POLICY NOTE ON GREEN INVESTMENT

ENERGY INVESTMENT AND CARBON PRICING IN EMERGING MARKETS

EMnet Working Group Meeting:
23 October 2017

INVESTMENT
ENERGY RISK MANAGEMENT
INFRASTRUCTURE INNOVATION
POPULATION GROWTH MIDDLE CLASS
GREEN GROWTH COMMODITIES
SKILLS REGULATIONS TRADE
PRODUCTIVITY
INDUSTRIALISATION
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Energy Investment and Carbon Pricing in Emerging Markets

The shift to a greener economy can drive economic growth and create opportunities for investment. Investments in renewable energy and carbon pricing are key ways to transition to a low-carbon economy and the private sector has an essential role to play in this process. This Note provides insights and recommendations from the private sector on energy investment trends and developments in carbon pricing. The analysis builds on discussions at the Working Group meeting held on 23 October 2017 at the headquarters of the Organisation for Economic Co-operation and Development (OECD) in Paris and organised by the OECD Emerging Markets Network (EMnet).

Key messages include:

- Following the peak in of 2015, global energy investments declined by 12% in 2016. Latin America and Africa were hit the hardest by the decline with 16.8% and 20.8% decreases respectively.
- Renewables are playing an increasingly important role in energy investments, driven by emerging economies such as China, India and Brazil. Emerging markets overall accounted for 63% of renewable energy investments in 2017.
- The evolving demand for energy in rural areas is changing energy systems. For example, thanks to mini-grid and off-grid innovations, electricity networks are more decentralised and offer effective solutions to facilitate access to energy in remote areas.
- Digitalisation is driving investments and presenting new opportunities for the private sector. Smart meters, new hydrogen technologies and big data analytics are generating increased interest and have the potential to substantially impact energy markets in emerging economies.
- Carefully designed and coherent public policies, such as pro-market reforms, financial support mechanisms or energy efficiency codes and regulations can help support the transition to a greener economy and give incentives for firms to place climate related issues at the centre of their decision-making processes.
- Carbon pricing constitutes an effective instrument in support of climate change policies, offering flexibility to firms whilst reducing emissions. The private sector sees a business case: over 20% of Fortune 500 companies declare that they are already pricing their carbon emissions.

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OECD EMERGING MARKETS NETWORK

Emerging Markets Network (EMnet) is an OECD-sponsored initiative dedicated to the private sector. Managed by the OECD Development Centre, the Network fosters dialogue and analysis on emerging economies and their impact on global economic, social and environmental issues.

EMnet gathers top executives (chief executive officers, vice presidents, managing directors, chief financial officers, heads of strategy, chief economists) of multinational companies from diverse sectors, willing to engage in debates with high-level policy makers, including heads of state and ministers, and OECD experts.

EMnet events are closed to the public and media and operate under Chatham House rule to encourage open and dynamic discussions on doing business in Africa, Asia and Latin America.

To learn more about EMnet, please see http://www.oecd.org/dev/oecdemnet.htm.

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ABBREVIATIONS AND ACRONYMS

BEECs	Building energy efficiency codes
CDP	Carbon Disclosure Project
ETS	Emissions trading system
EV	Electric vehicles
GHG	Green house gas
ICC	International Code Council
IEA	International Energy Agency
ISA	International Solar Alliance
MWh	Megawatt hour
OECD	Organisation for Economic Co-operation and Development
PHES	Pumped heat electrical storage
PPA	Power purchase agreement
PV	Photovoltaics
R&D	Research and development
REIPPPP	Renewable Independent Power Producer Procurement Programme
ROI	Return on investment
SOE	State owned enterprise
TCFD	Task Force on Climate-related Financial Disclosures
tCO_2e	Tonnes of carbon dioxide equivalents
Toe	Tonnes of oil equivalent
UHV	Ultra-high voltage

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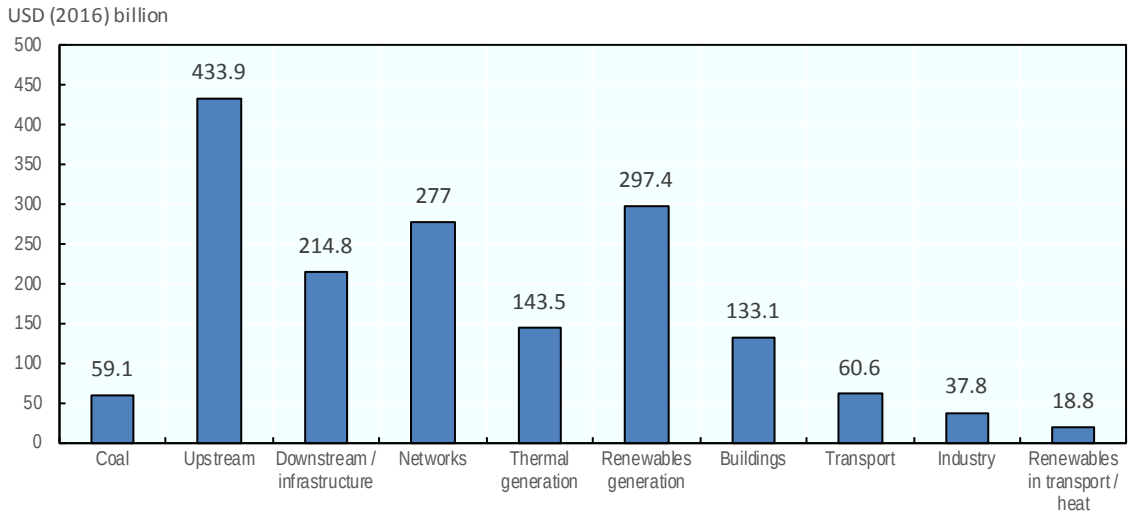
ENERGY INVESTMENT TRENDS IN EMERGING MARKETS

Global energy investment declined by 12% in 2016 to USD 1.7 trillion, driven by a decline in investments in the oil and gas sector (IEA, 2017a). In emerging markets, the decline in energy investments was most severe for Latin America (-16.8%) and Africa (-20.8%) whereas Asia saw only a slight decrease of 1.58% (IEA, 2017a; IEA 2016a). China continues to be the largest market for energy investment with 21% of the world's total (IEA, 2017a). In this context, China is shifting away from new coal plant investments and is focusing more on energy efficiency and low-carbon electricity. India took in the third largest amount of energy investment behind the United States. India's energy investment grew by 7% as the government pushes to expand and improve energy access throughout the country (IEA, 2017a). The continuing rise of renewable electricity has changed the overall composition of energy investment. Investment in the electricity sector, for example, overtook that of oil gas and coal supply for the first time in 2016 (IEA, 2017a). Including electricity networks, clean energy now accounts for over 40% of total energy supply investments (IEA, 2017a). Furthermore, public policies and private spending are increasingly supporting greater rural electrification in Africa, Asia, Latin America and the Middle East. Driven by recent technological improvements, competitive procurement as well as favourable regulatory and institutional frameworks, this shift in demand creates an opportunity for greater investment in decentralised renewable energy and is becoming one of the most cost efficient sources of energy (IRENA, 2017a). Coal plants investment continues to fall and is at its lowest level in nearly 15 years, primarily due to air quality concerns and the emergence of overcapacity in the People's Republic of China (hereafter "China") (IEA, 2017a) (Figure 1).

Figure 1. **Global energy investment, 2016**



Source: IEA (2017), World Energy Investment 2017, IEA, Paris, https://www.iea.org/publications/wei2017/.

Oil and gas investment has rebounded

Investment in upstream oil and gas increased in 2017, following a 44% decline between 2014 and 2016 due to falling oil prices as well as reduced drilling activity (IEA, 2017a). After North America, Latin America experienced the largest decrease in drilling activity, followed by Africa with a 49% and 43% decrease for both regions respectively. With a 24% decrease, Asia Pacific was the region that was least affected by this trend. The increase in 2017 was driven by investments in shale in the United States but also investments in onshore projects in the Middle East and the Russian Federation (IEA, 2017a). Mexico's development of offshore oil has also contributed to this trend (IEA, 2017a). Reforms to Mexico's regulatory and institutional framework *Reforma Energética* (Energy Reform), initiated in 2013, effectively opened the market to competition and international investment. These reforms have also supported investment and opened up new business opportunities for international players, through the abolition of long standing monopolies by state-affiliated enterprises (IEA, 2016b). The Italian energy company Eni, for example, drilled in 2017 the first well by an international operator in Mexican waters (Eni, 2017). Following new competitive bidding rounds, Eni signed three new exploration and production licenses in the country (Eni, 2017). At the same time, more policy reforms are needed to improve the business climate in emerging economies and increase private investment. In Africa's largest oil producers, Angola and Nigeria, strict local content requirements and unfavourable fiscal terms still create barriers to energy investment, particularly in offshore projects (IEA, 2017a). Similarly, the Southeast Asian offshore sector faces regulatory uncertainties that impede a rebound in activity (IEA, 2017a).

Overall slight declines in electricity investment

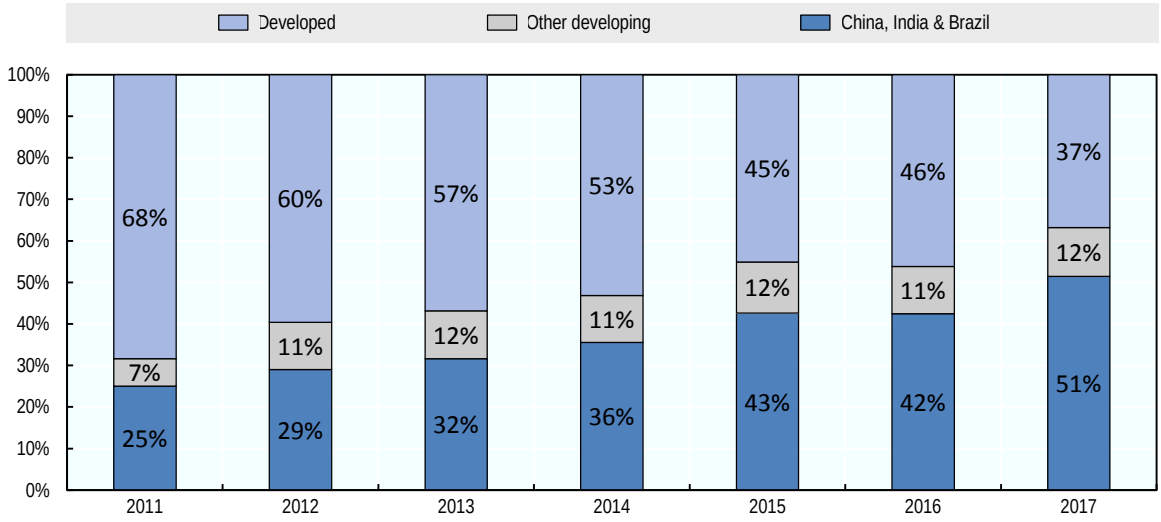
Global investments in electricity fell by almost 1% to USD 718 billion in 2016. The decline in overall expenditure was due to lower spending on electricity generation, although this trend was partially offset by an increase in spending on networks. The decline was driven by a reduction in coal-fired plants as well as lower levels of renewable energy investment, following limited wind and hydropower capacity additions and continued reduction in the price of solar photovoltaics (PV) (IEA, 2017a).

Despite the overall decline, investment in electricity networks and storage grew to an all-time high of USD 277 billion, driven primarily by investment in Asia. China in particular accounts for 30% of this spending, while an additional 15% was spent in India and Southeast Asia combined. Network investment reflects a trend to move away from solely providing electricity towards more integrated platforms for digital information (IEA, 2017a). Overall, 45% of investments were directed at expanding grids to better integrate new decentralised power generation assets and increase accessibility (IEA, 2017a). In general, although great progress has been made in terms of increasing electricity access, 1.1 billion people remain without access to electricity, including in particular 500 million in sub-Saharan Africa (IEA, 2017b). Although investments in electricity networks have helped reduce the access gap, new solutions such as mini-grids and off-grid systems can provide the most cost-effective solutions in sparsely populated rural areas (IEA, 2017b). In India, a country that has increased access to energy from 43% in 2000 to 82% in 2016, over 99% of the individuals benefitted from significant grid extension efforts (IEA, 2017b). The scheme for rural electrification named *Deendayal Upadhyaya Gram Joyti Yojana* has effectively contributed to these efforts, by providing financial assistance to electricity distribution companies involved in the deployment of the grid in rural areas (Government of India, 2016).

Driven by emerging economies, the renewables sector continues to attract investments

Global investment in renewable energy reached USD 279.8 billion in 2017, up 2% since the previous year (FS-UNEP/BNEP, 2018). Renewables account for 80% of electricity sector investments, reflecting a continued push towards cleaner sources of energy (IEA, 2017a). Emerging markets, which provide considerable renewable energy resource endowments, especially in solar and wind, are leading the trends in global investment (IRENA, 2018). In 2017, emerging economies accounted for over 63% of global investment in the renewable energy sector, representing a 20% increase from 2016. Together, China, India and Brazil accounted for over half of overall spending, with a record high of USD 143.6 billion invested in 2017 (Figure 2). At the same time, investments in developed countries dropped 19% to USD 102.8 billion (FS-UNEP/BNEF, 2018).

Figure 2. **Global investment in renewable energy, 2011-2017**



Note: New investment accounts for re-invested equity. Figures used for developed countries are based on OECD countries except Mexico, Chile and Turkey.

Source: Authors' elaboration based on Frankfurt School-United Nations Environment Programme and Bloomberg New Energy Finance (2018).

Asian economies led the performance of emerging economies in renewable energy investment from 2013 to 2016, reaching USD 88 billion in 2016 largely driven by China. Latin America and the Caribbean saw their investments fall from USD 17 billion to USD 9 billion from 2015 to 2016, weighed down by lower onshore wind investment in Brazil. This was somewhat offset by investment in solar PV, which increased by USD 700 million to USD 2.3 billion across the region in 2016 (IRENA, 2018). Furthermore, investment was heavily concentrated in a few countries: Mexico and Argentina saw their commitments to renewable energies rise remarkably with investments jumping nine-fold (FS-UNEP/BNEF, 2018). Africa remains behind in terms of renewable energy investment, although there are also positive initiatives to note. An example is the Renewable Independent Power Producer Procurement Programme (REIPPPP) in South Africa, which facilitates a competitive bidding process in order to draw private sector investment into the renewable sector (IRENA, 2016).

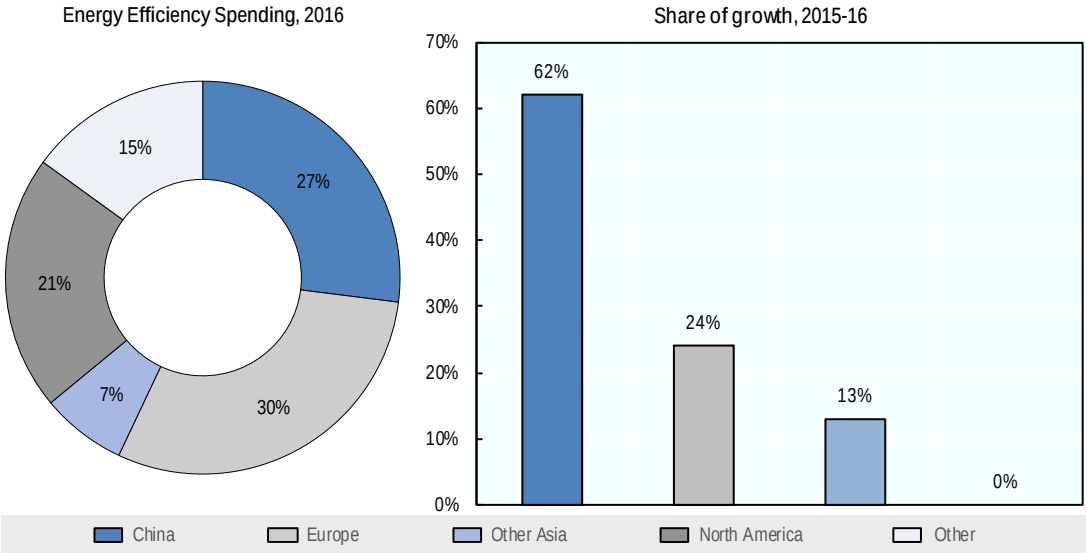
Its design, with a rolling competitive bid window and a standard suite of agreements and contractual arrangements[1], has enhanced the bankability of power procurement programmes in the country (IRENA, 2016). The programme has been successful at channelling private funds, with a total of USD 15.7 billion invested since its inception in 2011 to the end of 2016 (IRENA, 2016). Operations from 53 independent power producers (IPP) had already added 2.8 GW of power generation capacity by October 2016 (IRENA, 2016).

Public policies and other support mechanisms such as feed-in tariffs or power purchase agreements (PPA) continue to play an important role in supporting private investment, by underpinning returns and mitigating risks. Although feed-in tariffs provide a level of revenue certainty for energy producers, they do not always adapt to the decreasing costs of renewable technologies (OECD, 2017). Auctions are increasingly being used as an alternative instrument. Through auctions, governments can reward cost-effective developers, whilst securing competitive prices for end users (FS-UNEP/BNEP, 2018). Since 2012, the annual amount of capacity being awarded through auctions has increased globally 18-fold, reaching 50.6 GW in 2017 (FS-UNEP/BNEP, 2018).

Energy efficiency is improving and electric vehicle sales are growing

Energy efficiency has an important role to play in tackling climate change. Accordingly, investments toward greater energy efficiency continue to grow. In 2016, spending on energy efficiency jumped 9% to reach USD 231 billion, representing 13% of total energy investment. Globally, in 2016, Europe was the leading destination for energy efficiency investments while China has shown the strongest growth, with a 24% increase from 2015 to 2016 (IEA, 2017c) (Figure 3). The large majority of energy efficiency investments were concentrated in the building sector (58%), followed by the transport sector (26%) and industry (16%) (IEA, 2017c). Governments can implement policies, such as codes and standards as well as energy utility obligation programmes to encourage the purchase of more energy-efficient equipment and appliances and support the refurbishment of buildings. While these codes demand minimum energy performance standards, utility obligations specify the target of energy savings without prescribing the mechanisms to achieve them. These complementary measures have helped drive energy efficiency in the industrial, transport and construction sectors (IEA, 2017a).

Figure 3. **Energy efficiency investment by region and sector, 2016**



Source: IEA (2017), World Energy Investment 2017, IEA, Paris, https://www.iea.org/publications/wei2017/.

The growth in electric vehicle (EV) sales is also contributing to expanding global energy efficiency investments (IEA, 2017a). Sales of EVs grew by 38% in 2016 to reach 750 000 units, with China leading the world in sales (340 000 units). Globally, around USD 6 billion was invested in charging points for EVs in 2016, representing a 42% increase since 2015 (IEA, 2017a). Governments around the world are supporting the adoption of EVs through fiscal incentives as well as special access to driving lanes and parking. In China EVs have also been exempted from some specific licensing requirements (IEA, 2017a).

Research and Development (R&D) spending on energy has stalled

Global R&D spending on energy has remained subdued in recent years. R&D spending in the energy sector represented only 5% of total expenditure on all R&D (IEA, 2017a). The IEA estimates that USD 65 billion was spent globally by public and private entities on energy-specific R&D spending in 2015, 3% lower than the previous year (IAE, 2017a). The private sector was the most important contributor to R&D spending, with non-SOE corporate spending accounting for 44% of the R&D expenditure in 2015 (IAE, 2017a).The United States and Europe spent the most in absolute terms. However, when evaluated as a share of GDP, China leads spending on energy R&D, having overtaken Japan in 2014 (IEA, 2017a).

On the other hand, investment in R&D specifically focused on renewable energy set a record high in 2017 reaching USD 9.9 billion. Governments continue to provide the majority of investments with USD 5.1 billion. The private sector is however increasingly becoming an important actor: corporate investment in R&D stood at USD 4.8 billion in 2017, up 12% from the year before (FS–UNEP/BNEF, 2018).

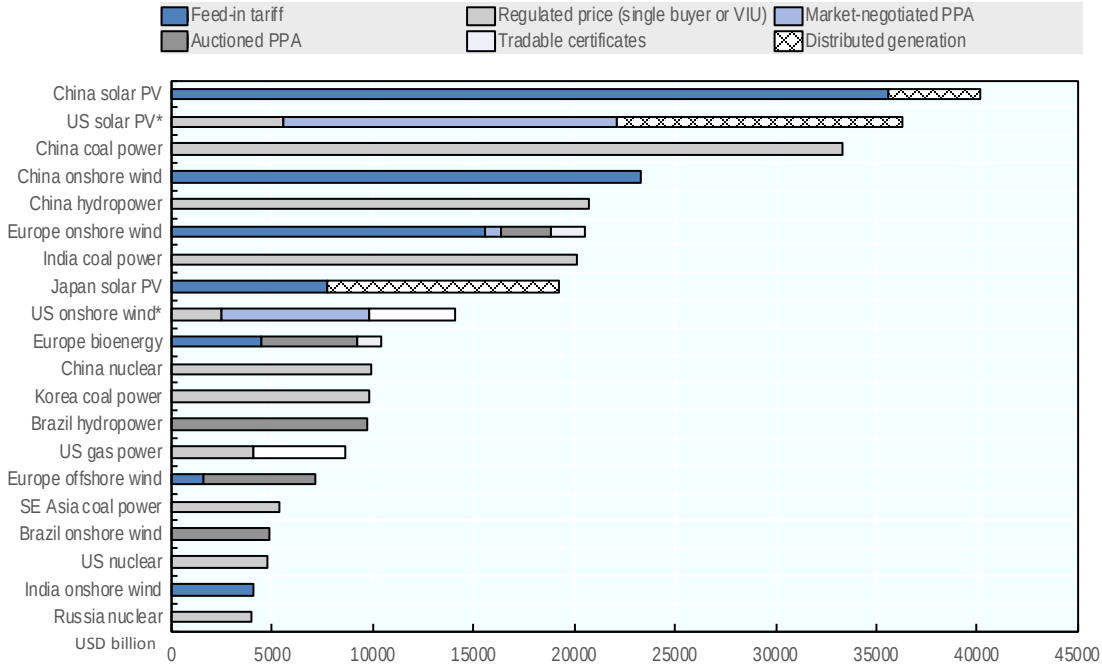
Digital infrastructure continues to attract investors

Companies and governments continue to invest in digital infrastructure for their energy systems, recognising its potential for both financial purposes and environmental benefits. The IEA estimates that USD 47 billion was spent in 2016 on smart grids, connected buildings and industrial control systems, as well as charging infrastructure for EVs. In addition, USD 2 billion was spent on software by utilities, which is used to integrate new digital infrastructure into their systems (IEA, 2017a). These investments have grown by 50% since 2014 and are now greater than the total amount of investment in gas-fired power plants. Smart meters[2], in particular, have become the largest category of investments in digital electricity infrastructure with Japan and China accounting for almost half of the global market in 2016 (IEA, 2017a). Smart meter penetration is still increasing; it is expected to reach 53% globally by the end of 2025, with a forecast penetration rate of 70% in Asia Pacific. Latin America and Africa are also increasingly adopting smart meter technologies, after a slow initial take-off (Navigant Research, 2016). In Mexico, for example, investment in smart grid technology has been reinvigorated by issuing numerous tenders for more than two million smart meters (Smart Grid Congress, 2017). In Nigeria, utility company Ibadan Electricity Distribution Company has secured a USD 400 million investment from the Trans Sahara Consortium to roll out its smart meter programme. On top of fighting energy theft, the programme will generate efficiency gains in terms of billing processes for the company and is expected to create over 250 000 jobs in the country (IBEDC, 2017).

Governments are key actors in shaping the energy investment landscape

Governments are important actors in the energy investment landscape, both as regulators and as investors, often through state-owned enterprises (SOEs). The role of regulatory policy cannot be overstated in influencing energy investment. According to the IEA, 94% of global power generation investments came from firms with fully regulated revenues or specific regulatory mechanisms to manage revenue risks. At the same time, the role of competitive mechanisms such as auctions is growing. In the case of utility-scale renewables, over 35% of investments was subject to auctions or corporate contracting (IEA, 2017a) (Figure 4).

Figure 4. I**nvestment in the top 20 power-generation sectors by main business model, 2016**



*Renewables in the United States benefit as well from federal tax credits and market-negotiated. PPAs are often struck to satisfy utility purchase obligations.

Note: Distributed generation breakdowns are only available for solar PV; VIU = vertically integrated utility; PPA = power purchase agreement.

Source: IEA, 2017, World Energy Investment 2017, IEA, Paris, https://www.iea.org/publications/wei2017/.

State-owned energy companies continue to play a major role. The share of state actors in total energy investment rose from 39% in 2011 to 42% in 2016, largely owing to SOEs in China, as well as national oil companies in upstream oil and gas (IEA, 2017a).

Other emerging markets are fostering investment opportunities through the implementation of market reforms. Mexico, for example, introduced an auction system offering long-term contracts for energy, capacity and clean energy certificates to attract investment from new players. In 2017, an auction with an estimated value of USD 2.4 billion of investment directed at sixteen selected projects constituted one of the world's most price-competitive large-scale clean energy auctions (Mexican Government, 2017). Two previous auctions in 2016 awarded nearly USD 7 billion worth of power generation (IEA, 2017a). It is worth mentioning that beyond its state players, through the reform of its electricity market, China has also seen an increase in participation from private actors in the distribution sector. Open market-based electricity trading has increasingly occurred via independent companies. Such transactions accounted for 30% of total power generation in 2016 (IEA, 2017a).

BUSINESS INSIGHTS ON ENERGY INVESTMENT TRENDS

The private sector constitutes a central player in the transition to a greener economy, representing 47% of total energy investments in 2017. Companies see energy-related sectors as a key source of new opportunities and are aware of the role they can play in support of the economic and social development of emerging markets, by for example driving innovation, promoting clean technologies and developing infrastructure. EMnet participants highlighted the importance of network interconnectedness, the use of digital technologies and the role of energy storage as key drivers of private energy investment.

Declining prices for clean energy are reducing the competitiveness for traditional fossil fuels

Firms welcome the expansion of renewable energy sources, particularly solar and wind, and also highlight the effects that they are having on energy markets. Participants highlighted that the rapidly declining prices for clean energy are reducing the competitiveness for traditional fossil fuels. The example of hydropower in China and India was frequently mentioned, as the sector has now become the cheapest source of electricity in both countries (IRENA, 2018). In parallel, project developers for coal and other traditional fuels are finding less opportunities in the market (IEEFA, 2017).

Technologies such as hydrogen and fuel cells are generating increased interest from both the public and private sector as alternative energy sources that can provide flexible, low-emission opportunities (IEA, 2015). For example, together with 12 energy and mobility companies, ENGIE launched the Hydrogen Council, which aims to foster the adoption of hydrogen technologies worldwide to achieve the low-carbon energy transition (ENGIE, 2017). This global initiative – the first of its kind – provides recommendations to policy makers, investors and international agencies to place hydrogen among the key solutions of the energy transition (The Hydrogen Council, n.d.).

Distribution of energy faces unresolved infrastructure constraints

Participants expressed the importance of investments in transmission and distribution infrastructure. Firms stressed that the energy shortages they sometimes face are often linked to distribution and transmission deficiencies, more than lack of energy supply. This issue is particularly relevant for the distribution of renewable energies, where poor connections or limited transmission capacity in the grid are more evident.

Some countries have already begun improving the transmission capacity of their grids. For instance, significant investments in ultra-high voltage (UHV) transmission systems in China have connected the resource-rich western regions with the eastern provinces where demand is booming (Kemp, 2014).

Furthermore, participants focused on the need to ensure that capacity is increased to handle the frequency of larger occurring peak loads. Renewables now account for the majority of new capacity additions each year and the share of renewables in electricity generation is expected to rise to 40% in 2040 globally (IEA, 2017d).

The role of digital technology in the energy sector is expanding

The IEA has highlighted the role that digitalisation can play in achieving various energy policy objectives. Increased productivity and efficiency, enhanced revenue collection and improved security are some of the benefits that digital tools can grant to achieve higher energy access (IEA, 2017e).

Digitalisation has helped energy producers increase productivity and decrease costs throughout the supply chain. In the upstream oil and gas sector for example, the widespread use of new technologies has the ability to enhance the recovery of oil and gas resources by 5%, representing up to 75 billion tonnes of oil equivalent (toe) and reducing costs by around 10-20% (IEA, 2017e). While the hardware used for energy systems is constantly improving and dropping in cost, the role of software to manage energy production and distribution is also growing (BNEF, 2017).

Companies highlighted the importance of using big data in production of renewable energies. Indeed, utility companies need to understand which technologies, such as wind or solar, work the best depending on the climate of specific locations. Big data analytics can be used to predict and evaluate the production capacity of renewable generation and help firms plan investments and maintain supply reliability (ESMAP, 2017). Participants highlighted the fact that managing consumer demand through digital technologies is also playing a significant role. Smart meters for instance were mentioned as a demand-side management tool, useful for deepening companies' understanding of household consumption patterns as well as encouraging reductions in energy usage (IEA, 2017e). Smart meters have shown great potential in reducing energy use through increased visibility on consumption patterns. Research conducted in the UK found that 85% of people with smart meters have adopted consumption habits that reduce use of energy and 56% have implemented changes to their home to be more energy-efficient (Smart Energy GB/Populus, 2017). Similarly, the potential gains in emerging markets from this new technology are significant, both in energy use and improved demand management. Although the majority of smart meter investment has been in developed countries as of yet, a study of 50 emerging countries showed that these countries are projected to invest USD 268 billion in smart grid infrastructure from 2017 to 2027 (BusinessWire, 2017).

Energy efficiency continues to improve

Concerns about cost reduction are driving improvements in energy efficiency. Companies see new opportunities, particularly in the area of energy-efficient equipment as well as buildings. Energy intensity – the final energy consumption per unit of gross value added – in manufacturing dropped by 30% from 2000 to 2016, in both IEA member countries[3] and major developing economies, with major improvements made in emerging markets. Most notably, energy intensity in China fell by 5.2% (IEA, 2017c).

In addition, the IEA has highlighted the opportunities to improve energy efficiency in cooling, particularly around air conditioners, which account for an increasing share of energy consumption. Average annual sales growth in air conditioning reached over 40% from 2014-16 in countries such as Bangladesh and Viet Nam, and over 20% in Nigeria, Mexico and Colombia. Demand for cooling installations is likely to rise faster in Africa and Latin America, as these regions increase their disposable income over the coming years (IEA, 2017a).

The building sector is also progressively contributing to the efficiency efforts to achieve global climate commitments (IEA, 2017c). Policies such as building energy efficiency codes (BEECs) present great potential in reducing heating, cooling and lighting loads in newly constructed buildings (ESMAP, 2014). The Mexican government e.g., in collaboration with the International Code Council, published the *Mexico Conservation Code for Buildings,* which establishes minimum requirements for energy efficient buildings for the country (ICC, 2016).

New technologies improve energy storage and create new business opportunities

Businesses highlighted the importance of supporting the development and commercialisation of efficient energy storage technologies. Renewable energy sources, such as solar and wind, are inherently variable. Therefore, greater flexibility to improve the match of supply with demand will progressively become an essential component of the electricity systems (IRENA, 2017b). Technologies such as Pumped Heat Electrical Storage (PHES), which uses heat pumps to store and recover electricity with a round trip efficiency of 70-75% (EASE, n.d.) or hydrogen and fuel cell technologies present considerable opportunities to increase storage capacity.

Electric vehicles (EV) show promise to reduce emissions but many barriers remain

Participants agreed that significant quality and durability improvements of electric car batteries are required to serve as a viable and efficient alternative to the existing fossil fuel operating vehicles. Nowadays, despite an increase of 60% in EV car stock when compared to 2015 (IEA, 2017f), the sector only accounts for 0.2% of the total worldwide vehicle stock, representing over 2 million units (IEA, 2017a). Furthermore, according to the IEA, electric cars sold in 2016 will decrease oil consumption by only around 10 000 barrels per day (IEA, 2017a). This decrease in oil consumption represents a relatively small contribution, considering that global daily oil consumption for road freight is about 16 million barrels (IEA, 2017a).

Companies agreed that there is a strong role for policy makers to play in terms of supporting the growth of the EV market and the adoption of fuel-efficient vehicles (IEA, 2017f). Financial incentives such as direct rebates, tax breaks or tax exemptions can stimulate electric car deployment. In Brazil for example, an acceleration in vehicle efficiency improvements was underpinned by the government's "Inovar-Auto" programme, which encourages production of fuel-efficient vehicles through fiscal incentives for manufacturers (ICCT, 2013).

Participants stressed, however, that there is a need to envisage ways to meet the increased electricity demand generated by EV penetration. The IEA predicts that additional electricity demand required by electric vehicles will amount to 1.5% of the global demand by 2030 (IEA, 2017f).The additional stress during peak hours that EV charging will induce on local distribution grids can accelerate the ageing of grid infrastructure and thus lead to possible service interruptions (Thomas, 2017). Charging patterns for EVs are concentrated in time, which can lead to localised surges in electricity demand. The largest proportion of electric car charging is forecasted to occur at home, in offices or in public charging facilities (IEA, 2017f). Investment in the reinforcement of networks at local hotspots as well as the deployment of charging infrastructure is therefore very important (IEA, 2017f). The use of price signals to encourage off-peak charging could also mitigate pressures the hours of highest consumption (IEA, 2017f).

Firms play an essential role in financing energy investments

More than 90% of global energy investment is financed from the balance sheets of firms (47% private vs. 42% SOE) or from individuals' own assets, originating either from borrowing, equity, cash flows or savings (IEA, 2017a). Companies stressed the importance of the cost of capital as an factor that can hinder investments in low emissions projects. The level of risk associated with these projects determines the level of the cost of capital and the return that investors demand. Several risks such as political and regulatory risks can be greater for projects that strongly rely on public support, such as for example low-carbon infrastructure projects. In this case, the potential short and medium-term volatility of public sector support, depending on policy priorities, can contrast with the long-term planning of infrastructure development (OECD, 2017). This uncertainty contributes to an increase in the financing cost of energy investments.

Policies that help to reduce the cost of capital and improve the cost-reflectiveness of electricity pricing are especially important in countries where electricity demand is growing (IEA, 2017a). In India and Indonesia for instance, two countries that are expected to constitute a fifth of global demand growth in the coming years, policies to reduce the cost of capital or mitigate risks have been implemented to improve the financial attractiveness of green investment. A recent public tender in the Indian Madhya Pradesh province, in which de-risking mechanisms from the central and state governments played key roles, awarded a 750 megawatt hour (MWh) solar park at a price of USD 55/MWh, one of the lowest prices awarded through an auction in the country (Waldron, 2017).

Firms see a clear movement away from financing fossil fuels to cleaner energy sources

The carbon content of an investment is increasingly viewed as a potential source of risk. Although the climate change is a long-term process, investors increasingly recognize the importance of considering the carbon footprint as part of their entire investment portfolio (EY, 2016). Climate risks are already reflected in investment decisions, as illustrated by the 20% drop in Chinese coal investment from 2015 to 2016 (IEA, 2017a). In 2017, a five-year investor-led initiative, Climate Action 100+, was launched to ensure companies improve their governance to reflect climate change issues. The initiative was launched with the collaboration of both large investor groups dedicated to the transition to a greener economy and the United Nation's Principles for Responsible Investment (UN PRI, 2018). 279 institutional investors, who manage nearly USD 30 trillion in global assets, have taken part and committed to tackle climate change through their worldwide investments (Climate Action 100+, n.d.).

Public sector and international financial institutions are also driving this trend. For instance, the World Bank has recently announced that it will no longer finance upstream oil and gas projects after 2019 (World Bank, 2018). Similarly, inter-governmental coalitions can make a positive contribution to help support cleaner energy adoption. Launched in 2015, the International Solar Alliance (ISA) encourages the use and deployment of solar energy in countries with substantial solar resource endowments (UNFCCC, 2015). ISA member countries undertake steps to create a common market by amalgamating and harmonising requests for capital, technologies and innovation in solar energy.

Regulatory financial frameworks are also moving to consider climate-change risks and expand financial markets for green investments. For example, France and Sweden announced additional co-operation to increase green and sustainable finance through a strategic partnership for innovation and green solutions (Government Offices of Sweden, 2017). Both countries already have carbon disclosure requirements for corporate and financial institutions. These measures could begin to serve as benchmarks for other economies when designing and implementing policies that address the same issues. At the same time, in 2017, the G20-comissioned Task Force on Climate-related Financial Disclosures (TCFD) developed a framework to promote more informed investment decisions through the production and use of climate-related financial disclosures, looking at governance, strategy and risk management practices (TCFD, 2017). The recommendations issued by the TCFD provide a foundation to support investment decisions through a better assessment and management of climate-related risks.

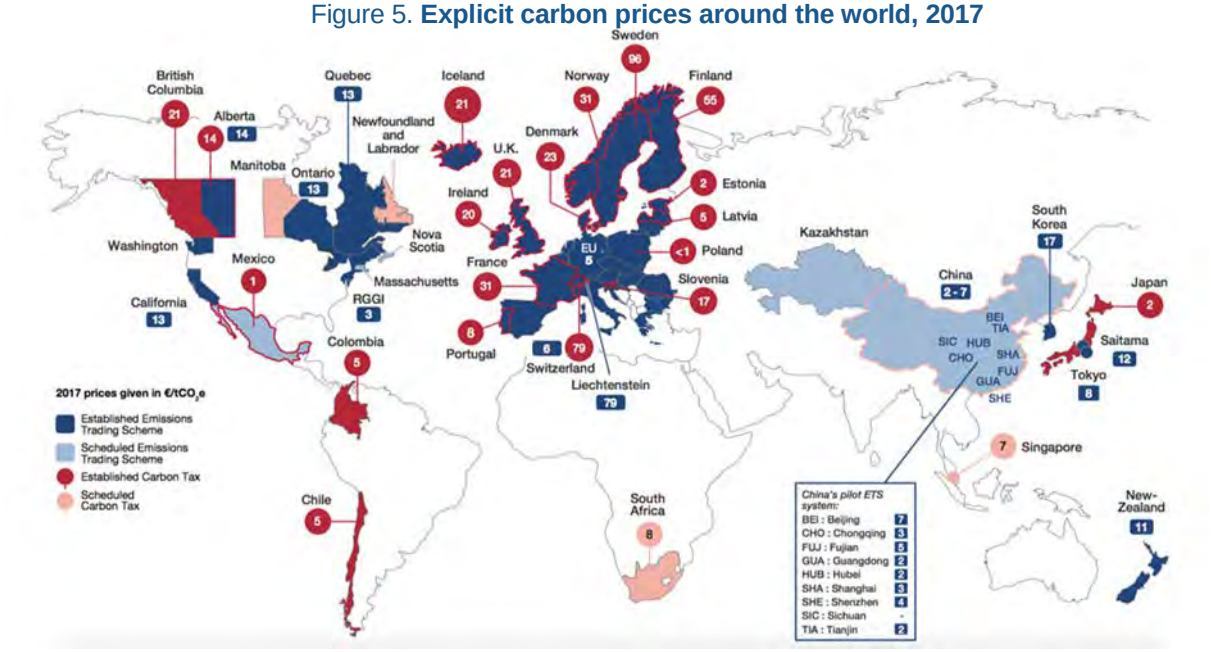
CARBON PRICING TRENDS

Putting a price on emissions and pollution through carbon pricing tools such as energy taxes and tradeable permits is an essential part of the climate change mitigation strategies (OECD, 2018a). Argentina, Brazil, China, India, Indonesia and South Africa are among the countries that have put in place energy use taxes, each at various degrees and levels. Although these recent developments reflect progress, current carbon pricing efforts vary widely across countries and price levels fall short of the recommended EUR 30 per tonne of CO_2. Furthermore, carbon pricing measures alone are not sufficient and should be complemented by other measures that respond to local barriers and challenges that could include for instance targeted investment incentives, the removal of fossil fuel subsidies or the support for low-carbon innovation developments (OECD, 2017).

Carbon pricing refers to policy measures that put a price on greenhouse gas (GHG) emissions and include taxes on energy use, carbon taxes and carbon emission permit prices. The term "effective carbon prices" or "effective carbon rates" include both explicit carbon prices through carbon taxes and emissions trading systems (ETS) as well as the implicit carbon prices from energy taxes. Using this approach, effective carbon rates are low or absent in sectors outside road transportation. In G20 countries, 84% of energy-related emissions take place beyond road transport, with only 2% of those emissions priced at EUR 30 per tonne or more (OECD, 2017).

The introduction of carbon taxes began in the 1990s and has since expanded throughout the world (Arlinghaus, 2015). Countries and sub-national areas continue to implement carbon pricing initiatives. Currently, 67 jurisdictions are implementing or planning to implement carbon pricing around the globe. Taken together, these jurisdictions account for about 50% of the global economy and 25% of global emissions (World Bank, 2017). Emerging markets across the globe are making progress as well. In Latin America, Mexico is preparing for an ETS pilot and Colombia and Chile are evaluating the development of an ETS after launching carbon taxes. China is launching a nation-wide ETS system after experimenting with regional pilots while Viet Nam plans to development a carbon market and Singapore is working to price carbon in 2019 (World Bank, 2017).

Figure 5. **Explicit carbon prices around the world, 2017**



Source: Institute for Climate Economics (2017) with data from ICAP, IETA, World Bank and public information, https://www.i4ce.org/wp-core/wp-content/uploads/2017/10/Global-panorama-carbon-prices-2017_5p_Final-version.pdf.

The pricing levels per tonne of CO_2 emitted vary widely as well as the use of proceeds (see Figure 5.). The damage from a tonne of CO_2 emissions can conservatively be estimated at EUR 30 (OECD, 2016). However, 90% of carbon emissions are priced at less than EUR 30, based on an OECD study of 41 OECD and G20 countries (OECD 2016). Moreover, the price for carbon is significantly context-dependent, as certain countries will charge less than others to allow businesses to operate within sustainable production costs. For example, Sweden (USD 140/tCO_2e) and Switzerland (USD 87/tCO_2e) have the highest carbon taxes per tonne of carbon dioxide equivalents (tCO_2e), while pilot ETS systems in China, and carbon taxes in Chile, Colombia and Mexico are priced at less than USD 10 per tonne (World Bank, 2017). The use of public revenues from carbon pricing is an essential aspect of policy design. The revenues collected are used for a variety of purposes but often go to finance tax cuts, support green investments or are allocated to the general budget (I4CE, 2017). The OECD has recommended that revenues originating from carbon pricing should both generate social benefits and ensure widespread support in carbon pricing policies. This can be done, for example, reducing growth-inhibiting taxes, increasing inclusiveness, compensating for loss of competitiveness or supporting low-emissions R&D (OECD, 2017). China uses revenues from new ETS to enhance firms' competitiveness. Mexico's carbon revenues go into the general budget and India's coal taxes funds a national Clean Energy Fund (OECD, 2017).

BUSINESS INSIGHTS ON CARBON PRICING DEVELOPMENTS

Companies find strategic reasons to support carbon pricing and more firms around the world are taking action to set internal carbon prices irrespective of the regulatory framework in which they operate. EMnet participants stressed the importance of governments developing carbon prices that are transparent, stable, long-term and that create a level playing field. A wide range of internal prices and strategic rationales exist within companies for carbon pricing. Firms highlighted in particular that carbon pricing can drive innovation, improve efficiency, enhance internal productivity and better position businesses to manage future risks. It is also a way to satisfy investors and customers that are increasingly seeking additional transparency and commitment to climate change. Furthermore, the private sector is recognising the urgency to be accountable to their clients and to society in general (OECD, 2018b).

Carbon pricing as a cost-effective solution to reduce emissions

Businesses find carbon pricing a cost-effective way to reduce emissions and generate funds, which can be used to accelerate further climate action. Through a global survey, executives affirmed that carbon pricing regulation would have a positive impact on fostering innovation (78% of respondents) and investment in green growth opportunities (81%) (EY, 2015). In their view, market-based approaches, such as a carbon taxes or cap-and-trade programmes, can help reduce emissions at the lowest possible cost. These approaches offer firms the flexibility to choose the most economical way to reduce emissions, rather than mandating one single approach.

More public-private collaboration is essential in designing climate policy

Despite the broad support, businesses highlighted that carbon pricing policies must be carefully designed. In particular, more consultation between both the private and public sectors is encouraged to ensure a successful carbon pricing policy. Several initiatives to foster collaboration between multiple stakeholders have been launched to this effect. For instance, governments, businesses and the World Bank have supported the launch of the Carbon Pricing Leadership Coalition. This initiative, which brings together government and non-government stakeholders, aims to deploy carbon pricing worldwide through experience sharing and expanding knowledge on effective carbon pricing systems and policies (World Bank, 2017).

Carbon pricing policy stability and transparency are key concerns for businesses

Firms highlighted that a stable and long-term system is more important than whether the carbon price is executed as a tax or permit system. Firms, however, tend to find taxes to be more stable than emissions trading schemes and more conducive to long-term planning. Companies furthermore stressed the importance of treating firms equally across and within sectors, to create a level playing field notwithstanding the fact that different priorities and approaches will exist in different countries and industries.

Companies fear "carbon leakage"

Carbon leakage can occur when emissions shift from a country with stricter carbon pricing to a country with less stringent measures. This phenomenon implies that climate mitigation policies are less effective and more costly in containing emission levels, making it a main concern for governments (IEA, 2008). Firms are concerned about the carbon leakage's impact on competitiveness, as companies may attempt to avoid regulation by shifting production to countries with less stringent climate change requirements. Although a review of the impact of carbon pricing on competitiveness by Arlinghaus (2015) showed that negative effects on competitiveness due to carbon pricing are limited, many firms receive exemptions or preferential rates, and few studies compare the competitiveness impacts of companies that are fully exposed to carbon pricing versus firms that are exempt. In order to reduce the risk of carbon leakage, governments can implement measures that can compensate energy-intensive sectors that see increased electricity costs as a result of climate policy. This is the case in Europe for example, where the European Commission gives Member States the possibility to provide financial compensation to exposed sectors through national state aid schemes (European Commission, 2012).

More companies are putting a price on carbon for their internal operations

In 2017, over 1 300 global companies reported using a carbon price or planned to implement one within the next two years and over 1 in 5 Fortune Global 500 companies currently price carbon internally (CDP, 2017a). The Carbon Disclosure Project (CDP), a global non-profit, runs a global disclosure system that helps companies to measure and manage their environmental impacts. The CDP found that the energy and utilities sectors have the highest proportion of companies currently using an internal carbon price with 79% and 84% of disclosers respectively (CDP, 2017a). In terms of growth, the materials and industrials sectors have shown the strongest expansion since 2014 (CDP, 2017a).The greatest expansion in companies pricing carbon comes from China, Japan, Mexico and the United States (CDP, 2017a). China's nascent ETS, the largest in the world, is likely to drive increased disclosure by Chinese companies in particular (Feng, 2017; CDP, 2017a). Indeed, the implementation of the Chinese national ETS is estimated to increase the share of emissions covered by carbon pricing initiatives from 13% to 20-25% of global GHG emissions (World Bank/Ecofys/Vivid Economics, 2016). Internally, firms have a wide range of carbon prices, often known as "shadow prices", which put a financial value on carbon emissions. The Indian vehicle manufacturer Mahindra & Mahindra, for example, uses an internal price of USD 10 per metric tonne, whereas Mexican cement producer CEMEX and the French tyre manufacturer Michelin set carbon prices at USD 30 and USD 59 respectively (CDP, 2017a).

A corporate carbon price can improve efficiency and develop new opportunities

Internal prices and targets can drive innovation within the company, spurring internal programmes and products that can help the firm meet its goals. Implementing internal carbon prices can incentivise resource allocation towards low-carbon activities, improving the business case for R&D investments and help firms identify hidden risks and opportunities in their own operations and supply chains (CDP, 2017b; Chang, 2017). A study of the impact of the European Union Emissions Trade System (EU ETS) found that its implementation prompted an increase of 36% in low-carbon patents in the firms examined (Calel and Dechezleprêtre, 2016).

Carbon pricing can help to reduce a company's carbon footprint. Companies noted that once they had priced carbon, they quickly came to see their energy use from a different perspective. When companies calculate their carbon footprint, they typically find that their energy consumption accounts for a large majority of their directly measurable emissions impact. As a result, energy shifts from a seemingly small cost item to the biggest part of their carbon footprint. Viewed from this perspective, businesses see a case for energy efficiency and low-carbon energy solutions. This has been confirmed by studies that have found the disclosure of climate risk and mitigation strategies to be linked to stronger financial performance. Indeed, among S&P 500 companies, industry leaders (i.e. firms that provide the most comprehensive information about the management and measurement of their carbon footprints) make a 18% higher return on investment (ROI), generate earnings that are 50% less volatile and distribute dividends to shareholders that are 21% higher than low scoring peers (CDP, 2014).

Setting an internal carbon price as a way to manage risks for climate policies

Companies view potential carbon regulations as a major climate-related risk and cite preparation for future policy initiatives that address this as one of the main motivations for adopting internal carbon prices (C2ES, 2017). In countries where carbon pricing mechanisms have not yet been implemented, 73% of respondents believe that these will be put in place in the next five years (EY, 2015). By implementing internal prices now, firms will have a head start in assessing and planning their emissions and their future impact on the overall operations and cost structures. They will consequently be better placed to remain competitive and handle any future regulatory change.

Shareholders and customers demand transparency on climate-related issues

Implementing internal carbon prices is viewed as a way to improve disclosure and better evaluate environmental risks, to better respond to stakeholders' demands. Investors are increasingly asking for additional disclosures on climate-related issues within their portfolios, and for strategies to handle potential risks coming from additional regulations on emissions. Shareholders' pressure can compel companies to adopt measures that reduce emissions and disclose risks that climate change poses to their business. For instance, large oil and gas companies ExxonMobil, Shell and BP have all announced initiatives to report climate change risk due to mounting shareholder demands for greener practices (Berke, 2017).

Additional costs associated to greening efforts should be included in the cost-benefit analysis

Although firms recognise that there are clear net benefits to climate policies, such as carbon pricing, they also highlighted the fact that other costs associated to the greening efforts should be included in the cost-benefit analysis and explain some cases of rising end-use energy prices. For example, total real end-use energy prices in the OECD rose by 3% year-on-year with the largest increase reported in Mexico (9%) (IEA, 2017g).

Although energy production costs have been decreasing on the supply side, the European electricity industry association (Eurelectric) published a report highlighting that additional costs coming from the application of energy policies has been contributing to rising prices in some sectors. On average, policy support costs and energy taxes made up 36.5% of total household prices in Europe. Policy support costs between 2008 and 2014 have increased by 170%, whereas the supply-side component has decreased by 7% (Eurelectric, 2016; Thomas and Ward, 2017).

Firms highlighted the need to better analyse the weight of all costs in final energy prices. Businesses in particular suggested taking into consideration more variables beyond carbon and energy taxes and emission permits, when estimating business contributions to achieving lower emissions. Some companies stressed that the additional costs of policies aimed at decarbonising the energy system, which may not necessarily be considered as taxes from a legal standpoint, are also integrated into the final price to consumers and exercise the same influence on their behaviour as a tax would. For this reason, new research on effective carbon rates should include them in the analysis.

CONCLUSION

More than two years after the Paris Agreement on Climate Change, companies remain committed to the climate action and the strategic value of embracing clean energies, particularly in emerging markets. Multinational companies see their role at the forefront of the transition towards more sustainable and are already collaborating with governments. Digital developments are opening up new investment prospects for both energy networks as well as energy efficiency.

The private sector sees carbon prices as an effective way to internalise the cost of emissions, especially when they are stable and transparent. Businesses are increasingly engaging in carbon pricing within their internal operations even if not legally required. Companies view this as an effective approach to improve transparency towards their investors, customers and other key stakeholders.

Although the private sector is increasingly embracing and driving the transition to a greener economy, much progress remains to be made in enabling companies to fully embrace climate policies. Governments have an important role to play in fostering an environment that not only catalyses low-carbon investments but also provides a stable, transparent and coherent policy framework. Companies also recognise the risks associated with climate policy. Namely, the risk of carbon leakage as well as additional hidden policy support costs, which risk to be ultimately transferred to the final consumer.

Notes

[1] REIPPPP contractual agreements include implementation agreements, government support agreements, power purchase agreements and direct agreements.

[2] Smart meters are a new generation of gas and electricity meters that give consumers real time information on energy use.

[3] IEA member countries include: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, The Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States

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