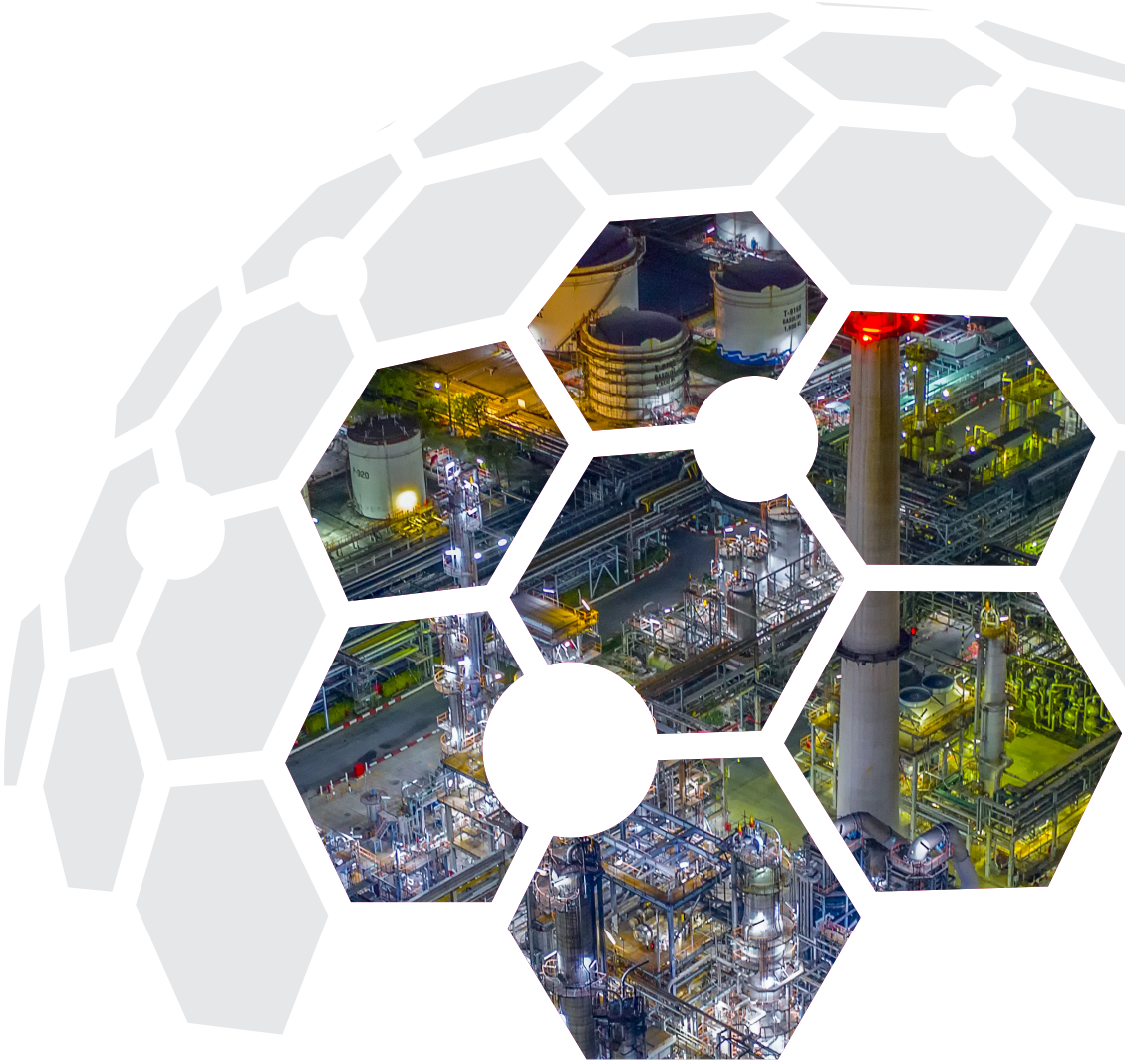
REALIZING OPPORTUNITIES FOR THE 21ST CENTURY THROUGH RESILIENT GLOBAL VALUE CHAINS

PETROCHEMICALS



IsDB
البنك الإسلامي للتنمية
Islamic Development Bank

THE FUTURE
Volume 2

Petrochemical plant at twilight, Southeast Asia - Large-scale industrial complexes provide efficiency gains over small-scale plants

REALIZING OPPORTUNITIES FOR THE 21ST CENTURY THROUGH BUILDING RESILIENT GLOBAL VALUE CHAINS

For people everywhere, everyday life is unthinkable without petrochemical products. The sector contributes some USD 5.7 trillion to global GDP. Despite owning nearly 60% of global oil and gas reserves, IsDB member countries contribute only 22% to petrochemical output.

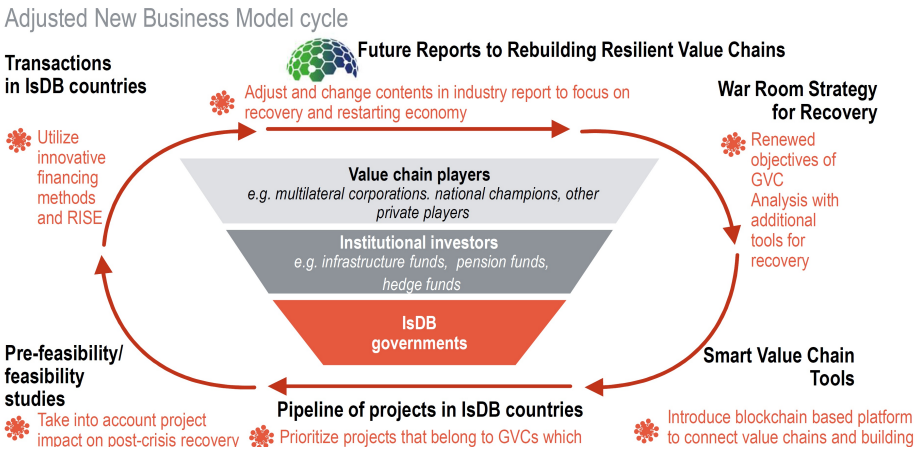
The coronavirus pandemic and the Great Lockdown since early 2020 poses unprecedented challenges that may streamline and restructure the overall petrochemical industry especially in IsDB member countries that consume or produce petrochemical products.

This report provides a vision, strategy and uses the value chain approach at its core in "Rebuilding Resilient Value Chains for the Future" that is increasingly important in the globally disrupted supply chains and provides IsDB member countries unique and innovative recommendations in facing the rising challenges in different parts of the petrochemicals value chain.

IsDB member countries need to take action now to create additional capacities, increase their productivity and transform their business models in order to support stable growth and innovation. In this report, IsDB offers an indepth view on key trends and initiatives that will shape the future of its 57 members through 2030 and beyond.

These initiatives require strong partners who jointly drive investments and disseminate knowledge in IsDB member countries. Looking ahead, such investments will unlock IsDB member countries' potentials for adequate employment and equitable living conditions, while providing private sector partners access to some of the fastest-growing economies worldwide.

To create and sustain a virtuous cycle for partnership and investment, the IsDB adopted a new business model that aims to Make Markets Work For Development. The new business model integrates strategic programming at the global level, country level, and even operations level. The Figure below is a demonstration of this integrated approach.



Dr. Bandar M. H. Hajjar

FOREWORD

A MARKET OF POTENTIAL – 57 COUNTRIES OFFERING GROWTH AND INVESTMENT POTENTIAL ACROSS A SET OF CORE INDUSTRIES

Our 57 member countries represent the purchasing power of almost a quarter of the world's population, with a joint GDP amount of roughly USD 7 trillion. Our countries include many of the fastest growing economies worldwide, with GDP growth rates of up to 8% per year. The economies of our member countries have much potential to further increase their market share in the global economy. However, with the coronavirus pandemic that is threatening the global economy at unprecedented levels, both from the global supply and demand side, our member countries may be vulnerable in short to long term.

As the development arm of our integration, IsDB has identified a set of core industries in which its members hold distinct comparative advantages. Petrochemicals is one of them, because it provides substantial value creation potential by building on the strategic advantage of our member countries. Oil and gas are the most important natural resources for our member countries. For many of them, the petroleum and petrochemical industries are the biggest contributors to exports and very important providers of good-quality jobs.

Yet while most of our member countries are net exporters of crude oil and gas, they are still net importers of high-value petrochemical products, the next downstream step in the petroleum value chain. This is an alarming situation, because natural resources are being exported without any new value being added. We are missing out on the opportunity of millions of jobs and billions of dollars of extra revenue from expanding into the petrochemical industry. Therefore, it has never been more crucial to develop primary and secondary processing from our inherent comparative advantage. Doing so will make our countries more resilient to petroleum price shocks.

DRIVING DEVELOPMENT, GROWTH AND INNOVATION TOGETHER – A NEW APPROACH TO DOING BUSINESS WITH THE ISLAMIC DEVELOPMENT BANK

In its 10-Year Strategy, IsDB has set clear goals to galvanize private and public investment in the economic and social development of its member countries to the greatest extent possible. To sustainably drive modernization and growth, IsDB places strong partnerships between the private and public sectors at the core of its strategy. The petrochemical sector requires such partnerships along its entire value chain, from oil and gas exploration and electricity generation to chemical production and further processing for the end industries that foster demand. This can also include education and training, as well as partnerships to drive innovation and R&D.

The development of the petrochemical industry requires very substantial capital expenditures, plus strong links to the global value chains of many other end-user industries. IsDB aims to plot a roadmap for a collaborative network of private and public entities at the OIC level in order to create the required market size and foster opportunities for flourishing end-user industries. This in turn will drive innovation in the petrochemical and other industries. By adding greater value in these highimpact/ high-growth industries, our member countries will be able to collectively evolve from oil-producing countries to technology developers, while at the same time diversifying and increasing their portfolio of products.

The sector insights contained in this Report and its critical view of the challenges, opportunities and potential that lie ahead provide a valuable baseline and starting point for future collaboration.

A crisis like the global pandemic is an opportune time to change course. Let us start right now.

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EXPOSITION

The Year 2020 marks a key milestone for globalization forcing the world nations to make an important choice: “To Deglobalize” or “To Reglobalize”. In light of the expansion of protectionism globally, the steady increase in the population with at least 40 million young men and women annually entering the job market, and the acceleration of structural challenges as a result of the fourth industrial revolution and the Covid-19 pandemic, the world sits at a crossroad with major trade-offs to make.

This publication belongs to a series of publications that aim to create a feasible pathway for Reglobalization or the active evolution and reform of globalization by world leaders to make it more Resilient, Smart, and Inclusive. This book demonstrates, for instance, how resilience in Global Value Chains can be achieved while maintaining optimal efficiency. By capitalizing on the intrinsic comparative advantage of developing countries, global markets can have alternatives that are as efficient in times of crisis. This not only makes globalization more resilient but also inclusive of nations that have been left behind historically.

The Future is a series of publications, led by the IsDB Department of Strategy and Transformation (DoST), dedicated to forecasting economic trends, emerging global priorities, and helping Member Countries to be better prepared to meet them. The chief aim of the series is to help create global coalitions that are driven by a shared vision of the future of humanity and the world.

Dr. Ahmed Elkhodary
Director of Strategy and Transformation
Islamic Development Bank (IsDB)

EXECUTIVE SUMMARY

The petrochemicals sector is of tremendous importance for the world in general and for IsDB economies in particular. By taking swift resolute action, IsDB member countries can....

... become more self-sustainable and reduce dependence on petrochemical imports from non-IsDB countries

... double value creation by exploring primary and secondary processing steps and leveraging their unique access to petrochemical feedstocks such as oil and gas

... create thousands of highly skilled jobs, with positive spill-over effects in education, governance and overall industrial competitiveness

HOW WILL THE INDUSTRY LOOK LIKE WITH THE GLOBAL PANDEMIC?

Over the next decade, developments in the petrochemical sector will also be influenced by global megatrends and trends in end industries – demand for petrochemicals is expected to grow

- The coronavirus pandemic may lead to negative growth for most petrochemical products in 2020 compared with 2019 due to weakening downstream demand. This decline coupled with declining oil prices is very alarming for IsDB Member countries
- Demand for petrochemicals is expected to rebound in 2021, depending on the prolonged severity of the corona-virus pandemic. In a fast recovery scenario, the industry is projected to rebound with a long term growth that may surpass USD 2 trillion by 2030, driven by increasing income levels and a growing global population
- Access to petrochemical feedstocks, in particular shale gas and crude oil, continues to be a competitive advantage. Despite a trend toward renewables, oil and gas are here to stay
- Rather than radical and game-changing innovations, incremental process efficiency gains and economies of scale to secure cost competitiveness will remain the driving force
- Overall industry development is guided by the needs of end industries such as packaging, construction, automotive, electronics and textiles – this holds true especially for new applications and efforts toward sustainability

PETROCHEMICAL SECTOR – WHERE ARE WE NOW?

While IsDB countries are currently focused on producing base chemicals and commodity petrochemicals, considerably greater value is added through secondary processing to produce engineered plastics and specialty chemicals. Deeper integration along the value chain and a broader product portfolio will increase value creation for IsDB member states in the future

- 50% of value creation in today's USD 1.5 trillion market for formulated petrochemicals comes from the production of finished chemicals – IsDB countries still focus predominantly on base chemicals, which only contribute 20% to total value creation
- While IsDB member countries possess 59% of global oil and gas reserves, they contribute only 22% of petrochemical output – substantial upside value creation potential remains to be tapped by IsDB member countries due to the high value of petrochemicals
- IsDB member countries are well positioned in the global value chain for base chemicals and commodity plastics, but development potential remains in engineered plastics such as polycarbonate (PC) and specialty chemicals such as surfactants and synthetic rubbers
- The IsDB member states as a whole are a net importer of petrochemicals – IsDB capacity can be increased to reduce dependence on imports from non-IsDB countries

HOW READY ARE IsDB COUNTRIES FOR THE FUTURE?

While certain countries are global leaders in the petrochemical industry, others are in the early stages of industrial development. Tailored strategies need to be implemented to increase petrochemical value creation across all IsDB member countries

- "Domestic formulators," which do not yet have a significant petrochemical industry, must address infrastructure deficits, streamline bureaucracy, improve qualifications and attract foreign cooperation partners to grow this industry
- "Dormant potentials" have the benefit of feedstock access but their petrochemical industry remains underdeveloped – above all, they must address governance issues and improve access to FDI to boost domestic demand in relevant end industries
- "Rising stars" are established regional players that can play the innovation card, building on an already solid infrastructure to drive sustainability and curbing export volumes to increase domestic demand
- "Demand leaders" face the challenge of enlarging the petrochemicals share of their sizable economies – improving workforce qualifications would drive job creation and help scale up this industryand access to finance (e.g. financing instrument recommendations)
- Saudi Arabia – the "trailblazer" – can make itself even more attractive to FDI, stepping up end-industry demand to enhance value chain integration and increase its focus on specialty chemicals
- There is no lack of potential across all five clusters – filling the identified gaps is key to realizing each country's individual petrochemical industry

HOW TO UNLOCK THE POTENTIAL OF IsDB COUNTRIES IN A HIGHLY VOLATILE WORLD

Investments from the private sector, governments creating conducive conditions and collaboration among IsDB countries will foster value creation in the countries' petrochemical sectors

- As the petrochemical industry depends on state-of-the-art infrastructure, the current infrastructure gap in many IsDB countries must be bridged by an integrated approach at both the national and donor levels, with the support of international donors such as the IsDB
- Since the petrochemical industry is driven by end-industry demand, stimulating end industries through comprehensive industrialization strategies will indirectly attract the petrochemical industry, for which proximity to end industries is an important factor
- IsDB member countries need to improve training for quality jobs and tailor courses to the petrochemical industry's need for highly skilled employees
- Faced with growing awareness of sustainability issues, IsDB member countries can give themselves a competitive advantage by promoting innovation through partnerships and becoming front-runners in the sustainable and innovative petrochemical industry
- Closer collaboration between IsDB member states can provide mutual benefit across these countries by connecting and interweaving their industry value chains

KEY QUESTIONS ANSWERED BY THIS PUBLICATION

How will the industry look like with the Global Pandemic? And how future-ready are IsDB's member countries?

How and where is value being created in the global petrochemical sector? And how are IsDB's member countries positioned in the country?

How can public and private players work together to drive profitable sector growth in all IsDB countries?

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Asian construction worker – Drones for site inspection can help improve maintenance levels and reduce associated costs

1

HOW WILL THE INDUSTRY LOOK LIKE WITH THE GLOBAL PANDEMIC?

Amid current crisis, demand for petrochemicals is projected to grow over the long term

Despite declining demand for petrochemicals in 2020 due to the coronavirus pandemic, a growing population and increasing income levels are going to drive overall petrochemical demand upward in the long term

Capacity optimization and efficiency gains outshine radical innovation

Long-term and capital-intensive investment cycles force industry players to focus on optimizing current processes, not quantum leaps forward

End-industry demand guides the future of petrochemicals

Changing customer needs and demand from end industries cause the sector to explore new applications and become more sustainable

Feedstock access remains key

Following the recent rise of shale gas, oil will gain fresh momentum from new technologies such as crude oil to chemicals

Three main challenges shape the petrochemical sector

IsDB member countries must cope with volatile raw material prices and market environments, an innovation gap in sustainability and tightening regulation

1.1

GLOBAL TRENDS AND THEIR IMPACT ON THE PETROCHEMICAL SECTOR

The coronavirus pandemic has changed not only the global economic outlook, but it has also brought several uncertainties in the short to medium term. The uncertainty from the pandemic not only challenges the status quo of the petrochemicals industry, it may also redefine or restructure some parts of the value chains especially with the focus on end market demand that is predicted to be sluggish due to the Great Lockdown.

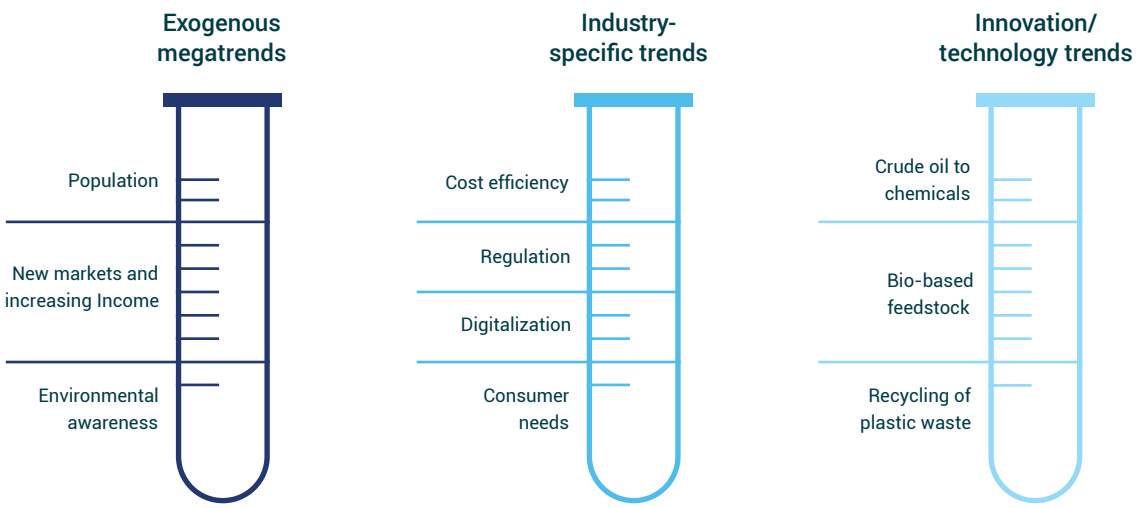
Even though demand may be challenging in the short term, petrochemicals is a vast global industry, organized in complex value chains that draws much of its feedstock from oil and gas, while producing intermediate and end products that are found in cars, detergents, medical devices and packaging to name a few that drives the global production of consumer and industrial goods.

The nature of the industry may see short term shifts in investments, reprioritization of projects, reorganization of certain value chains due to supply disruption and decline in output. However, the industry may remain intact at its core production given the vast and broad ranging products that depend on the industry. Depending on the pace of recovery, the growth rate of most, if not all petro-chemical products may be negative in 2020 compared with 2019. This decline in petrochemical demand coupled with declining oil prices may exacerbate the current economic crisis in many IsDB member countries that are dependent on both oil and gas and petrochemical earnings from export.

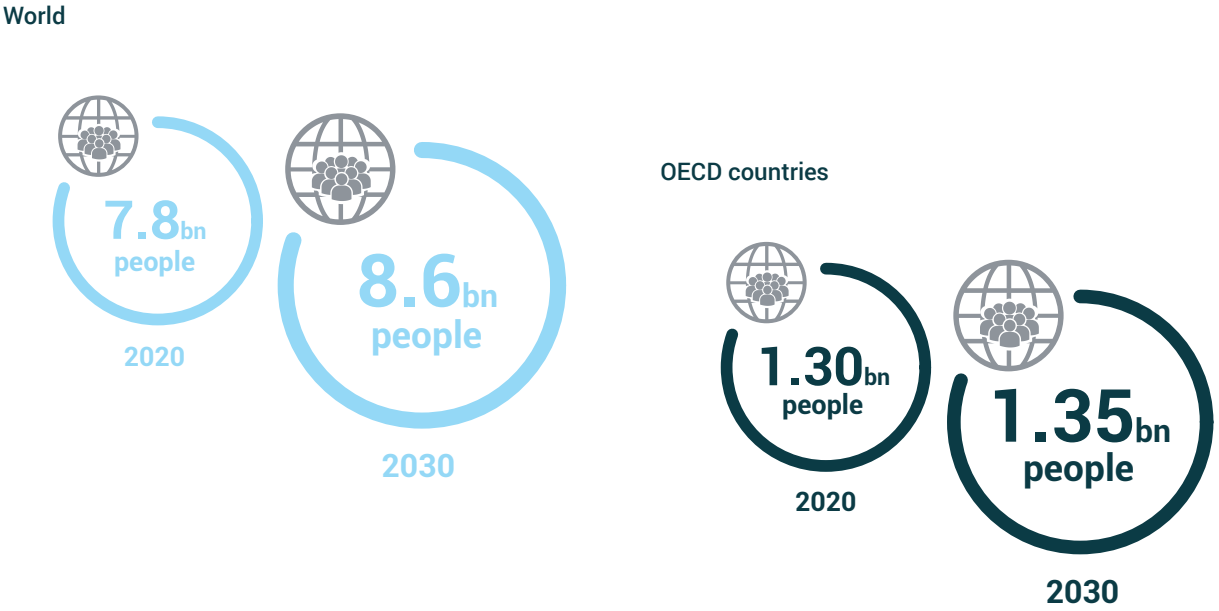
Unlike other previous crisis, such as the Global Financial Crisis, whereby petrochemical demand quickly rebounded led by policies especially from China which for instance shifted its focus to stimulate more local demand, this crisis is more global and affects both supply and demand. To date, similar policies is ineffective in the petrochemical sector.

However, given the vast ranging products in the petro-chemicals value chain, certain end market products may see some gradual rise in demand, although it might not completely compensate the loss of the overall demand. For example, despite the plummeting global demand in the industry, demand for sanitary and medical polymer may see an increase which is strengthened by packaging and medical devices end-markets. This is mainly due to increased healthcare sector activity such as the manu-facture of personal protective equipment, in addition to the fact that the Great Lockdown has resulted in consumers purchasing online delivery which requires packaging.

In addition, as we will theorize throughout this report, before the Covid19 pandemic we had two main views on the long-term outlook of the petrochemical industry. First, growth of petrochemical demand will be very



Population growth, 2020-2030



strong in the long-term. The proportion of oil refined to base chemicals has been growing significantly over the past years, which has helped oil lead firms invest on more primary processing capacity. Second, the share of the circular economy with more recycled plastics is becoming more and more important, and petrochemical lead firms are very active in driving this change.

In the long-term, depending on the pace of recovery, IsDB member countries should take the opportunity to reach out to the end-industry markets and increase the cost efficiency to compete in the global market. To help them respond to this question, it is important to explore three layers of trends that principally affect and shape the petrochemicals industry: exogenous megatrends, indus-try-specific trends and innovation/technology trends.

EXOGENOUS MEGATRENDS

Exogenous global trends influence the long-term outlook for the petrochemicals landscape. The most far-reaching impact on this sector is likely to be rooted in population growth, the emergence of new markets driven by rising incomes, and environmental awareness.

The first major trend shaping the petrochemical industry concerns demographics. The world's population is expected to increase from 7.8 to 8.6 billion by 2030, with more than 90% of this growth originating from lower-middle income economies such as Nigeria, Pakistan and India. Petrochemicals are used in packaging, buildings, cars, electronic devices, textiles, detergents – in other words, in a wide range of products used by almost everyone. Logically, therefore, global population growth will also increase demand for petrochemicals in general, especially in many IsDB countries.

Alongside this demographic trend, the global economic situation in recent years has contributed to the emergence of new markets for end industries that use petrochemicals. Worldwide GDP per capita topped USD 11,000 in 2018 – its highest level ever and twice the figure from the year 2000. This gain reflects increasing industrial output, but also increasing income levels, and they trigger demand. China and India, for example, have seen their middle classes expand significantly. As demand for end-industry products grows in these markets – and as consumption relentlessly rises even in established markets – the end industries themselves naturally need more petrochemical substances, intermediates and products. In combination with demographic growth, this upward spiral thus both adds to demand for and highlights the tremendous importance of petrochemicals.

The third exogenous megatrend revolves around a growing awareness of environmental and sustainability issues. While there is broad scientific consensus that human activity affects the world's climate, regional impacts from a changing climate can differ significantly. Most parts of Africa will see freshwater becoming ever scarcer, prompting greater social unrest. On the other hand, natural disasters are expected to grow in magnitude and frequency in Oceania. In the long term, the Middle East and North Africa are forecast to spend less than 0.1% of their GDP on adapting to climate change. By contrast, extremely challenging situations – such as Somalia's struggle with alternating floods, droughts and locust plagues – should drive the highest percentage spend (about 0.5% of GDP) across the sub-Saharan region. Given its environmental footprint, the petrochemical industry cannot avoid or ignore this trend and must proactively work to master and/or adapt to these challenges.

Fifty years ago, sustainable environmental legislation was unheard-of in most countries. Today, however, the "paradigm has shifted from the 'pollutee suffers' to the 'polluter pays,'" to quote a recent UNDP study. Ever more consumers, regulators and producers alike are recognizing and speaking out on the need for the sustainable production of petrochemicals and their recycling. Above all in light of the substantial role they play in CO_2 emissions, petrochemical players therefore have no choice but to take action.

From an exogenous perspective, rising population figures, increasing income in new markets and growing environmental awareness will all drive the transformation of the petrochemical sector over the next decade.

INDUSTRY-SPECIFIC TRENDS

While the above trends are beyond the control of the petrochemical industry, a wide range of developments are also unfolding within this sector and its value chains. Some of these too are crystallizing into definite trends, including a focus on cost efficiency, stricter regulation to mitigate the industry's environmental impact, digitalization and changing consumer needs. All these trends rank as key drivers of the petrochemical industry.

Cost efficiency

Efficiency gains in every area are an important lever to cut costs and make the petrochemical industry more resilient and competitive. Superior process efficiency is trending as a crucial way to reduce downtime at capital-intensive petrochemical facilities, make better use of valuable resources and thus also keep a cap on the volatility of raw material prices. Energy efficiency, too – be it through behavioral changes or advanced equipment – slashes costs and shrinks the industry's environmental footprint.

Specifically, to reduce transportation costs, there is also a trend toward ensuring geographical proximity between petrochemical processing sites, end-industry processing sites and feedstock sources. Across IsDB member countries in the Middle East and Asia, this approach harbors powerful potential for the further development of the petrochemical industry.

Regulation

Petrochemicals are regulated by a raft of national laws and international agreements and conventions, with the latter tending to call for implementation at the country level on the basis of national regulations. Ongoing assessment of hazardous petrochemical substances dictates that these regulations will expand over time – a trend reinforced by growing public awareness of the environment and of the potential dangers of a poorly regulated petrochemical sector. To take just one example, the European Commission decided in 2016 to further limit the amount of bisphenol A (a carcinogenic organic synthetic compound that damages fertility) that can be contained in thermal paper and toys. In the same vein, recent years have seen a strong surge in regulations limiting or banning the use of plastic bags and single-use plastics, as well as favoring recycling. The spectrum ranges from regional charges on plastic bags (e.g. in Malaysia) to nationwide bans on plastic bags (e.g. in the majority of West and Central African countries). The petrochemical sector must therefore prepare itself to deal with tightening regulation around the globe in the future – not forgetting, of course, that this can also stimulate further innovation.

Digitalization

Around the globe, digitalization is a major disruptive trend that unfolds its full potential particularly in B2C environments. In B2B environments such as petrochemicals, its potential tends to be realized at a more evolutionary pace, stimulating other trends in the same industry. The impact of digitalization can therefore best be described as an enabler for further incremental improvements in process management. It facilitates further integration and better management of supply chains through blockchain technology, for example, as well as enabling more efficient plant control. Big data also holds out significant potential for the petrochemical industry as it facilitates more precise demand assessments and predictions. At the same time, digitalization lends substance to predictive maintenance, thereby limiting costly repairs and replacements. To harness the potential of digitalization, the Abu Dhabi National Oil Company (ADNOC), for example, is developing a digital and artificial intelligence vision.

This vision seeks to advance profitability, efficiency, health and safety, performance and workforce skills by pushing digitalization based on a range of instruments: status quo assessments, analysis of new business opportunities, roadmaps and international benchmarks, to name but a few. Recent changes in R&D at BASF furnish another example of how digitalization can affect the petrochemical industry. One key to this development is a supercomputer that places ten times as much computing power at the disposal of the company's R&D community. Introduced in late 2017, it can shorten time to market by significantly reducing the time it takes to simulate complex issues. Alongside physical experiments, this kind of virtual modeling is itself becoming a key element of petrochemical R&D.

In the petrochemical sector, the impact of digitalization will therefore be felt mostly in gradual efficiency gains. In B2C environments, it can help improve the customer interface by facilitating new IT sales platforms and educational product apps – for coatings and agrochemicals, for example – which could help the industry bypass intermediaries such as wholesalers. That said, the level of disruption that awaits the petrochemical sector is likely to be smaller than in other industry sectors. The illustration on page 34 summarizes the key areas where digitalization is bringing change and improvement to the petrochemical sector.

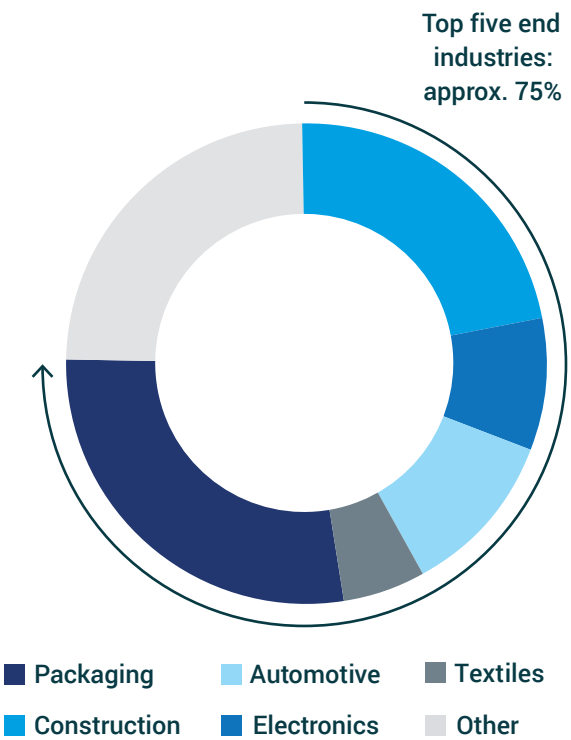
Consumer needs

Any trend in the petrochemical industry is ultimately driven by demand from end industries and consumers. Consequently, changes in consumer needs and product preferences also affect demand for petrochemicals. China, one of the fastest-growing chemical markets in the world, illustrates this point: As more and more segments of the population can afford more sophisticated products, demand for specialty chemicals is growing in this country. These inputs are used, for instance, in high-end personal care products, packaging for food ordered online and electric vehicles. This report therefore provides a detailed account of the singularly important issue of end-industry demand in the following chapter.

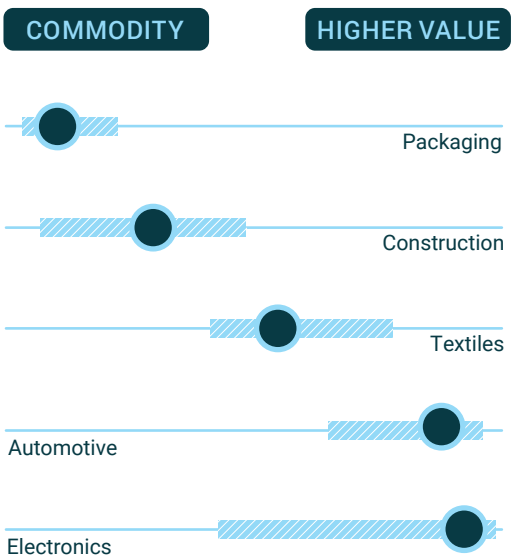
1.1 END-INDUSTRY DEMAND AND ITS IMPACT ON THE PETROCHEMICAL SECTOR

As emphasized in the previous sections, petrochemical products derive their value from the uses to which they are put in end industries. While they are indeed used in every area of manufacturing, five end industries alone account for around 75% of the global market for plastics – most of which are derived from petrochemicals.

Breakdown of the plastics market by end-industry demand (value)



Relative positioning of end industries in the plastics segment



To assess the prospects for the petrochemical industry as a whole, it is therefore crucial to analyze trends in the packaging, automotive, electronics, textiles and construction industries.

Given the very heterogeneous requirements illustrated in the figure above, these industries also constitute a good cross-section of different aspects of petrochemicals. Since detergents also represent the largest end industry for surfactants, we have selected the above five end industries plus detergents – six in all – as a basis from which to explore the future of petrochemicals in the sections that follow.

PACKAGING

INDUSTRY OUTLOOK

Revenue in the packaging industry is projected to grow by 3.3% p.a. between now and 2024, largely due to higher global consumer demand. Market saturation in developed economies means future developments must be seen to add greater value. In developing economies, demand for packaged goods is growing, but the packaging must remain affordable and functional.

IMPACT OF TRENDS ON THE PETROCHEMICAL INDUSTRY

Petrochemical companies must balance growing demand for commodity and higher-value plastics against an increasing focus on sustainable and renewable products. Sustainability will lead to less packaging per unit and, hence, less petrochemical content per unit, though this should be offset by volume growth overall. Packaging solutions must become more sustainable and new processes/innovative resins must improve recycling efficiency. Growing demand for renewable packaging feedstock will favor IsDB members that have access to this feedstock.

As online retail continues to boom, petrochemical players must also invest further in optimized formulations and innovative resins suitable for cost-efficient lightweight packaging.

AUTOMOTIVE

INDUSTRY OUTLOOK

Annual revenue growth of 3.3% is expected through 2024, buoyed by demand for new technologies and fuel efficiency in developed markets, and by higher disposable income (and growing demand for automobiles) in developing countries.

In today's mature automotive industry, strong growth opportunities demand heavy investment in five trends: mobility services, autonomous driving, digitalization, electrification and lightweighting. Mobility services are forecast to deliver 10-25% of OEMs' revenue by 2025, based on estimated consumer spending of USD 1.3 trillion.

IMPACT OF TRENDS ON THE PETROCHEMICAL INDUSTRY

Demand for polymers will increase in line with forecast automotive industry growth. At the same time, replacing steel with plastics and increasing plastic content per vehicle can profitably accommodate the lightweighting trend. Engineered plastics also add considerable value for OEMs and will find their way into cars across all price brackets.

ELECTRONICS

INDUSTRY OUTLOOK

Higher consumer spending should drive revenue growth of 2.7% p.a. in the next three to five years. This trend correlates with fast-rising incomes combined with relatively low product penetration in regions such as Southeast Asia. Increasing Internet usage worldwide and ever higher numbers of mobile phone subscriptions will account for much of this growth.

IMPACT OF TRENDS ON THE PETROCHEMICAL INDUSTRY

The positive outlook for electronics will keep demand for petrochemical products growing healthily, especially as plastics currently have virtually no viable substitutes in electronic devices.

Conversely, streaming services have taken over from CDs and DVDs and are showing how digitalization can negatively impact the petrochemical sector. Long-term widespread growth in mobile devices will nevertheless continue to drive volume (and possibly innovation) in petrochemicals.

TEXTILES

INDUSTRY OUTLOOK

A growing global population and higher disposable income should cause textile revenues to climb by 3.5% p.a. through 2024. Offshoring to low-wage countries will continue in the short/medium term, after which more textiles will be manufactured closer to their target markets – reducing both trade tariffs and time to market. Although technical innovation will continue to drive production automation, employment in textiles will continue to grow strongly in the years ahead.

IMPACT OF TRENDS ON THE PETROCHEMICAL INDUSTRY

Demand for synthetic fibers will increase in line with forecast growth in textiles, but also due to lower costs and more stable prices than, say, cotton. The nascent trend toward smart fabrics will reinforce demand for polyester (PET) and nylon (PA) fibers in particular. Innovations in these fibers should improve recycling capabilities in response to sustainability concerns, although some players may follow consumer preferences and shift back to natural fibers.

CONSTRUCTION

INDUSTRY OUTLOOK

All construction segments look set for substantial growth through 2030: housing (driven by population growth and urbanization), non-residential buildings (driven by industrialization) and infrastructure (driven by economic development). Smart technologies and energy efficiency will also keep the industry busy worldwide.

IMPACT OF TRENDS ON THE PETROCHEMICAL INDUSTRY

This ongoing growth, flanked by sustainability concerns, will stimulate more demand for high-performance petrochemical-based building materials (e.g. protective paints and coatings, insulation materials such as PU foams). However, given the focus of population growth in sub-Saharan Africa and Asia, however, petrochemical players must rethink their footprint and market proximity: Indonesia, Nigeria, Pakistan and Bangladesh will all rank among the top ten most populous countries by 2030 and have the potential to become significant manufacturing hubs.

DETERGENTS

INDUSTRY OUTLOOK

An increasing global population and the expectation of continued growth in per-capita disposable income will drive consumer spending on household goods (including detergents) up by 2.8% over the coming years. Demand for convenience packaging ("pods") is also rising sharply, as is the share of concentrated liquid detergents (especially in Western Europe).

IMPACT OF TRENDS ON THE PETROCHEMICAL INDUSTRY

Detergent industry growth will sustain rising demand for essential petrochemical components, subject to the trend influences described above. However, sustainability awareness will force producers to come up with formulations that use less water, permit lower wash temperatures and are less harmful to the environment. The type of surfactants needed will therefore change, stimulating further innovation in petrochemicals. Low oil prices would benefit petrochemical aspects of the detergent industry, but rising oil prices could push demand toward natural-based surfactants.

1.2
GAME-CHANGING INNOVATIONS AT A GLANCE

To properly serve all the end industries discussed above, the petrochemical sector relies heavily on technology and capital-intensive assets. Technological innovation therefore plays a crucial role in this sector, especially when it comes to enhancing value creation. Any analysis of innovation in the industry must, however, reflect the fact that the industry is roughly divided into the gas and oil camps. Historically, petrochemical feedstock has been oil-based, which remains the case for most national oil companies (NOCs). However, owing primarily to the boom in shale gas since the 2010s gas has now also gained importance as a petrochemical feedstock.

A new method known as, "crude oil to chemicals ", or COTC, is nevertheless swinging the pendulum back in favor of oil as a feedstock and is the subject of the first innovation case study in this chapter. By potentially cutting out an entire step in the production of petrochemicals, this technology has the potential to genuinely change the production game when it is fully scaled up.

The second case study explores the growing role played by bio-based feedstock. Especially in light of environmental and climate concerns, innovations in this area have the potential to sustainably reduce the petrochemical industry's carbon footprint. Yet renewable raw materials are also of considerable interest to IsDB countries that do not have access to sizable reserves of oil and gas, but that can harness bio-based feedstocks as an increasingly viable – and politically desirable – alternative.

Growing awareness of the need for sustainability has also brought the problem of recycling plastics sharply into focus. As governments worldwide tighten regulation on the use of certain plastics and, in some cases, increasingly insist on recycling quotas, the third case study examines the options afforded by chemical recycling as a way to convert used plastics into feedstock.

These three examples are merely that: promising examples indicative of so many areas where timely and carefully considered investment in innovation can help the petrochemical industry keep pace with the evolving needs of a changing world.

Aerial view of an oil refinery in Southeast Asia

1.2
CASE STUDIES
Innovations in petrochemicals

1 Crude oil to chemicals (COTC)

Crude oil to chemicals (COTC) is a method that effectively combines the refining and primary processing steps for petrochemicals. For countries with access to crude oil and an established petrochemicals industry, it harbors huge value creation potential as petrochemicals sell at much higher prices than crude oil. As Keith Couch, Senior Director Sales Support & Integrated Solutions at Honeywell UOP puts it:

"You can sell fuels for USD 550 a ton or convert them further to petrochemicals and get around USD 1,400 a ton"

This potentially game-changing innovation is capable of producing feedstocks such as liquefied petroleum gas (LPG) and naphtha in larger quantities than can be done with conventional technologies. The technology can be managed to provide a higher output of light products (COTC 1) or petrochemicals (COTC 2) and thus outperforms conventional integrated aromatics or olefin plants. It presupposes very heavy upfront investment, however, and is therefore only an option for certain countries.

Fluctuations in crude oil prices and increases in the price of conventional feedstock (such as naphtha) have been a powerful driver of this innovation. Crude oil to chemicals technology thus has the potential to significantly reduce refining costs.

Certain technical challenges nevertheless remain to be solved. For example, crude oil is harder to vaporize than conventional feedstock due to its higher boiling point and steam temperature. The need for more frequent de-coking cycles thus pushes up maintenance costs, and a lower olefin yield is the outcome.

Saudi Aramco and SABIC, **two IsDB member country firms**, have been leading the way in crude oil to chemicals innovation. In 2015, Saudi Aramco signed an agreement with CB&I and Chevron Lummos to commercialize the technology. Under the new method, the traditional cuts of a barrel of crude oil are fed into steam cracker furnaces. Feedstocks such as LPG and naphtha can then be produced in larger quantities than are possible with conventional technologies.

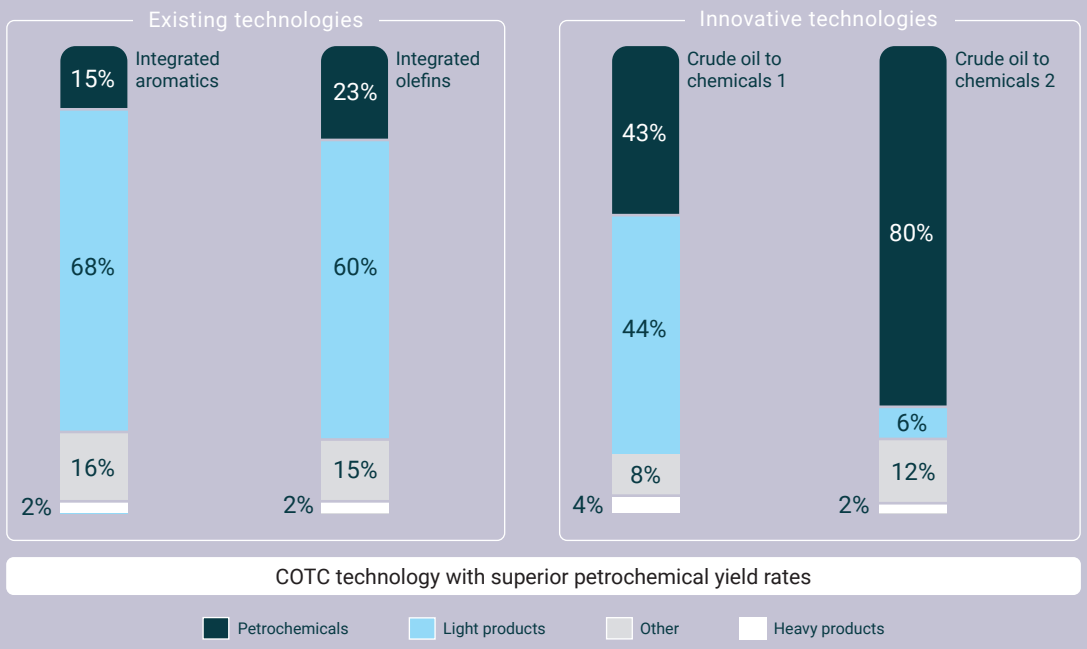
In cooperation with Siluria, Saudi Aramco has been pushing further innovation in this field using oxidative coupling of methane (OCM) technology. OCM directly converts natural gas into higher-value products such as ethylene.

Besides the issue of technological market maturity, several issues relating to the economic viability and appeal of this model must also be addressed. While COTC plants are expected to operate more competitively than existing naphtha crackers, construction costs, utilities, labor and the price of feedstock will naturally affect this calculation.

Discounts on crude oil feedstock relative to their market value would therefore seem a sensible way to pay off the up-front investment in crude oil to chemicals plants. In light of the cost of investment, countries with low extraction costs (such as Saudi Arabia and Iraq) are the most likely to adopt crude oil to chemicals technology.

In terms of market impact, a COTC facility the size of a global-scale refinery can yield about 4 million tons of ethylene and 3 million tons of propylene per annum, **which is 3-4 times the capacity of today's world-scale plants**. That is definitely an order of magnitude with the potential to bring disruption to petrochemical markets. As pointed out above, however, such a scenario will largely depend on the profitability of the required investments.

Refinery yields [% weight] from traditional and COTC processes (indicative)



1.2
CASE STUDIES
Innovations in petrochemicals

2 Bio-based feedstock

Chemical companies are increasingly using renewable raw materials. This is done by separating bio-based inputs such as corn and hemp into their different "building blocks" to generate outputs such as butadiene, pentanes and organic acids. Customer demand and regulatory developments are the main forces driving this trend.

Though they currently make only a minor contribution to global feedstock for the petrochemical industry, renewable raw materials offer several clear advantages. For countries with little or no access to oil and gas, they reduce dependence on imported resources and can thus play a part in developing a domestic petrochemical industry. Compared to oil and ethane-based feedstock, bio-based feedstock is also generally likely to be more sustainable and environment-friendly. Lastly, given the differences in input building blocks, renewable bio-based feedstock may expedite the development of products with attractive new properties such as biodegradability.

In countries that already have an established petrochemical industry, the appearance of bio-based feedstock initially implies a duplication of processes and facilities, they simply provide another way to produce known petrochemical derivatives. This consideration, however, has evidently not stopped a number of players in the industry from exploring this emerging option.

BASF, for example, now markets 1,4-butanediol (BDO), which uses cellulosic sugars, as a renewable feedstock. Another example is Neste, which sells renewable diesel. On the plastics front, Avantium and Toyobo are collaborating on the development of the fructose-based polymer polyethylene furandicarboxylate (PEF), which is 100% bio-based. PEF could be used in food packaging, for example, and should be on the market by 2024.

Another example is provided by Brazilian petrochemical company Braskem, which commissioned a bio-based ethylene plant in 2010 following years of research and development. The plant currently has an annual production capacity of 200,000 tons of polyethylene produced from sugarcane. To ensure the sustainability of sugarcane production for this purpose, Braskem's suppliers need to implement good environmental practices and respect biodiversity. Retaining the same properties as polyethylene of fossil origin, Braskem's bio-based polyethylene is used in the plastics production chain.

Due to the trend toward greater sustainability, work is already underway on innovative technologies to capture CO_2 for use as a raw material. Covestro and RWTH Aachen University, for example, have developed a way to combine CO_2 with plastic and use it in mattresses and special purpose soils – see the case study "Replacing oil with CO_2" on page 33.

This trend has the potential to help promote industrialization in a number of IsDB countries with little or no petrochemical industry. Oil and gas producing IsDB member countries can use CO_2 to further develop their

petrochemical industry without requiring more of their own oil and gas for feedstock, thereby improving their own environmental footprint. At the same time, IsDB member countries with no feedstock access could potentially become part of petrochemical value chains by capturing and using CO_2. This would appear most likely in cases where domestic or regional demand for petrochemical products comes from existing end industries. All these scenarios would, of course, have the desirable side effect of reducing CO_2 concentrations in the Earth's atmosphere.

Renewable feedstock such as palm oil or corn is on the rise for petrochemical materials

1.2
CASE STUDIES
Innovations in petrochemicals

3 Plastic recycling

Less than 20% of global plastic waste is currently recycled. Around the globe, growing awareness of the damage that unrecycled plastic can do to the environment is therefore spawning more and more initiatives to boost recycling rates. The European Commission, for example, has set a recycling rate target of 55% by 2030.

One recent trend that can help increase recycling rates involves what is known as chemical recycling, which transforms plastic waste into feedstock for new polymers. Chemical recycling offers major advantages over conventional recycling:

- **The polymers obtained from this process have the same characteristics as virgin polymers**
- **Producing polymers via chemical recycling is cheaper than producing virgin polymers**
- **Chemical recycling provides useful applications for plastics that would otherwise be unusable (for instance because they are contaminated)**

In spite of these benefits, challenges such as the cost of energy-intensive chemical recycling processes remain. Even so, awareness of environmental needs and ever stricter regulatory constraints are making this innovation more attractive.

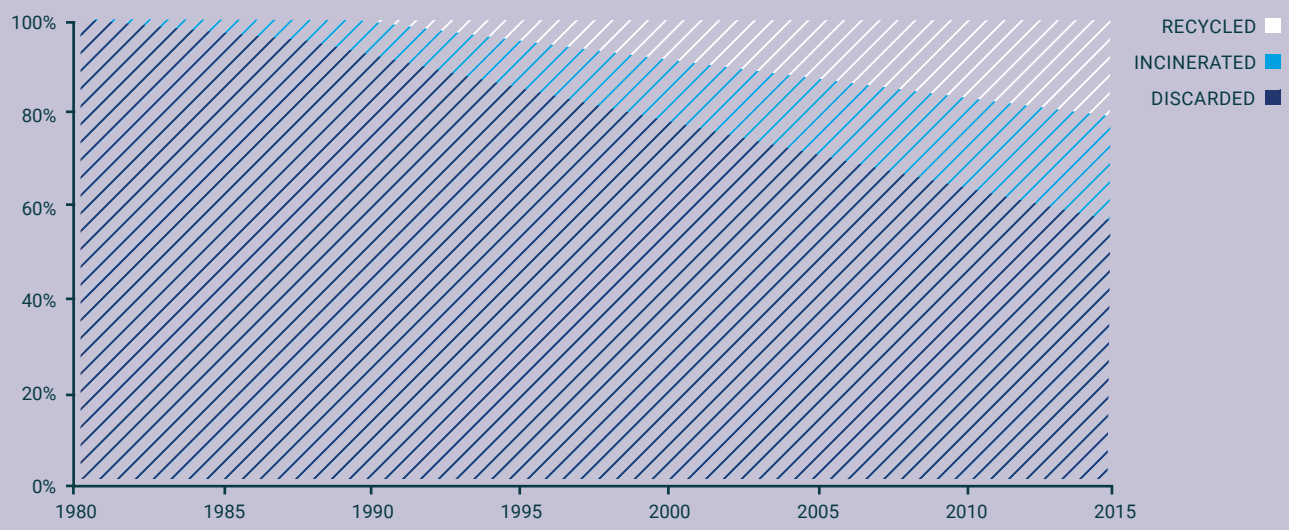
An assortment of players has already launched corresponding initiatives. Finland-based refinery group Neste, for example, has started using plastic waste as a source of feedstock for further refining and petrochemical production. With this thermochemical process, waste plastic is liquefied and converted into a material similar to crude oil. It then serves as polymer-grade feedstock. Now Neste is teaming up with German waste management company Remondis and Belgian recycler Ravago to build recycling capacity of 200,000 tons per year.

In Germany, Ineos Styrolution has succeeded in depolymerizing polystyrene into its original monomer. A plant is to be set up to scale the process. This initiative received public funding and was carried out in cooperation with external R&D partners. Ineos has been setting up partnerships with both food packaging and waste management companies to commercialize the process and its results.

Chemical recycling also figures on the agenda of key petrochemical players in IsDB member states. In Saudi Arabia, for example, SABIC has signed an agreement with UK-based Plastics Energy to use TACOIL, a feedstock based on end-of-life plastic, for the production of polyethylene and polypropylene at SABIC's facilities in the Netherlands. Similarly, in Malaysia, Petronas has signed a memorandum of understanding with Plastics Energy to conduct a joint feasibility study on the possibility of producing feedstock from local waste that is hard to recycle.

Given the broad range of chemical recycling initiatives currently in progress, its potential – to overcome feedstock scarcity, but also to deliver environmental benefits – is evidently seen as substantial. However, further innovation is necessary, however, especially to make the process less energy-intensive and thus more commercially viable and sustainable.

Estimated share of global plastic waste by disposal method



Tankers parked at an oil port The petrochemical industry is heavily dependent on reliable logistics

1.3

KEY CHALLENGES AHEAD

Global market and price volatility, an innovation gap and tightening regulation

Innovations such as those outlined in the previous section clearly demand heavy investment. Decisions on such investment nevertheless depend to a large extent on how the industry masters the challenges it faces. IsDB has identified three key challenges that are of special relevance to the petrochemical industry at the global level.

VOLATILE ENVIRONMENT

The first challenge concerns the **volatility of both the oil price and demand from different markets**. The price per barrel has fluctuated significantly over recent decades – witness the period between 2014 and 2015, when it plunged from USD 108 to USD 34. Especially for investors, volatility fuels considerable uncertainty in and around the petrochemical industry. While a low crude oil price makes feedstock comparatively cheaper, a high price is likely to encourage the emergence of bio-based feedstocks. At the same time, higher prices make new investment in crude oil refining more profitable while adding to the margin pressure on primary and secondary processors. As sustainability moves center stage, competitive pressure in the petrochemical sector will increase overall. In the same vein, **demand shifts across markets** will add to volatility. The global market for petrochemicals is still growing overall, thanks especially to the rise of the middle classes in the emerging markets of China and India, for example. Nevertheless, slow growth in Europe and North America presents a challenge, as supply chains have to be adjusted in order to better serve growing markets. Such shifts across markets thus also make long-term investment decisions more difficult. However, the chemical industry as a whole has, however, always been exposed to this volatile and cyclical environment. Markets move back and forth between overcapacity and supply shortages but do tend to maintain an equilibrium in the long term.

INNOVATION GAP

The second challenge is the relatively **high cost of innovation in the petrochemical industry**. These costs are driven by factors like the very asset-heavy nature of this sector. As a result, innovation (such as chemical recycling) typically requires significant investment in processing facilities, which obviously forces companies to try to maximize capacity utilization across new and existing facilities. Similarly, such innovations always run the risk of rendering important assets redundant, which negatively impacts the balance sheets of petrochemical companies. Another cost driver in petrochemical innovation is the fact that, as things stand, crude oil is still cheaper than renewable feedstock and recycled materials. Higher raw material and processing prices therefore continue to drive the use of virgin petrochemical products and further impede innovation in this sector. In effect, the combination of slow growth in mature economies and the high cost of innovation gives rise to an innovation gap that must be addressed proactively.

TIGHTENING REGULATION

The third challenge is a **growing number of regulations worldwide on the use of plastics**. Regulations on plastic bags are currently in place in 152 countries globally, with most of them having been introduced since 2018. They range from regional charges on plastic bags (e.g. in two Malaysian cities) to full nationwide bans on plastic bags (e.g. in the majority of West and Central African countries). Increasingly, bans are also targeting single-use plastics beyond plastic bags. A proposed law in China, for example, aims to gradually ban all single-use plastics across the country between 2020 and 2022. Regulatory concern does not stop at plastic alone: chemical compounds such as

bisphenol A (a major raw material for polycarbonate) and the plasticizers used in PET and PVC have also come to public attention and are now in the sights of regulatory bodies. Although recent studies continue to demonstrate their harmlessness, regulation will likely step up efforts to investigate petrochemical products and oblige players in this market to comply with stricter rules on environment-friendly processing.

To succeed in the future petrochemical industry landscape, countries must address all these issues. Given that tighter regulation often stimulates innovation, great care must be taken when enacting laws and regulations that can impact the petrochemical industry. Even more importantly, governments must create economic environments that foster innovative technologies for recycling and crude oil refining, for example.

SELECTED INNOVATIVE APPROACHES TO MITIGATE THE CHALLENGES

Developments around the globe demonstrate that gaps can indeed be bridged, that challenges can at least be mitigated. For IsDB member states, the three examples presented overleaf are indicative of many areas that can send positive signals to the market and show the way forward.

1.3
CASE STUDIES
Deep dive into innovative approaches for increased sustainability

Countries around the world are already rising to the challenges discussed above: Indonesia is actively addressing the problem of plastic waste and the need to manage its recycling. In Germany, Covestro is exploring sustainable ways to find renewable resources that can also reduce exposure to volatile oil prices. And the issue of tire recycling – a major challenge worldwide – is being tackled by an Australian firm. These innovative approaches are only three examples of many areas in which IsDB member states can gain competitive advantages, pre-empt tighter regulation and make their petrochemical activities more sustainable.

1 Dealing with plastic waste in Indonesia

Indonesia is the second largest contributor to plastic debris in the world's oceans, surpassed only by China. Four of its rivers appear on the World Bank's list of the top 20 polluters, and the army has repeatedly had to be deployed to clear rivers and beaches of plastic waste.

To tackle the issue, the Indonesian government has tabled a plan that involves civil society and businesses. It is coordinated by the Ministry of Maritime Affairs and the Ministry of Environment and Forestry in cooperation with the Global Plastic Action Partnership (GPAP).

The plan is based on a data-driven approach. By collecting local waste management data in Jakarta, it aims to build an analytical model designed to reduce overpackaging, promote the use of innovative recyclable plastic materials, substitute materials wherever possible, increase recycling rates and improve waste collection rates. For each of these issues, the model estimates necessary investments, timelines and the impact on both the environment and people's lives. Based on these data-driven estimates, the relevant stakeholders can develop roadmaps to reach the desired outcomes.

The impact on the wider petrochemical industry could be profound, as innovative recycling technologies boost sustainability by curbing demand for virgin plastics and new, data-driven business models find their way into the plastic lifecycle. Confident that the plan can be replicated both across the country and internationally, Indonesia can position itself as a front-runner in stemming the flood of plastic waste and send a positive signal to the world.

2 Replacing oil with CO_2

German specialty chemicals company Covestro has started using carbon dioxide (CO_2) as a resource to substitute for traditional petrochemical-based raw materials. Covestro, a major player in polycarbonate and polyurethane, is currently using CO_2 as a component of mattresses and specialty floor coverings.

To develop the process for capturing and using CO_2 in this way, Covestro teamed up with RWTH Aachen University. Besides mitigating the effect of global warming by capturing CO_2, the process also helps reduce the amount of fossil fuels needed as feedstock. In light of such a potentially very strong contribution to sustainability, this innovative process has already won multiple global awards. Products already on the market have a CO_2 share of up to 20% and are manufactured at a production plant in Germany.

The innovation was first used to produce foam for mattresses and later as a binder for soil at a hockey club stadium in the German city of Krefeld. Nor does the list end there, as the scientists at RWTH Aachen push for further applications: CO_2-based synthetic fabrics, for example, will soon also be ready for market.

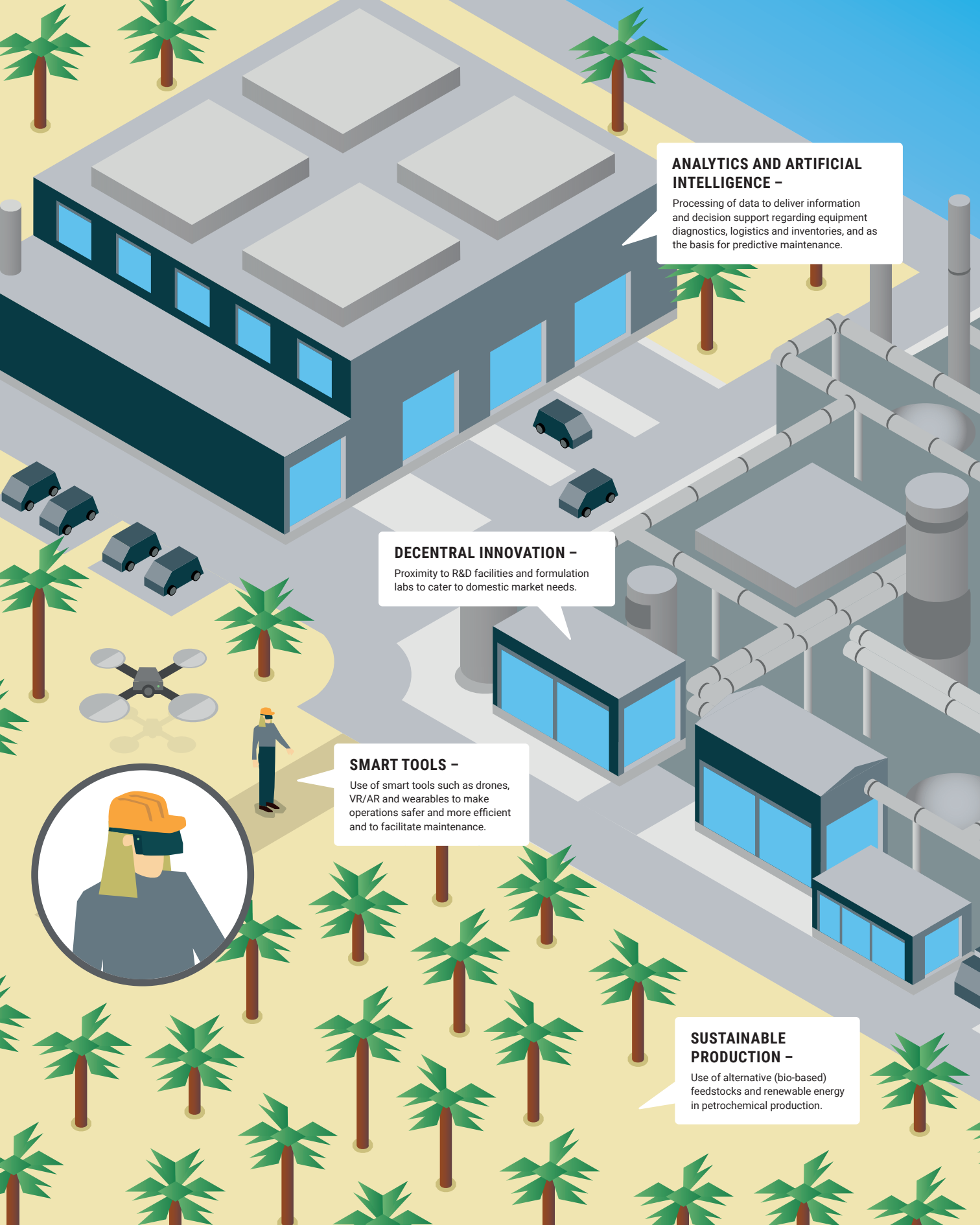
By reducing dependence on access to fossil-based feedstocks, this technique could help some IsDB countries close the innovation gap and reduce exposure to market volatility. Plastic production could even become feasible for states with no feedstock. While high costs will keep this approach from seriously hurting major oil and gas producers, putting a carbon footprint to good use could do much to improve petrochemicals' green credentials.

3 Tire recycling

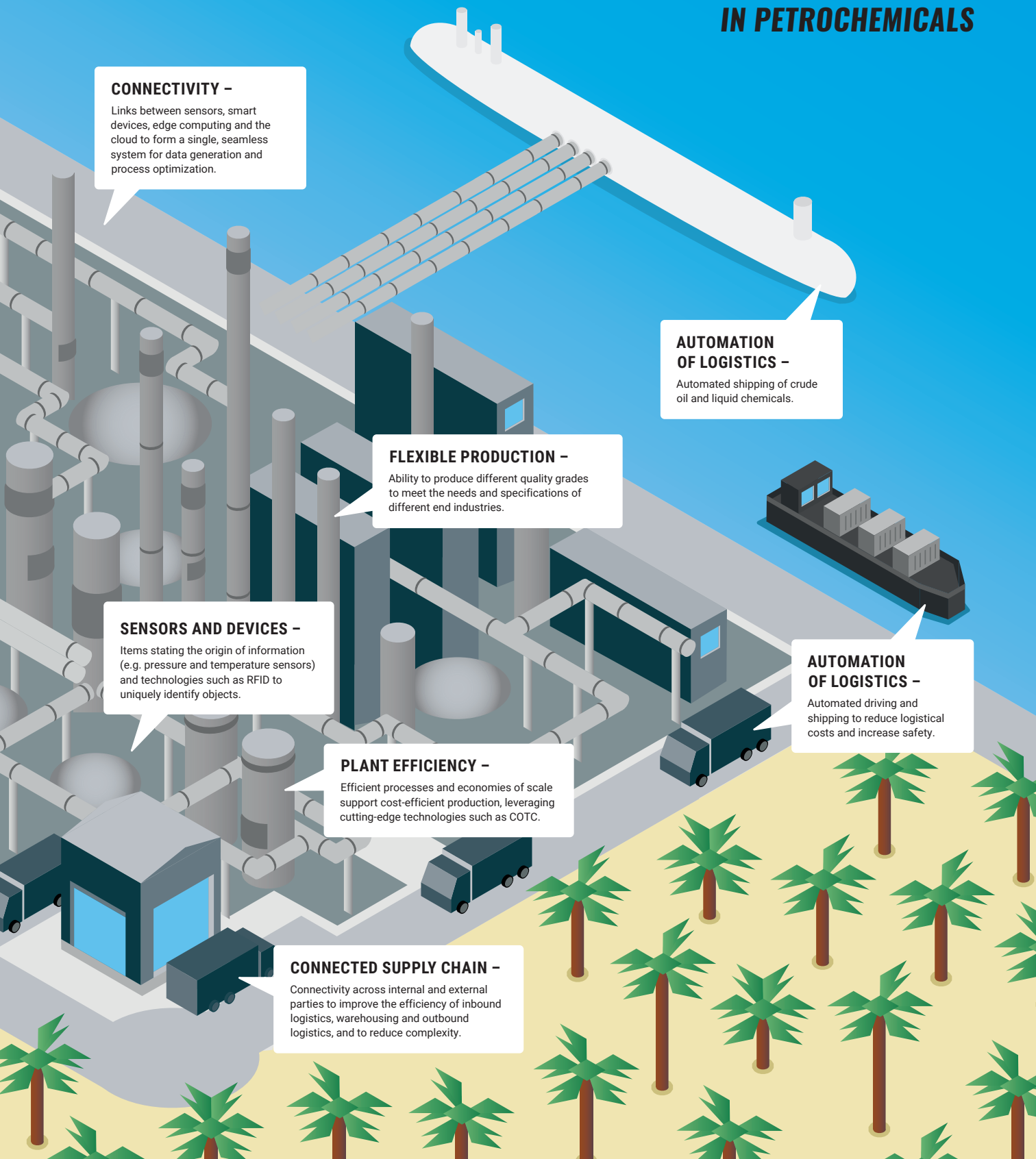
With no way to recycle them profitably, car and truck tires have burdened the environment since their invention. Though they have traditionally been ground into flakes or used to floor playgrounds, these practices neither change the rubber composition, nor can they be a general and global approach to recycling the 3 bn or so tires produced globally every year. In many parts of the world, old tires are therefore simply dumped: Kuwait is home to the world's largest "tire graveyard" in Sulaibiya.

To address this issue, Australia-based Green Distillation Technologies (GDT) uses a technique known as destructive distillation: heat applied in a vacuum chamber catalyzes a chemical reaction and decomposes tires into what ultimately becomes three valuable raw materials: oil, carbon and steel. A pilot plant set up for this process in New South Wales in 2009 is now expanding toward full commercial capacity of 19,000 metric tons per year, which is equivalent to 3% of the end-of-life tires generated in Australia every year.

This innovative technique opens up significant opportunities to combat one of the most pressing product lifecycle management issues anywhere in the world and should therefore be attractive to virtually all IsDB member states. Early adopters could also proactively avoid the tighter regulations that will surely add to the pressure on petrochemical players in the years ahead.


ANALYTICS AND ARTIFICIAL INTELLIGENCE –
Processing of data to deliver information and decision support regarding equipment diagnostics, logistics and inventories, and as the basis for predictive maintenance.
DECENTRAL INNOVATION –
Proximity to R&D facilities and formulation labs to cater to domestic market needs.
SMART TOOLS –
Use of smart tools such as drones, VR/AR and wearables to make operations safer and more efficient and to facilitate maintenance.
SUSTAINABLE PRODUCTION –
Use of alternative (bio-based) feedstocks and renewable energy in petrochemical production.

INNOVATION AND DIGITALIZATION ENABLE EFFICIENCY GAINS IN PETROCHEMICALS



CONNECTIVITY –
Links between sensors, smart devices, edge computing and the cloud to form a single, seamless system for data generation and process optimization.

AUTOMATION OF LOGISTICS –
Automated shipping of crude oil and liquid chemicals.

FLEXIBLE PRODUCTION –
Ability to produce different quality grades to meet the needs and specifications of different end industries.

SENSORS AND DEVICES –
Items stating the origin of information (e.g. pressure and temperature sensors) and technologies such as RFID to uniquely identify objects.

AUTOMATION OF LOGISTICS –
Automated driving and shipping to reduce logistical costs and increase safety.

PLANT EFFICIENCY –
Efficient processes and economies of scale support cost-efficient production, leveraging cutting-edge technologies such as COTC.

CONNECTED SUPPLY CHAIN –
Connectivity across internal and external parties to improve the efficiency of inbound logistics, warehousing and outbound logistics, and to reduce complexity.

Spherical gas tanks in Turkey. – Each IsDB country is starting from a different point in terms of feedstock access and petrochemical production.

2

PETROCHEMICAL SECTOR – WHERE ARE WE NOW?

Global petrochemical sector shows enormous opportunities

The sector's importance is expected to further increase as populations grow and demand for petrochemicals increases

Potential for IsDB countries remains untapped

Despite the strategic advantage of feedstock access, member countries could miss out on opportunities in petrochemicals

Value creation opportunities rooted in processing

IsDB countries' limited capabilities in primary and secondary processing can be boosted by stronger domestic demand

A bright future awaits many petrochemical segments

All industries will see demand increase, giving IsDB members opportunities to proactively shape the future industry environment

Sustainability gains ground, but fossil feedstock is here to stay

Oil and gas remain the dominant sources of feedstock, but bio-based materials are gaining in importance due to environmental issues

2.1
IMPORTANCE OF THE PETROCHEMICAL SECTOR
History, development and outlook

The report has so far looked ahead to 2030, describing trends, challenges and innovations that could all materially influence the road ahead in the petrochemical industry. Yet to embrace this future, it is also important to first take stock of where the industry in general – and IsDB-based players in particular – stand today.

For people everywhere, everyday life is unthinkable without petrochemical products. Plastics, rubbers and specialty chemicals are vital to everything from automotive engineering to construction, from electronics to packaging and from medical engineering to detergents.

Oil and natural gas are the main raw materials currently used to create chemical intermediates and end products in these and other industries. Petrochemical feedstock thus accounts for roughly 14% of the world's oil and 8% of global demand for gas: a sizable chunk, yet still a relatively small share compared to its significant impact and the value created.

The petrochemical industry accounts for over half of the world's chemical industry, which contributes some USD 5.7 trillion (7.1%) to global GDP (if indirect effects are included), making it a key pillar of the global economy. As a capital-intensive industry, its demand for production machinery and equipment adds value in other sectors, and petrochemical production also drives growth in secondary industries that depend on its supplies and innovations.

Petrochemicals serve a global market. Dominated almost exclusively by the USA, Western Europe and Japan until the 1970s, petrochemical production has since spread mainly to the Middle East and Asia, changing the competitive landscape beyond recognition and establishing the IsDB member states as a major player in this space.

Key indicators: IsDB vs. rest of the world

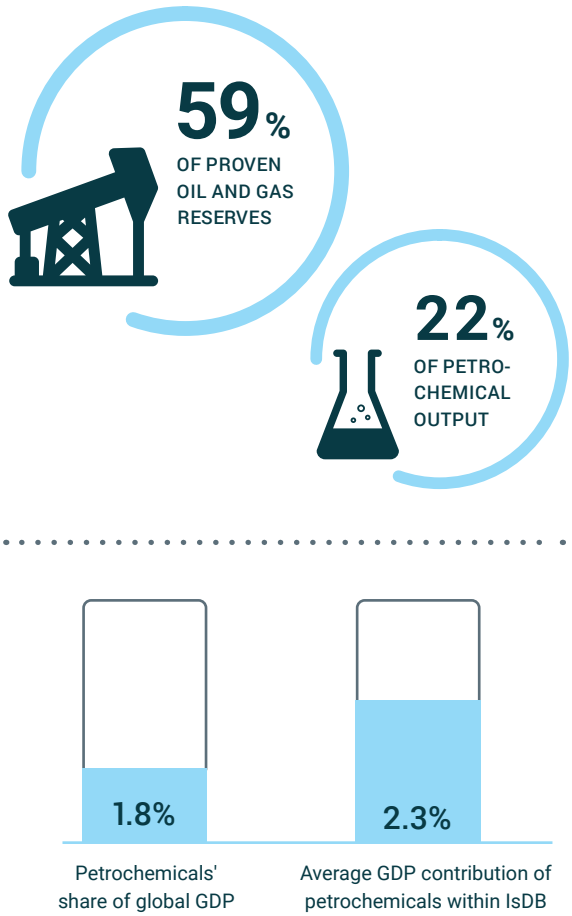
Share of IsDB member countries in terms of ...

Today, the market for formulated/fabricated petrochemical products has an estimated value of USD 1.5 trillion. Base chemicals were worth about USD 290 billion in 2018, with produced chemicals accounting for USD 1,000 billion. The petrochemical industry directly employs around 1.6 million people worldwide.

Backed by significant oil and gas reserves, the Middle East in particular has become a petrochemicals hub of global standing. Interestingly, while IsDB countries own around 60% of global oil and gas reserves, they contribute only 22% to petrochemical output. That said, the petrochemical sector is proportionally more important for IsDB countries than for other countries: petrochemicals represents 1.8% of global GDP, against an average contribution of 2.3% of GDP across all IsDB members.

As this figure suggests, other IsDB member states besides the Middle East are on their way to becoming integrated in the global petrochemical industry, though they still lag behind Saudi Arabia in this regard. Indonesia and Malaysia, for example, are now recognized as petrochemical hubs in Southeast Asia. Both countries also benefit from their bio-based feedstock. As climate concerns raise questions about the long-term future of carbon-based fossil fuels and about environmental degradation and sustainability, the need to explore viable alternatives to oil and gas will grow in importance and urgency. And for precisely those countries with access to bio-based alternatives, this may open a window of opportunity going forward. Many IsDB members that do not have the advantage of access to cheap feedstock will indeed have to adopt different and more diversified strategies. Turkey is one example of an IsDB country that, even without substantial oil and gas reserves, has successfully attracted multiple global specialty chemical companies. Not only that, it has also developed a domestic petrochemical industry by cultivating strong domestic demand.

In terms of where they are at today and what they bring to the petrochemicals table, the IsDB member states are decidedly heterogeneous. The world of petrochemicals is nevertheless a source of highly attractive opportunities for all countries that play their individual strengths the right way.

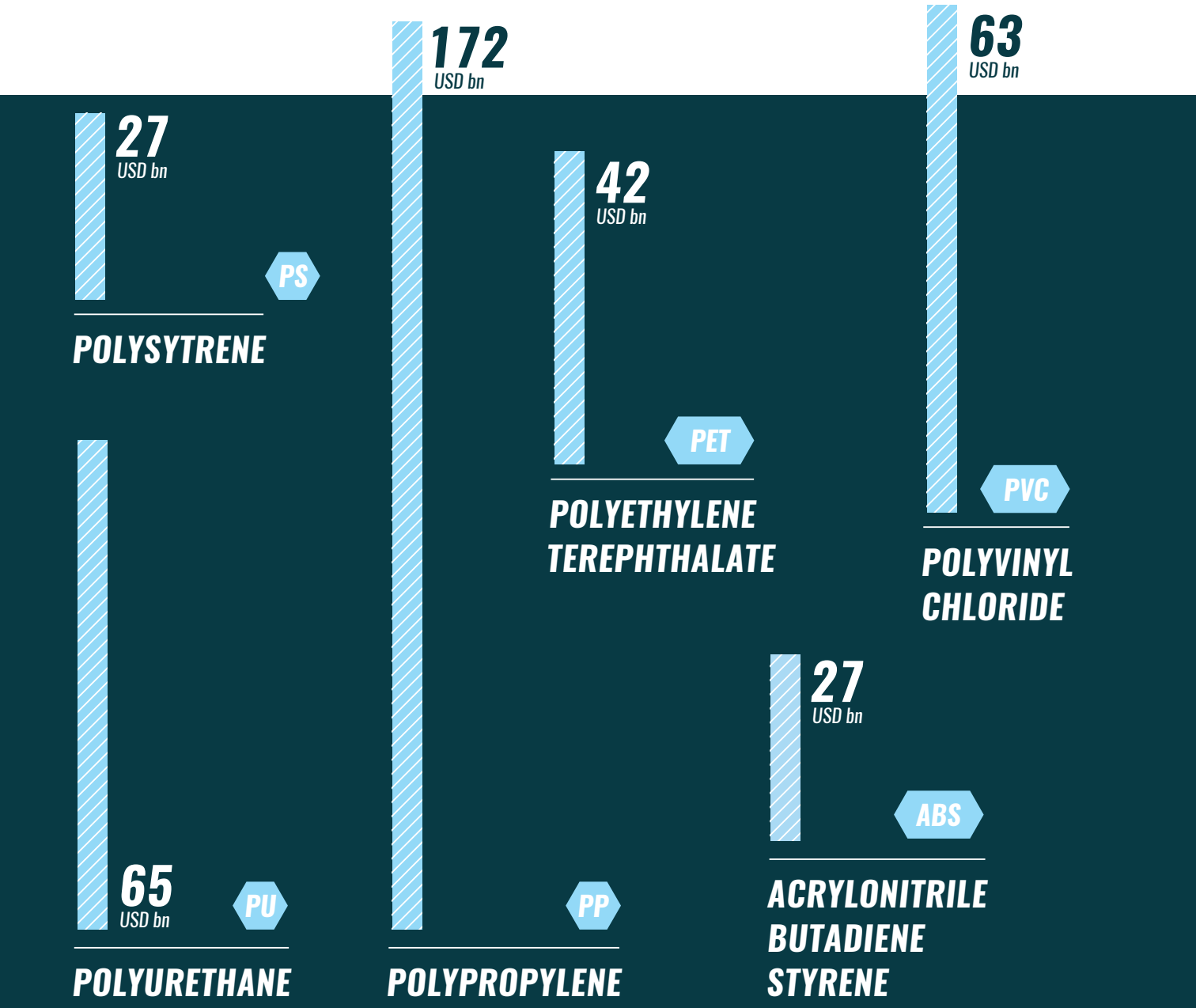


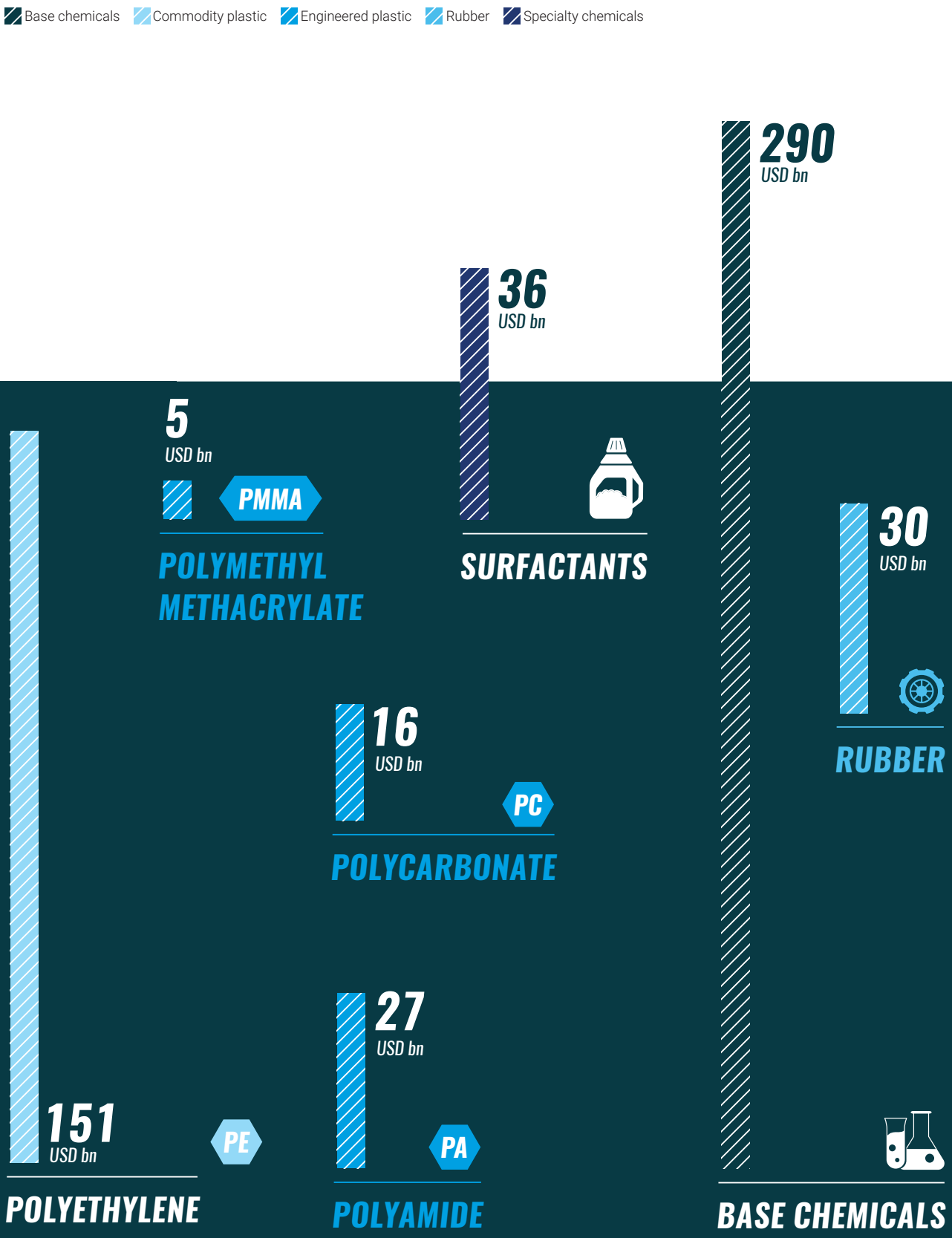
2.1

IMPORTANCE OF THE PETROCHEMICAL SECTOR

A market full of potenial

The petrochemical industry is and will remain of vast importance to the member states of the IsDB. To paint a clear and comprehensive picture of where the industry is at today, what key trends will shape the industry in the decade ahead and where the most pressing challenges and exciting opportunities lie, this study analyzes the current position and future potential of 13 different petrochemical value chains, of which 5 are portrayed in greater detail.




Base chemicals
Commodity plastic
Engineered plastic
Rubber
Specialty chemicals
290
USD bn
36
USD bn
5
USD bn
PMMA
POLYMETHYL METHACRYLATE
SURFACTANTS
30
USD bn
16
USD bn
PC
POLYCARBONATE
RUBBER
27
USD bn
151
USD bn
PE
PA
POLYETHYLENE
POLYAMIDE
BASE CHEMICALS

2.2

ISDB COUNTRIES' CURRENT POSITIONING

Main focus on base chemicals with great potential to increase value creation

IsDB member countries, like other regions, play to their own strengths, assuming an active role in those petrochemical segments in which they are well able to compete. Some, such as Saudi Arabia, enjoy inexpensive access to oil and gas feedstock – a vital condition of success in this line. Others, such as Turkey, benefit from robust domestic demand in specific end industries and have built up strong secondary processing capabilities on the ground. The key question is therefore: **How can each IsDB member country extend its vertical integration to create more value in the future?** Saudi Arabia's wealth of natural resources has perhaps given it a lead in the development of a basic petrochemical sector. It is already deeply integrated in the production of all kinds of petrochemical products. Yet other countries too are recognizing that significant value-added potential remains untapped.

The first step into petrochemicals requires substantial investment and a long-term asset strategy, so establishing a sizeable footprint in this industry takes a long time. Nevertheless, we see attractive opportunities for many IsDB member countries to grow their petrochemical sector by leveraging domestic and/or imported feedstock. Countries such as UAE, Qatar and Malaysia are already heading in this direction. Further diversifying their processing capabilities can empower them and other IsDB members to add still more value.

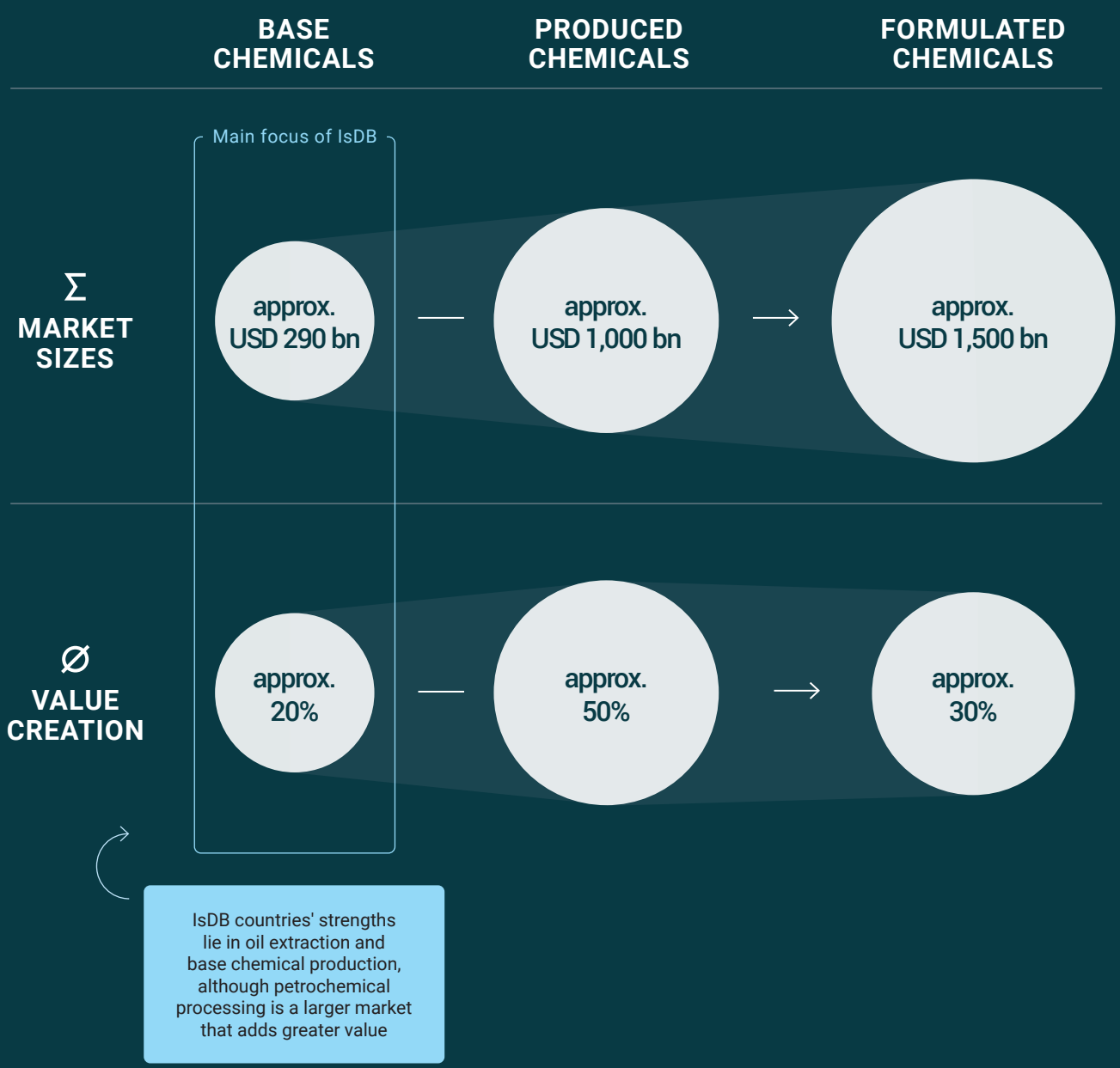
Conversely, restricted access to attractively priced feedstock makes it harder to develop such an industry from scratch. However, for countries facing this challenge, however, the beauty of petrochemicals lies in the global spread of secondary processing capabilities, which are typically needed close to the relevant end markets. By fostering domestic demand and attracting end industries such as construction, packaging and automotive, IsDB countries can also ramp up their local formulation and finishing capacity – reducing dependency on imports at the same time.

One thing is clear: **the current strengths of IsDB countries generally lie in production and primary processing**. However, considerable potential for added value lies further up the value chain, however, especially at the secondary processing stage. And it is here that many member countries are currently much weaker. Logically, IsDB members must therefore not only explore how they can diversify and deepen their level of vertical integration: they must also find out how they can stimulate sufficient demand from end industries to carry this development forward.

What does all this mean for IsDB countries and those looking to invest in them? It means that there is an obvious need for action to strengthen the petrochemical sector across all IsDB countries. The aim should be to nurture growth, innovation, value creation, employment, sustainability and equality in all member countries. Doing so will open up an attractive array of lucrative possibilities for private investors. In the petrochemical sector, the IsDB countries are truly a region with a bright future and a wealth of opportunities.

To see exactly how and where this potential can be realized, the next section briefly outlines the three main links in the global petrochemical value chain before zooming in on five specific segments that are of huge importance to the industry as a whole.

Value creation in petrochemicals

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HO

Research and development is key to stimulating innovation and improving local value creation.

2.3

INSIGHTS INTO PETROCHEMICAL INDUSTRIES

From oil and gas to petrochemical products

Global value chains mirror how various input factors are transformed and combined through different steps to arrive at finished products. They comprise stages such as selecting **input factors**, production/extraction, primary processing and secondary processing. Trading and logistics occur at various stages within the value chain.

Generally, the first stage of the value chain is the selection of input factors. These include oil, gas, coal and renewable sources for petrochemical products such as sugar cane and maize. This stage also includes plant equipment and energy. In technologically advanced systems, software may be an additional input factor.

The next step in the chain is **production**. Here, the input factors are used to create the next stage of the product – usually a semi-finished good that needs further processing to turn it into a finished product. For petrochemicals, the production stage involves refining and cracking oil and gas into base chemicals and creating intermediates such as olefins, alcohols and aromatics.

The production stage is followed by **primary processing**. For petrochemicals, this involves transforming base chemicals into finished petrochemical products such as plastics, surfactants and rubber. This process step therefore typically includes chemical reactions such as polymerization. The chemical products themselves often require further finishing – such as blending, formulation, mixing and molding – to generate a final product that can then be used by end industries. This final step, known as **secondary processing**, transforms chemical products into finished goods for distribution.

Trading occurs throughout the value chain. Some countries specialize in a single step of the value chain and are dependent on input from an early stage. However, most trading takes place at the stage of primary processing, where the chemical product has been manufactured but can still be customized for its final application and usage. Logistics for moving the commodities between the different steps in the value chain is also generally handled by traders or the chemical companies.

The above description is a somewhat simplified model, of course. In practice, the global value chains for specific goods are interwoven: complex structures that can include other intermediate steps are not shown in the illustration. We present some examples of key global value chains in the following section.

Thinking about the global value chains for different segments of the petrochemical industry helps focus our minds on certain key questions. The answers to these questions are of critical importance to both the countries themselves and potential investors in the region.

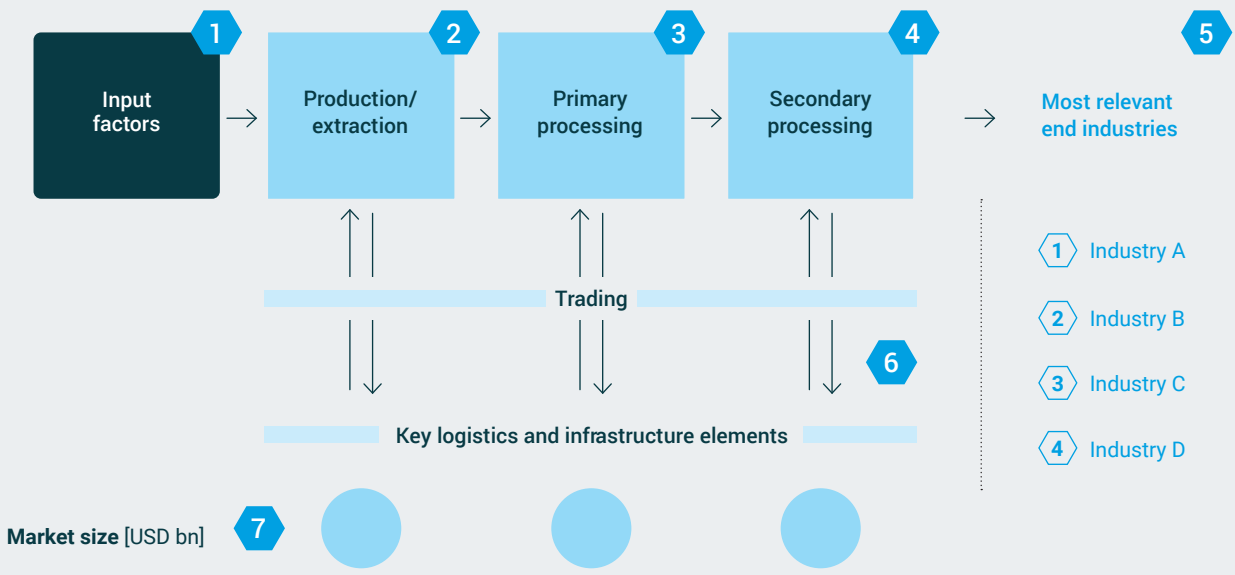
What we need to know:

Which links in each global value chain harbor the greatest market potenial?

What are the main trends driving demand and shaping global industries?

Where are IsDB countries currently positioned and how can they unlock the most value?

Key elements of the global value chain (GVC)



2.3

INSIGHTS INTO PETROCHEMICAL INDUSTRIES

Where IsDB members can tap the greatest potential in petrochemicals

It is impossible to do justice to the many and varied aspects of a global industry such as petrochemicals in a single report. The focus here is on those areas where IsDB member countries have the chance to exploit considerable potential in petrochemical products and substances that are in demand worldwide and have bright future prospects.

As discussed in section 1.1, the end industries that use petrochemical inputs are a major driver of demand in this industry. Working back from the needs of relevant end industries, the report has thus identified five major product categories that cover the lion's share of demand for petrochemicals worldwide and that are of direct relevance to IsDB countries' petrochemical plans for the future. Each of the sections that follow highlights examples from one of these representative categories: base chemicals, commodity plastics, engineered plastics, synthetic rubber and specialty chemicals. For each of these categories, the report explores key trends over the next decade, outlining major challenges and the dynamics of the market, and highlighting where IsDB countries stand today and how they could position themselves for the future:

- **Base chemicals** (such as alcohols and aromatics) are essential elements in every processed petrochemical product
- Polyethylene (PE), the world's most common plastic in volume terms, serves as an example of a **commodity plastic**
- Polycarbonate (PC) is used for all kinds of applications across a broad spread of end industries and is representative of the **engineered plastics** category
- **Synthetic rubber** is used predominantly in vehicle tires and construction and harbors attractive opportunities for several IsDB members
- **Specialty chemicals** are represented by surfactants, the principal chemical form used in detergents, a key end industry

Before examining these five categories individually, it is important to note that global petrochemical players tend to be highly diversified. Leading companies such as SABIC, Dow, ExxonMobil, Covestro, Teijin, BASF, Shell and Sinopec thus have their fingers in many of these pies. This diversification illustrates the need to leverage feedstock access for a multitude of different products. At the same time, it reflects the overall industry trend toward economies of scale to increase cost efficiency, diversification in general and the expansion of applications and portfolios. If they bear these factors in mind, IsDB member states – who already host Saudi Arabia's SABIC, one of the true global leaders – will be well placed to play a pivotal role in petrochemicals in the future.

2.3

BASE CHEMICALS

- **IsDB countries are a serious player, controlling 20% of the world's global base chemical production – they also have a significant share of primary processing, but could do better on secondary processing and by diversifying into specialty chemicals**

- **Demand for base chemicals should grow through 2030, aided by the favorable outlook for relevant end industries and downstream petrochemical production – IsDB countries with feedstock access can tap into this potential**

- **To add to their cost advantage over the USA and China, IsDB countries should explore opportunities in technology upgrades such as crude oil to chemicals plants**

2030 AND BEYOND

Operational efficiency and technological progress are the foremost drivers of base chemical production. Products used as intermediates are not normally exposed to application-specific or industry-specific trends.

Capacity is being expanded for different feedstocks and technologies around the globe. Since ethane can now be produced separately from propylene, both can be produced on demand. More balanced capacity utilization can thus improve market players' price positioning.

At the same time, new approaches such as crude oil to chemicals (COTC) technology could make petrochemical production less complex, combining cracking and refining in a single step. Though still in its infancy, this technology has the potential to more than double the value generated by oil exploration. It will, however, require closer integration between refiners and petrochemical companies and could therefore shake up the market landscape.

Sustainability is another key driver in base chemicals, where renewable resources such as alternative feedstocks are gaining in importance. The technologies currently available for bio-based base chemicals cannot yet compete with oil and gas, but growing political awareness and sustainability regulation could drive them forward.

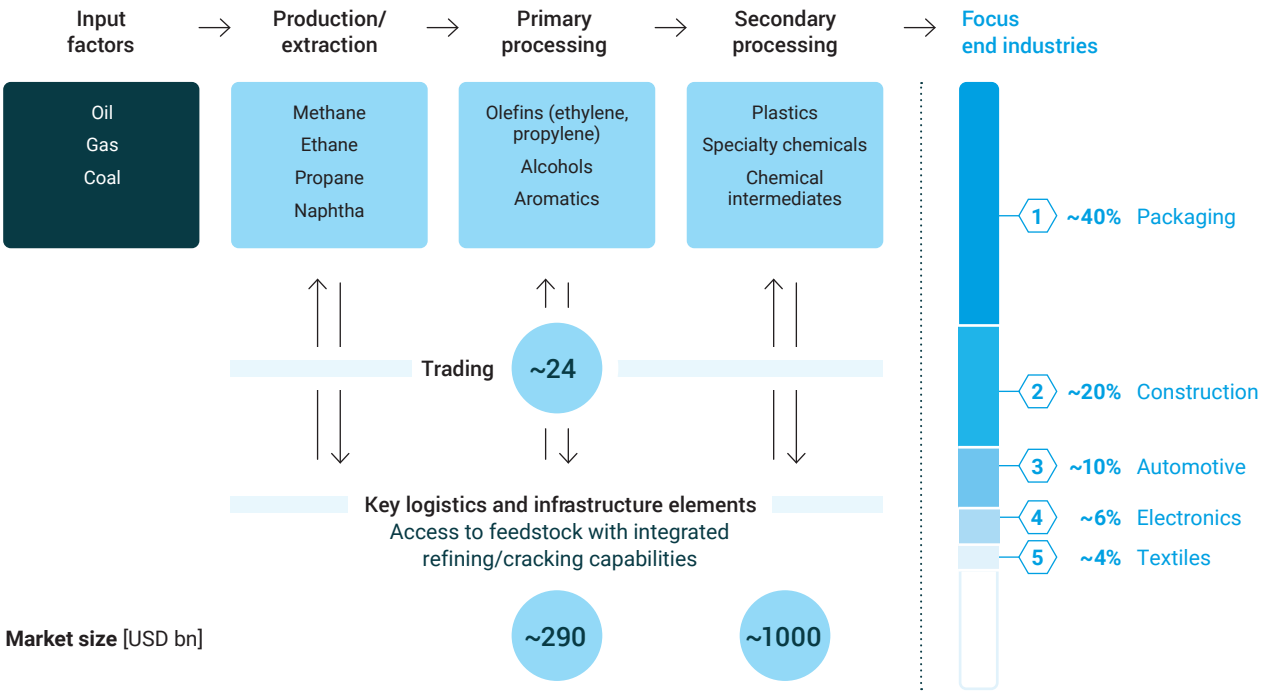
CHALLENGES AND MARKET DYNAMICS

The global base chemical market volume of around 515 million tons in 2018 was valued at around USD 290 billion. A generally conducive market environment and rising downstream demand are expected to sustain 4% annual value growth in the coming years. This increase will likely be shared between Asia Pacific (notably China), the USA and Middle Eastern countries with access to oil.

Olefins account for roughly 60% of total demand for base chemicals. Alcohols are often used as raw materials for chemical intermediates such as acids, or for fuel and petroleum applications. Aromatics too are mainly used in downstream chemical processes such as plastics production.

Feedstock refining, base chemical production and secondary processing are often integrated at a single site, making the global supply landscape fairly homogeneous on all three levels. International trade in base chemicals is limited. Extraction and primary processing together capture an estimated 30% of total value creation. Secondary processing is less capital-intensive but requires greater technical and product expertise and adds about 70% of total value. The most important end industries for this value chain – packaging, construction, automotive, electronics and textiles – account for around 80% of total base chemical demand.

BASE CHEMICALS | Global value chain overview



PRODUCTION AND CONTEXT

"Base chemicals" is the term used to denote commodity chemicals and chemical intermediates that are derived from oil and gas and used to manufacture plastics, specialty chemicals and other chemical products. Production from biomass is a small niche today but is forecast to grow in the future.

Production methods vary depending on the feedstock. Crude oil is typically refined into gases, naphtha and gasoline/fuels. Naphtha itself is further steam-cracked into the base chemicals olefins, aromatics and alcohols. Gas-based processes begin with the separation of natural gas into methane, ethane and propane, which are further processed to form olefins and alcohols.

IsDB COUNTRIES' POSITION AND OUTLOOK

IsDB members are already key players in the global base chemicals value chain. In Saudi Arabia, Aramco and SABIC are global leaders keen to further strengthen their global role. Some 20 to 25% of the world's base chemical production capacity is in the Middle East, with Indonesia and Malaysia also enjoying access to natural gas. IsDB members consume most of the base chemicals they produce domestically, with a mild end-industry focus on large-volume applications in packaging and construction.

IsDB countries must invest further in cutting-edge technologies to retain their global cost advantage and curb the risks posed by bio-based feedstock. Deeper vertical integration can further strengthen their role in the global petrochemical value chain. And for those countries with limited access to oil and gas, it may be worth exploring the potential of bio-based petrochemical feedstocks.

2.3

POLYETHYLENE (PE)

- **Polyethylene is the most commonly used plastic. IsDB countries' healthy feedstock position gives them a strong position in the global PE market and 20% of the world's capacity. Members focus mainly on primary PE processing and play a substantial role in international trade. Export rates of 80% show the need to boost domestic secondary processing via end-industry demand**

- **Despite tighter regulation on recycling and the use of plastics, demand for PE should continue to grow through 2030 as demand for low-cost plastics rises in emerging countries**

- **As global capacity wells and PE becomes commoditized, IsDB countries should investigate opportunities to map the application of PE resins onto higher-value segments such as 3D printing**

2030 AND BEYOND

Innovation in PE tends to come not in quantum leaps, but in small steps that make processes more efficient and improve capacity utilization. Three main positive trends are shaping developments. One is the exploration of new applications, such as the use of HDPE (high-density PE) in additive manufacturing. The second is the need to continually improve material properties to tap new, higher-value market opportunities and replace other plastic types. Third, new production technologies are deriving PE from coal and methanol. For IsDB countries with limited access to oil and gas, this approach can be a launch pad for domestic PE production.

CHALLENGES AND MARKET DYNAMICS

The global PE market totaled around 100 million tons in 2018 and should grow by 3.8% p.a. through 2030. Driven in part by emerging countries' rising demand for low-cost plastics, growth should be stronger in Asia Pacific (6%) but weaker in the Americas (3%) and EMEA (2%). The HDPE type is expected to see the fastest CAGR (compound annual growth rate) of 4.6% through 2030.

PE's global value chain breaks down into three steps. Ethylene is first produced from oil or gas (adding 27-29% of total value) and processed to form resins (45-47%). Secondary processing then puts resins into their final form (25-27%).

Extraction and primary processing are heavily concentrated in the hands of a few key players, including IsDB-based corporates such as SABIC. By contrast, secondary processing is heavily fragmented and largely bypasses IsDB players.

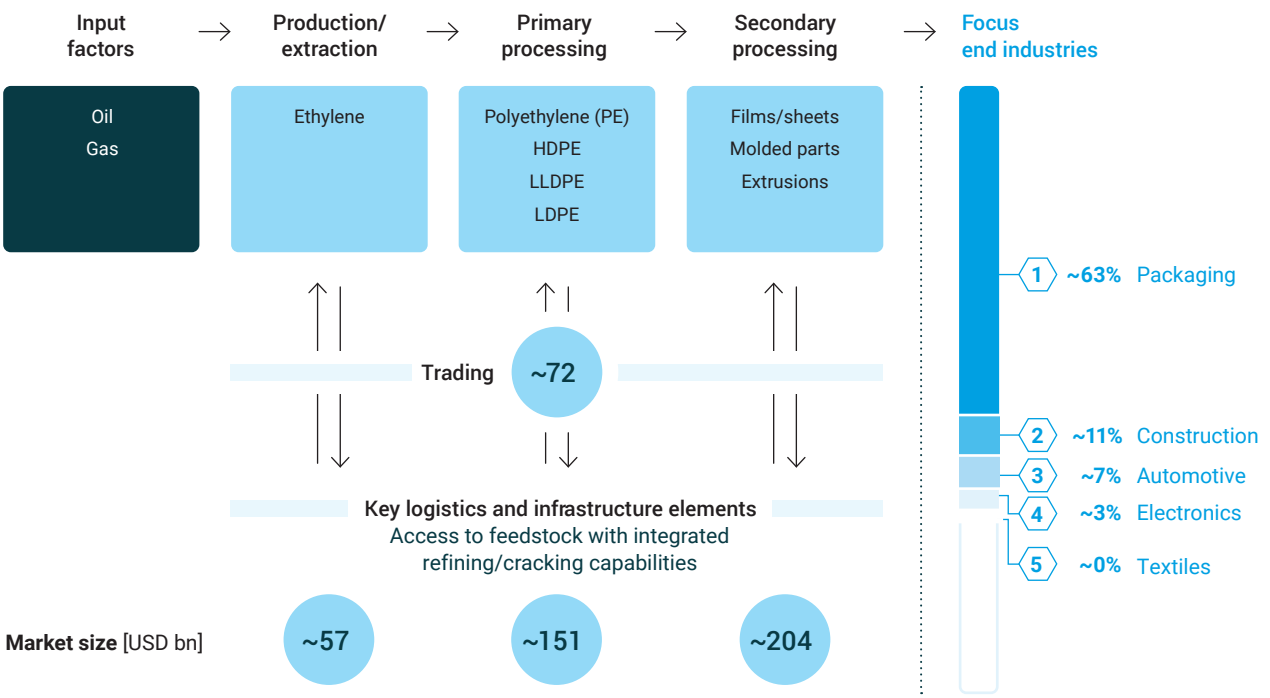
Though the total PE volume has nearly doubled in the last decade and almost 50% is traded internationally, there are regional imbalances: the US has excess capacity, but Latin America and Asia need imports to cover supply shortages. China is the biggest importer and Saudi Arabia the world's largest exporter.

IsDB MEMBERS' POSITION AND OUTLOOK

IsDB countries are well integrated in upstream feedstock supply and the refining/production process. Yet they cover less than 10% of the higher-value global market for secondary processing.

Their position in the global value chain also varies geographically: Middle Eastern members account for 80% of the IsDB group's total PE footprint, with Saudi Arabia alone responsible for nearly 50% of members' entire PE

POLYETHYLENE | Global value chain overview



PRODUCTION AND CONTEXT

Polyethylene (PE) is produced by cracking natural gas and naphtha into ethylene, which is then polymerized. It is a commodity plastic – the most commonly used plastic in the world. Different types have different mechanical properties for varying applications, three of which (HDPE, LLDPE and LDPE) cover 90 to 95% of total demand. PE bends but does not break easily, is water-resistant, enjoys good chemical stability and lends itself particularly to packaging. However, it is not very strong or hard and its recyclability is limited.

capacity. Central Asian IsDB countries have an initial footprint in ethylene and PE production, and Indonesia and Malaysia are important regional players. Here, significant recent investment in access to natural gas could reduce dependence on imports.

While the IsDB member states are well placed as a net exporter of PE today, China and the USA plan to increase capacity. IsDB states must therefore review their position in the global PE value chain to see how they too can enlarge their share of available capacity. They must also foster investment in secondary processing by attracting end industries (packaging, construction and automotive) to enhance local value creation across all relevant PE value chain steps and make future capacity expansion more self-sustaining.

Iran, Egypt, Oman, Azerbaijan, Kuwait and Malaysia have already announced plans to build more than 30 new plants over the next 3-5 years, and such investments will certainly help keep IsDB countries in the global mix. If other members follow suit, that could strengthen their position in the fiercely competitive global PE market. New technologies such as coal/methanol to gas and new PE applications can also create opportunities even for newcomers to this market.

2.3

POLYCARBONATE (PC)

- **Demand for PC varies greatly across different end industries. The exploration of new applications should drive ongoing global growth of around 3% p.a.**

- **Saudi Arabia and Iran are the only IsDB countries with any exposure to this market, making the IsDB member states a net importer of PC resins. In a positive market environment, new PC capacity in IsDB countries can enhance local value creation and make the region more self-sustainable**

- **Technological advances in new and more environment-friendly production processes will help the IsDB member states move toward the Sustainable Development Goals**

2030 AND BEYOND

Today's key players will still dominate in 2030. Overcapacity will put pressure on resin prices until demand rebounds toward the end of the decade.

Non-phosgene production technology should jump sharply by 2030 to improve the industry's green credentials. SABIC is one of several manufacturers also working on other sustainable PC solutions: its certified renewable feedstock can reduce PC's carbon footprint by up to 50%.

Expanding capacity is opening up all kinds of new applications, from medical devices to windshields. Such diversity will add complexity, forcing primary processors to develop superior resin grades and secondary processors to mix more varied PC blends and alloys. Barriers to entry will grow higher still, so existing players (including those in the Middle East) must exploit their competitive advantage. Players in IsDB countries – supported by IsDB – can then help shape the future PC value chain.

CHALLENGES AND MARKET DYNAMICS

The market volume of around 4 million tons in 2018 should expand by about 3% p.a. between now and 2030, mostly driven by electronics, automotive, construction and packaging. Rapid growth is projected in China, the Middle East and the CIS states, with Europe and the US shifting down a gear.

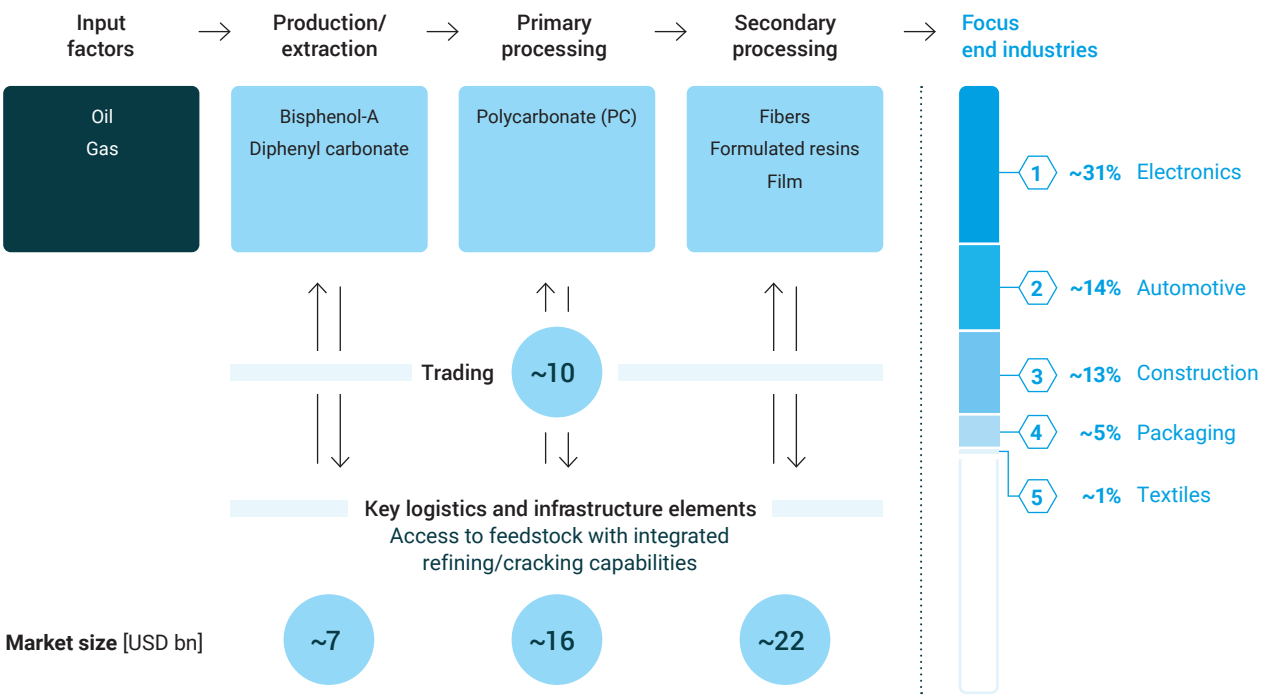
PC capacity is spread widely across Asia, Europe, North America and, to a small extent, the Middle East. The top five players in the heavily concentrated primary processing market controlled 70% of global capacity in 2018, all with backward integration into raw material supplies. Many market leaders are also forward integrated into secondary processing, although shapes and finished goods are produced by an array of end-industry-specific players.

As digitalization pushes demand for optical media into decline, electronics – currently the most important end industry for PC – will lose ground to automotive, construction and agriculture as the new growth drivers.

Value creation is fairly well split between the three links in the value chain, although primary processing adds the greatest value. Backward integration allows major players to also create considerable value from the production of raw materials.

Rising PC consumption is forcing manufacturers to address the issue of recycling, which is not yet available on a large scale. And in production, around 75% of global capacity still uses the highly toxic phosgene gas, albeit in a very efficient process. Replacing these plants is vital to sustainability but will be very expensive. Public institutions could incentivize the transition to more eco-friendly PC production and recycling.

POLYCARBONATE | Global value chain overview



PRODUCTION AND CONTEXT

Polycarbonate (PC) is an engineered plastic that can be injection-molded, blow-molded or extruded. Transparent, strong and stiff, its stable properties lend itself to versatile and often safety-relevant applications across all end industries. The fact that PC accounts for about 1% of the total plastics market volume but about 3% of its value is indicative of its high value. The original phosgene production method, developed in the 1950s, is currently being supplanted by a new approach that is less expensive and kinder to the environment.

IsDB MEMBERS' POSITION AND OUTLOOK

Saudi Arabia and Iran are currently the only IsDB member states that provide PC capacity to the world (6%). Yet the Middle Eastern region is still a net exporter of PC resins. IsDB members currently control less than 5% of secondary processing, most of which takes place close to end industries. Construction is the main end industry served by PC in the Middle East.

New capacity and cost-efficient, eco-friendly production will be needed once short-term overcapacity has been absorbed. And few players have yet started work on making PC recyclable. The IsDB can finance heavy investment in large-scale primary processing projects. It can also help countries such as Turkey, Indonesia and Malaysia build up expertise to serve strong domestic demand from end industries. Members with access to oil and gas can pursue backward integration. These steps forward will likewise support compliance with the Sustainable Development Goals.

2.3

SYNTHETIC RUBBER

- **Synthetic rubbers are forecast to grow by roughly 6% p.a. thanks to continued strong demand from the automotive industry and favorable macroeconomic trends, such as population growth and rising incomes in developing countries**

- **Today, IsDB countries' exposure to this industry is limited to about 5% of global production capacity. An emerging automotive industry in the IsDB member countries could foster growth in synthetic rubber production while also boosting countries with good access to natural rubber**

- **Recycling remains a key challenge for the rubber industry. IsDB members must address it proactively to support their progress toward the Sustainable Development Goals**

2030 AND BEYOND

Sustainability awareness and recycling issues are gaining traction in the rubber market. While superior material properties and lower processing costs have lately favored synthetic over natural rubber production, volatile oil prices will continue to mitigate this trend. Within the IsDB member countries, access to oil has embedded Iran and Saudi Arabia in the synthetic rubber value chain. Indonesia and Malaysia are top global producers of natural rubber and can profit from a shift to natural rubbers if oil prices rise. Sugar-producing IsDB countries could also benefit from the advance of bio-based raw materials.

Recycling finished goods in general – and tires in particular – remains a major challenge in the rubber market. As regulation of tire burning and disposal tightens, new technologies could advance recycling and are now being piloted by players such as Green Distillation Technologies in Australia. Converting rubber tires into bio-oil and carbon could also be a way into recycling for some IsDB members.

CHALLENGES AND MARKET DYNAMICS

The roughly 17 mt market for synthetic rubber in 2018 should grow by about 6% p.a. through 2030. Automotive demand remains strong alongside a range of non-tire applications in many end industries. And despite the sustainability trend, synthetic rubbers are increasingly preferred over natural rubbers, which should boost the former's market growth.

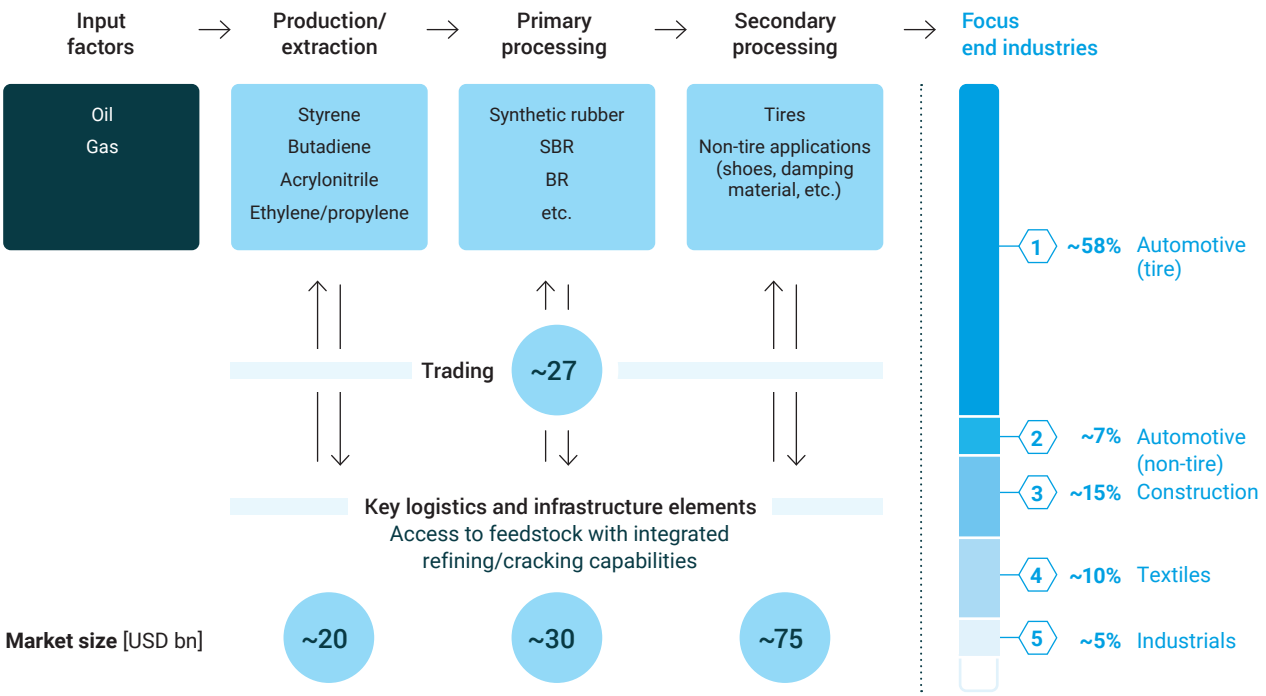
Asia Pacific, North America and Europe accounted for 84% of the world's rubber market in 2018. The Middle East (with a 9% share) should join Asia Pacific in experiencing strong annual growth of 7-8%.

Supply capacity is expected to increase in the future in response to a recent dip and global imbalances. China, for example, is currently investing in tire production in a host of countries in an attempt to bypass the anti-dumping measures that targeted its exports after overproduction caused prices to tumble. The Middle East too will add significant new capacity, largely in Iran.

Many leading producers of the raw materials used in synthetic rubber production are backward integrated into feedstock access. Conversely, being close to end customers allows companies with forward integration into secondary processing to tap substantial value creation potential. Various IsDB companies are involved in the synthetic rubber market, in which a concentrated tire landscape contrasts with a fragmented non-tire market structure.

The extraction/production stage contributes around 25% to total value creation, against 15% from primary and 60% from secondary processing. Most primary processors

SYNTHETIC RUBBER | Global value chain overview



PRODUCTION AND CONTEXT

While natural rubber is obtained from tropical plants, synthetic rubber is derived from petroleum and natural gas. In recent years, cost issues and better control have helped synthetic versions gain in importance relative to natural rubber. Elasticity, resilience and toughness make rubber the basic material for use in tires.

The five main types of rubber account for about 87% of global demand. In keeping with the required material properties, most of them rely on butadiene and styrene as raw materials.

are integrated in raw material production to enhance value creation. Secondary processors tend to be backward integrated into primary processing to secure supply.

IsDB MEMBERS' POSITION AND OUTLOOK

The end-industry focus of the IsDB member states (and worldwide) is on tires and construction. That said, IsDB countries have only a small footprint in the first two value creation steps and an even smaller one in secondary processing. Domestic demand is low and members focus mainly on exporting synthetic rubber, though some are active in the production of styrene and butadiene. There are only two IsDB producers of synthetic rubber.

Members can follow Turkey's example, supporting tire manufacturers' capacity expansion to stimulate demand for synthetic rubber. Primary processing capacity in the region should also be increased if IsDB countries are to play a significant role in the global value chain. Investment in new technologies such as tire recycling, but also in upgrading natural rubber products to compete with synthetic rubber, could further ramp up economic growth in regions such as Kuwait, Malaysia and Indonesia.

2.3

SURFACTANTS

- **Surfactants are forecast to grow by 4% p.a. in the future, bolstered by population growth and increasing demand from developing countries**

- **Besides petrochemical ingredients, bio-based oleochemicals also play a fundamental role in this industry. While IsDB members already provide up to 40% of global oleochemical capacity, they have the potential to add still more value by strengthening their position in petrochemical ingredient production and secondary processing**

- **The trend toward purely bio-based detergents can be an attractive opportunity for IsDB countries with limited access to fossil feedstock but rich agricultural production**

2030 AND BEYOND

In response to commoditization trends, major surfactant vendors are investing more in R&D to reduce production costs, enhance product properties and sharpen their competitive edge. Another trend is creating new markets by channeling surfactants into higher-value niche applications such as pharmaceuticals and construction materials. The Egyptian Petroleum Research Institute, for example, is investigating the role of surfactants in regulating cancer growth and using them to improve the delivery of cytotoxic agents.

Growing demand for pure bio-based (i.e. biodegradable) surfactants is backed by regulatory pressures in the EU and the USA, for example. It will take time to overcome the current higher cost of substituting synthetic surfactants with bio-based versions, but the latter's advance could come at the expense of the former.

CHALLENGES AND MARKET DYNAMICS

The 16 million ton global market for synthetic surfactants in 2018 should expand at around 4.4% p.a. through 2030. Increasing demand from personal care and detergent applications and a combination of population gains and higher household incomes in emerging countries have led to 6% growth projections for Asia Pacific, against slightly slower growth in EMEA and the Americas.

Anionic surfactants cover over half of the global market (52%), followed by non-ionic surfactants (23%), cationic surfactants (15%) and amphoteric surfactants (10%). The strongest growth (more than 6%) is expected in the latter category, due to the increasingly desirable low toxicity and eco-friendly nature of amphoteric surfactants.

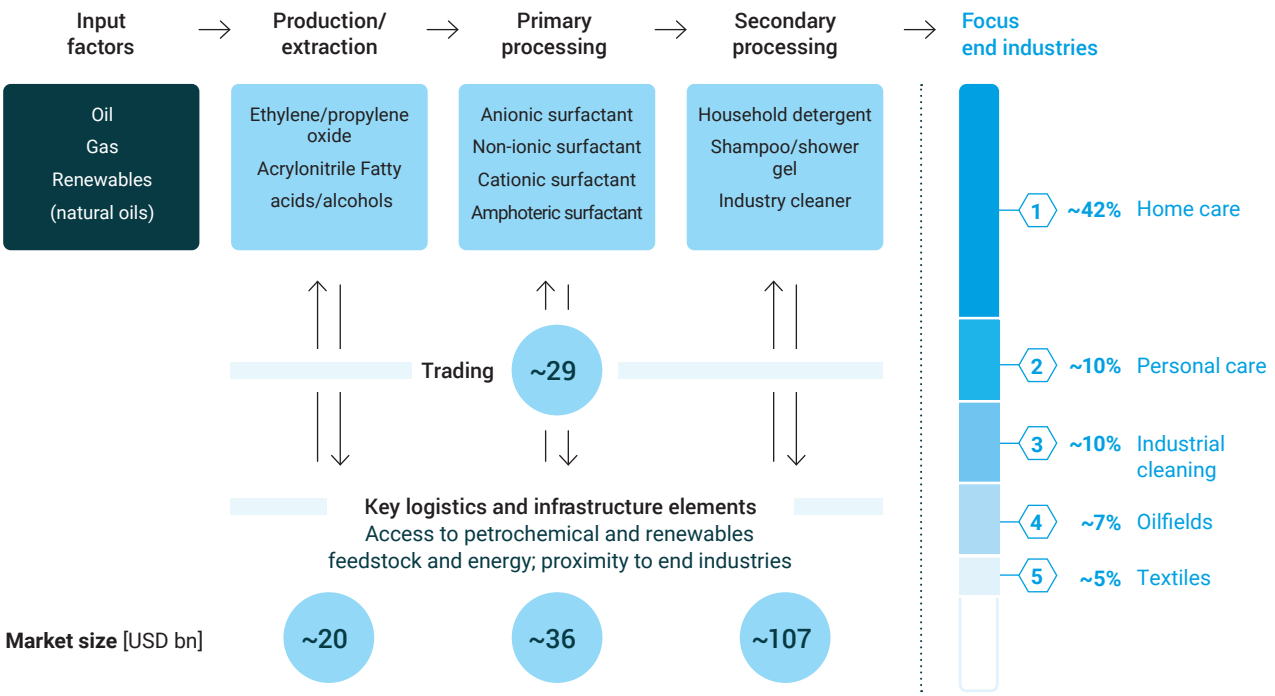
In the global value chain, oil, gas and renewable substances are first cracked and processed into intermediates. Primary processing then creates surfactant, though there is little integration between these first two steps. Secondary processing yields a wide variety of final products for use in end industries.

In surfactants, nearly two-thirds of value is created through secondary processing, largely due to the cost of purchasing and synthesizing materials not yet used in the first two steps. Home care is the biggest (42%) of many applications for products containing surfactants, though these agents are also widely used as far afield as in oilfields, textiles and agriculture.

IsDB MEMBERS' POSITION AND OUTLOOK

Access to palm oil positions Malaysia and Indonesia as key players in the production of oleochemical intermediates and related surfactants, with a roughly 30% global market share. By contrast, most petrochemical intermediates from IsDB members derive from local feedstock in the Middle East.

SURFACTANTS | Global value chain overview



PRODUCTION AND CONTEXT

Surfactants – surface-active agents – are amphiphilic chemical compounds that contain both a hydrophobic ("water-fearing") and hydrophilic ("water-loving") group. They are thus soluble in both organic solvents and water. Surfactants are a key segment within specialty/fine chemicals and are used as emulsifiers, wetting agents, dispersants and stabilizers for different chemical and industrial applications.

Synthetic surfactants (93% of the global market) are manufactured from petrochemical components, whereas bio-based surfactants (7%) are derived from biomass, i.e. from renewable raw materials. Partially synthetic surfactants comprise a mix of both, and very few "synthetic" surfactants are indeed purely synthetic.

Four types of surfactants are distinguished based on the electrical charge at the hydrophilic end of the surfactant molecule: (a) anionic surfactants, (b) cationic surfactants, (c) non-ionic surfactants and (d) amphoteric surfactants. They serve a wide variety of applications, from shampoos to fabric softeners, from household cleaners to coupling agents. Production is accordingly heterogeneous, depending on the final product and the feedstock used.

IsDB members' 6% share of primary processing in this field reflects a much broader geographical dispersion thanks to low shipping costs for chemical intermediates. In secondary processing, members have an estimated share of 8%. For IsDB countries, proximity to the oil and gas industry gives this sector slightly more relevance as an end industry.

Looking ahead, IsDB countries must build on their strong showing in intermediates and ramp up their surfactant and final production activities. Linking inexpensive petrochemical feedstock in the Middle East to the abundance of oleochemical feedstock in Malaysia and Indonesia could yield competitive advantages.

A refinery in Southeast Asia – Petrochemical players need to mitigate volatility in both feedstock prices and demand

3

HOW READY ARE IsDB COUNTRIES FOR THE FUTURE?

Upside potential exists for all IsDB countries, but all start from different points

Some are ready to move into high-value specialty chemicals – others must first create the right conditions to grow a petrochemical industry

Small beginnings can grow

Countries with little access to feedstock can take their first steps by attracting secondary processing

Feedstock opens doors

Many IsDB countries can leverage the advantage of feedstock access to add value at the higher end of the petrochemical value chain

Domestic demand and vertical integration are shared success factors

All IsDB countries can act in these two dimensions to drive their petrochemical activities forward

Inaction is the biggest enemy!

Opportunities abound – but only if IsDB countries take action to improve education, governance, resources and job creation and thus sharpen their competitive edge in petrochemicals

3.1

STARTING POINTS FOR IsDB COUNTRIES

Five main clusters with similar market characteristics

Domestic formulators

- Countries with potential to step up domestic formulation efforts
- Small petrochemical output, local end-industry demand and petrochemical feedstock today

Cooperative Republic of Guyana
Federal Republic of Somalia
Hashemite Kingdom of Jordan
Islamic Republic of Afghanistan
Islamic Republic of Mauritania
Kingdom of Morocco
Kyrgyz Republic
Lebanese Republic
Nation of Brunei
People's Republic of Bangladesh
Republic of Albania
Republic of Benin
Republic of Burkina Faso
Republic of Cameroon
Republic of Chad
Republic of Côte d'Ivoire
Republic of Djibouti
Republic of Gabon
Republic of Guinea-
Republic of Guinea Bissau
Republic of Maldives
Republic of Mali
Republic of Mozambique
Republic of Niger
Republic of Senegal
Republic of Sierra Leone
Republic of Sudan
Republic of Suriname
Republic of Tajikistan
Republic of The Gambia
Republic of Togo
Republic of Tunisia
Republic of Uganda
Republic of Uzbekistan
Republic of Yemen
State of Palestine
Syrian Arab Republic
Union of the Comoros

Dormant potentials

- Countries with potential to leverage existing petrochemical feedstock
- Relatively small petrochemical output and local end-industry demand today

Democratic and People's Republic of Algeria
Kingdom of Bahrain
Republic of Azerbaijan
Republic of Iraq
Republic of Kazakhstan
State of Libya
State of Qatar
Sultanate of Oman
Turkmenistan

Rising stars

- Countries with potential to expand secondary processing and foster end-industry demand
- Relevant access to petrochemical feedstock and medium-sized domestic end-industry demand today

Arab Republic of Egypt
Federal Republic of Nigeria
Islamic Republic of Iran
Islamic Republic of Pakistan
Malaysia
State of Kuwait
United Arab Emirates

Demand leaders

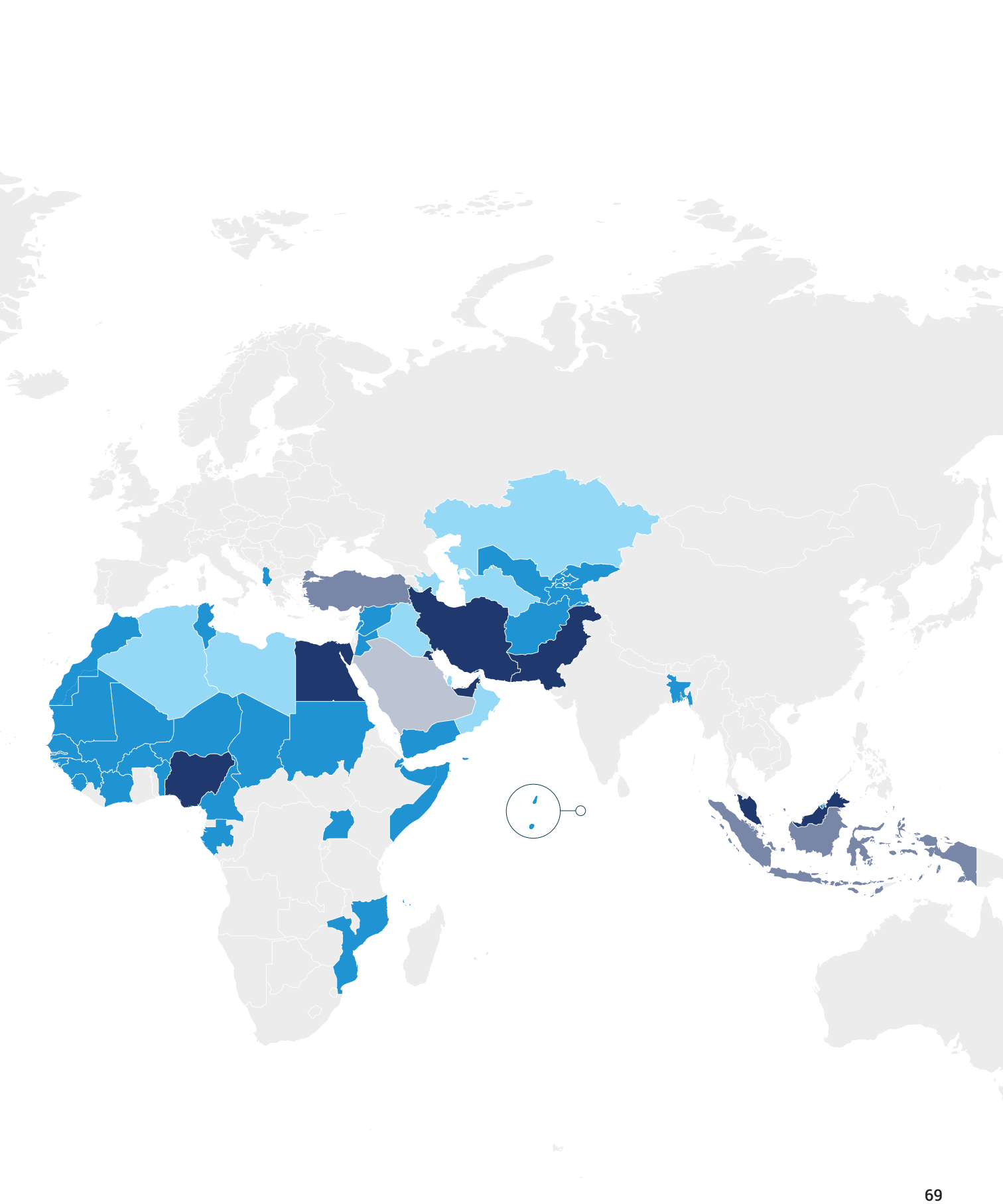
- Countries with potential for backward integration from end industries to secondary and primary processing
- Significant domestic demand from end industries today

Republic of Indonesia
Republic of Turkey

Trailblazer

- Large and well-developed petrochemical industry with potential to grow specialty chemical business and add higher value
- Considerable reserves of petrochemical feedstock today

Kingdom of Saudi Arabia



3.1

STARTING POINTS FOR IsDB COUNTRIES

Petrochemical feedstock, local demand and petrochemical output as filters

Chapter 2 analyzed where the global petrochemical industry is at today, and where different IsDB countries stand in key markets in terms of strengths, weaknesses, potential and opportunities. Building on the above analysis, this chapter assesses the overall readiness of IsDB countries to overcome challenges and seize the opportunities that present themselves. This "readiness assessment" takes a broader perspective, looking at sector capabilities, framework conditions, access to finance and sector competitiveness, as explained in detail below.

Outcomes of the global industry analysis likewise feed into the respective future readiness assessments. No two IsDB member countries are alike. Each has its own natural resources, industrial strengths and areas of expertise. Yet they do share similarities, and these are key to revealing their petrochemical potential.

To better understand the strengths of IsDB countries and the opportunities that await them in this sector, the 57 members were assessed, grouped into clusters and prioritized. This section outlines the methodology used.

EVALUATION AND CLUSTERING

Two filters were applied to cluster member countries.

The first filter was designed to identify those countries with the potential to develop a domestic petrochemical sector of global relevance and/or that could make a significant contribution to the domestic economy. This was done by analyzing three criteria: the supply side (access to raw materials for petrochemical feedstock), the demand side (demand from local end industries) and the current status of the country's petrochemical industry (potential for diversification).

Countries had to reach predefined thresholds for at least one of these criteria to "pass" this filter. Thirty-eight countries were set apart as countries with substantial potential where small investments can make a considerable difference. These countries – labeled the "domestic formulators" – figure highly on the IsDB's agenda and require a different approach to value creation and integration potential in the local petrochemical value chain.

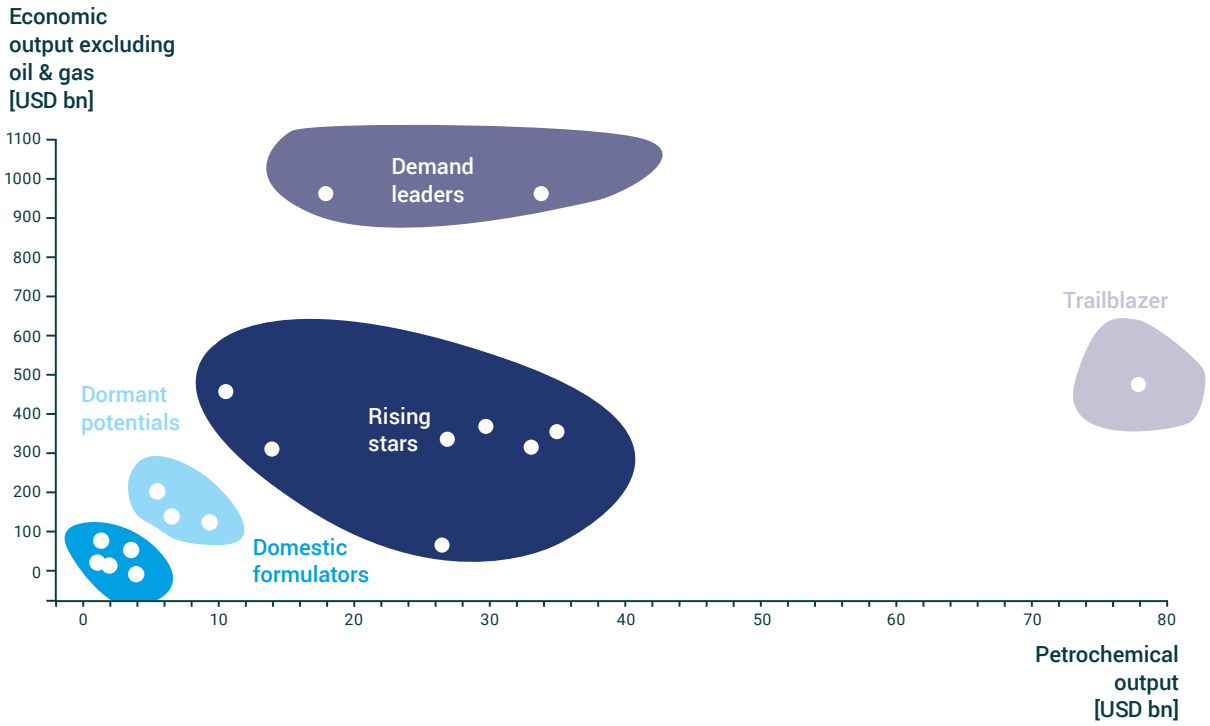
For the remaining 19 IsDB member countries, the current size of the petrochemical industry – the starting point for any further development – and domestic end-industry demand in terms of GDP were plotted on a two-dimensional matrix in an exercise that yielded four IsDB country clusters.

FINDINGS

The 38 countries in the **domestic formulators** cluster are not mapped on the matrix for the reasons cited above. Their specific needs and potential are discussed in detail throughout this report. Though they are starting from a low level, these countries could seek to stimulate domestic end-industry demand as a first step toward promising development. Examples of countries in this cluster include Bangladesh, Morocco, Senegal and Gambia. Of these, Senegal was selected for an in-depth readiness assessment whose fundamental findings and recommendations also apply to all the other **domestic formulators**.

The first cluster depicted in the chart – **dormant potentials** – comprises countries with a small petrochemical industry and comparatively little local demand due to the size of their economy. What they do have are reserves of relevant feedstocks that give them a competitive advantage and create potential to develop their petrochemical industry. Examples of countries in this cluster include Algeria, Iraq and Libya. The readiness assessment for dormant potentials homes in specifically on Algeria.

Five different clusters of IsDB countries



The **"rising stars"** in the second cluster have a petrochemical industry whose regional relevance extends beyond their own borders. The size of their economies also presents greater potential for domestic petrochemical product demand. This country cluster has healthy potential to further develop its petrochemical industry by building on existing infrastructure. Malaysia is the focus of our individual country assessment in this cluster, which also includes countries such as Nigeria and UAE.

The third cluster consists of **"demand leaders."** While their petrochemical industry is small compared to the size of their overall economy, the sheer scale of their economic output generates robust demand for petrochemical products that could be supplied domestically if the local petrochemical industry were to be developed further. Turkey and Indonesia are the only countries in this cluster, with Turkey selected for our readiness assessment deep dive.

In the fourth cluster, Saudi Arabia stands alone as the **"trailblazer"** due to its pre-eminent position in the global petrochemical sector. Saudi Arabia's ambition must be to further push demand from domestic end industries – by stimulating foreign direct investment, for example – and to diversify its existing petrochemical production.

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3.2
FUTURE READINESS ASSESSMENT
Status quo and scenario 2030 for each cluster

All IsDB countries have potential for further value creation in the petrochemical sector. However, realizing that potential will not necessarily be easy. In the previous section we clustered the 57 IsDB countries into five groups based on their overall feedstock resources and the contribution of end-industry demand and petrochemical sector to the domestic economy. What we need to know now is how ready they are to compete – and how their competitiveness is likely to change over the coming decade.

To this end, the following section contains a detailed examination of five nations that we consider representative of the IsDB countries in general. The first is Senegal, representing the domestic formulators cluster. The second is Algeria, representing dormant potentials. And the third is Malaysia, representing rising stars. The fourth is Turkey, representing demand leaders, and the fifth, the trailblazer, is represented by Saudi Arabia. Before we move on to the detailed country analyses, however, we take a look at the methodology that we use to determine a country's readiness.

READINESS ASSESSMENT METHODOLOGY

The methodology employed is designed to produce a comprehensive overview of both the current situation of the petrochemical sector in each of the representative countries and their potential positioning in 2030. It also highlights specific areas where these countries should take action to improve their global competitiveness over the coming decade.

We evaluate four key dimensions with respect to readiness: access to finance, sector competitiveness, sector capabilities and framework conditions. For each of these dimensions, we look at three or four indicators. In total, we look at 14 indicators for the petrochemical sector.

The dimensions chosen permit assessment of a country's degree of industrial readiness to become integrated in the global industry and compete on the open market. They are based on criteria defined by international organizations such as the United Nations and the World Bank, industry associations and public bodies, plus expert opinion and project experience. Taken together, these dimensions and indicators provide a holistic view of the current state of a country's petrochemical sector, highlighting where specific actions are required to advance this position.

The illustrations indicate the country's current level for each indicator with a white line, and its potential future position with a black line. Key areas for action are marked with red lightning symbols; these are the areas where countries can add the most value and optimize their development in the period to 2030.

DIMENSIONS AND INDICATORS

Access to finance: Blending and guarantees, provided by public or non-profit institutions to develop an industry, are usually the first source of financing. As the industry

Assessment dimensions

Top performance

Full competitiveness on a global scale, best practice for innovation and efficiency

Acceptable performance

Partially integrated value chains, productivity and innovation constraints

Room for improvement

Competitiveness on a national level, framework conditions constraints

Critical deficit

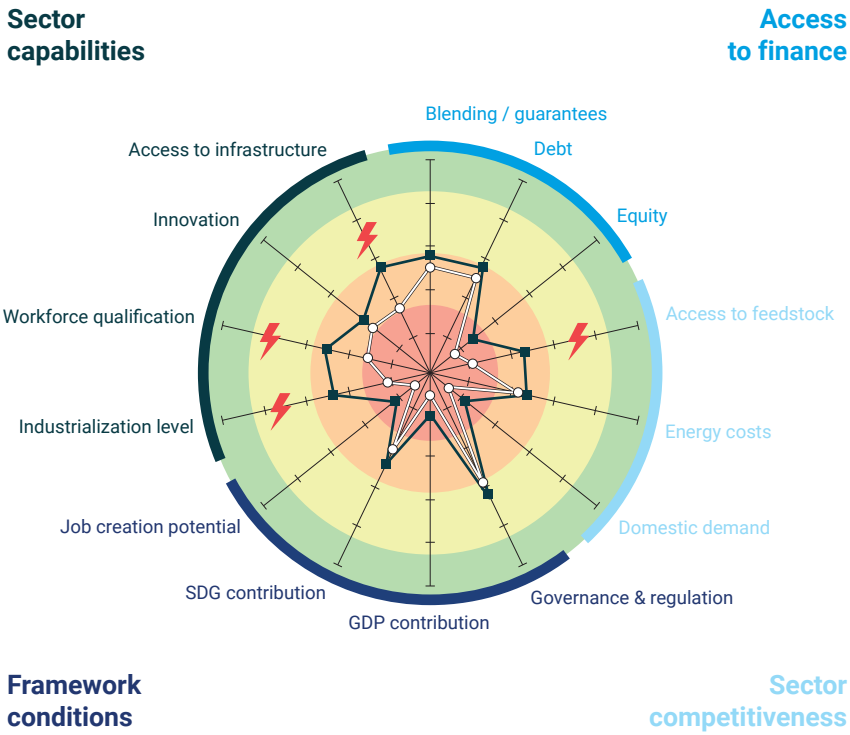
Focus on subsistence and local markets, lack of access to finance

Potential positioning for 2030

Current level

Key field for action

Future readiness assessment



builds, debt emerges as another source of financing, one that requires the borrower to take on risk. Finally, private investors may provide equity in the form of local investments or foreign direct investments (FDI).

Sector competitiveness: This dimension includes three indicators, namely access to feedstock, energy costs and domestic demand. Access to feedstock refers to the volume and value of the available raw material feedstock that is the basis for any petrochemical product. Energy costs characterizes the costs required for the petrochemical production process. Domestic demand refers to the size of the relevant local end industries as (potential) buyers of petrochemical products.

Sector capabilities: Workforce qualification measures how well qualified workers are along the global value chain, on the assumption that better-qualified workers generate greater value. Level of industrialization is important as the global petrochemical sector generally employ best practices and highly efficient processes across the globe. Innovation indicates how advanced the sector is in terms of technology and processes. Finally, access to infrastructure is critical, as a reliable energy supply is needed for efficient processing, and good transportation infrastructure and cross-border connections drive the feasibility of exports.

Framework conditions: Job creation potential means the number of jobs potentially existing in the sector and how much workers could earn, with higher-paying jobs in the industry favored over lower-paying jobs. Contribution to SDGs concerns the sustainability of resources, energy and other factors affecting the environment and people; a positive example would be a sector that is CO_2-neutral and does not have a lasting adverse impact on the environment, while at the same time reducing social inequalities. Contribution to the economy refers to the current value generated within the sector compared to the maximum potential if the available resources were exploited as effectively as possible. Finally, governance and regulation measure the quality of the regulatory framework and adherence to it – a vital indicator as it establishes the framework conditions for all the others.

3.2
FUTURE READINESS ASSESSMENT
Domestic formulators

Senegal – the first country selected for a future readiness assessment – stands for all 38 IsDB countries in the **domestic formulator** cluster that have not yet developed a significant petrochemical industry. Since countries in this cluster are not blessed with the same feedstock resources as others, they need a different approach and must initially focus on building up a relevant secondary processing industry. Senegal could therefore adopt a more opportunistic approach, stimulating end-industry demand at home as a first step toward generating value in petrochemicals.

COUNTRY OVERVIEW

The West African country of Senegal lies on the Atlantic coast and shares borders with Mauritania, Mali, Guinea, Guinea-Bissau and Gambia. More and more companies today use the capital Dakar – a seaport and the continent's westernmost city – as a hub to distribute products and services to the rest of French-speaking Africa. The country's 16-million-strong population is growing fast at 2.8% p.a. and is expected to top 21 million people by 2030. A young average age – more than 60% of all Senegalese are under 25 – should yield a substantial labor pool in the future. Having gained independence from French colonial rule in 1960, Senegal has maintained political stability and boasts a long democratic tradition.

Senegal's fairly diversified economy does not depend heavily on any one natural resource. With a GDP of USD 24 billion and low inflation of 1.7% in 2017, it is slated for real GDP growth of between 6 and 7% in the year ahead. Agriculture accounts for 16.9% of its GDP, industry for 24.3% and services for 58.8%. Yet although less than a fifth of GDP derives from agricultural products, more than 75% of the labor force works in agriculture. The majority of Senegal's workforce therefore currently lacks the industrial expertise that is crucial to the petrochemical sector. Mining and construction account for a large proportion of industry. The country's main export industries are phosphate mining, fertilizer production, agricultural products and commercial fishing.

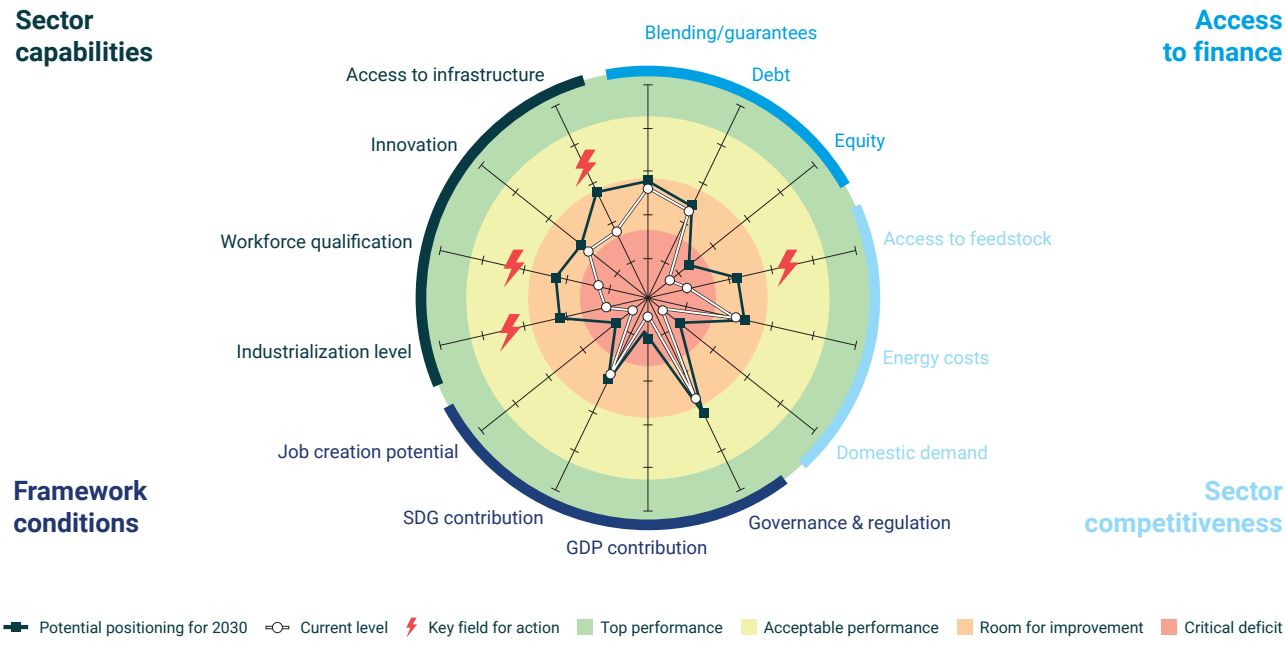
Senegal's petrochemical industry is currently restricted to small quantities of gas extracted from the Gadiaga Field. Limited access to feedstock for the processing of petrochemical products means that oil and gas play only a modest role in the country's economy today.

However, recent discoveries of major oil and gas fields should inflate the quantities extracted in the coming years. Around a billion barrels of crude oil and 40 trillion cubic feet of natural gas have been discovered in the past five years. Though large in comparison to other known reserves in Senegal, these discoveries are modest compared to those of Libya, Nigeria and Algeria, for example, and hydrocarbons will still account for no more than 5% of Senegal's GDP between 2024 and 2040. The country thus has the opportunity to start building an upstream petrochemical sector. Given the challenge of its limited global relevance and the importance of short-term actionability, the focus in domestic formulation should initially be on realizing opportunities for quick wins.

READINESS ASSESSMENT – SUMMARY

Positioned as a **domestic formulator**, Senegal could prepare for a larger petrochemical industry by taking on local secondary processing activities to service domestic demand. Examples include the local formulation of construction chemicals and the production of plastic films for the packaging industry. With the backing of new reserves of oil and gas, primary petrochemical processing could in the long-term open the door to value creation beyond pure

Future readiness assessment: Senegal



extraction. Senegal thus has a short-term and less capital-intensive opportunity to stimulate aspects of secondary processing by fostering domestic demand.

ACCESS TO FINANCE

In Senegal's economy, access to finance relies on donor assistance and remittances. Ambitious development plans such as the Plan Sénégal Émergent (PSE) have established strong trust in government institutions and their commitment to implementation. The Islamic Development Bank currently runs 82 projects with a total volume of USD 3.6 billion. Other institutions, such as the African Development Bank, have injected USD 1.1 billion over the past 50 years. Both institutions actively promote school education, vocational training and entrepreneurship programs. Looking beyond poverty reduction and educational efforts, the World Bank recently helped the government negotiate complex agreements with oil and gas companies – the aim being to foster private investment while respecting public interests. Private debt, loans and debt securities equate to about 29% of Senegal's GDP, but this volume is expected in view of newly discovered resources.

At USD 630 million, FDI is weak compared to other low-income countries. Though investment incentives are limited, the government has made it significantly easier to set up new businesses. A geographically advantageous location and political stability also help Senegal create a healthy investment climate. Despite shortcomings in infrastructure and workforce qualifications, FDI has thus increased in recent years and could be fostered further.

SECTOR COMPETITIVENESS

Below-average sector competitiveness leaves Senegal with considerable room to improve going forward. Apart from its new oil and gas reserves, the country's phosphor deposits have not yet been fully exploited and offer plenty potential for another 10-20 years. Gold exports are on the rise too, amounting to about 12% of the country's exports (compared to phosphate's 6% share). With the completion of extraction facilities scheduled for 2022, more oil and natural gas could be exploited. Beyond mere extraction, processing oil to form petrochemical products requires even heavier investment. However, the decision on whether to build refineries and crackers must be linked to the possibility that end industries

could be ramped up only slowly – automotive being a case in point. Alternatives could include the domestic formulation of construction and road materials and supplies for infrastructure programs.

Energy prices of around USD 0.17/kWh are among the highest in Africa, though there are still regular power outages. Larger companies report up to 30% lower output due to interrupted power supplies. In response, the government has taken considerable steps to diversify its energy mix with renewables (especially solar power).

Domestic demand for petrochemical products remains low, apart from (mostly imported) fertilizers to meet agricultural demand. Since Senegal does not yet host end industries that require a lot of petrochemical products, primary processing could be introduced gradually. Rather than concentrating on specialty chemistry, low-formulation commodities such as concrete, mortar and architectural coatings are already produced here in smaller factories run by Switzerland's Sika and US company PPG. Sika has also ramped up capacity at its initial plant and is now opening a mortar production facility. The latter could also consider tackling sodium cyanide: made from natural gas, this substance is used in gold mining and could be produced locally to substitute for imports – especially with new gold exploration ventures underway at Sabodala. Looking ahead, Senegal could also specifically foster the development of domestic companies in these kinds of businesses.

SECTOR CAPABILITIES

In sector capabilities too, average performance leaves room for improvement to boost both oil and gas extraction and primary petrochemical processing. Deficiencies in the transportation, energy and communications infrastructure must be remedied – which is why the Plan Sénégal Émergent details 27 infrastructure projects to significantly reduce power outages and improve urban development.

Senegal ranked 96th out of 126 countries in the Global Innovation Index 2019, demonstrating some strengths in the area of institutional competitiveness (political and regulatory environments) while urging improvements in infrastructure, knowledge, technology, human capital and research.

The latter aspect is especially important given a literacy rate of only 48%. Solid education of the workforce is indispensable if investment is to be attracted to Senegal. Development banks and government institutions alike are improving primary and secondary school education, but options for specialized petrochemical training remain limited. COS-Petrogaz (a group of experts headed by the Senegalese president) is thus aiming to set up a petroleum institute in the country with the support of the Institut de Pétrole in Paris.

On industrialization, the UN puts Senegal in the lower-middle performance bracket, at 108th out of 150 countries. The country also ranks 8th out of the 29 sub-Saharan countries assessed in this report.

FRAMEWORK CONDITIONS

With major steps forward in the pipeline, projections for Senegal's framework conditions look promising. Richer extraction opportunities and openings for SMEs focused on primary petrochemical processing could significantly increase job creation potential in this industry. However, since the relevant production sites are yet to be built, this potential may not be realized until after 2030.

Senegal ranks 124th in the SDG Report 2019, having recorded year-on-year advances for decent work and economic growth (SDG 8) and climate action (SDG 13). These scores could improve further as the country develops

its petrochemical industry.

Petrochemicals' contribution to GDP was less than 1%, mirroring the country's share of hydrocarbons. With a view to new exploitation opportunities, its share of GDP should jump to 4.6% in 2022 and 6.4% in 2023.

Stable conditions and the leadership's will to take the country forward have earned Senegal international plaudits in recent years. Structural reforms mark a major stride toward implementing economic policies that foster private initiatives. Seen as a top performer on implementing reforms, Senegal must rigorously uphold its strong policy framework remains, which is key to the successful exploitation of its oil and gas resources.

SCENARIO 2030

Unlike countries with larger and more mature upstream industries, Senegal will have seized the short-term opportunities at its disposal and expanded its petrochemical sector through 2030. Rather than focusing solely on upstream activities, it will have built on existing demand for secondary processing, assisted by growth in the construction sector – approaches that are already embraced by international companies such as Sika and PPG. A winning combination of a stable regulatory framework and economic reforms will have enhanced Senegal's appeal to (foreign) investors by filling former gaps in infrastructure and energy.

RECOMMENDED ACTIONS

Newly discovered oil and gas fields give the country's petrochemical industry a chance to expand. Since primary processing requires even larger investments in the absence of petrochemical-hungry local end industries, it may be worth considering building capacity for low-formulation processes. Securing the engagement of other foreign companies beside Sika and PPG could also bring in expertise that could be transferred to the local workforce. This would be an attractive way to develop a comparatively small-scale and low-cost petrochemical sector as opposed to expensive upstream operations. Primary processing could still be a starting point for more sophisticated developments in the long term, but would also demand substantially greater investment.

At the same time, the need to improve Senegal's infrastructure and build more housing – especially in Dakar – could make petrochemical-based building materials a favorable investment opportunity for secondary processing.

To boost the petrochemicals industry beyond mere oil and gas extraction, it is crucial to further improve the country's investment environment. Red tape could be cut further, making it easier to start new businesses and/or collaborate with foreign investors. The latter could deliver multiple benefits: by investing, of course, but also by providing specialized training to upgrade local workforce qualifications.

Closing the infrastructure gap could empower Senegal to take full advantage of its valuable strategic position and attract more businesses to the country. Power outages in particular could be overcome as the country collaborates with development agencies to diversify energy, with a focus on photovoltaic systems.

Moving on from the **domestic formulators** cluster, the next set of IsDB countries – the dormant potentials – today have relatively little local demand but feedstock resources that open up attractive potential for the future.

3.2
FUTURE READINESS ASSESSMENT
Dormant potentials

Unlike the **domestic formulators** analyzed above, Algeria is positioned in the dormant potentials cluster of countries that are blessed with relevant feedstocks that give them both a competitive advantage and the potential to develop their petrochemical industry. Due to the size of their economy, dormant potentials have not yet broadly developed their petrochemical industry, partly because of modest local demand.

COUNTRY OVERVIEW

Located in the north of Africa, Algeria forms part of the Maghreb region. This proximity to European markets could allow Algeria to capture a relevant role as an exporter. Algeria gained independence from French colonial rule in 1962 and is a semi-presidential republic. It is the largest IsDB member (almost 2.4 million km^2) and one of the most populous countries in Africa (with 43 million people). A balanced population distribution should deliver a sustainable supply of labor in the decades to come.

Algeria has one of the largest African economies, with a GDP of USD 178.6 billion in 2020. Oil and gas form the backbone of its economy (around one third of GDP and 85% of total exports) and make Algeria one of the most important exporters in this field. With the market dominated by state-owned oil company Sonatrach, Algeria has so far focused on upstream processing, with most downstream activities being handled abroad. The petrochemical sector is not yet broadly developed and focuses on the production of fertilizers. While the country's geographical location is favorable to both upstream/downstream activities and international trade, projected economic growth is rather modest for the coming years. Both oil and gas production have declined of late and are unlikely to increase without significant structural changes. Even so, the country has potential to exceed projected real GDP growth of 2.4% in 2020.

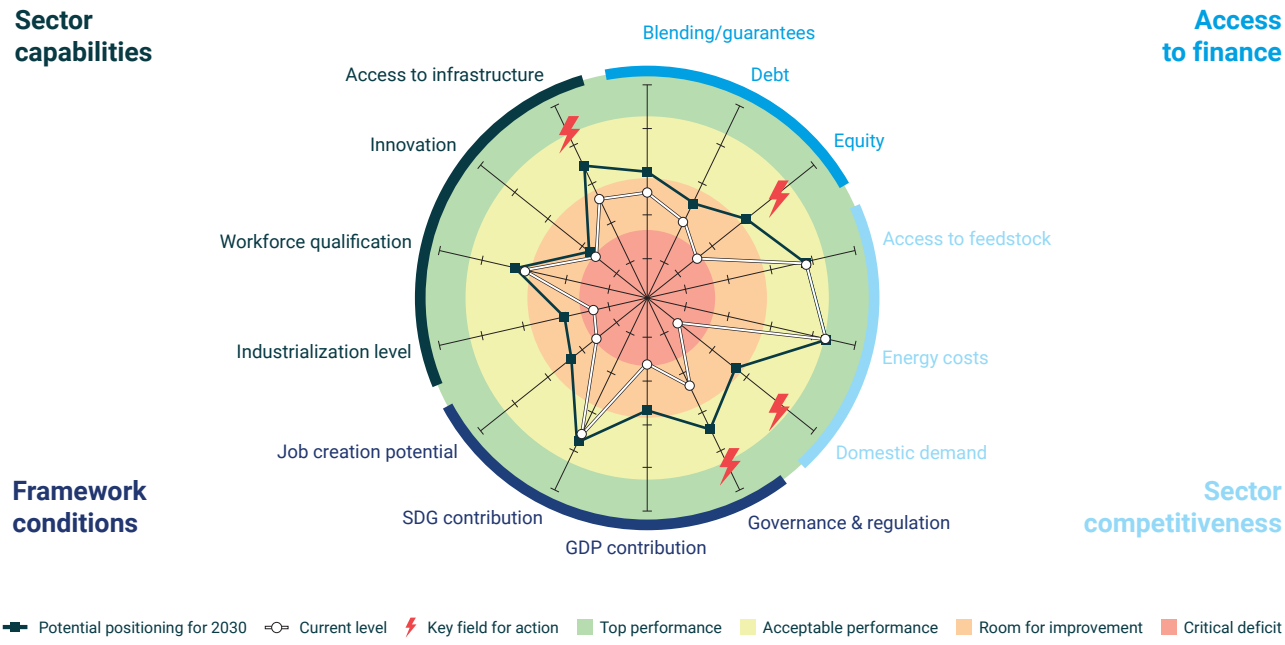
READINESS ASSESSMENT – SUMMARY

Algeria is positioned in the **dormant potentials** cluster: While the major requirement for developing a vital petrochemical industry is in place with large available feedstock, this is not exploited to the full, nor does it translate into further processing as part of the petrochemical manufacturing process. Potential could be realized by leveraging this feedstock and further boosting the country's petrochemical industry. Overall economic conditions could improve by further investing in the construction of new refineries and, even more so, in the processing industry. These investments should be accompanied by a stable regulatory environment to exploit the industry's petrochemical potential in the next decade and beyond.

ACCESS TO FINANCE

There is room for improvement in Algeria's access to finance, especially on equity and upscaling FDI. While FDI has improved since 2015 to USD 1.5 billion in 2018, that is still lower than the USD 2.3 billion netted in 2010. The African Development Bank and the Islamic Development Bank are among several donors who have provided substantial grants in recent years. The government, too, subsidizes the electricity sector, for example. Fiscal performance could further improve to match the developmental stages of other emerging economies. Private debt, loans and debt securities amount to almost 25% of the country's GDP.

Strict constraints on initial investments and a severe tax regime are major obstacles to further substantial investment from private companies and individuals. Foreign investors are not permitted to become majority shareholders, as



state-owned oil company Sonatrach must hold at least 51% of all shares. This fact appears to be unattractive to foreign investors and is further exacerbated by established windfall taxes. Past projects and planned plants financed through joint ventures of Sonatrach and foreign partners have often not been completed. Foreign investors have also criticized lengthy project authorization procedures. The bottom line is that current regulatory and financial conditions could be reformed to make foreign investment in Algerian oil and petrochemicals more attractive.

SECTOR COMPETITIVENESS

Algeria is below par on sector competitiveness but has the chance to increase domestic demand and enhance its petrochemical sector. In 2018, about 12.2 billion barrels of proven crude oil reserves and 159 trillion cubic feet of proven natural gas reserves gave Algeria global rankings of 16th and 11th respectively. Yet this wealth of natural resources cannot yet be fully exploited. Algeria's six active refineries can extract around 620,000 barrels of crude oil per day, while annual gas production totaled 6.5 trillion cubic feet in 2015. The government wants Sonatrach to raise these levels and the Hassi Messaoud Refinery should add another 5 million tons of crude oil per year as of 2024. That would mark a major step toward broadening extraction capabilities.

Much lower electricity costs than in competitor states signal an attempt to attract industrial investment. Electricity has been sold to consumers at a constant rate of USD 0.04 per kWh since 2005 to lure investors with lower production costs. On the downside, the country's main energy consumers have little incentive to invest in innovation and energy technology. As domestic energy consumption increases, Algeria could face the challenge of being unable to export its natural gas in the coming years. To address these undesirable developments, regulators have announced reforms that should keep energy costs from dipping further. Diversification of the energy sector to include renewable energy sources (mainly solar power) is also planned.

Domestic demand for petrochemical products could be further strengthened in Algeria. National construction production already accounts for a promising 9.8% of Algeria's GDP. Textile production and electronics make considerably smaller contributions, respectively accounting for about 0.9% and about 0.4% of Algeria's GDP. The Algerian automotive sector has historically outperformed that of

neighboring countries and is further expanding, with USD 3 bn in production turnover at manufacturers' selling prices. Nissan, for example, has announced plans to cooperate with Hasnaoui Group to open a new production plant in Algeria in 2020. Growing end industries such as this one could sharply boost domestic demand for petrochemical products.

SECTOR CAPABILITIES

Algeria's sector capabilities rank as moderate with significant development potential. Despite strategic access to the Mediterranean, the quality of Algeria's road network lags behind that of other developing countries. Since the chemical sector depends on a well-functioning infrastructure of ports, harbors, streets and pipelines, the adverse consequences are felt more severely in the petrochemical industry. Improvements catering to the needs of both the domestic and export markets are crucial to large-scale industrial development.

Regarding its innovation indicator, Algeria ranks 113th in the Global Innovation Index. Utilization rates have already improved in the petrochemical industry in recent years and are forecast to rise further. In the group of upper-middle income countries, Algeria nevertheless showed the strongest need for better performance. It is vital to further strengthen efforts toward technological improvement.

Algeria's young and fairly well-educated workforce meets a promising requirement for expanding the country's petrochemical industry. With more specialized knowledge needed in scientific and technological jobs, it is crucial to further invest and focus government spending on higher education in research and development facilities and universities.

Lastly, Algeria could significantly improve its industrialization level. The country currently ranks 94th out of 150 countries worldwide and 15th out of 19 countries in the MENA region. As long as its strategy was to export raw materials, have secondary processing performed abroad and then import the finished products, there was no need for technological sophistication in this sector. However, as the country attempts to shift its focus, it may be desirable to enhance the existing technological and scientific basis.

FRAMEWORK CONDITIONS

Algeria could also significantly boost its performance with regard to framework conditions. Job creation potential is healthy, and employment in industry overall has increased as jobless rates have fallen since the early 2000s. However, to what extent petrochemicals will increase its share of growing industry employment going forward depends on expansion rates in the industry.

Algeria ranks 53rd in the UN's Sustainable Development Goal Index – a remarkable score and the highest rank of all IsDB countries. Moreover, ramping up a vibrant petrochemical industry could further improve its contribution to certain SDGs, such as decent work and economic development (SDG 8) and industry, innovation and infrastructure (SDG 9).

Oil and natural resource exploitation accounts for a third of Algeria's GDP, making the upstream petrochemical industry the single largest GDP contributor. Hydrocarbons account for 95% of the country's total exports, a trend that is expected to remain stable. The petrochemical industry contributes about 0.5% to Algeria's total GDP. Since Algeria's gas and oil reserves will likely deteriorate in the years ahead if extraction continues at the current pace, stepped-up secondary processing could more sustainably increase the industry's share of GDP.

One of the greatest opportunities for progress in Algeria's

petrochemical industry could come from governance and regulation, by introducing a more favorable regulatory framework vis-à-vis foreign investment and capital inflows, calming political unrest, fighting corruption and easing current bureaucratic burdens. Foreign investment and the knowledge it brings with it could be welcomed, at least during the initial phase of developing downstream activities. Algeria currently ranks 157th out of 190 countries regarding the ease of doing business. Its score of 48.6 testifies to a strong commitment to improving in the aforementioned areas. Energy reforms for the upstream economy are already in the making and should be implemented as soon as possible to reduce investment barriers.

SCENARIO 2030

With favorable conditions for successful expansion of the petrochemical industry in place in Algeria, the country will have made major strides forward by 2030. Assisted by the strong petrochemical player SOCAR and its subsidiary Azerkimya, Algeria will have further expanded the processing of base chemicals and commodity plastics thanks to significant and increasing domestic demand from the automotive and construction industries. To further boost these local industries, Algeria will have successfully reduced the amounts of imports entering the country.

RECOMMENDED ACTIONS

Algeria has the world's 16th-largest oil reserves and its 11th-largest natural gas reserves, which sets it apart from the majority of IsDB member states. Going forward, its industrial design must therefore integrate upstream and downstream processing to put the country's ample petrochemical potential to good use.

Raising local demand in its domestic automotive and construction industries would further boost demand for the domestic processing of crude oil. Despite declining economic growth overall, the construction sector has still expanded by 6-10% in recent years and is seen as the engine of growth. The importance of agricultural products also means that demand for fertilizer production and processing is likely to increase. On top of these advances, further diversification would benefit not only petrochemicals but the country's overall economic performance.

Despite the strategic benefit of access to the sea, the quality of Algeria's road network lags behind that of other developing countries. The country is nevertheless laying the basis for further industrial growth: projects such as the Trans-Saharan Highway and the East-West Highway have also been moving forward. Further improvements to port and airport infrastructures, coupled with the repair and expansion of existing roads, are likewise crucial to both exports and domestic supply.

To facilitate diversification and the advance of domestic processing, government regulation and fiscal policies could be made more welcoming to foreign investment. Educational levels are already promisingly high compared to other emerging economies, but could be strengthened in the fields of chemistry and science to build a base for upcoming jobs in the industry.

Though much remains to be done, Algeria has the potential to become a big player in petrochemicals. The important thing is to act promptly, take advantage of fast-growing industries and build a viable Algerian petrochemical industry to service domestic end industries.

By harnessing this dormant potential, Algeria could point the way toward the rising stars in the next cluster, discussed here based on the example of Malaysia.

3.2
FUTURE READINESS ASSESSMENT
Rising stars

Malaysia is a representative example of countries in the **rising stars** cluster. Characteristic features of this cluster include a petrochemical industry whose relevance goes beyond that of dormant potentials, extending beyond the country's own borders, and a sufficiently large economy to harbor substantial potential for domestic petrochemical product demand. This country cluster can develop its petrochemical industry by building on a solid existing infrastructure.

COUNTRY OVERVIEW

Malaysia is home to approximately 32 m people and is part of the Commonwealth. Split into two parts by the South China Sea, it is one of Southeast Asia's most vibrant economies, with a GDP of about USD 350 bn. Since its independence in 1957, Malaysia has diversified from an agriculture and commodity-based economy to hosting robust manufacturing and services sectors. Today, it is a leading exporter of electrical appliances, electronic parts and components. It also has sizable automotive and construction industries. Malaysia is currently considered an upper-middle-income country but is expected to become a high-income economy by 2024.

Petrochemicals today earns Malaysia about USD 21 bn p.a., or roughly 6.1% of its GDP. Its petrochemical industry centers primarily around production of base chemicals such as ethylene, propylene, methanol, ammonia and urea, as well as commodity plastics such as polyethylene (PE) and polypropylene (PP). Examples of rapid expansion in this sector include the Refinery and Petrochemical Integrated Development (RAPID) project (a joint venture with Saudi Aramco) and the Yayasan Hartanah Bumiputera Sarawak Tanjung project. While the country's petrochemical market is buoyant at the moment, an oversupplied Asian market could diminish margins and make investment less attractive. The main home-grown petrochemical players are Petronas Chemicals Group (PCG), a state-owned petrochemical corporation of global standing, and Lotte Chemical Titan, a Korean JV and the first Malaysian company to produce olefins and polyolefins. Drawn by the lure of local oil and gas reserves, more and more foreign players also have a presence in the country. Malaysia also possesses a wealth of oleochemical feedstock such as palm oil.

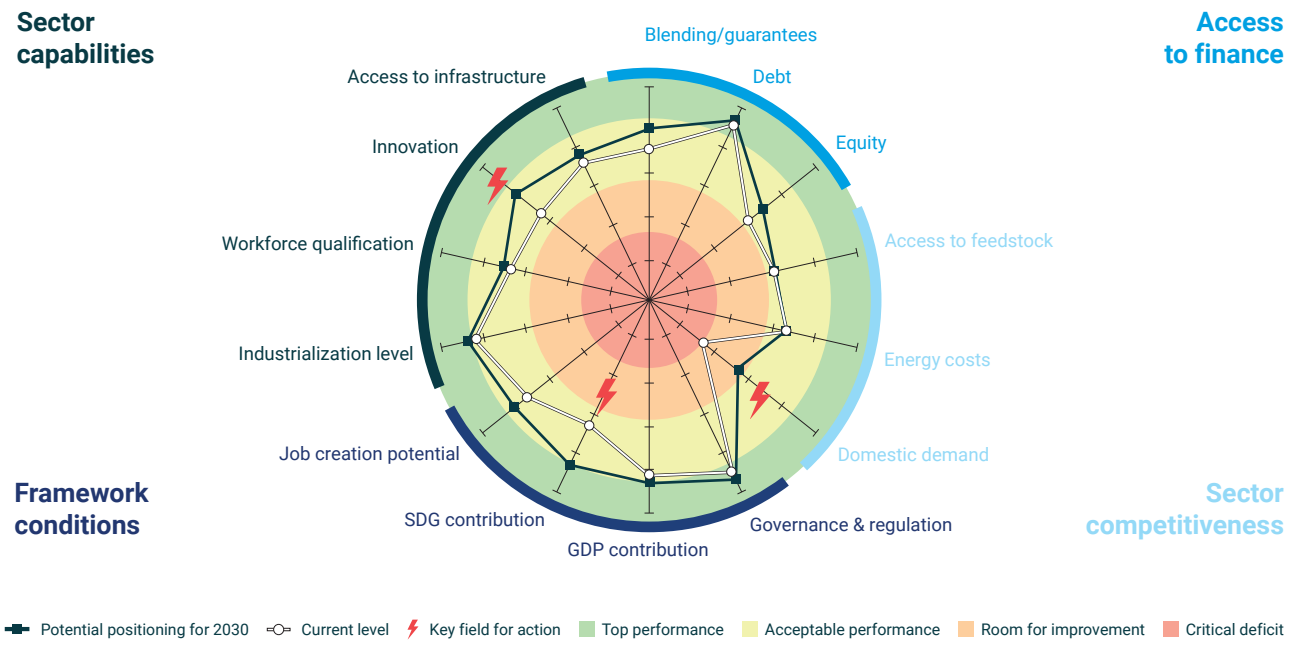
READINESS ASSESSMENT – SUMMARY

Overall, the petrochemical industry in Malaysia is well-developed after years of growing its petrochemical capacity. Blessed with sizable petrochemical and oleochemical feedstock, petrochemical output of regional relevance and considerable domestic demand, Malaysia is grouped in the **rising stars** cluster. While the current value chain focuses on extraction and the primary processing of base chemicals and commodity plastics, there is further potential to create value by diversifying the petrochemical portfolio and also embracing the next value chain step. Room for improvement can be found in Malaysia's innovation score in the petrochemical sector and in the need to attract FDI.

ACCESS TO FINANCE

Regarding access to finance, Malaysia shows acceptable to top performance overall. The country is also well equipped with government-backed development financial institutions (DFIs) whose purpose is to develop and promote key sectors of strategic importance to the country's socioeconomic development objectives (one of which is petrochemicals). The country's economy has also received support from a raft of international development banks.

A well-developed financial sector makes Malaysia a



top performer on debt, with private debt, loans and debt securities adding up to about 137% of the country's GDP – a very high level by global standards. Its equity performance is acceptable, too, as government seeks to boost the petrochemical industry by stimulating FDI. The current inventory of FDI amounts to USD 133 bn, putting Malaysia 41st in the world. To attract private sector investment to its petrochemical industry, the country stresses its advantages in terms of feedstock resources, geographical location and a growing internal market driven by its transition to a high-income country. Malaysia has focused development on fully integrated production, with base chemical facilities linked to increasingly diverse downstream products. To build up these investments, the government plans to add several new petrochemical zones while realizing the full potential of its existing ones. The presence of global players such as Shell, BASF and Eastman Chemicals – alongside local champions Petronas and Lotte Chemical Titan – is a clear statement of Malaysia's potential as an investment location for petrochemicals. Due to existing government initiatives, there is potential to further strengthen this indicator.

SECTOR COMPETITIVENESS

In the "sector competitiveness" dimension, Malaysia's performance is almost as strong as in the fiscal domains outlined above. In terms of feedstock access, it has the third- and fifth-largest proven oil and gas reserves in Asia, most of them offshore. Malaysian oil reserves totaled 3.6 bn barrels (bbl) and natural gas 1.2 tons per cubic meter (tcm) in 2018. A trans-peninsular gas pipeline and six gas processing plants also ensure a steady supply of gas to the industry.

Further development of indigenous resources for use as feedstock will nevertheless be necessary to stand up to an increasingly competitive market. Though certainly of regional significance, Malaysia's known reserves are small compared to the world's biggest producing nations. Moreover, Malaysian energy prices are very slightly below the global average of USD 0.12 per kWh. Lower energy prices would give a boost to the country's already well-placed but energy-intensive petrochemical production.

Domestic demand could be further strengthened, as a large share (about 80%) of the petrochemical goods produced in Malaysia is currently exported. However, an oversupplied Asian market, due to China's growing self-

sufficiency and cheap US petrochemical products based on shale gas, is reducing demand for Malaysian petrochemicals. Stimulating local demand would thus make the country less vulnerable to exogenous effects. Initial steps have already been taken to further grow some of the biggest end industries, including electrics/electronics (31.4% of GDP), automotive (3.6%) and construction (4.5%). For example, the Malaysian government is seeking to strengthen high-tech manufacturing industries in particular, which should support the diversification of petrochemical production. Similarly, large petrochemical plants have done a lot to develop local downstream plastics processing activities by providing a steady supply of feedstock for the plastics industry.

SECTOR CAPABILITIES

The country's sector capabilities are very well developed. Access to infrastructure has improved over the past decade, with Malaysia ranking 40th in the Infrastructure Index and boasting a near-ideal infrastructure for the petrochemical industry: integrated petrochemical zones with centralized utilities, efficient storage services and a comprehensive transportation network, plus the benefit of an outstanding power infrastructure.

Malaysia ranks 34th in the Global Innovation Index, with China the only upper-middle-income country that has a better score than Malaysia. Looking ahead, Malaysia could add to its innovative capabilities, building on its position as a producer of oleochemicals and tapping into the potential afforded by macrotrends such as sustainability and renewable sources – in bioplastics, for instance. Still more opportunities arise as growing numbers of global corporations seek to set up innovation hubs in Southeast Asia.

Innovativeness in Malaysia correlates to its education level and workforce qualifications. A sound education system and a plethora of universities have given the country's petrochemical industry a well-skilled workforce that ranks 62nd in the UN Education Index. Compared to its performance in other dimensions, however, even here there is room for improvement. By contrast, Malaysia's industrialization level is highly competitive and ranks 14th in terms of competitive industrial performance – a tribute to the country's competitive advantage in manufacturing compared to most countries.

FRAMEWORK CONDITIONS

Malaysia's framework conditions are very favorable to the petrochemical industry. Impressive governance and regulation ranks 12th in the world for ease of doing business, though starting a business could be easier (with a global rank of 126th), as could paying taxes (80th). Petrochemicals contributes an acceptable 6.1% to GDP (compared to 11.5% in best-in-class Saudi Arabia).

Malaysia is further expanding its petrochemical industry with several projects, the biggest of which – the RAPID project mentioned earlier – was completed in 2019. This project alone added 3 mt p.a. of new capacity, created 4,000 new jobs and is expected to spur more downstream manufacturing growth. Petrochemicals thus clearly offers further job creation potential, and the Malaysian government is keen to exploit it.

Malaysia's SDG contribution is above average among IsDB countries, with most potential for improvement relating to zero hunger, good health and well-being, gender equality, reduced inequality, climate action and life on land.

SCENARIO 2030

By 2030, Malaysia will have become a future-oriented innovation leader in the chemical field, driven by available feedstock and strong local end-industry demand. By making greater use of both petrochemical and oleochemical feedstock, Malaysia has the potential to obtain a unique position within the IsDB member countries. Thanks to the presence of companies such as Petronas and Lotte Chemicals Titan alongside international global players Malaysia's oleochemical industry will have demonstrated even better performance than today. Certain strategic improvements will have been embraced, enabling the country's petrochemicals industry to progress and realize this vision.

RECOMMENDED ACTIONS

Malaysia could reduce its dependence on the export of its petrochemical products, which currently amounts to around 80% of all petrochemical products manufactured in Malaysia. The reason is that global and regional competition for base chemicals and commodity plastics, Malaysia's core petrochemical product types, is becoming increasingly fierce. To avoid this competition for commoditized petrochemicals, one possibility is for Malaysia to focus on the production of specialty petrochemicals that add more value and face a less competitive environment.

Malaysia could also reduce its dependence on exports by strengthening domestic demand for petrochemical products. To do so, the country could attract relevant end industries as customers for locally produced petrochemical products. While the electronics/electrics industry already plays a significant role in Malaysia, other industries – such as automotive – could significantly increase demand on the domestic petrochemical market. However, attracting end industries is becoming increasingly difficult for Malaysia: As the country transitions from an upper-middle economy to a high-income economy by 2024, increasing labor costs could put it at a disadvantage given fierce competition from neighboring countries. The Malaysian government will thus need to find incentives, such as subsidies and tax breaks, to attract further FDI. Moreover, Malaysia will probably need to step up efforts to improve its SDG score, as foreign (and especially Western) investors are increasingly aware of sustainability, equality and environmental issues.

In addition, Malaysia could adopt a more sustainable approach by already putting itself in a strong position for the day when the finite resources oil and gas are exhausted. Given its role as a palm oil producer of global relevance, Malaysia has a considerable advantage over other oil and gas-rich countries in mastering this transition. Due to the increasing relevance of sustainability and growing environmental awareness, oleochemical products such as bioplastics (often based on palm, vegetable or rapeseed oil) are becoming more and more important. To benefit from this trend the country can gradually foster its local oleochemical industry with a view to the production of bioplastics and strengthen its positioning in natural rubber and surfactants. This will primarily require upfront investment in innovation and new processes.

After rising stars such as Malaysia, this report also identifies two demand leaders in the shape of Turkey and Indonesia. The following assessment of Turkey's future readiness highlights the challenges and opportunities ahead of both of these countries.

3.2
FUTURE READINESS ASSESSMENT
Demand leaders

Turkey belongs to the **demand leaders** cluster, which it shares with Indonesia. The sheer scale of Turkey's economic output generates robust demand for petrochemical products that could be supplied domestically if the local petrochemical industry were to be developed further.

COUNTRY OVERVIEW

The Republic of Turkey is the second-largest IsDB economy, with a GDP of about USD 980 bn and a population of approximately 82 m. Its geography is unique, lying partly in Asia and partly in Europe. Driven by ambitious reforms and government programs, Turkey's impressive economic and social progress has raised both employment and incomes, positioning it as an upper middle-income country. Services account for about 54% of GDP and manufacturing for about 29%. Key industries in Turkey include textiles, construction, food processing, automotive and electrics/electronics. The country has only limited reserves of oil and gas.

Valued at USD 17 bn, Turkey's petrochemical industry is globally significant but plays only a subordinate role in the domestic economy, contributing 0.9% to GDP. It manufactures a variety of products, from base chemicals to commodity plastics to more complex plastics and even carbon fibers and specialty chemicals. Most local production serves the domestic market and needs petrochemical imports to meet local demand. Overall, Turkey depends on polyolefin imports to satisfy 75% of its total demand. In the case of low-density polyethylene, domestic production at least manages to service 50-60% of local demand.

Turkey's two petrochemical complexes in Izmir and Kocaeli are also home to the two key local petrochemicals players. Petkim, owned by SOCAR Turkey, operates the country's only ethylene cracker, while Tupras is the only refiner in Turkey. By 2023, BP and SOCAR Turkey plan to build and run a complex in Aliaga to produce purified terephthalic acid (the precursor to PET) to supply the domestic packaging and textile industries. Work on another refinery and petrochemical hub in the southeastern city of Ceyhan is due to begin in 2021.

About 29% of Turkey's chemical output consists of fine and specialty products ranging from paints and coatings to soda to carbon fibers. Moreover, detergents and personal care products account for some 14% of total chemical output and are also important to the economy.

Faced with high-end industry demand, secondary petrochemical processing is vitally important to Turkey. Large-capacity plants produce synthetic fibers for textiles and fertilizers for agriculture, for example. Synthetic fibers and fertilizers produced in Turkey are used both by local end industries and for export.

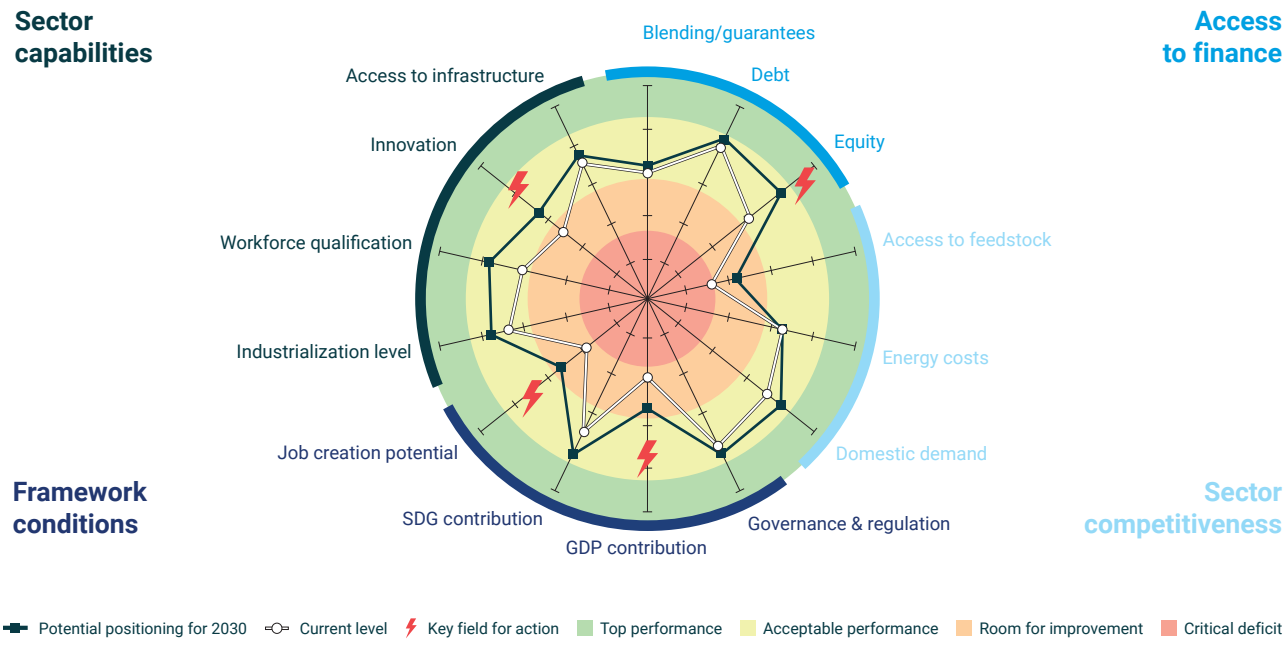
READINESS ASSESSMENT – SUMMARY

Due to its substantial domestic demand for petrochemical products, Turkey is labeled a demand leader. Demand for petrochemical products currently exceeds Turkey's supply capacity. Due to limited petrochemical feedstock, attaining a strong position in the value chain step of production/extraction is something of a challenge. Backward integration from end industries to secondary and primary processing appears to be a more promising approach to realize value creation potential. To further improve its petrochemical industry, Turkey could also improve its innovation performance and its job creation potential.

ACCESS TO FINANCE

Turkey's access to finance is internationally competitive. Blended finance/guarantees are on a decent level and are provided by various local and international institutions.

Future readiness assessment: Turkey



International institutions that operate here include the IBRD and the IsDB, which has realized a total of 540 projects in Turkey and currently has 53 active projects in the country – several of them in the petrochemical space.

With private debt, loans and debt securities adding up to 84% of GDP, Turkey's performance on debt beats that of most IsDB members and testifies to a well-oiled credit market. Many development banks such as the KfW, IFC and IBRD have also supplied debt to development projects here. The country's equity performance is considerable but has room for improvement. Ranking 40th in the world for FDI, Turkey has seen foreign direct investment decline since the mid-2000s attracting about 1% of global FDI in 2018. The largest investment threats comprise the security risks arising from proximity and exposure to the conflicts in Syria and Iraq, growing unrest at home and rising inflation.

SECTOR COMPETITIVENESS

The country's performance on sector competitiveness is patchy, with access to feedstock its major challenge. Turkey's oil and gas reserves amount to only 0.02% and 0.01% of global reserves respectively. To improve this situation, the government has launched the TurkStream project to build a gas pipeline through the Black Sea from Russia.

Turkey's energy costs are slightly below the global average of USD 0.12 per kWh, but nowhere near the top performers of IsDB member countries (USD 0.03 to USD 0.02 per kWh).

Domestic demand is a large source of potential for the domestic petrochemical industry. Key petrochemical customers include textiles (7.9% of GDP), construction (7.2%), automotive (4.3%) and the electrics/electronics industry (2.8%). The vibrant textile industry is of special importance, employing around 20% of the domestic workforce. Automotive engineering ranks 15th globally, with 1.6 m units produced in 2018. Driven by a large and growing Turkish population, construction likewise generates vast domestic demand for petrochemical products. With the population expected to reach about 88 m by 2030, flourishing demand gives Turkey a unique position among all IsDB member countries: it can move toward a more self-sustaining petrochemical supply, especially for plastics of importance to domestic end industries.

3.2

SECTOR CAPABILITIES

Apart from room for improvement on innovation, Turkey's sector capabilities exhibit impressive performance. Its access to infrastructure can easily compete with that of other countries, with Turkey ranking 32nd in the Global Infrastructure Index – the third-highest ranking of any IsDB member. While the country's air traffic and maritime infrastructures are well developed and globally competitive, improvement potential exists for the national rail system. Innovation leaves the largest room for improvement as part of this dimension, with the Turkish government keen to improve this indicator. A new USD 60 m Technology and Innovation Fund, for example, was launched in late 2019 to give capital support to technology ventures and new-generation startups – especially those at the country's technology parks.

Turkey's workforce qualifications are reasonable but have room for improvement. One key problem is that, in 2018, about 60% of 25 to 64-year-olds had no upper-secondary education, putting Turkey third-last among all OECD countries and negatively impacting on workforce qualifications in the petrochemical industry. Since the latter is driven by domestic end industries in Turkey, a clear link can be established between petrochemical production, material skills and application expertise. Education and innovation are thus even more important to Turkey than to countries with a stronger upstream focus. Adopted in 2012, the extension of compulsory education until 12th grade should increase upper-secondary enrollments going forward.

Turkey's industrialization level exceeds the global average. The country ranks 29th in the Competitive Industrial Performance Index, it is the fifth-largest emerging industrial economy and is clearly competitive internationally. Potential for improvement exists in technology application and labor intensity, with current industrial output largely rooted in a low-technology and labor-intensive environment. Moreover, the goods produced often yield only low margins.

FRAMEWORK CONDITIONS

Turkey's framework conditions vary very considerably in terms of performance. While job creation potential and GDP contribution reveal Turkey's greatest room for improvement in this dimension, its SDG contribution and its governance and regulation show remarkable performance. The country thus ranks 41st globally in terms of ease of doing business, with most room for improvement relating to resolving insolvency and starting a business. Consequently, Turkey has undertaken a series of legislative reforms to ease bureaucracy and protect intellectual property. Its SDG contribution ranks 79th globally – a respectable global performance with improvement potential in relation to nine goals. The petrochemical industry contributes 0.9% to GDP, though petrochemical development projects should improve this figure. Complexes in Aliaga and Ceyhan in particular are expected to add about USD 3.5 bn to Turkey's economic output – lifting GDP by nearly 0.5% and taking petrochemicals' share of GDP to approximately 1.5%. These two projects will also positively affect job creation potential, adding an estimated 10,000 new employees in the country's petrochemical industry.

SCENARIO 2030

Turkey's petrochemical industry has outstanding development potential. By 2030, the country will have become a self-sustaining and independent market for commodity plastics and specialty chemicals. Building on both its large industrial footprint (with SOCAR Turkey's

subsidiary Petkim and the Turkish Petroleum Refineries Corporation) and strong and prospering domestic end industries, the country will have further diversified its current petrochemical footprint and specifically attracted and developed a petrochemical industry with high value creation – even without significant feedstock access. Turkey will have further driven innovation in the sector to support the needs of several important end industries, such as textiles, construction and automotive. To reduce dependence on oil and gas imports, the country will have become even more deeply integrated in upstream processing, making Turkey an integrated petrochemical player by 2030 with strong expertise in secondary processing.

RECOMMENDED ACTIONS

Today, Turkey has to import around 75% of domestically required petrochemicals. To reduce this reliance on imports, the country could increase its domestic petrochemical output – for both commodity plastics and specialty chemicals. The ongoing development of petrochemical clusters could be further supported to reduce transportation costs and accumulate knowledge.

First, Turkey could strengthen its base chemical production. Since it only has a single ethane cracker today, further capacity to produce base chemicals could be envisaged. As all petrochemical products are derived from base chemicals, any capacity increase would naturally support the subsequent production of both commodity plastics and specialty chemicals. Improved access to feedstock through the TurkStream project will benefit the production of base chemicals. In a second step, Turkey can increase its capacity for the commodity plastics required by end industries. Local demand exists especially for polyethylene (PE) and polypropylene (PP) from the automotive industry, for polyvinyl chloride (PVC) and polyurethane (PU) from the construction industry, and for polyethylene terephthalate (PET) and polyamide (PA) from the textile industry. The third step could be to develop the ability to produce high-value specialty petrochemicals in Turkey. While it already boasts a well-developed non-petrochemical specialty chemical sector, specialty petrochemicals could further diversify the current portfolio.

To turn these plans into reality, it would be advisable for Turkey to improve its attractiveness for FDI. Vast equity investment is required to develop this capital-intensive sector. Today, however the country's attraction is hindered by the instability of the Turkish lira, inflation and the proximity of conflicts in the Middle East. That said, Turkey has already taken actions to become more attractive for FDI, such as a series of legislative reforms, measures to streamline administrative procedures and the strengthening of IP protection. Ideally, the FDI attracted by Turkey should not only be production-focused but should also include investments that drive innovation within the industry. One example could be encouraging global petrochemical players to set up regional petrochemical innovation hubs on Turkish soil.

All of the IsDB member states bar one are subsumed under the four clusters assessed above. The only one remaining – the Kingdom of Saudi Arabia – is, in many respects, in a league of its own and is therefore discussed separately below.

3.2
FUTURE READINESS ASSESSMENT
Trailblazer

Saudi Arabia stands alone in the **trailblazer** cluster due to its pre-eminent position in the global petrochemical sector. The country's ambition must be to further push demand from domestic end industries – by stimulating foreign direct investment, for example – and to diversify its existing petrochemical production.

COUNTRY OVERVIEW

Founded in 1932, the Kingdom of Saudi Arabia covers 80% of the Arabian Peninsula and is home to approximately 32 m people. It owns an estimated 16% of the world's proven oil reserves (ranking 2nd globally) and around 4% of its proven gas reserves (ranking 5th). GDP of about USD 680 bn gives it the largest economy in the Middle East. This has largely been built around the competitive advantage it gains from cheap feedstock access, with GDP generally rising in tandem with real oil growth. Saudi Arabia's global importance as an oil exporter has created economic interdependencies with many countries around the world. To reduce its own dependence on finite oil resources, the country has invested heavily in large-scale economic development, diversification and modernization initiatives in recent years, one example being the socioeconomic transformation program Vision 2030. Saudi Arabia is a high-income country.

The country's petrochemical industry benefits from plentiful access to the feedstocks referred to above and accounts for 6.9% of GDP. Base chemicals and commodity plastics are the main petrochemical products produced in Saudi Arabia. The industry has also partially diversified into higher-value plastics, although the country does not yet rank as a key global player in these areas. Its main petrochemical players are the state-owned petrochemical giants SABIC and Saudi Aramco. Saudi Kayan's plans to increase ethylene and propylene capacity by 2023 should expand the nation's petrochemical industry. Further relevant developments include construction of a mixed-feed cracker by 2024 and fresh investment in liquids-based petrochemicals, as Aramco and SABIC target a unique oil-to-olefins complex by 2025. However, despite diversification and the prospect of more capacity, Saudi Arabia's petrochemical industry faces pressure from low prices and strong competition. Simultaneously, domestic costs are rising as the government cuts subsidies for raw materials, fuels and electricity. Further subsidy cuts are expected and could diminish Saudi petrochemicals' cost advantage over foreign competitors. Key domestic end industries for the Kingdom's petrochemical industry are construction (6.7% of GDP), electrics/electronics (1.8%) and textiles (1.0%).

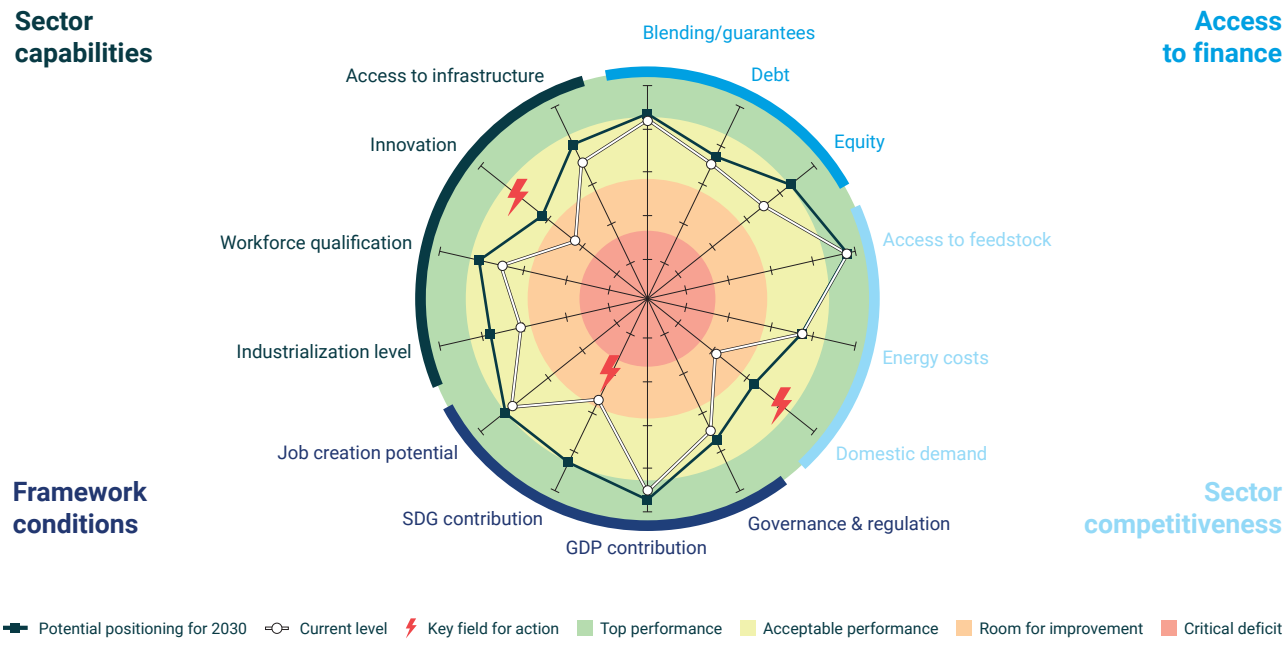
READINESS ASSESSMENT – SUMMARY

The outstanding performance of Saudi Arabia's petrochemical industry puts the country in a cluster of its own: the trailblazer. The country's large petrochemical industry has been developed over decades and has been built on globally unrivaled access to petrochemical feedstock. While Saudi Arabia today covers the entire petrochemical value chain from extraction/production to secondary processing, its ambition could be to attract end industries – such as automotive and the electrics/electronics industry – to further increase domestic demand for its petrochemical products. This move could also drive demand for more specialty chemicals with higher value creation potential, making the country less dependent on large-volume and commodity chemicals.

ACCESS TO FINANCE

Saudi Arabia's access to finance is outstanding – especially in terms of blending and debt. While the IsDB has supported

Future readiness assessment: Saudi Arabia



its petrochemical industry in the past, the Saudi government is also a major backer of development in this industry. Both the National Transformation Program (NTP) 2020 and Vision 2030 single out petrochemicals as a sector that can lead the journey away from dependence on fossil fuels. Under the NTP, the Royal Commission for Jubail and Yanbu (RCJY) was thus endowed with USD 11 bn to "plan, promote, develop and manage petrochemical and energy-intensive industrial cities."

The country's debt performance is equally remarkable. Besides financial institutions in Saudi Arabia, the Saudi Industrial Development Fund also provides mid-term and long-term loans to the private industrial sector, driving the manufacturing industries in Saudi Arabia. An overall figure of 63% nevertheless leaves Saudi Arabia's score well below many Western countries and other IsDB member countries such as Malaysia and UAE, leaving room for improvement for the next decade.

The Kingdom's equity performance is already strong, with the government attempting to further encourage foreign petrochemical companies to invest. FDI of USD 265 bn puts the country in an enviable 24th position globally. However, the condition that foreign firms can only participate in new projects through joint ventures with Saudi Arabian partners may dampen investors' enthusiasm. Major players such as Petro Rabigh, Sharq and National Chevron Phillips are all joint ventures between Aramco or SABIC and a foreign partner.

SECTOR COMPETITIVENESS

Saudi Arabia's sector competitiveness scores are rather mixed, with top ratings for access to feedstock and acceptable energy costs, but room for improvement on domestic demand. Feedstock from vast oil and gas reserves was Saudi Arabia's ticket to a petrochemical industry that did not exist prior to the 1980s. The country's oil and gas reserves are also comparatively easy to extract, making petrochemical feedstock inexpensive. Saudi Arabia's petrochemicals are mostly based on ethane (46%), propane (26%) and butane (12%), while naphtha (9%) and methane (7%) play a subordinate role.

The country performs well on energy costs, with electricity prices (USD 0.07 per kWh) well below the global average of USD 0.12 per kWh. Cuts in government

subsidies could, however, negatively impact energy costs for petrochemical businesses in the future. Domestic demand from petrochemical end industries is currently the sector's weakest indicator – especially compared to other global economies such as China, the USA and Europe. Key end industries for the petrochemical industry in Saudi Arabia could be enlarged to a size in keeping with the overall chemical sector. Construction accounts for 7% of GDP, but electrics/electronics contributes under 2% and textiles less than 1%. About 90% of the Kingdom's plastic intermediaries are exported: only 10% of polymers are sold locally to Saudi-based converters. This situation has arisen because Saudi Arabia's economy is largely based on the production, primary processing and export of oil and gas. The Vision 2030 program is nevertheless expected to augment domestic demand for petrochemical products.

SECTOR CAPABILITIES

The country's sector capabilities are globally competitive and access to infrastructure is deemed suitable for the petrochemical market. Ranking 43rd in the Global Infrastructure Index, Saudi Arabia's infrastructure is superior to that of most IsDB countries. Connecting the oil and gas fields with petrochemical hubs in the west, center and east of the country, its vast pipeline network is a key pillar of this industry. However, Vision 2030 acknowledges room for improvement in the Saudi road, rail and air freight infrastructure, and emphasizes the need for a unique, state-of-the-art logistics hub to streamline trading.

Innovation is the only area of comparative weakness, with the Kingdom ranking 85th in the Global Innovation Index. Saudi Arabia is, however, working to cultivate creativity and innovative capabilities to help drive its economy in the post-oil era, which will positively impact on workforce qualifications. The UN Education Index affords Saudi Arabia a globally competitive 34th rank. Moreover, the fact that enrollment is increasing for technical study programs is also benefiting the petrochemical industry.

Acceptable industrialization levels allow Saudi manufacturing to compete worldwide, with the country ranking 36th in the Competitive Industrial Performance Index. Investment and incentive schemes can further improve this score.

FRAMEWORK CONDITIONS

With the exception of its SDG contribution, the country's framework conditions are very favorable to the petrochemical industry. Saudi Arabia performs acceptably on governance and regulation, ranking 62nd in terms of ease of doing business. While the country is very good at protecting minority investors (ranking 3rd in the world), it needs to do better on resolving insolvency, trading across borders and getting credit. Another indicator with room for improvement is the SDG contribution, where Saudi Arabia ranks 98th globally. Potential for improvement in areas of exceptional relevance to the petrochemical industry are clean water and sanitation, responsible consumption and production and climate action.

Petrochemicals' 6.9% contribution to Saudi GDP is very impressive considering the overall size of the economy. Saudi Arabia's plans to add more petrochemical capacity will likely increase the industry's contribution to GDP and create new jobs. And while petrochemicals already plays an important role on the Saudi job market, its job creation potential is expected to rise further across both direct and indirect employment. Every new direct job in the petrochemical sector could create up to four additional indirect jobs. The core Sadara complex, for example,

employs about 4,000 employees directly, but also gives work to another 15,000 people in the wider industrial complex, in housing manufacturing and in conversion units. Another project that will grow the Saudi petrochemical industry and create an expected 30,000 direct and indirect jobs is the crude oil to chemicals (COTC) complex in Yanbu. This project, launched by SABIC and Saudi Aramco, applies a leading-edge process that will further drive the Kingdom's ambition to become a key global chemical production hub. Production will not start until 2025, but this complex alone should add about 1.5% to the country's GDP by 2030.

SCENARIO 2030

With Saudi Arabia's petrochemical players SABIC and Saudi Aramco already performing on a globally competitive basis today, the Kingdom's petrochemical industry has a bright future. By 2030, Saudi Arabia will have become one of the world's leading petrochemical hubs not only for commodities, but also for specialty petrochemicals. Attracting higher domestic end-industry demand will result in stronger diversification of the petrochemical industry, including the uptake of specialty petrochemical production and thereby increasing value creation.

RECOMMENDED ACTIONS

Existing limitations on domestic demand for petrochemicals could be overcome. Petrochemicals is not yet deeply integrated in the wider economy. Instead, the lack of an industrial base for chemical conversion forces Saudi Arabia to export a large share of its petrochemical products (mostly commodities). To enhance value chain integration, the Kingdom could grow demand in relevant end industries by becoming more attractive to investment in these industries. Creating a Saudi plastics and packaging cluster, for example, could establish valuable supply lines to the automotive, electrics/electronics and biomedical industries. The government is also currently talking to Volkswagen and Hyundai about automotive manufacturing plants in the Kingdom.

Moreover, a higher-value petrochemical segment can be grown out of the expanding domestic industry. Building on the production of commodity chemical and plastics, the next step could be to move into specialty chemicals production – especially once local end-industry demand is flourishing. While specialty chemicals already play a significant role in Europe and the USA, they are still underrepresented in Saudi Arabia's petrochemical production. Since specialty chemicals have unique chemical formulations and compositions, their production presupposes a build-up of technical capabilities, sizable investment and efforts to encourage innovation – an area where Saudi Arabia still lags behind North America, Western Europe and China.

The sections above examine the challenges and opportunities that lie ahead of all 57 IsDB member states across the five clusters identified. They map out a way forward to develop these countries' petrochemical potential, from those in their earliest stages to established international players. Yet the future is in the hands of each country alone, and there are also other alternatives to progress…

3.3

WHAT HAPPENS IF WE DON'T CHANGE?

Seven main impacts

We have talked a lot about potential, about what changes would be useful and how IsDB members can move beyond where they stand today in petrochemicals. Progress, however, is not the only option. It is therefore important to also question what lies ahead for IsDB countries that shy away from the challenges described and "stick with what they know today."

In a "business as usual" scenario, everything continues just as it is today and none of the recommendations in this report are put into practice. If this is how the future unfolds, different crisis scenarios are projected for different types of IsDB member states as a function of their access to feedstock and/or whether they already have a petrochemical industry. As undesirable as this future may be, it is important – and sobering – to spell out the consequences of simply carrying on as we are today.

COSTS OF A GLOBAL PANDEMIC

The Global Lockdown has slashed global petrochemicals demand in the short and medium term, an disrupted the supply side of petrochemicals due to maintenance and investment hiatus. These disruptions are leading to heighten volatility of the prices and margins of petrochemicals. For example, BASF has stopped the production of petrochemicals for the automotive end market, and is operating its plants as a group at a 60% capacity. In a business as usual scenario, petrochemical firms will forgo planned projects and investments. It will lead to petrochemical plants being run down and closed, and operating margins squeezed. This will have a big impact on IsDB member countries that rely on the industry to support their fiscal balance. This will be mainly the case for countries that are in the cluster groups of dormant potential, rising stars and trailblazer. These countries should manage two competing traits, the need to preserve cash to safeguard their petrochemical industry in the short term and the need for new investments to make sure that they are not left behind in the race for heightened petrochemical production efficiency in a world post Covid19.

VOLATILITY AND WASTED POTENTIAL

While access to feedstock will remain a key success factor for the future petrochemical industry, volatile oil prices will continue to challenge the long-term plans of corporates and whole countries. Specifically, it will influence any decisions about whether they can realistically target profitable, global-scale production. Deeper engagement with the petrochemical industry in any form must therefore be preceded by thorough analysis of a country's cost position, plus a roadmap to leverage the most efficient and cost-competitive technologies. If this vital step is skipped, IsDB countries could end up either unable to benefit from their own feedstock, or investing in plants that cannot operate profitably that may have to be shut down again. This threat could be heightened after 2025, when demand for oil for use in fuels is expected to peak before turning down. The trailblazer and Rising stars clusters could be worst hit by this development.

LOSS OF COST ADVANTAGES

In the long term, doing nothing to scale back dependency on petroleum and fuel exports could thus rob IsDB countries of their strategic cost advantage. Demoted to the level of raw material providers, they would see the US, Europe and China remain the epicenters of value creation in the petrochemical industry. Even those Middle Eastern oil and gas players that currently occupy a dominant position must therefore grasp the urgency of becoming more flexible and diversified in terms of production – following the example players in developed countries have already set. Large-scale production facilities today provide economies of scale and, often, fat profits in the region. However, the threat of international trade restrictions and more diversified global demand could push exports downhill in the future, posing a threat to the return on these huge investments.

MISSED BIO-BASED OPPORTUNITIES

On the other hand, the global trend toward sustainability – and the tighter regulation that goes with it – will buoy demand for renewable feedstock, bio-based materials and clean energy. This trend will affect all IsDB countries, who will consequently have to cope with demanding technological requirements and

Industrial wasteland in Reichstett, France – Bio-based feedstock and electrification could challenge the position of oil in the future

more difficult and expensive operations. Whether or not a given IsDB member state already has a petrochemical industry, it is important to stay abreast of innovative developments in areas such as renewable feedstock and bio-based materials. The fossil feedstock will eventually come to an end, which means that countries with their own oil supplies will one day lose their advantage. IsDB countries – especially those that currently petrochemical techniques and facilities. If they fail to do so, the capital-intensive nature of this industry means that any nascent petrochemical sector they have today will quickly be rendered obsolete. While the rise of viable alternatives presents an opportunity for IsDB countries devoid of their own fossil feedstock, climate change and growing demand for food production could, at the same time, put their position in the oleochemical space at risk. These countries must therefore perform a sustainable balancing act: finding a way to maintain food production while also exploiting potential in the chemical industry that can add considerable value to national economies.

LOSS OF INVESTMENT DUE TO POOR INFRASTRUCTURE

It is difficult to attract the investment needed to build up or expand a local petrochemical industry without first creating a commensurate infrastructure and putting good governance in place. Significant up-front investment in public infrastructure is thus needed to create or upgrade industrial zones, roads and ports, for example. IsDB countries must not only be able to compete within their region: they must also rise to the level of global chemical hubs such as Singapore. Limited infrastructure conditions lead to unreliable supply chains and higher transaction costs. Yet reliability is a strict imperative for today's global value chains. If that cannot be guaranteed, investment will continue to flow toward major existing petrochemical production hubs such as China, the USA and Europe. It would then be these regions that reap the rewards of the latest technological advances and skim off the high end of the global value chains. In this scenario, IsDB members would have a hard time becoming an integral, important part of these value chains. They would, in effect, be left on the outside, looking in.

Rubber tires in Reykjavik, Iceland – Recycling remains a key challenge all over the world, but especially in IsDB member countries

LACK OF SKILLS AND WEAK GOVERNANCE

Stagnation in other key areas such as education and governance would stifle development in the local petrochemical sector, eroding productivity and keeping foreign investors from getting involved. For domestic formulators, this could be the most important factor of all: if the required skill levels and basic structures are not in place, value creation potential will inevitably be limited, because countries continue to rely on exports of finished goods. Persistent high rates of unemployment could be the result. Weak governance likewise creates a more uncertain business climate, again making international players reluctant to invest in local production. At the same time, even diversification strategies pursued within the existing petrochemical industry will force the trailblazer, rising stars and dormant potentials clusters to improve educational levels in order to permit more specialized chemical production.

"TO STAND STILL IS TO GO BACKWARDS"

Regardless of the status quo, however, it is critical for IsDB members to focus on expanding local value creation by attracting relevant end industries. These industries stimulate demand for petrochemicals, but they also enhance value creation within the petrochemical value chain itself. Strong domestic demand can drive innovation and technology and help a country accumulate industry expertise. If a country wants to become more self-sustaining and reduce the risks associated with global trade restrictions, strong domestic demand is critical to keep capacity well utilized and justify the enormous investments this industry requires. Countries that fail to take this action will remain vulnerable to volatile movements in the prices of crude oil and renewable feedstock. That in turn would threaten their ability to create stable, lasting jobs and, logically, pose a risk to the positive impact of this employment on the national economy as a whole.

If these challenges are not met, IsDB countries will not progress significantly beyond their current capabilities. Instead, they will continue to suffer from the problems they know all too well today. Staying stuck at today's developmental level in an otherwise rapidly changing world is indeed likely to make these problems even worse. Resilience will be undermined, leaving them more exposed to the effects of economic and/or political crises.

IsDB is nevertheless confident that this gloomy scenario will not materialize – that none of its member states will be content to mark time and see the world pass them by. The following chapter therefore moves on from the theory of what is possible to the nuts and bolts of practical implementation: What, specifically, must countries do to realize the rich potential explored in the chapters above?

Saudi Aramco plant in Saudi Arabia – IsDB member countries have promising opportunities to strengthen their petrochemical sector

4

HOW TO UNLOCK THE POTENTIAL OF IsDB COUNTRIES

Creating the required infrastructure is an enabler for the petrochemical industry

The export-driven petrochemical industry demands the availability of extensive infrastructure and seamless logistics – the heavy investment needed to improve infrastructure requires collaboration between national agencies and international donors

Fostering local demand attracts petrochemical players

The petrochemical industry strives to stay close to sources of demand – stimulating industrialization in IsDB countries can attract end-industry demand, leading to growth in the local petrochemical industry

Establishing the desired workforce qualifications is vital to a prolific petrochemical industry

Technical and vocational education and training must be aligned with the needs of the petrochemical industry to help this sector flourish, provide jobs and drive the local economy

Financing opportunities and inter-country collaboration can give IsDB member countries a competitive advantage

Given the capital-intensive nature of the petrochemical industry, the IsDB's tailored financing tools can help drive its development – collaboration between IsDB member states via connected, interwoven value chains can create win-win situations

4.1
KEY FIELDS FOR ACTION
Bridging the infrastructure gap

Petrochemicals is a capital-intensive and often export-driven manufacturing industry that requires extensive infrastructure and seamless logistics. Five main areas are therefore crucial: Integrated **petrochemical production facilities** such as crackers and refineries are a fundamental prerequisite. A **transport infrastructure** is then needed to bring feedstock and other materials to production sites and ship processed petrochemical goods via pipelines, roads, ports and airports. A robust **utilities infrastructure** must ensure stable production in this energy-intensive industry. And – especially in the age of digitalization and interdependent production sites – a reliable **communication infrastructure** should facilitate smooth connectivity across production processes and along the petrochemical value chain. Lastly, a strong **research infrastructure** is perhaps not essential but certainly beneficial to the petrochemical industry, driving innovation based on lessons learned and challenges overcome.

Many IsDB member countries lack one or more of these aspects of infrastructure. Unless they are further developed in a systematic, joined-up manner, the petrochemical industry in IsDB member countries will not be able to unfold its full potential and compete internationally.

SEAMLESS INTEGRATION ACROSS ALL STAKEHOLDERS

Developing this kind of seamless infrastructure is a major undertaking. It requires access to finance, appropriate policies and regulations, public engagement, collaboration across various government agencies and the involvement of international donors such as the IsDB. The petrochemical players who ultimately stand to benefit must also be involved in the planning process and enabled to inform specifications.

One sensible option is to target an integrated approach at both the national and donor levels – an approach that mobilizes private funds to build, run and maintain the necessary infrastructure. Like the World Bank's Infrastructure Finance strategy, that could include advisory services on everything from financial market reforms to specific aspects of petrochemical sector development. At the same time, national development banks in IsDB countries could develop instruments to attract private investment.

OVERCOMING CONSTRAINTS AND CHALLENGES

All kinds of interrelated factors affect the investment climate, and this alone constitutes a major challenge. Investors want to see how a regulatory framework pans out over time, for example: political stability does not earn widespread trust overnight, so complexity and a long-term time frame place inherent constraints on efforts to attract private investment for infrastructure projects. Especially in developing economies with more pressing needs, public funding is scarce too and often hinges on an industry's growth prospects. Given the capital-intensive nature of petrochemicals, corruption can be yet another inhibiting factor that must be overcome.

CASE STUDY – FARSIGHTED INFRASTRUCTURE DEVELOPMENT KEY IN SINGAPORE AND SOUTH KOREA

Singapore is a good example of how infrastructure can be developed to support a home-grown petrochemical industry. Short on natural resources but strong on sustainable domestic demand, the city-state harnessed its strategic location along important trade routes by building four offshore refineries back in the 1970s. By the 1980s, it was

already established as a global leading refinery hub.

Building on this success, the country then partnered with foreign investors to set up the Singapore Petrochemical Complex, complete with a naphtha cracker and a downstream secondary processing plant. Further advances came when the artificial Jurong Island was completed in 2009, featuring a range of leading-edge facilities – such as an underground hydrocarbon storage facility – to benefit the petrochemical sector.

Similarly farsighted infrastructure planning and development is also a key to the success of the Yeosu petrochemical complex. Having opened for business in 1979, broad access to infrastructure has made it home to 283 companies and half of the country's petrochemical production. Its vast capacity for oil refining and the production of both ethylene and fertilizers is underpinned, for example, by access to sufficient industrial water, an electricity supply in excess of its daily consumption of 580,000 kW and a berthing capacity of up to 3,000 tons. All ships that pass through the port can also use a port-wide wireless Internet service to support further digitalization in the sector. Local authorities regularly align with petrochemical companies at the Yeosu complex to identify further infrastructure needs at an early stage.

IsDB POTENTIAL – PUTTING GEOGRAPHICAL ADVANTAGES TO GOOD USE

Looking beyond the infrastructure gap that many IsDB member countries have yet to bridge, the challenges can also be seen as opportunities to tap hidden potential. Middle Eastern members and some African countries (such as Algeria and Nigeria) have an abundance of fossil-based feedstock. For them, establishing or further expanding a petrochemical industry more or less "at source" has the obvious advantage that pipelines, roads and other means of transportation only have to cover short distances, thereby slashing logistical costs.

Many other IsDB countries are at least located near key petrochemical markets. Central Asian and Southeast Asian countries, for example, can benefit from proximity to China, where the Belt and Road Initiative (BRI) is already upgrading the infrastructure. Similarly, countries in the MENA region are close to the important European market and its well-developed infrastructure, but can also supply feedstock to future petrochemical processing sites in Africa.

To make the most of these opportunities, governments and the IsDB must foster an investment-friendly climate based on identified needs, new capacity and a suitable legal and regulatory framework to facilitate the commercially viable and environmentally sustainable development and operation of infrastructure.

4.1
KEY FIELDS FOR ACTION
Stimulating domestic end-industry demand

In many countries, low levels of industrialization are a key reason for inadequate development and demand. The global division of labor between countries that provide raw materials and those focused on processing them leads to significant inequalities – a situation often accompanied (and aggravated) by a lack of jobs in countries with little industrialization: few jobs mean less income for the people, lower tax revenues for the state and limited potential to invest in developing public services, for example.

Low industrialization also means that, in some IsDB countries, end industries with strong demand for petrochemicals – such as packaging, automotive, electronics, construction, textiles and detergents – are virtually non-existent. There is therefore no solid source of local petrochemical demand. In plastic product and packaging manufacturing, for example, Africa, the Middle East, Southeast Asia, India and Central Asia together accounted for only about 19% of global production locations in 2019 – against 32% in North Asia, 20% in Europe and 19% in North America.

JOINED-UP INDUSTRIALIZATION POLICIES WITH CONDUCIVE CONDITIONS

A comprehensive industrialization strategy can add value and create jobs in IsDB member countries – in petrochemicals directly, or indirectly in the end industries that need its products and thus drive demand for petrochemicals. Population growth across the IsDB member states should make it easier to argue the case for further developing the local construction sector, for example. That in turn can prepare the ground for the domestic formulation of construction chemicals as a starting point for further petrochemical industry development.

In countries with more advanced economies, attracting or further expanding end industries beyond construction should also be considered as a way to amplify demand for petrochemical products. However, any such strategy must also address a number of interdependent aspects, including industry policies that are conducive to such development. Favorable conditions must likewise be put in place to attract foreign direct investment, and easy access to this and other sources of finance must be ensured. Governments must support existing and startup entrepreneurs and create a framework that facilitates public-private partnerships. Collectively, these measures can lay a firm foundation for attractive investment opportunities to support countries' industrialization projects.

OVERCOMING CHALLENGES AND CONSTRAINTS

The capital-intensive petrochemical industry needs a high-quality transport infrastructure for the import and export of goods. It needs a reliable and ample supply of competitively priced energy. Sufficient demand must emanate from domestic and regional end industries, and that itself presupposes a certain level of GDP per capita. A skilled workforce, political stability and a robust regulatory framework are all equally essential. Lastly, healthy access to finance must be given.

Yet it is not enough to tackle only one or two of these issues, and therein lies the unique challenge: all these success factors must fall into line if a country's industrialization strategy is to be sustainable. At the same time, the individual situation of the country in question must be carefully examined with a view to stimulating existing and potential end-industry demand for petrochemicals.

CASE STUDY – TURKEY BUILDS AN END INDUSTRY THAT NEEDS PETROCHEMICALS

Turkey's automotive industry illustrates how a country can deliberately cultivate an end industry with substantial demand for petrochemical products.

Initially fostered by import substitution policies, the success of this development is largely based on partnerships between international and Turkish companies, plus Turkey's favorable geographical location. The sector gradually evolved from assembly-based production to an industry with R&D design capabilities and high added value. As a result, Turkey is now one of the largest commercial vehicle manufacturers in Europe, rolling out 1.6 m units in 2018 and accounting for exports totaling USD 32.2 bn – 85% of the country's total vehicle production. Big-league OEMs such as Hyundai Motor, Fiat Chrysler Automobiles and Toyota Motor continue to invest in the country and raise their production capacity.

Ford Otosan exemplifies how Turkey's automotive success story has unfolded. After committing to a partnership with Ford in 1997, it developed and produced various models and currently receives EU support for autonomous driving projects. The company possesses all the capacity and facilities needed to design, develop and test vehicles in Turkey and also operates in the field of electric vehicles, which could further augment demand for petrochemical products going forward.

IsDB POTENTIAL – LEVERAGING FEEDSTOCK ACCESS AND IDENTIFYING RELEVANT END INDUSTRIES

While industrialization levels in many IsDB member countries are comparatively low, favorable framework conditions create significant potential for further development of relevant end industries.

Many IsDB countries in the Middle East and Africa enjoy easy access to relatively cheap fossil-based energy. Other states have huge potential to generate renewable energy, especially solar energy. This gives them a clear advantage when developing energy-intensive petrochemical processing sites, for example. Proximity to oil and gas as feedstock in the MENA region and renewable feedstock (such as palm oil) in Southeast Asia can likewise benefit industrialization by cutting the cost of sourcing and transportation. As population growth and other factors drive global demand for petrochemicals, the prospects for sustaining end industries in this sector are good. Rising per-capita income levels in emerging markets will add to growth and justify investment in new processing sites. The labor pool, too, is plentiful in most IsDB countries but will need reskilling to properly handle the work entrusted to them in this complex sector.

To harness the potential of industrialization, the IsDB and member countries must together identify the most promising products, feasible capacity levels and the relative global cost position. A holistic approach to ongoing industrialization should then target further investment and integration in global supply chains.

4.1
KEY FIELDS FOR ACTION
Training people for quality jobs

A suitably qualified workforce is essential if further industrialization is to translate into local production and good jobs, as a petrochemical workforce must master a wide range of skills and competencies. Technical and vocational education and training (TVET) in particular can deliver the necessary process engineering, system and plant control, chemical engineering and health, safety and environmental expertise, thereby opening up opportunities for career advancement and growing prosperity.

In many IsDB countries, aligning TVET with the needs of the economy is a challenge. If the education system, the petrochemical industry and/or the government are effectively out of sync, TVET may fail to meet industry needs and/or hinder a government's economic policy. Especially for countries seeking to develop a petrochemical industry from scratch, the challenge can be enormous.

Despite its importance for jobs and value creation, TVET is sometimes perceived as inferior to university education, which may limit the willingness to invest in suitable courses. Students and trainees may also fear that they will be "too specialized" and unable to switch between different streams in the education system. Tuition fees can be an added deterrent, especially for individuals currently living at subsistence level. Especially in petrochemicals, where proper training requires expensive equipment, a systemic approach to resolving this dilemma is needed.

POTENTIAL SOLUTION – ALIGNING TUITION WITH THE NEEDS OF THE INDUSTRY

First and foremost, countries keen to create jobs through further industrialization in the petrochemical sector must recognize the vital importance of TVET. Building production facilities and a modern infrastructure will do nothing for national economic growth unless most jobs are filled by domestic labor.

TVET strategies must engage potential trainees. Training needs to be understood as an investment that can lead to rewarding jobs and careers, and as an education path that is neither socially nor financially inferior to a university education.

By forging strong links between TVET institutions and the petrochemical industry, TVET can also respond to the latter's specific demands and itself keep up with relevant trends and innovations. Joint curriculum development between the TVET sector and the industry is ideal, alongside TVET instructors who are industry practitioners. This approach can ensure that most petrochemical jobs in IsDB countries are indeed filled with well-trained local staff instead of expatriates.

OVERCOMING CHALLENGES AND CONSTRAINTS

Timing the training of a workforce for a virtually new industry is a "chicken-and-egg" dilemma: Which comes first? A qualified workforce is needed to run a country's petrochemical industry, but it is hard to motivate potential trainees to enroll in training for a nascent sector – especially if they have to forego their (low) income during training and pay tuition fees on top. IsDB members must therefore plan the development of both the industry and the TVET sector as accurately as possible: How many employees are needed when and for what aspects of the petrochemical sector? Ideally, course completion should roughly coincide with the time when graduates can be hired.

Reforms in the TVET sector must therefore be seen as an integral part of efforts to develop the petrochemical industry, but they must also fit in with the existing educational landscape. Established teaching institutions may be reluctant to retrain staff or hire new instructors, adopt new

curricula and comply with international standards in order to partner with an emerging sector. Policy approaches must therefore underscore the long-term economic benefits of expanding and professionalizing the TVET sector in countries that plan to further industrialize.

CASE STUDY – CAREFUL TIMING AND GLOBAL PARTNERSHIPS IN SENEGAL

Senegal understood from the outset the need to train a local workforce to maximize the socioeconomic benefits of its embryonic oil and gas sector. The state-owned Committee for Strategic Orientation in Oil & Gas (COS-PETROGAZ) thus pushed for the establishment of the National Petroleum and Gas Institute (INPG).

Launched in 2018, this institute is now training Senegalese nationals to become the technical workforce for the country's oil and gas sector. The INPG is initially focused on providing TVET to graduates in technical fields such as electromechanics, geology and civil engineering. In the future, additional courses will not require a previous university degree. An initial workforce should be ready to start working when Senegal begins to start producing oil in 2022.

The TVET strategy incorporated best practices from around the world. Students must complete a six-month internship as part of their training, for example, and are also instructed in natural resource management and sustainability. To this end, the INPG partners with companies such as Total, BP and Exxon, who have seats on the board and have provided funding of several million dollars.

IsDB POTENTIAL – LEARNING FROM OTHERS AND HARNESSING BEST PRACTICES

To teach a workforce the skills it needs to successfully operate a petrochemical industry, several timely opportunities must be seized.

Relatively young populations give many IsDB countries an ideal starting point to introduce TVET that will train a workforce to make a nascent petrochemical industry flourish and contribute to the country's wealth. Low language barriers in several IsDB member countries also favor the establishment of regional training hubs and facilitate regional job mobility. Arabic is widely spoken in the Middle East and North Africa, for example, while French and/or English serve as the lingua franca in large swaths of Africa, as does Russian in many parts of Central Asia. Additionally, the existence of an oil and gas industry in several IsDB countries means that expertise in operating large plants in a process industry is already in place – a useful asset when seeking to ramp up a petrochemical value chain.

Another natural advantage for IsDB countries is that they do not have to reinvent the wheel. Global oil companies, technical assistance agencies and international organizations have been supporting TVET development for many years and can import good practices from around the world. IsDB countries should seize this opportunity to strengthen their TVET sector in a way that supports the petrochemical industry, not forgetting adjacent job profiles (such as accounting and law) that can contribute to large-scale job creation.

4.1
KEY FIELDS FOR ACTION
Promoting innovation and mainstreaming sustainability

PROMOTING INNOVATION AND MAINSTREAMING SUSTAINABILITY

The petrochemical industry is capital-intensive, energy-hungry and produces goods that can harm nature if they are not recycled or properly disposed of. It has a large environmental footprint, churning out about 4% of total CO_2 emissions in 2017.

As in other industries, innovation is a key to success and sustainability in petrochemicals, too. Innovation can deliver a sharp competitive edge, reduce production costs, facilitate integration in global value chains, create quality jobs and mitigate environmental impacts. Importantly, it is not the exclusive preserve of advanced economies: emerging economies can also harness innovation to drive prosperity and sustainability. It is thus a core parameter in investment decisions, shaping the viability of an industry in any country or region. Today, however, IsDB countries are missing out on much innovation in the petrochemical sector, which addresses global challenges but is heavily concentrated in developed countries.

POTENTIAL SOLUTION – INNOVATION PARTNERSHIPS WITH NO RESEARCH AGENDAS

Promoting innovation should be at the forefront of IsDB states' efforts to launch or expand local petrochemical activities. Given the industry's chunky carbon footprint, close attention must be paid to topics such as recycling, bio-based feedstock and sustainability if industrialization is to remain viable in the long term.

Since nascent industries often lack the funding, experience and research infrastructure they would need to prioritize innovation, it is vital to leverage synergies. IsDB members should therefore promote partnerships between existing research facilities such as universities and industry players – preferably across national borders to stimulate intra-IsDB cooperation and foster regional innovation clusters. Partnering with established innovation centers in high-income countries is another valuable option. To keep research in tune with real-world needs, such partnerships should encourage innovation in general rather than setting a research agenda. Additionally, institutionalized innovation partnerships must avoid crowding out informal initiatives.

OVERCOMING CHALLENGES AND CONSTRAINTS

Limits on the development and implementation of innovations impose serious constraints in some IsDB member states.

The development of innovations can be hindered by a lack of established academic and corporate R&D activities, or simply by a backward-focused attitude. On the other hand, the implementation of innovations is frequently blocked by a lack of the necessary infrastructure. An immature market situation can also raise barriers to technical feasibility in certain countries.

When it comes to implementing sustainability practices, cost tends to be the primary constraint. Mainstreaming sustainability by developing policies and regulations and adapting them for specific countries is a laborious and expensive process, as is the subsequent need for constant monitoring. Then there is the material cost of investing in equipment to process renewable feedstock and recycle plastics. In countries with scarce funds to attract or develop a petrochemical industry, such expense can be a major disincentive.

These constraints point to a clear conclusion: if they are to play a significant role in petrochemical innovation, emerging IsDB countries need markets of a certain size.

That is what enabled China to emerge as an important innovator alongside the established markets of Europe and North America. An alternative approach could be to align innovation with specific local needs (such as deriving feedstock from palm oil in Southeast Asia).

CASE STUDY – THREE SUCCESSFUL PARTNERSHIPS

Three success stories suggest ways in which governments can either promote industry research and/or provide a suitable research infrastructure.

Leading global styrenics supplier INEOS Styrolution recently succeeded in producing virgin polystyrene from purely depolymerized material. This breakthrough has the potential to enhance resource efficiency, increase recycling and scale down the petrochemicals industry's environmental footprint. Backed by funding from the German Ministry for Education and Research, the aim now is for a pilot plant to scale up this closed-loop recycling. INEOS has also signed agreements with Belgian waste management company INDAVER (to further develop chemical recycling) and food packaging group Sirap (to develop packaging from recycled PS).

SABIC's innovation partnerships have proved similarly successful. Swedish automation giant ABB, for example, is installing an automation, control and safety system to digitalize a greenfield SABIC pilot plant in Jubail, Saudi Arabia. The project will give SABIC access to big data and predictive analytics in order to improve productivity and performance.

In a partnership with BASF subsidiary HTE, a laboratory for high-performance experimentation in Germany should streamline SABIC's R&D work on cutting costs and accelerating the development of new catalysts and petrochemical processes. A sister facility will also be installed at King Abdullah University of Science and Technology (KAUST) in Saudi Arabia. Knowledge transfer is authorized.

IsDB POTENTIAL – LEAPFROGGING FROM DIFFERENT STARTING POINTS

Not all IsDB countries are equally rich in feedstock, so paths to innovation and sustainability must differ. Member states with plentiful access to feedstock can jump straight to cutting-edge processing technology such as crude oil to chemicals (COTC). Conversely, those with little or no access to fossil-based feedstock can leapfrog their oil and gas-based counterparts by adopting innovative technologies such as capturing CO_2 for further processing as a petrochemical input.

IsDB countries can also pursue innovative approaches to setting up and expanding R&D infrastructure in petrochemicals. Malaysia and Indonesia, for instance, could become centers of excellence in bio-based feedstock research. GCC countries, on the other hand, could join forces to set up a COTC research hub. Where the development or expansion of a petrochemical industry is not feasible, countries could leverage competitive labor costs to set up R&D centers in support of markets and production sites elsewhere.

To seize these opportunities, IsDB member countries should focus on adding value through innovation, thereby leapfrogging the structures that exist in established markets. It is also important to facilitate intra-IsDB cooperation and target a broad base of stakeholders (especially within the industry) to secure the necessary investment and focus innovation on identified needs.

The petrochemical sector requires market knowledge, process expertise and access to finance – Collaboration is key to success

4.2
AN INVITATION TO COLLABORATE
Advantages of working with IsDB

The Islamic Development Bank equips people with the tools they need to build a sustainable future for themselves, their communities and their countries by putting the infrastructure in place to enable them to reach their full potential. Together with the private sector, IsDB sustainably drives modernization and growth within its member countries.

IsDB …

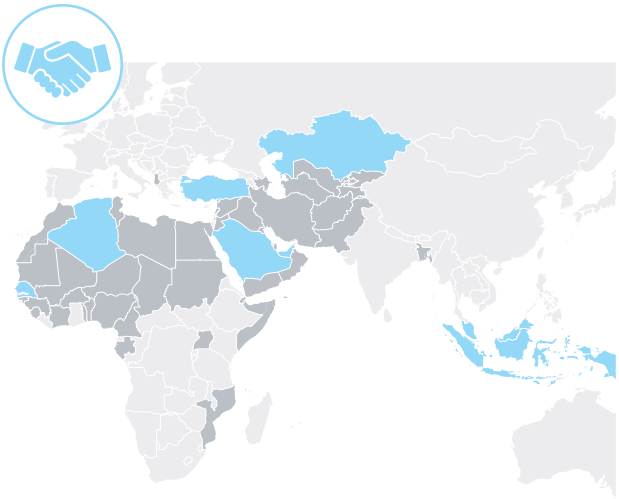
- **builds partnerships,** creating collaborative relationships between communities and nations by bringing together the public and private sector through public-private partnerships and joint project development
- **provides Islamic finance,** establishing long-term, sustainable and ethical financing structures as the global leader in Islamic finance to underpin project investments by issuing sukuk (five-year trust certificates)
- **fosters innovation and sustainable solutions,** championing science, technology and innovation-led solutions to meet the UN Sustainable Development Goals by boosting skills, sourcing ideas and transforming visions into real solutions through two main vehicles: the Engage Platform and the Transform Fund
- **develops high-potential markets,** investing in training, skill building and research and development so that member countries can generate and retain greater economic prosperity at home, raising the quality of their products and further integrating their value chains

IsDB member countries include many of the fastest-growing economies worldwide. Jointly, IsDB members represent the purchasing power of almost one quarter of the world's population. The joint GDP of IsDB members amounts to roughly USD 7 trillion. With GDP growth rates of up to 8% per year, they have considerable potential to further increase their market share in the global economy.

IsDB INVITES ITS PARTNERS TO COLLABORATE ON FURTHER DEVELOPING THE PETROCHEMICAL SECTOR, BY …

- providing them with **access to IsDB's extensive network** of public- and private-sector representatives and **high-level decision-makers**
- jointly building up **skills and capacities** within IsDB member countries, granting partners long-term and sustainable **access to promising future markets**
- offering joint **project financing** as well as future **risk sharing schemes** to mitigate investment-associated risks

4.2
AN INVITATION TO COLLABORATE
Opportunity examples



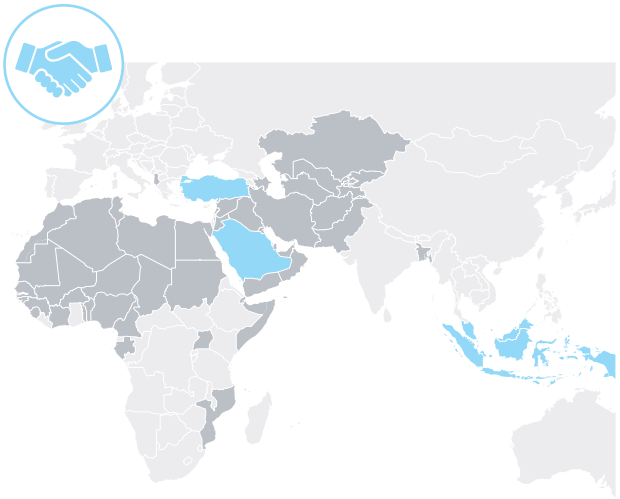
While the five different clusters obviously have much in common, this report also reveals major differences between IsDB member states. No two countries or markets are alike: Each has its own strengths and limitations, both of which naturally affect its petrochemical performance. Yet precisely this diversity, spread across 57 member states, opens up tremendous opportunities for collaboration: one country's competencies and capabilities could well help overcome the challenges faced by a fellow member state, and vice versa. In other words, a commitment to sharply focused cooperation between IsDB countries can forge win-win situations that tear down obstacles and enable the entire region to raise its petrochemicals game.

Share knowledge and technology

Technology and knowledge are key success factors in this capital-intensive sector. Countries with significant expertise and investment capabilities could therefore help member states in the dormant potentials and rising stars clusters enhance their primary and secondary processing capabilities. Similar cooperative ventures could support selected domestic formulators in developing extraction and primary processing.

Demand leaders Indonesia and Turkey could, for example, export technology to or set up subsidiaries in IsDB countries with a small petrochemical industry and little domestic demand. Alternatively, members with superior primary processing expertise, such as Malaysia, UAE and trailblazer Saudi Arabia, could help dormant potentials such as Algeria and Kazakhstan develop base chemical production capabilities.

To make such collaboration genuinely meaningful, the recipient countries could offer equity interests in return. While equity returns may remain limited in some cases, cross-investments with more mature countries already exist in some markets (such as cooperation between Indonesia's Pertamina and Saudi Aramco). Clearly, there is vast potential to step up such mutual support ventures on an amicable basis between IsDB member countries.

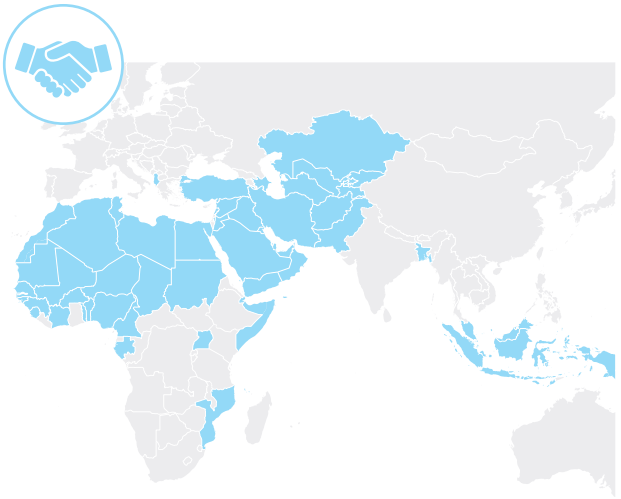


Set up trade agreements and integrate value chains

Beyond the transfer of knowledge and technology, trade agreements could leverage countries' varying strengths at different links in the value chain and help overcome the limitations of minor primary or secondary processing capacity. Large primary processors such as Saudi Arabia could, for instance, export their products to countries with considerable secondary processing capabilities and/or strong domestic demand and then import the secondary processed products.

To facilitate this kind of cross-border value chain integration, useful steps include abolishing customs tariffs, establishing bilateral or multilateral trade agreements and improving connectivity (e.g. transport infrastructures) between IsDB member states. For member states with little or no petrochemical feedstock of their own, this model could be a valuable alternative to domestic value chain integration.

Another approach to industry-specific collaboration could see countries with substantial access to oleochemical feedstock (such as Malaysia and Indonesia) and oil-and gas-rich member states coordinating their activities – rather than competing – to give both sides a global competitive advantage in terms of both cost competitiveness and, especially, sustainability.



Operate joint innovation platforms

Continuing with the theme of sustainability, the global fight against climate change has magnified the importance of environmental awareness on political and industrial agendas alike. In many areas, research and innovation are needed to "green" the petrochemical industry, so it makes sense to share the costs – and benefits – of these efforts.

One option is a joint innovation platform to drive sustainability in both upstream and downstream processing steps. By funding a regional innovation hub, for example, member states could tailor sustainability solutions to the needs of different IsDB countries. The hub could be located in a country equipped with in-depth petrochemical expertise, large industrial facilities and sizable research institutes. All member states would then profit from the latest technological insights and advances, strengthening their collective competitive position on the global market.

To guard against (non-IsDB) free-riders cashing in on the resultant innovations – and thus to attract more investment into this kind of venture – steps should be taken to protect intellectual property.

4.2
AN INVITATION TO COLLABORATE
Potential financing instruments for future collaboration

To achieve equitable growth and innovative development by 2030, a range of innovative financing instruments can be applied. Such instruments will facilitate collaboration between the IsDB and its partners, unlocking significant investment opportunities for the private sector. Details of some of these instruments are shown below.

Debt instruments

Description

Low and middle-income countries often fail to secure the private capital that is essential to further infrastructure and industrial development. Bond repayment guarantees for carefully selected projects can help attract private funding.

Potential for the private sector

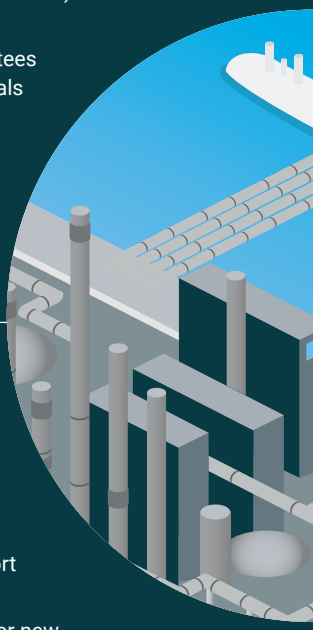
- Limited risk of exposure to corruption and political pressure due to careful selection of investment projects
- Minimized risk of loan default
- Improved allocation of private capital to long-term projects that contribute to development

Decentralized loan schemes for infrastructure development in small-scale projects (e.g. domestic formulators)

Loans for feasibility studies and guarantees for large-scale pilot projects in petrochemicals

Demand-stimulating projects such as innovation hubs for end industries

Bond repayment guarantee for selected investment projects



Innovative financing approaches

Description

Companies in emerging economies and public authorities both lack large-scale data for forecasts and innovation. Cofinancing of data sharing platforms can bridge this gap, giving the corporate and public sectors the tools they need to collect anonymized data

Potential for the private sector

- Superior market insights for petrochemical players
- Anticipation of trends stemming from local end-industry development
- Reliable, anonymized data for innovation and research

Lead arrangement for private funding

Sovereign data financing and shared data centers

Host government agreements for infrastructure support

Crowdfunding (debt or equity) for new petrochemical innovations (e.g. recycling technologies)

Equity instruments

Public equity finance for risk-sharing across large-scale processing facilities (e.g. COTC)

Petrochemical-focused infrastructure master planning (e.g. integrated site and road/port planning)

Long-term Islamic industrialization fund for growth/export strategies

Equity fund for sustainability initiatives

Description

Many developing economies face a dilemma: domestic demand for end-industry products (and hence petrochemicals) is too low, but government deficits cannot be widened any further. An international Islamic long-term industrialization fund can sustain demand without adding to national fiscal deficits, thereby supporting demand for petrochemicals.

Potential for the private sector

- Access to long-term finance, including high-risk finance
- Development of new (export) industries
- Domestic demand unaffected by fiscal austerity measures

Advisory services for national SMEs in export and expansion strategies

Funding of PPP projects with associated capacity-building

Development and finance of TVET centers

Incentivization of cross-border education/ knowledge support for local construction and maintenance expertise

Description

Creating domestic jobs, generating taxes and addressing externalized costs can maximize the benefit industrialization gives to a country's development. Public-private partnerships (PPPs) are a good way to accommodate the interests of both sides. Linking PPP funding to capacity expansion can help countries achieve development objectives and stay attractive to private investment

Potential for the private sector

- Contribution to development and to petrochemical demand
- Improved investment climate thanks to stronger institutional environment
- Risk-sharing with the public sector

Combination of knowledge and capital

4.2 RECOMMENDATIONS

LAYING THE FOUNDATION

SECTOR CAPABILITIES	 **Industrialization level**	**Industrialize step by step** • Move away from a pronounced agricultural sector • Start with smaller domestic formulation sites before moving onto building and modernizing primary processing technologies
	 **Innovation**	**Learn from others and adopt technology** • Focus on domestic formulation and primary processing with lower technological barriers by attracting global companies and their expertise
	 **Workforce qualification**	**Accumulate technical knowledge and skills** • Strengthen primary and secondary education • Foster vocational training in collaboration with industry players to build up the basic technical knowledge needed for plant management and processing
	 **Access to infrastructure**	**Improve the road infrastructure** • Facilitate transportation between petrochemical production sites and end industry sites (mainly construction hubs)
FRAMEWORK CONDITIONS	 **GDP contribution & job creation potenial**	**Leverage the vast labor force and boost the petrochemicals industry**
	 **Governance & regulation**	**Safeguard stability and cut red tape** • Introduce structural reforms and implement economic policies that foster private investment • Ensure political stability and create a predictable regulatory environment • Ease the burden of bureaucracy for the industrial sector
SECTOR COM-PETITIVENESS	 **Domestic demand**	**Build domestic end industries** • Support local end industries for petrochemicals (focusing on the local formulation of petrochemical products for supply to the construction sector) • Reduce reliance on imports of commodity plastics (as the population increases)
ACCESS TO FINANCE	 **Equity**	**Make it easier to do business** • Streamline bureaucracy for (foreign) private investments • Support small and medium-sized companies to sustainably and actionably enlarge the industrial base

Domestic formulators **Dormant potentials**

FOSTERING COMPETITIVE ADVANTAGES

Modernize and build scale
- Modernize outdated and unsustainable production sites to improve utilization rates and energy efficiency
- Integrate backward from end industries

Achieve leadership in selected technologies
- Upgrade technological equipment at older production sites
- Adopt new processing/recycling technologies
- Provide government funds for research and development to foster domestic innovation labs

Focus on specialized higher education
- Strengthen secondary and tertiary education, e.g. by increasing funding for academic institutions
- Found specialized institutes for vocational training in collaboration with industry and international training institutes

Improve pipeline networks and ports/airports
- Strategically enlarge and improve pipeline networks to connect production sites to mainly national end industries
- Raise port and airport quality to internationally competitive levels to foster export readiness

- Leverage a large and affordable labor force for labor-intensive production steps by investing selectively and effectively in training and education
- Focus on strengthening the industrial sector due to substantial employment potential

Incentivize direct investment
- Incentivize direct investment and thus diversify the petrochemical sector by introducing effective investment incentives, such as Special Economic Zones (SEZs)
- Incorporate regulatory best practices and industry norms

Enlarge local end industries
- Continuously diversify the economy, focusing on end industries for petrochemical products
- Foster cluster development
- Reduce dependence on imports (cut imports of high-end products)

Ensure effective support for investors
- Remove investment uncertainties
- Foster intellectual property
- Make regulatory policies more transparent

BECOMING A GLOBAL LEADER

Build state-of-the-art (research) facilities
- Introduce and foster sustainable technologies to build high-value products
- Leverage cutting-edge technology for automation and digitalization

Foster an open approach to innovation
- Increase resources for new processes and sustainable/renewable technologies
- Set up technology parks and innovation hubs with near-ideal research environments (that integrate research and industrial production sites)

Educate highly qualified employees
- Focus on tertiary education, with specialized petrochemistry departments to deliver highly qualified professionals who can drive research and development in both academia and industry

Concentrate on logistics hubs
- Enlarge logistics and transshipment hubs to connect local and international markets in a fast, cost-effective manner
- Prepare infrastructure for international trade

Diversify the petrochemical product portfolio
- Diversify the petrochemical production portfolio to incorporate and focus on specialty chemicals and secondary processing
- Lower employment barriers, e.g. by easing labor package regulations

Advance the regulatory framework
- Maintain an already favorable investment climate through appropriate policies (tax incentives, strengthening of SEZs etc.)
- Streamline administrative processes
- Integrate petrochemical and end-industry production sites

Focus on specialized local end industries
- Focus on supplying higher-value specialty chemicals to specialized and technologically advanced industries such as the automotive and electronics sectors
- Integrate petrochemical and end-industry production sites

Provide a near-ideal investment environment
- Diversify the investment portfolio
- Attract specialty chemical companies
- Allow for a larger share of private ownership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Oil refinery in Europe – Growing global demand for petrochemicals opens the door to new petrochemical players worldwide

GLOSSARY

amphoteric
Molecules that can react both as an acid and as a base

anionic
Molecules with a negative electrical charge

aromatics
Cyclical organic chemical compounds (e.g. benzene, toluene, xylene)

base chemicals
Substances that provide the building blocks for the petrochemical value chain (e.g. ethylene, propylene, methanol)

blow molding
Manufacturing process used to form hollow plastic parts

cationic
Molecules with a positive electrical charge

copolymer
Polymer derived from more than one species of monomer

crude oil to chemicals
Direct conversion of crude oil to high-value chemical products instead of traditional transportation fuels

dispersant
Substance used to improve the separation of particles and prevent settling or clumping

distillation
Process of separating components from a liquid mixture using selective boiling and condensation

downstream
Value chain links that refine and process crude oil into petrochemical compounds

emulsifier
Substance that stabilizes a mixture of two or more liquids that are normally immiscible

extrusion
Process used to create objects with a fixed cross-sectional profile: The material is pushed through a die with the desired cross-section

hydrocarbons
Organic chemical compounds consisting entirely of hydrogen and carbon; mostly out of oil and gas

injection molding
Manufacturing process to produce parts by injecting molten material (e.g. plastics) into a mold

LPG
Liquefied petroleum gas

naphtha
Mixture of liquid hydrocarbons

olefins
Unsaturated hydrocarbons that contain a carbon-carbon double bond (e.g. ethylene, propylene)

oleochemicals
Chemical products obtained from vegetable oils, animal oils and fats

petrochemicals
Chemical products obtained from petroleum by refining

polyester
Category of polymers that contain the ester functional group in their main chain

polymerization
Process of reacting monomer molecules together in a chemical reaction to form polymer chains or three-dimensional networks of plastics

pyrolysis

Thermal decomposition of materials at elevated temperatures in an inert atmosphere

shale gas

Natural gas that is found trapped within shale formations

stabilizer

Chemical used to prevent degradation

steam cracking

Petrochemical process in which saturated hydrocarbons are broken down into smaller, often unsaturated, hydrocarbons. Steam cracker units are facilities that thermally crack a feedstock such as naphtha, LPG, ethane, propane or butane through the use of steam

thermoplastic

Plastic polymer material that becomes pliable or moldable at a certain elevated temperature and solidifies upon cooling

upstream

Value chain links in the petroleum industry that focus on oil and gas exploration

vertical integration

Capturing various processing steps within a single supply chain

vulcanization

Chemical process in which rubber is heated with sulfur to form cross-links between long rubber molecules. The process improves elasticity, resilience, tensile strength, viscosity, hardness and weather resistance

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This publication is led with extensive contribution from **Dr Khalid Ibnou Walid Kane, Dr Mohammed Faiz Shaul Hamid** of the GVC Section, Department of Strategy and Transformation (DoST), **Dr Ahmed Elkhodary,** Director of DoST and **Dr Bandar Hajjar,** President of IsDB. This publication covers a wide range of complex topics and incorporated content from multiple stakeholders including IsDB staffs, IsDB Member Countries, United Nations bodies, various agencies and industry experts. We thank all of the organizations whose knowledge of the industries and related subjects has informed this publication. This brings many insights into the global challenges of multilateral development banking in the twenty- first century.

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