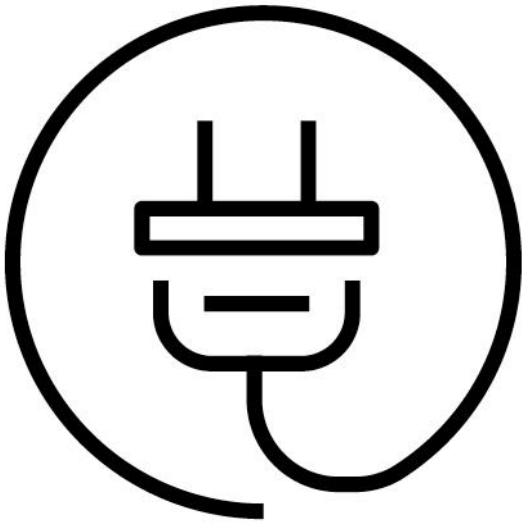

Sectoral Guide Consultation Version 1

Energy access and power generation

GREEN CLIMATE FUND | Sectoral guides

6 May 2022

Green Climate Fund (GCF)
Songdo Business District
175 Art Center-daero
Yeonsu-gu, Incheon 22004
Republic of Korea

www.greenclimate.fund
+82 32 458 6059 (KST)
info@gcfund.org

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CONTENTS

EXECUTIVE SUMMARY

The Green Climate Fund (GCF) is dedicated to boosting climate finance for developing countries and has set an ambitious agenda with its Strategic Plan for 2020-2023[1]. In spite of the global pandemic, GCF is providing increased support to developing countries, helping them to build a low-emission, climate-resilient recovery. The GCF Sectoral Guide series supports the progressive work programme approved for 2020-2023[2] providing evidence-based information for impactful projects in priority investment areas and giving further momentum to making GCF operations more efficient and more effective.

There are eight result areas that GCF has targeted because of their potential to deliver a substantial impact on mitigation (reduction of emissions) and adaptation (reducing vulnerability and enhancing resilience) in response to climate change. Result areas provide the reference points that guide GCF and its stakeholders to ensure a strategic approach when developing programmes, projects, policies and regulations, while respecting the needs and priorities of individual countries. Each GCF Sectoral Guide has certain cross-sectoral issues that are addressed through multiple result areas in a complementary manner, as shown in Table ES-1.

Table ES-1: Cross-sectoral issues addressed throughout the series

Sectoral guide name	Cross-sectoral issues addressed
Agriculture and Food Security	Water pumping, irrigation, food waste minimization applications.
Forest and Land Use	Sustainable land use and sustainable limits for biomass use in energy.
Buildings, cities, industries and appliances	Energy efficient building design, building integrated solar PV, urban rooftop solar.
Ecosystem and ecosystem Services	
Energy Access and Power Generation (This Guide)	Energy from renewable or geothermal sources, produced in a sustainable manner and including solar, wind and tide energy, bioenergy, as well as hydropower; efficient and reliable energy transmission, distribution and storage for an increased share of renewable energy in the energy mix as well as increased flexibility and climate resilience; modern[3] renewable energy for cooking, grid connections as well as off-grid electricity supply such as green micro- and mini-grids and solar home systems for access in remote areas are covered in this guide.
Energy efficiency	Industrial energy efficiency, energy efficient appliances, standards and labelling for energy end-use applications, efficient cooling applications for space, health, and agriculture supply chains.
Health, food, and water Security	Climate resilient health infrastructure
Infrastructure	
Livelihoods of vulnerable communities	
Transport	Electric vehicles and charging infrastructure.

GCF Energy Access and Power Generation Sectoral Guide

Low emission energy access and power generation is a key target for GCF, which contributes to the energy transition by funding energy projects and programmes. The GCF Energy Sectoral Guide supports countries and Accredited Entities (AEs) in their transition towards low-emission energy access and power generation for climate-resilient development. This Guide identifies innovative, high-impact, transformative projects and programmes, providing insights to financial mechanisms in the energy result area, linking these to the GCF

[1] https://www.greenclimate.fund/document/updated-strategic-plan-green-climate-fund-2020-2023
[2] https://www.greenclimate.fund/document/gcf-b28-inf13
[3] Modern renewable energy excludes traditional biomass and liquified petroleum gas (LPG)

Strategic Plan 2020-2023 and GCF Investment Framework. It also provides a context based on scientific evidence, experiences and lessons learned, shares examples of good practice, and links to country ambitions and needs.

The energy sector is one of the largest contributors to greenhouse gas emissions as a result of the world's reliance on fossil fuels (around two thirds of global emissions are from the energy sector). At the same time, hundreds of millions of people still lack access to electricity, and a third of the world's population lack access to clean energy sources for cooking. To limit global temperature increases to 1.5°C as well as meet the sustainable development goals, the energy sector must undergo a paradigm shift, transitioning from unsustainable fuelwood, coal, oil and gas to modern renewable energy (IRENA, 2021). This would entail increasing the share of renewable energy in the final energy consumption to almost four times by 2030 and ten times by 2050 (IRENA, 2021).

While per capita emissions from developing countries' energy sectors are relatively low compared to developed countries at present, their energy demand growth rate is very high. Hence, they have a unique opportunity to leapfrog to low emissions energy generation from renewable sources which have a lower lifetime cost than new fossil fuel based power in most parts of the world. Therefore, it is of paramount importance that developing countries plan strategically to attract global financial flows to shift to a renewable energy-based power system for meeting their economic and social goals, including economic diversification and job creation.

Further, energy access and power generation projects contribute to both climate mitigation and climate adaptation aims of GCF. For instance, universal access to affordable, reliable, and modern energy enables access to early warning systems, information and communication technologies to vulnerable communities, and it also enables essential services such as water, health and food security through applications such as water pumping and purification, internet and mobile telephones, lighting, cool-storage, clean cooking, and space heating.

Paradigm shifting pathways

In the overall energy sector, paradigm shift relies on enabling a shift to renewable energy-based electricity and promoting access to renewable energy to all sections of society. This can be achieved by integrated, long-term planning and policies, reducing risks and technology costs, and supporting the acceleration of investment at scale, particularly private sector driven investment (GCF B.22 inf 12). Paradigm shift builds on the reduction and removal of profound systemic barriers in order to pave the way for further investments in the sector beyond a given GCF intervention.

This Guide focuses on a part of the GCF energy result area – low emissions energy access and power generation, referred to as the Energy result area[4]. Three distinct transformational pathways within the Energy result area can deliver significant and paradigm shifting impact, through one or more pathways, during the first replenishment period (2020-2023):

- Low Emission Power Generation focuses on generating electricity from geothermal and renewable sources in a sustainable manner and includes geothermal energy, solar and wind energy, hydropower, bioenergy, and ocean energy.
- Efficient and Reliable Energy Transmission, Distribution, and Storage focuses on investing in grid flexibility, digitalization, and storage to make power grids more capable of efficiently and reliably operating with higher shares of renewables.
- Promoting Access to Modern Renewable Energy focuses on modern[5] renewable energy for cooking, grid connections and off-grid electricity such as green mini-grids and solar home systems for access in a way that promotes sustainable development and climate resilience for the societies while reducing emissions.

For these three pathways, alignment between long term strategic energy systems planning, national financial planning, and green budgeting that integrate climate and development goals are key factors. Public financing

[4] The Energy guide's coverage is comparable to the NDC mitigation priority area "Energy Supply".
[5] Modern renewable energy excludes traditional biomass and liquified petroleum gas (LPG)

will not suffice for the projected investments needs for energy transition in developing countries to meet the goals of the Paris Agreement and crowding in private investment must be given high priority. Therefore, GCF interventions that make blended finance work for developing country markets is of paramount importance. Even though levelized cost of energy from most renewable technologies are now lower than new fossil fuel-based energy generation, the financial risks are high because the initial investment costs need to be covered by many years of revenue that should be assured through commitment for shifting to renewable energy. Substantial investment in transmission, distribution, storage and flexibility is also required.

Barriers and enablers to achieving paradigm shifting pathways

Despite increasingly competitive costs for renewable energy technologies, multiple factors in developing countries impedes investment at scale. Developers and financiers are often exposed to uncertainties in long-term planning, policies and power market regulations. Direct or indirect government support and subsidies to incumbent energy suppliers make renewables seem less competitive. There are limitations in capacity of national power grids to integrate renewable energy, including flexibility and storage.

A counterparty with poor creditworthiness constitutes a major risk for the renewable energy option because of the high initial investment. For off-grid investors, the investment recovery risk is elevated by uncertainties related to the arrival of the national grid as well as inabilities to secure connection rates, customer load development, paying ability and resulting cash inflow. For energy access, high technology costs compared to ability to pay further hampers market growth. Further, risk premium for developing country markets adds to the cost of capital.

To compensate for these risks and others, investors require a high rate of return, or they are not willing to invest at scale. Higher rates of return can dramatically affect the affordability of renewable energy to developing countries. Overcoming the financial barrier has been a main concern in earlier GCF proposals in the Energy result area. GCF aims to leverage its range of grant and non-grant instruments to de-risk renewable energy investments, reduce the cost of financing and thus the expected rate of return required by investors, increase affordability to end-users and accelerate the transition to renewable energy technologies.

Role of GCF in financing the paradigm shifting pathways

GCF offers a four-pronged approach to drive implementation of the paradigm shifting pathways at scale. While business models, project development systems, financing structures and ability to attract Private Institutional and Commercial finance (PIC) differ significantly across regions, these approaches can support developing countries' efforts in the Energy result area. The four pillars are:

(1) Transformational planning and programming: examples include developing long-term sustainable energy planning and budgeting that integrates climate externalities and socio-economic and environmental co-benefits, including to build local capacity.
(2) Catalysing climate innovation: innovative business models and employing high-impact innovative technologies, including local technology assembly or manufacturing, and can become powerful tools for climate goals with strong mitigation-adaptation synergies.
(3) Mobilising funds at scale: improving access to climate finance through de-risking investments and unlocking local capital.
(4) Coalitions and knowledge to scale up success: sharing knowledge of successful innovations, fund mobilization efforts at scale and developing climate expertise of financial institutions to replicate them, including to build local capacity.

Actions can include enabling adoption of best industry practices in grid capacity, storage and flexibility for higher renewable energy penetration, increasing the national and sub-national energy service buyers' green procurement capacity, strengthening the scientific verification of causality between access to electricity and increased climate resilience. Figure ES-1 gives an overview of the three main paradigm shifting pathways and the associated drivers.

To deliver a paradigm shift, GCF financial resources act as tools to address barriers in a systemic way and not just as a source of funding to deliver an investment for a specific project. The fund can deploy several financial instruments (grants, reimbursable grants, loans, equity and guarantees) that can be coordinated with co-financiers, blended, and sequenced in order to leverage other public and private capital. GCF's also provides readiness grants, that can support specific energy sector planning and reforms. Full scale proposals for renewable power generation, should include incremental cost reasoning based on levelized cost of electricity[6]. Taxes and subsidies related to fossil fuels and other cost items should be transparent. External costs and benefits should be attributed a value in the economic analysis.

When developing high impact renewable energy GCF projects, AEs and other stakeholders are requested to take into consideration the GCF core principle of country ownership and align their intervention with existing national planning processes (e.g., Nationally Determined Contributions (NDCs), National Adaptation Programmes of Action (NAPAs), Technology Need Assessments (TNAs) as well as GCF country programmes developed by the National Designated Authorities (NDAs) and Focal Points. The country programmes present the country's climate priorities to GCF, including a pipeline of projects to develop with GCF in the renewable energy sector. GCF strives to increase the focus on Direct Access Entities and acknowledges local financing's role in nurturing transformational business models.

Finally, partnership has formed the basis of the GCF business model since it was established. GCF is a fundamentally partnership-based institution, thus leveraging existing sectoral initiatives, coalitions and platforms when planning interventions remains critical to creating multiplier effects at scale and promoting joint learning and knowledge transfer in the renewable energy sector.

GCF investment criteria

Proposals to GCF are assessed based on six GCF Board approved investment criteria:

(1) Impact potential: to what extent does the project or programme contribute to the achievement of GCF objectives and results in terms of climate mitigation and climate adaptation.

(2) Paradigm shift potential: degree to which the proposed activity can catalyse impact beyond a one-off project or programme investment and foster a deep and fast change at scale.

(3) Sustainable development potential: how do the actions align with national SDG priorities and wider benefits and priorities? What are expected environmental, social, gender, and economic co-benefits?

(4) Recipient needs: vulnerability and financing needs of the beneficiary country and population

(5) Country ownership: beneficiary country ownership of, and capacity to implement, a funded project or programme, policies, climate strategies and institutions.

(6) Efficiency and effectiveness: economic and, if appropriate, financial soundness of the programme/project.

Section 6 provides examples of how these criteria could pertain to the Energy paradigm shifting pathways.

[6] Fuel prices should refer to global commodity prices, with fuel taxes and subsidies made transparent.

Figure ES-1: Possible actions for each pathway following the four pillars of the GCF Strategic Plan

Sector		Actions across the drivers of the GCF Strategic Plan			
Energy access and power generation		**Transformational planning & programming**	**Catalyzing climate Innovation**	**Mobilization of finance at scale**	**Coalitions & knowledge to scale up success**
Paradigm shifting pathway	**Low emission power generation**	• Integrated energy, land-use, and climate investment planning • Carbon pricing and energy subsidy reforms • Renewable portfolio standards, Feed-in-tariffs, auctions, enabling tariffs and agreement models • Deep decarbonisation planning	• Scale up of emerging RE technologies such as offshore or floating wind • "Virtual power plant" and innovative technologies for increased dispatchability of variable renewable energy (VRE) • Innovative financial structures for nascent technologies in new markets	• Anchor investments in scalable, low emission technologies to unlock capital markets for large scale investments in RE • Crowd-in private investment at scale via early phase financing, first loss position, and tenor extensions etc. • Originating RE investments where there are market failures	• Communities of Practice for RE product design • Disseminating information through GCF knowledge repository • Green procurement guidelines for energy services • Ex-ante estimation tools reflecting dispatch of RE-based power generation
	Efficient, reliable energy transmission, distribution, and storage	• Long-term grid modelling for high penetration of variable renewables • Long-term deep decarbonisation planning and financial modelling • Market rules for auxiliary, flexibility, and storage services	• Innovative grid digitalisation, system integration, and storage technology • Innovation in long-distance RE transmission, offshore transmission, and climate resilient sub-stations • Anchor investments in piloting new, scalable storage technologies	• Support financing for demand response and smart grid technologies to integrate flexibility services (e.g. electric vehicle charging and desalination plants) • Support sequencing of risk to leverage national and private capital for large-scale investment in "green grids", on-grid storage and grid flexibility	• Grid flexibility product design in Communities of Practice • Ex-ante estimation tools reflecting grid capacity, flexibility, and storage • Grid codes development for highly flexible grid operations
	Promoting access to modern renewable energy	• Integrated energy access, financial, and climate planning • Policy and regulatory reforms in modern renewable energy access (e.g. RE rural concession, mini-grid regulations) • Raising modern renewable energy access ambitions for NDCs	• Transformational business models for clean cooking • New business models for productive energy services such as cooling/milling/food production • New modern renewable energy access technologies	• Credit lines to local financial institutions for energy access services linked to productive RE use • Capitalisation of rural energy funds • Addressing liquidity risks for small scale energy access service providers	• Modern renewable energy access products design in Communities of Practice for the benefit of grid operators • Skills development at local national level • Articulating causal links between energy access and climate resilience

RE = Renewable energy, VRE = Variable renewable energy, Modern energy excludes traditional biomass, clean cooking refers to cooking with minimal indoor pollution based harnessing modern renewable energy.

1 INTRODUCTION

1.1 GCF Sectoral Guides

The Green Climate Fund (GCF) is the world's largest dedicated fund helping developing countries reduce their greenhouse gas emissions and enhance their ability to respond to climate change in line with the Paris Agreement. Low emission energy access and power generation is a key result area for GCF, which contributes to the energy transition by funding energy projects and programmes.

There are eight result areas[7] that GCF has targeted because of their potential to deliver a substantial impact on mitigation and adaptation in response to climate change. Result areas provide the reference points that guide GCF and its stakeholders to ensure a strategic approach when developing programmes and projects, while respecting the needs and priorities of individual countries.

This Sectoral Guide focuses on GCF result area 1. However, there are linkages to other sectors and respective GCF Guides. Table 1 identifies cross-sectoral issues covered in other Guides in the series that may have reference to or relevance for the energy sector.

Table 1: Cross-sectoral issues addressed throughout the series

Sectoral guide name	Cross-sectoral issues addressed
Agriculture and Food Security	Water pumping, irrigation, food waste minimization applications.
Forest and Land Use	Sustainable land use and sustainable limits for biomass use in energy.
Buildings, cities, industries, and appliances	Energy efficient building design, building integrated solar PV, urban rooftop solar.
Ecosystem and ecosystem Services	
Energy Access and Power Generation (This Guide)	Energy from renewable or geothermal sources, produced in a sustainable manner and including solar, wind and tide energy, bioenergy, as well as hydropower; efficient and reliable energy transmission, distribution and storage for an increased share of renewable energy in the energy mix as well as increased flexibility and climate resilience; modern[8] renewable energy for cooking, grid connections as well as off-grid electricity supply such as green micro- and mini-grids and solar home systems for access in remote areas are covered in this guide.
Energy efficiency	Industrial energy efficiency, energy efficient appliances, standards and labelling for energy end-use applications, efficient cooling applications for space, health and agriculture supply chains.
Health, food, and water Security	Climate resilient health infrastructure
Infrastructure	
Livelihoods of vulnerable communities	
Transport	Electric vehicles and charging infrastructure.

1.2 Renewable energy context

Given the world's reliance on fossil fuels, including for electricity generation, the energy sector is one of the largest contributors to greenhouse gas emissions. At the same time, hundreds of millions of people still lack

[7] . GCF result areas: 1. Reduced emissions from energy generation and access, 2. Reduced emissions from low-emission transport, 3. Reduced emissions from buildings, cities, industries, and appliances 4. Reduced emissions from forests and land use, 5. Increased resilience of most vulnerable people, communities, and regions, 6. Increased resilience of health food and water security, 7. Increased resilience of infrastructure and the built environment, 8. Increased resilience of ecosystems and ecosystem services

[8] Modern renewable energy excludes traditional biomass and liquified petroleum gas (LPG)

access to electricity, and a third of the world's population lack access to clean cooking energy sources. To limit global temperature increases to well below 2°C above pre-industrial levels and pursuing efforts to limit the warming to 1.5°C °C as well as meet the sustainable development goals, the energy sector must undergo a paradigm shift, transitioning from coal, oil and gas to renewable energy (IRENA, 2021). This guide will focus on increasing the share of renewable energy in the power generation mix while also facilitating and pacing up that electricity can be accessed by all and extensively used in final consumption including all sectors, also industry and transportation.

In the context of the Sustainable Development Goals (SDGs), GCF contributes directly to the achievements of SDG 7.1 By 2030, ensure universal access to affordable, reliable, and modern energy services and 7.2 By 2030, increase substantially the share of renewable energy in the global energy mix, which are covered by this Sectoral Guide. Similarly, as GCF is a partnership organization at heart, this Guide partly covers GCF contribution to SDG 7.a By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology.

In line with the GCF mandate of serving least developed countries, small island developing states, and African countries, this Sectoral Guide also covers GCF contributions in relation to SDG 7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States, and land-locked developing countries, in accordance with their respective programmes of support. By promoting access to modern renewable energy, investments also contribute to several other SDG's as mentioned in sections 6.1 and 6.3 of this report.

Climate change already challenges the reliability of energy supply in various ways, and the impacts will increase as the global mean temperature rises. For the most vulnerable people reliable access to basic energy services will increase their chances to overcome climate change induced hazards.

The purpose of this Guide is to support countries, GCF Accredited Entities (AEs), and other stakeholders to identify high impact, transformative projects in the energy sector that contribute significantly to mitigation and adaptation within GCF Strategic Plan for 2020-2023[9].

The Energy Sectoral Guide translates this focus into three main paradigm shifting pathways that contribute to the result area, namely:

- Low Emission Power Generation focuses on generating electricity from geothermal and renewable sources in a sustainable manner and includes geothermal energy, solar and wind energy, hydropower, bioenergy, and ocean energy.
- Efficient and Reliable Energy Transmission, Distribution, and Storage focuses on investing in grid flexibility, digitalization, and storage to make power grids more capable of efficiently and reliably operating with higher shares of renewables.
- Promoting Access to Modern Renewable Energy focuses on modern[10] renewable energy for cooking, grid connections and off-grid electricity such as green mini-grids and solar home systems for access in a way that promotes sustainable development and climate resilience for the societies while reducing emissions.

This Sectoral Guide shares evidence-based knowledge, best practices, and lessons learnt to enable transformative changes and inspire proposal development for GCF under its first replenishment period 2020-2023. These investments aim to transform the energy sector while meeting country priorities. This Guide also provides strategic insight into where GCF funded activities can have the greatest impact across the different

[9] https://www.greenclimate.fund/document/updated-strategic-plan-green-climate-fund-2020-2023
[10] Modern renewable energy excludes traditional biomass and liquified petroleum gas (LPG)

result areas related to renewable energy and informs countries and AEs in developing funding proposals that meet GCF investment criteria.

1.3 Organisation of the document

This Guide has seven sections. After this introduction, Section 2 provides an overview of the energy sector within the global context of climate action; Section 3 highlights the barriers and opportunities to achieving a paradigm shift in the energy result area; Section 4 provides guidance on how to scale up and catalyse public and private investment; Section 5 provides case studies that demonstrate paradigm shift potential; Section 6 provides specific guidance for the development of impactful projects and programmes based on GCF investment criteria; and Section 7 is the conclusion.

2 GLOBAL CONTEXT

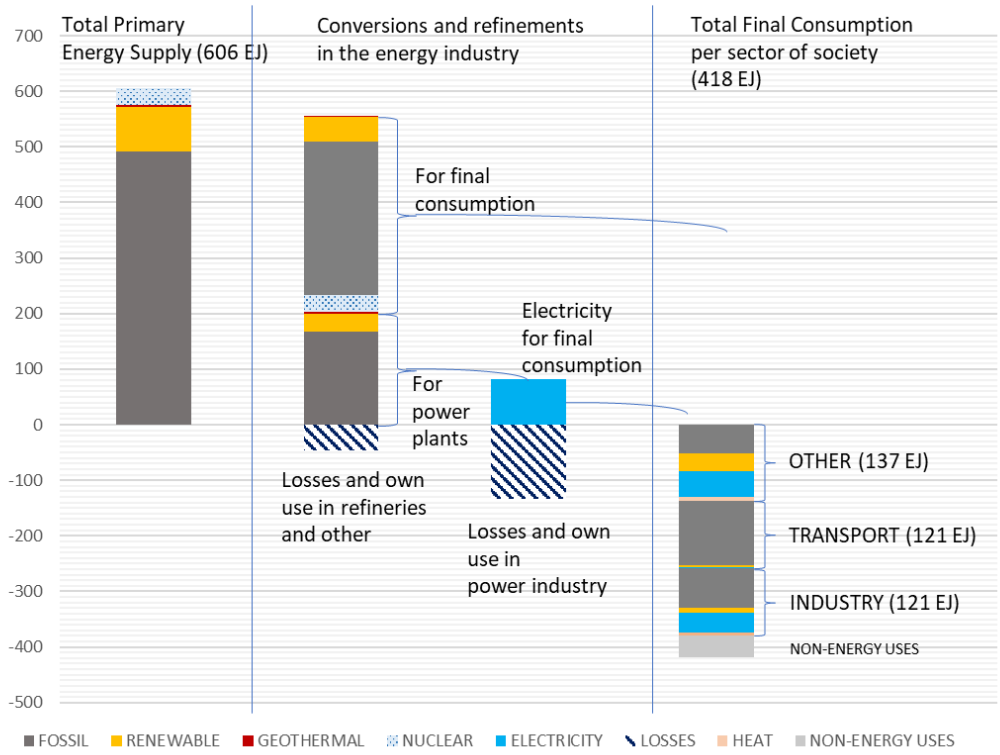
2.1 Scientific basis: why is the energy sector relevant to climate action?

To reach the 1.5°C -goal or at least keep the global temperature increase well below 2°C, as stated in the Paris Agreement, the world's energy supply and end use needs to cease net GHG emissions by 2050. Energy consumption currently emits, by a long measure, the largest share of greenhouse gas emissions – two-thirds of global greenhouse gases (IRENA, 2020a). Greenhouse gas emissions from world energy consumption is expected to rise from around 35 Gt/yr in 2019 to 43 Gt/yr in 2050, driven largely by growth in energy demand in developing countries (IRENA, 2020a). At the same time, 759 million people in developing countries, of which 570 million are in sub-Saharan Africa, do not yet have access to electricity and 2.6 billion people do not have access to clean cooking (IEA, IRENA, UNSD, World Bank, WHO, 2021).

Total primary energy supply in the world is almost entirely, more than 80%, based on fossil fuels (oil, coal, and natural gas). Oil and oil products fuel the transport sector to a large extent. Coal is the dominating fuel in the power industry. Renewable energy (solar, tidal, wind, biomass[11] and hydro power) contributes only 13 %, nuclear energy close to 5% and geothermal energy less than 1%. Refer also, to Figure 1.

[11] Biomass is only renewable when the growth surpasses the energy outtake.

Figure 1. Overview of the world's Total Primary Energy Supply by type of energy carrier, conversion, and final consumption by sector (Exa Joule, EJ). *Based on IEA Energy statistics database (Exa = 10^{18})*



The largest category of final energy consumption world-wide is the sector "other" which includes residential, commercial, and public buildings with e.g., lighting, ventilation and comfort cooling as well as other energy services such as for agriculture, forestry, and fisheries (refer also to Figure 1). This sector will continue to grow globally and become more prominent because of population growth, economic development and urbanisation. Growing urban populations will also mean rapid growth in energy demand for industrial production and mobility. In the industrial sector, while processes need as well be addressed, most notably in the cement-, steel-, and chemicals industry sectors, decarbonisation to a large extent involves low-emission energy fuels and upstream sources for electricity. Thereto, electricity will eventually need to substitute much of the oil and oil products that in essence fuels transportation.

The International Energy Agency, IEA describes a Net Zero Scenario (NZE) in which all countries, including developing countries will have net zero GHG emissions by 2050. With a 50% chance, the Net Zero Scenario complies with a development trajectory that limits global warming to 1.5 °C increase. At a global level, while the announced pledges will keep annual Gt CO_2 emissions unchanged until 2030, global annual emissions in the NZE are around 33% lower by 2030. For the immediate future and upfront 2030, a massive deployment of all available clean energy technologies – such as renewables is required between now and 2030. Clean energy investments will create millions of new jobs around the world. Beyond scaling up existing mature technologies, we need to ensure that complementary solutions are market ready on time (between 2030 and 2050). (IEA, 2021b)

Especially in developing economies, the electricity demand is forecasted to have doubled in 2030 and the sustainable pathway requires a firm focus on energy efficiency to limit and optimise demand (see the separate guide on energy efficiency) and opting for electricity generation from renewable energy sources rather than including coal and gas to the extent planned by countries according to their stated policies (IEA, 2019a). In China, India and Southeast Asia, the prime challenge is to shift from planned and projected coal power plants to more pumped hydro integrated with wind and solar. In Africa, in addition to opting against planned investments in coal power plants there is also a need to shift away from planned gas power plants

For humanity to prevent catastrophic climate change, it is imperative and urgent to shift investment toward increases in large scale deployment of low carbon electricity to avoid continued dependence on fossil fuels, and to support the extension of access to sustainable energy services for poor and underserved communities as well as to more sectors of society.

Climate change threatens the reliability of energy supply in various ways, and the impacts will increase as global temperatures rise. For example, increasing temperatures affect the hydrological cycle and access to water, which in turn also affects reliability and sustainability of hydro power output. Tropical cyclones, storm surge, extreme rainfall, riverine floods, lighting and wildfires can destroy infrastructure and resilience include to design and invest for persistent power systems and the ability to restore services within reasonable time. Across the developing world, frequent power outages result in the use of back-up diesel generators to supplement the power needs of industry and households. Business models for the benefit of renewable energy-based back-up supply will be an important ingredient in the sustainable energy transition.

Traditional biomass in the form of fuelwood, charcoal and agricultural residues remains a primary source of energy for more than one-third of the global population, leading to unsustainable use of biomass resources and forest degradation. Fuel-switching and adoption of efficient appliances, along with forest protection management, can promote more sustainable biomass use and reduce land degradation (IPCC, 2019). Land degradation is devastating for people who directly depend on natural resources for subsistence, food security and income, as it reduces land productivity and increases the workload of managing the land, affecting women disproportionally in some regions. Land degradation and climate change act as threat multipliers for already precarious livelihoods, leaving them highly sensitive to extreme climatic events, with consequences such as poverty and food insecurity. Having access to modern renewable energy services will be imperative for the most vulnerable people in these areas, for shifting away from unsustainable use of traditional biomass, for accessing information and basic financial services, for being able light up a dwelling or shelter, for irrigating and for basic processing and preservation of food.

Developing country NDCs recognize the importance of investment in access and renewable energy and identify low-emissions and renewable energy as a priority across the board (GCF, 2019 b). Thus, supporting the deployment and scale-up of renewable energy is of vital importance to GCF.

2.2 Global baseline: where is the sector today?

2.2.1 Power generation

Total renewable energy capacity is growing strongly, but because of the growing global energy demand, the overall share of renewables in global final energy consumption has increased only slightly since 2010. Geothermal energy and modern renewables[12] make up 14% of total primary energy supply (IEA, 2019a). Concerning power generation, in 2019 global electricity from renewables increased by more than the increase in electricity demand, and fossil-fuel electricity generation decreased. Most new power generation capacity is based on renewables. Investment in modern renewables, much of which has come from the private sector, has greatly increased in the past decade, following a significant fall in the price of wind power and solar PV (see Figure 2). Solar PV and wind power are increasingly the cheapest sources of electricity in many countries, and likely to be fully cost competitive within the next decade (IRENA, 2019). Yet, investments in new fossil fuelled power plants continue in many countries.

Over the years 2016-2020, the investment spending on electricity generation in emerging markets and developing economies in Africa, Europe, Latin America[13], the Middle East, and Asia[14] amounted to 163 billion USD per year. Of these investments, 91% was utility scale, 50% renewable, 44% fossil and 7% nuclear (IEA,

[12] Modern renewables excludes traditional use of biomass.
[13] Including Chile Colombia, Costa Rica and Mexico
[14] Excluding China

2021a). Investment spending on electricity generation in these countries will need to increase, as further elaborated in section 4.

The competitiveness of power generation technologies is very much dependent on decisions taken by policy makers, regulators, and the industry. This is why energy transition requires high level national strategic policy making, financial planning and green budgeting. For example, pricing CO_2 and other pollutant emissions would fundamentally change the comparisons, further improving the competitiveness of renewable energy sources compared with fossil fuels. A lower cost of capital would also improve the case for renewable energy technologies. While access to finance is in general a constraint for many local businesses and households in developing countries, it specifically hampers the energy transition since these investments' viability rely on cheap capital and high utilisation rates.

Looking forward, offshore, and ocean-based energy has a huge potential. For example, technical potential for offshore wind to grow is enormous in the global perspective and could become a crucial input to the production of low-carbon hydrogen. Challenges for offshore and ocean-based energy include difficulties with regulatory frameworks, competitiveness, permitting or transmission connections, and challenges relating to public acceptance, relationships with other maritime industries and the marine environment.

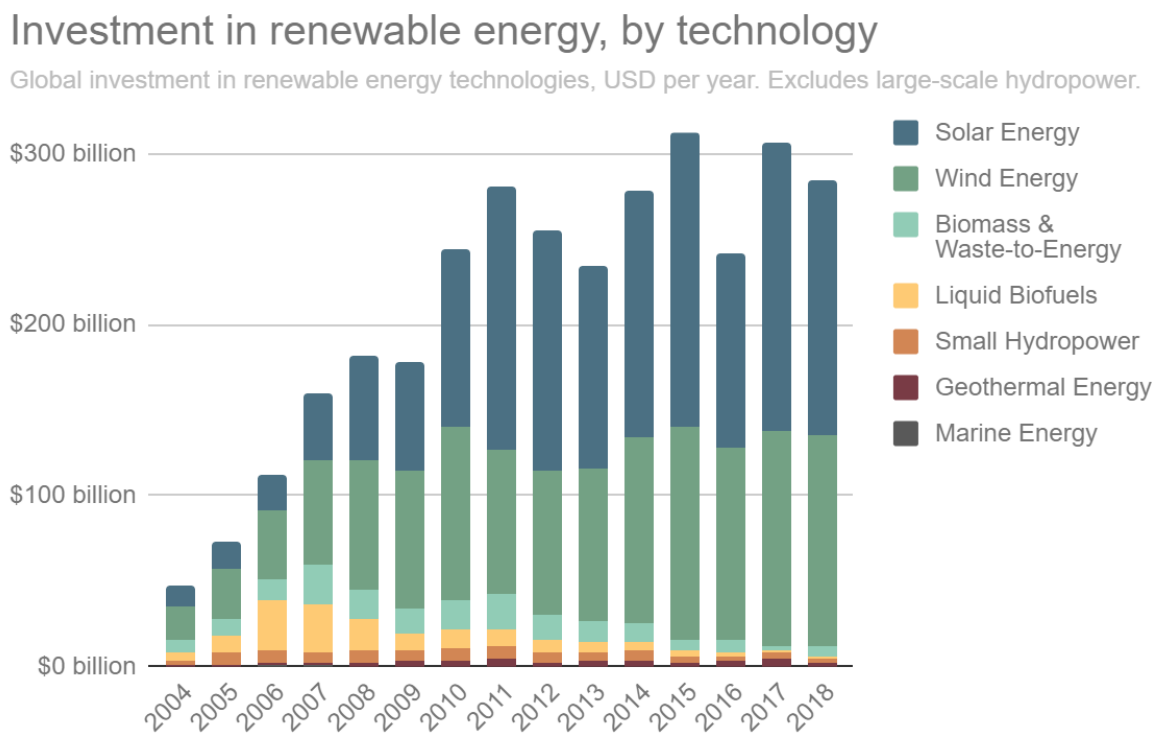
These changes and opportunities are bringing about a transformation of energy systems, but the change is not quick enough to reduce the world's dependence on fossil fuels in line with 1.5°C emissions pathways, as presented by the IPCC, and is mostly taking place in developed countries with supportive policies. The International Energy Agency projects that, given existing stated policies, modern renewables will comprise 15% of total final energy consumption in 2030, well short of the estimated 23% that would represent substantial progress on Sustainable Development Goal (SDG) 7 "Affordable and Clean Energy".

According to the IPCC, renewable energy must comprise 52-67% of global primary energy by 2050 to reach pathways consistent with a temperature increase of 1.5°C (Rogelj, et al., 2018). According to the 2021 IRENA *World Energy Transitions Outlook: 1.5°C* Pathway, this will require increasing the share of renewable energy in the final energy consumption to almost four times by 2030 and ten times by 2050 (IRENA, 2021).

For emerging and developing markets, renewable power needs to account for more than 90% of the generation capacity added over the next decade, according to the IEA climate driven scenarios. (IEA, 2021b)

By implementing improvements in renewable energy and energy efficiency, the world can reach at an estimated annual CO_2 emission of 9.5 Gt (IRENA, 2020).

Figure 2: Investment in renewable energy, by technology



Source: (IRENA, 2020b) and Our World in Data

2.2.2 Transmission, distribution, and storage

The transmission, distribution, and storage of energy along with market reforms that allows consumer participation in flexibility and auxiliary services plays a significant role in decarbonizing energy systems.

Globally, network spending is on the rise to support replacements, upgrades, and extensions to assure the security of electricity supply and to integrate rising shares of variable renewable energy (VRE). Investment in transmission and distribution networks already represents almost half of total power sector investment, about 3% of which is for fast chargers for Electric Vehicles (IEA, 2019a). However, these investments are neither at the scale nor speed required to meet the goals of the Paris Agreement. In many developing countries, power markets would need to mature, and it is imperative that politicians cooperate to find the right business model to scale up cross-border investments.

Transmission and distribution

As the world transitions to renewables along with more people gaining access to electricity, efficient and reliable transmission and distribution (T&D) is essential to decarbonize the energy sector[15]. Besides addressing old and obsolete infrastructure, modernizing and upgrading of the electricity grids is necessary to accommodate the fundamental changes in the supply and demand of electricity.

Electric power transmission and distribution losses due to technical processes of conducting power through aging or not optimally designed electricity networks, and to non-technical processes such as theft or billing failures can be up to 19% in developing countries, which is higher than world average (8-9% of total output).[16]

The ability to feed large shares of renewable electricity into grids is critical for the cost-effective integration of renewables into the electricity system. Large shares of VRE, that is not dispatchable, requires the grid, major

[15] There is also a role for thermal energy distribution which has been covered in the "cities, buildings and urban infrastructure" guide.

[16] From 1990-2014, electric power transmission and distribution losses worldwide generally averaged between 8 and 9% of total output (World Bank, 2018), and in most developing countries have been much higher (e.g. Latin America & Caribbean 16%, LDCs 16%, Middle East & North Africa 13%, Sub-Saharan Africa 12%, South Asia 19%) (World Bank, 2018). Models show these trends continue into 2020, and fall only moderately by 2025 under a business as usual scenario (Sadovskaia, et al., 2019).

loads, and other power plants to be operated in a more flexible way that limits the curtailment of these VRE investments. A modern grid is expected to perform in ways and in a context for which most grids were not originally designed; flexible, climate proof and digitalised for seamless services and operations that are too fast for human operators. Business models that have evolved due to market deregulations over the latest decades are still by and large based on a traditional, supply driven, centralized power system.

By expanding grids in a way that favours renewable energy integration while addressing curtailment and dispatch issues– with the objective of not only enhancing access rates but also integrating renewables and increasing reliability – countries can decarbonize alongside expanding access. These, and related investments can ultimately improve the commercial viability of investments in renewable energy.

Over the years 2016-2020, the investment spending on electricity networks in emerging markets and developing economies in Africa, Europe, Latin America[17], the Middle East, and Asia[18] amounted to 75 billion USD. Of these investments, 29% was for transmission and 71% for distribution (IEA, 2021a). Investment spending on electricity networks in these countries will need to increase, as further elaborated in section 4.

Achieving universal access in 2030 will also require off-grid solutions (IEA, 2019a). While designed for off-grid, isolated mini-grid systems may be designed to account for future integration by adhering to the same national electricity standards as the main grid and may well be partly integrated with the power grid as time evolves, although at present this is not common practice and there are both technical and financial barriers to future integration.

Storage

Given the intermittent nature of sunshine and wind, energy system flexibility is fundamental to the deployment of much VRE. Flexibility can be enhanced through enhanced operations of existing dispatchable power plants, upgrades in transmission and distribution infrastructure alongside energy storage and demand side management. The traditional power sector, however, has been built upon a model consisting of centralised electricity production matched with fluctuating needs of local consumers in real time (IRENA, 2015).

There are many energy storage options available including pumped-storage hydro, compressed air energy storage, green hydrogen based solutions such as power to gas[19], gravity based storage solutions and various types of batteries such as lithium-ion, iron-air or solid state batteries. Storage can also be deployed at various locations in order to limit VRE curtailment and increase grid flexibility, such as balancing and bulk storage close to the generation system, grid-located storage within transmission and distribution systems, along with consumer-located “behind the meter” storage.

Hydrogen production from renewable energy sources can contribute to decarbonizing hard-to-abate sectors and can also provide additional flexibility in the grid. In the public, residential and commercial sectors, new business models that combine smart grids, storage and flexibility aspects for a group or type of electricity customers, can become instrumental for increasing the power grid’s ability to adopt more VRE along with offering affordable and reliable energy services, tailored to suit the needs. As generation assets, storage can provide capacity, energy, and services such as frequency control. As transmission and distribution assets, storage can enhance the capacity of networks to accommodate new power by providing congestion relief. Storage can address demand response to reduce power demand at peak periods. Further to storing energy, excess energy, including abundant electricity and excess heat, can be utilised in other essential processes, such as fertilizer production de-salination of water and district heating[20].

Energy storage offers a promising and essential technology solution. The IRENA RE map, estimates that 150 GW of battery storage and 325 GW of pumped -storage hydroelectricity will be needed globally in order to double the share of renewable power generation by 2030 (IRENA, 2015), and IRENA forecasts Thermal Energy Storage

[17] Including Chile Colombia, Costa Rica and Mexico
[18] Excluding China
[19] For example, producing green hydrogen from abundant wind power, storing it and reverting to generate electricity from fuel cells when needed.
[20] Please refer to other sectoral guides that cover industrial processes and district heating.

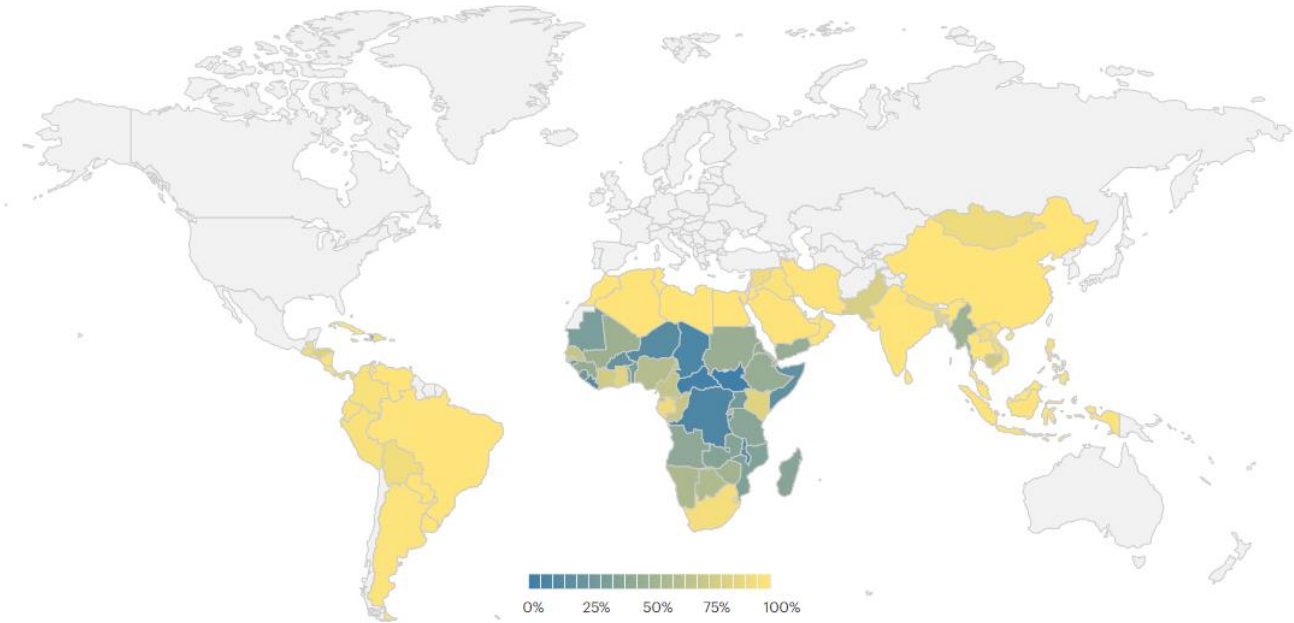
could reach over 800 GWh by 2030 (IRENA, 2020c). IEA expects an additional 320 GW of battery storage to be installed by 2040 (IEA, 2018). Global storage markets are growing and annual deployment of storage nearly doubled between 2017 and 2018 and in 2019 remained significantly higher than the 2017 figures despite almost 30% drop in new capacity (IEA, 2020). Installed capacity is still low for almost all storage technologies given market barriers, particularly in developing countries. Investment spending on battery storage has been insignificant in emerging markets and developing economies in Africa, Europe, Latin America[21], the Middle East, and Asia[22] over the years 2016-2020, the (IEA, 2021a).

2.2.3 Access to modern renewable energy

Despite consistent progress, a substantial portion of the world's population still lacks access to electricity and clean cooking. Currently 759 million people lack access to electricity (IEA, IRENA, UNSD, World Bank, WHO, 2021). In sub-Saharan Africa, there are still, in 2019, 570 million people (IEA, IRENA, UNSD, World Bank, WHO, 2021) – one out of two people – without access to electricity and this is set to increase in 2020 (IEA, 2020b).

In 2019, 2.6 billion people[23] lacked access to clean cooking fuels and technologies with data showing a gradual decline, which is now threatened as a result of the Covid-19 pandemic (IEA, IRENA, UNSD, World Bank, WHO, 2021). Many of these people rely on traditional biomass such as wood, charcoal, and organic waste for cooking, often in inefficient traditional cookstoves in poorly ventilated cooking places which contribute to early deaths through indoor air pollution. 2.5 million people a year die prematurely from illness attributable to the household air pollution caused by exposure to emissions from the inefficient use of solid fuels and kerosene for cooking (IEA, 2020b). Women and girls often do most of the cooking in a household. Access to clean cooking will improve their health and free up time otherwise spent fetching wood and tending to fires (IEA, IRENA, UNSD, World Bank, WHO, 2021).

Figure 3: Share of population with access to electricity



Source: (IEA, 2020b)

An increase in access to electricity and clean cooking facilities is vital for several reasons, including resilience to climate change, reducing poverty and improving health outcomes, particularly in Asia and Sub-Saharan Africa.

[21] Including Chile Colombia, Costa Rica and Mexico
[22] Excluding China
[23] The latest data from the Energy Progress Report 2021 indicates a rage from 2.2 to 3.1 billion (IEA, IRENA, UNSD, World Bank, WHO, 2021, p. 6)

Of the top 20 electricity access deficit countries, 5 are in Asia and 15 are in sub-Saharan Africa. Of the total population lacking access to clean cooking, 25% live in India and 20% live in China (IEA, IRENA, UNSD, World Bank, WHO, 2021). At present, population growth in Sub-Saharan Africa outpaces the growth rate of access to clean cooking.

Target 7.1 of the SDG on Energy aims to "ensure universal access to affordable, reliable, and modern energy services" by 2030 (SDG Knowledge Platform, 2019). Thus, the world targets 100% access to electricity, compared to 89% in 2017; and 100% access to clean cooking, compared to 90% in 2019 (IEA, 2020b).

2.3 Global mitigation and adaptation potential

Prospects for reaching at net zero GHG emission in global energy systems by 2050 is real as illustrated by for example IEA and IPCCC. The challenges are political and financial including global trade and national long term and fiscal planning as will be further outlined in section 3. More global financial resources and private capital needs be channelled to renewable energy investments in developing countries

For adaptation, the potential pertains to demand driven wholistic, green and diversified economic planning in countries to allow for and resource efficient use of energy to meet an increasing energy demand while acknowledging eco-systems values, food- and water security. Energy demand sectors planning ability, procurement ability and ability to foster innovative processes for shaping sustainable energy services will be decisive of how countries can become climate resilient and reach national targets for sustainable energy supply systems with access to all.

2.4 Financing – How much will it cost?

IEA estimates that average annual investment spending on renewable energy power generation need to reach at 573 billion USD/year by 2030in emerging market and developing economies to limit the global temperature to 1.5 °C. This is ***seven-fold*** if compared to 2020. Similarly, average annual investment spending on electricity networks need to ***quadruple*** (from 75 to 299 billion USD/year) and for battery storage, levels need to approach 26 billion USD/year from the currently insignificant spending Around USD 41 billion is required each year for improving access to electricity and for substituting unsustainable traditional biomass use. Capital expenses will be an increasing proportion of electricity supply costs in emerging and developing economies while fuel costs will decline. (IEA, 2021a).

In recent years, public sources of finance have accounted for nearly half of energy supply investments in developing countries. State owned enterprises (SOEs) such as utilities, often financing projects on their own balance sheet, account for most of this public contribution, they account for over three-quarters of electricity grid spending (IEA, 2021a). SOEs have low ability to raise enough funds themselves, a situation that has exacerbated with the COVID-19 pandemic. Around half of all coal power is financed by SOEs and around 40% of oil and gas spending is underpinned by national oil companies (IEA, 2021a).

In some areas, such as in the sub-Saharan Africa power sector, absence of financially resilient utilities combined with persistent risks has translated into a high reliance on international public finance. Public finance also underpins a large part of investment made in improving energy access for areas that lack reliable electricity or clean cooking facilities. State-backed financing and ownership play a greater role in large-scale dispatchable renewables, such as hydropower and geothermal, and more than 50% of hydropower investment depends on public sources (IEA,2021a).

Other renewable energy investments have been financed mostly by private sources and often included project finance structures, where risks are shared among funding providers in non-recourse vehicles held off the balance sheet of the project owners. Off-balance sheet structures, such as third-party ownership and leasing arrangements, are also used in smaller-scale assets for end users (IEA,2021a).

In the 2016-20 period, mature technologies such as coal, solar PV and wind power in emerging and developing markets were financed with around 60% of debt, on average, and more than 30% on a project finance basis

(IEA, 2021a). Private finance initiatives were important players in this picture, allowing for higher levels of debt and project finance. Other technologies with higher development risks, such as hydro, needed generally more than 40% of equity and were financed based on state owned companies' balance sheets (IEA, 2021a).

Renewable energy investment in developing countries is typically a very cost-effective way to reduce emissions on a global basis, which besides justice and ethics[24] should work in favour of developed nations fulfilling their promises to provide the financing needed to support developing countries. The cost and availability of capital for investing in clean energy transitions will determine the ability of developing countries to meet sustainable development goals, but currently, these countries hold only around 10% of the world's financial wealth (IEA,2021a). Financing the rise of clean power, which will likely come through independent power producers (IPPs) and project finance structures, requires a significant increase in debt finance (IEA,2021a). In chapter 4 Financing paradigm shifting pathways, it is presented how GCF financing can contribute and catalyse capital resources.

3 PARADIGM SHIFTING PATHWAYS: ENERGY RESULT AREA

3.1 Drivers of change across paradigm shifting pathways

A core strength of the GCF approach is its focus on supporting a paradigm shift through its funding support. The term **paradigm shift** refers to the degree to which the proposed project/programme investment can catalyse impact into medium or long-term sectoral change, beyond a one-off project investment (GCF, 2020).

As per GCF board decision from B.22, "Project proposals should identify a vision for paradigm shift as it relates to the subject of the project. The vision for paradigm shift should outline how the proposed project can catalyse impact beyond a one-off investment. This vision for longer-term change should be accompanied by a robust and convincing theory of change for replication and/or scaling up of the project results, including the long-term sustainability of the results, or by a description of the most binding constraint(s) to change and how it/they will be addressed through the project." (GCF B.22/05)

For example, a utility scale solar PV project should not only increase renewable energy generation in a country's energy mix but should also remove systemic barriers and enable at-scale investments from others in solar PV generation as well as other VRE in the future.

Three dimensions commonly define transformational change: depth, scale, and speed. Depth is the essence of a transformational shift; and refers to the degree to which an intervention has been embedded within the intervention's target group or system. Deep transformations cut across sectors, levels, and generations, and are needed to change cultures, decision making power dynamics, and structures (markets, laws, institutions, and gender balance). Scale refers to the degree to which there has been a significant increase in results beyond the scope of the project. Speed indicates how quickly transformations can be achieved; the urgency of the climate crisis puts an emphasis on early outcomes achievable in 5-10 years (the 2030 goal) over those achievable in 30 years (the 2050 goal), because each 'missed year' increases the size and complexity of the task ahead. For the energy sector, scale and speed makes market ready renewable energy supply a high priority.

To maximize impact and a paradigm shift, GCF has adopted a Theory of Change (ToC) based on transformational planning, catalysing climate innovation, mobilizing finance at scale and knowledge replication (GCF 2020). Mapping these above-mentioned dimensions onto the GCF ToC (see Figure 4Figure 4) facilitates action towards a paradigm shift across different stakeholders, rights holders, institutions, geographies, and processes, as follows:

[24] For example with reference to the "polluters pay principle," which is recognized globally by the Rio Declaration.

(1) **Transformational planning and programming:** This involve financial planning and budgeting for an accelerated and deep shift at scale, from fossil fuels to renewable energy options for power generation and energy access, with a view to provide energy service needs as articulated by women, men and youth, to integrate climate externalities, to develop a robust pipeline of projects, and to strengthen public sector capacity while increasing the inclusion of the private sector.

(2) **Catalysing climate innovation:** Projects or programmes that can test or scale innovative business models or employ high-impact innovative technologies, at the commercialisation stage for climate goals with strong mitigation-adaptation synergies and for broad groups including women, men and youth, including local technology assembly or manufacturing.

(3) **Mobilisation of finance at scale:** Using private and public finance, countries can de-risk investments, unlock local capital, provide liquidity, and deepen access to commercial markets or commercial finance for energy investments. Where appropriate[25], projects can recycle debt / equity capital to support scaled up investment.

(4) **Expansion and replication of knowledge:** By sharing lessons learned, methodologies, and standards from existing investments, future projects and programs can reinforce good practice and improve local and international capacity for the first three outcomes for both public and private sector.

In National Designated Contributions (NDC's), energy is by far the most frequently identified sub-area for domestic mitigation measures, mentioned in all NDC's. Renewable energy generation is the most frequently indicated mitigation option in this priority area. Similarly, renewable energy is a major focus of quantitative mitigation targets for 2030, but also beyond. (UNFCCC, 2021).

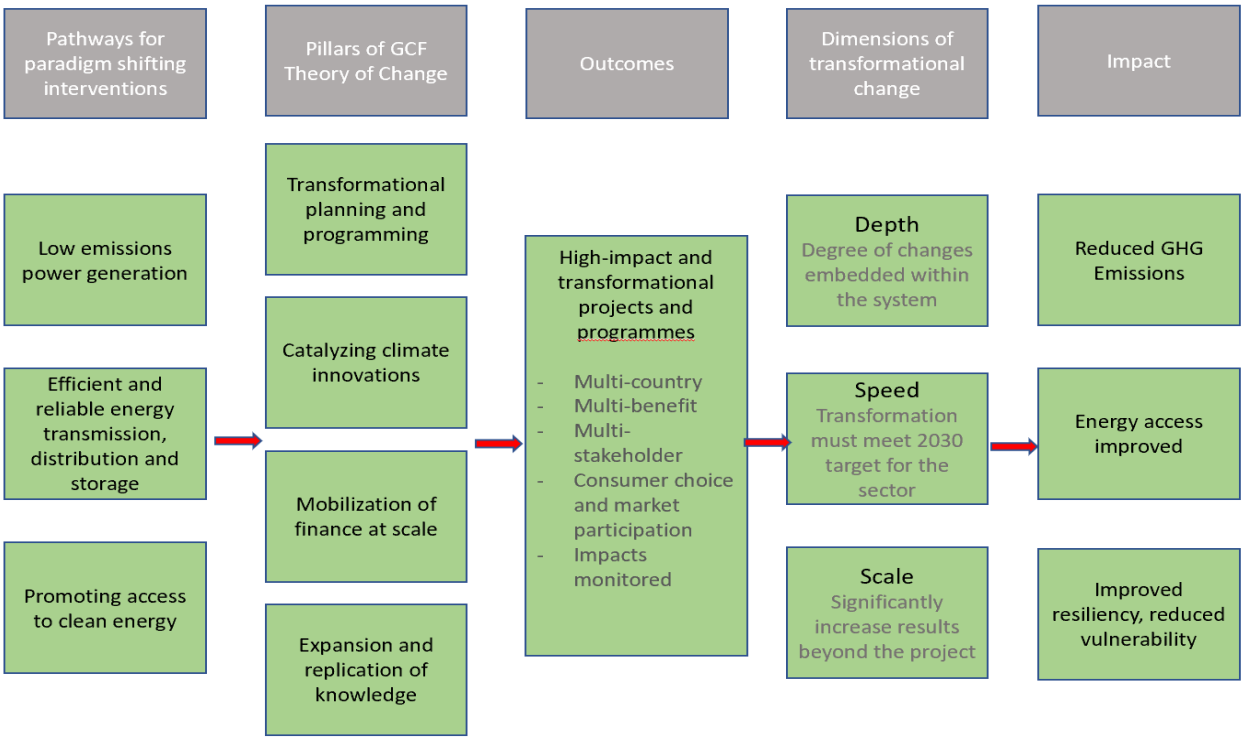
Nevertheless, to achieve a paradigm shift and reach the energy targets outlined in Section 2, developing countries must raise their ambition for investment in renewable and low-emission, affordable and reliable energy. Policy and regulations reforms are required to create an investment-friendly environment for renewable energy and energy access. There is no lack of financial resources globally, but even though these investments are prone to be financially viable the money is currently not accessible in many developing countries at terms that attract private investors. While there are opportunities for carbon finance, countries also need to ensure environmental integrity of emission reductions in relation to national targets and international norms.

In line with a country's ambitions, GCF can assist the accessibility to capital by de-risking investments, and funding activities that address the systemic barriers to low emissions development. The focus of GCF support is in countries that have underdeveloped markets, facilitating the transfer of knowledge and expertise from countries where transformation is already well underway, to those that have not yet started and supporting local commercialisation, job creation, capacity building and skills development, including local financial capacities and local manufacturing or assembly of technologies.

Investments in the energy sector are driven by multiple agendas including sovereignty, economic development and diversification, as well as many sustainable development goals. GCF proceeds aim to complement and catalyse other financial resources, with the purpose of supporting an ambitious climate agenda.

[25] Recycling of capital may be needed to crowd in institutional investors who prefer to invest in relatively less risky operational assets and free up the balance sheets of local banks or financial institutions such than they are able to provide incremental financing for new capacities

Figure 4: Elements of transformational change linked to pillars of GCF Theory of Change



Three paradigm shifting pathways have been identified that constitute central, transformative priority actions for energy access and power generation in developing countries in the period up to 2030. These are:

- Low Emission Power Generation focuses on generating electricity from geothermal and renewable sources in a sustainable manner and includes geothermal energy, solar and wind energy, hydropower, bioenergy, and ocean energy.
- Efficient and Reliable Energy Transmission, Distribution, and Storage focuses on investing in grid flexibility, digitalization, and storage to make power grids more capable of efficiently and reliably operating with higher shares of renewables.
- Promoting Access to Modern Renewable Energy focuses on modern[26] renewable energy for cooking, grid connections and off-grid electricity such as green mini-grids and solar home systems for access in a way that promotes sustainable development and climate resilience for the societies while reducing emissions.

In this sphere, GCF will act for mobilising investment at scale and strive to make capital available at competitive terms. GCF is prepared to take financial risks to catalyse that the sector moves rapidly towards set NDC-targets and beyond. Rather than financing actions that make minor enhancements within an incumbent system, GCF will finance significant change and future solutions that are compatible with net zero GHG-emissions.

GCF do not have eligibility criteria. Instead, proposed actions are screened against GCF policies and standards, and assessed against GCF investment criteria, the latter are presented in chapter 6. AEs hold certain levels of standards pertaining to fiduciary functions and environmental and social risks, thanks to their accreditation. In addition, each funding proposal need to present how it meets the standards as set out in GCF disclosure policy, GCF environmental and social policy, GCF indigenous peoples' policy, GCF gender policy. It is also required to describe the project/programme's financial management, including planned procurement.

[26] Modern renewable energy excludes traditional biomass and liquified petroleum gas (LPG)

Investments in energy infrastructure include activities with potential significant adverse environmental and/or social risks and impacts that, individually or cumulatively, are diverse, irreversible, or unprecedented (GCF ESS Category A)[27]. The construction site selection highly influences the impact form investments in energy infrastructure. Power plants, including surrounding infrastructure, fuel/energy sourcing, as well as transmission and distribution networks, impacts on land- and marine eco-systems and biodiversity to a varying degree, depending on the site selection. Social impacts concern people and individuals living on site, in the vicinity of the site or that are otherwise affected or potentially affected by the activities. For example, accessibility to water in the water catchment area of a hydro power site will be affected. People may need to be relocated. There are also risks that dams collapse. For the three GCF priority pathways, power plants harnessing geothermal energy and hydro power certainly involve environmental and social aspects on prospecting and siting, but also solar-PV and on-shore wind as well as transmissions and distribution lines compete for land that can be subject to conflicting priorities. It is important to ensure that the investments in renewable energy do not lead to maladaptation, such as excess conversion of food productive agricultural lands or negatively impact on aquifers.

An increasing surge worldwide for electricity storage, and lithium-ion batteries requiring rare earth metals, is an example of how technologies can be subject to potential natural resource constraints and un-sustainable mining. Material recycling and waste management is a challenge, for example, when increased access to modern energy renders a distribution of equipment farther into livelihoods and ecosystems.

As stated by IEA, for the Net Zero Scenario, less mature technologies will also become imperative after 2030, and it is important to already prepare markets for priorities beyond GCF1. For example, sustainable biomass including waste to energy, may be of high relevance for countries that strive to shift away from coal and that have limited non-fossil alternative opportunities for dispatchable power production from renewable energy sources According to IPCC, while there is high confidence that the technical potential for bioenergy and bioenergy with carbon capture and storage (BECCS) is large, this potential is certainly reduced when environmental, social and economic constraints are considered. (IPCC, 2019)

The GCF environmental and social management system will be continuously reviewed and updated in a transparent and participatory manner. It will also be consistently aligned with international best practices and applicable standards. Harmonized application of safeguards will be promoted, to reduce multiple and overlapping requirements.

3.2 Three paradigm shifting pathways in the Energy sector

The following section articulates the vision, barriers[28], and pathways to a paradigm shift in each of the three paradigm shifting pathways – low emission power generation (Section 3.2.1), energy transmission, distribution, and storage (Section 3.2.2), and access to modern renewable energy (Section 3.2.3). Projects should address one or more of these three pathways:

3.2.1 Pathway 1: low emission power generation

Vision. In low emission power generation, the paradigm shift vision incorporates developing countries raising their ambition for renewable or geothermal energy in the context of their NDCs and deploying policy and regulatory reforms. Conducive environments that actively contribute to de-risking transactions for power generation based on renewable energy are of key importance. Coupled with capacity building, these systemic changes, should accelerate investments in renewable energy and pave the way for a transition to a low-

[27] The environmental and social risk categories of activities supported by GCF are defined as follows: Category A. Activities with potential significant adverse environmental and/or social risks and impacts that, individually or cumulatively, are diverse, irreversible, or unprecedented; Category B. Activities with potential limited adverse environmental and/or social risks and impacts that, individually or cumulatively, are few, generally site-specific, largely reversible, and readily addressed through mitigation measures; and Category C. Activities with minimal or no adverse environmental and/or social risks and/or impacts.

[28] For each area, typical barriers have been identified based on a survey of GCF accredited entities, NDAs and line Ministries who were surveyed and asked to identify the main barriers to renewable energy deployment.

emissions economy where markets do not already exist. This transformation will be achieved because attractive and viable opportunities for renewable energy investments would have been created.

Paradigm shifting actions address system-wide barriers to low emission power generation, mitigation of financial risks for scaling up renewables, and commercialisation of technologies that have passed the demonstration stage. In countries where the renewable energy market is currently nascent and supportive legislation is missing or ineffective, off-balance sheet project finance can have a substantial effect on scaling up renewable energy. In countries with a more mature renewable energy market, focus may be on de-risking rapid scale up of renewable energy to enable a low emissions and climate resilient development pathway, including to improve operational flexibility in non-renewable base load plants.

Overall, the GCF role is to deepen market maturation to accelerate market transformation, support local financial capacities, and increasing the public sectors capacity to procure green alternatives, to shift budgets and push developers and investors towards minimum life cycle costs, minimum externalities, maximum benefits and climate neutrality. For the immediate future and GCF1 (2020-2023) and with the 2030 horizon as a first major target in sight, the emphasis will be put on power generation based on renewable and geothermal energy.

Barriers and enablers to paradigm shift in low emission energy generation can be found in Table 2 and Table 3.

Table 2: Selected barriers to paradigm shift in low emission power generation

Barrier	Description
Policy uncertainty	This may relate to renewable energy targets, energy master plans, sector policies (e.g., land use or zoning) that don't include renewable energy or other key strategic options such as the unbundling of the sector or devolving some value-add to the private sector.
Deficient **legal** and **regulatory framework** for project development	This can arise at many different levels, from a lack of governmental (renewable) energy authorities that oversee the sector, down to inadequate design of standard PPAs and Grid codes, PPA tendering procedures, or tariff discovery.
Costs of complex and lengthy procedures for permits acquisition and grid connections	Labour-intensive, complex processes and long-time frames for obtaining licenses and permits (generation, EIAs, land title) for renewable energy projects, including unfavourable allocation of grid costs, are a significant cost driver of these projects. For example, **excessive power quality requirements** for issuing grid connection permits can necessitate installation of expensive additional equipment for power quality control.
Capital scarcity in nascent markets	Capital scarcity is the most frequently cited barrier, although it is usually not a root cause in markets which have a healthy and stable financial sector. In many cases this is not a result of lack of liquidity in the banking sector, but a result of a) lending restrictions, b) risk aversion, c) Requirement of additional collaterals and d) too low investment attractiveness (low net present value or internal rate of return). Capital scarcity is a particularly significant barrier for renewable energy projects in nascent markets, small and remote markets, and markets which do not have a well-developed financial sector. Therefore, they are unable to provide financing in local currency. Additionally, for the banking sector, asset-liability issues (i.e., lack of access to long term liabilities to match the long-term loans needed for this sector), is a critical barrier in all markets.
Poor **creditworthiness** (utilities and investors)	Institutional and market organisation barriers include limitations in the utility's (or other electricity purchaser's) credit quality, corporate governance, management and operational track record or outlook; or unfavourable policies regarding the utility's cost-recovery arrangements, driving investor requirements **for higher returns**.
Grid integration constraints	These arise due to lack of grid connectivity between high renewable resource regions to high power demand centres, grid flexibility and deficient assessment of available resources. Conventional **market design rules** face challenges in accommodating a large share of **intermittent energy sources** (from electricity trading to grid operation rules), requiring a much higher degree of flexibility than in grids with a baseload power supply provided by large, fossil-fuel powered plants.

Barrier	Description
Lack of strategic, managerial, and **technical knowledge and expertise** at multiple levels	Barriers include lack of specific technical skills such as those needed for primary energy resource assessment plant design, installation, operation and maintenance, master planning and awareness about renewable energy amongst consumers, end users and residents. Moreover, there is a lack of **policy expertise** at various levels of government, e.g., regarding use of incentives such as feed-in tariffs (FITs). "Green electricity" is often not available and, major end-users continue to utilize un-sophisticated sourcing and energy supply agreements.
Lack of banking experience	Lack of **awareness of the degree of maturity** of technologies can affect the confidence of investors and lead to high-risk perception, leading to increased capital cost for such projects. Other important skills-related barriers include lack of: • Information, assessment skills and track record in renewable energy projects in the investor community • Network effects among investors found in established markets • Familiarity and skills with non-recourse project finance structures

Table 3: Possible actions to support paradigm shift towards low emission power generation

Outcome	Possible actions and transformational potential
Transformational planning and programming	• Supporting long-term integrated energy, land-use and climate investment planning, including climate proofing of energy infrastructure • Support the development and availability of updated renewable energy and geothermal energy resource mapping, such as wind maps, insolation, cloudiness and albedo inventories, water measurements and geothermal resource mapping • Supporting the set-up of policy and regulatory reforms (e.g., RE Act, RE ambitious target setting in NDCs, fossil fuel phase out targets, energy subsidies reform) • Supporting dedicated renewable energy programming mechanisms (e.g., renewable portfolio standards, feed-in-tariff, auctions, carbon pricing frameworks, power purchase agreement frameworks) • Encouraging energy transition planning, deep decarbonization planning and long-term modelling, along with financial planning in GCF country programmes • Supporting business transformation planning for utilities to transition to low emissions energy services business models to ensure financial sustainability in changing energy markets • Support countries' planning and financing of a managed phase-down of coal fired power, while preserving electric grid reliability
Catalysing climate innovation	• Supporting new and innovative contractual arrangements for increasing life-time dispatch of RE power plants • Supporting investments in virtual power plants or similar solutions that increase dispatchability of VRE • Promoting technological innovation in lesser mature technologies such as offshore or floating wind, wave energy • Taking anchor investment positions in early deployment of innovative and scalable low emission generation technologies • Support regional cooperation and innovation to mature and deploy viable technologies and business models, including aggregation mechanisms as appropriate • Mobilizing support for innovation in business models or technology by private sector, including public private partnerships and general voluntary branch R&D for scalable commercialisation of new solutions and mechanisms for shifting, voluntary standards and carbon trading • Providing risk mitigation finance for high impact innovative technologies with a proven case.
Mobilisation of investment at scale	• Supporting power suppliers to nclude "Green electricity" in the offering to public and private electricity consumers to drive the market

Outcome	Possible actions and transformational potential
	• Developing customized micro- and mini-grid financing products for renewable energy services for fossil fuel replacement • Creating financing facilities dedicated to scaling up energy transition investments including replacement of existing fossil assets with renewable assets • Originating renewable energy projects where there are market gaps or failures • Developing financial products and risk mitigation tools to lower cost of capital for large scale projects for fossil fuel substitution • Leveraging existing capital to catalyse large scale investments for renewable energy power generation • Covering incremental cost of delivering renewable energy-based and climate resilient energy systems • De-risking periodic loss of revenue or other liquidity management challenges for newly established renewable energy service providers in nascent markets
Expansion and replication of knowledge	• Developing renewable energy knowledge products within Communities of Practice • Effectively disseminating information through GCF knowledge repository and networking events • Putting knowledge feedback/learning loops in place to reinforce all outcomes, including local skills development • Developing of green procurement guidelines for energy services that incorporate climate impact and minimum life cycle impact • Promoting application of best practices, environmental and quality standards • Advance internationally accepted climate impact ex-ante estimation tools for new and innovative contractual arrangements including climate resilient infrastructure.

3.2.2 Pathway 2: energy transmission, distribution, and storage

Vision. For efficient transmission, distribution and storage, the paradigm shift vision incorporates developing countries actively seeking to support relevant investments to improve grids through upgrading, climate proofing, and incorporating flexibility and storage as required. Reduction of barriers results in the share of renewable energy increasing while electricity grids increasingly become "low-emissions and climate resilient infrastructure".

Paradigm shifting actions need to be focussed on addressing system-wide barriers to upgrading and maintenance of transmission and distribution networks to enable the increase of renewable energy in the grid, minimizing risks for climate induced power outages, mitigating financial risks for grid upgrades and integration of storage and technology transfer for innovative storage technologies that have passed demonstration stages.

Barriers to paradigm shift in transmission and distribution can be found in Table 4; barriers to efficient storage projects in Table 5. Enablers for transmission, distribution and storage can be found in Table 6.

Table 4: Selected barriers to paradigm shift for transmission and distribution

Barrier	Description
Regulatory and legislative barriers	Regulatory and legislative frameworks are not in place in many developing countries to facilitate grid modernization. While some developing countries allow third party access to electricity, wheeling and private sector participation for grid development, the necessary secondary regulations and directives often do not exist. This can have consequences such as the inability to receive licencing for grid extensions.
Poor **creditworthiness** of network operators and utilities	Grid modernization/upgrading investments require high capital investments. Many developing countries utilities and network operators are struggling even to sustain the usual grid infrastructure. The financial status of many utilities in developing countries is weak, mainly because they do not collect sufficient revenue to invest since tariffs are supressed and bills not paid, a situation that has worsened due to the COVID-19 pandemic.

Barrier	Description
Electricity Industry Barriers	Even though there are some initiatives in the direction of modernization of grids, the vision of grid modernization is not commonly institutionalized. Incumbents' vertical role in the power industry, often including both generation and transmission business, may impede the diversification of actors in developing economies. The electricity industry management is affected by complex bureaucracies and frequently different players do not have the same understanding and commitment grid modernisation. Because of historical organisational structures stakeholders may work towards conflicting goals.
Lack of **knowledge, awareness and technical expertise** at multiple levels	Many utilities and network operators are preoccupied with routine work and hence lag in continuous learning and skill upgrading necessary for the design, planning and realisation of upgrading and climate proofing of T&D infrastructure.

Table 5: Selected barriers to paradigm shift for energy storage

Barrier	Description
Poor technology **cost competitiveness** under local conditions	While electricity storage costs are rapidly decreasing, many technologies remain costly and require support to make them competitive, particularly in developing country contexts.
Policy uncertainty around existing regulations	In markets where transmission, distribution and generation are separately managed there are often regulatory challenges to deploy storage since the services it provides cover segregated functions. For vertically integrated electricity markets challenges include lack of mandate and targets, and market designs that allow stakeholders to benefit from storage. New regulatory structures need to be created that encourage and enable distribution-level assets to provide key services.
Poor **creditworthiness** (of network operators and utilities)	Institutional and market organisation barriers include limitations in credit quality, corporate governance, management and operational history for network operators and utilities outlook.
Standards and codes	Interconnection standards need to be redesigned to facilitate integration of storage into networks, bidding parameters need to be developed, new market products need to be created, and grid codes need to be developed.

Table 6: Possible actions to support paradigm shift for transmission, distribution and storage

Outcome	Possible actions and transformational potential
Transformational planning and programming	• Supporting planning and programming for efficient and climate proof T&D and storage • Encouraging energy T&D and storage planning, deep decarbonization planning and long-term modelling, along with financial planning in GCF country programmes • Supporting market rules development for auxiliary and flexibility services that can unlock private investments • Supporting market rules and regulations that enable island operation of integrated renewable energy-based distribution networks • Supporting financial planning by countries to scale up investment in efficient and climate proof T&D and storage.
Catalysing climate innovation	• Supporting and mobilizing new forward looking contract models, including public private partnerships, with major load clusters for optimising power factor, flexibility, storage, and demand-response measures for higher volumes of renewable share, including with green hydrogen as well as aggregation mechanisms where useful • Supporting development of cost-efficient offshore transmission, sea-cables and optimisation of large offshore RE park solutions • Supporting addressing of curtailment and dispatch issues as well as regional power markets for renewable energy trade to increase power pooling volumes • Support improvements in multiple storage technologies to avoid single market reliance and help developing countries to develop local skills for manufacturing, assembly, and

Outcome	Possible actions and transformational potential
	operations of storage technologies, to reduce costs and improve local implementation, disposal and recycling • Providing risk mitigation capital and promoting technological innovation in nascent as well as advanced markets • Supporting investments in innovations in low emissions, climate resilient grid infrastructure technology to reduce losses, introduce digitalization, advanced system operation methods, new materials and technologies, including new storage technologies • Support voluntary carbon markets for facilitating that private sector financing/IPP's can contribute to investments in grid enhancements.
Mobilisation of investment at scale	• Creating facilities dedicated to scaling up efficient T&D and storage investments for large scale RE integration • Supporting large scale investment in "green grids", on-grid storage and grid flexibility through sequencing of risk to leverage national and private capital • Supporting financing for demand response and smart grid technologies to integrate flexibility services from charging of electric vehicles, desalination plants, industries and other loads • Taking anchor investment positions in early deployment/piloting stage of new scalable technologies/sectors • Originating energy storage projects where there are market gaps • Participating in syndication for large scale T&D or storage deals that clearly demonstrate the potential for low emission pathways • Mobilizing financing for new business models for T&D and storage services for "green" grids.
Expansion and replication of knowledge	• Developing grid flexibility knowledge products within Communities of Practice • Developing grid codes and knowledge transfer to grid operators for highly flexible grid operations • Effectively disseminating information through GCF knowledge repository and networking events • Putting knowledge feedback/learning loops in place to reinforce all outcomes • Promoting application of best practices, environmental and quality standards. • Advancing internationally accepted climate impact ex-ante estimation tools for grid capacity, flexibility, and storage within the grid.

3.2.3 Pathway 3: promoting access to modern renewable energy

Vision. For access to modern renewable energy, the paradigm shift vision is a balance between developing countries creating investment friendly environments dedicated to solving the problem of energy access and actively designing and implementing transformational renewable energy access interventions. These systemic changes will result in the rates of energy access increasing significantly. Both access and demand increase as customers climb the "energy ladder" and increasingly use *renewable* energy. An increasing number of investors will find low carbon rural energisation to be a commercially viable activity.

Paradigm shifting actions need to address systemic barriers to modern renewable energy access, mitigating financial risks for modern renewable energy access projects and programmes as building blocks in future fossil free systems, and delivery of innovative business models and technologies that have passed the demonstration stage. Attention to ensuring fair, transparent and non-exploitative supply chains ensuring that materials and products minimise life cycle costs and externalities and maximise benefits and climate neutrality for all.

Barriers and enablers to paradigm shift in energy access projects can be found in

Table 7 and Table 8.

Table 7: Selected barriers to paradigm shift in access to renewable energy

Barrier	Description
Poor technology cost competitiveness	Many factors limiting the technology competitiveness arise from the regulatory environment, from market distortions such as high fossil fuel subsidies to uncertainty or inflexibility in electricity tariff regulations. Some cost drivers are common to both developing and developed countries. For example, decentralised renewable energy projects have **high due diligence costs** due to the small size of projects. Cost is also an important factor given the isolated nature of communities and in some cases low population density.
Insufficient data and market linkages	A challenge for investors is the lack of reliable data: at national and regional levels there is limited access to grid expansion plans, and at the site level there is little data available to make investment decisions, particularly as it relates to market potential, and community needs and priorities.
Risk of stranded assets	A specific issue facing all off-grid projects is the **risk of stranded assets** if a location is connected to the national grid, leading to obsolescence of the off-grid technology.
Social acceptance	A lack of social acceptance can create significant barriers to adoption of new technologies. Social barriers related to the ability to pay and willingness to pay can be significant but can be addressed by business models that allow affordable services to the recipients and matches their cash flow. Some acceptance barriers come about because of a lack of awareness and can be addressed through information provision. Others represent human rights issues that must be addressed to reduce or remove this barrier in the same way as for other investments in infrastructure. Lack of trust in the technology, due to substandard products in the market and lack of stringent quality standards for the systems is also an issue in many markets.
Lack of **technical expertise** at multiple levels	Barriers include lack of awareness about renewable energy amongst consumers, end users and residents; specific technical skills such as those needed for primary energy resource assessment, plant design, installation, operation and maintenance; and lack of **policy expertise** at various levels of government and in the private sector.
Access to finance	Lack of working capital and affordable finance to cover high start-up costs associated with off-grid energy businesses, and a lack of consumer finance, preventing large scale adoption of renewable energy equipment.

Table 8: Possible actions to support paradigm shift for access to renewable energy

Outcome	Possible actions and transformational potential
Transformational planning and programming	• Supporting strategic, long-term energy planning that integrates power systems, energy access and climate goals • Encouraging access to renewable energy in planning, long-term modelling, along with financial planning • Establish cross sector dialogues to capture long term demand scenarios • Supporting countries to raise their renewable energy access ambitions in NDCs • Supporting the set-up of policy and regulatory reforms in renewable energy access (e.g., RE rural concessions, mini-grid regulations, policies related to the arrival of the national grid, RE Access target setting in NDCs) • Promoting actions including local community engagement and consultations when designing energy access initiatives.
Catalysing climate innovation	• Implementing transformational business models for electrification of rural cooking based on renewable energy, also considering aggregation mechanisms as realistic

Outcome	Possible actions and transformational potential
	• Supporting innovative business models that provide tailored, energy services for productive uses of electricity (e.g., cooling, processing, milling, graining, vacuum-packaging) with high/acceptable standards made transparent • Promoting shared risk business models or leasing arrangements to enable access to machinery and equipment for productive and value adding electricity uses, including prosumer business models for distributed energy that may be considered for grid inclusion • Supporting business models, including public private partnerships, with anchor customers e.g., commercial enterprise, public services or humanitarian agency as core customer • Funding innovative and impactful renewable energy access technologies including to address last-mile electrification for remote, disbursed populations, also considering aggregation mechanisms as realistic • Supporting community or cooperative level energy projects or similar collective business and financial models
Mobilisation of investment at scale	• Improving business models including linkages with partners such as digital financial service providers • Supporting credit lines for energy access models that are linked to food production, health, education, or others • Unlocking local financial institution or commercial finance for low emission energy access projects, including securitization of renewable energy investments to unlock private capital • Capitalizing of rural energy funds • Originating aggregated energy access programmes • Recycling debt/equity capital as appropriate to support wider access to renewable energy • Covering incremental cost of delivering resilient energy services based on renewables • Addressing liquidity risks for small scale service providers through creation of special purpose funds for common goals
Expansion and replication of knowledge	• Developing renewable energy access knowledge products within Communities of Practice • Effectively disseminating information through GCF knowledge repository and networking events • Putting knowledge feedback/learning loops in place to reinforce all outcomes • Promoting application of best practices, environmental and quality standards and consumer protection principles • Promote local skills development and local customers' more informed articulation of aspects on quality service provision • Advancing internationally consented methods for estimating causality between energy access and climate resilience

4 FINANCING PARADIGM SHIFTING PATHWAYS

GCF has a critical role to play in providing finance, particularly through de-risking instruments and in countries where markets are nascent or less mature.

GCF has a comparative advantage in financing renewable energy in developing countries that are highly indebted since its primary aim is to de-risk investments through concessional finance at its point of greatest need. GCF is uniquely positioned in that it follows a country driven delivery model and can take on higher financial risks to catalyse renewable energy and energy access projects. This unique financial mandate enables GCF to pioneer investments in developing countries and to deploy donor finance in highly innovative ways.

This section provides an overview of GCF financing trends, models, and opportunities to catalyse and scale up public and private investment in support of the paradigm shift identified in Section 3. The section motivates developed countries to provide the financing needed to support the energy transition through GCF projects for developing countries.

4.1 Financial barriers

In Section 3, we discussed barriers to the scale-up of renewable energy and energy access, including barriers in enabling environment (for example policies and regulations), institutional and market environment, as well as institutional capacity and awareness barriers. These barriers result in higher risks for financiers and, consequently, they either seek a higher rate of return for their investments or are unwilling to invest.

The most common financial barriers in projects submitted to GCF and delivering impact in the result area "Low Emissions Energy Access and Power Generation", are cited by over 80% of approved projects in the GCF portfolio[29] and they are:

- Short tenor of commercial loans (over 50% of projects mentioning this barrier)
- Need for financial incentives (50%)
- High up-front cost of renewable energy technologies (40%)
- Lack of private financing (35%)
- High interest rates on loans (35%)

To deliver a paradigm shift, GCF financial resources should be tools to address the policy, market and financial barriers in a systemic way and not just as a source of funding to deliver an investment project. Proposals should examine the broad range of GCF investment criteria prior to selecting financial instruments.

4.2 GCF financial instruments for low emissions energy access and power generation projects

During GCF 1, focus will be on scaling up and leveraging more private capital within mature fields of technology with a view to reaching NDC targets and beyond for 2030 based on the visions as presented in section 3 and ultimately the vision of net zero GHG emissions by 2050. A key for financing these visions is adopting or preparing the grounds for a higher degree of debt financing. A foundation for this will be the local sector preparedness and clarity as regards long term plans, regulations, reforms, budgeting, and sequential implementation priorities that contribute to de-risking investments.

As a foundation for developing strong and paradigm shifting funding proposals, GCF provides grants for countries' readiness and preparatory activities and technical assistance, such as the preparation or strengthening of low-emission development strategies or plans, NAMAs, NAPs, and NAPAs, as well as for in-country GCF-related institutional strengthening, refer to the readiness and preparatory support guidebook. Many of the energy sector transition actions mentioned in section 3 regarding transformational planning and programming can be supported by readiness activities, also to establish a proper energy sector resource mapping and monitoring to support strategic programming and monitoring of trends as well as to establish baselines for funding proposals.

Funding proposals (project and programmes), that are developed by GCF accredited entities can be micro-sized, below 10 million USD, and up to several hundred million USD.[30] If useful, AE's can access Project Preparation Funds (PPF) to prepare a more detailed ESS assessment, financial and economic modelling, better monitoring, or other. A funding proposal is assessed by the GCF Secretariat and the independent Technical Advisory Panel and is approved by the GCF Board.

A central part of justifying GCF proceeds is the presentation of the project's/programmes Theory of Change and articulation of the climate rationale. A baseline and a business-as-usual-scenario will be the basis of presenting how the alternative scenario (proposed activities) contribute to mitigation as well as adaptation. In the economic analysis, all costs and benefits are compared against a counterfactual scenario, which is the situation that would prevail in the absence of the project. The net benefits are calculated as the difference between the "with project" and "without project" scenarios. A complementing financial analysis shows the viability of the investment from different financing parties' perspective, also with and without GCF proceeds. A strong

[29] According to a study and review of the portfolio made by E Co Ltd.
[30] micro (< 10m million USD), small (10-50m USD), medium (50-250m USD) or large (> 250m USD).

argument for justification can be if a project has a high economic value (high climate impact), but poor financial returns without GCF proceeds and especially if the poor returns affect poor and vulnerable people.

Scenarios should be based on context specific insight, market studies, development plans and feasibility reports and will be the backbone of a successful proposal. For energy sector proposals, the business-as-usual scenario shall be clearly presented including transparency on any taxes or subsidies. For the alternative scenario, concessionality should be tailored to incremental cost or the risk premium required to make investments viable, or to cover specific activities.

GCF uses five key financial instruments, grants, reimbursable grants, loans, equity and guarantees. The following paragraphs outlines the available financial instruments followed by some *examples* of their application to the three priority pathways of this sector guide.

Concessionality can be applied to all GCF financial instruments and be extended to interventions in both the public and the private[31] sectors in several ways. For example, as a non-reimbursable grant (i.e., 100 per cent concessionality), as minimum concessionality for proposals using debt structures (loans), or as first loss shares in junior positions or the "anchor" portion in equity funds. GCF proceeds shall contribute the appropriate incentive to achieve the mitigation and adaptation impacts, with minimal market distortion.

For public proposals, grants should not displace investments that would otherwise have occurred, including for private sector investment. Overall levels of public debt in the recipient country should be considered so as not to encourage excessive indebtedness. For private proposals, terms are structured on a case-by-case basis to address specific barriers and based on the minimal concessionality principle. GCF will avoid crowding out other potential financiers but will support local financial institutions and aim to maximize leverage of co-financing and parallel financing, including private and public. GCF can combine its instruments as suitable and agreed with AEs, as long as the guiding principles are adhered to.

Non-reimbursable grants are typically used where there is no direct repayment (or reflow) mechanism such as local capacity-building and technical assistance. Non-reimbursable grants are appropriate as funds to spark the initiation of a new climate compatible pathway through short-term technical assistance, or in operations where a non-repayable capital expenditure or operational expenditure grant is most efficient. Grants will also be justified in countries where International Monetary Fund programmes limit sovereign borrowing.

Grant funded technical assistance within a funding proposal, may be focused on creating enabling environments through policies, regulations and standards, institutional and market environment development, as well as capacity building and awareness raising. The justification of grants for technical assistance and capacity building hinges on the presented overall transformational planning, including other parallel actions and financial contributions in the sector or more broadly and should contribute to the overall energy transition.

Grants can also be justified to promote universal access to energy among beneficiaries that have no access to date and with limited ability to pay, particularly in the climate vulnerable, least developed countries (LDCs), small island developing States (SIDS), and African States. Grants can also be justified for covering incremental costs for climate proofing energy infrastructure and for investments in Climate Resilient Infrastructure.

In addition, a reimbursable grant could be used to finance activities that have some revenue generation potential, but for which the magnitude or exact timing could not be accurately estimated at the time of project/programme development, and in cases where a country could not take on additional debt owing to the fiscal situation.

Concessional loans are debt instruments that have more favourable terms for borrowers than otherwise accessible on the financial market– such as a longer loan tenor, extended grace periods, and lower interest rates. Concessional loans are typically appropriate for reflow-generating private sector clients or established

[31] A project could be considered private when all financial resources that are provided for its implementation from financing entities are more than 50 per cent owned and/or controlled by private shareholders. A project could be considered public if all financial resources, other than the GCF proceeds, that are provided for its implementation from the public sector or entities are more than 50 per cent owned and/or controlled by the public sector.

sub-sovereign clients with revenue-generating operations (e.g., utilities). Terms can vary and can include below-market rates, as well as longer tenors and grace periods.[32]

Commercial loan terms are structured on a case-by-case basis. A concessional, commercial loan can have different seniorities (senior, *pari passu*, subordinated) and may have a lower interest rate compared with that prevailing in the market, with generally longer tenors and grace periods before the first repayment, as well as facilitation of more flexible terms.

Equity from GCF can provide a capital base for operations and reduce investment risks for other investors.

Guarantees are part of a group of de-risking instruments that are used to reduce the perceived risk-reward profile of an investment and thus encourage others to invest. Different types of guarantees can be bank guarantee, partial risk guarantee, revenue risk guarantee/off-taker guarantee or portfolio guarantee.

Investing in the sustainable and paradigm shifting energy pathways in developing countries should be viewed against the backdrop of suppressed demand and surge for power resulting from more people needing access to electricity and each individual customer increasing demand when climbing the energy ladder. Investments in supply can help avoid the lock-in of incumbent solutions such as fossil fuel combustion in thermal power plants and stand-alone diesel gensets. The additionality and impact of an intervention will, thus, include both providing more access, contributing to climate mitigation as well as climate resilience and climate adaptation.

GCF can support debt for climate swaps. This is an innovative funding mechanism that combine debt relief with climate action support. An indicative implementation structure for such a mechanism is centred on a three-party assignment agreement subject to which a creditor country contributes funds to GCF that are converted into climate project proceeds, to be complemented by additional project funding (equity, loans, grants) from co-financiers. A swap can lead to more resources for climate project financing and debt relief, and it can support local currency funding as well as an overall higher concessionality in the project funding mix.

GCF can support non-reimbursable funds in revolving funds with a view to pace up the paradigm shift and to reinvest funds as the surge for more sustainable and climate compatible energy services grow in LDCs, SIDs and African States. In these markets where private actors are scarce, revolving funds may be an efficient way of using seed-funding grants to facilitate the involvement of private renewable sector investors or project developers. Within the public domains (which may also be dependent on development funding), there can be poor incentives mechanisms to finance and procure renewable energy options, due to limited annual budgets and or short planning horizons, even when the life cycle costs may be lower, and pay-back periods may not be long for renewable energy alternatives to diesel gensets.

4.3 Co-financing

GCF projects seek to incorporate co-financing where possible to maximise the impact of GCF funds, although there is no minimum amount of co-financing required. Co-financing is assessed in conjunction with other indicators and not as stand-alone targets, thus, for example, projects with a high impact potential and delivering a significant paradigm shift may potentially have lower levels of co-financing.

[32] GCF terms and conditions for outgoing concessional loans to the public sector: Major convertible currency, 20 or 40 years maturity; 5 or 10 years grace period; 2%-6.70% of initial principal for annual repayment; 0%-0.75% Interest; 0.25%-0.50% service fee per annum; up to 0.75% Commitment fee (per annum).

5 CASE STUDIES

The following selected case studies are examples of transformative initiatives in different country contexts that illustrate projects that systematically address barriers for climate solutions in the energy result area.

5.1 Case study 1: Indonesia Geothermal Resource Risk Mitigation Project

Theme:	Assist Indonesia in scaling up geothermal energy development by de-risking investments in the sector		
Country:	Indonesia	Project size:	USD 410m (large) – tranche 1
Emission reduction:	112.2Mt	GCF financing:	Senior loans: USD 7.5m Reimbursable Grants: USD 90m Grants: USD 2.5m
EES category:	Intermediary 1 (High)	Co-finance:	Senior loans: USD 225m Equity: USD 60m Loan: USD 25m
Accredited entity:	World Bank	Co-finance ratio:	75.6%
Approved:	October 2018	Completion:	May 2030
Information:	https://www.greenclimate.fund/project/fp083		

Impact potential. Indonesia's electricity sector is dominated by fossil fuels, and only 12.5% of its electricity generation comes from renewable energy. Indonesia has a geothermal potential comprising 40% of known reserves globally – approximately 29 GW. To date only 1.8 GW has been developed so there is significant potential for development of this energy source.

Country ambition. In 2015 at the COP21 in Paris, Indonesia committed through its Nationally Determined Contribution (NDC), to a 29 percent reduction of national greenhouse gas emissions by 2030. This translates into a target to increase the share of renewable energy in the power generation mix to 23 percent by 2026. It is planned that geothermal energy will contribute seven percentage points of the 23 percent, which is equivalent to adding 5.8 GW to the present 1.8 GW geothermal generation capacity. This would require investments in the order of US$ 25 billion (assuming an average cost $4.3 million per MW as per Indonesian experience), most of which would have to come from the private sector.

Barriers addressed. A key barrier to the development of Indonesia's high-potential geothermal sector is early stage exploration risk faced by geothermal developers.

Pathway to paradigm shift. The project consists of two components funded through two tranches that systematically address the barriers in the geothermal sector:

- Component 1: Geothermal resource risk mitigation – in which a new Geothermal Resource Risk Mitigation Facility will be established, consisting of Public-Sector and Private-Sector Windows, providing geothermal developers debt financing for their resource confirmation drilling, through: (i) soft loans to public sector developers, and (ii) loans to private developers and the subscription of convertible bonds issued by private sector developers, to be used alongside their own equity. GCF is providing a funding package that employs senior concessional loans for the public sector, and reimbursable grants for the private sector. Where resources are confirmed, power plant development and exploitation drilling will then be financed by commercial and other financiers.
- Component 2: Technical assistance and capacity building – finances a multi-year support programme to cover for incremental operating costs and enhance capacity in managing the Facility to build capacity

within the key sector stakeholders and to provide technical assistance support towards improving the overall sector governance and investment climate for geothermal development in Indonesia.

Expected impacts. Overall, the project aims to develop 1 GW to 1.5 GW of geothermal energy, providing an estimated emissions reduction of 187-281 million tonnes of CO_{2eq} over the lifetime of the generating assets. The project exemplifies the use of innovative finance to de-risk a sector with a high impact potential. It has the potential to ***catalyse Indonesia's transition*** to cleaner energy while meeting its growing energy needs.

5.2 Case study 2: Mali solar rural electrification project

Theme:	Partnership with the West African Development Bank (BOAD) and the Government of Mali to scale up rural electrification through solar photovoltaic mini grids		
Country:	Mali	Project size:	USD 41.6m (small)
Emission reduction:	821.8kt	GCF financing:	Senior loans: USD 29.5m Grants: USD 2m
EES category:	Category B (Medium)	Co-finance:	Senior loans: USD 10.1m
Accredited entity:	BOAD	Co-finance ratio:	24.2%
Approved:	February 2019	Completion:	February 2025
Information:	https://www.greenclimate.fund/project/fp102		

Impact potential[33]. In Mali, 70% of the population lives in rural areas, and 80% of the rural population lacks electricity. Though Mali has a high potential for solar energy, grid extension to all is currently not feasible due to myriad technical and financial challenges. Thus, mini grids have the potential to bridge the energy access gap while greening Mali's electricity supply.

Country ambition. Under the Paris Agreement, Mali committed to reduce emissions in its energy sector by up to 31%. Its National Adaptation Plan of Action (NAPA) and 2011 national climate change policy and strategy feature renewable energy as a key component for achieving its climate targets.

Barriers addressed. Mali has weak planning processes, domestic financial institutions, and frameworks for public-private partnerships. Renewable energy technology has a high up-front cost and consumers cannot afford modern renewables without subsidies. There is limited human resource capacity in the sector, and a lack of research on impacts and market conditions challenges the ability to create a standardised programmatic approach to energy.

Approach to paradigm shift. The project has the following components:

- Component 1: Capacity building and technical assistance – The project will support rural electrification institutions through training and sharing lessons learned. It will provide technical assistance to operations and maintenance companies that will operate the mini-grids.
- Component 2: Installing solar mini-grids – This component will install mini-grids in 70 different localities. With a mix of grants and highly concessional loans, the project takes a public-private partnership approach wherein the government owns the mini-grids, while a competitive bidding process will determine the private sector actors responsible for their construction, maintenance, and operation.
- Component 3: Providing microfinance for productive use of electricity – The project will partner with local financial institutions to provide small loans to consumers who wish to purchase tools and appliances that

[33] The Mali solar rural electrification project focussed on monitoring mitigation impact only. Moving forward, GCF will value that energy supply and access projects also consider climate resiliency aspects and monitor climate adaptation.

use electricity to improve economic productivity, such as refrigeration, processing of agricultural products, or power tools for small industry.

Expected impacts. The project is expected to install 3.78 MW of power in its first tranche, providing emissions reductions of 821.8 kilo tonnes over its lifetime. It will improve access to electricity for 28,300 households and encourage investment in tools and appliances that improve economic productivity.

Beyond the project's increasing of energy access, its public-private partnership model allows for the de-risking of energy access by improving commercial viability while encouraging the participation of the private sector. The project's technical assistance component will strengthen the capacity of institutions to engage with private sector stakeholders in the future.

5.3 Case study 3: Espejo de Tarapacá project

Theme:	With an equity investment from GCF, MUFG Bank aims to provide stable pricing for renewable energy throughout the day by combining a solar power plant with pumped storage hydroelectric energy		
Country:	Chile	Project size:	USD 1.1b (large)
Emission reduction:	35Mt	GCF financing:	Equity: USD 60m
EES category:	Category A (High)	Co-finance:	Senior loans: USD 647.3m Equity: USD 386.7m
Accredited entity:	MUFG Bank	Co-finance ratio:	94.5%
Approved:	July 2019	Completion:	February 2025
Information:	https://www.greenclimate.fund/project/fp115		

Impact potential. Despite its ambition to decarbonise, in 2018 more than 50% of Chile's energy was generated from thermal units – mostly coal-fired plants. By implementing the first bulk energy storage in Chile, the project has the potential to provide grid flexibility while encouraging further investment in VRE. Having mobilised an additional $1 billion in private sector co-financing, it has the potential to decarbonise 5% of Chile's energy mix.

Country ambition. As a party to the Paris Agreement, Chile has submitted an NDC with targets to reduce emissions per capita by 30% versus 2007 levels, or 35-45% contingent upon receiving international grants. It aims to reach and 60% renewable power generation by 2035, and 70% by 2050.

Barriers addressed. A major challenge to the transition to renewables is the intermittent nature of solar energy, which creates volatile pricing on the spot market.

Approach to paradigm shift. The Espejo de Tarapacá project will use solar energy during the day and pumped storage hydroelectric at night – stabilising energy generation and prices around the clock. This project is an example of how GCF can take on project development risk where other stakeholders are unwilling.

The project components are as follows:

- Component 1: Project development – This component includes preparing the final project phase up to the financial close of debt financing. It involves preparing to participate in Power Purchase Agreement auctions and securing permits.
- Component 2: Project construction – Using a mix of equity and senior loans, the project will construct a 561 MW-AC PV solar park, and a 300 MW pumped hydro storage plant with a desalination plant.
- Component 3: Community works – This component includes training and investment for fishermen near the hydro plant and providing clean drinking water from the project's desalination plant.

Expected impacts. The project is expected to generate 1,500 GWh (net) of renewable energy per year, avoiding 35Mt of emissions over the projects 35-year evaluation period. It is expected to provide 17.6 million people with renewable energy. The project's combination of hydro and solar power can serve as a model for other renewable energy projects in Chile.

6 GCF INVESTMENT CRITERIA FOR IMPACTFUL ENERGY PROPOSALS

GCF investments are guided by six investment criteria. To receive funding, projects should meet each of these criteria. Project developers should refer to GCF project preparation information and further instructions from the GCF programming manual.

In this section, specific guidance is given on how to develop quality GCF proposals that meet the investment criteria in the GCF energy result area.

6.1 Impact potential

Increasing the share of renewable energy has a high mitigation potential. Proposals must describe the envisaged project/programme impact for mitigation and elaborate on how the project/programme contributes to low-emission sustainable development pathway through shifting away from or avoiding lock-in of fossil-based energy. With reference to GCF's portfolio target of a 50:50 balance between mitigation and adaptation, it is highly recommended to also identify and report adaptation impacts from energy projects. The proposal must then also describe the envisaged climate change induced hazards and elaborate on how the project/programme contributes to increased climate-resilient sustainable development.

For quantifying the expected emissions reduction, as in Core indicator 1: GHG emissions reduced avoided or removed/sequestered, the AE is required to provide an ex-ante estimation based on transparent and established methods.

Adaptation impacts will need to be specified and backed by a documented, scientifically based climate change vulnerability in the project area. Thereto, the causal link between project-specific activities, technologies, and approaches and the intended reduction in vulnerability to climate change need be described.

In all paradigm shifting priority pathways presented in this guide, it can be relevant to specify how the built infrastructure is made more resilient to climate change, and to report adaptation impacts in the result area ARA3: Infrastructure and built environment. In such case, the proponent must present how climate change impacts the infrastructure and explain how the investment is made climate resilient through the project/programme. Assets can also be given a monetary value in order to report impacts in Core indicator 3: Value of physical asset made more resilient to the effects of climate change and/or more able to reduce GHG emissions.

For projects or programmes providing "access-to-energy" it is expected that proponents specify direct and indirect beneficiaries provided with increased resilience to climate change. Thus, to what extend the improved access results in ARA1: Increased resilience of most vulnerable people, communities, and regions as well as ARA2: Increased resilience of health, food and water security. It requires that the proposal can demonstrate how, and to what extent, accessing (more) energy from renewable sources can help address any element of climate vulnerability (reduced exposure, increased adaptive capacity), or how it helps to strengthen adaptive capacity. This should be project-specific, referring to the project technology and level of service (SHS, or mini-grid, no of hours, peak power, etc.) as well as the end user needs and priorities. For a proposal that provide energy access **with** adaptation impacts, it will be more justified with grants.

In addition, Core indicators 5-8 are used for reporting on the proposed activities' contribution to the enabling environment, including but not limited to strengthening institutional and regulatory frameworks, technology

deployment, market development, and knowledge generation (please refer to the integrated results management framework, IRMF[34]).

6.2 Paradigm shift potential

High impact GCF projects should result in a paradigm shift: transformational changes that deliver a medium or long-term sectoral change or 'tipping point' with impacts beyond a single project.

The guidance below is anchored in GCF sub-criteria for assessing paradigm shift (GCF B.09/05), including innovation, scalability, knowledge and learning, sustainability, market transformation, replicability.

Proposals are evaluated for their ability to crowd in low carbon energy investments and create a lasting impact on national / regional energy sector development. For example, a shift to non-fossil alternatives is more paradigm shifting than hybridisation efforts in existing thermal power plants. A shift from traditional biomass use to electric cooking or other modern renewable energy certainly involves a deep cultural transition. Strong female leadership with proactive and inclusive energy planning will be a paradigm shift in the male dominated energy industry.

Impactful projects are likely to address systemic barriers to investment including regulatory reform or development to enable future investment in low carbon energy generation, energy access, or energy infrastructure – this includes development of renewable energy legislation, target setting for renewables, and grid access. GCF looks for national, context-specific "tipping points" for systemic transformational change, including convincing theories of change for how the project will be replicated in the future or continue beyond the investment period without GCF participation.

6.3 Sustainable development potential

Impactful projects deliver significant sustainable development co-benefits. In UNFCCC's NDC Synthesis summary 2021 (UNFCCC, 2021), targets within SDG 7, Affordable and clean energy, were complemented by targets in SDG 13 Climate action, SDG 8 Decent work and economic growth, SDG 11 Sustainable cities and communities, SDG 9 Industry, innovation and infrastructure, followed by SDG 1 No poverty, SDG 2 Zero hunger, SDG 3 Good health and well-being, and SDG 12 Responsible consumption and production (in order of frequency).

Projects reporting in GCF's energy result area should identify at least one positive co-benefit in at least two of the four coverage areas: economic, social, environmental, and gender empowerment. Where appropriate, proposals should reference the achievement of one or more of the United Nations Sustainable Development Goals.

The proposal should provide an associated co-benefit indicator, as well as baseline and target values for the co-benefits. For projects providing access to energy, GCF recommends that AEs provides an indicator for social, environmental, economic co-benefit related to the increased access. It is useful to describe contribution to load growth per economic sector besides the fund level outcome indicator *M6.2 Number of households and individuals (males and females) with improved access to low-emission energy sources.* It is suggested that, more than number of households, this co-benefit indicator should specify the project/programmes contribution to load growth per sector of economy with the underlying assumption that access to reliable and affordable electricity is contributing to the general development and climate resilience. As such GCF and AEs would contribute to the learning loop of informed demand forecasting in the energy area.

[34] GCF/B.29/14 Integrated results management framework (IRMF)

6.4 Needs of the recipient

For impactful projects under the energy result area, attention must be given to identify and address the needs of the recipients. This involves working with recipients to understand their priorities and the barriers that they experience when shifting to low emission pathways.

For the energy result area, in many cases, needs of recipients for low carbon energy generation, and investments in transmission, distribution and storage can be identified through careful stakeholder interviews and market mapping. The challenge for energy access projects is that recipients are frequently marginalized and vulnerable, and in some cases difficult to access (for example the voice of poor women is sometimes difficult to hear), but essential if a project is to have the intended impacts.

Describe how the project/programme addresses the following needs: the economic and social development level of the country and the affected population; the absence of alternative sources of financing (e.g. the fiscal or balance-of-payment gap that prevents the government from addressing the needs of the country; and the lack of depth and history in the local capital market); and the need to strengthen institutions and implementation capacity. For adaptation projects, describe the vulnerability of the country and/or specific vulnerable groups, including gender aspects. Proposals should then outline how the proposed intervention will address the identified needs and barriers.

6.5 Country ownership

High impact projects should demonstrate a strong alignment with national plans, climate strategy, energy sector plans, policies and institutional frameworks. This includes alignment with the country's NDC, nationally appropriate mitigation actions (NAMAs) and national adaptation plans of action (NAPAs); and its GCF country programme. In addition, country ownership includes the engagement with relevant stakeholders at the time of proposal development, and during implementation. Relevant stakeholders include national authorities and beneficiaries. For energy projects, engagement with stakeholders that are affected, ensures that they agree to and are aligned with the project outcomes and approach. Countries' NDA or Focal point may need to pro-actively involve the Ministry of Finance and the Ministry of Energy as well as Energy Agencies to the extent that they exist. Broad engagement is particularly important for low-emission power generation and energy access projects, where vulnerable groups may be adversely affected, and to address issues such as food security, land-grabbing and related human rights. The role of the national designated authority; and engagement with civil society organizations and other relevant stakeholders, including Indigenous peoples, local communities, women, and other vulnerable groups. Projects that are locally accepted and supported have strong foundations to ensure that they deliver significant and lasting positive impacts. The capacity of AEs or executing entities (EEs) to execute the project should also be demonstrated.

6.6 Efficiency and effectiveness

Efficiency and effectiveness for energy projects is measured using quantitative indicators. A set of separate indicators are proposed for the efficiency and effectiveness of mitigation and adaptation projects.[35]

- Mitigation efficiency and effectiveness indicator: ***cost per tonne of carbon dioxide equivalent***. Projects should give the cost per tonne of carbon dioxide equivalent of the GCF intervention.
- Mitigation efficiency and effectiveness indicator: ***ratio of co-financing***. As appropriate, projects should indicate the ratio of co-financing mobilized relative to the GCF contribution to the total project.
- Mitigation and adaptation indicator: ***expected rate of return***. As appropriate, projects should provide an estimate of the expected economic internal rate of return and/or financial internal rate of return, depending on the needs of the project.
- Mitigation and adaptation indicator: ***application of best practices***. Projects should describe how the proposal applies and builds on the best practices in the sector.

[35] *Refer to B.22/05*

These factors are assessed on a case-by-case basis. Project developers are encouraged to compare the efficiency and effectiveness of their projects against comparable projects in the GCF portfolio and those of other similar projects globally.

7 CONCLUSION

Three distinct transformational pathways can deliver significant and paradigm shifting impact for low emission energy access and power generation. They are electricity generation from renewable energy sources, efficient and reliable transmission, and distribution of electricity (including storage) to accommodate for high share of renewable energy-based power generation and rapid acceleration of universal access to modern renewable energy. These transformational pathways also lead to greater adaptation and resiliency impacts.

Alignment between long term strategic energy systems planning, national financial planning, and green budgeting that integrate climate and development goals are key factors. Public financing will not suffice for the projected investments needs for energy transition in developing countries to meet the goals of the Paris Agreement and crowding in private investment must be given high priority. Therefore, GCF interventions that make blending of finance from different sources work for developing countries are of paramount importance. Even though levelized cost of energy from most renewable technologies are now lower than new fossil fuel-renewable energy-based power generation, the financial risks are high because the initial investment costs need to be covered by many years of revenue that should be assured through commitment for shifting to renewable energy. Substantial investment in transmission, distribution, storage, and flexibility is also required.

Overall, the selection of the most appropriate financial mechanisms and structures for GCF and co-financers is highly dependent on many factors including country-specific factors (such as financial markets, legislation and regulatory environment, type, and status of market actors as well as market maturity). Moreover, technology and business models, and the financing mechanism itself (such as attractiveness to financiers, transaction costs, private sector leverage, cost effectiveness, and the sustainable development potential) will be guiding factors. Generally, for mature technologies – such as many of the grid-connected renewables – and where markets are more developed, high levels of private co-finance are likely, and more sophisticated de-risking instruments are appropriate for rapid scale up. Where technology is more nascent, markets are immature and beneficiaries more vulnerable, more public sources are likely, and GCF funding can be more concessional.

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