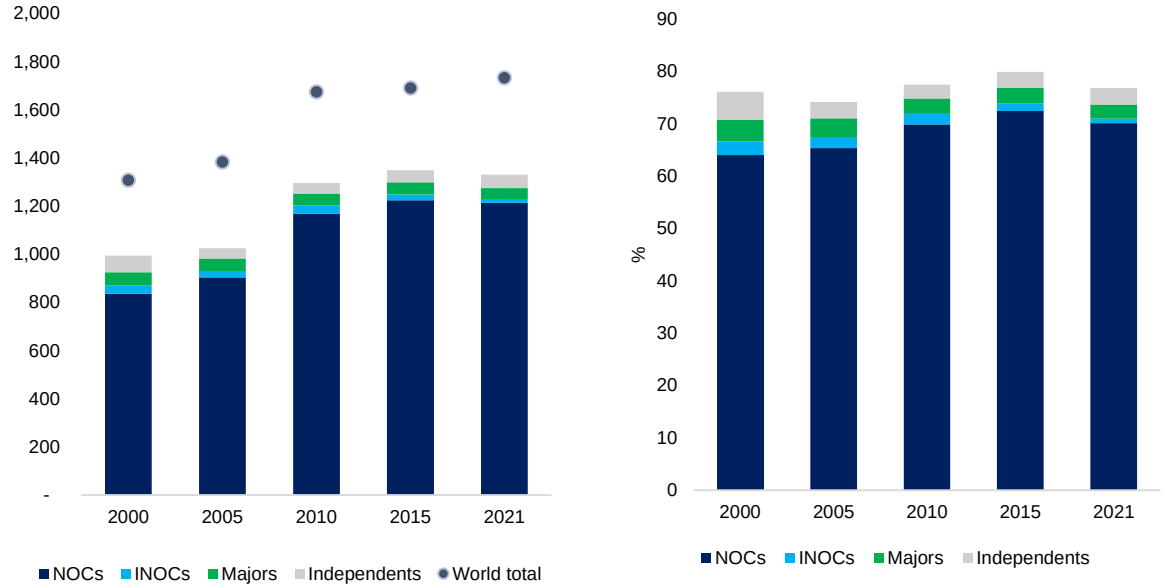
The comparison of oil and gas companies' ownership of global oil reserves unmistakably highlights that NOCs stand as the principal players in the oil market and are the last man standing. However, they also bear a relatively higher exposure to the risks associated with the energy transitions, notably the prospect of stranded assets.

While NOCs' vast reserves play a crucial role in meeting global oil demands and ensuring a stable energy supply, they confront the looming possibility of these reserves losing value as the energy transitions gains momentum. To address this challenge, a potential solution lies in the decarbonisation of their oil and gas operations and the provision of cleaner fuels.

It is important to highlight that NOCs' control over depleted reserves presents an opportunity for these entities to serve as essential storage facilities for emerging energy transition technologies, including Carbon Capture, Utilisation, and Storage (CCUS). This innovative technology offers a cost-effective means of storing carbon dioxide, thereby making a substantial contribution to global efforts aimed at reducing emissions. The gradual acceptance and adoption of CCUS are gaining momentum, and repurposing depleted reserves for this purpose could offer a pragmatic solution to address pressing environmental concerns.

Essentially, as NOCs navigate the challenges of a changing energy landscape, they have the capacity to not only maintain their relevance but also actively contribute to the transition to cleaner energy sources, as well as the mitigation of climate change. This transformation aligns with their dual goals of energy security and environmental sustainability.

Figure 4. Oil and gas companies ownership of global oil reserves (billion barrels)



Source: Author calculation based on Energy Intelligence data (2022)

Despite recent efforts by major oil companies to diversify their portfolios away from oil, their distinctive business models, objectives, and operational geographies continue to set them apart from NOCs. This divergence in approach highlights the multifaceted nature of the energy industry, where both NOCs and majors navigate a complex landscape driven by economic, environmental, and technological considerations.

2-2-4 NOCs gas reserves ownership

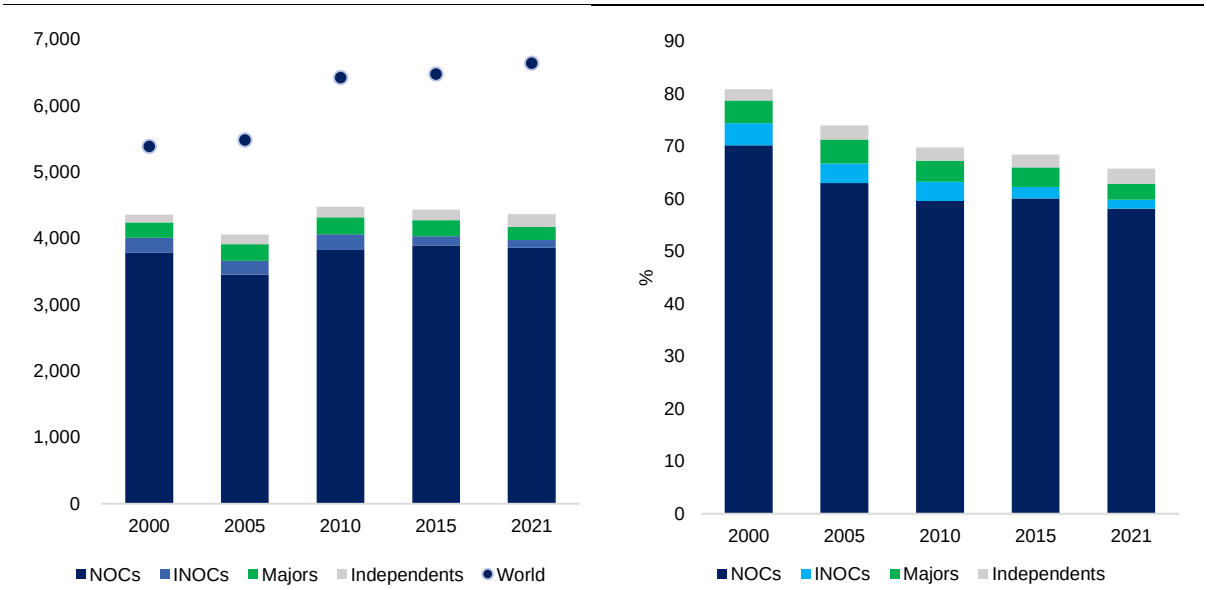
Global gas reserves have long been regarded as a crucial parameter to ensure an abundant energy supply, regardless of the trajectory of energy transitions. Historically, these reserves have exhibited an upward trend, climbing from 5,386 trillion cubic feet (tcf) in 2000 to a substantial 6,640 tcf in 2021, as shown in Figure 5. Presently, NOCs retain approximately 60% of these reserves, a notable shift from their historical share of 74% in 2000. Despite the drop over the two decades' scope of this report, NOCs have sustained their prominent position in gas production, compared to IOCs, who have witnessed a more significant reduction in their gas reserves, plummeting from 4.3% in 2000 to 3.0% in 2021. This divergence in the trajectory of gas reserves highlights the NOCs' enduring influence in the energy sector compared to the more substantial setback faced by IOCs over the same period.

The findings regarding the distribution of global oil reserves among oil companies also hold true when examining gas reserves. NOCs, as the dominant players in the gas

industry, grapple with the challenge of balancing increased gas production to ensure reliable and affordable energy for global inclusive and sustainable development while simultaneously reducing greenhouse gas (GHG) emissions to safeguard the environment.

A significant differentiator between oil and gas lies in the notable environmental credentials of natural gas. Amidst ongoing discussions about energy transitions, natural gas reserves continue to hold a central role. Recognised as one of the cleanest fossil fuels, natural gas possesses distinct advantages that mitigate its likelihood of becoming stranded assets, even amidst accelerated transitions. This resilience can be attributed, in part, to its importance as a feedstock for hydrogen, ammonia, and other electro-fuels, as well as its increasing acceptance among global energy consumers due to its minimal carbon footprint.

Figure 5. Oil and gas companies ownership of global gas reserves (tcf)



Source: Author calculation based on Energy Intelligence data (2022)

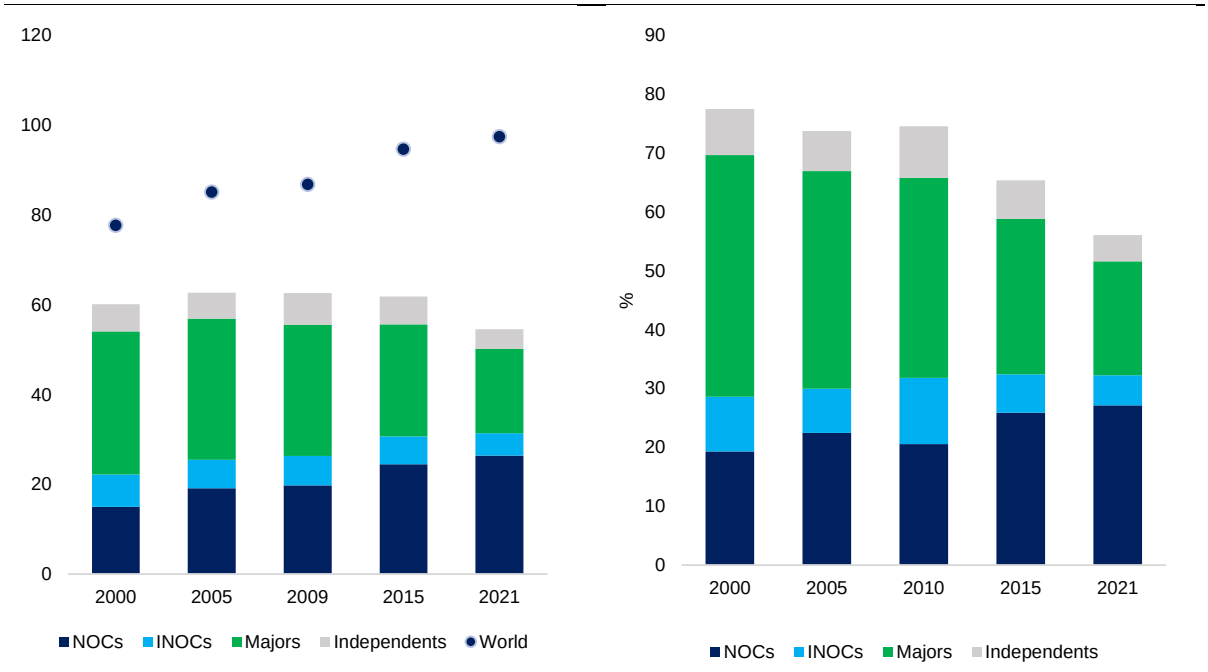
The ongoing energy transitions discourse continues to underscore the importance of natural gas reserves. These reserves remain integral to the evolving energy landscape due to their role as a key component in the production of blue hydrogen. The production of blue hydrogen by NOCs positions them as potential suppliers of low-cost hydrogen, a prospect that aligns seamlessly with their substantial reserves. As the energy industry navigates the complex dynamics of transition, NOCs stand poised to contribute significantly as producers of blue hydrogen, a critical element in achieving a more sustainable energy future.

2-2-5 NOCs oil products market shares

As far back as 2000, the ownership and control of oil production and reserves have been firmly held by NOCs, while the complex infrastructure for oil products, such as refineries and distribution networks, largely fell within the domain of major international corporations. However, the trajectory of this landscape began to shift around the turn of the millennium.

Since the year 2000, a transformative trend has gradually emerged: NOCs have steadily increased their involvement in the downstream sector, particularly in product sales. This shift in focus has been nothing short of remarkable, as NOCs' product sales surged from 15 mbd to a remarkable 26.4 mbd in 2021. Strikingly, this momentum has even outpaced that of the major international players since 2015, cementing NOCs' ascendancy in this arena and securing a substantial 27% market share by 2021, while their major counterparts found themselves with a more modest 19% share, as shown in Figure.6. This trend clearly illustrates NOCs are actively pursuing strategies aimed at enhancing the vertical integration of their operations. Their goal has been to maximise the value derived from oil and gas production by efficiently delivering the final products to end consumers.

Figure 6. Oil and gas companies market share in the product market (mbd)



Source: Author calculation based on Energy Intelligence data (2022)

Interestingly, another integral player in this dynamic is the INOC. Throughout this evolving landscape, INOCs have played a role that is relatively consistent with their historical position. This development can be attributed to strategic investments in oil processing and conditioning facilities that took shape over time. These forward-looking investments have paved the way for the emergence of critical sectors such as petrochemicals and refining. As the complex web of petrochemical plants and refineries emerged, the downstream sector became an ever more integral component of the broader energy industry landscape, contributing to the substantial transformation witnessed in recent years.

The interplay of these trends underscores the shifting dynamics of the oil and gas industry. While NOCs have historically held the reins in the realm of oil reserves, their ascendant role in product sales, coupled with the pivotal role of INOCs in facilitating downstream growth, has led to a new equilibrium. This multifaceted evolution highlights the industry's capacity for adaptation and innovation in response to changing market demands and technological advancements.

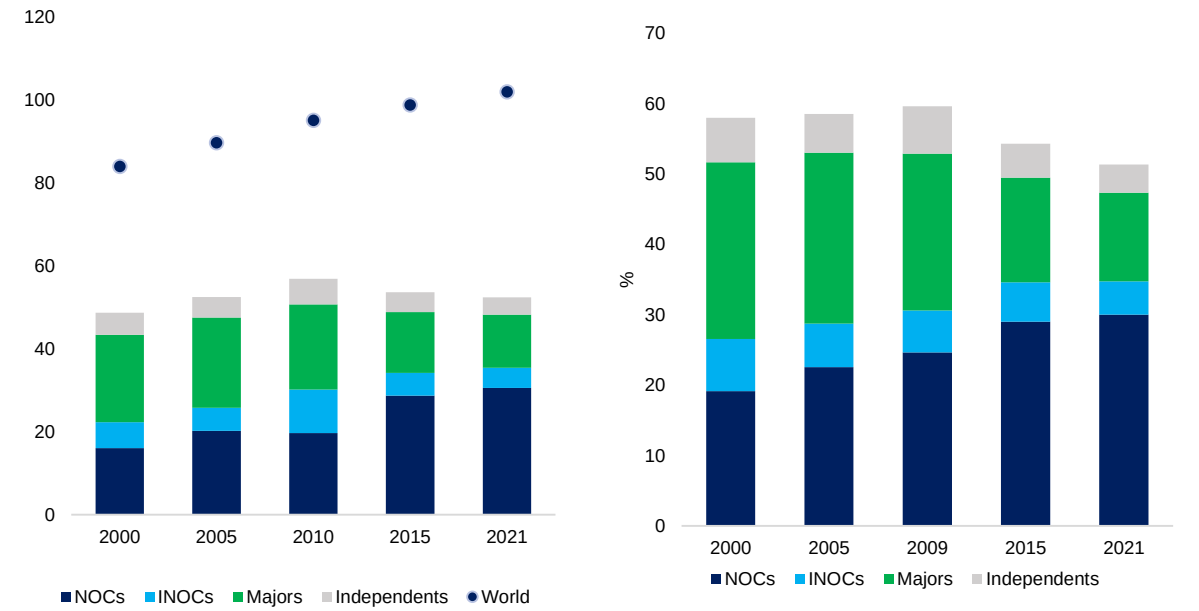
2-2-6 NOCs refining capacity

Over the course of two decades, a profound transformation has been unfolding in the global refining landscape, reshaping the roles and fortunes of NOCs and major international corporations. The refining capacity of NOCs has experienced a noteworthy upward trajectory, surging from a modest 19% in 2000 to a significant 30% by 2021. This dynamic shift contrasts starkly with the majors' declining fortunes in this arena, as their refining capacity has dwindled to half its former strength over the same period. By 2021, the NOCs' refining prowess stands at an impressive 30 mbd, dwarfing the majors' diminished 13 mbd refining capacity shown in Figure 7.

These divergent trends in refining capacity have unfolded against the backdrop of a global surge in oil demand, which has soared to nearly 101 mbd. The majors' inability to maintain their refining capacity amidst this heightened demand signals a potentially seismic shift in their business models. The position of NOCs' growing refining capacity and the majors' contraction raises significant questions about the strategic direction and adaptability of the latter group. The erosion of their refining presence, coupled with the persistent demand for petroleum products, underscores the complexities and

challenges major international corporations face as they navigate a changing energy landscape.

Figure 7. Oil and gas companies control over refining capacity (mbd)



Source: Author calculation based on Energy Intelligence data (2022)

The contrasting fates of NOCs and major players within the refining realm point towards a larger industry shift. NOCs' expanding refining capacities reflect their concerted efforts to harness greater value from their resources, diversify revenue streams, and enhance their position in the global market. In contrast, the majors' decline in this domain signals the need for re-evaluation and adaptation in light of changing market dynamics. The emerging landscape necessitates strategic recalibration, with a focus on sustainable growth and resilient business models that can navigate the evolving energy ecosystem.

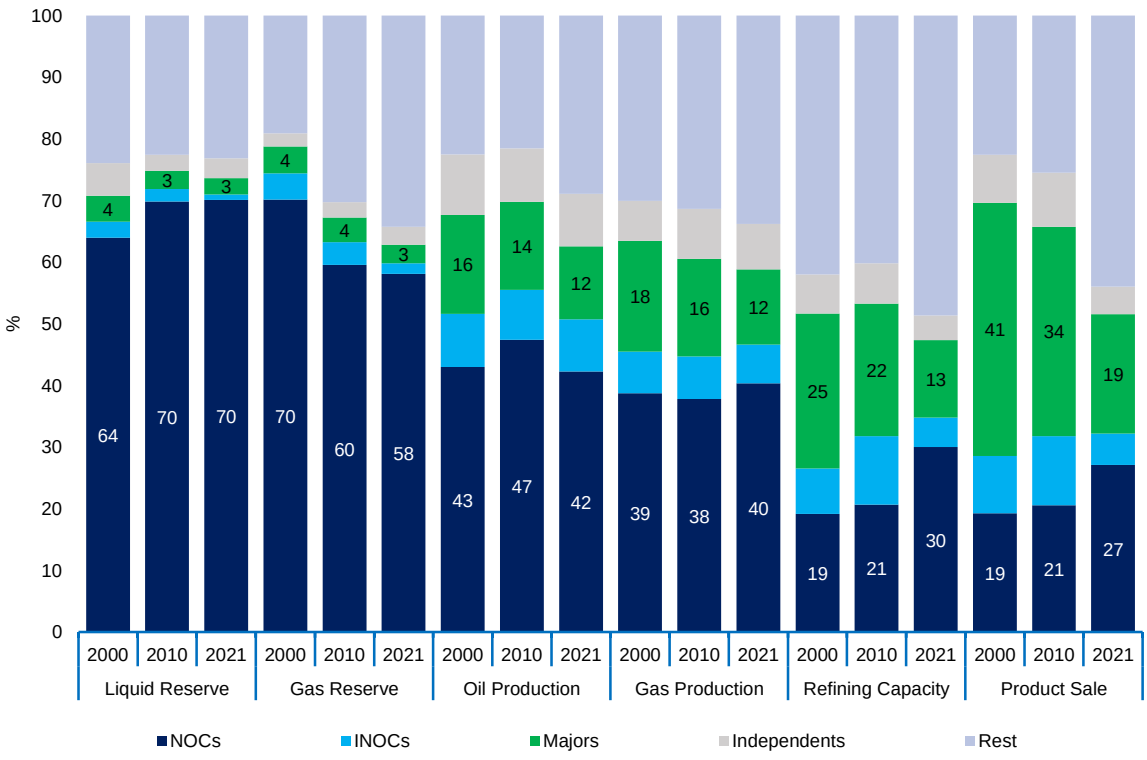
2.2.7 Oil and gas supply-chain picture

The majority of global liquid and gas reserves are predominantly under the ownership and control of NOCs, reflecting their pivotal role in the global energy landscape. These state-owned entities are entrusted with the management and stewardship of their countries' hydrocarbon resources. With their extensive access to reserves, NOCs wield significant influence over the global supply of oil and gas. Notably, they are responsible for producing over half of the world's oil and gas, contributing to both energy security and economic development for their respective nations. Their

dominance in reserves and production underscores the central role NOCs play in shaping energy markets and geopolitics.

Moreover, NOCs have exhibited an elevated level of integration within the energy value chain. Beyond exploration and production, many NOCs have diversified their operations into downstream activities, including refining and product sales. This strategic move allows them to capture additional value from their hydrocarbon resources and secure a stable revenue stream. By vertically integrating into downstream sectors, NOCs gain greater control over the entire lifecycle of their products, from extraction to distribution, as shown in Figure 8. This level of integration not only enhances their ability to manage price fluctuations but also provides them with a stronger foothold in the market. As NOCs continue to play a central role in the energy sector, their multifaceted activities contribute to shaping the dynamics of both global energy markets and domestic economies.

Figure 8. Oil and gas companies' position in the supply chain (%)



Source: Author calculation based on Energy Intelligence data (2022)

3- Concluding remarks:

Over the coming three decades, energy demand is set for a significant and dynamic expansion, a trajectory that remains resilient to the ongoing energy transitions

sweeping the industry. This growth is driven by population growth, global economic expansion and the quest for higher standards of living, creating an engaging landscape for energy sector stakeholders.

The strategic necessity of protecting the environment, while inherently aligning with the pursuit of enhanced competitiveness, intersects with a multifaceted array of factors. This includes not only adapting to evolving regulatory environments but also aligning with the shifting expectations of discerning financial investors. Moreover, it involves recognising the escalating significance of a company's environmental footprint in the ever-evolving dynamics of international competition. In particular, decarbonisation has emerged as a multi-dimensional compass steering the energy industry toward a sustainable future.

Presently, the energy sector is experiencing a dynamic phase of innovation akin to Schumpeterian creative destruction. Within this dynamic setting, we witness the emergence of groundbreaking technologies, novel operational practices, and pioneering business models, fundamentally reshaping the established energy landscape in profound and unexpected ways. This wave of innovation is redefining the boundaries of what is possible in the energy sector.

In this transformative context, NOCs, notable institutions within the industry, are assuming a pivotal and nuanced role. They find themselves at the crossroads of addressing the urgent climate challenge while embracing the boundless opportunities that the future holds. Striking a delicate balance between tradition and innovation, NOCs are charting a course that not only ensures their relevance but also positions them as influential agents of change.

NOCs, often considered the last man standing in the oil and gas sector, are displaying remarkable adeptness in crafting decarbonisation strategies that effectively navigate the complex risks associated with energy transitions. Simultaneously, they are displaying foresight by strategically positioning themselves to seize the growing opportunities within the burgeoning carbon market, recognising that sustainability can also be a source of prosperity.

Within the framework of decarbonising the oil and gas industry, several pivotal technologies take centre stage. Energy efficiency, reducing gas flaring and methane emissions, and Carbon Capture, Utilisation, and Storage (CCUS) stand as the

cornerstones of this transformative journey. These technologies are not just tools; they are the foundational building blocks for shaping a more sustainable, responsible, and climate-resilient energy future.

Looking ahead to the near future, we foresee the emergence of an expansive CCUS industry, one that parallels the competencies and stature of its oil and gas counterpart. This development, expected to materialise over the next three decades, is set to redefine the energy landscape, reshaping the practices and priorities of carbon management and emission reduction efforts. It expects to diversify the portfolios of energy companies and unlock new possibilities in the pursuit of climate goals.

However, it is paramount to acknowledge that, amidst this transformative journey, there is no one-size-fits-all strategy. Individual oil and gas companies are confronted with unique circumstances, possess distinct resources, and face particular challenges. Therefore, tailored approaches and strategies are essential to effectively navigate the intricate terrain of decarbonisation. Flexibility and adaptability will be the watchwords for success as we embark on this transformative journey toward a sustainable, low-carbon energy future. This journey is not just about meeting environmental objectives; it is also about ensuring the resilience and prosperity of the energy industry in an ever-evolving world.

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