2 Planning and governance for bioenergy development

Colombia's ambitious decarbonisation targets are supported by a number of national policy strategies, such as the Green Growth Policy (Política de Crecimiento Verde) and the forthcoming energy transition policy (Política de Transición Energética). Yet, fossil fuels still account for over half of energy supply outlooks to 2050. A clearer strategy for Colombia's clean energy transition is therefore needed to encourage finance and investment in renewable energy solutions. This includes reflecting long-term power sector needs and opportunities within short- to medium-term generation expansion plans, which do not currently reflect the technical or socio-economic value of potential clean energy solutions like biomethane electricity production. Additional measures such as a more streamlined planning and approval process for power generation projects can equally help reduce barriers to bioenergy development.

Highlights

- Colombia has put forward a number of national policy strategies that emphasise the country's commitment to climate action, but bioenergy opportunities, beyond high-level mentions, are not spelled out clearly in energy transition plans to 2050.
- The cross-sectoral nature of bioenergy projects can involve multiple actors and various regulations, making for a complex policy environment for developers to navigate. Improved planning and co-ordination across government authorities and relevant stakeholders will help to identify and streamline barriers to bioenergy projects.
- While decarbonisation is highlighted as a priority in national energy plans, fossil fuels still account for as much as 55% to 66% of energy supply to 2050. Spelling out a clear strategy on how the government plans to achieve the clean energy transition and its emissions reduction targets will encourage development and investment in bioenergy solutions such as biogas.
- Reliance on current project pipelines in the Reference Generation and Transmission Expansion Plan does not reflect the technical opportunities or socio-economic value of potential clean energy solutions like biomethane electricity production. Generation plans can do more to reflect policy ambitions using techno-economic models that consider how to meet power system needs in the most efficient or acceptable manner, as is often done in other countries.
- The multi-year approval process for electricity generation projects and grid connection can be a barrier for bioenergy projects, particularly for smaller developers that may need support to navigate multiple policy environments. Shortening lead times and facilitating the planning and approval process can help create an early pipeline of bioenergy projects and attract greater interest in developing future capacity additions.

Colombia only represents around 0.5% of global greenhouse gas (GHG) emissions (ClimateWatch, 2021[1]), but the country has nevertheless set ambitious emissions reduction targets in its recently revised Nationally Determind Contibutions (NDC) under the Paris Agreement, aiming to cut emissions by 51% by 2030 with appropriate international funding support (Climate Action Tracker, 2021[2]). That target is up from the 30% previously indicated in Colombia's 2015 NDC (Government of Colombia, 2015[3]), demonstrating the country's commitment to climate action on the international stage. The update also aligns more closely with ambitions to achieve carbon neutrality by 2050, as set forth by the Ministry of Environment and Sustainable Development (Ministerio de Ambiente y Desarrollo Sostenible, MADS) in its long-term strategy to face climate change (MADS, 2020[4]).

To achieve these emissions reduction targets, Colombia has a number of national policy strategies touching upon the country's clean energy transition, including the government's 2018 Green Growth Policy (Política de Crecimiento Verde),[1] the 2019 National Circular Economy Strategy (Estrategia Nacional de Economía Circular),[2] and a forthcoming energy transition policy (expected in late 2021). Given Colombia's abundant bioenergy resources, the strategies take note of the role these solutions can play in supporting decarbonisation objectives through fossil fuel substitution (e.g. through biogas production), whilst also addressing the environmental impact of Colombia's waste streams.

At the same time, Colombia's strategic policy still includes a notable reliance on fossil fuels in the country's long-term energy vision to 2050, and bioenergy mentions, while noted, remain relatively high level and non-specific. A clearer indication would thus help to set forth the role these opportunities are expected to play in reducing emissions to 2050, particularly given the more complex nature of bioenergy projects (e.g. in sourcing, sorting and treatment of waste). A more strategic policy framework for bioenergy would also

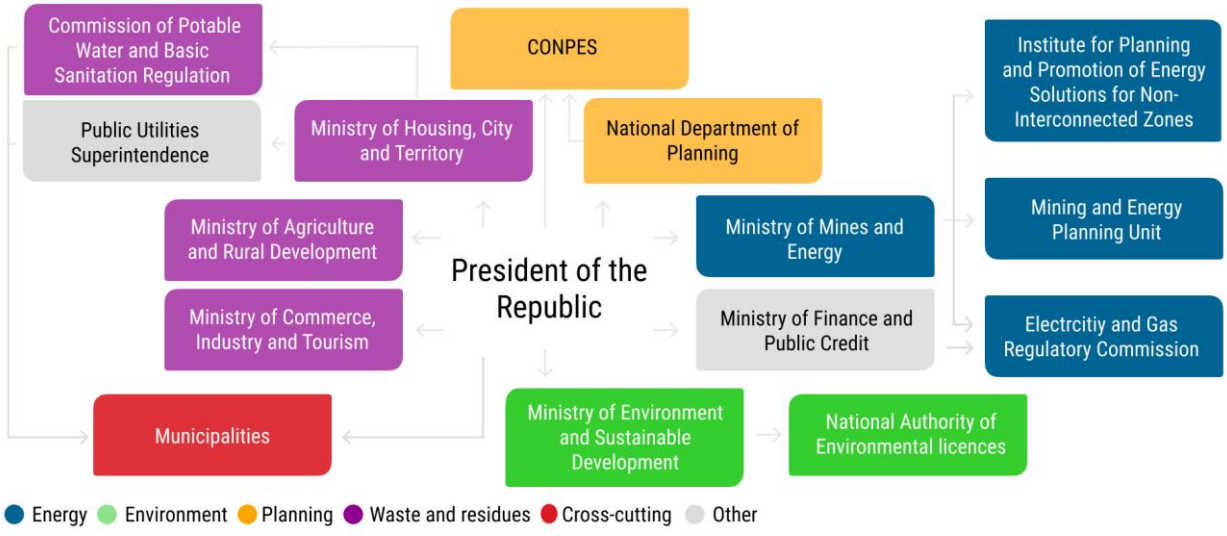
help to tailor any measures or policy support to stimulate market growth, for example for solutions like biogas and biomethane production that have yet to gain real traction. This type of national strategy for bioenergy development would equally encourage a more coherent institutional framework, especially given the number of actors and policies that touch upon agricultural, industrial and municipal waste streams.

Increasing institutional co-ordination will facilitate bioenergy development

Colombia's clean energy transition and the potential role for bioenergy to diversify the country's energy mix are touched upon in a number of national strategies set forth by the National Council for Social and Economic Policy (Consejo Nacional de Política Económica y Social, CONPES). These strategies, co-ordinated by the National Planning Department (Departamento Nacional de Planeación, DNP), provide an overarching planning framework to evaluate and direct policy priorities across government bodies, where DNP is the executive administrative agency in charge of leading, co-ordinating and defining inter-sectoral public and economic policy.

The Ministry of Mines and Energy (Ministerio de Minas y Energía, MME) is then the primary authority for the energy sector, whilst a number of other government bodies also influence the energy market and policy related to bioenergy and waste (Figure 2.1). For example, MME oversees regulation of the electricity market, but the Energy and Gas Regulation Commission (Comisión de Regulación de Energía y Gas CREG), sets the rules and roles for participating agents in the electricity market. CREG also sets eligibility criteria for non-conventional renewable energy (NCRE) incentives, including for related bioenergy projects.

Figure 2.1. Authorities influencing national bioenergy governance in Colombia



Note: the table only reflects governance at the national level and does not account for subnational authorities influencing bioenergy.
Source: Adapted from (OECD, 2021[5])

The Planning Unit of the Ministry of Mines and Energy (Unidad de Planeación Minero Energética UPME), oversees and determines the country's long-term energy strategy, including importantly the National Energy Plan (PEN), which established long-term scenarios for renewable energy development. UPME also sets short- to medium-term energy strategies for NCRE development via its Reference Generation and Transmission Expansion Plan, and part of this is touched upon by the Institute of Planning and Promotion of Energy Solutions in Non-Interconnected Zones (Instituto de Planificación y Promoción de Soluciones Energéticas para Zonas No Interconectadas, IPSE). Specifically, IPSE plans, identifies, implements and monitors sustainable energy solutions for Non-interconnected Zones (ZNI).

The wide scope of bioenergy and waste means several other ministries influence the policy framework for these projects. For example, the Ministry of Agriculture and Rural Development (Ministerio de Agricultura y Desarrollo Rural) oversees rural and agricultural policy, whilst the Ministry of Housing, City and Territory (Ministerio de Vivienda, Ciudad y Territorio) is in charge of urban planning policy, including water, waste and sanitation services. The Ministry of Commerce, Industry and Tourism (Ministerio de Comercio, Industria y Turismo) also influences potential bioenergy use, for example through its industry policy and regulations. Additionally, MADS and the National Authority of Environmental Licences (Autoridad Nacional de Licencias Ambientales) are responsible for any related environmental policy and licencing.

MADS and the Ministry of Housing, City and Territory are two particularly important ministries given their role in overseeing waste streams (including collaboration with the Ministry of Agriculture on organic waste) that are the feedstock for bioenergy projects. For example, the Ministry of Housing oversees the Superintendence of Residential Public Services (Superintendencia de Servicios Públicos Domiciliarios) and the Regulation Commission of Potable Water and Basic Sanitation (Comisión de Regulación de Agua Potable y Saneamiento), which each regulate waste management entities as well as the design and implementation of related policy, such as municipal waste tariffs at landfills. MADS similarly oversees environmental policies related to Colombia's extended producer responsibility programme,[3] which works with industry to improve end-of-lifecycle management of post-consumer waste, such as plastic packaging, batteries and tyres. This, of course, also touches upon policies and regulations overseen by the Ministry of Commerce, Industry and Tourism.

Given the cross-sectoral nature of bioenergy opportunities (e.g. touching on landfill disposal and industry policy), progress on project development can be hindered, in part, by the large number of actors involved, without these necessarily being well co-ordinated. There are currently no mechanisms in place to ensure that ministry objectives and resultant policy frameworks on waste streams and bioenergy development are aligned (DNP, 2018[6]). Enforcement and monitoring can also fall under different authorities at both the national and subnational levels. For instance, municipalities are directly responsible for the design and implementation of their own 12-year waste management plans (planes de gestión integral de residuos sólidos) (RVO, 2021[7]). Yet, these plans do not include considerations for energy recovery, despite allusions to bioenergy and circular economy opportunities in national policy. Varying local regulatory conditions with multiple responsible authorities can also make it challenging for alternative waste treatment solutions to emerge, as developers have to navigate the complex policy environment affecting the chain of activities related to bioenergy projects (Chambers and Partners, 2020[8]). This can add layers of complexity for project development, for instance in acquiring permits and licences. In practice, it also has led to waste being transported long distances to be disposed of in other landfills, rather than employing it as an alternative local energy solution.

Indeed, the juxtaposition of relevant authorities is evident in the government's recent Bioeconomy Strategy,[4] which was developed in participation with no less than six ministries, alongside DNP, the Presidential Council for Competitiveness and Public-Private Management (Consejería Presidencial para la Competitividad y la Gestión Pública-Privada) and several other partners (Government of Colombia, 2020[9]). The strategy outlines a number of important objectives and opportunities to support achievement of the government's vision for a competitive bioeconomy, but it falls short of outlining how these actions will be co-ordinated across the relevant authorities. In fact, the 2018 Green Growth Policy and the 2019 National Circular Economy Strategy both highlighted this issue, emphasising that the untapped potential of waste stream recovery for energy production will require strengthened institutional co-ordination.

To support a robust pipeline of bioenergy development and open the door to investment opportunities in these projects, the government should build upon its ambitious clean energy and bioeconomy strategies with greater planning and co-ordination across relevant government institutions and related stakeholders. This would help to identify and streamline barriers in the regulatory environment for bioenergy and waste-to-energy projects, whilst equally improving use of national and subnational government resources in support of project development. Increased dialogues across public and private stakeholders will also help

co-ordinate activities to identify and support viable projects. Such co-ordination could be led by DNP, in its role on managing inter-sectoral public and economic policy, or possibly through a special task force across key actors, such as those involved in the 2020 Bioenergy Strategy.

One such example of said co-operation for bioenergy development is the Inter-institutional Bioenergy Table that was created in Ecuador. The table was created to co-ordinate actions across several policy authorities in order to identify and implement measures that enable development of activities related to bioenergy, including creation of new value chains and measures that have a positive impact on the country's trade balance.[5] A similar task group known as the Biobased Products and Bioenergy Co-ordination Council[6] was formed in the United States in 2013. This council provided a forum under the Department of Agriculture for government agencies to co-ordinate, facilitate and promote biobased products and bioenergy from agricultural and forestry materials.

Strategic planning can spell out the opportunities for bioenergy projects

UPME's PEN set the long-term framework for national energy policy and outlined four energy pathways to 2050, based on increasing degrees of decarbonisation through penetration of renewable and energy-efficient technologies, as well as through elements of changing consumer behaviour (Figure 2.2). These pathways range from the business-as-usual trajectory ("actualisation"), continuing current market and policy trends, to a "disruption" scenario with technology breakthroughs that would achieve deeper levels of emissions reduction, with a particular focus on penetration of green hydrogen. In between, the "modernisation" scenario places specific focus on natural gas as a transition fuel, and the "inflection" scenario focuses on increasing electrification with greater penetration of renewables (including bioenergy, offshore wind and geothermal technologies) as well as some nuclear energy.

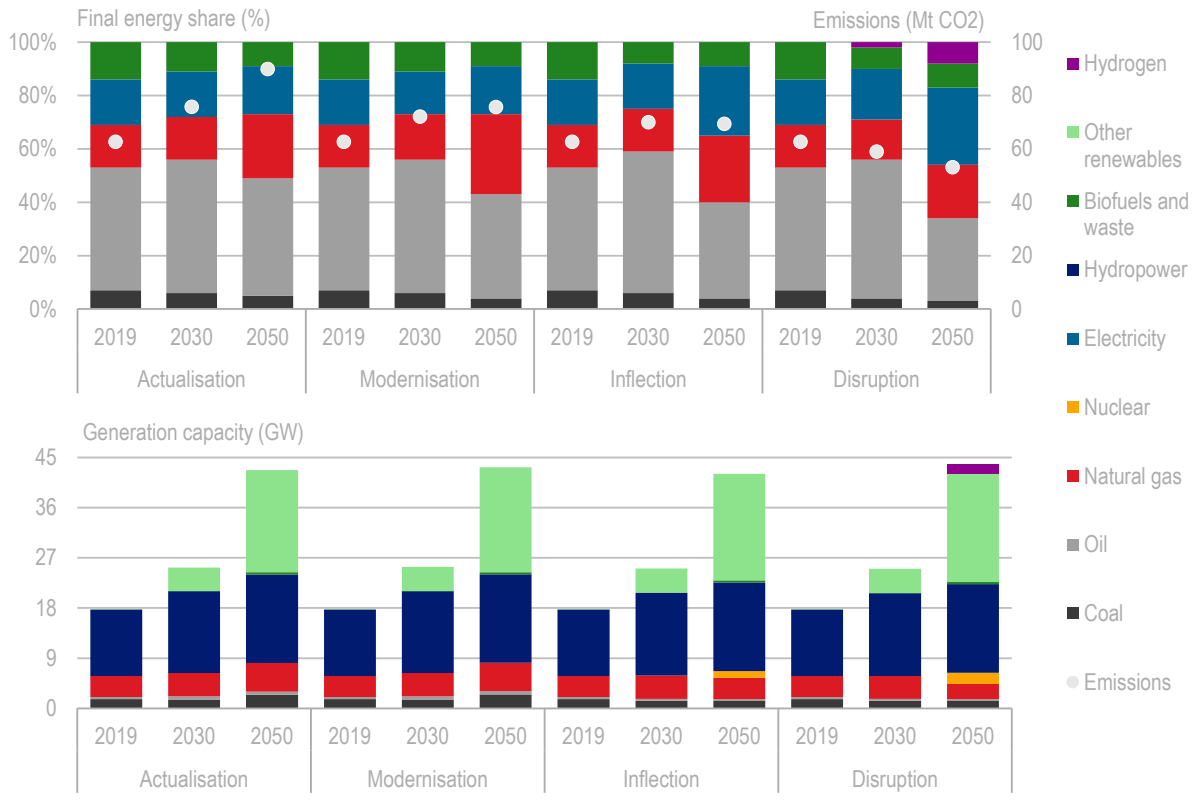
Under the actualisation scenario, energy demand is set to grow by 48% over 2019 levels, driven in particular by projected economic growth and continued rise in household income. Strong reliance on coal and oil leads to 55% growth in energy-related emissions by 2050 over 2019 levels, while in the modernisation scenario, expanded use of natural gas and liquefied petroleum gas help to transition energy demand away from coal, in line with currently stated policy ambitions. Still, energy-related emissions continue to increase in the modernisation scenario, even if less sharply than in the actualisation case. Neither pathway thereby aligns with Colombia's NDC to 2030 nor with the government's long-term decarbonisation ambitions.

The inflection and disruption scenarios require a more substantial change in energy policy priorities. This includes greater levels of renewable energy penetration as well as support to develop and deploy "disruptive" technologies such as carbon capture and storage. Both alternative pathways see emissions reduced compared to the actualisation scenario to 2050 (by 23% and 41%, respectively), in part because of lesser growth in energy demand (e.g. through energy efficiency measures) and due to use of renewable energy sources (alongside greater electrification). Yet, only the disruption scenario leads to an absolute reduction (19%) in energy-related emissions relative to the 2019 baseline. This scenario also relies heavily on deployment of green (renewable) hydrogen production.

Whereas decarbonisation is highlighted as a priority in all three alternatives to business-as-usual growth, none of these pathways are discernibly aligned with Colombia's new NDC targets to 2030, nor ambitions to move towards carbon neutrality by 2050, as set forward in the MADS long-term strategy to face climate change. Specifically, fossil fuels remain a core component of all the energy scenarios, accounting for as much as 55% and 66% of energy supply across the pathways to 2050 (UPME, 2020[10]). Renewable energy plays an increasingly important role in lower-carbon inflection and disruption scenarios, but overall bioenergy use, despite large technical potential, does not change substantially across the scenarios. Moreover, "biofuels and residues", which include traditional use of biomass as well as modern forms of bioenergy and biofuels, are not broken down in the 2050 outlooks, and waste-to-energy is not included at

all in the scenarios. Thus, while PEN messaging highlights certain fuels such as biogas both as a potential resource for electricity generation and as input to energy supply (e.g. as a natural gas substitute), there are no eventual targets provided under the scenarios.

Figure 2.2. PEN scenarios by fuel consumption, emissions and electricity capacity mix, 2019-50



Source: adapted from (UPME, 2020[10]).

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Bioenergy targets in the clean energy agenda will support project development

A clearer energy transition strategy can provide targeted deployment levels to signal Colombia's intent to develop bioenergy solutions in line with its sustainable development objectives. This includes providing more specific decarbonisation targets for the overall energy sector, as these were not provided within the recently revised NDC. Rather, the update only provided high-level objectives to diversify the country's energy matrix, for instance by promoting self-generation of electricity through alternative fuel sources and by transforming electricity generation in ZNI. This leaves a large gap in expected details on what the energy mix would look like to achieve these objectives, including where solutions like bioenergy development would support the achievement of the country's clean energy transition.

Spelling out these fine points on how the government plans to achieve its NDC will send stronger signals on expectations and opportunities for clean energy development. UPME should consider development of an explicit NDC scenario, underscoring how Colombia can achieve its 51% emissions reduction targets by 2030 through specific clean energy technology deployment and with appropriate international support. This would send clearer indication on policy priorities and investment opportunities with respect to the government's intended medium- to long-term energy transition pathway. It also would help to clarify which

of the PEN scenarios, or perhaps which elements within the different pathways, are expected to achieve the country's NDCs.

On-going preparation by DNP of a CONPES framework for the clean energy transition should help to provide a better assessment of these strategic energy policy priorities over the next decade and beyond. The overall CONPES process is an effective tool for defining, co-ordinating and leading policy actions across ministries, although its impact depends on the level of ambition and the specificity of actions outlined in this strategic framework. One relevant example is the action to promote investment in NCRE electricity generation projects under the 2018 Green Growth Policy. This required MME to provide guidance under its Decree No. 570 of 2018,[7] defining a competitive mechanism for long-term contracting of electric power generation projects. Subsequent MME Resolutions No. 40791[8] and No. 40795[9] of 2018 then provided the regulatory environment for power purchase agreements (PPAs) as well as operational guidance for renewable electricity auctions. Without these, renewable energy progress in recent years would likely have been considerably slower.

As DNP finalises its forthcoming CONPES on the energy transition, it will be important that subsequent measures spell out the planned targets and policy actions to decarbonise the energy sector. This includes clearly defining a long-term strategy to transition from fossil reliance towards solutions such as biogas and waste-to-energy technologies, as current signals do not provide sufficient foresight to clean energy project developers and potential investors. The CONPES could also recommend actions to set legally binding targets for the clean energy transition, as has been done in a growing number of countries. For example, Spain recently passed its Climate Change and Energy Transition Law (Ley de Cambio Climático y Transición Energética)[10] in May of 2021, setting forward a roadmap to reach carbon neutrality by 2050, with specific targets to double renewable energy penetration by 2030 (Climática, 2021[11]). The United Kingdom also enshrined its emissions reduction targets in May 2021 under the government's sixth Carbon Budget,[11] legally limiting the country's emissions to a 78% reduction by 2035, as compared to 1990 levels (Government of the United Kingdom, 2021[12]). France's National Assembly similarly approved a climate law[12] in 2021, not only establishing legal reductions for emissions but also setting specific measures to achieve those reductions, for instance by preventing future airport expansions (Reuters, 2021[13]).

Climate commitments are an opportunity to improve bioenergy capacity

Colombia already has its own climate law (Ley No. 1931 of 2018)[13] that provides guidelines for the management of climate change, including the creation of a National System for Climate Change (Sistema Nacional de Cambio Climático) to formulate, co-ordinate, monitor and evaluate mitigation and adaptation policies. The 2018 Law also established a National Council on Climate Change (Consejo Nacional de Cambio Climático) to advise the Intersectoral Commission on Climate Change (Comisión Intersectorial de Cambio Climático, CICC) on decision-making in order to achieve an effective articulation and management of climate change measures. Additional precisions in the law included details on the economic and financial instruments that relevant public institutions should use in their mitigation and adaptation efforts.

The law and subsequent measures such as the 2020 CICC approval of the baseline to update Colombia's NDCs are laudable measures to empower climate action. Even so, specifics of how these ambitions will be achieved can be spelled out more assertively, providing a transparent long-term decarbonisation strategy to stimulate interest in deploying emissions abatement measures, including in non-energy sectors. For example, around 23% of the country's GHG emissZions are from agriculture, with another 31% from land-use change (e.g. deforestation). An additional 6.3% and 5.5% are from waste and industrial processes (ClimateWatch, 2021[1]). Bioenergy solutions can play a major role in abating these emissions and their environmental impact, for example through recovery of livestock manure for biogas production that would reduce both agricultural and energy-related GHG emissions (e.g. from industry and power generation), whilst equally avoiding soil degradation.

These opportunities, and subsequent actions to enable them, can be laid out further in the design of emerging policy measures such as Nationally Appropriate Mitigation Action (NAMA) that the government plans to implement in support of its NDC. Setting forth details on opportunities and policy ambitions for bioenergy development would equally complement wider socio-economic objectives, such as those set out in the country's 2018-22 National Development Plan (Plan Nacional de Desarrollo).[14] For example, the government is seeking support for NAMA preparation to develop renewable energy solutions in ZNI, where there are strong potential resources to improve electricity access and reliability through bioenergy solutions. Yet, the call[15] only notes clean fuels, solar and wind energy, whereas bioenergy technology and landfill gas collection are unchecked in the request for support (UNFCCC, 2021[14]). A similar request seeking support for preparation of a Sustainable Bovine Livestock NAMA[16] looks to reduce emissions from enteric fermentation but does not note the opportunity to produce bioenergy as part of that NAMA (UNFCCC, 2021[15]). These are potentially missed opportunities to benefit from international support and expertise in the development of bioenergy solutions, for instance as secure, reliable and affordable electricity supply in ZNI.

The government is also considering formulation of a biogas NAMA, which would endeavour to align climate mitigation actions with use of biomass residuals for energy production (Government of Cololmbia, 2021[16]). The proposed NAMA can be an opportunity to outline strategic ambitions for bioenergy development, for example through production of biogas as a substitute for natural gas and LNG imports. It could equally consider relevant implementation support to achieve development of bioeconomy objectives and the 2020 National Strategy for the Circular Economy (Estrategia Nacional de Economía Circular),[17] for instance through technology solutions and best management practices for recovery of organic residues. Such considerations, including applying assessments like the Bioenergy and Food Security Approach,[18] would also help to ensure that development of bioenergy supply chains does not contribute to environmental degradation (e.g. competition for water resources or increased deforestation for biofuel crops).

These types of strategic considerations and subsequent policy signals will help to create the business case for bioenergy development and investment in these projects, building upon Colombia's impressive foundational framework that already distinguishes the opportunity for bioenergy solutions across a number of government strategies. For example, the 2016 National Policy for the Integral Management of Solid Waste (CONPES No. 3874)[19] set forth ambitions to reduce waste going to landfills by promoting the sorting, treatment, recycling and re-use of waste, including as recovery for energy production. Asserting the expected role bioenergy solutions will play in waste management and the clean energy transition will in turn help to make these opportunities clearer in a more predictable policy environment for market actors and investors. It will also help to identify where further policy action or market support is needed, for instance with respect to increasing landfill tipping fees or addressing barriers such as technology cost.

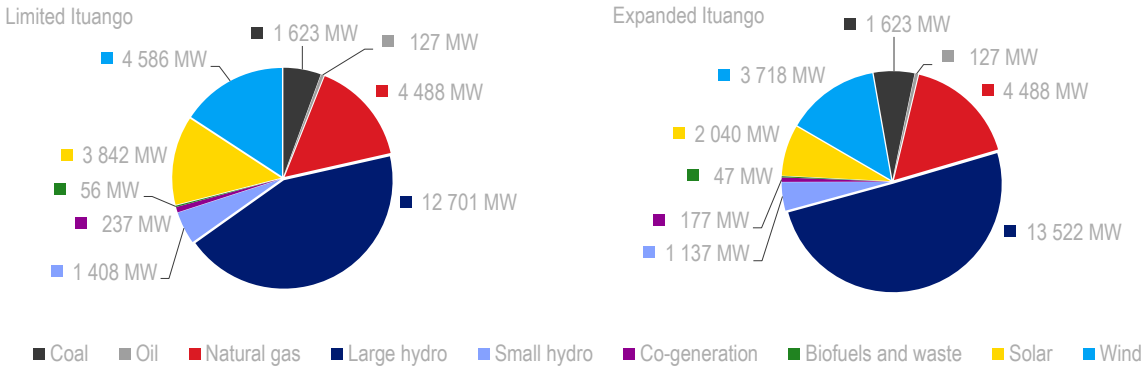
Electricity planning can do more to facilitate bioenergy capacity additions

UPME's Reference Generation and Transmission Expansion Plan is the primary tool for electricity planning and development. It is expounded every three years with subsequent annual reviews. In the baseline scenario of the Plan, capacity additions take into account the existing pipeline of electricity projects that have been successfully approved by UPME for development, either through electricity auctions or by confirmation to connect to the grid. Remaining capacity needs with respect to expected future demand are then determined based on the cost of energy and foreseeable availability of generation technologies in UPME's project registry (specifically, those that have not yet been granted rights to connect to the grid). As such, previously approved projects play a critical role in the baseline electricity generation outlook. Technologies without a clear pipeline of projects accordingly are not well represented in UPME planning.

Colombia's large hydro development project, known as Ituango, is an additional, key determinant in the Reference Expansion Plan. There remains some uncertainty over whether Phase 2 of the Ituango project

will be completed by 2034, thereby influencing the need for greater or lesser additional generation capacity. The uncertainty around this project (ranging from 1.2 to 2.4 GW) leaves considerable ambiguity for NCREs, where over 2.5 GW of renewable electricity generation would be cut if the Ituango project achieves its full capacity. In particular, the share of solar energy would drop from 3.8 to 2 GW of planned capacity. Wind would fall from 4.6 to 3.7 GW, and biomass would fall from 56 MW to 47 MW. Cogeneration likewise would shift modestly from 237 MW to 177 MW (Figure 2.3). By contrast, planned growth for coal and natural gas generation would remain unchanged.

Figure 2.3. Variations in installed generation capacity under UPME's Expansion Plan, 2034



Source: adapted from (UPME, 2020[17]).

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The current Reference Expansion Plan for 2020-34 has four additional scenarios that subsequently model: a one-year delay in the development of the Ituango project; greater influence of El Niño phenomena; inclusion of an emissions tax (USD 5 per tonne of CO_2); and the implementation of environmental flow[20] measures that would limit use of existing hydro capacity. These scenarios have negligible impact on the share of renewables, including bioenergy capacity additions, and underscore the critical influence of UPME's existing pipeline, project registry and grid connection requests on its electricity generation scenarios and Reference Expansion Plan.

While outlooks and scenarios based on current pipelines are not necessarily an issue for short-term projections, the reliance on these projects in the more medium-term UPME planning process does not particularly reflect the technical feasibility or overall socio-economic value of potential clean energy technologies like biomethane electricity production, including how these solutions can deliver on the government's clean energy and sustainable development ambitions.

Emphasis should focus on shaping a vision for clean, reliable and affordable electricity

In other countries, electricity generation plans are often developed with respect to political targets, which either reflect upon or subsequently apply techno-economic models that consider how to meet power system needs in the most efficient or acceptable manner (Box 2.1). For example, Thailand's 2018-37 Power Development Plan explicitly targets renewable energy shares in electricity generation planning, sending a strong political and policy signal in line with the government's Alternative Energy Development Plan, National Strategy on Climate Change and its National Strategy for Eco-friendly Development and Growth (IEA, 2021[18]).

In Indonesia, the State Electricity Company, PLN, sets forth its ten-year Electricity Business Plan, reflecting priorities set forth in the National Electricity General Plan and the country's National Energy Policy, which

provide an overarching policy framework with respect to the government's high-level strategy to achieve energy security and energy independence whilst addressing accessibility, affordability and sustainability of energy supply (OECD, 2021[19]).

Box 2.1. Electricity development under the National Energy and Climate Plan of Greece

The European Union's 2018 Regulation on the Governance of the Energy Union and Climate Action required member states to outline their National Energy and Climate Plans to 2030. The objective of these plans was to provide a coherent picture of how countries aim to meet climate and energy objectives, giving greater visibility to how targets like renewable energy additions are expected to evolve over the next decade, whilst attracting investment and supporting job growth.

The government of Greece noted in its National Energy and Climate Plan that it plans to increase the share of renewable energy sources from 20% in 2020 to approximately 60% by 2030 (equivalent to 9 GW of new capacity over the period). This includes solar and wind additions as well as ambitions to increase bioenergy use for heating, cooling, transport and electricity generation. In particular, the country plans to quadruple the share of biomass and biogas in electricity generation to 1.6 TWh by 2030. It will do so by increasing installed generation capacity by over 200 MW over the next decade. To achieve this ambition, the Plan was accompanied by a number of planned polices and measures aimed at supporting investment, including use of feed-in-premiums, simplification of licencing procedures and prioritisation of energy from agricultural, industrial and municipal waste.

Greece's clean energy deployment targets were determined through a techno-economic assessment considering the potential of various renewable energy technologies to meet the country's energy demand over the next decade and beyond. This assessment was then used to inform market reforms and electricity planning to 2030. For instance, high shares of variable renewable energies like solar and wind will need to be integrated in the electricity system and will influence natural gas capacity additions, which are planned to provide system balancing and reserves as older lignite generation is phased out. Pumped hydro storage, hybrid hydro storage, battery storage and biogas capacity will also support reliable electricity supply. These capacity additions are subsequently featured in the Ten-Year Network Development Plan created by Greece's Independent Power Transmission Operator.

As such, Greece's National Energy and Climate Plan provides political commitment to increase the share of renewable energy as well as clear targets to inform energy system planning. These strategies allow for more targeted policy measures to achieve Greece's stated ambitions, including a clear sense of direction on capacity additions by technology type. In turn, these will help to drive project development and investment decisions for clean energy technologies like bioenergy solutions.

Source: (GoGreece, 2021[20]), (Hellenic Republic, 2019[21]) and (Trinomics, 2021[22]).

The National Electricity Plan of India similarly reflects high-level commitment to transform the electricity sector, specifically by retaining the government's target of deploying 275 GW of renewable energy by 2027. The plan also gives priority to electricity generation technologies (e.g. hydro, bioenergy and natural gas) that can help to deliver on related policy priorities such as the Indian government's goals on reducing air pollution and other GHGs (CEA, 2018[23]).

UPME should consider how best to reflect the role of clean energy technologies within the development of its Expansion Plan. For instance, it can take into account opportunities signalled in high-level policy

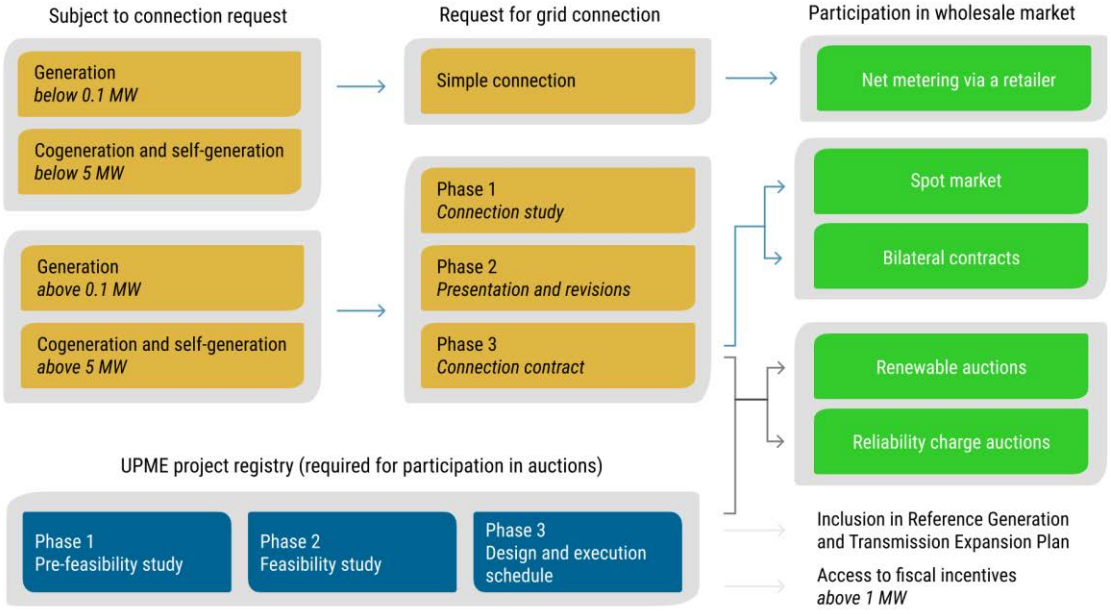
ambitions such as the Bioeconomy and Circular Economy Strategies as part of the country's Reference Expansion Plan to 2034. Integrating these strategies into the country's electricity plans would also help to assess the future availability of sustainable bioenergy feedstock, for example by taking into account the influences of circular economy measures.

Facilitating planning and approval can help build up a pipeline of bioenergy projects

UPME can also consider ways to facilitate the overall planning and approval process, which can disregard the impact of the lead times for projects to enter the pipeline in order to then be considered in the Expansion Plan, thereby creating a sort of recurring loop in which some technologies may consistently be under-represented. This is a particular consideration for bioenergy projects, which similar to other distributed renewable energy technologies may not have the experience or the capacity to navigate a multi-year approval process as would other large national or international project developers, for instance for utility-scale solar and wind developments.

Approval of capacity additions effectively happens in two stages (Figure 2.4). The first is listing in the generation project registry,[21] which indicates if a project has successfully undergone three years of feasibility studies and evaluation. This includes pre-feasibility assessment in Phase 1 (including environmental impact studies), a feasibility assessment considering technical and economic aspects in Phase 2, and finally verification of definitive designs and execution schedule in Phase 3. After successful listing, the second step is then allocation of grid capacity, which indicates that UPME has approved connection to supply electricity to the grid, depending on available capacity at the connection point. This agreement must be obtained in order for a project to be considered as confirmed in the Expansion Plan. Before going to construction, the project must also be accompanied by a bank guarantee, providing evidence that project development will ostensibly proceed.

Figure 2.4. Approval process for electricity generation projects and grid connection



Source: adapted from (UPME, 2007[24]), (UPME, 2016[25]), (CREG, 1995[26]), (CREG, 1998[27]), and (CREG, 2006[28]).

This process can be a barrier, or at least cumbersome, for some project developers, such as bioenergy projects that may have to steer through a number of policy environments in order to demonstrate feasibility and obtain approvals, not only from respective authorities but also if requesting bank financing. The

process can equally create bottlenecks within the pipeline, for example when failed or delayed projects already approved for connection hold up planned grid availability, consequently hindering new projects from obtaining grid connection rights (IRENA and USAID, 2021[29]). CREG published Resolution 233 of 2020[22] in response to this issue, establishing amongst other conditions a time limit for projects to connect to the grid. Yet, the Resolution did not address the potential front-end bottleneck for some projects simply to reach the approval process (and consequently be included in the Expansion Plan).

To facilitate greater interest and investment in bioenergy capacity development, government efforts can focus on supporting an initial pipeline of project approvals with the UPME registry. For example, a pilot programme working with municipalities could work to create a pipeline of new biogas capacity additions. UPME could also consider running dedicated procurement for bioenergy projects, whereby considerations for the added benefits of those projects (e.g. locally available, round-the-clock power capacity without storage facilities) could be taken into account in generation and transmission expansion planning. These types of targeted measures would help to signal to project developers the interest in developing bioenergy capacity, whilst strengthening market demonstration of the economic potential for these technologies to potential investors (RVO, 2021[7]). They also would help to ensure future UPME planning reflects bioenergy opportunities as highlighted in broader strategic policy.

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[5] More information on actions and experiences to promote the development of bioenergy solutions in Latin America and the Caribbean can be found in the LEDS-LAC Bioenergy Community of Practice: https://ledslac.org/comunidades-de-practica/bioenergy/.

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