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13. Framework conditions for renewable energy: Towards a new era of carbonomics?

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Abstract There seems to be a broad consensus that we are in an "energy transition" towards a low-CO_2 emissions power generation. This raises questions such as how much capital this transition will require, how financing will be sourced to support the transition and what the implications are for the economy. This chapter presents a review of major developments in the areas of public climate commitments, climate reporting standards, public support schemes and green fiscal and monetary policy initiatives.

Keywords climate accounting I green finance I energy transition

13.1 INTRODUCTION

Climate change is very much on the top of the global policy agenda. There seems to be a consensus that the world is in an "energy transition," where energy consumption increasingly must shift away from the combustion of fossil fuels towards electrification and greater use of low-CO_2 power generation technologies. This has involved the promotion of wind and solar power production. Simultaneously, regulations and incentives relating to climate policy have increasingly become drivers of investments and developments in the electricity sector.

The purpose of this chapter is to analyse the global framework conditions for climate finance and the promotion of renewable power generation. To shed light on the all-embracing and rapidly developing conditions around climate policy and finance, we will review recent developments in areas such as international climate commitments, regulations, financial climate reporting standards, public support schemes and even monetary policy. Our intention is to provide an overview that will illustrate the bigger picture and how multiple forces increasingly align in this area.

Over the period 2011–2018, USD 3,660 billion was spent on global climate change projects (ÓhAiseadha et al., 2020), which is almost as much as the GDP of Germany (USD 3,861 billion in 2019[1]). Around USD 2,000 billion of this has gone to wind and solar energy, increasing their share of global energy consumption from 0.5% to 3% over the same period (ÓhAiseadha et al., 2020). Thus, it has cost the world around USD 2,000 billion to increase the share of renewable power generation by 2.5 percentage points over these eight years, although overall production also increased in this period, as we will illustrate below.

With several countries committing to "carbon neutrality" by 2050–60, activists, NGOs, governments, and academics are exploring power systems based on up to 100% renewables in the future. This raises important questions, including the amount of capital such a transition would require and how such a massive amount of financing can be sourced and channelled to support the transition. This chapter will look at both of these questions, with a focus on the latter.

Profound changes are already taking form in the way public and private capital is channelled to support climate objectives. Both the financial and the corporate sectors, regulatory agencies, and governmental and multilateral institutions are increasingly committing to making all financial flows consistent with a pathway towards low greenhouse gas (GHG) emissions, as stipulated in article 2.1c of the Paris Agreement (Averchenkova et al., 2020).

In the power sector, the climate governance framework has implications at all levels. As an example, global central bank policy, regulatory mandates, taxonomies and financial portfolio standards may increasingly become drivers of technology selection in the power grid. Meanwhile, only a few system planners, analysts, investors, policy makers or regulators are likely to have a comprehensive overview of developments across all levels. Given the major changes that are being driven by climate policy, one may question whether there is sufficient understanding among market participants of the relevant governance frameworks as a whole.

This study therefore seeks to provide an overview of some essential developments and to draw connections from the level of global climate governance to the investment incentives at the level of a power plant. The goal is to contribute to promoting awareness, dialogue and decision making in a transformative period for the power sector.

The chapter is organised as follows: Section 13.2 provides background information on energy use, emissions and electrification. In section 13.3, we set the stage by looking at the governance framework for climate policy at the global level.

1 World Bank. (2021). GDP (current USD) – Germany. Data available from https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=DE&most_recent_value_desc=true

Section 13.4 is devoted to climate finance, while in section 13.5, we consider incentives and subsidies for promoting renewables. In section 13.6, we look to the greening of the financial system – the future of carbonomics. The final section summarises the chapter.

13.2 BACKGROUND: ENERGY USE, EMISSIONS AND ELECTRIFICATION

Climate change features prominently on the policy agenda worldwide, increasingly as an integrated and institutionalised part of global governance. Manifestations of this can be seen as climate mitigation policy becomes enshrined and implanted through law, finance, industrial and trade policy, corporate governance and fiscal and monetary policy.

A primary focus of climate policy is to transform energy systems to produce fewer emissions. A term such as “sustainable energy transition” is commonly used in policy making, the academic literature and the media when discussing the challenges facing the energy sector on the pathway to decarbonisation (e.g., Antal & Karhunmaa, 2018; Markard, 2018; OECD/IEA & IRENA, 2017; Sgouridis & Csala, 2014; Solomon & Krishna, 2011). Global energy-related CO_2 emissions reached a historic high in 2018, driven by an increase in coal use in the power sector (IEA, 2019). In 2019, after two years of increases, CO_2 emissions flattened at around 33.2 Gt. Power sector emissions fell year-on-year, thanks to the expanding role of renewable sources (mainly wind and solar photovoltaic), fuel switching from coal to natural gas and higher nuclear power output (IEA, 2020). About two-thirds of global GHG emissions originate from energy production and use (IRENA, 2017).

In terms of primary energy[2], the share of fossil fuels in the global energy mix is about 85% (Cembalest, 2020). Despite large increases in the production of renewables, primarily wind and solar, fossil fuels still account for nearly two-thirds of electricity generation, the same share as 20 years ago (IEA, 2019). The world’s decarbonisation efforts have so far mostly taken place on the electricity grid, but the share of electricity in global energy consumption is only about 17%. To achieve further cuts in emissions, there is a drive to further reduce the emission intensity

2 The US Energy Information Administration (EIA) defines primary energy as “Energy in the form that it is first accounted for in a statistical energy balance, before any transformation to secondary or tertiary forms of energy. For example, coal can be converted to synthetic gas, which can be converted to electricity; in this example, coal is primary energy, synthetic gas is secondary energy, and electricity is tertiary energy” (www.eia.gov).

of electrical power generation and to make more of energy consumption reliant on energy from the power grid, that is, electrification.

Between 1990 and 2017, global electricity consumption more than doubled – from 11,811,500 TWh in 1990 to 25,555,900 TWh in 2017 (Figure 13.1). Projections indicate a demand in the range 45,569,000–47,611,000 TWh in 2050 – almost a doubling compared to 2017[3]. Many countries promote renewables as part of their policies to reduce emissions. While renewable electricity in 2019 represented about 25% of total electricity consumption, this share is forecast to increase to 55–73% in 2050, depending on policy scenario (Equinor, 2020).

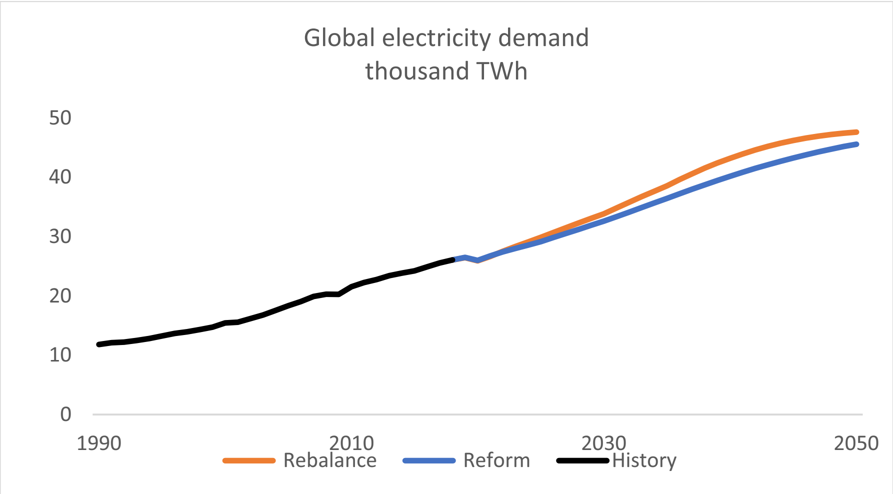

Figure 13.1: Global electricity demand: 1990–2017 (history) and 2018–2050 (projections). Source: Equinor (2020).

Three important priorities of energy policy and regulations are 1) reliability: ensuring access to adequate and reliable supply; 2) economics: competitive prices (while ensuring that private sector entities will be able to recoup their investment); and 3) environment: limiting environmental impact (Meier, Vagliasindi, & Imran, 2015; Oliver & Sovacool, 2017). These goals are sometimes formulated as an "energy trilemma," with competing goals (Oliver & Sovacool, 2017). Power system development is driven by an evolving mix of these goals, under the influence of policy, investment incentives and regulatory mandates. Thus, power system anal-

3 The projection is taken from Equinor (2020), which presents two future scenarios. *Reform* represents an accelerating energy transmission but one that is not sufficient to meet climate targets, while *rebalance* represents a well below 2°C scenario.

ysis is complex. A particular trend in the past decade has been an increasing focus on the environmental policy aspect of the energy trilemma. Following high political and academic emphasis on renewable expansion, concerns are being raised as to whether appropriate governance mechanisms are in place to ensure balance against the other two priorities: affordability and security of supply (e.g., Angwin, 2020; Hannesson, 2019; Sepulveda et al., 2018; Sioshansi, 2013).

Improved access to reliable, affordable and environmentally sustainable energy can represent a challenge, which can be particularly costly if a low-carbon solution is sought through high proportions of intermittent renewables (Hannesson, 2019; Markard, 2018; Meier et al., 2015; Sepulveda et al., 2018). These sources of energy have high capital requirements (generation and distribution) but are often poor at providing capacity at times of peak demand. To meet the needs of society in terms of continuous power availability, aggregate power generation capacity must therefore increase if the system includes a lot of renewables. In economic terms, this implies that more investment capital needs to be recouped. Moreover, there will be changes and shifts in price and market dynamics and in the physical power flows in the grid, typically in ways that increase volatility, complexity (including more grid management systems and administrative infrastructure) and costs (Heymann & Auer, 2019; Hirth, Ueckerdt, & Edenhofer, 2015; Meier et al., 2015). In countries that historically relied on thermal power generation, power plants were typically built close to the centres of electricity demand, namely, major industrial centres. In contrast, renewable energy (RE) generation units are often located where the renewable resource potential is highest and land relatively abundant. This is often in rural areas with limited local demand. Such characteristics require fundamentally different grid layouts and enormous investments over the coming decades (Rayner et al., 2018).

The increasing importance of climate policy to grid governance is manifested in the drivers of investment. By 2017, almost all new investment in European electricity generation was in the form of subsidised renewables (Pollitt & Chyong, 2018). If policy and investment incentives become the key determinants of capacity development, there could be a risk of this happening at the expense of security of supply, consumer prices and overall cost effectiveness. These concerns become more important as we strive to increase electrification and make ever more economic and social activity reliant on power from the grid.

13.3 GLOBAL CLIMATE GOVERNANCE

Global climate policies are governed under the United Nations (UN) frameworks. At the UN Conference on Environment and Development in 1992, also known as the Earth Summit, an international environmental treaty was negotiated and signed by 154 states to address climate change. This treaty is the UN Framework Convention on Climate Change (UNFCCC) (UN, 1992), which established a framework for international cooperation to combat climate change by limiting average global temperature increases. It entered into force on 21 March 1994.

The UNFCCC outlines a set of general commitments applicable to all parties, while specific commitments apply only to developed countries (de Chazournes, 2008). General commitments include long-term national planning, the diffusion of technologies and processes to control emissions, the conservation of "sinks" so as to remove greenhouse gases from the atmosphere (e.g., planting trees, which take up carbon dioxide from the air), cooperative adaptation planning, adjustment of environmental policies, systematic observation and development of data archives, exchange of information, as well as promotion of education, training and public awareness (de Chazournes, 2008). Developed countries that commit to the aim of returning individually or jointly to their 1990 levels of emissions are subject to more stringent reporting requirements and must coordinate relevant economic and administrative instruments that contribute to increased GHG emissions (e.g., subsidies and energy pricing) as well as reviewing their policies regularly (article 4 (2) of the UNFCCC) (de Chazournes, 2008).

To ensure effective follow-up, the UN Commission on Sustainable Development (CSD) was established by the UN General Assembly in December 1992 (UN, n.d.). The CSD held annual meetings from 1993 until it was replaced by the UN High-Level Political Forum on Sustainable Development (HLPF) following the 2012 UN Conference on Sustainable Development (Rio+20). The HLPF is now the main UN platform on sustainable development and has a central role in the follow-up and review of the 2030 Agenda for Sustainable Development at the global level[4], the Sustainable Development Goals (SDGs) (HLPF, 2021).

The supreme decision-making body of the UNFCCC, the Conference of the Parties (COP), meets annually to assess progress in dealing with climate change. The first COP took place in 1995 in Berlin, Germany. To promote effective implementation, the COP is authorised to examine national reports, parties' obligations and institutional arrangements under the UNFCCC; review the adequacy of com-

4 General Assembly resolution 70/299 provides further guidance on the follow-up and review of the 2030 Agenda and the SDGs.

mitments in article 4, paragraph 2; coordinate national measures; and make recommendations on any matters necessary to realise the goals of the UNFCCC (de Chazournes, 2008).

The UNFCCC also stablished four additional bodies: a secretariat (article 8) located in Bonn, Germany; two subsidiary bodies, one for scientific and technological advice (article 9) and the other for implementation (article 10); and a financial mechanism (article 11).

The first implementation of measures under the UNFCCC was the Kyoto Protocol, which was signed in 1997 and entered into force in 2005 (United Nations Treaty Collection, 2021). The Protocol legally binds developed country parties to emission reduction targets (UNFCCC, 2021). The Protocol's first commitment period was 2008–2012, the second 2013–2020 (UNFCCC, 2021). As of 2021, the UNFCCC has 197 signatory parties and 192 Parties to the Kyoto Protocol (UNFCCC, 2021).

The Kyoto Protocol[5] was adopted as an international treaty in 1997 at the third COP, constituting the first addition to the UNFCCC, and went into force in 2005. It called for national programmes to reduce the emission of six GHGs[6] in 41 countries plus the European Union to 5.2% below 1990 levels during the "commitment period" of 2008–2012 (Encyclopedia Britannica, 2021). The adoption of the Kyoto Protocol spurred exponential growth in mainstream RE investment around the world. In 2008, for the first time, RE, including large hydropower projects, attracted more investment globally than fossil-fuel-based technologies (Meier et al., 2015; UNEP, 2012).

The Kyoto Protocol provided several means for countries to reach their targets. One approach was to make use of natural processes, or sinks. Another approach was the Clean Development Mechanism (CDM), to encourage developed countries to invest in technology and infrastructure in less-developed countries (Encyclopedia Britannica, 2021). Under the CDM, the investing country could claim the effective reduction in emissions as a credit towards meeting its obligations under the Protocol. Such projects can earn saleable certified emission reduction (CER) credits, each equivalent to one tonne of CO_2, which can be counted towards meet-

5 In full: The Kyoto Protocol to the United Nations Framework Convention on Climate Change – named after the Japanese city in which it was adopted in December 1997.

6 The "Kyoto basket" of GHG includes the big-three natural greenhouse gases – CO_2, CH_4, N_2O – whose increases over the industrial era can be ascribed to human activities (Prather and Hsu, 2008). It also includes synthetically produced greenhouse gases categorised by name, such as sulfur hexafluoride (SF_6), or by class, such as hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs).

ing Kyoto targets (UNFCCC, n.d.). An example would be an investment in a clean-burning natural gas power plant to replace a proposed or existing coal-fired plant (Encyclopedia Britannica, 2021). A third approach was emissions trading, which allowed participating countries to buy and sell emission rights and thereby placed an economic value on GHG emissions.

The EU Emission Trading System (ETS)[7] (Directive 2003/87/EC) is the flagship example of a cap-and-trade emissions trading system, where governments set a total allowable amount of emissions ("cap") over a certain period and issue tradable emission permits ("trade"). According to initial rules, each member state had to submit National Allocation Plans which detailed a country-wide reduction target together with a list of regulated installations. The permits, typically good for one tonne of CO_2, are the currency in carbon markets (Bayer & Aklin, 2020). Countries that failed to meet their emissions targets would be required to make up the difference between their targeted and actual emissions, plus a penalty of 30% in the subsequent commitment period, beginning in 2012. They would also be prevented from engaging in emissions trading until they were judged to be in compliance with the protocol (Encyclopedia Britannica, 2021).

The 15^{th} COP – the Copenhagen Climate Change Conference in 2009 – produced the Copenhagen Accord, a non-binding document negotiated by the leaders of some 30 countries (European Commission, 2019). The Accord was not adopted as a UN decision, but has been endorsed by over 140 UNFCCC Parties. All key elements were subsequently formalised at COP 16 in 2010 in Cancun.

The Copenhagen Accord contained several key elements, including the long-term goal of limiting the maximum global average temperature increase to no more than 2°C above pre-industrial levels, subject to a review in 2015 (UNFCCC, 2009). It also included a reference to consider limiting the temperature increase to below 1.5°C. Other central elements included developed countries' promises to fund actions to reduce GHG emissions in developing countries; agreement on the measurement, reporting and verification of developing country actions; a mechanism on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD-plus); a High-Level Panel under the COP to study

7 The EU ETS started in 2005 and operates in phases. The first phase, from 2005 to 2007, was a pilot to get the system up and running. The second phase covered the Kyoto Protocol commitment period, 2008 to 2012. The third phase started in 2013 and lasted until 2020. During the first phase, about 12,000 installations received permits to emit roughly 2.2 billion tons of CO_2 across the then 25 EU members, covering almost 50% of the EU's total CO_2 emissions. Carbon markets are deemed appealing as they reduce CO_2 emissions at lowest cost, at least theoretically (Bayer & Aklin, 2020).

implementation of financial provisions; the Copenhagen Green Climate Fund (GCF); and a Technology Mechanism (UNFCCC, 2010).

The 2015 Paris Agreement marks the latest major step in the evolution of the UN climate change regime, as the first-ever legally binding global treaty on climate change (European Commission, 2016). It was adopted at COP 21 in Paris and entered into force in 2016. As of April 2021, the Agreement had 195 signatories (United Nations Treaty Collection, 2021). The Agreement is most known for its article 2, paragraph 1 (a), stating the long-term goal to **limit global warming** to well below 2°C, **preferably to 1.5°C**, above pre-industrial levels.

The year 2020 marks the beginning of the Paris Agreement's formal Nationally Determined Contributions (NDC)[8] submission cycle (Hackmann, 2016; IRENA, 2019). As the implementation process enters this first five-year submission cycle, the focus is set to become increasingly directed at article 2, paragraph 1 (c) of the Agreement, which aims at "Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development" (IRENA, 2019; Paris Agreement, 2015, p. 3). Related to this is also the Copenhagen Accord: under the Paris Agreement, developed country parties extended the pledge to jointly mobilise USD 100 billion a year in climate finance between 2020 and 2025 to assist developing countries' climate action, and with new and higher goals envisioned after this period (European Commission, 2016). Collective progress towards achieving the Agreement's goals will be assessed in global stocktaking every five years, starting in 2023 (article 14) (Sælen et al., 2020). In the lead-up to COP26 in 2021, climate finance seems set to be placed at the heart of the agenda.

13.4 CLIMATE FINANCE AND RENEWABLES

Nationally Determined Contributions (NDCs)[9] are a cornerstone of the Paris Agreement. They set out the actions countries plan to undertake to achieve the Agreement's objectives. Renewable energy features prominently in most NDCs. From 2020 onwards, NDCs will be revised or updated every five years, with each revision aimed at being more ambitious than the last (IRENA, 2017).

8 Amid the Covid-19 pandemic, many countries missed the NDC deadline, and the COP26 is scheduled to be held with a one-year delay in Glasgow, Scotland, in November 2021 under the presidency of the United Kingdom. See next section for more information on NDCs.

9 These typically contain a combination of conditional and unconditional contributions. Conditional contributions depend on international support for their implementation, whereas unconditional contributions are those that parties intend to implement regardless of international climate assistance.

An analysis of NDCs undertaken by IRENA (2017) found that of the 194 Parties to the UNFCCC that submitted NDCs, 145 referred to RE action to mitigate and adapt to climate change, while 109 Parties included some form of quantified target for renewables. Although 85 Parties to the UNFCCC have not included quantified NDC targets for renewables, many of them have ambitious national energy plans in place. To implement the RE targets, over USD 1.7 trillion would be needed by 2030 (of which 70% relates to unconditional targets that countries plan to implement unilaterally). The full implementation of the RE components of existing NDCs would add at least 1.3 TW of installed capacity globally between 2015 and 2030, representing a 76% increase in the world's total installed capacity compared to 2014.

A variety of metrics are employed to express quantified RE targets in NDCs. These can be expressed in terms of absolute physical units (e.g., additional power capacity in MW, or number of new mini-grids installed), as shares of future total electricity generation or energy production/consumption, in terms of investment needed, and/or with reference to emission reductions targeted (IRENA, 2017).

OECD/IEA and IRENA (2017) have shown that the decarbonisation of the energy sector requires a total of USD 25 trillion to be invested in renewables up to 2050. The majority of this new capacity would be installed in Asia (1 TW), with China, India and Japan accounting for 66%, 21% and 6% of the total, respectively. Africa would account for approximately 95 GW, followed by Latin America with almost 85 GW (IRENA, 2017). Relatively speaking, the largest growth would occur in Africa and in Small Island Developing States, both nearly quadrupling their total renewable power installed capacity between 2015 and 2030, albeit from a low base.

To implement the RE targets of the NDCs, IRENA (2017) estimates that more than USD 1.7 trillion would be needed between 2015 and 2030. More than 70% of this relates to unconditional targets for RE development domestically, while the rest refers to international finance commitments to support developing countries' conditional targets (IRENA, 2017).

With respect to the conditional RE targets in developing countries' NDCs (USD 500 billion), about USD 31 billion (on average) would have to flow into the RE sector every year in the form of international climate finance (IRENA, 2017). As public resources are limited, the bulk of investment needed for the implementation of NDC-based RE targets will have to come from the private sector (IRENA, 2017).

Another way to illustrate the upscaling requirements for low-carbon energy and energy efficiency is to assess their "investment gaps", that is, the total incremental investment needs for these cleaner options beyond those likely to happen anyway based on a continuation of today's trends. McCollum et al. (2018) estimate that meeting countries' most recent pledges (NDCs) would necessitate only a marginal increase in total future investments, relative to a continuation of trends. In contrast, more aggressive policies promoting an energy system transformation (2°C and 1.5°C pathways) would require a marked increase. Achieving the current NDC pledges of countries implies a global near-term (to 2030) low-carbon energy and energy efficiency investment gap of approximately USD 130 billion per year (model mean), accounting for around 7% of all energy investments worldwide in 2015 (McCollum et al., 2018). If the aim is instead to keep global temperatures below 2°C or 1.5°C in the long term, then this gap escalates to USD 300 billion or USD 460 billion per year, respectively.

The increasing capital requirements to meet climate policy objectives raise some important issues. Either the overall level of investment will have to rise substantially, or there will be crowding out of other kinds of productive investment. That, in turn, will affect the rest of the economy and its ability to maintain a given level of production.

Investment in the power sector is quite cyclical (Blyth, McCarthy, & Gross, 2015). The rising investment trend not only is driven by the retirement of existing power plants due to ageing but is accelerated by the retirement and replacement of coal plants and nuclear plants as a result of political objectives, favouring a new set of technologies. In terms of new capacity, the low-carbon-labelled technologies that receive investments are capital intensive (Blyth et al., 2015). They also have a lower power density, which is a deviation from previous energy transitions to progressively higher power density[10] and increasing energy abundance (e.g., from wood to coal, from coal to hydrocarbons, from direct use of fuels to electricity) (Smil, 2010).

There is little debate about the implications of power sector capital expenditure as an increasing share of GDP and of potential related crowding-out of other private investments – or public ones, for that matter. Coupled with this is the potential for increased energy input costs for businesses and consumers in a more capital-intensive power system. This issue may be particularly relevant for developing

10 Engineers have used power densities as revealing measures of performance for decades, but several specialists have defined them in their own particular ways. Smil (2010) defines the measure of power density as perhaps the most universal measure of energy flux: W/m^2 of horizontal area of land or water surface (rather than per unit of the working surface of a converter). It can be used to evaluate and to compare an enormous variety of energy fluxes ranging from natural flows and exploitation rates of all energy sources (be they fossil or renewable) to all forms of energy conversions (be it the burning of fossil fuels or water- or wind-powered electricity generation).

countries, where investments in such systems are bound to have an opportunity cost in terms of reduced investments in other sectors of the economy. This is an important area for future research.

13.5 INCENTIVES AND SUBSIDIES FOR PROMOTING RENEWABLES

The rapid growth of RE has been possible through decreasing technology costs, increasing fossil-fuel prices and the continued payment of direct or indirect subsidies. According to Hannesson (2019), the EU recognises that wind and solar energy are not competitive on their own, necessitating economic support if the share of RE is to be increased. Abolhosseini and Heshmati (2014) show that three types of support mechanisms are widely used: feed-in tariffs (FITs), tax incentives (including subsidies and tax deductions) and tradable green certificates.

Meier et al. (2015) propose a taxonomy of incentive mechanisms with four general categories: price incentives, quantity incentives, and direct and indirect support. Price incentives are government interventions to provide preferential output prices for renewable generators (while the market determines the quantity). Examples include FITs, avoided cost tariffs (ACTs), premiums over generation market prices ("adders") and premiums over retail price ("green tariffs"). Quantity incentives imply that the government sets a target for renewable capacity, while the marketplace determines the price (examples include renewable portfolio standards [RPSs] and auctions to establish a certain amount of capacity). Direct support can be cash subsidies from the government or from the sale of RECs and carbon credits (e.g., by the CDM). Indirect support can be provided to developers through tax rebates and incentives, preferential public or private financing, loan guarantees, concessionary carbon financing and supportive infrastructure access (e.g., grid and market related). Who ends up paying for the renewable support schemes varies both with the type of instrument and how it is designed.

The different incentives all relate to the financial engineering of projects by reducing the financial costs to the developer (or increasing the financial benefits through preferential tariffs). For example, a preferential rate of income tax is carried by taxpayers, and green tariffs are carried by consumers. Countries that enhance transmission investments also pave the way for attracting more investment in renewables.

The large variation in incentive mechanisms makes it difficult to offer an overview. A few examples are discussed further below.

13.5.1 Feed-in tariffs (FITs)

A FIT offers a long-term purchase agreement for the sale of electricity. There are three essential provisions for the success of FIT policies: guaranteed access to the grid, stable and long-term power purchase agreements and prices calculated based on the unit costs of power. The tariffs may be used as a fixed rate (higher than market price) or as a mark-up that is added to the current market price (Abolhosseini & Heshmati, 2014).

Germany, which likely has developed the most expensive renewable electricity program in the world, applies a transparent consumer surcharge (Meier et al., 2015). In 2019 residential customers paid about 30 cents/kWh for electricity, of which the renewables surcharge accounted for 6.41 cents/kWh – around 21% of the average bill (excluding value-added tax) (Thalman & Wehrmann, 2020). This is up from 1.31 cents/kWh (5.6%) in 2009. It is often supposed that these incremental costs are spread to all consumers in Germany through a levy, but power-intensive industrial consumers (and the railways) benefit from various degrees of exemptions (Meier et al., 2015).

A key advantage of a FIT is that it reduces investor risk by offering a guaranteed price. On the other hand, a FIT that is too generous can stifle innovation and unnecessarily increase procurement costs. The introduction of FITs and, more broadly, of other support mechanisms is positively and significantly associated with the introduction of public-private partnerships (PPPs)[11] in RE generation, controlling for several variables (including supply and demand factors), economy-wide governance indicators, and sectoral controls. FITs affect both the entry and the level of investment in renewable-based energy.

Zhang (2013) models several FIT design elements and finds that high feed-in rates do not necessarily lead to an increased uptake of wind power in European countries, but guaranteed grid access and length of feed-in contracts are crucial policy characteristics for RE deployment. Furthermore, Zhang (2013) suggests that high subsidies in Europe's FIT program may have driven up investment costs by allowing installation at low-wind-speed sites.

13.5.2 Tax credits

The major federal subsidy programmes in the US are the production tax credit and the investment tax credit, of which the more important is the production tax

11 The PPP may take on very different forms. In some countries, for example, Indonesia, PPPs are simply independent power producers (IPPs) with sovereign guarantees. In others, PPPs imply equity contributions from a government or international financial institution, for example, the International Finance Corporation.

credit. In 2015, it was 2.4 cents/kWh, but this has been phased down and was scheduled to end in 2020, although a renewal has been announced under the Biden administration. Under this policy, the renewable developer is entitled to receive the 2.4-cent credit for each kWh produced and fed into the grid. As an example, a 2-MW wind turbine with a 30% capacity factor produces 5,256,000 kWh of energy in a year. If each kWh earns two cents of production credits, the turbine generates an annual tax credit of USD 105,120[12] which can be deducted from the owner's federal tax bill. For a profitable company, that deduction is more valuable than receiving an income subsidy, which would have been taxable. Industry representatives have been quoted to say that production tax credits can represent as much as 60% of project costs (Starsia, 2019). As early as 2014, Warren Buffet stated that tax credit subsidies are the only reason to build wind farms (Pfotenhauer, 2014).

Hughes (2020) shows that actual capex costs reported for onshore wind farms completed in 2016–2019 were GBP 1.61 million per MW (USD 2 million using the average exchange rate for 2020). That would imply a project cost of USD 4.13 million for the illustrative 2-MW case given above. An annual tax credit of USD 105,120, amounting to USD 1.05 million nominally over 10 years would account for 25% of the project's capex cost. This is much less than 60% of capex, but still substantial.

Compared to production tax credits, the investment tax credits seem to be relatively less important. An investment tax credit gives tax credits against federal taxation for investments in renewable project development such as building a wind farm. The investment tax credit is 30% of the investment for small turbines of 100 kW or less, while 12% for larger turbines. It has since been scaled down and was scheduled to end in 2020 (Angwin, 2020), but a renewal has been announced under US President Biden in 2021, with credits expanded (Gold & Blunt, 2021; Tax Credit Policy, 2021).

13.5.3 Renewable portfolio standards (RPSs)

RPSs are a prevalent and popular climate policy in the US (Greenstone & Nath, 2019). RPSs mandate a certain percentage of electricity supply in a state to be met by generation from sources designated as renewable.

These programmes play a central role in existing US climate policy, covering 18% of US CO_2 emissions compared to 8.4% for state and regional cap-and-trade

12 The amount per kWh has declined over time, starting at 2.4 cents. A facility completed in 2017 would receive 20% less per kWh for the first 10 years of production, and facilities that begin construction in 2020 would not receive credits – although that prospect has been changed as the policy is being revived in 2021 (which so far has tended to happen after each expiration).

programs (Greenstone & Nath, 2019). Several states have set ambitious 2030 RPS targets, such as 35% for Massachusetts, 60% for California and 70% for New York, although there is little, if any, historical precedent for integrating renewables into the electricity generation system at such a scale (Greenstone & Nath, 2019). Proposals for national legislation, including from the 2020 Biden presidential campaign, recommend policies that build on features of existing RPS programs.

An advantage of an RPS is that it can promote development of the most cost-effective renewable projects by inducing competition between suppliers (Meier et al., 2015). However, that cost effectiveness is limited by the extent to which renewable power generation is cost effective, compared, for instance, to a technology-neutral approach to emissions reduction (e.g., carbon abatement cost). Menz and Vachon (2006) also note that an effective RPS can facilitate adoption of renewable capacity in states with low resource potential. As such, RPSs may lack inherent mechanisms to ensure sound spending of public funds in support of RE generation. Using a comprehensive data set, Greenstone and Nath (2019) find US electricity prices to be 1.2 cents/kWh (11%) higher seven years after RPS passage, largely due to indirect grid integration costs (e.g., transmission and intermittency). Twelve years later they were 1.9 cents, or 17%, higher. Meanwhile, carbon emissions were 10–25% lower, and the cost per tonne of CO_2 abatement ranged from USD 58–298 (generally above USD 100). As of June 2021, this compares to a carbon price of around EUR 50 (EU ETS) in Europe and an estimated social cost of carbon of USD 51 under the Biden administration.

13.5.4 Renewable Energy Credits (RECs)

RECs are generated by qualified renewable power plants on a per-kWh basis (there may be multiple "classes" of credits). In the US, most RECs are awarded by regional authorities and involve several states. Once awarded, the credits can be sold separately from the underlying electricity, enabling flexible transfer of the credits while providing additional revenue to renewable suppliers (Greenstone & Nath, 2019). Electricity providers can demonstrate compliance with an RPS program through possession of RECs. In practice, a utility in Connecticut can buy RECs from a wind farm in Maine and claim to be using renewable power (Angwin, 2020). The buyers and sellers of RECs may not even need to be connected to the same grid system; in the US, most RPS states allow compliance through out-of-state REC purchases (Greenstone & Nath, 2019).

By buying RECs, a firm can claim to use 100% renewable electricity, even though it is using continuous power from the grid based on whatever the power mix is at the time of consumption. In other words, if wind- and sun-powered generation falls, the firm can still consume electricity uninterrupted from thermal generation on the grid. A drawback to the use of RECs by some utilities and businesses is therefore that it may conceal the real issues related to security of supply and total system costs in a power system based on large shares of renewables. Entities can claim 100% renewable sourcing without facing the demand adjustments and additional costs of generation and storage this would imply if they were actually dependent on intermittent renewables.

13.5.5 Green certificates

Green certificates are another example of tradable credits. In contrast to a pure subsidy policy where the government sets the premium (e.g., FIT or tax credits), a tradable green certificate market is quantity based and relies on market participants to determine the certificate price (Hustveit, Frogner, & Fleten, 2017). An example is the Swedish-Norwegian green certificate scheme, a support scheme for RE projects based on tradable (often labelled as market-based) certificates (Linnerud & Simonsen, 2017).

Following Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources, Norway and Sweden established an electricity certificate market and agreed to develop production capacity corresponding to a total of 28.4 TWh of additional renewable electricity production between 2012 and 2020 (NVE, 2018). This would amount to about 20% of the existing Norwegian power production in 2012, and about half of the annual Norwegian household consumption in 2018 (NVE, 2018). As of June 2020, a total of 39 TWh had been commissioned under the scheme, 11.9 TWh in Norway and 27.1 TWh in Sweden. Adding projects that have yet to come online, the total capacity under the scheme (from 2012 to 2021) is estimated to reach around 60 TWh (OED, 2020).

Norway and Sweden committed to finance 50% of the certificates each, regardless of where the production would be located (the "regulatory credit" would be allocated to each country according to their given financing shares regardless of where the production capacity was located). The subsidy scheme is financed by electricity consumers, as the cost of electricity certificates is passed through in the electricity bill[13].

13 However, all else being equal, the introduction of TGC quotas reduces wholesale electricity prices because of an increased supply of electricity with a low short-run marginal cost. Thus, the tax burden is fully or partly redirected to the producers of conventional electricity (Hustveit et al., 2017).

Under the green certificate scheme, new generators of renewable electricity qualify to receive certificates for 15 years, according to their realised production. One certificate is allocated for each MWh of renewable electricity produced. In this way, the electricity producers receive an extra income in addition to the electricity price. Demand for the certificate is ensured through regulation, as the electricity retailers (sellers of electricity to end consumers) must buy a proportional number of certificates, often referred to as a quota, for each MWh of electricity they sell (Linnerud & Simonsen, 2017). The term *market-based* comes from the supply and price dynamics: low establishment of new renewable generation will lead to high prices of green certificates. This, in turn, provides incentives for new entry, until the price is no longer attractive again.

13.5.6 Wholesale grid prices versus consumer costs

In evaluating the economics of renewable power sources, there are several risks of data misinterpretation. Importantly, the intermittent nature of renewables leads to different impacts on wholesale power prices (periodically depressed during high wind/sun generation) versus retail prices and consumer costs (generally enhanced due to increased out-of-market funding mechanisms). A common and much-criticised approach is to compare the levelised costs of electricity (LCOE) of different technologies, which fails to consider issues related to intermittency and total system costs. Intermittent power sources require backup generation for power supply to be available continuously. In essence, power demand must either accept that electricity is periodically very scarce or, alternatively, that old-fashioned on-demand generation capacity from thermal power plants must be kept available beside the additional renewables. That would imply a large increase in installed capacity and fixed costs, inevitably increasing the total costs that somehow need to be recovered. Moreover, dispersed and more volatile production in space and time adds to the capacity requirements from the grid to transport electricity from where it is generated to where it is demanded. Grid management also becomes more complex, and the market infrastructure to support real-time balance and frequency stability requires shorter timeframes and increasing ancillary services.

13.6 LOOKING FORWARD: CARBONOMICS – GREENING THE FINANCIAL SYSTEM

In June 2019, the UK was the first G20 country to set a legally binding target of net-zero[14] emissions by 2050, a step that was followed by commitments to achieve net-zero by 2050 by the European Union, Japan and South Korea. In September 2020, China, currently the world's largest emitter, pledged to achieve net-zero by 2060. Equally significant is the new commitment made by President Biden to commit the US to climate neutrality by 2050.

With 127 countries adopting or considering a net-zero target (CAT, 2020), central banks and supervisors are now also working to establish their approach to net-zero, while increasingly emphasising climate-related risks and sustainability more broadly as drivers of their financial and monetary stability work (IFRS Foundation, 2020; Robins, Dikau, & Volz, 2021). The Network of Central Banks and Supervisors for Greening the Financial System (NGFS) was established at the Paris "One Planet Summit" in December 2017 by eight central banks and supervisors to strengthen global efforts to meet the goals of the Paris Agreement as well as enhance the financial system's role in managing risks and mobilising capital for green and low-carbon investments (NGFS, 2021). As of February 2021, the NGFS consists of 87 members and 13 observers, covering more than 60% of global emissions (NGFS, 2021).

In 2020, the Bank of International Settlements released a review of ways to address climate risks within central banks' financial stability mandate (Bolton et al., 2020). It notes that central banks can have a role to play in coordinating the measures of governments, the private sector, civil society and the international community to fight climate change. This includes climate mitigation policies such as carbon pricing, the integration of sustainability into financial practices and accounting frameworks, the search for appropriate policy mixes and the development of new financial mechanisms at the international level (Bolton et al., 2020; Brainard, 2021).

Robins, Dikau, and Volz (2021) recommend that net-zero should be a core element of supervisory practice at micro and macro levels. This could involve requiring all regulated financial institutions to submit net-zero transition plans; implementing net-zero in disclosure frameworks such as that of the Task Force on

14 The term *net-zero* refers to the target of reducing the GHG emissions that cause global warming to zero by balancing the amount released into the atmosphere from sources with the amount removed and stored by carbon sinks. This is also described as *carbon neutrality* and sometimes *climate neutrality*. See www.lse.ac.uk/granthaminstitute/explainers/why-is-net-zero-so-important-in-the-fight-againstclimate-change/ for a full explanation of net-zero

Climate-Related Financial Disclosures (TCFD); addressing climate risks in regulatory ratios; and having central bank instruments and policy portfolios become operationally aligned with net-zero (Robins, Dikau, & Volz, 2021). In terms of international cooperation, there is also a focus on partnerships with multilateral development banks in developing and emerging economies (Robins et al., 2021). This would apply, for instance, to the operational work of the International Monetary Fund, comprising surveillance, technical assistance and training, emergency lending and crisis support, aligning this with net-zero.

A number of proposals have been made to bring monetary operations into line with net-zero, including the design of green targeted longer-term refinancing operations (TLTROs) in the EU (van 't Klooster & van Tilburg, 2020; Senni, 2021), the greening of corporate bond purchases (Dafermos et al., 2020) and the greening of collateral frameworks (Monnin, 2020; Oustry et al., 2020). These proposals are increasingly recognised by European central bankers. The ECB recently admitted that market neutrality might be problematic as a benchmark, given that the markets have failed to produce climate-efficient outcomes (Dafermos et al., 2020; Schnabel, 2020). The move away from market neutrality in central bank interventions can already be seen. In 2019, the Swedish Central Bank began analysing the composition of foreign exchange reserves based not only on a risk and yield assessment, but also on how much the assets contribute to GHG emissions (Sveriges Riksbank, 2020). Following this, they took the step of excluding bonds from Western Australia, Queensland, and the oil-rich Canadian province of Alberta from their foreign exchange reserves due to high GSG emissions from these regions (Flodén, 2019).

Central banks are only one part of the growing initiatives for greening of the financial system. The TCFD was established in 2015 by the Financial Stability Board (FSB)[15] and published its final report on promoting better climate disclosure in June 2017. Since then, the TCFD's recommendations have attracted widespread support internationally, with more than 1,500 companies publicly expressing their support (Financial Conduct Authority [FCA], 2020). The UK government was one of the first to publicly endorse the TCFD's recommendations and make its implementation a central part of their 2019 Green Finance Strategy (BEIS, 2019; FCA, 2020). A five-year roadmap towards mandatory TCFD-aligned

15 The FSB is an international body that monitors and makes recommendations about the global financial system. Its mandate is to promote international financial stability, which it does by coordinating national financial authorities and international standard-setting bodies as they work toward developing regulatory, supervisory and other financial sector policies across sectors and jurisdictions.

disclosure obligations across the UK economy was released in November 2020, with most of the measures to be introduced by 2023. The roadmap is published by a cross-Whitehall/cross-regulator taskforce, including the FCA, BEIS and the Department for Work and Pensions (FCA, BEIS, & Department for Work and Pensions, 2020). It sets out plans regarding measures for listed companies, asset managers, life insurers and FCA-regulated pension schemes[16].

In the EU, the European Commission has proposed a legally binding target of net-zero GHG emissions by 2050 with the European Climate Law (COM/2020/80 final, 2020). This regulation aims to write the goals set out in the European Green Deal into law. Several other Green Deal Initiatives will serve to support the objectives of the regulation, including a new, more ambitious EU Strategy for Adaptation to Climate Change, the launch of the European Climate Pact, an EU industrial strategy and a sustainable finance strategy to embed sustainability into corporate governance frameworks (COM/2020/80 final, 2020). Work is being done to (a) establish an International Platform on Sustainable Finance (IPSF); (b) review the Non-Financial Reporting Directive; (c) prepare non-financial reporting standards; and (d) develop a taxonomy for sustainable activities (IFRS Foundation, 2020).

An emergence of industry-led initiatives indicates that the private sector is seeking opportunities in climate-focused activities. This includes the COP26 Private Finance Hub and the Taskforce on Scaling Voluntary Carbon Markets (TSVCM) (Brainard, 2021; TSVCM, 2021). Under the leadership of Mark Carney[17], the Bank of England has launched the "COP26 Private Finance Strategy to Drive Whole Economy Transition" (Bank of England, 2020). The overarching objective of the initiative is to promote frameworks and strategies to ensure that every professional financial decision will take climate change into account. This involves targeted efforts towards reporting, risk management, returns, Multilateral Development Banks (MDBs) and Development Finance Institutions (DFIs) and innovative finance (Bank of England, 2020).

The UN-convened Net-Zero Asset Owners Alliance includes more than 30 pension funds and insurers with over USD 5 trillion in assets (PRI, 2021). Another initiative, the Net Zero Asset Managers initiative[18] has a total of 73 global asset

16 Though not reflected in the roadmap, the Ministry of Housing, Communities and Local Government also intends to consult in 2021 on implementation in the Local Government Pension Scheme by 2023 (FCA, 2020).

17 Mark Carney is a former Governor of the Bank of Canada (2008–2013), Governor of the Bank of England (2013–2020) and Chairman of the Financial Stability Board (2011–2018); currently the UN Special Envoy for Climate Action and Finance (and a Vice Chair and Head of ESG and Impact Fund Investing at Brookfield Asset Management).

18 The Net Zero Asset Managers initiative is accredited by the UNFCCC Race to Zero campaign.

manager signatories, representing USD 32 trillion in assets under management, and more than a third (36%) of the total assets under management across the globe (Net Zero Asset Managers Initiative, 2021). Signatories will report progress annually against the Task Force for Climate-Related Financial Disclosures (TCFD) recommendations, including setting out a climate action plan and submitting this based on a specified methodology (consistent with Race to Zero criteria) and acting in line with the commitments.

Regulators are already starting to incorporate climate analyses into stress tests, and regulatory stress testing of banks and insurers increasingly includes estimates of climate-change impacts (IFRS Foundation, 2020). Standard-setting accounting bodies and financial industry interest groups argue that climate-related risks can be material, and financial statements should reflect this (Anderson, 2019; Fiedler et al., 2021; IFRS Foundation, 2020; IOSCO, 2019; TCFD, 2017). The frameworks under development will facilitate climate-related measures to be considered in financial regulation, credit scoring, asset management and portfolio standards, insurance assessments and even standards for bond issuance and holdings of collateral (e.g., green bonds) (Henningsson, 2019; OECD, 2017). As a result, favourable climate ratings can contribute to a lower cost of capital directly through standards and regulations, but also through the magnifying effect of financial capital markets and investor demand[19].

Banks are also adapting, often prompted by investors to take action (IFRS Foundation, 2020; Robins et al., 2021). The Collective Commitment to Climate Action (CCCA) brings together a group of 38 banks with over USD 15 trillion in assets, from across all six continents, who have committed to align their portfolios with the global climate goal to limit warming to well below two degrees, striving for 1.5°C. All 38 signatories are also signatories to the Principles for Responsible Banking, which has 227 signatories as of May 2021. In their 2020 "Year One in Review" report, the CCCA signatory banks reported the development and deployment of new products and services covering a wide range of activities: RE projects financing, green loans, green bonds, green financing, green mortgages, sustainability-linked loans, and green car loans, to name but a few (CCCA/UNEP FI, 2020). The industry-led, UN-convened Net-Zero Banking Alliance was launched on 21 April 2021 and is the banking element of the Glasgow Financial Alliance for

19 Given regulatory regime changes, investors and managers may seek to position themselves in anticipation of such trends and the related future capital flows toward "green growth" opportunities. Thus, the self-reinforcing nature of financial markets may magnify the positive effects on these companies' market valuations and cost of raising capital (Mandelbrot & Hudson, 2004; Soros, 2003).

Net-Zero. It brings together 43 banks from 23 countries with USD 28.5 trillion in assets (UNEP FI, 2021).

The Net-Zero Banking Alliance, the Net-Zero Asset Owners Alliance and the Net Zero Asset Managers initiative are all part of a strategic forum that is taking form to bring together the leading net-zero initiatives across the financial sector. This will also include a UN-convened Net-Zero Insurance Alliance (yet to be released). The forum Glasgow Financial Alliance for Net-Zero (GFANZ) is chaired by Mark Carney (UNEP FI, 2021).

Averchenkova et al. (2020) present a Climate Finance Framework, outlining the key channels through which the USD 100 billion commitment by 2020 can transform the climate finance system. It underlines the relative scarcity of public concessional resources (primarily from bi-lateral donors), and hence the need to deploy these for maximum impact (i.e., mobilising much larger pools of non-concessional finance). Multilateral concessional vehicles can target climate finance, especially for low-income and vulnerable countries, and catalyse financing from other sources[20]. The DFI system, including MDBs and the International Development Finance Club (IDFC), is considered central international means to support enhanced climate action in developing countries and for mobilising and leveraging climate finance at scale (Averchenkova et al., 2020). The DFI system is also the principal interface between the public and the private sectors, including through strategic partnerships.

Given the scale of climate finance needs in the coming years, the international community under the leadership of the UN is positioning to explore all options to enhance international public finance flows, including through innovative and alternative sources of finance. Notably, one option that has been highlighted in the high-level dialogue on financing for development in the era of Covid-19 and beyond is large additional special drawing rights allocations and revised allocation mechanisms to enable poor and vulnerable countries to access low-cost finance (Averchenkova et al., 2020). Nevertheless, private finance is by far the biggest but largely untapped pool of capital.

20 These vehicles are composed of dedicated climate/environmental funds such as the GCF, GEF, AF and CIFs, as well as non-dedicated ones such as the IDA, AfDF or AsDF (the concessional windows of MDBs).

13.7 SUMMARY

This chapter has outlined the comprehensive and growing framework of global climate governance. Going forward, climate and emissions are set to become major determining factors behind finance and capital flows. Multilateral development institutions, central banks, governments, financial regulators, the banking system, money management, capital owners, insurers and private corporations are beginning to align around some common principles and governance frameworks that are ultimately intended to implement concerns about climate change and carbon emissions into all levels and aspects of financial and managerial decision making.

The energy system is among the core areas affected by these trends. Given the importance of energy systems as the underpinning of modern society and economic activity, the relevance of these developments can hardly be exaggerated. Despite this, there is not much literature to suggest that a holistic approach is being taken to understand the forces that are currently driving substantial changes to global energy systems – from the global macro level, via governments and the financial system, to the individual investment decisions by developers, utilities and the grid.

As noted, the traditional functions of energy policy and regulation in the power sector are to ensure access to adequate and reliable supply, protect consumers from pricing power abuse and ensure that utilities and private sector entities will be able to recoup their investments. Historically, investments in power generation and distribution have been licensed and permitted based on these criteria, primarily by power system insiders with a good understanding of resource adequacy and the workings and constraints of the power system. However, the traditional priorities have increasingly been subverted to the growing emphasis on climate policy. With the increasing importance of regulations, subsidies and policy-driven preferential financing as drivers of energy investment, this raises questions as to whether the governance frameworks at the micro level are capable of balancing such influence with the traditional priorities of reliability, affordability and the economic viability of utilities.

The influx of new technologies, political incentives and financial incentives in the power sector is already having a large impact on the workings of electricity systems, both in terms of price formation and in terms of physical flows in the grids. Following a decade of increasing reliance on intermittent renewables and natural gas, typically at the expense of thermal generation plants, concerns are being raised about the impact on grid reliability and power prices. However, as this chapter attempts to demonstrate, there might increasingly be a disparity between the drivers of power system investment and development, in terms of regulation, policy and financial flows, and the operational concerns at the level of production, operation and consumer concerns.

Nevertheless, when looking at the future, much uncertainty remains as to which policies will actually be implemented. It also remains to be seen the degree to which financial commitments for the future will be honoured. In any event, in the run-up to COP26 climate negotiations and the first formal round of NDC submissions, business, industry, finance, academics and consumer groups might want to pay attention to the evolving – or, possibly, shifting – framework conditions of climate accounting and carbonomics.

ABBREVIATIONS

ACTs	Avoided cost tariffs
AfDB/AfDF	African Development Bank /African Development Fund
AsDB/AsDF	Asian Development Bank / Asian Development Fund (Multilateral concessional vehicles; non-dedicated [“concessional windows of MDBs”])
BIS	Bank of International Settlements
BNDES	Brazilian Development Bank
BSTA	Body for Scientific and Technological Advice
CCCA	Collective Commitment to Climate Action
CDM	Clean Development Mechanism
CER	Certified emission reduction (credits)
CO_2	Carbon dioxide
COP	Conference of the Parties
CPI	Climate Policy Initiative
CSD	UN Commission on Sustainable Development
CSP	Concentrated solar power
DFI	Development Finance Institution (incl. MDBs and IDFC)
FCA	Financial Conduct Authority
FITs	Feed-in tariffs
FSB	Financial Stability Board
GCA	Global Commission on Adaptation
GCF, GEF, AF, CIFs	Green Climate Fund, Global Environment Facility, Adaptation Fund, Climate Investment Funds (Multilateral concessional vehicles; dedicated climate/environmental funds)

GFANZ	Glasgow Financial Alliance for Net-Zero
GHG	Greenhouse gas
HLPF	UN High-Level Political Forum on Sustainable Development
IDA	International Development Association (Multilateral concessional vehicle; non-dedicated)
IDFC	International Development Finance Club
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
IPSF	International Platform on Sustainable Finance
IRENA	International Renewable Energy Agency
MDB	Multilateral Development Bank
NDCs	Nationally Determined Contributions
NGFS	Network of Central Banks and Supervisors for Greening the Financial System
NGO	Non-Governmental Organisation
PPPs	Public-private partnerships
PTC	Production Tax Credits
RE	Renewable energy
RECs	Renewable Energy Credits
REDD-plus	Reducing Emissions from Deforestation and Forest Degradation in Developing Countries
RPSs	Renewable portfolio standards
SBI	Subsidiary Body for Implementation
SDGs	Sustainable Development Goals
SDR	Special drawing rights
SEFI	Sustainable Energy Finance Initiative
TCFD	Task Force on Climate-Related Financial Disclosures
TGC	Tradable green certificate
TLTROs	Targeted longer-term refinancing operations
TSVCM	Taskforce on Scaling Voluntary Carbon Markets
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNEP	UN Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change

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