Advancing Decarbonisation Through Clean Electricity Procurement

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Abstract

The number of corporations announcing clean electricity pledges has increased substantially in recent years, with many companies setting specific goals to meet some or all of their electricity demand with clean supply. These goals can support new capacity in clean generation, helping to boost overall shares in power systems. Increasingly, clean electricity goals can be specified in different ways; this can have implications for the clean technologies procured, the amount and location of procurement, and the resulting emissions reduction. In some regions, corporates have a range of options to choose from when purchasing clean electricity; in other regions, legal and regulatory barriers still constrain engagement in corporate procurement.

This report examines the options available and the ways in which they contribute to decarbonisation and, ultimately, net zero electricity goals. Using the IEA's regional power system models for India and Indonesia, the report applies quantitative analysis to examine the implications of different procurement strategies for emissions reduction, procurement costs and technology deployment. A key finding is that when companies set more granular goals – such as matching their electricity demand hourly (rather than annually as has been the dominant practice) – it can stimulate deployment of the wider portfolio of flexible technologies needed for net zero transitions in the power sector.

The report aims to guide corporates in choosing impactful ways to procure clean electricity. It also highlights the roles of policy makers, regulators, system operators and network owners and operators in increasing the availability and impact of corporate procurement options. The final chapter offers targeted recommendations for different stakeholder groups.

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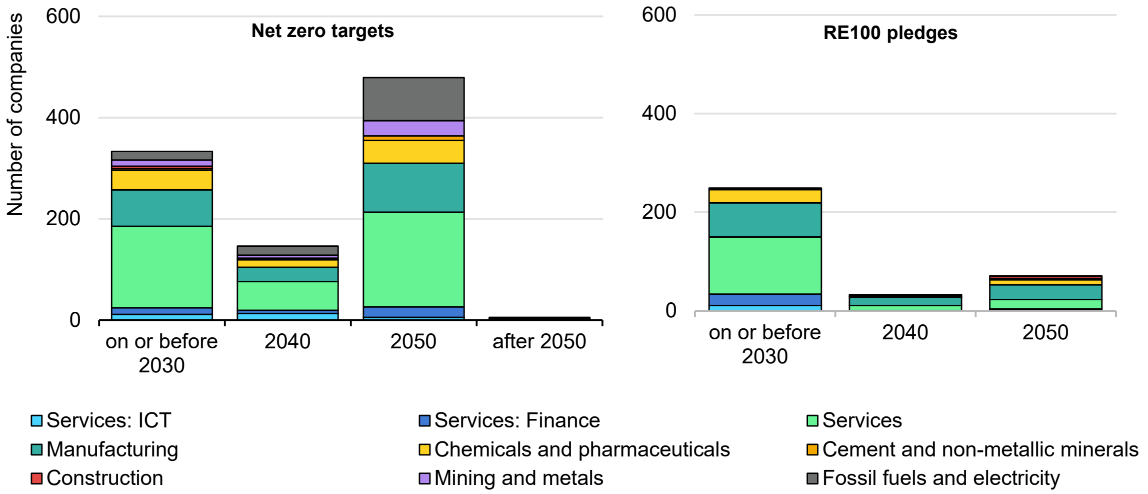
Executive summary

An increasing number of companies are looking to ensure – and show – that they are trying to help mitigate climate change and contribute to clean energy transitions. At the same time, more and more consumers want to choose products and services compatible with sustainable development. In this context, almost 1 000 companies across different activity sectors have pledged some form of emissions reduction or climate neutrality goals. To achieve these goals, many companies have started defining targets to reduce or eliminate emissions arising from their electricity consumption by procuring electricity from clean sources.

Number of companies with net zero targets (left) and Renewable Energy 100 pledges (right) by year and by sector



Note: RE100 = the Renewable Energy 100 initiative.
Source: IEA Analysis of Net Zero Tracker (accessed 28 September 2022), and RE100 (accessed 19 July 2022).

This report aims to support consumers of all sizes in choosing impactful ways to procure clean electricity. To this end, it provides guidance not only to companies but also to key stakeholder groups – policy makers, regulators, and system and network operators.

Our analysis shows that the way clean electricity goals are specified influences how clean energy procurement impacts power systems and actual emissions reduction. At present, most corporate clean electricity procurement is guided by accounting practices set out in the Greenhouse Gas Protocol. This guidance allows companies to apply an emissions factor of zero to their electricity consumption in their greenhouse gas (GHG) emissions accounting by matching their demand with the purchase of clean generation on an annual basis, e.g. under the Renewable Energy 100 (RE100) initiative.

Emissions reduction goals based on annual electricity matching have underpinned the large rise in procurement activity in the last decade and can continue to drive increasing deployment of clean generation, particularly solar and wind, for power systems in earlier phases of renewables integration. More recently, strategies that focus directly on emissions impacts and prioritise the most cost-effective emissions abatement are also gaining attention.

However, goals based on annual matching of electricity or only targeting emissions do not deliver all the technologies that will be needed as power systems decarbonise and reach higher renewables integration phases. Thus, companies seeking to lead net zero transitions are developing other strategies. One alternative aims to match the corporate demand profile on an hourly basis (or less) with demand and generation both located within the same grid. This approach delivers more robust emissions reduction in high-renewables systems and drives deployment of a more diverse and flexible portfolio of clean technologies and solutions.

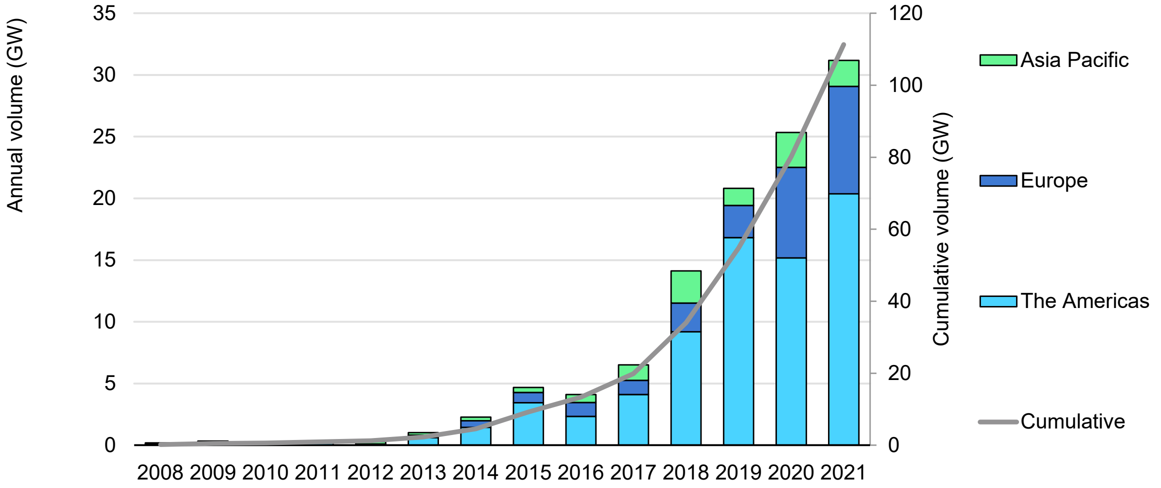
The type of procurement that corporates undertake to meet their goals also influences emissions reduction outcomes. Depending on the market, a number of options for clean electricity procurement are available:

- On-site or "behind-the-meter" (BTM) generation, in which corporates invest in clean electricity generation to meet their own demand.
- Energy attribute certificates (EACs), which are tradeable credits that can include attributes such as type and time of generation. Examples include Renewable Energy Certificates (RECs) in the United States and Guarantees of Origin (GOs) in Europe, or the emerging, more granular, time-dependent energy attribute certificates (T-EACs).
- Power purchase agreements (PPAs), which are long-term contracts between a consumer and an electricity producer. The contracts can be physical (including actual delivery of electricity to the consumer) or financial (as a price hedging instrument).
- Green power products or green tariffs through which the corporate procures clean electricity from a utility or a clean electricity supplier.

This portfolio of clean electricity procurement options gives corporates flexibility to choose one that fits their needs and capabilities. However, there is a need to consider whether clean electricity procurement directly contributes to increased clean generation beyond what would be achieved through existing public policy targets and measures. This is referred to as "additionality", and is easier to demonstrate for some forms of procurement, such as BTM generation or a PPA for a new plant.

To date, EAC schemes have been the dominant option for corporate procurement. The uptake of PPAs has risen sharply in the last decade as corporates seek to maximise the visibility and additionality of their procurement efforts.

Global corporate power purchase agreements volumes by region, 2008-2021



Note: On-site PPAs excluded.
Source: Bloomberg New Energy Finance (2022).

Policy and regulation should maximise the availability of diverse procurement options

The extent of electricity industry liberalisation has an important influence on the possibilities for clean electricity procurement. Some power market structures allow for a great diversity of procurement options; others are more restricted. Green power products, for example, are technically possible within most electricity market structures while PPAs between generators and consumers typically require a greater degree of liberalisation.

Across all types of power markets, whether fully integrated or fully liberalised, policy makers can take specific actions to foster the development of clean energy procurement. Introducing a licensing process that grants access to the electricity network and specifies which actors can interact with the incumbent utility can be important first steps (as shown in India, Indonesia and South Africa). In parallel, policy makers and regulators need to establish clear and transparent processes for cost calculations and allocate responsibilities to ensure developers and consumers are able to place trust in the market.

While the available mechanisms to enable clean electricity offerings to customers will vary from one power system to the next, policy makers, regulators and utilities should take action to maximise the accessibility of clean electricity procurement options. For large consumers, liberalisation of generation and allowing consumers to choose their electricity provider can stimulate the emergence of corporate PPAs, EAC schemes and green tariffs through retailers. For small consumers, policy makers can enable procurement by requiring utilities to develop green power products and letting consumers choose among clean energy suppliers.

Policy action should empower consumers with greater climate ambitions – without reducing the obligations of other participants

As noted above, ensuring that corporate procurement makes a real contribution to deploying more clean generation (also referred to as additionality) is vital – from both policy and corporate perspectives. To truly accelerate clean energy transitions, the most critical requirement is that voluntary procurement actually goes beyond existing government mandates and initiatives. If this criterion is met, all corporate clean electricity goals and all types of procurement can contribute to accelerating energy transitions. This can also add robustness to corporate claims of decarbonisation.

For certificate schemes, this requires careful design to ensure that accounting and reporting mechanisms are compatible with government clean electricity targets and mandates. This implies the need for clear guidelines as to what should be reported as part of the country's own policy-driven process and what is driven by individual corporate initiatives, as well as mechanisms to avoid different types of double counting. This applies within clean electricity tracking and to the interaction between certificates and carbon credits. It is critical to avoid, for example, double issuance in which both a clean electricity certificate and a carbon credit are created for the same unit of generation and subsequently claimed by two separate actors.

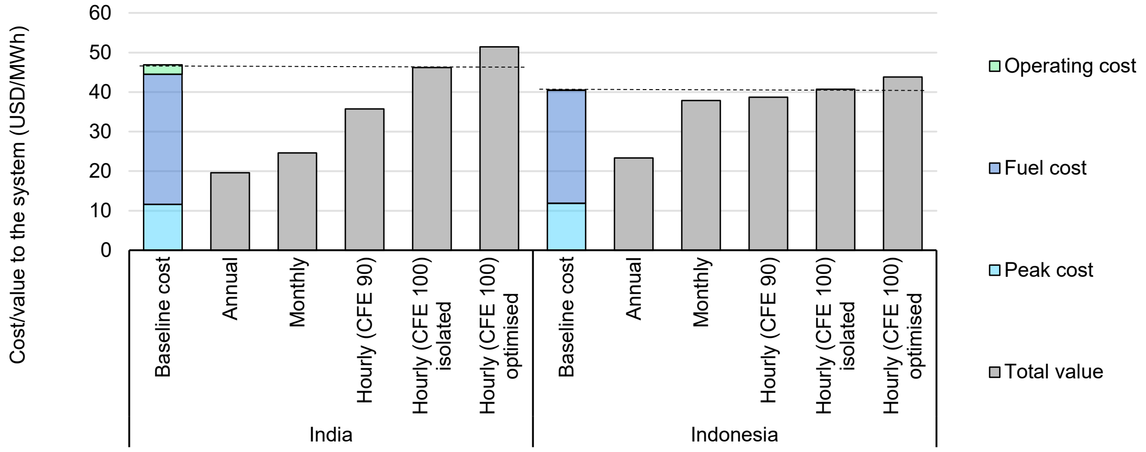
Regulators need to ensure clear allocation of system costs

Annual matching goals, which focus on electricity and tend to be satisfied by variable renewable technologies, create a set of specific challenges. Companies using these strategies still rely on services that other generators provide – e.g. supplying capacity adequacy, balancing and stability, as well as use of the grid. This may imply costs for other actors providing them, such as generators and system and network operators, which must be recovered through consumer billing structures. If such costs are not allocated explicitly, the total costs may end up, by default, being passed to other grid users in an unfair manner. Alternatively, the system operator may have no mechanism to recover them and face solvency issues.

Regulators play a major role in ensuring a clear allocation of costs that support system operations and decarbonisation, and should therefore develop clear mechanisms to evaluate and allocate them. In systems where renewables deployment requires policy support, regulators should design remuneration mechanisms in a way that ensures that all parties contribute to reducing the impact on overall system costs and allow system operators to cover additional costs efficiently. A key consideration is that such mechanisms ensure support for clean electricity deployment without inadvertently passing costs to vulnerable consumers. Mechanisms should also recognise the contribution that flexible technologies provide to the system.

We illustrate this in an IEA modelling case study for India and Indonesia in 2030 in which we evaluate system impacts for corporate generation based on different clean electricity goals. The modelling evaluates system costs and value in relation to impacts on fuel costs, operating costs (including startups and ramping), and estimated peak contribution. We find that the system value of annual matching portfolios is substantially below the cost to serve the corporate load with standard grid supply. In contrast, hourly matching portfolios bring a much higher value, which may even exceed the costs for serving the corporate load.

System costs and value contribution in India and Indonesia, 2030



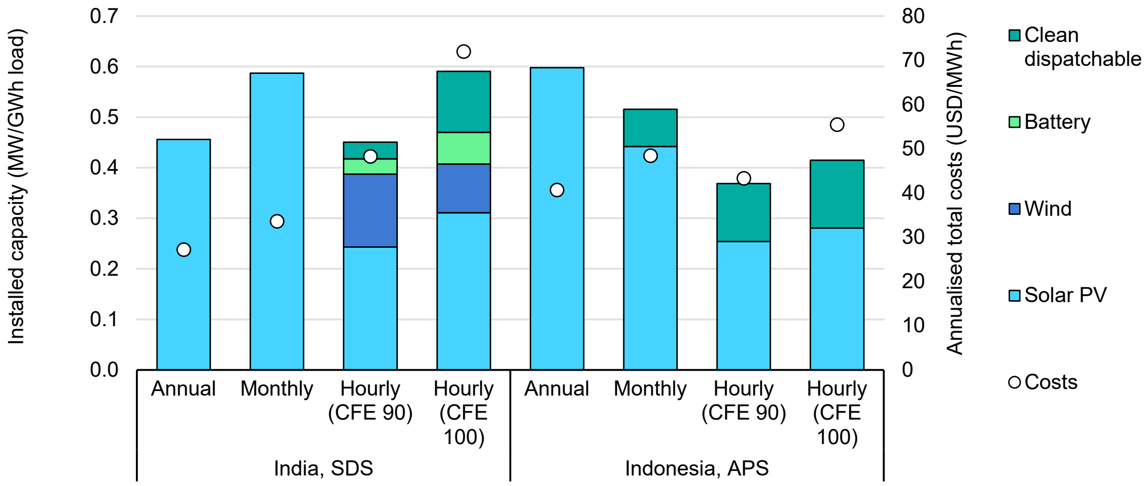
Notes: CFE = carbon-free energy, SDS = Sustainable Development Scenario, APS = Announced Pledges Scenario. The CFE 100 case is based on corporate portfolio built to fully meet corporate demand in every hour; the CFE 90 case uses a corporate portfolio that depends on imports in some hours but achieves a CFE score of 90 based on the methodology published by Google. Isolated dispatch refers to a case in which the corporate portfolio is operated only to match the corporate load profile. Optimised dispatch seeks to align optimisation of the corporate portfolio with that of the entire power system.

Hourly strategies allow companies with higher ambition to help lead net zero transitions

Clean electricity goals based on matching clean generation to corporate demand on an annual basis have played an important role so far, driving procurement of clean electricity mainly from solar and wind. These goals continue to provide value across the world in systems where the priority is adding clean electricity, particularly from variable renewables.

Achieving net zero power sector transitions, however, will ultimately require a broader range of clean, flexible electricity supply and service options. Corporates can take the lead in accelerating decarbonisation by setting more ambitious goals that can stimulate deployment for the full portfolio of clean dispatchable technologies. IEA modelling for India and Indonesia shows that hourly matching strategies (as compared to annual) lead to a more diverse technology portfolio, including clean dispatchable generation and storage.

Procurement portfolios and procurement cost for annual and hourly demand matching in India and Indonesia, 2030



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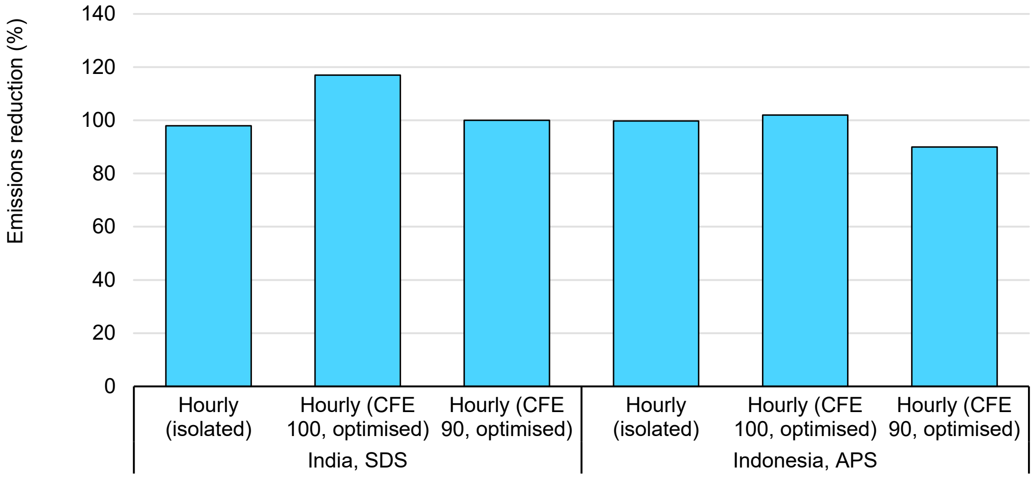
Companies adopting hourly strategies should take a systems perspective to ensure power system efficiency

Hourly matching strategies imply corporate generation closely matching corporate demand profiles. In principle, this does not consider the overall demand profile of the entire system. Such an approach could lead to investment decisions that overlook the fact that large, interconnected power systems benefit from increased efficiency by aggregating load and sharing generation resources.

To avoid the risk of inefficient investment, all procurement strategies should allow for interaction between the corporate generation and the power system, which includes exporting surplus generation to the rest of the system and utilising system services. One option to achieve this for hourly strategies is targeting hourly matching at less than 100% in each hour. Relative to annual matching strategies, this approach stimulates a much more diverse and flexible portfolio and provides a greater contribution to system services. In this case, the corporate remains dependent on the main system for peaking requirements and some balancing services, which helps to avoid inefficient overbuilding of the system.

Trading of time-based certificates (T-EACs) can also allow corporates to pursue hourly matching in a more cost-effective manner. Certificate trading allows corporates to trade surplus clean generation in specific hours, which effectively allows for aggregation of generation to meet different demand profiles. In this case, it is essential to assess additionality and ensure the certificates for meeting 24/7 goals do not come from existing generation without increasing flexible supply. IEA modelling for India and Indonesia shows that, relative to an isolated dispatch matched to the company load profile, optimised dispatch of hourly matching portfolios reduces both system costs and emissions.

Reduction in CO_2 emissions using siloed and optimised dispatch in India and Indonesia, 2030

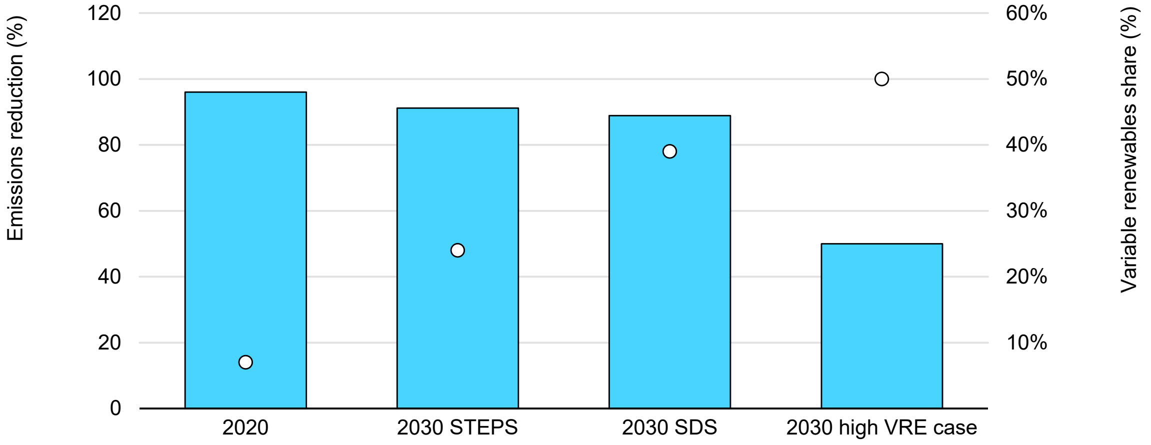


Notes: CFE = carbon-free energy, SDS = Sustainable Development Scenario, APS = Announced Pledges Scenario. Isolated dispatch refers to a case in which the corporate portfolio is operated only to match the corporate load profile. Optimised dispatch seeks to align optimisation of the corporate portfolio with that of the entire power system. The CFE 100 case is based on corporate portfolio built to fully meet corporate demand in every hour; the CFE 90 case uses a corporate portfolio that depends on imports in some hours but achieves a CFE score of 90 based on the methodology published by Google.

Update emissions accounting approaches to better align calculated and actual emissions impact

While reducing carbon emissions is an important objective of clean electricity procurement strategies, existing frameworks fail to fully consider all aspects that affect emissions. In particular, accounting frameworks based on matching electricity demand and supply on an annual basis create a risk of discrepancies between attributed and actual emissions reduction. While relatively fit-for-purpose in many power systems today, as power systems reach higher [phases of renewables integration](), these approaches will increasingly fall short. IEA modelling for India shows that corporate procurement based on annual electricity matching reduces company emissions by 96% in 2020. However, as the share of renewables in the electricity mix increases, the same approach delivers only 89% emissions reduction by 2030 in the Sustainable Development Scenario. In a case with the share of variable renewables reaching 50%, the emissions reduction value falls to around 50%, reflecting increased curtailment of renewables in the rest of the system and the corporate generation mostly displacing gas (rather than coal) during hours of surplus.

Emissions reduction resulting from corporate clean generation for annual matching strategies in India, 2020 and 2030



Notes: Emissions reductions are measured as a percentage of emissions resulting from corporate electricity consumption. STEPS = Stated Policies Scenario, SDS = Sustainable Development Scenario. High VRE case consists of the SDS with additional renewables generation to bring the VRE share to 50%.

Current accounting practices for average annual emissions do not account for these effects. As such, under an annual average approach, all of these cases would appear to achieve 100% emissions reduction, while the actual impact of the interventions may be much lower. Such approaches may remain the most appropriate for attributing emissions across the entire system; however, they do not provide good guidance for the most impactful procurement decisions.

Hourly average approaches can provide better information about the time at which demand response and clean generation bring the most value to the system. Even so, they do not accurately capture how changes in load and generation actually impact emissions. Marginal impact methodologies that include a long-term perspective provide the most accurate way to understand the actual impacts of various interventions on the power sector. Such approaches are challenging to adopt as they require greater availability of data; power system modelling is required to determine most accurately the most effective deployment of clean electricity and demand response. Nonetheless, use of such methodologies should be increased wherever possible. Policy makers can support this by ensuring increased data availability and including guidance on optimal pathways for system development within planning studies.

Corporate clean electricity goals

Introduction

A growing number of companies are seeking to ensure – and to show – that they are taking efforts to mitigate climate change and contribute to clean energy transitions. In parallel, more consumers want to be able to choose products and services that are compatible with sustainable development. This context is prompting many companies to identify the sources of their emissions – including from electricity consumption – and take steps to reduce them.

More broadly, electricity will underpin global net zero transitions. As shown in the IEA's Net Zero Emissions by 2050 Scenario, potential exists to decarbonise electricity relatively rapidly and, through electrification, to make it the vector for decarbonising other harder-to-abate sectors.

All consumers, whether corporates or individuals, should be able to choose clean electricity. Policy makers and regulators should take the lead role in ensuring that clean electricity options are available. In turn, the electricity industry structure and the regulatory environment are critical to determine the range of options by which consumers can procure clean electricity. Recent years have seen a marked increase in the availability of clean electricity products in some geographies. Still, increased clarity is needed on the degree to which these products truly increase clean electricity generation and important barriers remain to be addressed in many regions.

Across the private sector, commercial and industrial consumers span a huge range of size and sophistication as electricity consumers, from small and medium enterprises (SMEs) up to global corporations. Their capabilities to participate in power sector transitions vary accordingly – as do their needs. For small companies, sustainability initiatives may come in the form of selecting a green power product or installing rooftop solar panels. At the other extreme, large national and multi-national corporations may have dedicated teams working on electricity and may even have more expertise than some local electricity utilities. As such, they may have the capacity to directly negotiate PPAs to meet their own demand and the ability to take a leadership role in developing new clean electricity options that can be made available to other consumers.

Decarbonisation is a joint effort that requires action across all levels of society. This report aims to support consumers of all sizes in choosing impactful, clean electricity options. To this end, it provides guidance not only to companies but also to key stakeholder groups – policy makers, regulators and system operators.

This first chapter gives an overview of the increase in corporate clean electricity goals and introduces the main types of goals being adopted, including matching electricity consumption with clean electricity supply on an annual or hourly basis.

The second chapter introduces the potential options by which corporates can procure clean electricity. It also explains the concept of "additionality" and examines various barriers faced by different types of consumers.

The third chapter examines how the structure of the electricity industry influences corporate procurement and provides case studies highlighting positive development for new clean electricity procurement as well as some remaining barriers in selected countries.

To illustrate some of the technical considerations relevant to corporate procurement, the fourth and fifth chapters present the results of modelling exercises undertaken by the IEA for India and Indonesia. The fourth chapter focuses on the challenges of measuring emissions impacts while the fifth examines how different corporate procurement goals contribute to the broader net zero transition of the power sector.

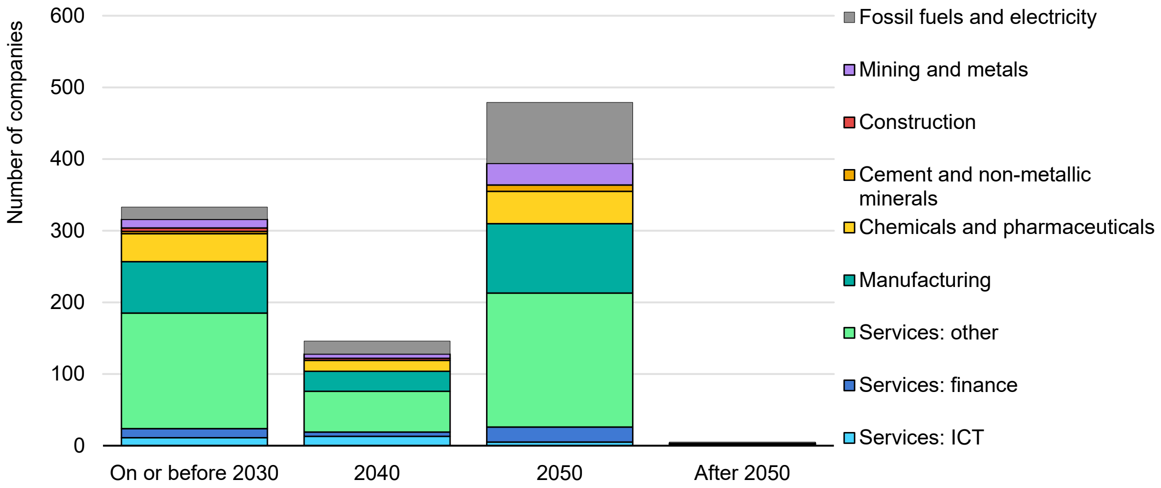
Finally, the last chapter provides a summary of key messages, organised by stakeholder group, based on the qualitative and quantitative analysis of the report.

Corporates in net zero transitions

Achieving net zero emissions requires a focus on reducing primary emissions

To date, almost 1 000 companies across different activity sectors have pledged some form of emissions reduction or climate neutrality goals. Some 90% of them are located in advanced economies. Driven by several factors, such as corporate sustainability initiatives, customer demand for low-carbon products and services, brand positioning, or the desire to reduce commercial risk, companies are increasing their participation in solutions for the climate and for energy systems. Examples of initiatives that engage companies include the Race to Zero campaign, the Net Zero initiative, Transform to Net Zero and the Climate Pledge. Many pledges target 2050, with a smaller share aiming at 2030 or 2040. At present, the services sector has the leading share on all horizons.

Number of companies with net zero targets by year and by sector



Note: ICT = information and communications technology.
Source: IEA Analysis of Net Zero Tracker (accessed 28 September 2022).

Emitters have historically used carbon credits[1] purchased through carbon markets to support their emissions reduction and removal claims. With the aim of lowering the costs of mitigating climate change, carbon credit markets were created to provide economic efficiency and flexibility as to where and when greenhouse gas (GHG) emissions are reduced or removed. Some markets provide flexibility to achieve emissions obligations at the international level, such as the Clean Development Mechanism (CDM), and some at sub-national levels, such as the California Compliance Offset mechanism. Others were created to allow companies and other actors to reduce their emissions on a voluntary basis and are connected with voluntary markets such as the American Carbon Registry, Gold Standard, Climate Action Reserve and Verra.[2]

However, there is increasing pressure for emitters to limit the reliance on carbon credits. The IEA-OECD Climate Change Expert Group (CCXG) and other standards, such as the Science Based Targets Initiative (SBTi), propose that the role of carbon credits in achieving net zero should remain limited to a small share of emissions (e.g. 5-10% according to SBTi), as emitters should focus on reducing their own emissions first. Energy conservation and efficiency continue to be among the top priorities in this respect.

In their early phases, carbon markets faced several implementation challenges leading to uncertain emissions impacts. Concerted effort has already been made to improve their efficacy in bringing about abatement. The Paris Agreement and

[1] Carbon credits correspond to verified metric tonnes (Mt) of carbon dioxide (CO_2) reduced or removed from the atmosphere.
[2] Some of the voluntary registries may allow trading with certificates in compliance markets, provided that they fulfil common standards.

its rulebook, for example, have much more stringent rules than previous international regimes, especially in terms of double counting of emissions reduction. Despite an agreement at COP26 on the broad rules of Article 6 of the Paris Agreement, which covers carbon credits, negotiations on their implementation are still ongoing. Correctly implemented, carbon credits can be an important complement to other carbon abatement efforts.

Clean electricity goals support primary emissions reduction initiatives

In order to reduce primary emissions, companies have started defining more targeted goals to mitigate emissions linked to their electricity consumption. Emissions reduction can take place across three main categories, based on the widely used accounting standard by the GHG Protocol:[3]

- **Scope 1:** emissions occurring from sources that the organisation directly owns or controls. This might include, for example, emissions from operating gas boilers in an industrial plant or from company vehicles.
- **Scope 2:** emissions associated with purchased electricity,[4] steam or heat. An organisation may not have direct control – aside from reducing consumption of purchased energy – but can take steps to influence such services.
- **Scope 3:** emissions associated with the company's upstream and downstream value chains. For an automotive manufacturer, for example, this encompasses emissions from its upstream materials suppliers and its downstream retailing activities.

This report focuses on clean electricity procurement, which falls mainly under Scope 2 emissions reduction efforts. Scope 3 is also relevant for electricity emissions across a company's supply chain but is not the focus of this report. A company installing on-site clean electricity generation (e.g. solar PV) to replace previous on-site fossil fuel generation (e.g. diesel backup generators) could also overlap with Scope 1 boundaries.

As renewables generation becomes increasingly cost-competitive and governments reduce or remove associated subsidies, engaging large private consumers to directly purchase renewable energy ensures market availability and helps reduce the risks for developers. At the same time, consumers can benefit

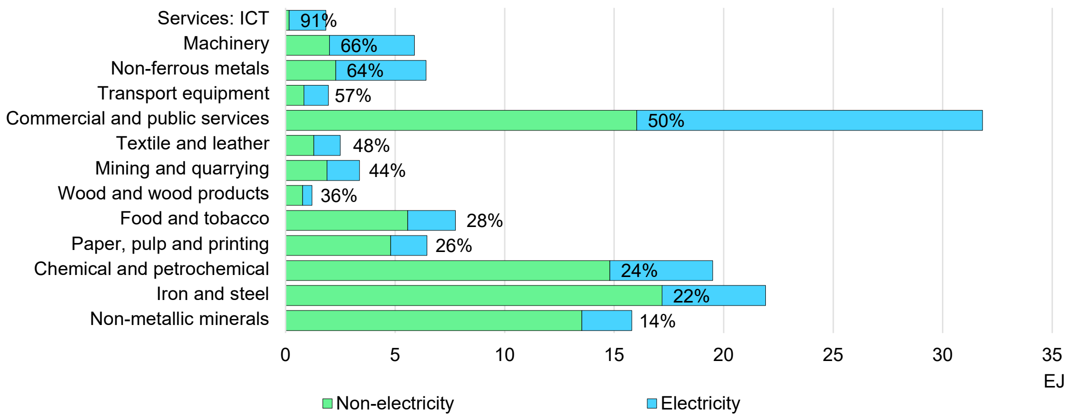
[3] The GHG Protocol is an emissions accounting and reporting framework initiated by the World Resources Institute and World Business Council for Sustainable Development. ISO 14064 provides minimum standards for compliance in GHG accounting.
[4] Emissions from electricity could be accounted based on the emissions of the local grid from which electricity is consumed (location-based accounting) or on the emissions from the generators contracted to supply electricity (market-based accounting). More detail on this difference is explained in the chapter on emissions accounting.

from the availability of cost-effective renewable resources that – depending on the market and electricity procurement approach taken – may also provide hedging from electricity market price risks.

Corporates with more flexibility have potential for fast decarbonisation

Companies and industries that rely on electricity for a major share of energy in their activities and who have flexible operations have high potentials for fast decarbonisation. For several key sectors – such as manufacturing of machinery and transport equipment, aluminium smelting, and commercial and service activities (notably information and communications technology [ICT]) – electricity already constitutes a major part of their direct energy use. Applying procurement strategies to leverage clean electricity generation can help these industries rapidly decarbonise a significant part of their emissions profile.

Global energy use and share of electricity by sector, 2019



Note: ICT = information and communications technology.
Sources: IEA Analysis of World Energy Balances 2022 and Data Centres and Data Transmission Networks

In turn, flexibility in production processes can facilitate matching demand with the availability of variable renewables, whether installed on-site or procured from the electrical grid. Common sources of demand flexibility within different company activities include:

- Aluminium: scheduling flexible smelting processes.
- Data centres: moving computation activities to other territories, using cooling loads as thermal storage or employing redundant batteries as electrical storage.
- Commercial buildings: shifting heating/cooling loads.
- Manufacturing: identifying mechanised aspects that can be used for material storage.

- Retail supermarkets: using the implicit thermal storage of refrigerators and freezers to shift load.
- Transport and storage activities: scheduling charging loads of electric vehicles.
- Wastewater: time-shifting aeration, pumping and filter backwashing.

Increasing electrification of sectors such as heating and transport, as well as increased automation of processes that enables demand response, add to the potential value of demand-side flexibility. Developing procurement strategies can provide a valuable opportunity for companies to decarbonise while also supporting integration of more clean energy sources in power systems.

Commitments to remove historical emissions from the atmosphere

A significant portion of GHG emissions, such as CO_2, linger in the atmosphere for 100 years or more, meaning their total volume accumulates over time. Past emissions substantially increase the risk of not achieving the Paris Agreement's climate target.

Currently, there is no widely accepted standard to account for historical emissions. Nonetheless, initiatives to remove historical emissions from the atmosphere can help with meeting climate targets and unlocking investment in carbon-negative projects.

In January 2020, Microsoft announced a plan to be carbon-negative by 2030 and to remove its historical carbon footprint – going back to its foundation in 1975 – by 2050. The plan covers Scopes 1, 2 and 3 emissions and entails Microsoft both reducing its current emissions to net zero and funding carbon-negative projects such as direct air capture.

Velux, a roof window manufacturer founded in 1941, also committed to capture its historical emissions by 2041, covering Scope 1 and 2 emissions. It focuses on forest conservation projects in collaboration with the World Wildlife Foundation (WWF).

Clean electricity goals

Emissions and system impacts depend on the type of goal

In the attempt to reduce Scope 1 and 2 emissions, many companies have explored setting clean electricity goals to align with their energy purchases. These goals vary in their time span and procurement specifications and can lead to debates about the accuracy of emissions reduction claims.

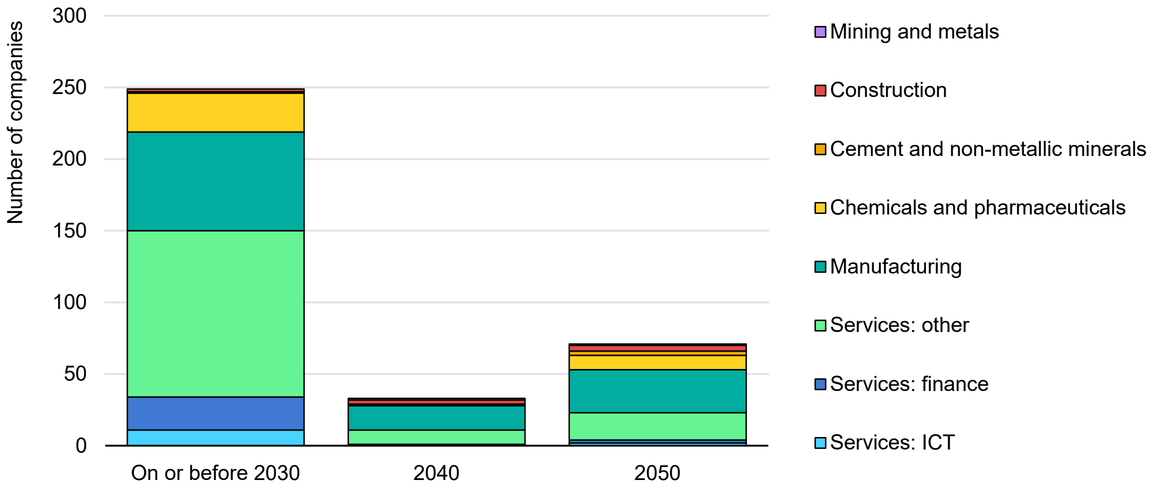
A major part of the debate stems from the fact that, in many cases, end-users do not directly consume the "clean electrons" they procure and, indeed, in interconnected power systems, it is impossible to differentiate which sources of electricity are delivered to which consumers. As a result, clean electricity claims are largely based on contractual agreements. The company's strategy may involve purchasing clean electricity certificates or contractual supply of clean electricity produced in locations and time periods that differ from its actual electricity demand. This may mean that actual corporate demand and contracted supply are physically balanced by electricity sources that are not clean.

How clean electricity goals are defined plays an important role in the potential impact of corporate action on clean electricity procurement, which is the focus of this section. The impact also depends on the type of procurement undertaken – e.g. purchasing certificates or PPAs – which is addressed in the following chapter.

Annually matched goals

The most widespread practice today is for a company to procure an amount of clean electricity equal to its total annual consumption, either through supply contracts or certificates. This approach aligns with emissions accounting guidance in the GHG Protocol under what is termed a "market-based" approach. The Renewable Energy 100 (RE100) initiative brings together a large group of companies aiming to use 100% renewable electricity by 2050 based on annual matching and now covers 380 terawatt hours (TWh) of electricity demand. Notably, at this scale, if it were a country this would place it just outside the top 10. Targets made by companies engaged to date show earlier timelines than overall corporate net zero goals. This is consistent with the sectoral trajectories in the IEA Net Zero by 2050 Scenario, in which the power sector decarbonises more rapidly than other parts of the economy.

Renewable Energy 100 targets around the world by decade and sector



Source: IEA Analysis of RE100 (accessed 19 July 2022).

Typically, companies aim to meet these goals by tapping into the lowest-cost renewable generation technologies, i.e. solar PV and wind power. Such strategies have underpinned the large rise in corporate procurement in the last decade. These goals benefit from relative simplicity: by increasing demand for clean electricity, annual matching spurs greater investment in renewables that can displace fossil fuel-based power generation.

Since it corresponds with currently available certificate schemes, annual matching of electricity is also highly accessible. This is the dominant avenue for procurement to date, however there can be large differences in the actual impact, depending on whether the certificates are linked to new or existing power facilities (discussed in the following chapter).

While having clear merits, annual matching can lead to discrepancies in the emissions that a company effectively reduces compared with those for which it is responsible, linked to the fact that solar and wind are variable and uncertain. In periods with low solar and wind output, the company consumes more than its contracted generation, and thus relies on generation from the main grid – which may come from fossil fuels. Conversely, when the contracted solar and wind produce more electricity than the company consumes, this surplus is accommodated by other generators in the grid having to reduce their production. Such changes may also imply other costs having to be borne by the rest of the system. (These issues are explored in detail in the chapters on emissions accounting and net zero transitions).

Location of generation and demand is another aspect affecting emissions. Both emissions resulting from demand and reduction resulting from procurement will vary depending on the emissions level of the generation in the specific grid. Annual matching goals do not always specify that the electricity generation should occur in the same grids as the company's electricity demand. RE100, for example, has a broad definition of market boundaries from which corporates can procure renewable electricity. This flexibility gives companies options to support renewables development even if their operations are located in regions where clean energy is scarce or the investment environment for renewables is heavily restricted. It also allows them to support development where emissions reduction impact could be maximised or where they can benefit from lower emissions abatement costs.

Overall, the performance level of annual matching goals in terms of emissions reduction impacts can vary considerably. They could lead to large emissions reduction in the system, or it could be far below what companies may expect. This will depend on the specific systems in which consumption and procurement take place and the procurement approaches used. Tracking such variations requires a direct assessment of emissions impact.

Hourly matched goals within the same grid

The leading alternatives to annual matching attempt to address continued dependency on fossil-fuel based grid generation by matching the corporate demand profile in real time, within the same grid where the demand occurs. This involves accurate metering of a company's hourly consumption and a trading and communications platform that can allow precise matching with clean electricity. Relevant initiatives include 24/7 Renewable Energy Sourcing (RES), 24/7 carbon-free energy (CFE), a goal first announced by Google and now an aim of many organisations under the UN 24/7 CFE Compact, and Microsoft's '100/100/0' pledge.

These approaches have potential to address the criticisms raised for annual matching goals. Since clean generation equal to the company's demand is injected into the same grid in every hour, in principle these approaches should effectively reduce 100% of its electricity emissions, if contracting zero-emissions sources. Importantly, as achieving hourly matching requires more control over generation and demand, these goals guide corporates to procure more diverse and flexible clean technologies and solutions. In turn, this will help to ensure that the grid is flexible enough to integrate the variable renewables procured and, thus, that the corporate generation does not drive increased curtailment. As a result, corporates adopting these strategies provide a more comprehensive contribution to bringing power systems along the net zero transition and can lead the way in developing the technologies needed. This is explored in detail in the chapter on net zero transitions.

Hourly matched goals pose challenges that may be easier for certain sectors to overcome than for others. Load flexibility becomes a major advantage as some demand – e.g. data centres, commercial refrigerators and metal smelters – has some ability to decouple energy use from typical production or service schedules. Sophisticated tools for forecasting also provide an advantage: companies that can forecast energy use and production can invest in technologies for load shifting or storage that help maximise profits and/or emissions reduction. Hourly matched goals would require changes in regulatory frameworks (discussed in the third chapter).

Intermediate approaches

Many options exist in between annual and hourly electricity matching. Simply accounting on intermediate time periods (e.g. daily, weekly or monthly) is one possibility. Another is applying the more granular hourly approach but with some tolerance for deviating from perfect balancing in every hour. Deciding on the right level of tolerance is complex: companies should ensure that meeting the goal does require flexible generation and should be guided by an explicit evaluation of emissions impact (discussed in the next section).

Google's 24/7 CFE approach provides an example of this: its methodology calculates a "CFE score" out of 100 based on the amount of clean generation consumed in every hour. A score of 100 corresponds with 100% clean consumption. The CFE score in each hour depends on the share of corporate demand matched by the company's own clean generation. In hours when the company produces less than its own demand, or effectively "imports" from the grid, the score is adjusted based on the share of clean electricity in the grid mix in that hour. For example, if, in a certain hour, the company produces 80% of its own energy from clean sources, the base score would be 80. The score for the remaining 20% of demand would be assessed based on the grid mix in that hour. If the grid mix is 50% clean, this implies another 10% of clean electricity and would give the company a score of 90 for that hour. The annual score is then the load-weighted average of all hourly scores.

Under this methodology, the score in any hour cannot exceed 100. As a result, to raise the annual score it is necessary to reduce the volume of grid "imports" (or increase the share of clean electricity on the main grid) in hours where local clean energy is not available, rather than increase excess generation in hours when generation already matches consumption. Targeting a score below 100, such as CFE 90, would still require the company to exercise a higher degree of control over the timing of its generation and/or demand, but without needing to fully independently match its own profile. This type of approach may have some advantages, but the outcome will be highly sensitive to the score targeted. This topic is explored in the chapter on net zero transitions.

Emissions-based approaches

The strategies discussed so far do not explicitly target emissions reduction as the first priority and, depending on how precise matching is in time and place, potential remains for discrepancies in emissions caused and reduced. In principle, targeting emissions reduction directly can allow for more cost-effective solutions to reduce emissions. Yet a number of complexities arise when the focus is on emissions reduction in isolation.

A first challenge is to account accurately for the volume of electricity emissions a company is responsible for and reducing. Second, in the case that there is no direct physical link with consumption, it is difficult to show that real emissions reductions are being achieved (discussed in the following chapter). Finally, there is an element of financial complexity: if procurement takes place in different markets from the company's electricity demand, price hedging is not directly achieved.

Despite these complexities, since emissions reduction is a central objective of corporate net zero strategies, quantifying emissions impacts and being guided by this information is a way for companies to improve their decision making and ensure that they achieve the underlying aims of their clean electricity procurement goals. Emissions-based approaches could be followed directly or could also be pursued as a complement to the other types of clean electricity goals described above.

Noting that projects in different locations and in different systems can result in different emissions impacts, various organisations are working together to better measure the real-world impact of different interventions on emissions reduction. An interesting example of such joint effort is WattTime, which has developed a methodology to estimate the marginal impact of different renewables projects. They are working with other actors to develop a standardised framework that better incorporates global emissions reduction into current emissions accounting frameworks.

Procurement approaches

Companies can undertake procurement of clean electricity through diverse approaches that differ in terms of ease of access, timing (both length of commitment and granularity of the clean electricity provided), and whether a direct connection exists with the physical flow of electricity. While this range of options can make it easier for corporates to find a clean electricity procurement option that fits their needs, they do not all have the same level of "additionality" – i.e. it is not always clear to what extent they result in increased clean electricity. Also, some options are not easy for smaller companies to access or implement. Availability of the options also differs by region and the regulatory environment (discussed in the following chapter). Policy makers should ensure that regulatory and legal frameworks incentivise and make clean electricity procurement accessible to the largest array of consumers possible, and that corporates have the opportunity to take action that actually adds to existing government commitments.

Options for corporate procurement

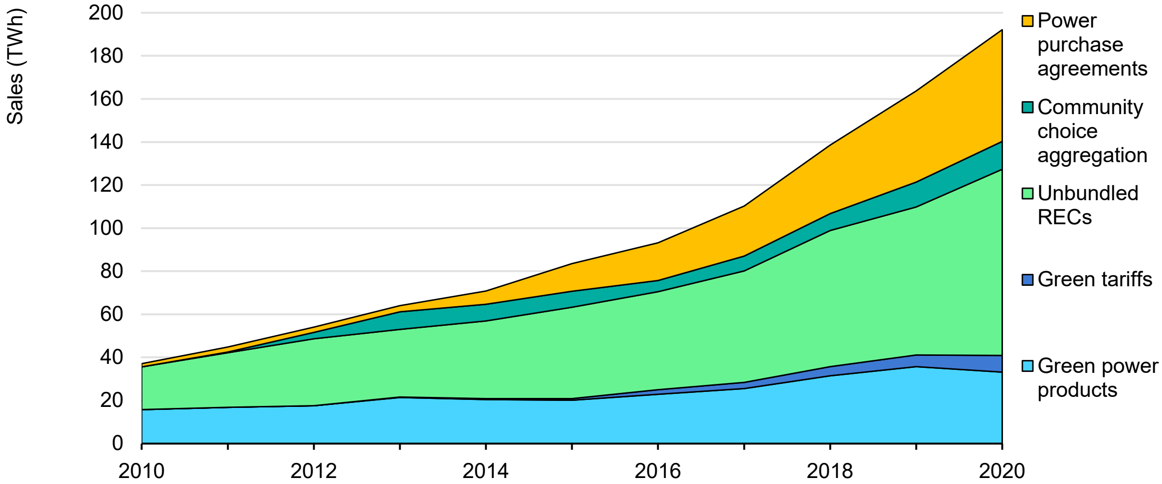
The options to procure clean electricity vary in terms of location and the stakeholders involved. The locational aspect reflects whether electricity is generated on- or off-site and within or external to the grid in which the consumer operates. Broadly, these options can be classified into four main types:

- On-site options, or "behind-the-meter" (BTM) assets are installed in the same location as the corporate load.
- Energy attribute certificates (EACs), or the emerging, more granular, time-dependent energy attribute certificates (T-EACs), allow corporates to buy certificates (not electricity) that correspond to the amount of electricity they consume over a specific period (usually yearly for EACs but hourly for T-EACs). Examples of EACs include Renewable Energy Certificates (RECs) in the United States and Guarantees of Origin (GOs) in European markets.
- Power purchase agreements (PPAs) are long-term contracts signed between a consumer and an electricity producer. They provide the supplier with secure revenue that can support build-out or extend operation of a plant. Different types of PPAs exist, with the two main categories being physical and financial (also called virtual).
- Green tariffs and green power products are contracts under which the corporate procures clean electricity through a utility or a clean electricity supplier.

Uptake of clean electricity procurement options is evolving with time and corporate objectives, and levels of engagement and preferred options vary from region to region. In the United States, for example, RECs retain the highest share of total clean electricity sales (45% in 2020) but the share of PPAs increased from 4% in

2010 to 27% in 2020. Greater efforts, on the part of corporates, to clearly demonstrate that procurement strategies contribute to new renewable electricity capacity is one of the reasons for this increase.

Clean electricity sales by type in the United States, 2010-2020



Notes: Community choice aggregation is a type of procurement in which small electricity consumers aggregate their demand to procure their electricity from a local government supplier with a green power product. REC = Renewable Energy Certificate.
Source: IEA based on data from NREL (2020), US Voluntary Green Power Market 2020

Many parameters influence the choice for one or another option, such as the size of the corporate, ease (or difficulty) of accounting, geographical availability, and availability of land (for BTM options). The corporate's engagement towards proving actual decarbonisation impact also comes into play. These parameters are summarised in the table below and described more fully in the following sections.

Benefits and limitations of corporate procurement options

Clean electricity procurement option	Benefits	Limitations
On-site or behind-the-meter (BTM)	• High visibility for the end-consumer as installed on-site • Clear additionality claims • No added transmission and distribution, and grid costs associated with procurement • Reduces volume of needed electricity purchases	• Up-front investment costs (if installed by the corporate) • Scale limitation (may not cover total electricity demand, particularly for solar PV and wind) • Requires careful allocation of system costs
Energy attribute certificates (EACs)	• Easy to implement, especially when unbundled • No long-term commitment	• Unclear additionality • No direct visibility (information added in T-EACs can improve this) • May not cover all clean dispatchable technologies

Clean electricity procurement option	Benefits	Limitations
Time-dependent energy attribute certificates (T-EACs)	• Stronger reflection of time-value of generation • Can be used to verify 24/7 matching • Higher granularity increases transparency	• Volume of data to store • Standardisation needs • Ensuring EAC and T-EAC complementarity
Power purchase agreements (PPAs)	• Electricity price certainty • More control over additionality claims • Supports long-term planning for buyer and seller	• May require long-term commitment • Creditworthiness needed (difficult for smaller corporations) • Accounting challenges (esp. for financial PPAs)
Green tariffs and green power products	• Easy to implement (utility contract) • Accessible to all sizes of corporates (burden shifted away from consumers) • No long-term commitment	• No control on price in the long term • No direct visibility • Unclear additionality • Design-dependent (accounting issues)

Note: T&D = transmission and distribution.

Sources: IEA analysis based on Douglas, B. et.al. (2020), Introduction to Corporate Sourcing of Renewable Electricity in Europe; ENTSO-E (2022), Views on a Future-Proof Market Design for Guarantees of Origin; Espinoza, T. (2022), Four key accounting questions when considering a renewable energy PPA in Europe, *3Degrees (22 December)*; European Commission (2019); John, J. (2022), Can 24/7 carbon-free energy become a global standard?, Canary Media (31 March); Texier, M. (2021), A timely new approach to certifying clean energy; Serrurier, B. (2020), Introduction to Renewable Energy Certificates (RECs); Wills, T. (2020), Corporate Procurement of Renewable Energy: Implications and Considerations.

On-site generation reduces grid electricity consumption with clear additionality

Electricity generation on site is also referred to as “behind-the-meter” (BTM). This option requires sufficient resources (e.g. solar irradiance, wind speed or biomass) and space at the corporate’s facilities. Utility requirements such as the hosting capability must also be met. The installation can be owned by the corporate or leased, in which case the corporate rents its land to a clean electricity developer through a leasing agreement or an on-site PPA.

BTM installations offer the benefit of high visibility: clean generation installed on-site is a tangible asset that customers visiting the premises can see directly. In addition, on-site generation directly lowers consumption of electricity from the grid, thereby reducing associated power bills. It does, however, require up-front investment costs on the part of the corporate. A recent survey highlights scale limitations – of 740 companies producing on-site electricity nearly 400 (54%) reported producing less than 1% of their demand on site.

Policy makers need to design billing arrangements carefully to account for the impact of BTM installations on the power system. Electricity injected into the grid when the availability of low-carbon electricity is high may have a different value than electricity consumed from the grid during times of high demand but low availability of clean electricity. For options, such as net-metering schemes, that allow electricity consumed in one period to be offset with electricity injected in other hours, policy makers should ensure system costs are accounted for and allocated clearly. This is illustrated in the chapter on net zero transitions.

Energy attribute certificates represent a major share of global clean electricity procurement

Buying EACs is the most widely adopted form of procurement. These certificates are created for each unit of renewable electricity generated (usually a megawatt hour [MWh]) and contain information on the time of production (usually at monthly or yearly granularity) and the generator (location and technology, as well as age). Once created, EACs are traded on one of several markets that exist around the world, the main ones being the North American Renewable Energy Certificate (REC) market, the European Guarantees of Origin (GO) market, the Chinese Green Electricity Certificates (GEC) and the International REC Standard (I-REC).

EACs can be purchased together with the electricity from the clean generator, e.g. packaged with a PPA, in which case they are called “bundled”. Alternatively, they can be purchased separately, referred to as “unbundled” certificates. Buying unbundled EACs is an accessible option to meet clean electricity targets as they allow the buyer to claim the environmental benefits of a given amount of clean electricity without engaging in a PPA. For example, the popular RE100 initiative considers unbundled renewable EACs sufficient to meet a 100% renewables goal, although the company does not directly purchase the electricity from the renewable power plants. Once an EAC has been claimed, it needs to be retired to ensure it is only used once.

Unbundled EACs do face a major challenge, however, in terms of their actual contribution towards decarbonisation, which, depending on allocation rules, can be unclear – this is discussed in the section on impact of different procurement options. Another issue arises when EACs do not account for grid losses – for example, the EU Concerted Action on the Renewable Energy Sources Directive proposes to solve this issue in the European Union by cancelling an amount of EACs equivalent to the incurred losses.

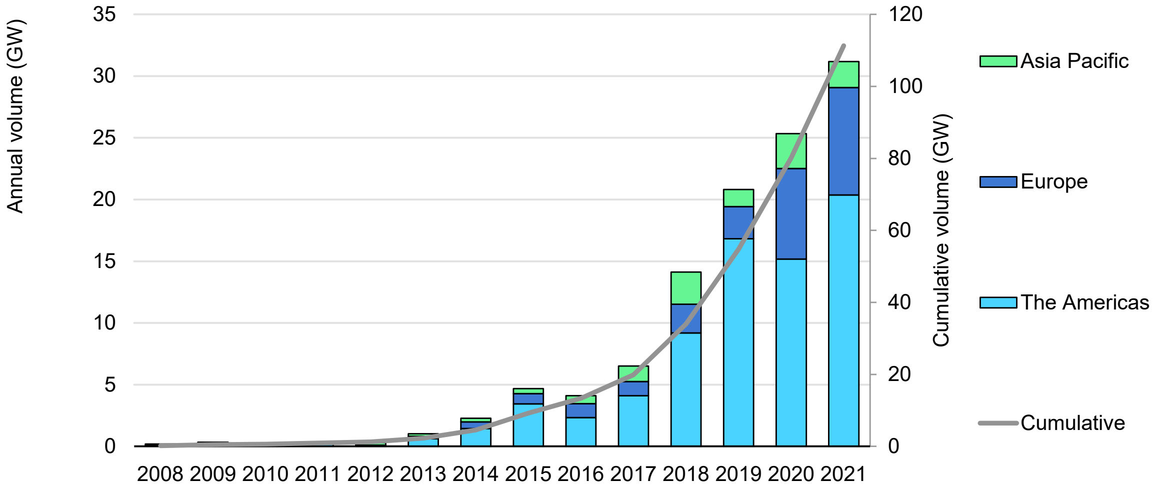
The use of EACs for hourly matching strategies would require finer time granularity than that available in existing schemes. With a growing number of corporates and initiatives considering hourly matching goals, interest is also increasing regarding time-dependent energy attribute certificates (T-EACs), with a granularity closer to real time (hourly or on 15-minute basis as suggested in a recent paper by ENTSO-E). The advantages of increasing EAC granularity include better accounting for the variability of renewable electricity generation, greater transparency, and a better reflection of the market value of consumption and production of electricity in specific time periods. Granular certificates are also a strong facilitator for tracking electricity used to produce clean hydrogen, a subsector in which the origin of electricity will be crucially important.

Challenges remain on the logistical side, however, as higher granularity entails a much larger number of certificates and data to be stored, validated and checked. Consistency and uniqueness of the data would also have to be ensured through standardisation, and how T-EACs and EACs can co-exist needs to be verified, including ways to ensure that T-EAC purchases actually support increased clean flexible generation. The availability of granular generation and consumption data is crucial for deployment of T-EACs and 24/7 procurement strategies. Hence, a first step towards developing such solutions is for policy makers to ensure easy access to transparent and granular data on electricity generation mixes. To enable consumers to track their own consumption, policy makers should facilitate the use of digital technologies while protecting data privacy.

Corporate power purchase agreements are on the rise

Procurement through PPAs, in which a corporate signs a contract directly with a power producer, is growing quickly worldwide. Different types of PPAs exist, with the two main categories being physical and financial (or virtual).

Global corporate power purchase agreements volumes by region, 2008-2021

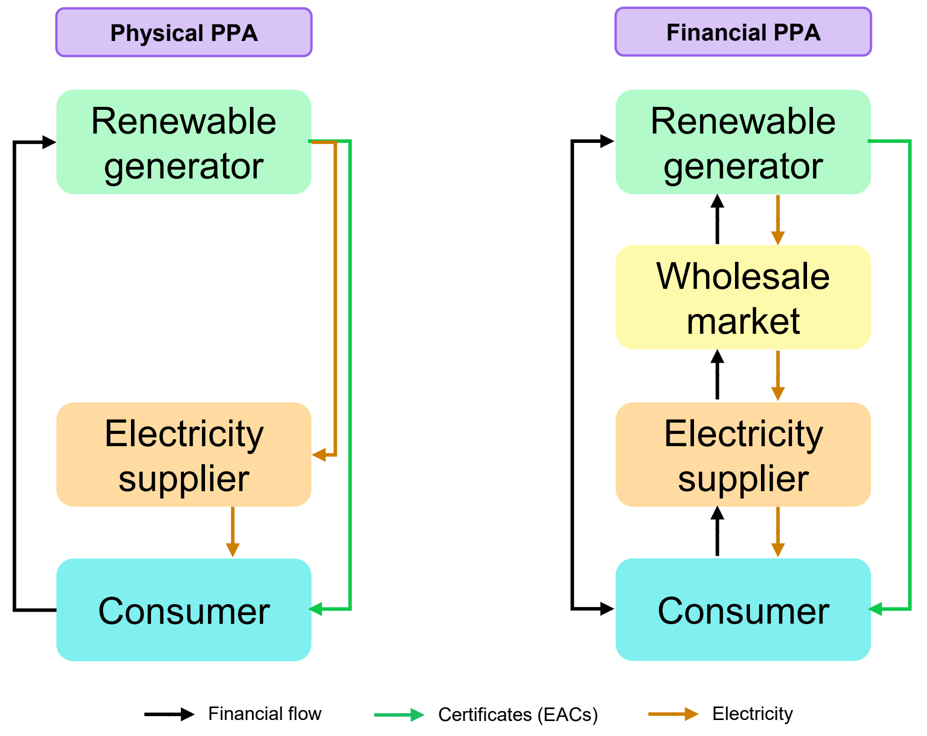


Note: On-site PPAs excluded.
Source: Bloomberg New Energy Finance (2022).

Under a physical PPA, the consumer buys electricity directly from the producer, typically together with any corresponding EACs. As such, a physical PPA requires the contractual parties to be in the same grid and bidding area. One aspect to consider in physical PPAs is that, because the corporate is procuring electricity directly, they will have to communicate their production and consumption to the system operator. This task may add complexity and is often outsourced to third parties. From a system perspective, it is important to note that physical PPAs can add inflexibilities to the grid. One example is when the terms of the contract hinder system-friendly behaviour, e.g. by prohibiting the use of voluntary curtailment.

Financial or virtual PPAs do not require a physical connection between the generator and the consumer. A key advantage is that the contracting parties can be located and/or operating on different grids and even in different countries (called a cross-border PPA). Compared to financial PPAs in the same electricity market, cross-border PPAs bring additional financial risks, particularly in relation to possible differences in pricing between the markets in the different regions. The pricing structure of a virtual PPA is a contract for difference, in which a price is agreed contractually. When the wholesale market price is higher, the generator will reimburse the consumer; when the market price is lower, the consumer will reimburse the generator.

Physical and financial power purchase agreements flows



Notes: PPA = Power Purchase Agreement, EAC = Energy Attribute Certificate.
Sources: IEA based on Douglas, B. et.al. (2020), Introduction to Corporate Sourcing of Renewable Electricity in Europe and KYOS Energy Consulting (2022), What is the difference between a virtual and physical PPA?.

PPAs offer several advantages to each party. For the corporate, engaging in a PPA can reduce the amount of electricity purchased at market prices, allowing for long-term price certainty. In the case of a newly-built plant, it also clearly demonstrates the positive impact of the procurement. For renewable developers, PPAs bring the revenue certainty needed to secure investment in the plant. However, as will be discussed in more detail below, establishing PPAs can be challenging due to a lack of knowledge of financial products in corporations as well as added layers of complexity coming from legislations and regulatory frameworks. Depending on the context and market structure, PPAs can be a more complicated procurement option. While PPAs can technically be contracted for different time scales, many PPA contracts for new plants require the corporate consumer to enter into a long-term contract, which is often not possible for smaller businesses. This can potentially be addressed by companies forming consortia to purchase together, discussed at the end of this chapter.

Green tariffs and green power products can be the simplest option where available

Another option by which corporates can procure clean electricity is through offers from retailers and local utilities, who in turn contract PPAs with clean electricity generators or procure EACs. Under this structure, two main possibilities exist for corporates: green power products or green pricing programmes and green tariffs.

In the first option, green power products or green pricing programmes, corporates contract with a retailer or a utility, paying a cost premium to receive unbundled EACs. This implies that the electricity received does not originate from a designated project. A key advantage of such products is that they require only a short-term commitment and offer greater flexibility, making them more accessible for all sizes and types of consumers. The adoption of such programmes has been very successful in many economies in Europe. In other countries, such as India, the added premium acted as a barrier and many consumers preferred to invest in options such as BTM renewables. Since they are based on unbundled EACs, green power products face similar challenges in relation to their contribution to decarbonisation (discussed in the next section).

The second option, procuring electricity through green tariffs, allows the consumer to purchase both the electricity and the EACs from a specific project, via a contract signed with a local utility. This contract can be specific to one company, i.e. negotiated between the corporation and the utility or supplier, or a generic offering established by the utility which its customers can select. In both cases, the supplier matches clean electricity purchases with the electricity consumption of the corporate, which also receives the bundled EACs. This is usually at monthly or annual time granularity but, with increased interest from corporates, it could evolve towards hourly matching schemes.

Green tariffs are typically established via three main models: the subscriber model, the sleeved PPA and the market-based rate model. All involve the corporate contracting with the utility, but they vary in terms of utility's role and their availability to different consumers. Depending on the model, such a tariff can be more or less accessible to smaller corporates. In the United States, for example, the Clean Energy Buyers Association observed that the subscriber model is usually available for smaller corporates that aggregate with others to have at least 1 MW. In contrast, a sleeved PPA model usually requires a minimum load of 1 to 10 MW and a market-based rate model is reserved for corporates with peak demand of minimum 5 MW.

Impact of different procurement options

Not every option delivers the same added value to increase clean electricity generation

As noted above, decarbonisation requires joint effort. From a policy planning perspective, it is important to ensure that corporate clean electricity procurement provides a real contribution to increasing clean generation. From a corporate's perspective, being able to show that their procurement action has contributed directly towards power system decarbonisation is a clear visibility advantage.

Central to both perspectives is the concept of "additionality" – i.e. that efforts are truly "adding" to the production of clean electricity. The underlying principle is a question of causation – i.e. determining whether the procurement activity leads to more clean electricity in the power system, either by adding new capacity or extending the lifetime or operations of existing plants – and, consequently, a real reduction in emissions.

Given the relevance of this question to whether corporate activity contributes meaningfully to enable energy transitions and help mitigate climate change, policy makers, regulators and corporates seeking to act responsibly should all apply some basic principles of additionality. Being able to effectively track the origin of renewable electricity will, moreover, be of growing importance in the context of increased electrification of end-uses and use of electricity to produce renewable fuels of non-biological origin, such as hydrogen.

Assessing additionality in the context of corporate procurement is complicated by the fact that there is no single, agreed definition. Since corporate clean electricity goals are voluntary, the extent to which a company pursues additionality, and the definition applied, is often a matter of individual preference. This is also reflected in initiatives such as RE100, which does not impose any strict additionality requirement on its members, although it does provide some guidance on making credible claims.

A similar issue is seen in the domain of carbon credits, which commonly applies two main concepts to identify whether credits deliver real carbon reductions: regulatory and financial additionality. By this definition, to be able to claim the additionality of a carbon credits project, entities need to show that the project is not already mandated by law and that it would not have existed without carbon credits providing the price signal. A nascent definition under the Paris Agreement is adding the relation to nationally determined contributions (NDCs) as another component of additionality, such that project proponents would need to justify that their project is not part of NDC-related country efforts.

Similar aspects can be considered for electricity procurement. First, whether corporate procurement adds to existing government targets and the schemes to achieve them. Second**,** whether the procurement provides financing for deployment that otherwise would not be cost-effective or for which investment would not take place.

For the efficacy of corporate procurement and the validity of corporate green claims, the relationship with other government targets is critical. As such, policy makers need to ensure that overall clean electricity deployment targets include provisions that allow all consumers with high climate ambitions to go beyond stated targets – in terms of both quantity and timing of the deployment – without reducing the obligations of other participants. In the absence of such provisions, the efficacy of clean procurement choices is undermined. An example of this is seen in in the United Kingdom. At present, the majority of the renewable electricity generated is covered by government schemes and green pricing schemes simply re-allocate this generation to consumers who opt in. An analysis by Ofgem showed that only three of several hundred green offerings actually contributed to adding renewable generation to the system.

Such a situation can be avoided by designing government obligation-based schemes to ensure that all consumers must receive a minimum allocation. In this case, entities or tariff offers seeking to claim "100%" renewables would need to procure additional clean electricity since the mandated minimum has to be allocated to other consumers. In regions where decarbonisation objectives are mandated directly through carbon reductions, without electricity-specific obligations, addressing this issue requires either ensuring that electricity emissions reductions are tracked directly through carbon credits or introducing electricity-specific mandates.

Related to this, policy planning should seek to better define and assess the ways in which renewable electricity targets set by the government interact with clean electricity procurement by corporates. Where levels of ambition differ, the attribution of renewable deployment to government targets or corporate goals needs to be transparent and should not be misleading to a general audience. The entirety of a corporate “100% renewable” pledge, for example, should not be counted towards a government target of “20% renewables” for the entire electricity system. At the same time, policy makers should consider policy support mechanisms that foster higher levels of ambition in corporate procurement. Again, this simply needs to be transparently separated from broader decarbonisation obligations or targets.

Situations in which procurement takes place across borders are another point to consider in terms of additionality with respect to targets at different levels. Policy makers need to build mechanisms into renewables deployment tracking to ensure that clean electricity is not being claimed twice and in relation to two separate targets: e.g. towards government targets in one country and, in another country, towards voluntary goals that go beyond mandatory targets. An approach could be applied similar to the corresponding adjustment introduced under the Paris Agreement to ensure carbon credits are not applied to two different national targets.

Financial additionality, or the question of whether procurement is providing financing to a project that would otherwise not occur, is a complex topic in the context of corporate procurement – and the most difficult to prove. In a strict sense, financial additionality may not be necessary. For systems in which renewable electricity is actually the lowest-cost option, this does not imply that corporate procurement should not count towards deployment targets, rather that the pace and level of ambition of these targets should be increased. However, some important principles should be applied in such situations.

Fair attribution of system costs is a key consideration. In some cases, corporates may be able to lower their electricity costs through renewables procurement only as a result of tariff arrangements or wheeling agreements that pass integration costs and the cost of other system services to other consumers. This is particularly relevant for BTM generation or PPAs under wheeling agreements. Country examples for this are given in the next chapter and this issue is illustrated quantitatively in the net zero transitions chapter.

Here, the essential point is for regulators to ensure fair distribution of system costs. There is no problem if renewables procurement is genuinely the cheapest option, but regulators need to ensure it does not result from unfair distribution of system charges. Conversely, intentionally subsidising system charges as a support mechanism for renewables is an acceptable practice, but policy makers should ensure such subsidies are explicitly defined. In this case, corporates should transparently acknowledge the role of such support in their procurement activities. As per the first point, if such procurement is used to claim meeting goals above the level of government ambition, it needs to be explicitly separated from main government targets in accounting.

The question of financial additionality is commonly raised in relation to EACs, as in practice today they may provide a negligible part of project financing for new plants. They may also be attached to existing projects: in France, for example, most unbundled EACs are linked to hydropower plants – i.e. old assets that are entirely financed already and would thus operate regardless of the procurement of their EACs.

At the same time, it can be argued that EACs for existing plants also play a useful role. They may, for example, provide renewable electricity suppliers with an additional revenue stream that could (depending on the pricing level of EACs) provide some support to installations for which subsidies have run out. In principle, if the EAC market brings reliable value to existing plants, this expected revenue stream could also help secure financing for new plants. EACs are also an important mechanism in that they may be the only option for some smaller buyers that do not have access to green tariffs and lack the profile to enter into a long-term PPA.

Concerns about financial additionality for EACs should be addressed based on the same principles discussed above for clear allocation of clean generation to targets. If well designed, EACs and T-EACs can provide a useful mechanism to minimise the costs of decarbonisation and track clean electricity. Provided policy makers ensure that EACs allocated to government targets need to be retired, then additional EACs will be needed to meet more ambitious voluntary goals.

In the future, unbundled EACs will be an essential tool to track the origin of electricity used to produce hydrogen. With this in mind, rules defining the conditions under which hydrogen can qualify as renewable – especially with respect to additionality and time and locational constraints – are central to current debates on the European Renewable Energy Directive.

Facilitating the trade of granular certificates (such as T-EACs) while ensuring transparency of the location and time of generation can increase the economic efficiency of procuring 24/7 clean electricity for corporates. The interaction of T-EACs with existing EAC schemes does require careful design, however. Indeed, if T-EACs are based on the same pool of certificates as EACs but with additional time-based data attached, there is a risk that purchasers can fulfil hourly goals by reallocating existing EACs without requiring new flexible generation. Preventing double counting is also a critical aspect for EACs (discussed in the next section).

Addressing the risk of double counting

A distinct but related point to ensure that government and corporate actions effectively lead to decarbonisation is to verify that a given unit of clean generation is only counted once within tracking methods such as EAC schemes and carbon credits, i.e. is not double-counted. Double counting can arise from certificates being issued twice (double issuance) or two entities making claims on the same action (double claiming), when the retirement of certificates is faulty, for example.

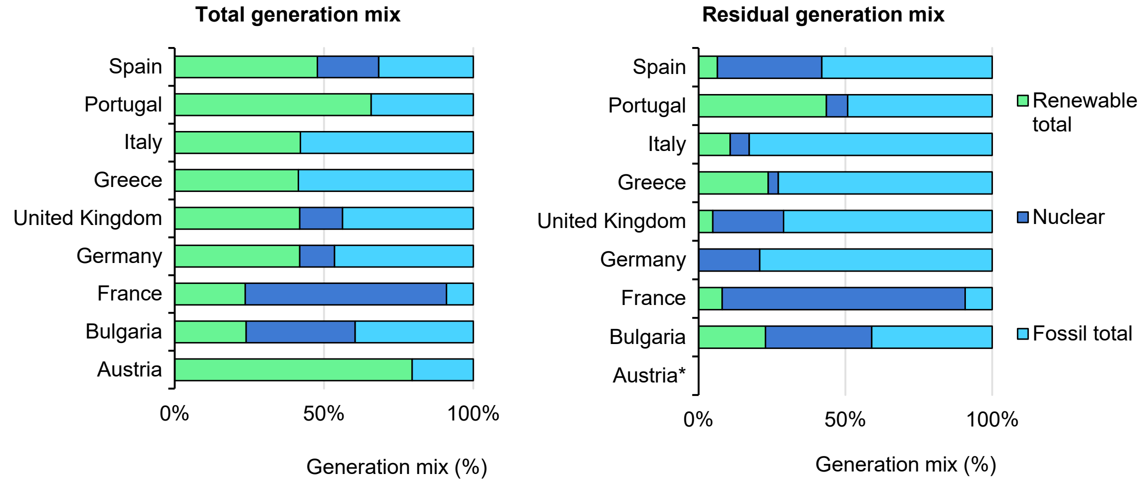
As per the RE100 technical criteria, "a credible renewable electricity usage claim [should be associated with the] ownership of all environmental attributes associated with the generation". Current practice in the People's Republic of China (hereafter "China") allows renewable electricity generators to issue both EACs and carbon credits. This is a form of double issuance, which enables selling the decarbonising impact attributed to such generation to two different buyers. Double counting can also occur when a PPA is contracted without bundling the EACs, if the EACs are bought by a different party and entities make green claims on the basis of both the PPA and the EACs.

In addition, when assessing the electricity generation mix of a country, a region or a utility, it is essential to be able distinguish the generation mix of the grid and the residual mix – i.e. the generation mix that excludes the share of the electricity claimed through tracking systems. This ensures separation of the part of the clean electricity generation that is claimed through unbundled EACs, whether for mandatory or voluntary procurement. Indeed, in power systems in which not all generation is tracked via EACs, the residual mix provides transparency to power consumers as to the origin of sold electricity.

For example, in the European Union, the residual mix of countries is calculated and published at national level by the Association of Issuing Bodies[5] (AIB). An exception is Austria, which implemented "full disclosure", meaning that GOs are issued for all electricity generated and, hence, all electricity delivered to final customers is declared via GOs. In the United States, two bodies provide information on the residual mix and associated CO_2 emissions, Green-e and the Edison Electric Institute. At present, this information is not available for all countries worldwide, which makes it more difficult for corporates to understand the fuel mix of their consumption. In general, where data are available it is only on an annual basis, which prevents corporates from being able to carry out a more granular assessment when wanting to procure 24/7 clean electricity.

[5] More information on the calculation method of the Residual Mix can be found at the Association of Issuing Bodies.

Generation and residual mix in selected European Union countries, 2021



* Austria has implemented "full disclosure", meaning that GOs are issued for all generation (fossil, renewable and nuclear); hence, as their tracked mix is 100%, their residual mix is zero.

Note: The residual mix of a European country shows the sources of the electricity supply that is not covered by Guarantees of Origin (nor with other Reliable Tracking Mechanisms) and excludes the share of the electricity claimed through such tracking systems. It also accounts for exports and imports of GOs and attributes claimed through any other Reliable Tracking Mechanism.

Sources: IEA analysis based on data from IEA monthly electricity statistics and AIB

Establishing a standardised methodology to compute – at a granular level – the residual mix and ensuring such information is available and accessible is important to ensure actors have a clear view of the environmental impacts of their consumption. Existing gaps in data availability, particularly the low availability of information on the residual generation mix at the hourly level, are problematic, especially for corporates aiming to apply 24/7 approaches.

To prevent double counting, strong governance of EAC markets should account for the uniqueness of EACs (in terms of geographical boundaries and other attributes) and set clear rules regarding the cancellation of certificates. In the United States, for example, the Federal Trade Commission issued guidance on the legal consequences of fraudulent claims and highlighted in its Green Guides that power linked to unbundled EACs could no longer be marketed as renewable. In turn, as the availability of transparent and detailed data will minimise double counting and claiming possibilities, reporting requirements should be strengthened. The EU RED III, for example, has strengthened reporting requirements of PPAs. EU member states now have to report the expected share of the national renewable power that will be procured through corporate PPAs, while ensuring that PPA buyers receive the relevant EACs.

Policy makers should create frameworks that support additionality

To maximise the impact of corporate procurement while ensuring corporate goals are compatible with policy planning, expected procurement by corporates should be accounted for in planning. Policy makers should actively facilitate corporate procurement initiatives that deliver added value to decarbonisation efforts. This requires that governments establish clear frameworks that allow corporates to make credible claims for their investments into renewable capacity while ensuring corporates do not receive credits for projects they did not initiate (e.g. projects originating from government auctions).

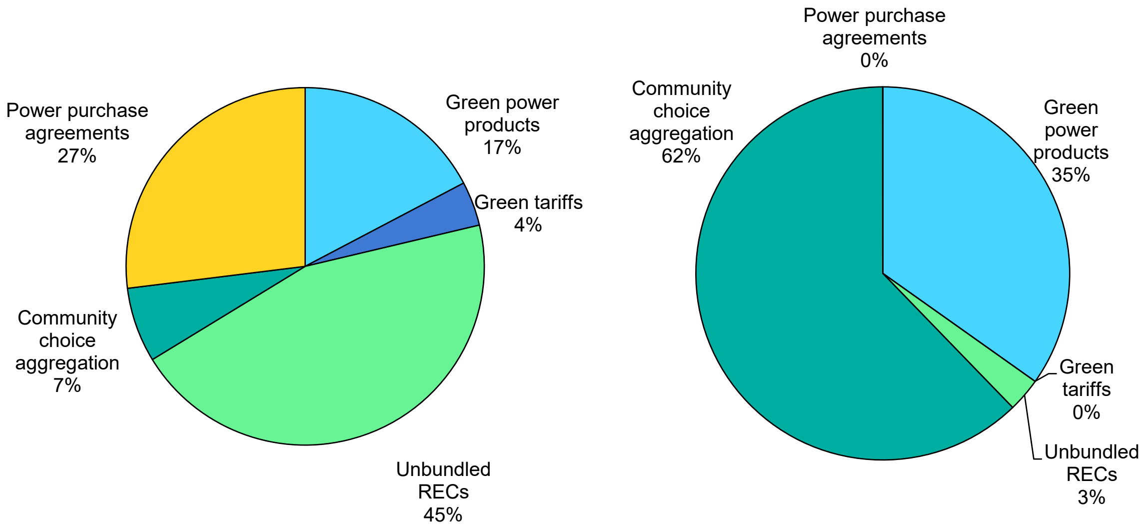
In certain policies, to ensure the corporate-driven deployment of renewables extends beyond legal obligations, it can be advantageous to integrate the concept of "regulatory surplus". This refers to "the renewable electricity that is not used to meet governmental targets, laws or legal mandates". Regulations put in place by various states under the Renewable Electricity Standard in the United States provide a relevant example. Electricity suppliers have a legal obligation to produce a certain share of their electricity from renewables; the regulatory structure ensures that EACs the utilities use to fulfil their obligations cannot also be used to meet corporate goals.

Procurement for smaller companies

Enabling companies of all sizes to access clean electricity procurement options maximises the benefits of corporate procurement. In practice, despite the existence of several procurement options, not all are equally feasible for corporates of different sizes. Smaller companies can struggle with options, such as PPAs, that may be contractually complex and need high bankability.

Analysis of voluntary clean electricity procurement in the United States shows that while unbundled EACs and PPAs represent 72% of the total clean electricity sales in 2020, they represent only 3% of the total number of consumers procuring clean electricity. In fact, unbundled EAC purchases are mostly made by commercial and industrial consumers buying large volumes. In contrast, other options, such as community choice aggregation, are mostly carried out by residential consumers.

Clean electricity sales in the United States, share of volume (left) and share of number of consumers (right), 2020



Note: Community choice aggregation is a type of procurement in which small electricity consumers aggregate their demand to procure their electricity from a local government supplier with a green power product
Source: IEA based on data from NREL (2020), US Voluntary Green Power Market 2020

Despite having lower electricity consumption individually, in aggregate, smaller companies represent a large part of total electricity consumption. In Europe, for example, the energy consumption of small and medium enterprises represents 9 to 18% of gross inland consumption across European countries. As these enterprises often supply other companies, their actions can impact the Scope 3 emissions of the larger corporates, ultimately having a significant impact on the global supply chain.

Multiple barriers constrain participation of smaller corporates in clean energy procurement. On top of challenges linked to creditworthiness and high up-front investment needs, lack of capacity to deal with the complexity of frameworks and negotiations leading to PPAs can act as a soft barrier. Some companies lack understanding of energy markets, which is challenging when corporate procurement options rely on wholesale market prices. Larger corporates can also face these challenges, for example when seeking to meet procurement goals in countries in which they operate at smaller scales.

Boosting the access of smaller corporates to procurement options should be a priority. Policy intervention and regulation are central but other companies can also facilitate. Larger corporates can help by sharing their experience with new procurement models, such as the Carbon-Free Energy Manager for companies pursuing 24/7 procurement goals. Other corporates could pave the way by encouraging smaller entities to engage in aggregation to procure either directly or through a platform or energy trader.

When larger corporates engage in a contractual scheme or negotiate a green tariff with a utility, they can include smaller corporates (through aggregation contracts, as explained below). They can also share such experiences with other companies or the utility may also be able to replicate the same kind of tariff structure for other corporates. Such approaches are especially relevant in contexts where electricity markets are not present, there are no aggregators and traders, and legislation frameworks restrict procurement possibilities.

Aggregation is also a useful facilitator to procurement. Among existing models, some require that each corporate signs a PPA for a share of the developer's generation. In others, only one buyer has a PPA with the developer; this lead buyer then contracts back-to-back PPAs with other buyers. In some cases, a utility or a trading intermediary takes on the role of the lead buyer. The transaction can also be done via an aggregating platform. Some green tariff products also allow customers to aggregate to reach the minimum demand required. One example is the Green Direct Program, a green tariff that commercial and municipal customers can subscribe to as a means to invest into new, local assets. This allows corporates to procure clean electricity while clearly identifying the origin of their investment. Within this programme, the utility Puget Sound Electricity (PSE) contracts PPAs with newly-built renewable projects and establishes service agreements with its eligible customers.

The Dutch wind consortium is an example of large corporations aggregating; its first PPA was negotiated in 2016 for construction of a 102 MW wind power plant. The experience of these companies highlights the main advantages of such a model: economies of scale, cost saving and sharing, portfolio diversification, and replicability. Notably, it took three years for the consortium to negotiate the first PPA and the next one was completed in just a few months. Challenges identified include partner selection, transaction complexity, finding the correct governance structure and management. Each of the four participating companies was responsible for a specific aspect of the deal negotiation, according to their respective strengths and expertise.

Larger corporations can also aggregate with smaller ones to jointly sign procurement contracts. This would reduce accessibility hurdles for smaller corporates while spreading the risk among diverse parties, which is advantageous for suppliers. An inherent challenge, however, is that it can be difficult for smaller corporates to agree to similar price and offtake conditions as their larger partners. Provided the electricity market is liberalised and financial markets have been developed, one way to facilitate participation of different-sized corporates is through an energy aggregator or trader that negotiates several PPAs with clean electricity suppliers to match them to a portfolio of consumers. The Apple, Akamai, Etsy and Swiss Re aggregation (facilitated by 3Degrees) is an example of a consortium of buyers with different demand profiles aggregating to procure clean electricity. This process enabled the four corporates to sign side-by-side PPAs for very different sizes of procurement, ranging between 4.5 MW and 134 MW.

An emerging alternative, viewed by many experts as the best strategy to allow smaller corporates to access corporate PPAs, is aggregation of smaller consumers' electricity demand. Similar to the Dutch wind consortium model, smaller corporates can also create a consortium to contract a PPA. This approach was taken in the United Kingdom, between a renewable developer and 20 universities. In this case, the contract was facilitated by a supply platform specialised in enabling businesses to procure clean electricity, which arranged a standardised and simplified documentation of the agreement. According to that supply platform, such deals are possible starting with an electricity volume of 2 GWh. In India, by aggregating demand of several smaller corporates, a demonstration project of the World Resources Institute was able to achieve better terms and higher return on investment for procurement from newly-built rooftop solar PV than each corporate could have secured individually.

Countries in which clean electricity procurement options are available for all sizes of corporates will be very attractive to corporates that have decarbonisation goals – and to their suppliers. Policy makers should ensure that required contractual efforts are minimised – for example, through standardised procedures and contracts, and by analysing how to mitigate financial risk for SMEs. To make clean electricity procurement more accessible for smaller corporates, policy makers can take actions across three key areas:

- Establish a portfolio of diverse clean electricity procurement options that allows corporates to start with an accessible option that suits their needs and move up in terms of risk and complexity as they gain experience.
- Monitor and enable new solutions, such as new types of green tariffs, that address the need to better demonstrate additionality.
- Where electricity markets are in place, support development of financial markets to allow for energy trading. This will enable aggregators and traders to support the clean electricity procurement targets of corporates.

Impact of electricity industry structure and regulatory frameworks on procurement options

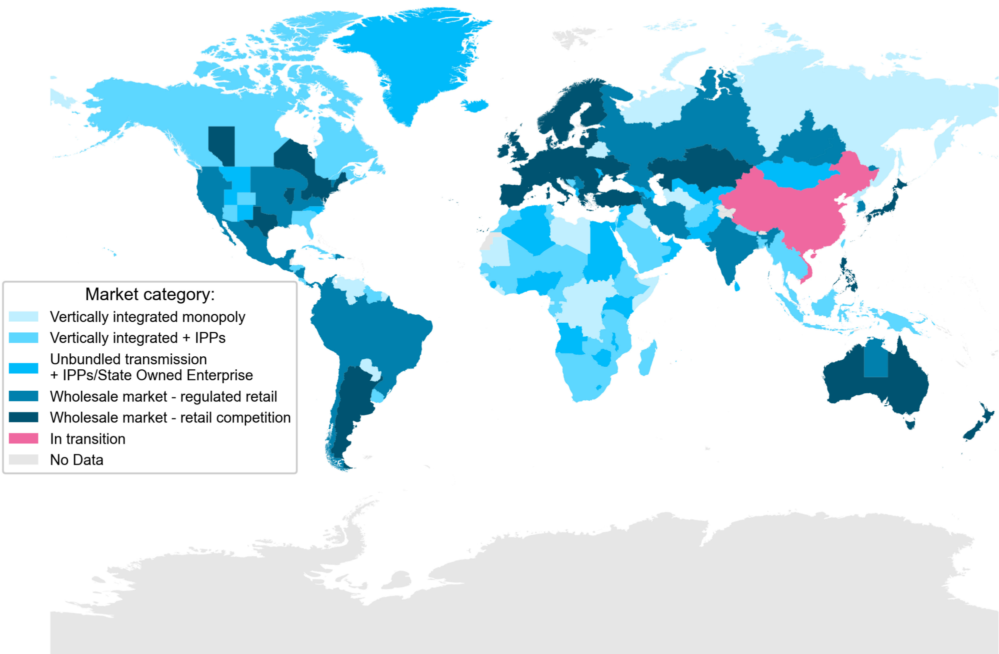
Regional variations in procurement options

Available procurement options depend on the regulatory environment

To a large degree, electricity market structures define the possibilities for procurement of clean electricity. Across the world, power systems differ in their degree of liberalisation and vertical integration. Fully integrated utilities encompass generation, transmission, distribution and supply to end-consumers and can be either investor- or state-owned. Fully liberalised power sectors allow private actors to participate in generation and electricity retail and let consumers choose their electricity suppliers.

Currently, around 50% of electricity in the world is generated in systems that rely on competitive power markets. This could increase to around 76% of global supply as power markets in China implement diverse models of competition.

Status of electricity markets around the world in 2022



Source: IEA (2022), Steering Electricity Markets towards a Rapid Decarbonisation

The diverse electricity industry structures around the world give rise to a number of barriers to direct procurement of clean electricity. These barriers differ in terms of their legal nature and the actors that need to address them, but they can broadly be categorised as follows:

- Constitutional or legal barriers to the participation of private actors in electricity generation. This can relate to constitutional rules that define electricity supply as the sole responsibility of the state or legal requirements that reserve the ownership of critical supply infrastructure solely to national stakeholders.
- Generation-side regulatory barriers that restrict who can produce electricity and to whom they can sell it (e.g. in a single-buyer model).
- Consumer-side regulatory barriers that determine the breakdown of regulated consumers as compared with liberalised consumers who can choose their supplier.
- Business model barriers due to lack of appropriate contractual arrangements or lack of experience in the local utilities.
- Commercial barriers related to the way network, energy and balancing charges encourage or discourage individual organisations or actors from procuring their own electricity.
- Infrastructure-based barriers due to lack of metering, monitoring and baseline practices needed to enable more ambitious corporate procurement options (such as 24/7 CFE).

These barriers affect the different procurement strategies outlined in the previous chapter to varying degrees. Generally, green tariffs are technically possible despite most barriers; in contrast, PPAs between generators and consumers require the greatest degree of market liberalisation. This chapter explores examples of countries with integrated, partially liberalised and fully liberalised power sectors, taking stock of procurement strategies available in each and of policy approaches to increase opportunities for clean electricity procurement.

Lower costs drive increased appetite for renewables, but regulations still pose barriers in many regions

In many economies, the growing gap between high wholesale electricity prices and variable renewable energy technologies delivering low-cost supply is incentivising large corporate consumers to look for alternative ways to source clean electricity. The following section examines the drivers and possibilities for clean electricity procurement in countries around the world, presenting experiences across the whole spectrum from integrated, state-owned utilities to fully liberalised systems. Finally, the chapter draws on these examples to identify concrete actions policy makers and regulators can take to remove barriers and enable corporate participation in efforts to accelerate deployment of clean electricity.

Australia

Australia's corporate PPA market has been growing steadily since 2017, following a rise in wholesale prices and certificate spot prices 2016 that made PPAs more competitive for large consumers. By 2021, these conditions had spurred the completion of around 110 PPA deals. Typically, developers commit only part of their capacity through corporate PPAs to ensure the bankability of projects and trade the remaining output in short-term markets. According to the Australian Renewable Energy Agency, a total of 4 GW of renewable capacity committed through PPAs has enabled development of a total of 10.5 GW. Most contracts have been signed by manufacturing, government and education-related organisations.

The country's fully liberalised power market is complemented by a system of clean electricity certificates for utility-scale generation. This helped Australia achieve its renewable energy target of 33 GWh by 2020, although deployment has since slowed. In previous years, most corporate PPAs were directly between corporates and generators; more recently, there has been a shift towards clean electricity supply contracts – or green tariffs – enabled by retailers. A gap still exists, however, between the availability of new projects in the pipeline and increasing demand for clean energy on the part of companies. Corporate interest in clean PPAs is driven both by the need to fulfil mandatory renewable energy portfolio standards and by cost advantages.

Ongoing challenges in Australia relate to building internal company expertise to implement the best fit of corporate PPAs and to carrying out necessary due diligence to ensure new projects will not be delayed because of interconnection and network access issues.

Brazil

Historically dominated by hydropower, Brazil's power system is the cleanest in Latin America. In recent years, liberalisation of the power market has enabled corporate buyers to contract PPAs directly with generators, even in other regions. For large consumers, procuring from newer, lower cost facilities can be an opportunity to reduce electricity costs in comparison to current market costs, which reflect the existing generation mix. In this case, however, buyers have to account for price differences between the different regions of the interconnected national system. A market for EACs has also emerged, for example through the REC Brazil programme and the proposal of the Brazilian GHG programme. The latter states that – provided quality criteria regarding the electricity source and emissions factors are followed – PPA contracts with renewable energy facilities can be used as an origin tracking mechanism, allowing for traceability. As of 2022, around 10.7 GW of renewable capacity had been procured through corporate PPAs.

Following the blackouts in 2001, Brazilian government policy encouraged the self-consumption modality as a means to increase electricity generation. Specifically, it granted discounts on charges, including those for use of the network. Depending on the area and voltage level at the point of interconnection, the discounts ranged from USD 3.89/MWh to USD 10.68/MWh.[6]

Most recently, as part of its power sector modernisation programme, Brazil shifted the calculation of zonal prices from weekly schedules to hourly settlements. This is a direct response to increases in variable renewables and gas generation and should lead to improvements in how directly contracted renewable energy generators are deployed across the Brazilian power system. Introducing hourly and sub-hourly settlement horizons helps better reflect fluctuations in the value of electricity generation, particularly when considering the shift from hydropower (which varies over days and weeks) to solar and wind (which vary within hours and days).

Regarding other procurement approaches for clean electricity, the Brazilian net-metering scheme has helped trigger growth of distributed generation, namely solar PV, particularly in residential and commercial markets. In January 2022, the government announced reforms to ensure that small installations (below 5 MW) will remain eligible for net-metering tariffs until 2045. At present, such installations account for 8.4 GW of 13 GW of solar PV capacity. In regards to specific green power products for smaller consumers as self-consumption solar PV remains more attractive. At the same time, smaller regulated consumers have the ability to access time-of-use tariffs that significantly reduce the cost of service.

European Union

Liberalisation of power markets across the European Union has enabled the possibility to implement all procurement options – EACs, direct PPAs, on-site generation and, increasingly, green power products. Across the continent, corporate PPAs have continued to increase in significance, particularly in response to the move away from fixed feed-in-tariffs (FITs) to more market-oriented renewable energy remuneration models. In parallel, the presence of liberalised retail across much of the European Union has also enabled the emergence of aggregators for smaller loads and encouraged retailers to develop clean electricity offerings for their customers. Permitting and interconnection, however, constitute significant barriers for renewable energy projects in general, which slows the development of new corporate PPA projects.

At the European level, the most recent amendment to the Renewable Energy Directive (RED III) aims to improve conditions for clean electricity procurement. It

[6] 1 EUR = 0.97 USD

proposes, for example, that all renewable electricity generated across the continent be eligible for EACs to improve tracking and requires that governments state how much of their renewable energy targets is expected to be met through corporate PPAs. While implementing these proposals is likely to take time, the move towards more standardised issuing and transfer of credits could help ease the process of contracting PPAs.

More recently, the European Network of Transmission System Operators for Electricity (ENTSO-E) published a position paper on Ensuring a Future-Proof Market Design that proposed increasing the temporal matching of certificates – to an hourly or even 15-minute basis. The aim is to improve the integration of renewable energy and encourage consumers to procure renewable electricity that generates when it brings the most value to the system. The paper also proposes including locational aspects and determining market areas for the trade of EACs, both of which would further incentivise development of generation in areas where it delivers the greatest value.

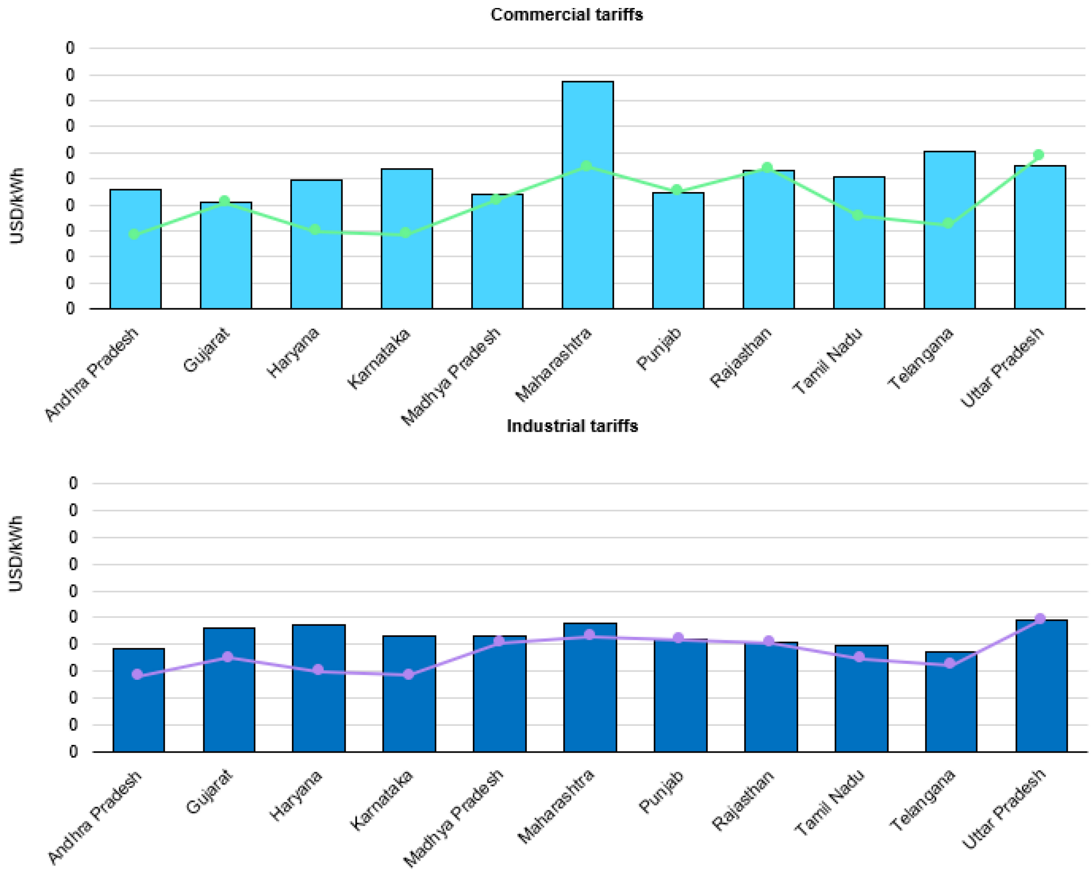
India

In India, corporate procurement capacity reached 5.2 GW in 2021. The majority share comes from large conglomerates in the construction, automotive and textile sectors. As in other major economies, new renewable energy investments are currently more cost-competitive than electricity bought from local utilities, which mainly purchase electricity from coal-fired power stations. Nonetheless, the ability to procure electricity directly through PPA models still faces hurdles related to delays in network access permissions and the diversity in network charges and other surcharges, which vary across states.

The economic case for corporate procurement in India varies from state to state, depending the difference between local grid costs and costs resulting from solar tariffs but also on how favourable or detrimental the regulator deems such projects to be to cost recovery. Overall, two main models are prevalent: open access and captive generation.

India's open access model allows consumers, particularly large ones, to serve aggregated consumption from multiple sites, for example, through a large grid-connected solar plant. However, if the generation and consumption sites are located in multiple states, additional costs arise from the open access network charges (also called wheeling charges) imposed individually by the state regulator where the generators are located.

Solar tariffs including open access charges vs grid tariffs for commercial and industrial consumers in India, 2019



Source: World Business Council for Sustainable Development and Bridge to India (2018), [Accelerating Corporate Procurement of Renewable Energy in India]

In contrast, under the captive model, a group of buyers can benefit by pooling the investment costs to support large projects, essentially allowing these consumers to have their cross-subsidy charges waived. Under captive models, it is possible to contract both off-site and on-site generation. Off-site contracts typically include wind generation while on-site captive generation typically includes rooftop solar or on-site coal generation for large steel and cement facilities.

As in other emerging economies, India's electricity tariffs have historically been structured such that cross-subsidies support the expansion of energy access: higher tariffs for commercial and industrial consumers help keep costs low for residential consumers. Since PPAs allow companies to exit the customer base of the incumbent distribution company (DISCOM), state regulators have started implementing strategies to keep recovering these costs through the open access tariffs. In experience to date, exemptions of cross-subsidy surcharges, transmission and wheeling charges, along with electricity banking,[7] have been among the most effective policy design aspects for promoting corporate procurement. If explicit funding for these subsidies is not allocated, however, these approaches can place a financial burden on DISCOMs. Some DISCOMs are taking steps to address these disconnects. The state of Haryana, for example, introduced a reliability surcharge of USD 0.018/kWh on open access solar and increased energy banking charges by the same amount.[8]

In 2020, India also launched the Green Term Ahead Market. This pan-Indian platform allows both merchant renewables plants and DISCOMs with surplus beyond their renewable power obligations to sell directly to DISCOMs or corporate buyers with loads above 1 MW. The platform covers four types of short-term contracts including:

- Intra-day contracts with round-the-clock, 15-minute settlement periods
- Day-ahead contingency contracts, available nation-wide in 15-minute windows
- Daily contracts with a two-day ahead delivery window
- Weekly contracts, available on Fridays and Saturdays, for delivery in the following week.

Indonesia

With an installed capacity of 76 GW, Indonesia's electricity mix is largely dependent on fossil fuels. Its power sector is structured as a single-buyer model, giving the state utility Perusahaan Listrik Negara (PLN) priority in terms of generation, transmission and distribution. The country's latest NDC (announced at COP26) set a target to achieve at least 23% new and renewable energies by 2025. PLN's latest Electricity Business Plan, which outlines capacity and network development for the next ten years, presents a scenario in which renewable energy additions amount to 21 GW, which accounts for half of the total capacity additions. Total capacity additions were subsequently revised down, reflecting lower expected demand growth as a result of the Covid-19 pandemic. The government also recently announced measures to start its coal phase-out in 2030, starting with easier to retire plants and finalising the phase out by 2060.

To increase investment in new generation, Indonesia introduced a series of provisions that allow special licensees to sell electricity directly to the main utility or to provide electricity in specific industrial zones. Due to constitutional injunction, the current model restricts corporates to buy their electricity only from the state utility, PLN, or to fully self-supply with on-site generation. Corporate sourcing of

[7] Electricity banking as deployed in a number of Indian states refers to captive or third-party open access projects in which large corporate consumers supply their excess generation to a DISCOM; at later date, by paying a "banking charge", they can use this excess balance to obtain electricity from the DISCOM.
[8] INR 1.00 = USD 0.012

off-site renewables has also been complicated by wheeling agreements. Notably, despite a principle of open, non-discriminatory network access, the transmission holder determines the terms and costs, which can vary from region to region. The calculation methodology lacks transparency, which creates uncertainty.

In September 2022, the Indonesian government introduced the Presidential Regulation 112/2022 on Acceleration of Renewable Energy Development for Electricity Supply. By defining remuneration schemes for different renewable technologies and introducing adjustment factors for the country's different areas, this new regulation could contribute to increased certainty among investors. In contrast to the barriers for direct investment in corporate PPAs, Indonesia has already taken steps to boost net-metered solar PV. In 2021, the introduction of Regulation 26 allocated a one-to-one credit per kWh fed into the grid (replacing the previous discounted credit). The new regulation also shifted the monthly settlement credit within a single quarter to a six-month energy bank, with any banked energy beyond the end of the year being cancelled, which reduces the time granularity of renewables supply and demand matching.

Japan

Japan has recently seen an increased interest in corporate PPAs, with the number of companies with RE100 pledges rising from 19 in 2019 to 57 in 2021. Together, these companies represent 2.6 TWh of demand, with 14% of their electricity coming from renewable energy sources.

Until recently, the Japanese market was characterised mainly by on-site generation as private renewable energy projects needed to be supported exclusively through FITs. It was not possible to obtain EACs for these projects as this possibility was only open to clean electricity supplied through retailers. In 2021, the Japanese energy ministry started reforming the Non-Fossil Certificates market to comprise two parts. First, the Renewable Energy Trading Value Market (REV market) allows both retailers and eligible consumers to purchase certificates. Second, the Market for Achieving Energy Supply Act Obligations (ESA market) aims to ensure retailers can meet their renewable portfolio standard obligations as per the Energy Supply Act. The current REV market, however, only allows for trading certificates of FIT-supported renewable energy. The government is currently reviewing options to also allow trading of renewable projects developed using feed-in-premiums (FIPs) or commercially. This, along with the introduction of FIP models for developers, is expected to drive an increase in corporate PPAs in the coming years.

South Africa

In South Africa, development of PPAs has been driven both by lower cost of new generation technologies (e.g. wind, solar and storage) and, importantly, by the need to ensure reliability in the face of its ongoing power supply crisis.

Two PPA models are possible: close-to-premises and wheeled PPAs. In the first, generation is installed on or close to the consumer's facilities and provided by an independent power producer (IPP). The second requires special wheeling amendments to both the terms between the local utility and the consumer and to use-of-system arrangements between the specific consumer, the generator and the grid operator (Eskom). In practice, most PPA agreements are between IPPs and Eskom through the Renewable Independent Power Producer Programme (REIPPP). While transmission codes and licensing provide for open and non-discriminatory access, barriers persist as to how licensing is administered as a whole and defined at the municipality level. At present, only a few successful direct procurement agreements have been made, most notably a biogas plant supplying power to a BMW assembly plant.

Regarding other clean electricity procurement options, municipalities, which are in charge of delivering electricity to consumers, are increasingly moving to procure their own electricity from local generation sources. This is grounded in municipalities' obligations to provide affordable and accessible electricity and pursued primarily in the interest of reliability. It could also help increase the share of variable renewables being offered to end-consumers.

In August 2020, the South African government announced several measures to address the power supply crisis. One was to remove licensing requirements for private energy projects while still retaining the requirement to register with the regulator. This builds upon the earlier (June 2021) relaxation of licensing requirements, which raised the license exemption threshold from 1 MW to 100 MW. In the coming years, this should accelerate Eskom's and the municipalities' ability to procure clean power directly. Already, this change led to a number of announcements from large industrial consumers, including many large mining companies, to power their own operations using a combination of renewable technologies.

United States

The United States is the country with the largest volume of corporate PPAs, owing largely to the presence of mature liberalised markets and other favourable conditions for investment in renewables (e.g. federal tax credits and renewable energy portfolio standards). The largest share of PPAs is procured by large corporations rather than by retailers or small integrated utilities.

In December 2021, the federal government introduced a target to reach 100% clean electricity in all federal buildings on a net annual basis by 2030, with half of this supplied by 24/7 CFE projects. In light of the diversity of load sizes and types across the whole of the federal administration, this order could encourage greater uptake of clean electricity procurement agreements by smaller consumers. One benefit is to build a greater understanding of how small consumers with sites in multiple locations can determine their electricity requirements and pool their loads to interact directly with either developers or with their local utilities. Additionally, in areas served by regulated utilities, implementing this act will require the development of green electricity tariffs to supply local government offices, which could subsequently open up the market for other consumers seeking green tariffs.

Recommendations

Across all power market types, policy makers have a wide scope of action to enable clean electricity procurement

Across all types of power markets, whether fully integrated or fully liberalised, specific policy actions can foster development of clean electricity procurement. Introducing a licensing process that grants access to the electricity network and specifying what actors can interact with the incumbent utility are good first steps to enable a greater share of clean electricity in the grid, as shown by the examples of India, Indonesia and South Africa. Morocco, through the amendment of Law 13-09, also recently opened access to the grid to enable a greater share of investment in renewable generation.

In practice, it is important to back the introduction of non-discriminatory network access by: implementing clear calculations for network costs; establishing a transparent process for applying for and issuing licences; and clearly allocating responsibilities across the energy ministry, regulator, network operator and incumbent utilities. These policy actions are critical to ensure that interested developers and consumers can place trust in the market. In South Africa, steps that removed double licensing requirements at the network and at the municipality level are examples of concrete actions to enable the entry of new providers of clean electricity and extend fair conditions for network access. The reform of land use and planning barriers across much of the European Union shows how addressing the administrative barriers for variable renewables development as a whole is key to enable investments, including corporate procurement.

Policy makers should ensure that consumers have clean electricity options

While the mechanisms to enable clean electricity offerings to customers will vary from one power system to the next, policy makers, regulators and utilities can use a number of pathways to maximise consumers' options to procure clean electricity. For large consumers, liberalisation of generation and of some share of the consumer market are generally seen as key to triggering the emergence of corporate PPAs, EACs and green tariffs through retailers. For small consumers, policy makers can introduce models for self-consumption of clean electricity or incentivise utilities to develop green energy tariffs (such as in the United States or South Africa). This implies reforming the rules to ensure that municipalities in charge of providing electricity can choose their own suppliers and resell to consumers.

Updating use-of-service charges can drive clean electricity investment while ensuring appropriate distribution of system costs

Regardless of the level of state integration or liberalisation, reviewing incentives embedded in the design of use-of-system charges and other power system levies is essential. In particular, policy makers must ensure that the emergence of corporate procurement or self-supply models does not lead to system and grid costs being passed on to vulnerable or regulated consumers. Defining use-of-system charges based on the three annual demand peaks, for example, has been a driver for net-metering investment in places such as Quebec and the United Kingdom. The profitability of this model and its impact on shifting system costs were key reasons behind the reform of the United Kingdom's TRIAD system.

The potential for cost shifting is also evident in power systems that are partially liberalised. Retailer choice allows large industrial consumers to move away from more expensive contracts with the incumbent utility, which cover network, legacy contract costs and energy-access cross-subsidies (as has occurred in Brazil, India and Mexico). Actions taken by state regulators in Haryana and Karnataka, India, show how regulations can ensure that all power system users account for their share of both network costs and socially oriented cross-subsidies. Ensuring a nimble regulatory process and engaging with electricity industry stakeholders are important to steer investments towards decarbonisation while also ensuring mechanisms exist to remunerate corporate projects for any contributions they make to system stability and security.

Emissions accounting

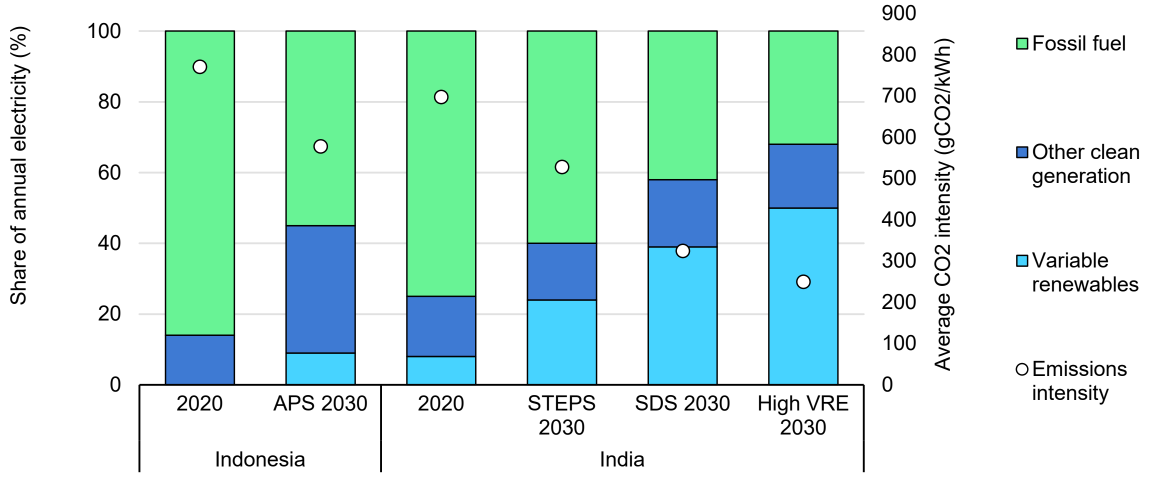
Reducing CO_2 emissions is a core objective of clean electricity strategies; however, accurately determining the emissions impact of clean procurement is not straightforward. The question of whether corporate activity leads to new clean generation is only one aspect of the challenge (already discussed in the chapter on procurement approaches). Even in the case that a corporate acquires clean generation with clear additionality, accurately identifying the resulting emissions reduction remains complex.

The ability to count emissions is fundamental to determining the impact of different procurement actions. As such, this topic requires attention. This chapter illustrates that different accounting methodologies may give very different results. Existing frameworks do not consider all aspects that affect emissions but establishing more accurate methods raises multiple challenges. This chapter highlights the main considerations for emissions accounting in the context of clean electricity procurement and provides recommendations to improve its accuracy in support of effective emissions reduction.

Power sector modelling

In order to provide in-depth analysis of the impacts of different corporate procurement goals, this report presents power sector modelling case studies for two countries – India and Indonesia. This analysis incorporates capacity expansion modelling based on corporate clean electricity procurement into the IEA's India regional power system model and Indonesia regional power system model. India and Indonesia are selected to extend analysis of this topic to developing economies, relative to existing research examining markets in the United States and Europe. Several different scenarios are assessed, including the Announced Pledges Scenario (APS) for Indonesia and the Stated Policies Scenario (STEPS) and the Sustainable Development Scenario (SDS) for India. Comparisons are also made against a historical year (2020) and a high-renewables case for India.

High-level summary of decarbonisation progress in analysed scenarios



Notes: For Indonesia, APS = Announced Pledges Scenario. For India, STEPS = Stated Policies Scenario, SDS = Sustainable Development Scenario, High VRE case consists of the SDS with additional renewables generation to bring the VRE share to 50%.
Sources: IEA (2021), World Energy Outlook; IEA (2022), World Energy Outlook

Modelling analysis in this report assesses emissions impacts on a marginal basis for both load and generation, with a long-run perspective focusing on impacts in 2030 under specific scenarios. Procurement for all participating corporate load is assessed in aggregate (see Annex for detailed modelling methodology).

Emissions accounting methodology

Emissions accounting encompasses the calculation of both a company's carbon footprint based on its activities and the impacts of various interventions it undertakes to reduce or offset these emissions. At present, accounting for Scope 2 emissions typically follows guidance in the Greenhouse Gas Protocol, which allows for two methodologies: location-based or market-based.

Location-based accounting calculates a company's emissions using the annual average grid emissions factor for the region within which it is operating, which may be defined by a national or more local boundary. This approach is useful for situations where procurement is only available through behind-the-meter (BTM) generation. Three options exist for reducing calculated emissions under location-based accounting: reducing demand (e.g. energy efficiency); increasing BTM generation; or increasing clean energy in the overall grid mix. It is relatively challenging for corporates to claim net zero electricity under this methodology, as it either requires that the main grid be net zero or that the company meets its own demand with on-site clean generation.

Under the market-based methodology, emissions are calculated based on the emission factors of different electricity procurement options and relies on the availability of PPAs, green tariff offerings or EACs in addition to BTM options. It reflects contractual instruments that do not represent the actual flow of electrons. Currently, market-based accounting is the most widely applied approach for calculating electricity emissions. It provides more options for corporates to support net zero claims but is nonetheless challenging to quantify actual emissions reduction.

In effect, under the market-based approach, the emissions impact of specific procurement actions is not directly assessed. Rather, to apply an emissions factor of zero to their electricity consumption, corporations need to procure, on an annual basis, a volume of clean electricity (or unbundled EACs) equal to their demand. This methodology assumes that, even if there is a mismatch between the time and location of consumption, emissions reduction in other locations and at other times are equivalent to those triggered by the corporate demand.

This has the benefits of being simple to calculate and having relatively small data requirements. It fails to account, however, for the variation in emissions factors by time and location within a grid. Additionally, as systems reach higher shares of variable renewables, since market-based accounting does not consider the time and precise location of generation, companies pursuing net zero targets may contribute to the oversupply of generation at certain times (e.g. solar PV during the day) and in certain parts of the grid.

New methodologies are being developed to account for these effects and, in turn, better calculate the impact of a company's activities on emissions. These vary in terms of their data requirements and the type of information they give. First, there are two different overall approaches that have different interpretations: average vs marginal accounting. Second, within these approaches different possibilities exist for temporal (e.g. annual vs hourly) and spatial granularity (e.g. local or whole-grid for average). Accounting for future changes to power systems adds another layer of complexity.

Average approaches are the most accessible in terms of data requirements. The annual average is commonly used to determine the carbon footprint of electricity consumption on a specific grid. Its main weakness is that it provides no information about the times at which generation or demand response would be most valuable. Reformulating market-based accounting to reflect hourly or even sub-hourly average emissions factors (rather than annual) would better account for the variation of emission intensity in the grid across a year, thus provides better information to guide load shifting or to indicate times at which clean generation is most needed.

Finer spatial granularity of this emissions factor, that more closely links to the physical power system and flow constraints on the grid, can also provide more accurate locational signals. The closer the link to operational decisions in both time (e.g. dispatch interval) and space (e.g. balancing region), the more information emissions factors can provide as to when and where demand response and generation are most valuable and efficient.

Finer granularity on both factors would increase data requirements, although many jurisdictions already publish real-time hourly electricity information (e.g. generation by source) on which this could be built. Electricity Maps, a start-up based in Denmark, for example, offers a service that consolidates available data on electricity supply to estimate average carbon intensity by hour for many regions. RTE, the transmission system operator in France, already publishes this real-time information directly.

Even at higher granularity, a shortcoming still exists: neither annual nor hourly average approaches can provide accurate information about the direct impacts a change in load or generation has on the system. If, for example, a company increases its power requirement in a specific hour by 10%, the system operator engages the marginal generator to increase its power output by the same amount. In the middle of the day, despite solar PV providing a large share of generation, the marginal generator could be a natural gas plant. Hence, the resulting increase in emissions would reflect the emissions intensity of the natural gas plant, not the average for the whole grid. An hourly average emissions factor would therefore underestimate the emissions caused by the company’s increased activity. If the marginal generator is the same in most or all hours, the hourly average may actually give a less accurate estimate of the emissions impact of clean generation than the annual average. Nonetheless, greater granularity gives better information about when generation and demand response are more valuable to the system.

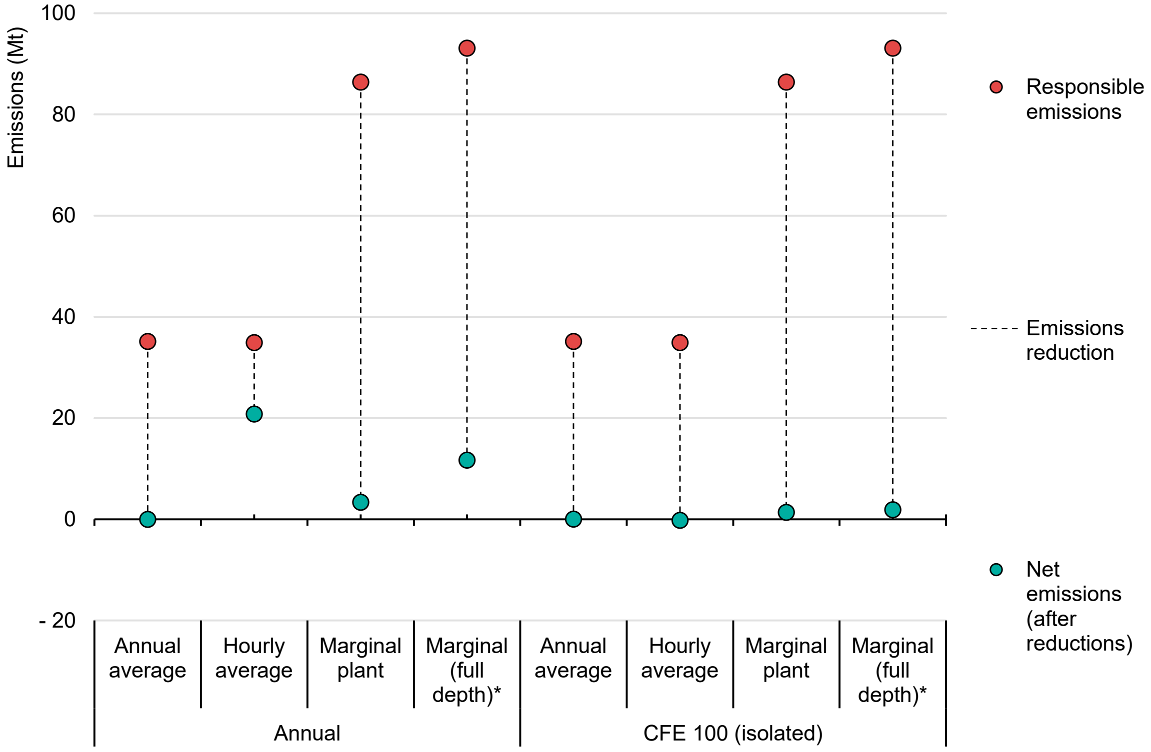
Using marginal emissions calculations gives a more accurate picture of how interventions reduce load or increase generation at specific times. However, this approach not only needs to use hourly data, but it also needs to distinguish between the short and long term. A marginal emissions factor for current grids only captures the impacts on short-term operations and decisions. In many cases, interventions to reduce emissions may be linked to longer term decisions, such as building new generators or expensive retrofits to equipment. This creates the need to be able to take into account how the grid will evolve and how additional load or generation would affect emissions in a future system on a year-by-year, hour-by-hour (or even sub-hourly) basis. National Renewable Energy Laboratory (NREL) has developed and published an example of this for the United States as an output from their annual projections on the evolution of the US power system.

Companies should choose a short-run or long-run marginal emissions factor to align with the timeframe of the changes or interventions they are assessing. For flexible load that is already available, a short-run marginal approach can identify the best operating pattern within the current system. A long-term marginal approach provides the most accurate assessment of the lifetime emissions impact of a new demand or generation facility.

The depth of the change also needs to be considered in marginal accounting. For a very small change in load or generation, the marginal impact may be accurately accounted by analysing the single marginal generator. A larger change could trigger the need to change the output of multiple generators – and thus requires a more detailed analysis to estimate. In addition, if uncoordinated market players respond to a marginal signal, it could change the marginal value. Assessing all interventions together gives the most accurate results.

The impact of different accounting methodologies can be demonstrated by comparing corporates' calculated emissions (both those they are responsible for and the reduction their procurement provides) under four approaches in different procurement cases in India in 2030 in the SDS. First, each methodology produces different results for emissions caused and reduced, as well as different outcomes as to the balance between emissions caused and reduced. Second, some procurement approaches are more sensitive to the methodology: 24/7 CFE essentially achieves 100% reduction under all methodologies, while annual matching falls short in this scenario when marginal methodologies are applied.

Examples of emissions calculation approaches for different procurement strategies in India in the Sustainable Development Scenario, 2030



Notes: The marginal emission factor (marginal plant) considers the carbon intensity of the marginal plant within the system for the entire depth of the incremental load. Marginal full depth considers the full marginal impact on emissions accounting for multiple plants changing their output. CFE = carbon-free energy.

To directly compare or balance emissions linked to an entity's activities, and the degree to which its interventions reduce emissions, both aspects need to be calculated with a consistent methodology. Calculating, for example, the company footprint from an hourly average emissions factor while using a marginal approach to compensate for these emissions, would give a misleading result that only reflects a fraction of produced emissions. While the use of annual average approaches remains relevant for some reporting requirements, marginal approaches are more appropriate to guide decision making around procurement actions as they more accurately describe the effect of changes to generation and load. Hourly average approaches also provide value to guide decision making for the timing when generation or demand response are valuable but may be misleading for overall emissions attribution. From this perspective, it may be appropriate to use two methods in parallel, which implies undertaking two separate accounting exercises.

Emissions accounting is important to help guide clean electricity strategies; however, the emissions impact should not be the sole consideration. Companies should actively assess the emissions impacts of their planned interventions to inform practical procurement decisions. In turn, it is essential to keep in sight that net zero electricity will ultimately require decarbonisation of the entire power system. This responsibility needs to be shared by all stakeholders. As the impact of any intervention will be linked to any other changes taking place in the system, co-ordinated planning is essential. Policy makers should also support corporate decision making by ensuring that long-term planning provides guidance on how the power system will develop and the resources needed over time for cost-effective decarbonisation.

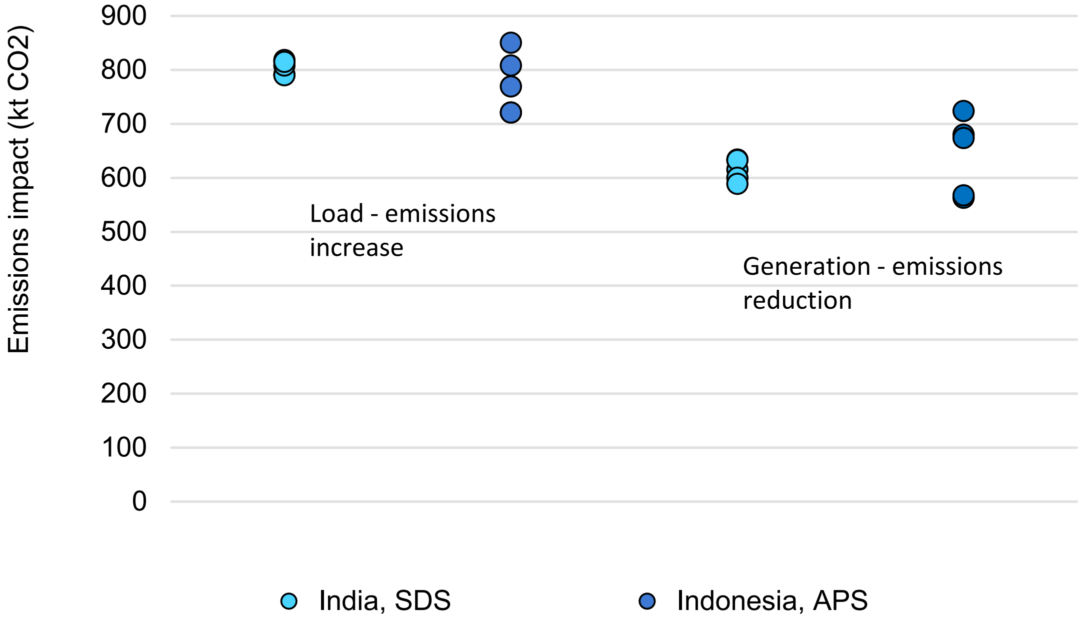
Impacts of procurement on emissions

Location matters …

The actual impact corporate procurement has on emissions depends on where and when both load and generation take place. As the market-based approach to emissions accounting lacks any strong enforcement requiring companies to match generation to the location of load, it can lead to substantial discrepancies between the emissions caused and reduced on the system.

Analysis of the impact of a set of test loads and generators placed in different regions within the power systems of India and Indonesia illustrates this disconnect. A test commercial load of 100 MW average across the year pushes up emissions on the system, but the exact amount varies depending on the power system and where the load is located within it. Generally, emissions will be higher in a higher emitting system. The marginal impact, however, will tend to be different from the average emissions of the system – and could be higher or lower depending on the types of generation covering the additional demand. Similarly, if placed in the same locations, a test generator producing generation equal to the load on an annual basis (i.e. satisfying the RE100 criterion) results in emissions reduction that vary according to the location.

Emissions increase for a 100 MW test load in different regions vs emissions decrease for equivalent solar PV generation in different regions in India and Indonesia, 2030



Notes: SDS = Sustainable Development Scenario. APS = Announced Pledges Scenario. Test scenarios include a CO_2 price of USD 100/t CO_2 to illustrate the impact of new load and generation in systems in which low-emissions generation is prioritised. This effect could also reflect priority dispatch for low-emitting generation, for example in the absence of direct carbon pricing. The different locations are based on placing load and generation in different nodes within the two regional models (see Annex for description of regions). The scenario for Indonesia assumes contractual flexibility that allows fossil fuel generators to be ramped down to accommodate increased renewables.

Comparing the different values for emissions increase and reduction illustrates how, for an RE100 strategy in which load and generation are placed in different locations, three possible outcomes emerge. The overall balance could see generation reducing substantially less emissions than the load is responsible for, a close match between emissions caused and reduced, or even an emissions reduction of more than 100%. The extent of emissions caused and reduced depends on the marginal generator during the hours of electricity consumption or production. As such, the largest reductions are in regions that have high-emitting coal generators operating on the margin. Two important conclusions arise from these findings:

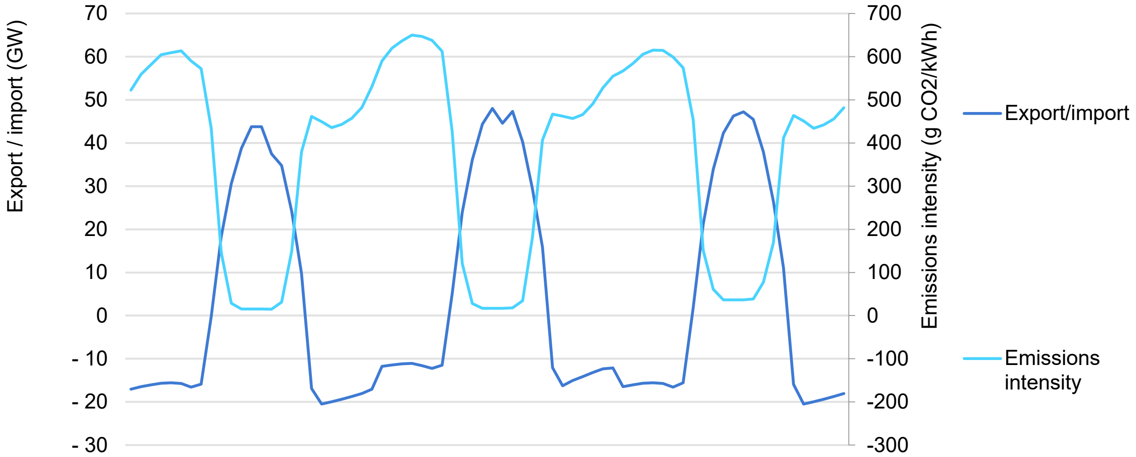
- Methodologies matter: accounting practices that match demand with clean electricity on an annual basis do not accurately capture the emissions impact of clean procurement.
- Location matters: the location of both load and generation impacts emissions outcomes. This should be taken into consideration when siting both demand and clean generation facilities.

… and so does timing

The timing of load and generation also impacts the degree to which corporate procurement reduces emissions. We analyse the emissions impact of a share (10%) of commercial and industrial load undertaking clean procurement in a modelling case study for India. The procurement activity matches the corporate load with clean generation on an annual basis. The analysis covers three scenarios for 2030 – STEPS, SDS, and a high VRE case – as well as 2020 (historical) to illustrate the impact of the power system context (see Annex for detailed modelling methodology).

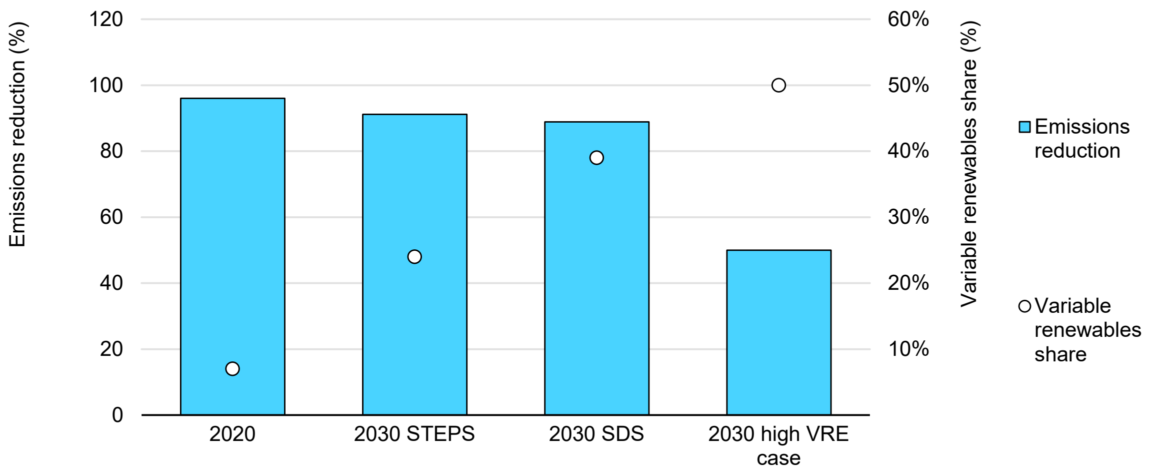
In all scenarios, the most cost-effective way to achieve annual matching between load and generation is a generation portfolio consisting only of utility solar PV. Although procured generation and load are, in this case, within the same system, the pattern of PV generation is such that corporates would end up in effect exporting excess generation to the rest of the system during daylight hours and importing generation when the sun is not shining. For a system with a substantial share of PV, emissions intensity of the system will tend to be lower during hours when the corporate is exporting and higher when the corporate is importing. This can lead to emissions reduction being less than emissions caused by the corporate load.

Import and export (left axis) during a 3-day period in March 2030 for a corporate portfolio achieving annual matching and overall emissions intensity (right axis) in India in the Sustainable Development Scenario



The overall impact of annual matching on emissions is highly scenario dependent. In the Indian power system as structured in 2020, annual matching with solar PV can reduce 96% of the emissions caused by the corporate load, largely because the marginal generator is coal in almost all hours. As the share of variable renewable increases, by 2030 an annual matching approach is much less effective for reducing emissions and is greater in the STEPS than in the SDS.

Emissions reduction resulting from corporate clean generation relative to emissions from corporate electricity consumption in India under different scenarios



Notes: STEPS = Stated Policies Scenario, SDS = Sustainable Development Scenario. High VRE case consists of the SDS with additional renewables generation to bring the variable renewables share to 50%.

Eventually, the system can reach a point at which solar PV continues to have the lowest build cost to achieve annual electricity matching, but the system faces challenges to integrate more solar during the middle of the day. Unless more flexible technologies (such as storage) are added to help integrate more solar, this scenario could result in increased curtailment in the rest of the system. This is illustrated using a high VRE case in 2030, in which the share of variable renewables is increased from 39% (SDS) to 50%. In this case, corporate procurement with an annual matching strategy reduces only 50% of the emissions caused by the corporate load, as a result of increased curtailment of renewables in the rest of the system and exported electricity mostly displacing gas (rather than coal).

Steps to better account for emissions

Corporates should assess emissions for all strategies

By matching load with clean generation in each hour of the year on the same grid, in principle, hourly and regional matching strategies (such as 24/7 CFE) address both the locational and timing aspect. Still, emissions reduction from 24/7 CFE can vary, with the score targeted (calculation described in the first chapter) playing an important role. From an investment perspective, targeting a score below 100 – i.e.

allowing some import from the main system – may be more efficient than fully matching consumption in every hour. This does allow some generation from emitting sources, however. Whether the 24/7 CFE portfolio also exports to the rest of the system also influences emissions outcomes. It could lead to more emissions reduction, either compensating for those caused during hours of import or even exceeding overall emissions that result from serving the corporate load.

Finally, depending on technologies allowed within a 24/7 CFE strategy, some generators might be present that have low but not zero emissions (e.g. carbon capture and storage). In this case, even 24/7 CFE with a score of 100 will have some residual emissions. If, without also matching annual consumption, corporates target relatively low CFE scores, this could result in less emissions reduction than an RE100 approach.

Based on these considerations, companies wanting to credibly claim that they are fully addressing their electricity emissions, should ensure that where possible their strategy includes an explicit assessment of how their clean procurement actions impact emissions – regardless of their specific procurement goals. They have multiple options to address any deficit, e.g. by strategically locating their load and generation, through additional procurement, by increasing efficiency, or by acquiring high quality carbon credits – with reducing primary emissions remaining the highest priority.

Clear reporting requirements and robust platforms for sharing generation and certificate data are vital to a healthy clean electricity market

Quality and completeness of data will underpin the transparency of corporate procurement and the ability to monitor progress. Thus, it is essential for energy ministries, regulators, system operators and utilities to set up clear reporting requirements and effective reporting tools. Key information – such as the generation mix over time, profile of distributed generation, locational and time attributes of EACs, and any grid issues – should be available to all power sector stakeholders to inform their investments. This is particularly true in systems that support multiple clean energy procurement strategies.

Ministries, policy makers and regulators need to consider the needs and capabilities of diverse consumers. From the small consumer perspective, it is vital that utilities accurately report the share of clean electricity being provided to end-consumers, both to ensure credibility and to facilitate monitoring progress towards larger policy objectives (e.g. compliance with renewable portfolio standards). For large or corporate consumers, data are essential to inform their choice among procurement strategies, monitor their actual emissions and accurately report on how their actions reduce emissions. This is particularly important as more financial institutions and investors start to monitor these factors within environment, social and governance reporting metrics.

Emissions tracking and reporting need to be improved

As noted above, most corporates currently follow a simplified approach to electricity emissions accounting, outlined in the market-based accounting method of the Greenhouse Gas Protocol. Its simplicity has offered benefits, particularly over recent decades during which the main priority for electricity decarbonisation has been increased renewables deployment. Overall, this approach has been relatively fit-for-purpose.

As power systems globally must now move rapidly towards deeper decarbonisation, this methodology begins to fall short. The option to locate generation and load at different sites can result in a mismatch between emissions caused by demand and emissions reduced. If corporates favour procurement in more accessible markets with lower emissions impacts, this may constitute a missed opportunity for corporates to help lead deployment in more challenging markets.

As emissions accounting is the foundation of reduction efforts, it is vital that policy makers, regulators and companies pursuing clean electricity goals collaborate to update and improve relevant practices. In parallel, regulators need to ensure that system operators make clear power system data available so that consumers can assess their emissions impacts. Within and across interconnected regions, policy makers should harmonise EAC schemes to the greatest degree possible and support efforts to enable more time-granular products. Companies, in turn, should be transparent about their emissions profile and actively assess and publish the emissions impact of their clean electricity strategies. Marginal impact methodologies should be the foundation of decision making for procurement.

Net zero transitions

The context for achieving net zero transitions in the power sector is evolving rapidly. Power systems in the early stages of decarbonisation depend on large shares of dispatchable fossil-fuel technologies, prompting an initial need to increase clean sources of energy. For corporate procurement, annual electricity matching strategies have aligned with this need, focusing on boosting clean electricity output while relying on existing power system flexibility to provide the services to support renewables integration.

Today, increasing the share of clean generation remains vital, particularly for systems that still face a large decarbonisation challenge. At the same time, some regions are rapidly reaching higher shares of variable renewables – and consequently higher phases of renewables integration. As a result, the focus in these power systems shifts towards the need for more flexibility and other system services via clean technologies that help maintain secure electricity supply.

Procurement strategies that balance demand with generation on an hourly basis can help power systems advance along their net zero pathways by delivering clean dispatchable technologies. These strategies also contribute more flexibility and more value to the power system, which needs to be recognised within tariff frameworks.

Several complexities must be considered, however. A major advantage of large, centralised power systems is that it is more efficient and cost-effective to serve many connected loads in aggregate than to build separate generation systems for smaller, individual loads. If corporates follow a granular, time-matching strategy (such as a 24/7 CFE score of 100) – and each needs to meet this goal on an individual basis – it may lead to inefficient investment. Strategies that introduce more temporal granularity while still allowing for interaction with the rest of the system offer a pathway to contribute more fully to net zero transitions while avoiding inefficient investments. This interaction can be achieved through mechanisms such as certificate trading, if more time-granular certificates are available. Targeting hourly matching at less than 100% could also play a role.

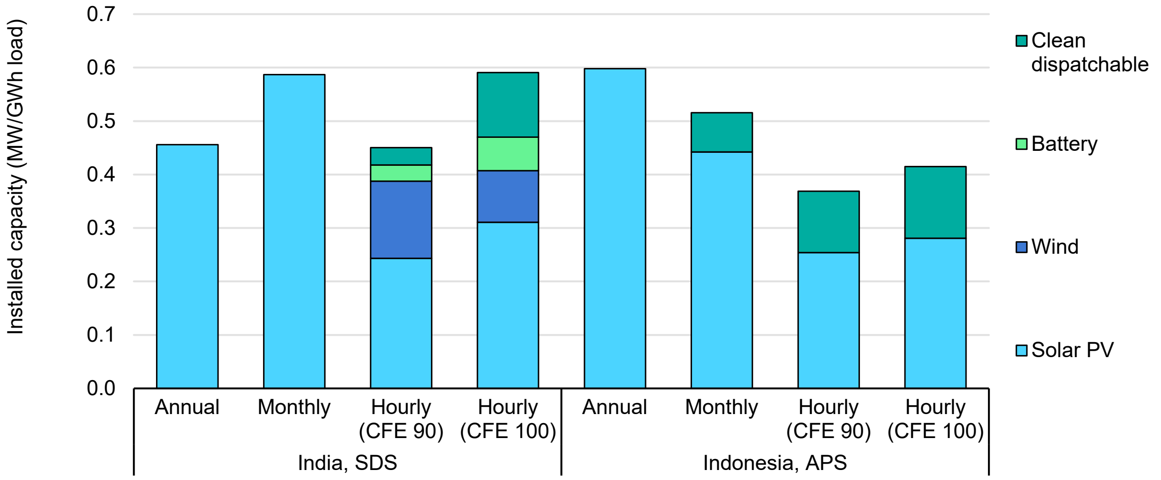
Impacts of hourly goals

Different goals deliver different technologies

The most cost-effective way for corporates to meet annual electricity matching goals is to source clean generation with the lowest levelised cost of electricity (regardless of the procurement option). Based on current and projected technology costs, such annual strategies will mainly be met by solar and wind capacity. In contrast, hourly matching strategies depend on dispatchable technologies that can follow closely the load profile. These include dispatchable clean generation, energy storage and demand response. Some tariff arrangements, such as energy banking, have intermediate accounting periods (e.g. monthly banking); matching at this level, however, may lead to increased capacity without substantially increasing technology diversity or flexibility.

To examine this, we model a case in which 10% of commercial and industrial load forms a consortium and procures clean electricity under strategies with different levels of time granularity (see Annex for detailed modelling methodology). The model compares outcomes under the SDS in India and the APS in Indonesia in 2030. Annual matching, in both cases, results in solar PV meeting the full load due to its low cost of energy. Targeting monthly balancing results in solar PV only for India and a mix of solar and dispatchable capacity in Indonesia. This analysis assumes that a certain amount of capacity is built to meet the corporate demand; in practice, procurement could be based on direct PPAs or on well-designed certificate schemes that ensure voluntary certificates correspond with additional generation capacity (discussed in the second chapter).

Procurement portfolios for annual and hourly demand matching in India and Indonesia, 2030



Notes: CFE = carbon-free energy, SDS = Sustainable Development Scenario, APS = Announced Pledges Scenario.

In contrast, hourly matching strategies with CFE scores of either 90 or 100 both result in a more diverse set of technologies – including more wind and less solar in India and increased dispatchable capacity in both systems (following Google's methodology for assessing CFE scores as described in the first chapter). The CFE 90 score reduces the quantity of dispatchable capacity relative to CFE 100 but stimulates a similar diversity of technologies. It is important to note that this outcome is dependent on still targeting quite a high CFE score – e.g. scores of 60-80 may be achieved by an annual matching portfolio.

Additionally, how these strategies influence technology choice will depend heavily on the technology costs. As shown in the Indonesia model, if some dispatchable capacity is available at very low cost, it could be selected even within monthly or annual matching strategies.

Demand response remains largely untapped

Despite having large potential to enable more cost-effective integration of variable renewables, demand response participation still has a long way to go. Smart meters and other enabling infrastructure are becoming more widespread, but the contribution of demand response remains far below its potential. In many regions, institutional arrangements present a barrier to activating demand response. By harnessing any flexibility available in their loads and making it available to support power system operation, both small and large companies have potential to reduce their electricity costs while contributing to net zero transitions.

Current market-based emissions accounting, in which energy is balanced on an annual basis, does not provide incentives for demand response. A strength of hourly matching is that it fills this gap and drives corporates to pursue demand response; in turn, this can reduce the requirement for flexible technologies to achieve their electricity goals. Several companies are already leveraging demand response as part of their hourly matching strategies, including Google (through its carbon-intelligent platform) and Grupo Bimbo (the world's largest bakery, which uses microgrids with peak demand management capabilities).

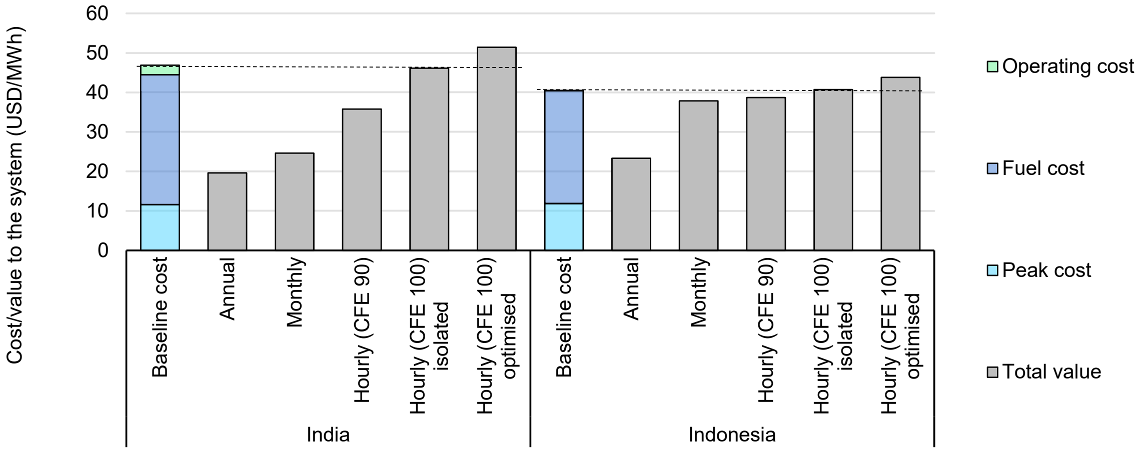
Clear allocation of system costs is fundamental to efficient energy transitions

Because annual matching strategies focus on energy and favour variable renewable technologies, companies using these approaches still rely on grid services – i.e. supplying capacity adequacy, balancing and stability, as well as use of the grid. Providing these services incurs costs that system operators need to recover in their billing structures.

To ensure fair allocation that supports system decarbonisation, regulators should therefore develop clear mechanisms to evaluate and allocate system costs. In systems where renewables deployment requires policy support, remuneration mechanisms can be designed to ensure that all parties contribute to reducing the impact on overall system costs and allow system operators to cover additional costs efficiently. The key consideration is that such mechanisms allow policy makers to ensure support for clean electricity deployment without inadvertently passing costs to vulnerable consumers.

This value can be demonstrated by quantifying how corporate load affects different components of system costs and comparing it against the value that different corporate portfolios bring to the system. The gap between the total value corporate generation brings to the system and the baseline cost to serve the load indicates the cost still imposed on the system. (This analysis does not assess interconnection costs, another component that may not be considered in some regions.)

System costs and value contribution in India and Indonesia, 2030



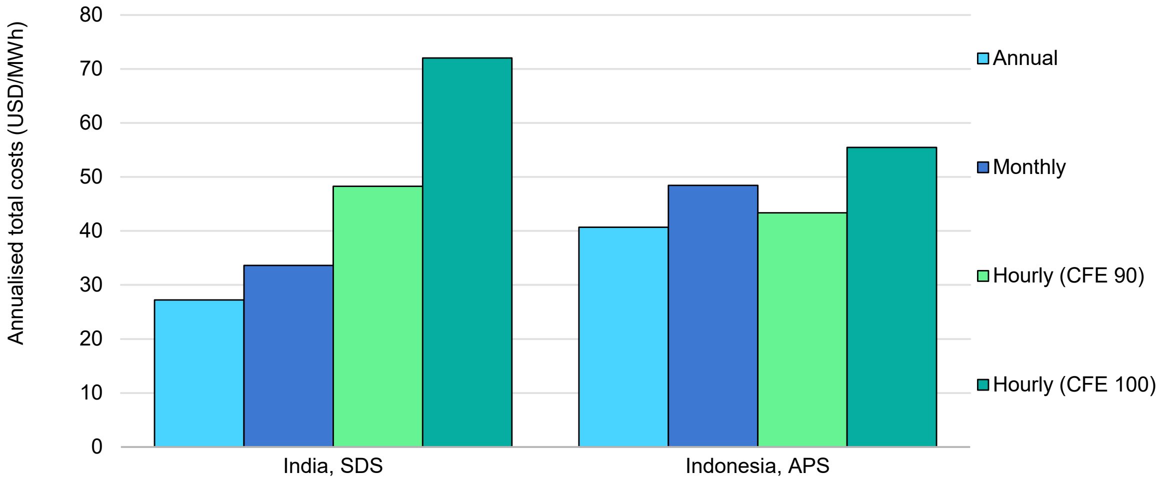
Notes: SDS = Sustainable Development Scenario, APS = Announced Pledges Scenario.

Comparing the services that corporate portfolios provide according to the different matching goals gives insights into their system impacts. The annual matching portfolio contributes almost exclusively to energy, provides no contribution to peak and actually increases operating costs as higher use of variable renewables means dispatchable generators have more ramping and start-up costs. The renewable generation mostly compensates the fuel cost of serving the corporate load; however, since the marginal fuel cost is at times higher during periods of import than periods of export, the value of the generation is slightly less than the cost.

In contrast, the hourly matching portfolio contributes to all services. In the case where corporate generation operates purely to match corporate load, its value to the system equals 100% of the cost to serve the load. This could be slightly less than 100% in cases in which the corporate still relies on the system during extreme peak hours or relies on other services such as sub-hourly balancing (which is not considered here).

Variable technologies are often already the cheapest source of energy, and their costs are continuing to fall. In this context, the additional value that more granular matching strategies bring to the system is expected to come at an extra cost. The scale of this additional cost will depend on the strategy employed, the specific technologies available, and the evolution of both technology costs and the demand curve. Early deployment by corporates of firm clean electricity generation or advanced storage options that have higher costs can help spur cost declines, ultimately making these technologies more cost-effective.

Cost to meet corporate load including capital, fixed and variable costs* for different clean electricity strategies in India and Indonesia, 2030



* Excludes transmission connection costs and costs directly linked to the use of grid infrastructure.
Notes: CFE = carbon-free energy, SDS = Sustainable Development Scenario, APS = Announced Pledges Scenario.

As demonstrated by the analysis, annual matching is the cheapest option in both India and Indonesia, and hourly matching with a CFE score of 100 is the costliest – again in both countries. Intermediate strategies, such as monthly matching and CFE 90, have intermediate cost profiles. Depending, however, on the balance between value brought to the system and additional cost, one or the other might be preferable. The cost of meeting the different goals is sensitive to technology availability as well as costs in the different regions. Thanks to the availability of relatively low-cost biomass generation in these scenarios, Indonesia can achieve hourly matching more affordably than India. This confirms, as is consistent with other studies in the United States and in Europe, that cost increase depends strongly on the available technologies. The extent of decarbonisation in the rest of the system could also increase or decrease the procurement cost. Increased uptake of technologies such as solar and wind may reduce the availability of sites with the best resources while also contributing to declining technology costs by stimulating learning curve and scale effects.

Refining price signals and improving market integration can ensure clean energy procurement adds value to systems

Even before companies engage in large-scale deployment of 24/7 CFE-type strategies, policy makers can take important steps to ensure the market integration of new clean energy investments – particularly by refining price signals and the granularity of settlement periods for both small- and large-scale consumers. As noted in the third chapter, market-based premiums for large-scale renewable energy can encourage deployment of technologies that generate at the times and locations that provide the greatest value for the system. Similarly, greater granularity in the settlement period (for both self-consumption schemes and time-of-use tariff design) can encourage small consumers to choose options that enable a better match between clean electricity supply and demand. This can prevent, for example, saturating the market with solar PV output during the middle of the day while still requiring expensive peaking generation in the evening – as has been the case in power systems such as Brazil, India and California.

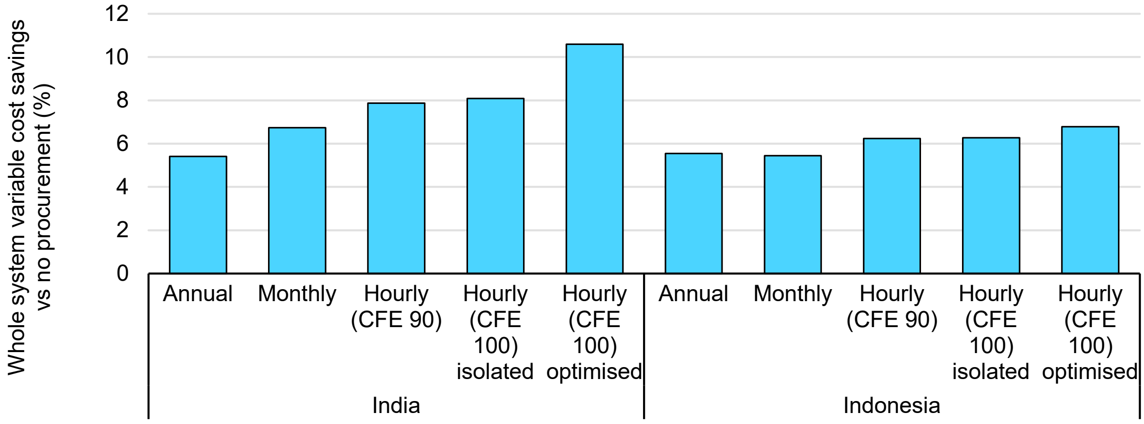
Other examples of policy solutions to improve market integration of EACs and PPAs exist. Japan proposes to reform its certificate trading market to allow the trade of EACs from merchant projects while ring-fencing the certificates market, which is dedicated to satisfying the country's renewable energy target obligation. In Europe, ENTSO-E has proposed an update that allows certificates to be cleared hourly rather than only monthly while also accounting for locational aspects. This measure should help drive investment in projects that generate when and where they are most needed.

Companies with hourly strategies should adopt a systems perspective

The principle of hourly matching under the 24/7 CFE goal directs corporate generation to closely match corporate load profiles. In principle, this means effectively dispatching the company generation to meet its own demand under a "siloed" approach, without considering the overall demand profile of the entire system. However, as mentioned at the start of this chapter, large, interconnected power systems benefit from increased efficiency by aggregating load and sharing generation resources. Dispatch in silos results in inefficient system operation. In practice, dispatch of corporate resources will depend on the structure and operating practices of the electricity industry. Still, this principle is an important consideration in defining objectives for granular electricity matching strategies to maximise benefits to the whole power system. Trading of time-based certificates, which can provide a mechanism to effectively aggregate load and clean generation in meeting hourly goals, is a key option to address this.

We can illustrate this by comparing the difference in overall costs between using corporate resources solely to match the company load profile (effectively operating as an isolated system and importing only a small amount of energy, if necessary) with optimising dispatch across the entire system. In turn, this can also be compared with the overall variable cost reduction that corporate generation brings for the other clean electricity goals. Due to the lower variable costs of the clean energy sources involved, all of the corporate portfolios (including annual matching) reduce the overall operating costs relative to a case with no corporate procurement.

Reduction in system costs under different clean energy strategies with both siloed and optimised dispatch for hourly matching in India and Indonesia, 2030

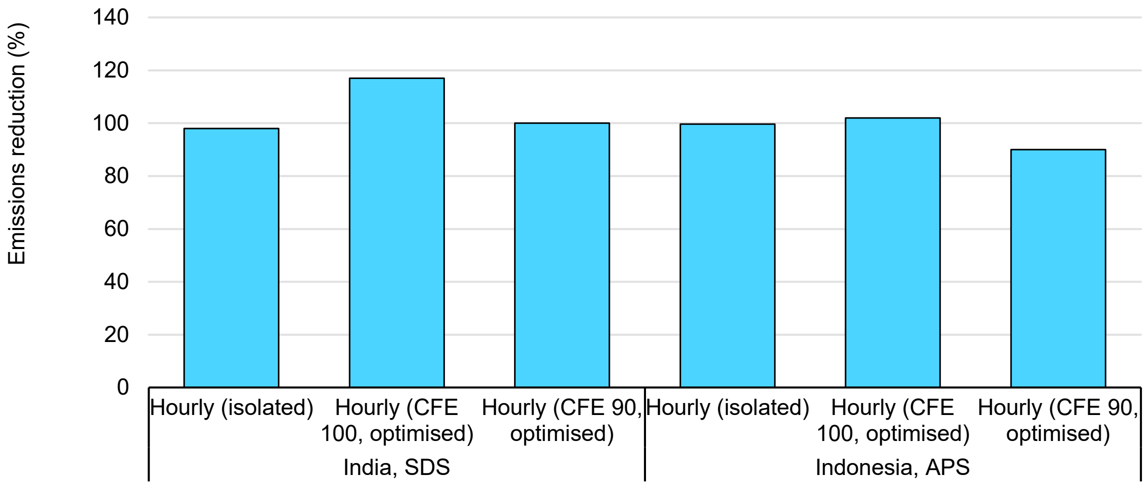


Notes: CFE = carbon-free energy, SDS = Sustainable Development Scenario, APS = Announced Pledges Scenario.

The analysis shows that corporate procurement of clean energy can bring more value to the system when dispatch is based on whole-system optimisation. In both models, the cost reduction for the CFE 90 portfolio for optimised dispatch is similar to that of the CFE 100 portfolio being operated on a siloed basis. This highlights that taking the whole-system perspective and allowing for interaction between corporate resources and the rest of the system can deliver more efficient outcomes from both the corporate and whole-system perspectives. In practical terms, wholesale price signals that account for aspects such as emissions and defining clear balancing responsibilities can contribute to ensure that clean energy is dispatched to maximise overall system efficiency.

In parallel, it is important to directly assess the emissions impact of the different procurement options and dispatch strategies. Depending on the presence of carbon pricing and other system characteristics, optimised dispatch could either decrease or increase emissions. As such, this outcome needs to be analysed directly.

Reduction in CO_2 emissions due to different clean energy strategies with both siloed and optimised dispatch for hourly matching in India and Indonesia, 2030



Notes: CFE = carbon-free energy, SDS = Sustainable Development Scenario, APS = Announced Pledges Scenario.

For both models, as expected, operating the hourly portfolio to match the corporate load alone achieves close to 100% emissions reduction. In India, optimising the dispatch of corporate generation substantially increases the emissions savings, as corporate generators export a significant volume of clean electricity to the rest of the system. The CFE 90 portfolio also achieves close to 100% emissions reduction relative to the corporate emissions in India, since emissions caused by corporate imports in some hours are balanced by clean electricity exports at other times.

For the Indonesia model, the emissions reduction from optimised CFE 100 is only slightly above the siloed case while CFE 90 dispatch results in less than 100% emissions reduction. In the latter case, the imbalance is because the corporate portfolio exports less energy to the rest of the system than it needs to draw.

These analyses highlight that emissions outcomes vary substantially according to the clean electricity strategy and the power system in which load and procurement are located. This underlines the importance of estimating the emissions impact as part of selecting and carrying out a net zero emissions electricity goal.

Achieving net zero

Annual electricity matching goals have been relatively fit-for-purpose over the last decade when the main priority for power system decarbonisation was increasing renewables deployment. For systems today that are still in lower phases of renewables integration, these strategies can still provide needed impetus to increase clean electricity supply. For companies seeking to help lead net zero transitions, more granular strategies such as hourly matching can deliver the full portfolio of technologies needed to decarbonise the entire power sector.

Annual electricity matching will continue to play a role in power sector transitions and regulators need to ensure clear allocation of costs for use of the grid and power system services. In systems where renewables deployment requires policy support, regulators should design remuneration mechanisms to ensure that all parties contribute to reducing the impact on overall system costs and allow system operators to cover additional costs efficiently.

Electricity consumers undertaking procurement should ensure that their generation assets are available to support system needs. In some markets, it may be possible to operate corporate assets exclusively to follow corporate load. This is not, however, the most cost-effective approach and it does not maximise the emissions reduction impact of procurement. Consumers pursuing clean electricity strategies that include procurement of clean dispatchable resources and demand response should also adopt a systems perspective. This potentially includes depending on the power system for some services and allowing their assets to provide value to the rest of the system.

Detailed recommendations

Across all types of power markets, achieving net zero emissions ambitions requires engagement of all stakeholders – from the policy makers and regulators who establish 'how' systems and markets function through to the system operators and end-consumers, whether large corporations or individual households.

Drawing on analysis presented across this report, this chapter synthesises key recommendations, grouped by the actors who can implement them. As a whole, these recommendations should contribute to ensuring that clean electricity procurement options are available to consumers of all sizes and that their efforts contribute effectively to emissions reduction such that all share in the benefits of electricity systems that are cost-efficient, reliable and mitigate the impacts of climate change.

For policy makers and regulators

A key role of policy makers is to ensure consistency across various policy objectives in the energy market. This includes putting in place mechanisms to ensure that clean electricity procurement strategies implemented by companies or organisations, whether individually or collectively, are not simply linked to clean electricity that policy already enables but truly adding clean generation to power systems and advancing progress towards overarching goals. Crucially, policy makers need to ensure that mechanisms exist allowing corporate consumers to go above and beyond existing clean electricity mandates.

Regulators can also play a crucial role in enabling diverse options to support the emergence of clean energy procurement models. Whether the regulator is independent or integrated into the energy ministry, regulation effectively determines the rules for all stakeholders involved. This encompasses creating specific legal frameworks that enable market access (directly or indirectly), defining conditions of entry, setting use-of-network access charges, and determining rate design for small and large consumers.

To ensure consistency across enabling policy and regulatory actions, it is crucial that the decision makers defining objectives and rules have a strategic approach with a clear planning horizon. On one hand, this allows the right sequence and timing of new laws, regulations and technical standards; on the other hand, it allows companies and consumers to participate in clean energy procurement in an effective and cost-efficient manner.

The following recommendations group actions that should be taken by both policy-making and regulatory bodies. This reflects the fact that policy makers and regulators must work closely to enable clean electricity procurement while recognising that the allocation of responsibilities between these two types of actors varies across jurisdictions.

- **Reduce barriers to clean electricity procurement to maximise the array of options available to all buyers.** Corporate and commercial buyers have different needs and abilities in clean electricity procurement. As such, it is important that policy makers enable choice, allowing both large and small consumers to define purchasing strategies that best fits their organisations.
- **Develop clear rules to ensure that voluntary actions go beyond mandates set out in existing policy frameworks and do not reduce the obligations of other participants**. With many organisations implementing actions to meet their own net zero goals, mechanisms are needed to ensure they are adding clean energy above what is already required by existing mandates. In the case of international procurement, this includes establishing mechanisms to ensure correct interaction among objectives in different countries such that a given procurement activity is not counted towards decarbonisation objectives in both (analogous to the corresponding adjustment for carbon credits).
- **Ensure mechanisms such as EACs are available for trading clean generation that goes beyond existing mandates**. As EACs are one of the more accessible and widely used options for corporate procurement, policy makers should make them available where possible. In turn, accounting and reporting of certificate schemes must be made compatible with the country's clean electricity targets and mandates. This implies, for example, establishing clear guidelines as to what should be reported as part of the country's own policy-driven process and what reflects voluntary initiatives. Policy makers should also support including more granular time- and location-based information in certificate schemes to increase their applicability for consumers pursuing more ambitious procurement goals. The interaction between time-based certificates and existing annual certificates must be designed carefully so that hourly goals do not result in simply reallocating certificates from existing generation.
- **Develop mechanisms to ensure compatibility between clean electricity mechanisms and carbon markets, where applicable, and avoid double issuance**. Depending on the specific power system, corporates implementing their own net zero or decarbonisation targets may choose to fulfil part of them through the purchase of carbon credits. As carbon credits tend to be traded internationally, it is important to ensure compatibility and verifiable tracking between clean electricity bought in one country and carbon credits bought or sold from abroad – i.e. it is crucial to ensure that the credit trade actually contributes to decarbonising the local power system. It is also necessary to eliminate any possibility that any kilowatt hour of generation is involved in double issuance, i.e. that both an EAC and a carbon credit are issued and claimed separately.
- **Open new pathways for independent generators and clean energy procurement**. In both single-buyer, integrated and liberalised electricity system

models, collaboration between policy makers and regulators is essential to empower regulators to open new participation possibilities and to co-ordinate how regulation can enable such participation. One example is the need to ensure non-discriminatory network access.

- **Introduce incentives or requirements for both liberalised and regulated utilities to offer green tariff schemes and green power products**. In markets where consumers are not able to procure their own electricity directly – or for consumer segments that do not have direct access to markets – regulators should ensure that all consumers have the possibility to opt into a clean electricity supply arrangement. In markets where local utilities have an area concession, such as South Africa or some states in the United States, this might require empowering the utility to procure their own electricity or establishing other ways to ensure that clean electricity offers are available to consumers. Regulators can also update tariff design, particularly in countries that are just starting to deploy clean energy, to empower consumers to install clean energy on-site. This is important to ensure that small companies have access to clean electricity procurement.
- **Review ancillary service and network charges to ensure a clear allocation of costs that provides incentives for all stakeholders to participate in reducing system costs**. Often, on-site clean energy procurement is driven by an economic incentive to avoid certain regulated costs. Regulators should review rate design aspects to ensure that clean energy procurements are economical and make necessary adjustments to recognise any additional burden or contribution to the power system.
- **Work with planners and developers to ensure long-term visibility for network planning.** Whether a function of the ministry or the network operator, long-term planning is important to properly account for the conditions of the transmission and distribution network and to ensure that market signals orient investments to the areas that bring the most value to the power system. If price signals and investment incentives are not aligned with network constraints, it could lead to new capacity creating additional constraints and eventually higher system costs for all consumers. Scenario-based analysis for network development, taking into account the country's decarbonisation objectives, can help planners identify potential network reinforcement needs well in advance.
- **For interconnected power systems, ensure clear and economical rules for allocating cross-border transmission capacity**. Across a number of markets with nascent demand for direct clean energy procurement, despite an economic case for investing in low-cost renewables, the lack of clear processes for determining network access and wheeling charges can be a major barrier. Implementing transparent methods to determine network charges and solving network capacity allocation issues among jurisdictions will help make clean electricity procurement more attractive, particularly for large-scale, off-site, grid-connected projects.
- **Engage in cross-industry collaboration to develop clear and transparent reporting mechanisms.** A main priority during the emergence of direct clean

energy procurement and EAC trading, particularly related to the ability of organisations to report green credentials, has been the need for consistent monitoring mechanisms. Particularly in systems in which multiple clean energy procurement systems co-exist, it must be possible to account for all of them consistently. Policy makers should actively engage in developing reporting guidelines that also improve how the country monitors its own decarbonisation progress.

- **Ensure the availability of high-quality power system data that enables consumers to assess their emissions impact.** The development of robust information systems to monitor the type of generation and consumption taking place over time and in relevant grid locations is essential to the expansion of clean electricity procurement schemes and to efficient integration of new generation technologies. Regulators should introduce reporting obligations and information reporting standards that enable interoperability across all consumer segments and corporate procurement approaches. Whether the obligation to operate the platform is delegated to the system operator, the incumbent utilities or an independent clearing platform, the regulator should establish the foundation for a sound data ecosystem.

For system operators and network owners and operators

Across the world, the tasks of system operation, network ownership and network operation are allocated differently. They may be carried out by separate independent system operators, by regulated utilities that own and maintain the physical network, or by integrated utilities that carry out all the tasks in-house. Recommendations in these areas therefore apply to the relevant organisation undertaking these activities rather than a unique stakeholder type.

- **Collaborate with regulators and developers to ensure that new investments do not lead to additional transmission constraints**. In terms of network development, system operators need to offer greater visibility about where new generation can best support the system and establish processes to co-ordinate a smooth interconnection process for new generation. Depending on the power system, network operators may be able to introduce provisions for generators to pay for the cost of additional reinforcements needed for interconnection, ensuring that the calculation accounts for impacts this may have on the cost of new projects and allocation of costs for subsequent projects that benefit from the newly available grid capacity.
- **Work with regulators to update balancing and forecasting rules.** With greater shares of decentralised and distributed variable generation, system operators will need to introduce requirements for telemetry and remote operations, at least for large-scale generation. Here, it is also key that requirements are in place for self-forecasting and balancing for large plant operators or large consumers with self-generation schemes.

- **Develop procedures to ensure that assets in direct procurement schemes are dispatched in a system-optimal way**. For small-scale variable renewable generation (e.g. solar PV for self-consumption), develop a registry of installations as well as tools to forecast the potential output close to real time and optimise the allocation of reserves.
- **Develop the expertise and infrastructure necessary to monitor, ensure visibility of and manage decentralised and distributed generation efficiently**. Developing an understanding of how distributed assets interact with the grid and establishing dedicated procedures to dispatch distributed and aggregated assets can reduce the long-term increase in balancing costs. It can also encourage deployment of distributed energy resources such as batteries and smart charging.

For organisations procuring clean electricity

For both small and large consumers, a range of options exists to ensure their procurement activities result in a real increase in clean electricity.

- **Signal interest in helping decarbonise power systems by introducing clean electricity goals.** By setting these goals, companies can encourage policy makers to pursue more ambitious decarbonisation strategies and create momentum for clean energy transitions, thereby increasing deployment and reducing technology costs. While different types of goals have different benefits, all procurement strategies (including annual matching) bring value to power systems.
- **Take steps to enhance emissions accounting and reporting.** This includes applying a marginal impact methodology to guide decision making related to procurement. This is important to organisations in terms of both reputational impact and ensuring their investments truly contribute to decarbonisation. With emissions reporting emerging as a metric for investors, implementing verifiable methods for emissions reduction will increasingly help ensure access to finance. Such reporting includes actively assessing the impact of clean electricity strategies, publishing comprehensive data on company emissions impacts (Scopes 1 and 2 and assessment of Scope 3), and ideally clearly acknowledging how company efforts align with and benefit from government targets and support schemes. Companies should also collaborate with system operators and regulators by communicating to the relevant authorities when required data is not available or accessible.
- **Companies can help lead clean energy transitions by looking beyond annual matching to clean electricity strategies that support deployment of flexible technologies.** While annual matching goals can build momentum for direct energy procurement, flexible technologies will be needed for a full net zero transition of the power sector. Companies and organisations can take the lead in accelerating decarbonisation by setting more ambitious goals that help accelerate deployment for the full portfolio of clean dispatchable technologies needed.

- **When pursuing hourly matching strategies for clean electricity investment, allow for interaction with the power system to reduce emissions and incentivise clean flexible technologies while avoiding inefficient investments**. As shown in the India and Indonesia modelling analysis, strategies that consider hourly demand matching help to incentivise flexible technologies. In many cases, it will be more efficient to still depend on the grid for some services, which can be paid for through appropriately defined network tariffs. Corporates can also achieve hourly strategies more efficiently by trading clean generation with other companies, such as through time-granular certificate schemes. By enabling dispatch of their assets in consideration of power system needs (as opposed to following only their own demand profile as if separate from the grid), companies can contribute to power system decarbonisation more efficiently.
- **Work together with other clean energy consumers to expand procurement opportunities, share knowledge and expertise, and ensure consistent reporting**. Typically, larger corporations have greater expertise and capabilities to enter into long-term agreements such as PPAs as well as to negotiate specialised tariff arrangements or wheeling agreements. As economy-wide net zero will require decarbonisation across the entire power system, clean electricity procurement efforts will have more impact if they boost access for both small and large consumers. Establishing transparent reporting mechanisms and sharing experience will be essential to enable both large and small consumers to participate in and benefit from clean energy procurement.
- **Take into account, particularly for companies with international reach, the impact of location in their investment decisions for both load centres and clean generation**. Having a detailed understanding of the emissions impact of different locations for load and generation will allow companies to make the best decision in terms of power system decarbonisation. Depending on the geographical distribution, when making decisions about siting, companies may need to consider the balance between effective emissions reduction and hedging between different markets.
- **Trial pilot projects, particularly for small businesses, can be a way to participate with other businesses, retailers and policy makers to develop new procurement models.** Sharing expertise built through pilots (e.g. aggregating loads for clean electricity procurement) and communicating results and limitations for implementation is a good first step towards enabling clean power purchasing options. Engaging with utilities, policy makers and regulators early on can accelerate the roll-out of new models and spur innovation.
- **Work with utilities to establish new procurement mechanisms and appropriate contract structures.** Large consumers have the potential to work and negotiate directly with utilities to develop more clean energy offerings, particularly in markets in which direct procurement through PPAs is not an option. A parallel benefit is that building the expertise and infrastructure for clean energy offerings for large consumers can eventually help open the market for smaller consumers.

Annexes

Modelling methodology

To provide a deeper analysis of how corporate procurement could impact future power systems, the IEA has carried out two case studies on corporate-driven, cost-optimised capacity expansion, using our India Regional Power System Model and our Indonesia Regional Power System Model. The base scenarios analysed are the Stated Policies Scenario (STEPS) and Sustainable Development Scenario (SDS) for India and the Announced Pledges Scenario (APS) for Indonesia.

Each case assumes that, in line with different clean electricity goals, corporates procure clean electricity generation amounting to 10% of commercial and industrial demand. This fixed share is used to illustrate the impacts of different clean electricity goals. In practice, some barriers to procurement exist in both countries (as discussed in the third chapter).

Both models undertake a techno-economic analysis, using a production cost modelling approach to examine one-year "snapshots" for 2030 (with 2020 included as the reference year for India). The capacity expansion supplies a 10% share of corporate demand, resulting in additional clean electricity capacity, above the levels in the World Energy Outlook scenarios, to reflect different corporate clean electricity goals. Build cost assumptions and other techno-economic inputs come from World Energy Outlook modelling. Available clean technologies modelled include solar PV and wind as well as small hydropower, biomass, geothermal, concentrating solar power, combined cycle gas with carbon capture and storage, and nuclear technologies.

Following the capacity expansion analysis, a detailed hourly model was then run to obtain the most accurate annual results for emissions and operational impacts. The hourly modelling includes detailed operating characteristics (e.g. operating costs, plant technical minimum operating levels, minimum up and down times, start-up times, and ramp rates) as well as interregional transmission. It is important to note that an hourly time resolution does not fully capture aspects such as plant-level ramp rate restrictions and that some metrics (e.g. renewables curtailment) may be underestimated relative to a more granular time resolution.

Emissions are estimated based on fuel characteristics and plant efficiencies. Renewables sites are selected using detailed geospatial analysis that takes into account resource characteristics and factors such as land use, slope, altitude, proximity to cities, roads and transmission infrastructure, and weather data. Renewables generation profiles are then based on weather data from the ERA5 database (obtained from Copernicus Climate Store), which is processed using US National Renewable Energy Laboratory's (NREL) PySAM.

To provide hourly electricity demand curves, load profiles for both models are based on detailed bottom-up analysis from the World Energy Outlook, which estimates hourly demand by end-use for all demand sectors. The hourly profile of the aggregate corporate demand is made up of a 10% share of all industrial and services sector hourly end-use profiles. Annual electricity demand projections for each end-use sector rely on national macro indicators (e.g. population dynamics and economic growth), integrating the latest policies. The potential for demand-side response by end-use is based on projected demand in each region. Power generation capacity expansion in the STEPS, SDS and APS is determined on the basis of current and proposed policies and the value-adjusted levelised cost of electricity. The model assumes that projected capacity for existing and new technologies is made available for dispatch.

The India regional model includes a representation of the five regions comprising the Indian power grid (which are controlled by regional load dispatch centres) and the interregional transmission connections. Transmission is based on Central Electricity Authority plans. The Indonesian model disaggregates the Indonesian power system into five regions represented by Java-Bali (JVB), Sumatra (SUM), Kalimantan (KLM), Sulawesi (SLW), and the rest of Indonesia – which comprises the combined regions of Maluku-Papua-Nusa Tenggara (MPN). A very limited amount of interconnection is modelled between the regions in 2030, with only 1 GW of transmission capacity between Java-Bali and Sumatra. The rest of the systems operate independently.

Summary of cases analysed

Case	Description
Main	Baseline World Energy Outlook scenarios including 2020, 2030 STEPS and SDS for India and 2030 APS for Indonesia
Corporate load excluded	A case with the participating corporate load removed from the model to calculate its marginal impact on system operations
Annual procurement	Clean energy procured to match 100% of participating corporate load on an annual basis
Monthly procurement	Clean energy procured to match at least 100% of participating corporate load in every month
24/7 CFE 90	Clean energy procured to provide the participating corporates with a CFE score of 90 on average across the year
24/7 CFE 100	Clean energy procured to provide the participating corporates with a CFE score of 100 on average across the year

Case	Description
Test load (x5 per country)	100 MW average annual load (shape based on commercial and industrial load profiles) added separately to each model region
Test generator (x5 per country)	Solar generator with 100 MW average output added separately to each model region

Calculation methodologies

All emissions, cost and value impacts are calculated on a marginal basis by comparing model runs with and without the relevant load or interventions included in the target year. This approach accounts correctly for the full depth of the intervention (i.e. it can recognise the impact of increasing or decreasing generation from multiple plants at each point in time). As a result, it provides an evaluation for emissions that is more accurate than analysing, for example, only the marginal plant. It also captures all different impacts on system operations, such as changes in the amount of system ramping or startups and shutdowns. To estimate emissions caused by corporate load, for example, the model compares emissions in the base case (E_{Base}) against those with corporate load excluded (E_{NoCL}).

$$Emissions\ caused = E_{Base} - E_{NoCL}$$

Similarly, the underlying cost to serve the corporate load is obtained by comparing the same two cases, for each cost component.

$$Cost\ to\ serve\ load = C_{Base} - C_{NoCL}$$

C_{Base} and C_{NoCL} reflect the total system operating costs in the cases with and without corporate load included. This can also be considered a long-term marginal cost approach since it evaluates the impact in future scenarios. This could be further enhanced by analysing the impact of procurement across the entire lifetime of the assets.

To assess the system value and emissions reduction that procurement provides, we analyse a third case that includes both corporate load and corporate procurement. We calculate emissions reduction as a percentage of the quantity of emissions caused by the corporate load in the absence of procurement:

$$Emissions\ reduction = 100 - \frac{E_{Proc} - E_{NoCL}}{E_{Base} - E_{NoCL}} * 100$$

Where E_{Proc} is the emissions with both corporate load and corporate procurement included.

Similarly, the value contributions are calculated based on the degree to which procurement alleviates the costs incurred to serve the corporate load. This value could be negative if the costs are actually higher due to procurement, as in the case of some operating costs relating to plant startups and ramping:

$$System\ value\ of\ procurement = C_{Base} - C_{Proc}$$

Where C_{Proc} is the total system operating cost in the case with both corporate load and corporate procurement included. To illustrate the benefit of optimised whole-system dispatch, the 24/7 hourly matching strategy is modelled in two ways. In both cases, the capacity expansion is based on the ability to meet the corporate load in each hour of the year. In one case, the hourly dispatch runs such that the corporate portfolio exclusively serves the corporate load on an hourly basis; in the other, the output of the corporate portfolio is optimised with the rest of the system for overall least-cost.

Abbreviations and acronyms

AIB	Association of Issuing Bodies
APS	Announced Pledges Scenario
BTM	behind-the-meter
CCXG	Climate Change Expert Group
CDM	Clean Development Mechanism
CFE	carbon-free energy
CO_2	carbon dioxide
COP	Conference of the Parties
DISCOM	distribution company
EAC	energy attribute certificate
ENTSO-E	European Network of Transmission System Operators for Electricity
ESA	Energy Supply Act
EU	European Union
FIP	feed-in premium
FIT	feed-in tariff
GEC	Green Electricity Certificate
GHG	greenhouse gas
GO	Guarantee of Origin
ICT	information and communications technology
IEA	International Energy Agency
IPP	independent power producer
I-REC	International Renewable Energy Certificate standard
NDC	nationally determined contribution
NREL	National Renewable Energy Laboratory
OECD	Organisation for Economic Cooperation and Development
PLN	Perusahaan Listrik Negara
PPA	power purchase agreement
PSE	Puget Sound Electricity
PV	photovoltaic
RE100	Renewable Energy 100
REC	Renewable Energy Certificate
RED III	Renewable Energy Directive III
REIPPP	Renewable Independent Power Producer Programme
RES	Renewable Energy Sourcing
REV	Renewable Energy trading Value
RTE	Réseau de Transport d’Électricité
SBTi	Science Based Targets initiative
SDS	Sustainable Development Scenario
SMEs	small and medium enterprises
STEPS	Stated Policies Scenario
T&D	transmission and distribution
T-EAC	time-dependant energy attribute certificate
VRE	variable renewable energy
WWF	World Wildlife Foundation

Glossary

kWh	kilowatt hour
MW	megawatt
MWh	megawatt hour
GW	gigawatt
GWh	gigawatt hour
TWh	terawatt hour

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