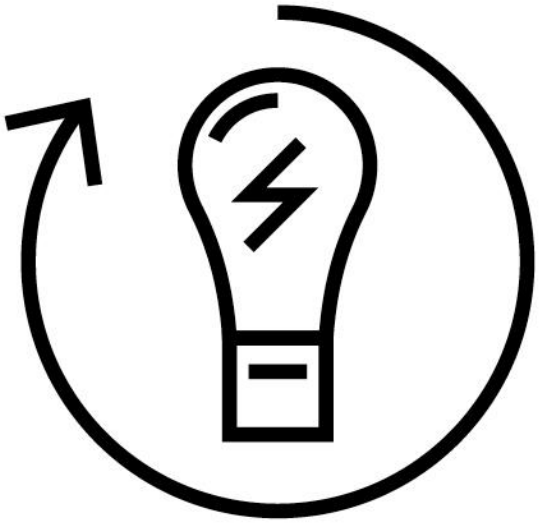

Sectoral Guide Consultation Version 1

Energy efficiency

GREEN CLIMATE FUND | Sectoral Guides

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Contents

Abbreviations

AC	Air Conditioner
AE	Accredited Entity
BAU	Business As Usual
CaaS	Cooling as a Service
DAE	Direct Access Entity
DSM	Demand Side Management
EBRD	European Bank of Reconstruction and Development
EE	Energy Efficiency
ESCO	Energy Service Company
ESI	Energy Savings Insurance
ESS	Environmental and Social Safeguards
CO_2eq	Carbon Dioxide equivalent
GCF	Green Climate Fund
GDP	Gross Domestic Product
GHG	Greenhouse Gas
Gt	Gigatons
GWP	Global Warming Potential
HVAC	Heat, Air Ventilation, and Cooling
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
ISO	International Standards Organisation
IoT	Internet of Things
LDC	Least Developed Country
MEPS	Minimum Energy Performance Standards
MSME	Micro, Small and Medium Enterprise
M&V	Monitoring and Verification
NDA	National Designated Authority
NCAP	National Cooling Action Plan
NDC	Nationally Determined Contribution
NEEAP	National Energy Efficiency Action Plan
OEM	Original Equipment Manufacturers
PIC	Private, Institutional and Commercial
RAC	Refrigeration, Air conditioning and Cooling
S&L	Standards and Labelling
SDG	Sustainable Development Goal
SIDS	Small Island Development States
TNA	Technology Need Assessments
ToC	Theory of Change
UNFCCC	United Nations Framework Convention on Climate Change

Executive summary

The Green Climate Fund (GCF) is the world's largest dedicated fund helping developing countries respond to climate change. It was established by the United Nations Framework Convention on Climate Change (UNFCCC) in 2010 and has a crucial role in supporting developing countries in achieving their commitments and ambitions toward meeting the goals of the Paris Agreement. The GCF is dedicated to boosting climate finance for developing countries and has set an ambitious agenda with its Strategic Plan for 2020-2023. Despite the global pandemic, GCF is providing increased support, helping developing countries build a low emission, climate-resilient recovery. The GCF Sectoral Guide series supports the progressive work programme approved for 2020-2023 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 focuses on to deliver a substantial impact on mitigation and adaptation in response to climate change (GCF, 2018b). 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. The energy efficiency (EE) sector is an important, cross-sectoral part of climate mitigation and adaptation. These cross-sectoral issues are addressed through multiple result areas in a complementary manner, as shown in Table ES-1.

Table ES-1: Cross-references with other Sector Guides

Sector	Cross-Sectoral issues addressed
Agriculture and food security	• Agribusiness cold supply chains for food processing and food waste reduction. • Efficient water pumping and irrigation practices.
Cities, buildings, and urban systems	• Climate-resilient and resource-efficient building design practices in urban areas. • Resilient cities and urban systems to reduce heat island effects. • Efficient district heating and cooling networks.
Climate information and early warning systems	• Weather monitoring and climate information systems. • Internet of Things (IoT) and cloud storage applications for weather and climate data.
Ecosystems and ecosystem services	• Ecosystem-based approaches to reduce cooling demand for adaptation to heat waves.
Energy efficiency	• Industrial energy, material, and resource efficiency practices. • Energy efficient appliances, standards, and labelling for consumer and small business needs. • Efficient cooling applications for buildings. • Efficient energy system planning practices coupling electricity, heating, air conditioning, and ventilation requirements. • Energy efficient building and city-district design.
Energy access and power generation	• Electricity generation from renewable energy resources. • Efficient and reliable energy transmission and distribution networks for high penetration of renewable energy. • Clean energy access, including clean cooking.
Forests and land use	• Efficient biomass usage and conversion practices for electricity, heating, cooling, and cooking needs. • Efficient biomass usage and conversion practices for industrial uses.
Health and wellbeing	• Cold supply chains for medicine and vaccines. • Efficient, long-term cold storage and logistic practices. • Health services preparedness, *including cooling solutions*, for extreme events, *such as heatwaves*.
Low emission transport	• Vehicle fuel efficiency standards. • Efficient electric mobility applications. • Efficient fuelling and charging networks.

Sector	Cross-Sectoral issues addressed
Water security	• Efficient water pumping systems and networks for both municipal water supply as well as for irrigation.

GCF Energy Efficiency Sectoral Guide

On a global scale, energy efficiency (EE) addresses critical issues in the production, delivery, and consumption of energy across all sectors, societal groups, income levels and geographies and is imperative for sustainable development. EE plays a central role in allowing affordable, just, and manageable energy transition. It is an essential approach for mitigating climate change by reducing energy-related CO_2 emissions as well as reducing and offsetting energy demand growth. EE features among the mitigation options highlighted in the most recent IPCC assessment report which is feasible to deploy at scale in the near term (IPCC, 2022). Investments aligned with EE paradigm shifting pathways can transform industrial sectors, the built environment, energy systems and appliances/equipment supply chains while meeting country priorities and beneficiary needs. In the International Energy Agency (IEA)'s Net Zero Emissions by 2050 Scenario, the energy intensity of the global economy is projected to improve (that is, to fall) by 35% by 2030 – driven by a mix of EE measures, combined with electrification of processes and behavioural change (IEA, 2021b). The Energy Efficiency Sectoral Guide highlights how meaningful progress can be made through the design and inclusion of EE measures and co-benefits within a wide range of climate mitigation and adaptation investments.

Paradigm shifting pathways

A major worldwide push to increase EE is urgently needed. According to the IEA's net-zero 2050 scenarios, the annual rate of economy-wide energy intensity improvements needs to increase to 4% by 2030 – about three times the average rate achieved over the last two decades (IEA, 2021a). Given the need to significantly reduce greenhouse gas (GHG) emissions during this decade to meet the Paris Agreement goals, GCF has identified the following three energy efficiency (EE) paradigm shifting pathways for advancing the highest climate impact projects and supporting country needs:

- **Scaling-up industrial energy efficiency:** This pathway envisages accelerating ambitious shifts to low-emission sources for highly energy-intensive industrial processes, scaling up the use of low-emission feedstocks for priority industrial materials, and catalysing and benchmarking industrial innovations to drastically reduce energy, material, and carbon intensity. Integrated programming and policies such as legally binding industrial material recycling targets, mandatory energy intensity reduction targets for manufacturing processes, mandatory periodic energy audits and carbon taxes on energy use for industry, will create the enabling environment for scaling up climate finance. Transformative investments in reducing net energy demand, switching to low-emission fuel sources for process heat, or shifting to new processes using electricity will be prioritised.
- **Enhancing "space" energy efficiency** [1] **:** This pathway envisages reducing emissions from energy consumption in heating, cooling, and lighting in residential, commercial, public, and industrial "spaces". Space heating and cooling contribute to the highest end-use energy consumption in buildings, followed by lighting. Innovations in building design solutions that significantly reduce energy demand for space heating, cooling, and lighting integrate ecosystem-based approaches within a building envelope and scale up low-emission building materials for residential, commercial, and industrial buildings will be prioritized.
- **Catalysing rapid market switch to highest efficiency appliances/equipment:** This pathway envisages supporting breakthrough EE programmes across critical super-efficient appliances/equipment supply chains. Programmatic approaches that catalyse rapid market switches by integrating a variety of public/private EE market aggregation partners will be prioritized. Capacity building and technical

[1] Space heating includes sustainable heat supply for manufacturing and industrial processes.

assistance coupled with financial de-risking solutions and ambitious policy instruments can make the uptake of various super-efficient appliances/equipment supply chains transformational.

Barriers to achieving paradigm shift

Most EE project portfolios provide compelling paybacks with stable cash flows from energy, material, and other savings, and involve tested technologies with a relatively low implementation risk. Reducing energy subsidies can be a major driver for scaling-up EE solutions at a country level. Many EE opportunities remain untapped, largely because energy, material and resource efficiency are not seen as a strategic priority for market actors (outside of those engaged in energy-intensive activities as their core business). This dynamic often leads to the inaction of decision-makers and stakeholders along a supply chain. A wide range of financial, regulatory, technical, and other barriers across economic sectors is to be addressed on a case-by-case basis. Above all, there is an immediate need to consolidate and mainstream an effective, high-impact EE business model that (a) is adaptable and scalable to various country and regional contexts; (b) can deploy a diverse set of financial products through national or regional financing facilities in coordination with GCF Accredited Entities (AEs) and National Designated Authorities (NDAs); and (c) can implement measures to ensure effective knowledge sharing, capacity building, and continuous product and service development globally.

Role of GCF in financing paradigm shifting pathways

GCF offers a four-pronged approach to drive implementation across the three ambitious energy efficiency (EE) paradigm shifting pathways identified. While business models, project development systems, financing structures, and ability to attract Private Institutional and Commercial (PIC) finance differ significantly across regions, these approaches can support developing countries' efforts in scaling-up energy efficiency. These four strategic GCF pillars are:

(1) Transformational planning and programming
(2) Catalyzing climate innovation
(3) Mobilization of finance at scale
(4) Coalitions and knowledge to scale up success.

To deliver a paradigm shift, GCF´s financial resources act as tools to address barriers in a systemic way and not just as a source of funding to deliver project-by-project investments. GCF´s range of financial instruments shall be efficiently and effectively coordinated with co-financiers, blended, and sequenced to leverage other public and private capital. GCF is a fundamentally partnership-based institution, thus leveraging existing sectoral initiatives, coalitions, and platforms remains critical to creating multiplier effects and to promoting joint learning and knowledge transfer.

When developing high impact GCF energy efficiency (EE) projects and programmes, AEs and other stakeholders are requested to take into consideration the GCF core principle of country ownership and align their intervention with existing national infrastructure planning and programming processes. GCF thereby strives to increase the focus on Direct Access Entities (DAEs) and acknowledges the role of local financing in nurturing and mainstreaming transformational business models. Figure ES-1 gives an overview of the three paradigm shifting pathways and their associated drivers, following the four pillars of the GCF Strategic Plan (GCF, 2021b).

GCF Investment Criteria

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

(1) **Impact potential:** degree to which a project or programme contributes to the achievement of GCF objectives and result areas.
(2) **Paradigm shift potential:** degree to which the proposed activity can catalyse impact beyond a one-off project or programme investment.

(3) **Sustainable development potential:** degree to which the actions proposed for funding align with national SDG priorities and promote environmental, social, gender, and economic co-benefits and/or wider benefits and priorities.

(4) **Recipient needs:** degree to which the vulnerability and financing needs of the beneficiary country and its population are considered.

(5) **Country ownership:** degree of beneficiary country ownership of, and capacity to coordinate and implement, a proposed project or programme, including aligned sectoral policies, climate strategies, and national institutions.

(6) **Efficiency and effectiveness:** degree of the economic and, if appropriate, financial soundness of the proposed programme or project.

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

Table ES-2: Possible actions for each pathway following the four pillars of the GCF Strategic Plan

		Actions across the four pillars of the GCF Strategic Plan			
Energy Efficiency		**Transformational planning & programming**	**Catalyzing climate innovation**	**Mobilization of finance at scale**	**Coalitions and knowledge to scale up success**
Paradigm-shifting pathway	**Scaling up efficiency in energy-intensive industries**	• Mainstreaming mandatory energy consumption targets, resource and material efficiency standards • Enforcing legislation for mandatory, periodic energy audits in industry • Setting and enforcing supply chain emission reduction targets • Promoting time-bound roadmaps for phasing out high-emitting industrial processes and fostering fuel switches • Mainstreaming technical and financial planning and programming across energy intensive industries • Promoting best-practice international energy management standards • Participating in high-impact research pilots	• Demonstrating technology innovations in critical energy- and resource-intensive manufacturing • Substituting fossil fuels with alternative solutions • Promoting innovations in reuse/recycling of industrial waste materials • Demonstrating anchor investments in new breakthrough high risk and high potential business models • Testing and deploying innovative large-scale market based financial instruments for breakthrough technology innovations	• Policy-based loans for transformational industrial value chain developments • Guarantees and political risk insurances to de-risk novel, large scale, and catalytic industrial energy efficiency investments • Energy efficiency funds and credit lines for industries • (Junior) equity for early-stage, breakthrough, private sector-driven industrial energy efficiency technology adoption • Industrial energy specific export financing schemes for global value chains	• Capturing experiences and developing knowledge products on EE business models and financing options • Disseminating best practices through GCF knowledge repository and networks • Establishing green procurement and distribution guidelines for energy efficient services • Linking or merging EE building codes with resilience standards for buildings • Capacity building, technical assistance and knowledge hubs, e.g. for ISO 50001 implementation • Establishing an MEPS repository
	Enhancing "space" energy efficiency	• Scaling zero-carbon building design code implementation with ambitious EE and material reuse standards, labels, and certificates • Adhering to best-practice MEPS for space efficiency measures • Promoting "zero-carbon" retrofit for residential, commercial, public, and industrial "spaces"	• Integrating "ecosystem-based solutions" in building plans • Scaling up innovation in building material that significantly reduces energy demand • Defining layered building codes • Using new business and service models (e.g. super ESCO, cooling as a service) • Implementing integrated Internet-of-Things solutions for space energy demand reduction • Switching to Co-gen – Tri-generation from standard HVAC solutions	• Aggregated finance models (e.g. including local currency finance) • Service models (e.g. ESCOs, bulk procurement, bulk distribution) • De-risking tools (e.g. guarantee or partial guarantee, risk insurances) • Green mortgage/white certificate • Energy saving Insurance • Revolving funds	
	Enabling market switch to highest efficiency appliance/ equipment	• Harmonising and adhering to MEPS at best practice levels • Harmonising MEPS monitoring across regions • Establishing monitoring and verification for standards and labelling practices • Scaling testing and verification practices and labs • Adopting green public procurement standards	• • Innovating supply chains for market switch to high efficiency appliances • • Adopting Internet-of-Things /data analytics for appliance/equipment energy demand reduction • • Setting a competitive "innovation" challenge for highest efficiency appliance/equipment • • Promoting innovations in technical verification protocol/digital growth (data) • Listing product services in terms of efficient products	• Supply chain capitalisation and financing • Vendor financing • Standards based funds and credit lines • Product based financing • Energy saving Insurance	

1 Introduction

1.1 GCF Sectoral Guides

The Green Climate Fund (GCF) is the world's largest dedicated fund helping developing countries respond to climate change. It was set up by the United Nations Framework Convention on Climate Change in 2010 and has a crucial role in upholding the Paris Agreement, supporting the goal of keeping the average global temperature rise well below 2°C and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels. It does this by channelling climate finance to developing countries, which have joined other nations in committing to climate action. It has set an ambitious agenda with its Strategic Plan for 2020-2023 (GCF, 2021b). Despite challenges related to the global pandemic, GCF is providing increased support to developing countries, helping them to build a low emission, climate-resilient recovery.

There are eight result areas that GCF focuses on to deliver a substantial impact on mitigation and adaptation in response to climate change[2] (GCF, 2018b). 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. EE can be addressed across all eight result areas, with the highest potential for transformational impact in the "buildings, cities, industries and appliances" and the "infrastructure and built environment to climate change threats" result areas. Cross-sectoral issues are addressed through multiple result areas in a complementary manner, as shown in Table 1.

Table 1: Cross-references with other Sector Guides

Sector	Cross-Sectoral issues addressed
Agriculture and food security	• Agribusiness cold supply chains for food processing and food waste reduction. • Efficient water pumping and irrigation practices.
Cities, buildings, and urban systems	• Climate-resilient and resource-efficient building design practices in urban areas. • Resilient cities and urban systems to reduce heat island effects. • Efficient district heating and cooling networks.
Climate information and early warning systems	• Weather monitoring and climate information systems. • Internet of Things (IoT) and cloud storage applications for weather and climate data.
Ecosystems and ecosystem services	• Ecosystem-based approaches to reduce cooling demand for adaptation to heat waves.
Energy efficiency	• Industrial energy, material, and resource efficiency practices. • Energy efficient appliances, standards, and labelling for consumer and small business needs. • Efficient cooling applications for buildings. • Efficient energy system planning practices coupling electricity, heating, air conditioning, and ventilation requirements. • Energy efficient building and city-district design.
Energy access and power generation	• Electricity generation from renewable energy resources. • Efficient and reliable energy transmission and distribution networks for high penetration of renewable energy. • Clean energy access, including clean cooking.
Forests and land use	• Efficient biomass usage and conversion practices for electricity, heating, cooling, and cooking needs. • Efficient biomass usage and conversion practices for industrial uses.

[2] GCF´s eight result areas include four mitigation result areas, namely Energy generation and access; Transport; Buildings, cities, industries, and appliances; and Forests and land use; and four adaptation result areas, namely: Livelihoods of people and communities; Health, food and water security; Infrastructure and built environment; and Ecosystems and ecosystem services.

Sector	Cross-Sectoral issues addressed
Health and wellbeing	• Cold supply chains for medicine and vaccines. • Efficient, long-term cold storage and logistic practices. • Health services preparedness, *including cooling solutions*, for extreme events, *such as heatwaves*.
Low emission transport	• Vehicle fuel efficiency standards. • Efficient electric mobility applications. • Efficient fuelling and charging networks.
Water security	• Efficient water pumping systems and networks for both municipal water supply as well as for irrigation.

1.2 Energy efficiency context

On a global scale, energy efficiency (EE) addresses critical issues in the production, transformation, delivery, and consumption of energy – and associated materials and resources - across all economic sectors, societal groups, income levels and geographies. EE is a key enabler of climate change mitigation and adaptation and one of the keyways the world can meet energy demand with lower energy use, which is crucial in most IPCC GHG emissions pathways limiting global warming to 1.5°C (IEA, 2021a). Bankable EE projects have the potential to create diverse jobs and facilitate economic growth across various economic sectors, helping to manage countries´ recovery from the ongoing pandemic.

EE is a key indicator in the UN Sustainable Development Goals (SDGs) framework. SDG 7 "Affordable and Clean Energy" has established a target to double the global rate of improvement in EE by 2030 (SDG 7.3). EE remains a critical part of improving essential industry, energy, health care, education, water, sanitation, and communication infrastructure systems and services while adapting to and building resilience against future shocks, such as climate change, and pandemics (IEA, IRENA, UNSD, World Bank, WHO, 2021). This Guide partly covers GCF contributions to SDG 7, namely, to "enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, EE and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology" (SDG 7.A).

In line with the GCF mandate of serving least developed countries (LDCs), small island developing states (SIDS), and African countries, this Sectoral Guide also covers GCF contributions in relation to SDG 7 "to 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 2030 (SDG 7.B).

1.3 Organisation of the document

This Guide has seven sections. After this introduction, Section 2 provides an overview of the energy efficiency (EE) sector within the global context of climate action; Section 3 highlights the barriers and opportunities to achieving a paradigm shift in result areas linked to EE; 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 EE projects and programmes based on GCF investment criteria; and Section 7 is the conclusion. Annex 1 lists additional global and regional EE networks, and coalitions and partnerships for designing EE projects/programmes along the three EE paradigm shifting pathways. *Throughout this Guide energy efficiency examples (EE) are italicised*.

2 Global Context

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

Climate resilient and energy efficient development integrates adaptation measures and their enabling conditions with mitigation measures to advance sustainable development for all. Energy efficiency (EE) is among the mitigation options highlighted in the most recent IPCC assessment report which is feasible to deploy at scale in the near term (IPCC, 2022). To keep the global mean temperature increase well below 2°C and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, as stated in the Paris Agreement, the world's industrial production and energy supply processes need to decarbonise by 2050. Despite many pledges and efforts by governments to tackle the causes of global warming, CO_2 emissions from energy and industry have increased by 60% since the United Nations Framework Convention on Climate Change (UNFCCC) was signed in 1992 (IEA, 2021a). On a global scale, EE addresses critical issues in the production, delivery, and consumption of energy – and associated materials and resources - across all sectors, income levels, and geographies and is imperative for sustainable development. EE plays a central role to allow for an affordable, just, and manageable energy transition. It is an essential approach for mitigating climate change by reducing energy-related CO_2 emissions, offsetting and reducing and offsetting energy demand growth, and adapting to climate change by enhancing the resilience of critical infrastructures for the benefit of affected societies, communities and people.

Building the resilience of critical infrastructure systems and services against future shocks, such as climate change, requires careful, people-centric, data-driven, and highly granular planning. Private sector engagement in adaptation across sectors is slowly growing – as risks, vulnerabilities, and the business case for adaptation finance for energy-efficient infrastructure systems and their environmental and social impacts are better understood. Financial intermediaries, including local financial intermediaries, are currently developing and testing pro-adaptation approaches to increase the resilience of critical, highly efficient infrastructures against climate threats and advancing the understanding of people-centric adaptation needs, *for example by designing water resource efficiency credit lines and energy-saving insurance schemes* (GCF PSAG, 2018). Furthermore, ecosystem-based approaches and low-tech solutions, *such as appropriate urban district planning and green city designs, which allow for increased natural ventilation and thereby reduce air-conditioning demand to encounter threats of heatwaves*, are emerging as cross-sectoral climate finance approaches.

2.2 Global baseline: where is the energy efficiency sector today?

Since 1990, global Gross Domestic Product (GDP) has more than doubled, while total primary energy supply at a global level increased by just over 50% - differences in these two growth rates are the result of consistent improvements in global primary energy intensity, a national economic indicator for energy efficiency (EE) used by the International Energy Agency (IEA). While global primary energy intensity improved drastically during the pandemic, global energy-related CO_2 emissions are currently on track to rise by 1.2 billion tonnes in 2021, erasing two-thirds of the pandemic-related reduction seen in 2020 (IEA, 2021b).

EE factors strongly in government climate policies and strategies that aim to reduce emissions in line with Nationally Determined Contributions (NDC) pledged under the Paris Agreement. Yet, while nearly two-thirds of NDCs contain EE targets, these are often limited to high-level commitments, lack detail on implementation (IEA, 2017) or are generally not ambitious enough (IRENA, 2019).

Progress in implementing and enforcing EE policies had been slowing ahead of the global pandemic, limiting the ability of energy, material, and resource efficiency gains to offset the impact of economic growth on energy demand. While over 120 countries have already developed or implemented mandatory EE standards or labels for key equipment and appliances (IEA, 2021b), about two-thirds of global energy end-use consumption was

not yet regulated (IEA, 2018a). In 2021, the rate of primary energy intensity improvement[3] was just 1.9%, less than the historic five-year compound annual primary energy intensity growth rate of 2.3% in the previous decade and far below the 4.2% required in the IEA´s Net Zero Emissions by 2050 Scenario for the current decade towards 2030 (IEA, 2021b).

In the industrial EE sector, a range of energy and carbon-intensive manufacturing processes remain challenging to decarbonise, *such as iron and steel, cement, and (petro-)chemicals as examples for energy intensive industries*. Industrial manufacturing processes currently account for around 29% of global CO_2 emissions, of which iron and steel, cement, and chemicals and petrochemicals account for 7%; 6.25% and 4% of global emissions, respectively. In the steel sector, process heat accounts for nearly 90% of industrial energy demand, cement around 70%, and chemicals vary between 45% and 60% (IEA, 2021c). Most industrial process heat is currently provided by fossil fuels; thus, reducing this fossil fuel consumption and developing alternative means of generating industrial heat needs to be prioritised. However, the rate of primary energy intensity improvements across industry globally dropped from 3.4% during the period 1990–2010 to 2.6% in the current decade. This slower industrial EE improvement rate can be largely attributed to increased industrial production in emerging Asian economies and North America, particularly in the steel and petrochemical sub-sectors, despite upgrades to more efficient industrial manufacturing processes worldwide (IEA, IRENA, UNSD, World Bank, WHO, 2021). Not all industrial processes and their heat and cool demands can be electrified, therefore there is an urgent need for technological innovation to replace fossil fuels across certain industrial sub-sectors (IEA, IRENA, UNSD, World Bank, WHO, 2021; UNFCCC CMA3, 2021).

As global temperatures rise, a growing number of people around the world, particularly across developing countries and particularly vulnerable groups within developing countries, will be exposed to heat stress. More than 1 billion people worldwide currently lack access to sustainable cooling solutions, with significant implications for public health, food security, productivity, and economic growth (IEA, 2018b). Connecting vulnerable or hard-to-reach communities and people, *such as women and girls*, to crisis support systems remains challenging across developing countries, as recent evidence during the pandemic showed (UN WOMEN, UNDP, 2022). Space heating and cooling, followed by lighting, contribute to the highest end-use energy consumption after industry. While the total final energy consumption of the global buildings sector remained at the same level in 2019 compared to 2018, CO_2 emissions from buildings, including heating and cooling, have increased during the pandemic: to around 28% of total global energy-related CO_2 emissions. If emissions from the buildings construction industry and building materials are included under a life-cycle assessment approach, current building emissions increased from 28% to 38% of total global energy-related CO_2 emissions during the pandemic (UNEP GAC, 2020). Globally, "space" cooling represents the fastest growing end-use and source of electricity demand in buildings, as its energy demand more than tripled between 1990 and 2018, driven by increased wealth and comfort demands for cooling in emerging markets worldwide (UNEP GAC, 2020).

A wide range of consumer appliances[4] are available for purchase on global, regional and/or national markets, with widely varying degrees of appliance/equipment-specific energy, material and resource efficiency standards and labels (partially) established in line with best-practice levels, (partially) monitored and (partially) required for testing within countries or regions. Opportunities for the implementation of ambitious energy, material and resource efficiency solutions for consumer appliances/equipment lie in these persistent regulatory gaps within and across countries and current market inefficiencies along predominantly global supply chains. One example is air conditioning. Air conditioning is energy-intensive and has a large emission footprint. Space cooling energy intensity has increased sharply since 2010 as a result of greater cooling demand in hot regions due to climate change (UNEP GAC, 2020). There are huge disparities in the efficiencies

[3] The rate of global primary energy intensity improvement is defined by the International Energy Agency (IEA) as the percentage decrease in the ratio of global total primary energy supply (in mega joules) per unit of gross domestic product (in U.S. dollar purchasing power parity), calculated as a compound average annual growth rate. This rate has slowed in recent years. Global primary energy intensity was 4.75 mega joules per 2017 U.S. dollar purchasing power parity in 2018, which corresponds to a 1.1 % improvement from the previous year 2017. This was however the lowest annual rate of energy intensity improvement since 2010. (IEA, IRENA, UNSD, World Bank, WHO, 2021)

[4] Consumer or end-use appliances include air conditioners, refrigerators, TVs, radios, computers, printers, lights, cook stoves, microwaves, washing machines, clothes dryers.

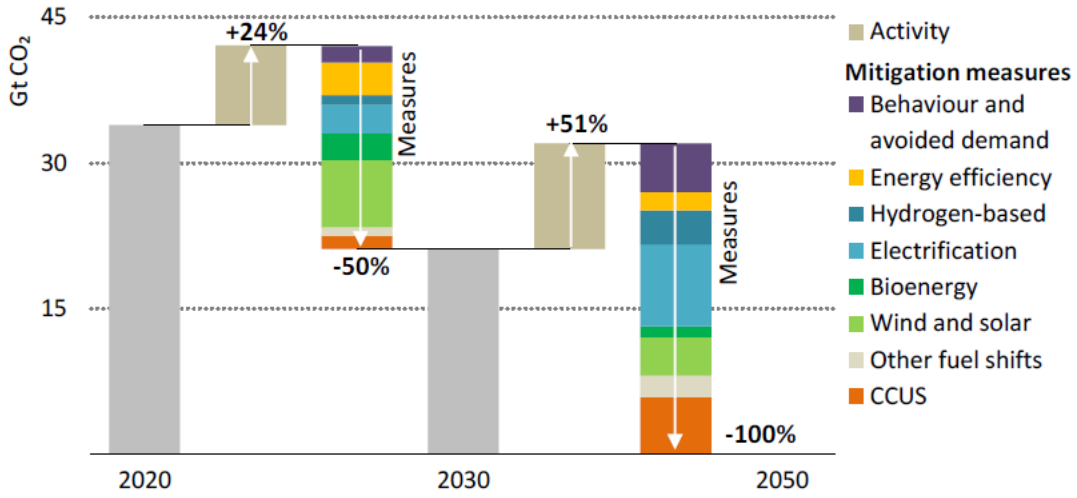
of air conditioners sold today in many countries (IEA, 2018b), which can be addressed through a mix of policy interventions and continuous investments in research, development, demonstration in cooperation with equipment manufacturers, and scaling-up best-in-class energy and material efficient technologies, products and services in many countries. Global best available cooling technology is typically twice as efficient as the global market average (IEA, 2018b). Switching to super-efficient air conditioning equipment would thus help reduce the impact of increasing space cooling demand on electricity grids during peak demand.

2.3 Global adaptation and mitigation potential: where does the sector need to be?

A significant gap remains between what is required to achieve the objectives of the Paris Agreement and the existing scale of country ambitions in energy efficiency. Despite a wide range of new NDC pledges and public-private sectoral initiatives announced in Glasgow during the 26th UNFCCC Conference of the Parties (CoP) Glasgow climate summit in 2021 (UNFCCC CMA3, 2021), cumulative global emissions are still expected to be almost twice as high in 2030 as necessary for a 1.5°C compatible scenario[5] (CAT, 2021). The lack of concrete supportive policies highlights an urgent need for more robust energy, material and resource efficiency policy and regulatory efforts in consultation with all affected stakeholders, which will be critical to achieve global EE targets and sustainable development goals.

A major worldwide push to increase EE is an essential part of the IEA's net-zero emissions by 2050 scenario, as shown in Figure 1. In this scenario annual rates of energy intensity improvements averaging 4% – about three times the average rate achieved over the last two decades – are already required to be implemented globally in the next few years to 2030 (IEA, 2021a). More efficient use of energy, materials, water, and other resources, combined with behavioural changes, are expected to offset increases in demand for energy services as the world economy grows and access to energy is extended to all. In the IEA net-zero scenario, global energy demand in 2050 is around 8% smaller than today, but it serves an economy more than twice as big and a population with 2 billion more people (IEA, 2021a). IEA estimates that the global demand for industrial materials continuous to grow rapidly due to economic development, population growth and rapid urbanisation, in particular within emerging and developing countries. Replacing or re-constituting the feedstock for these energy-intensive industries could lead to large-scale emission reduction (IEA, 2021b).

Figure 1: Key mitigation measures (including energy efficiency) in the IEA Net Zero Emissions by 2050 Scenario



Source: IEA 2021a. Activity refers to the projected energy service demand changes from economic and population growth.

[5] Climate Action Tracker is an independent scientific analysis produced by research organisations tracking climate action since 2009 with modelling and scenario analysis tools, including progress towards the Paris Agreement. Website: https://climateactiontracker.org/

2.4 What will it take to deliver maximum climate and sustainable development impact?

Industry is the largest end-use sector in terms of energy use and CO2 emissions globally (IEA, 2021c). Reaching net zero by 2050 requires cutting industry emissions by at least 95% by 2050 according to the International Energy Agency´s net-zero scenario (IEA, 2021a). Much of the untapped emission reduction potential remains in the heavy industry sub-sector, where opportunities for fossil fuel switches and materials efficiency are substantial and low emissions technologies are less mature than in most other sector (IEA, 2021c). Industrial emissions in IRENA's net-zero world energy transition scenario are expected to fall from current levels by around 11 Gt CO2eq towards negative levels in 2050, as shown in Figure 2 (IRENA, 2021). Industrial sub-sectors in focus over the next decades would primarily be in the iron and steel, cement and (petro-)chemicals sub-sectors due to their high energy use and high CO_2 emission baselines at global scale (IEA 2021c). These three heavy, energy-intensive industry sub-sectors account for nearly 60% of industrial energy consumption and around 70% of CO2 emissions (IEA, 2021b). Ambitious, long-term frameworks for the development of a low-carbon and renewable gas industry and related markets, slowly emerging today, require massive scaling (IEA, IRENA, UNSD, World Bank, WHO, 2021). This is only possible when a critical number of large-scale investments in innovations to decarbonise energy-intensive industries and subsequent shifts in primary energy supply patterns across industrial sectors take place by 2030. For example, around 25% of total heat used in industry in 2030 would need to come from electricity and low-carbon fuels, *such as green hydrogen*, up from negligible levels today (IEA, 2021c). In 2050, the IEA expects almost 50% of global emission reductions requires breakthrough technologies that are currently only at the prototype or demonstration phase. In heavy industry (iron and steel, petro-chemicals) this includes critical innovations, *such as for green hydrogen-based industrial value chains*. For example, every month from 2030 onwards, 2 GW of electrolyser capacity are projected to be added at industrial sites worldwide to progress towards net-zero objectives (IEA, 2021a). Alongside direct emission reductions, opportunities to reduce indirect emissions in a wide range of industrial sub-sectors - *such as textile, pulp and paper or food industries* – need to be scaled up in parallel.

Building related emissions in IRENA´s net-zero world energy transition scenario are expected to fall from current levels by around 2.3 Gt CO_2 towards net-zero in 2050, as shown in Figure 3 (IRENA, 2021). To be on track to achieving a net-zero carbon building stock by 2050, the IEA estimates that direct building CO_2 emissions would need to decrease by 50% towards 2030[6] (UNEP GAC, 2020). By 2050, global energy consumptions from "space" cooling are however projected to triple, putting pressure on energy systems and decarbonisation efforts for buildings (IEA, 2018b). Without major efficiency improvements to cooling equipment, it is estimated that electricity demand for cooling in buildings could increase by as much as 60% globally by 2030 (IEA, 2019b). Well-designed building solutions of new more efficient "spaces" can reduce incremental costs to as low as just 3-5% from the current cost differential of 10-15% (LBNL, 2019). Without targeted policies to improve EE, reduce and offset cooling demand, the projected growth in refrigeration, air conditioning and cooling (RAC) demand could result in energy-related climate emissions of 230–430 Gt CO_2eq by 2050, representing about a decade of additional global energy-related CO_2 emissions at 2018 levels (LBNL, 2019).

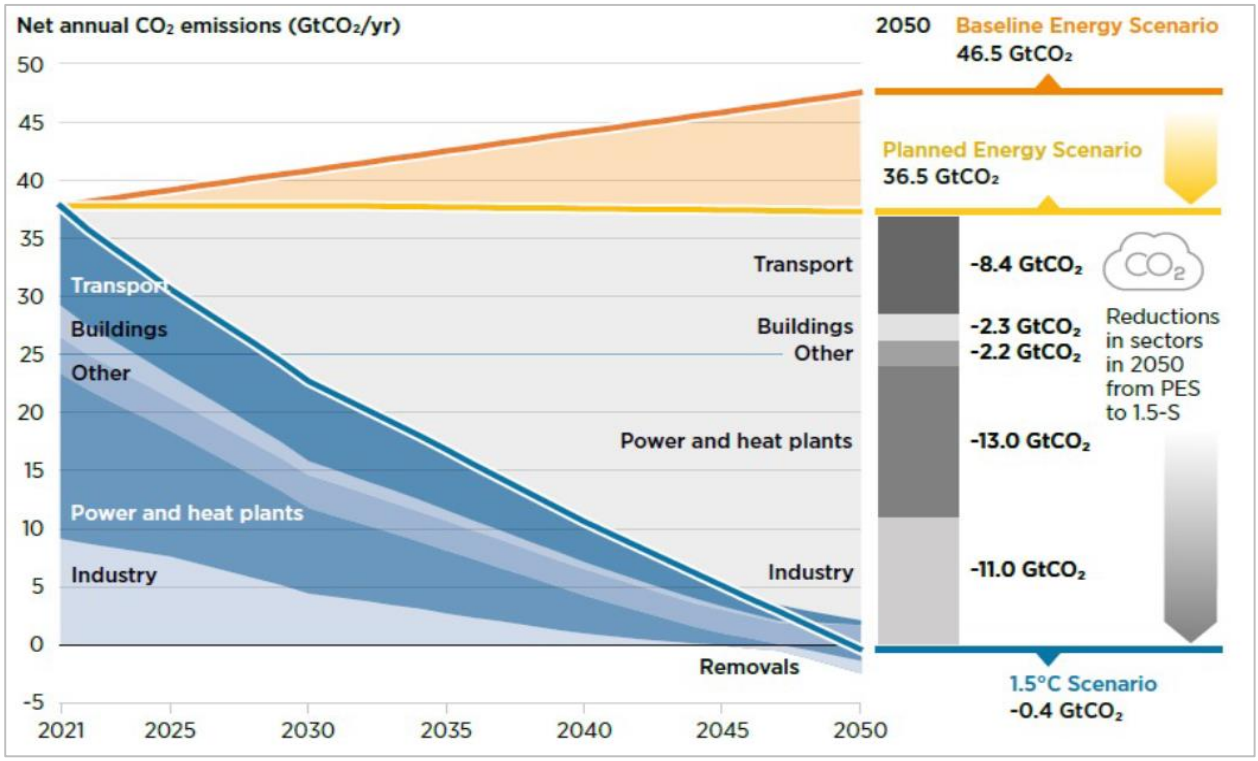
A transition of the scale and speed, as described by the IEA's net-zero 2050 scenario and IRENA's 2050 world energy transition scenario, cannot be achieved without sustained support and participation from citizens. At least 55% of the cumulative emissions reductions in the IEA net-zero 2050 scenario are linked to consumer choices, such as retrofitting a house with energy-efficient technologies, installing a heat pump or purchasing an electric vehicle (IEA, 2021a). Shifting the current world stock of larger-scale air-conditioning and refrigeration equipment from their current levels of energy-efficiency to "best-available technology" EE levels and low Global Warming Potential (GWP) refrigerants towards 2050 would theoretically avoid up to 373 Gt CO_2eq with existing electricity grid emission factors[7] (LBNL, 2019). It is thus highly beneficial to pursue ambitious energy, material and resource efficiency goals as a cross-sectoral planning and programming approach, *for example combining the transition to lower GWP refrigerants – e.g. as required under the*

[6] This translates into building sector emissions decreasing by around 6% per year from 2020 to 2030. (UNEP GAC, 2020)

[7] About two-thirds of the 373 GT CO_2eq savings are from reduced electricity sector emissions from improved energy efficiency and about one third of the 373 GT CO_2eq savings due to equipment energy efficiency improvements and transition to lower GWP refrigerants. (LNBL, 2019)

Montreal Protocol – with appliances/equipment re-design and replacement and a switch from fossil fuel to renewable power supply, transmission and distribution systems.

Figure 2: Net-annual CO_2 emission reductions in IRENA´s world energy transition 2050 scenario



Source: IRENA. 2021

2.5 Financing adaptation and mitigation: how much will it cost to get there?

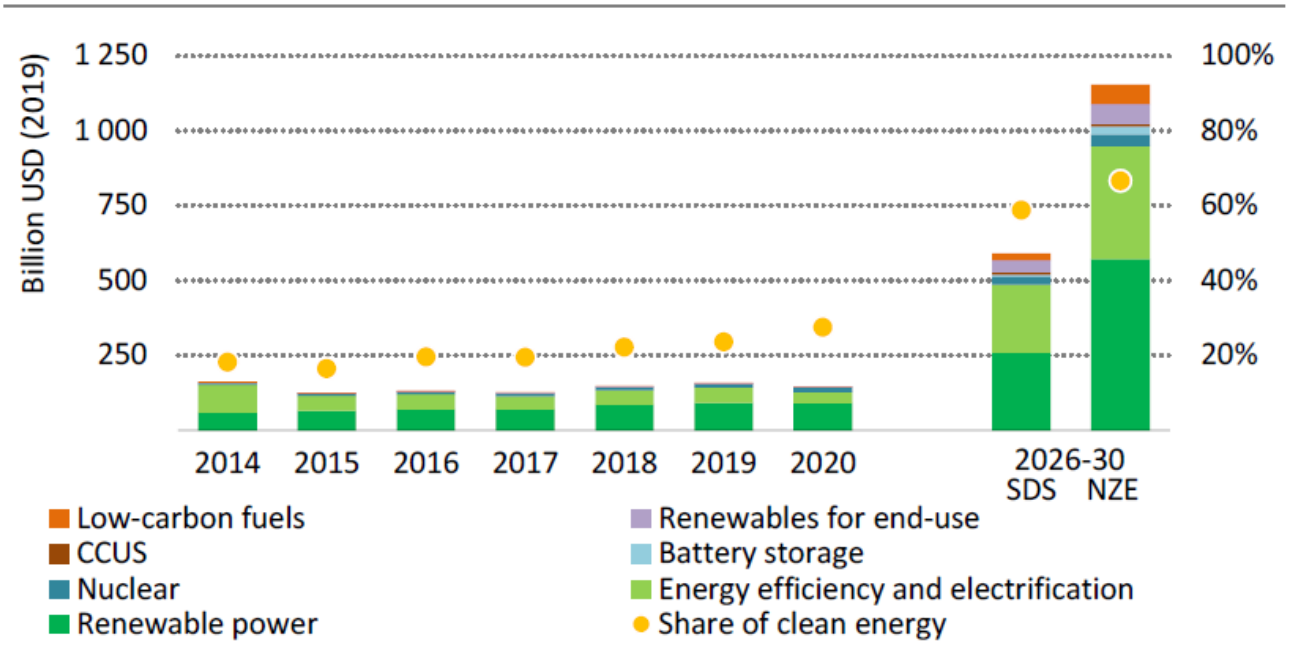
To achieve the objectives of the Paris Agreement, a massive scaling-up and re-directing of energy sector investments (including EE investments) will be required on a global scale to put the world on track to reach net-zero emissions by 2050. The IEA estimates that global annual clean energy investment needs will reach USD 4 trillion by 2030 (IEA, 2021c). For emerging and developing countries this translates into expanding access to clean energy finance (including EE finance)[8] from currently about USD 150 billion annually by more than seven times to more than USD 1 trillion annually in 2050 (IEA, World Bank, WEF, 2021). Assessing, tracking and comparing EE investments globally, *including material efficiency and "space" energy efficiency services and efficient appliances/equipment*, remains challenging[9]. The IEA estimates that clean energy investments in emerging and developing countries will need to increase sharply in the coming decades, dominated by investments in EE in the buildings, industry and transport sectors, electrification and renewable energy (Figure 3). More recently however, actual global investments in EE have remained stagnant, in the range of USD 230–240 billion during 2016 and 2018[10] (UNFCCC, 2021) – with European Union countries accounting for about 65% of these global investments (IEA, 2021b).

[8] Clean energy finance tracked and modelled by the IEA includes the following seven categories: low carbon fuels, carbon capture and storage, nuclear, renewable power, renewables for end-use, battery storage, energy efficiency and electrification.

[9] This is due to the following reasons: (a) high burden of voluntarily reporting a mix of energy efficiency investments, often part of larger multi-sector projects, as part of national statistics; and (b) limited commitment to invest in (digital) energy efficiency monitoring systems at the equipment level in order to (automatically) construct energy efficiency baselines in comparison to a business-as-usual investment; (c) a lack of understanding of the extent to which often highly granular energy efficiency investments are consistent with increasingly stringent low-carbon and climate-resilient pathways in an industry or country (UNFCCC, 2021).

[10] The IEA defines energy efficiency investment as the incremental spending to acquire a more efficient alternative that consumes less energy than would otherwise have been used to provide the service, had the consumer not bought a more efficient option. For estimating energy efficiency investments, IEA gathers technology and application-specific sales data from across the buildings, transport and industry sectors and subsectors. Incremental investment estimates are calculated against the cost of similar technologies at minimum energy performance standards or sector averages (UNFCCC, 2021) .

Figure 3: IEA annual clean energy investment in emerging and developing countries compared with 2030 projections in the IEA sustainable development scenario (SDS) and net-zero emissions scenario (NZE)



Source: IEA, World Bank, World Economic Forum. 2021

3 Paradigm-Shifting Pathways: Energy Efficiency

3.1 Drivers of change across paradigm shifting pathways

A core strength of the GCF approach is its focus on supporting high impact project and programmes through its funding support, which are characterised by both a high paradigm shift and a high sustainable development potential in three core dimensions: scalability, replicability, and sustainability (GCF, 2021a). Through the 2020-2023 Strategic Plan (GCF, 2021b), GCF seeks to help developing countries and implementing partners support paradigm shift to significantly improve the design and quality of projects, and to achieve sustainable results. To achieve a paradigm shift and reach the EE targets outlined in Section 2, developing countries must commit to ambitious and long-term processes.

As per GCF board decision from B.22 approving GCF's investment criteria indicators, "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, 2019).

As per GCF board decision from B29 approving a new integrated results management framework (GCF, 2021a), AEs will develop project/programme-level theory of change (TOC), logical frameworks and measurement approaches which will be linked to the overarching GCF integrated results management framework (IRMF) and thus integrate the following impact-level dimensions of paradigm shift potential and sustainable development potential as part of their funding requests:

- **Scalability:** refers to the "degree to which the GCF investments expanded the scale and impact of interventions". This requires defining what dimension of energy, material and resource efficiency approaches are scalable, including the numbers of people impacted, the energy demand savings and GHG emission reductions expected, and the geographical extent of the potential change over time.

- Replicability: refers to the "degree to which the GCF investments exported key structural elements of the proposed programme or project elsewhere within the same sector as well as to other sectors, regions or countries". This requires specifying what elements of energy, material and resource efficiency approaches are replicable in the future, for example by targeting more technologies or sectors within an existing geography or transferring an EE approach from the current country-level to regional-level or global-level.
- Sustainability including co-benefits: refer to the "degree to which the GCF investments promoted positive co-benefits in environmental, social, economic and gender-related aspects". This requires detailed, data-driven planning, monitoring and evaluation of associated non-technical elements of energy, material and resource efficiency approaches, such as cost savings for vulnerable people, health benefits, education benefits, security benefits that are directly and indirectly linked to EE improvements.

Mapping these impact-level dimensions onto the four pillars of the GCF Strategic plan (Figure 4) facilitates action towards a paradigm shift and sustainable development across different stakeholders, rights holders, institutions, geographies, and processes.

- Transformational planning and programming: how GCF´s EE projects/programmes are implementing integrated planning processes across multiple dimensions to ensure higher impact at lower costs and reduced risks.
- Catalyzing climate innovation: how GCF's EE projects/programmes are enabling innovations in highly efficient and breakthrough energy, resource and material dependent industrial process, technology business models or climate financing for establishing critical proof points and evidence to reduce real and perceived risks and overcome barriers, in particular in developing countries.
- Mobilization of finance at scale: how GCF's EE projects/programmes are pooling and blending energy-efficiency specific financial instruments to ensure optimal value-for-money investments.
- Coalitions and knowledge to scale up success: how knowledge generated and data acquired through GCF's EE projects/programmes can improve financial instruments and systems, technical standards and specifications and country- and industry-wide policies and regulations in the future.

Figure 4. Elements of energy efficiency paradigm shifting pathways, across the four pillars of the GCF Strategic Plan (GCF 2021b)

Pathways for paradigm shifting interventions		**Pillars of GCF's Theory of Change**		**Outcomes**		**Dimensions of transformational change and sustainable development**		**Impact**
Scaling up industrial energy efficiency pathway Enhancing "space" energy efficiency pathway Catalysing rapid market switch to highest efficiency appliances/equipment pathway	⇒	Transformational planning and programming Catalyzing climate innovation Mobilization of finance at scale Coalitions and knowledge to scale up success	⇒	Reduced emissions and increased resilience GHG emissions reduced, avoided or removed Direct and indirect beneficiaries reached Value of physical assets made more resilient to the effects of climate change and/or more suitable to reduce GHG emissions	⇒	Scalability degree to which the energy efficiency investments expanded the scale and impact of interventions Replicability degree to which the energy efficiency investments exported key structural elements of the proposed programme or project elsewhere within the same sector as well as to other sectors, regions or countries Sustainability including co-benefits degree to which the energy efficiency approach promoted positive co-benefits in environmental, social, economic and gender-related aspects	⇒	High paradigm shift and a high sustainable development potential for scaling up industrial energy efficiency High paradigm shift and a high sustainable development potential for enhancing "space" energy efficiency High paradigm shift and a high sustainable development potential for catalysing rapid market switch to highest efficiency appliances/equipment

3.2 Visions, barriers, and cross-cutting enablers for paradigm shifting pathways

The following three sub-sections articulate the vision, barriers, and possible actions to paradigm shifts in each of the three energy efficiency (EE) pathways:

3.2.1 Scaling-up industrial energy efficiency pathway

The scaling-up industrial energy efficiency (EE) pathway envisages accelerating shift to low-emissions sources for process heat, scaling up use of low emission feedstocks *including recycling*, and catalysing innovations in production processes to reduce energy, resource and carbon intensity. Selected barriers and possible actions to paradigm shift in enhancing scaling-up industrial EE can be found in Table 2 and Table 3.

Table 2: Selected barriers to paradigm shift in scaling-up industrial energy efficiency

Barriers	Description
Industrial development policy and market uncertainty	A vision for green, low-carbon infrastructure development is rarely institutionalised in developing countries. Frequently different stakeholders do not have the same understanding and commitment to modernising infrastructure and integrating innovations in materials and processes. Energy and resource intensive manufacturing industries, because of historic organisational structures, might constitute complex public institutions in many nascent markets. Many institutions tend to focus on incremental upgrades for existing infrastructures instead of considering switches of whole manufacturing value chains and will thus mainly fund small EE measures in an ad-hoc manner; without seeking to address large-scale decarbonisation potential and subsequently seeking external financing for those projects/programmes. Overall, industrial development policy barriers can arise at many different levels, ranging from a lack of dedicated governmental industrial EE authorities that oversee several economic sub-sectors, to inadequate design of standardised public/private large-scale infrastructure development partnership models, tendering procedures, energy audit requirements or tariff setting methodology.
Lack of awareness on bankability of emerging industrial manufacturing technologies, processes and value chains	Lack of awareness of the degree of maturity of emerging industrial manufacturing technologies and processes, replacing well-known, traditional manufacturing technologies and processes, can affect the confidence of investors and lead to a high (perceived) risk perception and subsequently to increased capital costs for such large-scale infrastructure projects. Technical personnel may find it difficult to put potential savings into financial terms and persuade key decision-makers to invest in breakthrough, emerging manufacturing technologies, and value chains.
Capital scarcity to finance innovations for technology change across industrial value chains in nascent markets	Capital scarcity is a particularly significant barrier for industrial infrastructure projects in nascent markets and markets which do not have a well-developed banking sector. In many cases, this is not only a result of a lack of liquidity in the banking sector but also a result of lending restrictions, institutional risk aversion, the requirement of additional collaterals, and too low (perceived) investment attractiveness. Unfavourable institutional risk assessments with regards to a (public) company´s credit quality, corporate governance, management, and operational track record or outlook; or unfavourable policies regarding a public company´s cost-recovery arrangements, are driving investor requirements for higher returns. Resulting asset-liability issues (i.e. *lack of access to long-term liabilities to match the requirements of long-term infrastructure development loans*) are among the critical barriers to closing multistakeholder infrastructure deals. Breakthrough low-carbon manufacturing technologies might require dedicated venture funding windows to access patient growth capital and (junior) equity investors, in particular for high-risk emerging markets.

Barriers	Description
Lack of technical expertise and/or planning capacity for scaling-up industrial energy, material and resource efficiency efforts	Best practices and lessons learned are frequently missing in the institutional management of rapid technology changes in a developing country context. Technical personnel primarily responsible for reliable operation of large-scale infrastructure systems and trained in "traditional" fossil fuel-related industry sub-sectors may find it difficult to integrate emerging low-carbon industrial technologies into their day-to-day work, especially if they (potentially) risk reducing their personal job security. Furthermore, limited planning capacity due to underfunded government agencies can reduce the quality and pace of preparing innovative industrial EE funding proposals.

Table 3: Possible actions to paradigm shift in scaling up industrial energy efficiency

Drivers	Possible actions and transformational potential
Transformational planning and programming	• Establishing and mainstreaming ambitious industrial energy consumption targets, energy, resource and material efficiency standards and industrial emission reduction targets. • Enforcing legislation for mandatory energy management systems and periodic EE audits for monitoring large industrial energy users, *such as energy intensive manufacturing industries (steel, cement, chemicals)*. • Implementing monitoring, verification and enforcement practices for industrial energy, material and resource use along value chains and associated industrial emission reduction targets. • Setting and enforcing supply chain carbon and industrial emission reduction targets, e.g. *by enabling smart infrastructure system elements and data exchanges* • Promoting integrated, time-bound roadmaps for phasing out high-emitting industrial processes and fostering the switch to low-carbon fuels and resource-efficient, circular economy raw materials. • Mainstreaming technical and financial planning and programming among critical public/private actors for increased industrial value chain efficiency, e.g. *adding National Energy Efficiency Action Plans (NEEAPs) to integrated industrial development strategies, low-carbon infrastructure planning, public procurement, and financial planning*. • Promoting best-practise energy management systems for energy intensive industries, *e.g. in line with ISO 50001 standards* • Participating in high-impact research pilots
Catalyzing climate innovation	• Demonstrating technology innovations in critical energy- and resource-intensive manufacturing value chains in developing countries. • Substituting fossil fuels with alternative low or zero carbon emissions fuel or feedstock solutions to demonstrate innovative industrial manufacturing at scale, *for example process changes towards electrification and green hydrogen use*. • Promoting innovations in the large-scale reuse/recycling of industrial waste materials as feedstocks or composites. • Demonstrating anchor investments in new breakthrough high risk and high potential business models to generate investment proof points for industrial energy, material and resource efficiency in developing countries. • Testing and deploying innovative large-scale market based financial instruments for breakthrough technology innovations, such as tradable certificates for zero carbon steel/cement/plastics.

Drivers	Possible actions and transformational potential
Mobilization of finance at scale	• Using policy-based loans for transformational industrial value chain developments to mobilise public/private finance at scale. • Including guarantees and political risk insurances to de-risk novel, large scale, and catalytic industrial energy, material and resource efficiency investments • Scaling EE funds and credit lines • Allowing (junior) equity for early-stage, breakthrough, private sector-driven industrial energy, material and resource efficiency technology adoption in nascent markets for mobilising senior investors. • Designing industrial energy specific export financing schemes to strengthen global value chains.
Coalitions and knowledge to scale up success (*see Annex 1 for further resources*)	• Capturing experiences and developing context-specific knowledge products for industrial innovations, business models, and emerging financing options to advance industrial EE regulations. • Sharing real-time and systemic industrial manufacturing supply-chain emission and resource use data through industry-specific networks and coalitions. • Capacity building, technical assistance and strengthening large-scale partnerships and alliances, including multinational companies, to enable (voluntary) time-bound decarbonisation targets across global supply chains.

3.2.2 Enhancing "space" energy efficiency pathway

The enhancing "space" energy efficiency (EE) pathway envisages reducing emissions from energy consumption in heating, cooling, and lighting in residential, commercial, public and industrial "spaces". Selected barriers and possible actions to paradigm shift in enhancing "space" EE can be found in Table 4 and Table 5.

Table 4: Selected barriers to paradigm shift in enhancing "space" energy efficiency

Barriers	Description
Regulatory and legislative barriers for scaling "space" efficiency at various institutional levels	Existing regulatory and legislative frameworks to facilitate systemic infrastructure modernisation in the built environment and assure sector coupling between electricity, and district heating and cooling services are not yet fully in place in many developing countries and their implementation still lacks enforcement. The implementation of (mandatory) building codes as one key driver for the uptake of insulation, HVAC solutions, and other appliances/equipment upgrades across residential, commercial, public and industrial buildings remains challenging. While some developing countries allow third-party access to network development, retrofits, and Internet-of-Things (IoT) technology integrations, the necessary secondary regulations and directives often do not yet exist. This can have negative consequences, such as the inability of ESCOs to receive licensing for new energy-efficient "space" development, retrofit, or IoT technology integration approaches. Moreover, unclear third-party contract terms, *e.g. non-standardised, unbalanced risk allocations for EE services offered by ESCOs to public entities*, frequently prevent efficient and effective implementation of EE measures at scale.
Lack of awareness of climate mitigation and adaption benefits of "space" efficiency	Decision-makers underestimate the mitigation and adaptation benefits of energy savings and reductions in demand for heating and cooling, and associated cost savings and employment benefits. This is frequently due to a lack of awareness and a general culture of neglect around the technical planning details for implementing energy efficiency. The human health impact also influences demand (e.g. *restricting a worker's physical functions and capabilities, work capacity and productivity during heat waves*). A cross-sectoral vision for healthy, green "space" and real-estate development is not commonly institutionalised. Frequently different stakeholders do not have the same understanding and commitment to real estate development, city-district modernisation and building retrofits. Public and private stakeholders may work towards conflicting goals, due to different underlying priorities, incentives, and business models.
Financial barriers for ambitious building, district or city-level energy, material and resource efficiency programmes	Financial barriers are not only a result of lack of liquidity in the banking sector but can be a result of lending restrictions, risk aversion under emerging climate change threats, the requirement of additional collateral, and too low investment attractiveness (low net present value or internal rate of return) for capital intensive real-estate developments. Furthermore, climate change threats and risks, such as flooding, may affect the structural foundations of buildings and thus increase the risk of stranded assets, if locations of new developments or renovations are not carefully chosen. Private debt financial products designed specifically for energy renovations in buildings are currently not fully developed, as financial institutions are often unfamiliar with these investments and thus perceive EE loans as high-risk investments. High transaction costs for relatively small projects and failure to offer financing for terms long enough to support deeper measures are additional factors hindering rapid market uptake. The lack of revolving fund-type mechanisms may also preclude national, state, and/or local governments from sufficiently investing in and scaling up EE retrofits and upgrades.
Lack of technical expertise to rapidly scale up "space" efficiency success at multiple levels	"Green" real-estate developments integrating efficient electricity, and district heating and cooling services require multistakeholder partnerships, including public utilities, network operators, and engineering companies offering a set of technical skills for the design, planning, construction or rehabilitation, and operation of associated infrastructure. Technical personnel primarily responsible for reliable operation of equipment find it difficult to put potential savings into financial terms and persuade key decision-makers to invest. Continuous learning and skill upgrading is necessary across stakeholders to ensure that best-in-class technologies, products and services are integrated. EE consultants might often produce sophisticated on-off analyses and recommendations and lack the skills to create actionable proposals outlining clear and compelling financial benefits. Furthermore, digital measuring and monitoring tools are not yet widely used to adjust energy, material and resource efficiency potentials identified in technical audits to changing business needs.

Table 5: Possible actions to paradigm shift in enhancing "space" energy efficiency

Drivers	Possible actions and transformational potential
Transformational planning and programming	• Scaling zero-carbon building design code implementation with ambitious EE and material reuse standards, labels, and certificates in nascent markets. • Integrating National Cooling Action Plans (NCAPs) and climate adaptive heat action plans with other national action plans, national infrastructure strategies and short-term targets, that align with international standards and regulations, e.g. *the provision of the Montreal Protocol and its Kigali Amendment*[11]. • Mainstreaming ambitious efficiency specifications in public procurement schemes to enable efficient and effective government-driven bulk procurement and distribution schemes for "space" heating, cooling and lighting. • Adhering to best-practice MEPS for space efficiency measures • Strengthening and enforcing building-level EE driven adaptation/resilience measures by climate adaptation/resilience specific laws and regulations, such as "zero-carbon" retrofits, for residential, commercial, public and industrial "spaces".
Catalyzing climate innovation	• Piloting city-level, ecosystem-based "space" adaptation approaches for demonstrating optimal adaptation/resilience of residential, public, commercial and industrial "spaces" to heatwaves, e.g. *by layered building codes* • Scaling up innovation in building material that significantly reduces "space" energy demand. • Promoting new technology-agnostic energy efficiency, service-based business models, *like cooling as a service (CaaS)*, in high risk and high potential contexts. • Implementing integrated Internet-of-Things solutions for space energy demand reduction • Switching to Co-generation and Tri-generation systems from standard HVAC solutions
Mobilization of finance at scale	• Crowding in local currency finance instruments for scaling-up investments in "space" cooling. • Pooling and blending public/private debt finance for "space" related "EE as a service" business models, for example, *via Super-ESCOs*, to enable attractive, end-user centric products and solutions at scale. • Integrating technical innovations with de-risking instruments across financial institutions, *such as using digital, internet-of-things (IoT) technologies for measuring, monitoring, and verifying "space" energy benefits for loan guarantees*. • Standardising demand-side financial instruments for "space" efficiency across financial institutions in emerging markets, *such as "green mortgages" or "white certificates"*. • Scaling revolving fund mechanisms for retrofits and upgrades of public buildings (e.g. *schools, hospitals, administrative buildings, public housing*)
Coalitions and knowledge to scale up success (*see Annex 1 for further resources*)	• Capacity building, technical assistance and granular data sharing on super-efficient cooling, heating and lighting business models and investments in risky emerging markets. • Facilitating open access to MEPS repositories within "space" cooling, heating and lighting, *for example for enabling switching to efficient co-generation and tri-generation solutions from standard heat, air ventilation and cooling (HVAC) solutions*. • Advancing state-of-the-art "space" energy, material and resource efficiency standard developments in developing countries, *for example, integrating emerging evidence about symptoms of heat stress and "space" efficiency solutions to counter it*. • Dissemination of best practices and knowledge sharing tailored to local contexts and involving vulnerable groups in society, e.*g. addressing behavioural change and gender-specific aspects to accessing and implementing energy efficient solutions in households*

[11] The Kigali Amendment, which entered into force on 1 January 2019, added hydrofluorocarbons (HFCs) – commonly used in various sectors and applications, such as refrigerants in refrigeration, air-conditioning and heat pump equipment; as blowing agents for foams; as solvents; and in fire extinguishers and aerosols - to the list of controlled substances under the Montreal Protocol. The Montreal Protocol is an international treaty agreed in 1987 to protect the ozone layer by phasing out the production of numerous substances that are responsible for ozone depletion.

3.2.3 Catalysing rapid market switch to highest efficiency appliances/equipment pathway

The catalysing rapid market switch to highest efficiency appliances/equipment pathway envisages supporting governments to design and implement the best-in-class Minimum Energy Performance Standards (MEPS) for appliances and equipment and complementing it with financial de-risking to capitalise supply chains from manufacturing to distribution. Selected barriers and possible actions to paradigm shift in catalysing rapid market switch to highest efficiency appliance / equipment can be found in Table 6 and Table 7.

Table 6: Barriers to paradigm shift catalysing rapid market switch to highest efficiency appliances/equipment

Barriers	Description
Lack of strategic, managerial, and technical planning approaches for scaling best-in-class supply chains	Barriers to overcome include a lack of awareness about EE standards, labels, certificates and associated co-benefits across multiple actors involved in appliances/equipment supply chains. Frequently, a lack of combined technical and financial skills hinders a rapid, ambitious, and catalytic implementation of a supply-chain wide programme, *such as standardised qualifications needed for portfolio-level technology assessment, risk evaluations and financial mechanism designs*. Moreover, there is often a lack of policy expertise at various levels of government, *e.g. integrating EE policy options consistently across regulatory frameworks and appliances/equipment supply chains*. In addition to setting MEPS, governments are often insufficiently equipped to ensure the testing of appliances/equipment and ensuring the enforcement of MEPS along supply-chains.
Lack of innovations centred around increasing social acceptance of novel appliances/ equipment	A lack of social acceptance can create significant and persistent barriers to the rapid adoption of new technologies. Social barriers related to the ability and willingness to pay can be significant but can be addressed by user-centric business models that allow affordable services to the recipients and matches their (individual) cash flows. Some acceptance barriers come about because of a lack of awareness and can be addressed through information provision. Lack of trust in super-efficient appliances/equipment solutions due to substandard products in the market and lack of enforcement of stringent quality standards is also a critical barrier across many nascent markets.
Insufficient data and market linkages for assessing bankability and mobilising commercial finance	A challenge for investors is the lack of reliable data for a wide range of energy-efficient appliances/equipment. Only limited standardised datasets are available to make rapid EE investment decisions at a highly granular level (households and MSMEs). Matching market niches for new technologies with local market potential, community needs, and priorities often requires capacity building within the (local) banking sector. Furthermore, digital measuring and monitoring tools are not yet widely used to adapt to changing business needs and scaling up innovations. EE-specialised engineers and consultants might often produce sophisticated one-off analysis and recommendations, lacking the skills to create actionable and bankable investment proposals, outlining clear and compelling financial benefits and scale-up potentials.

Table 7: Possible actions to paradigm shift catalysing rapid market switch to highest efficiency appliances/equipment

Drivers	Possible actions and transformational potential
Transformational planning and programming	• Establishing and maintaining programmatic planning processes for integrating a variety of public/private EE market aggregation partners along various appliances/equipment supply chains, *such as original equipment manufacturers (OEMs), energy service companies (ESCOs), consulting companies, appliances/equipment vendors, utilities, appliances/equipment testing laboratories, government agencies and industry associations*. • Setting MEPS for appliances and equipment to best practice levels. • Harmonising MEPS across regions to best practices to enforce MEPS for super-efficient appliances/ equipment across all economic sectors and to integrate these with budgeting processes and procurement plans at national, regional, and municipal levels. • Establishing monitoring, verification and enforcement practices for energy, material and resource efficiency standards, associated labelling and testing programs. • Integrating National Energy Efficiency Action Plans (NEEAPs) with integrated energy sector planning, other relevant national action plans, public procurement, and financial planning. • Promoting efficient and effective transformational planning practices at a regional, multi-country level, *e.g. allowing for joint testing capability regionally* • Adopting green public procurement standards
Catalyzing climate innovation	• Piloting supply chain innovations for rapid market switches to best-in-class efficiency appliances/equipment. • Testing of Internet-of-Things (IoT) driven granular data analytics for proofing appliances/equipment energy demand reductions and cost savings in near-real-time. • Piloting open, competitive circular economy driven "innovation" challenges for advancing business models centred around best-in-class appliances/equipment deployment and recycling. • Promoting innovations in technical verification protocol/digital growth (data) • Listing product services in terms of efficient products.
Mobilization of finance at scale	• Scaling portfolios of emerging innovative loan repayment instruments to enable large scale, supply-chain wide financial solutions at attractive commercial terms, *for example, via energy performance contract bills, property taxes, utility bills, on-bill financing, vendor financing, appliances/equipment leasing, on-wage or payroll deduction financing mechanisms.* • Linking mezzanine finance to best-in-class energy-efficiency standards and labels across consumer appliances/equipment categories in high risk and high potential markets. • Scaling Energy Saving Insurances in nascent markets. • Promoting efficiency standards-based funds and credit lines.
Coalitions and knowledge to scale up success (*see Annex 1 for further resources*)	• Sharing real-time data and evidence on super-efficient energy appliances/equipment business models, bulk procurement and distribution schemes and financing options that facilitate bankability at the supply-chain scale. • Capacity building, technical assistance and exchanges of best practices in reducing risks for technology adoption and behavioural changes, *for example, by the open-access publication of standardised super-efficient appliances/equipment catalogues with regulatory tested and pre-approved technologies for optimal consumer information and choice*. • Advancing state-of-the-art appliances/equipment standard developments and regulations in developing countries relating to green public procurement standards with performance specifications.

3.3 Role of GCF in financing the paradigm shifting pathways

Key actions for each of the paradigm shifting pathways, across the four pillars of the GCF Strategic Plan 2020-2023 are summarised in Figure 4 followed by a detailed description of each driver.

Figure 4: Possible actions for each pathway following the four pillars of the GCF Strategic Plan

		Actions across the four pillars of the GCF Strategic Plan			
Energy Efficiency		**Transformational planning & programming**	**Catalyzing climate innovation**	**Mobilization of finance at scale**	**Coalitions and knowledge to scale up success**
Paradigm-shifting pathway	**Scaling up efficiency in energy-intensive industries**	• Mainstreaming mandatory energy consumption targets, resource and material efficiency standards • Enforcing legislation for mandatory, periodic energy audits in industry • Setting and enforcing supply chain emission reduction targets • Promoting time-bound roadmaps for phasing out high-emitting industrial processes and fostering fuel switches • Mainstreaming technical and financial planning and programming across energy intensive industries • Promoting best-practice international energy management standards • Participating in high-impact research pilots	• Demonstrating technology innovations in critical energy- and resource-intensive manufacturing • Substituting fossil fuels with alternative solutions • Promoting innovations in reuse/recycling of industrial waste materials • Demonstrating anchor investments in new breakthrough high risk and high potential business models • Testing and deploying innovative large-scale market based financial instruments for breakthrough technology innovations	• Policy-based loans for transformational industrial value chain developments • Guarantees and political risk insurances to de-risk novel, large scale, and catalytic industrial energy efficiency investments • Energy efficiency funds and credit lines for industries • (Junior) equity for early-stage, breakthrough, private sector-driven industrial energy efficiency technology adoption • Industrial energy specific export financing schemes for global value chains	• Capturing experiences and developing knowledge products on EE business models and financing options • • Disseminating best practices through GCF knowledge repository and networks • • Establishing green procurement and distribution guidelines for energy efficient services • • Linking or merging EE building codes with resilience standards for buildings • • Capacity building, technical assistance and knowledge hubs, e.g. for ISO 50001 implementation • • Establishing an MEPS repository
	Enhancing "space" energy efficiency	• Scaling zero-carbon building design code implementation with ambitious EE and material reuse standards, labels, and certificates • Adhering to best-practice MEPS for space efficiency measures • Promoting "zero-carbon" retrofit for residential, commercial, public, and industrial "spaces"	• Integrating "ecosystem-based solutions" in building plans • Scaling up innovation in building material that significantly reduces energy demand • Defining layered building codes • Using new business and service models (e.g. super ESCO, cooling as a service) • Implementing integrated Internet-of-Things solutions for space energy demand reduction • Switching to Co-gen – Tri-generation from standard HVAC solutions	• Aggregated finance models (e.g. including local currency finance) • Service models (e.g. ESCOs, bulk procurement, bulk distribution) • De-risking tools (e.g. guarantee or partial guarantee, risk insurances) • Green mortgage/white certificate • Energy saving Insurance • Revolving funds	
	Enabling market switch to highest efficiency appliance/ equipment	• Harmonising and adhering to MEPS at best practice levels • Harmonising MEPS monitoring across regions • Establishing monitoring and verification for standards and labelling practices • Scaling testing and verification practices and labs • Adopting green public procurement standards	• • Innovating supply chains for market switch to high efficiency appliances • • Adopting Internet-of-Things /data analytics for appliance/equipment energy demand reduction • • Setting a competitive "innovation" challenge for highest efficiency appliance/equipment • • Promoting innovations in technical verification protocol/digital growth (data) • Listing product services in terms of efficient products	• Supply chain capitalisation and financing • Vendor financing • Standards based funds and credit lines • Product based financing • Energy saving Insurance	

4 Financing paradigm shifting pathways

4.1 Financial barriers

Common financial barriers to energy efficiency (EE) projects and programmes are (a) lack of available long-term funds and research funds for technology innovations; (b) actual and perceived credit risks; (c) high collateral requirements and/or high interest rates of banks in lending to technology service providers, energy services companies (ESCOs) and end-users; and (d) scarcity and high cost of project sponsor equity for large-scale industrial EE infrastructure projects. Besides financial barriers, there is a range of other non-financial barriers in the energy, material and resource efficiency sector that hinder paradigm shift. Financial barriers are often a consequence of other barriers, such as limited experience, high risk perception, uncertainty in policies, regulations and strategies, and lack of technical expertise or planning capacity. It is therefore critical that funding proposals address barriers holistically and systemically so that country-specific financial barriers can be best addressed with GCF support, involving all relevant stakeholders.

A key component of any national EE policy is to foster engagement with the private sector and local financial institutions to overcome financial barriers across EE market segments. Financial institutions are in the unique position of having access to key decision-makers in companies and are key influencers on questions related to a company's investment planning. By identifying a portfolio of bankable projects, highlighting their strategic importance, and providing local currency financing for those projects, local financial institutions serve as important catalysts for sustainable energy investments. In this instance, the role of a local bank is to create value by bringing in expertise from the market to identify bankable opportunities in energy efficiency. Although these market segments may be novel or perceived as risky for many local financial institutions, with the right level of technical assistance, training and resources (*e.g. pre-approved technology and appliances/equipment lists and third-party accreditation schemes for the implementation of EE services*), banks can successfully engage in energy, material and resource efficiency infrastructure investment portfolios with relatively limited effort and without accruing significantly higher costs.

4.2 Financial instruments for energy efficiency projects and programmes

GCF can deploy a range of financial instruments to help address financial and non-financial barriers. These financial instruments include grants with and without repayment contingency, loans, guarantees, and equity. Combining these serves to shift from unsustainable to sustainable EE investments. The appropriate financial support is based on the alternative costs for the more sustainable option and based on a consented understanding of the baseline and business-as-usual (BAU) scenario. The methodology for establishing a baseline on the overall portfolio of structured EE measures suggested for funding by an AE should be clarified, including (a) the extent to which energy, material and resource efficiency has evolved in the direction of paradigm shift towards low-emission and climate-resilient development in the corresponding (sub-)sector, industry or country context, considering adaptation and mitigation angles for climate exposed EE infrastructure, and how financial instruments were tailored; (b) the business as usual scenario; and (c) any alternative scenarios analysed during the preparation phase that were not prioritised for GCF funding.

- Grants are typically used to make systemic changes that contribute to overcoming barriers to the implementation of a sustainability goal. As a principle, grants are appropriate as funds to spark the initiation of a new climate-compatible pathway through short-term technical assistance. The technical assistance may be focused on creating enabling environments through policies, regulations and standards, institutional and market environment development, capacity building, and raising awareness. Financial incentives for end-users designed to accelerate the uptake of EE solutions in the market can be designed as grants, subsidies, and rebates.

- Recoverable grants are grants that are expected to be paid back at some point in the future depending on the success of the funded activity. They are particularly suited to situations in which capital is needed to stimulate initial technology uptake, and in situations where the adoption of the technology is expected to build ongoing assets (i.e. *a long-term subsidy is not required*).
- Concessional loans are debt instruments with favourable terms for borrowers that address liquidity issues such as a longer loan tenor, extended grace periods, and lower interest rates. For example, long-term concessional loan co-financing, which is provided to AEs at a low interest rate and blended with AE or other funds, thereby addressing interest rate barriers and the need for longer tenors to match the economics and useful lifetime of EE investments.
- 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. For example, energy-saving instruments offered by insurance companies could provide minimum savings guarantee to ensure that technology service providers and energy service companies meet guaranteed energy savings benchmarks for end-users and otherwise compensate end-users for the gap (with the insurance company covering this obligation if the technology service provider and energy service company is unable to).
- Equity from GCF can provide a capital base for operations and reduce investment risks for other investors. *For example, Super ESCOs can be a vehicle to aggregate a portfolio of EE projects and mobilise financing on attractive terms from several financial institutions, including shares of equity within a Super ESCO´s capital structure*.

The applicable technologies, products and services across the EE sector differ in a wide variety of ways, including up-front and operating costs, market maturity, geographic applicability, ability to be dispatched, scale, and environmental impact. Context is crucial in evaluating the potential climate impact of different technologies. Similarly, each technology has its own optimum application context. It follows that business models and financial mechanisms also rely on local factors. Financial instruments such as grants may be appropriate in an LDC and SIDS context, while guarantees, loans, or equity may deliver the same paradigm shift in a more developed economy. Terms and financial instruments should be structured on a case-by-case basis and clearly link barriers to paradigm shift or market transformation in a local context.

In deciding the type and level of GCF financing, consideration should be given to (GCF, 2013b), (GCF, 2015) so that:

- The business-as-usual (BAU) scenario is clearly presented including transparency on any taxes or subsidies. For the alternative scenario, grants should be tailored to incremental cost or the risk premium required to make investments viable or to cover specific activities such as design of transformational policy, market rules, or technical feasibility studies.
- Terms and financial instruments are structured to clearly address the specific barriers to paradigm shift or market transformation within the context of the country in question. The right level of concessionality should not displace either public or private investments that would otherwise have occurred, and to avoid crowding out commercial finance. Concessionality should also factor in the imperative for beneficiaries to be viable and profitable, though care must be exercised to ensure that the private sector does not earn unreasonable profits as a result of GCF concessionality or create market distortion. In this regard, the full suite of GCF financial instruments from grants, loan, equity, and guarantee should be considered as a catalytic financing mechanism to crowd in other sources of public and private finance.
- Levels of indebtedness and the capacity of the recipient are considered to avoid excessive indebtedness.

While appropriate financial instruments are determined on a case-by-case basis, they may be characterised by:

(5) Scaling up industrial energy efficiency: higher infrastructure capital costs and lower levels of technology readiness for innovations, *such as electrolysers for green hydrogen value chains in energy-intensive industries*, may require higher levels of concessionality and more complex, multi-donor financing structures, including guarantees, to reduce and share risks while new global markets for such technologies are emerging. Funding proposals need to include a clear exit strategy to prevent dependency on subsidies and high concessional funding.

(6) Enhancing "space" energy efficiency: this may include subsidy elements provided through grants, concessional lending or guarantees for infrastructure networks and related data services, in the minimum amount necessary to make the project or programme viable and help achieve the GCF paradigm shift and sustainable development objectives. Funding proposals need to include a clear exit strategy to prevent dependency on subsidies and high concessional funding.

(7) Catalysing rapid market switch to highest efficiency appliance/equipment: this may include grants, subsidies, and rebates for portfolios of diverse and small-scale energy-efficiency product and service-based solutions. Innovative financial models to reach end-users, such as on-bill financing, vendor financing at the point of sale, and energy savings insurances for energy service companies and technology service providers, should be analysed.

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 that deliver significant paradigm shift may potentially have lower levels of co-financing.

These best practices underpin GCF funding to mobilise and leverage public, private and/or commercial sources of finance and drive energy, material and resource efficiency market growth. This can be achieved through a combination of co-financing and technical assistance with the intent of systematically addressing market barriers (*including limited access to affordable financing, a lack of long-term funds, credit risks, energy system performance risks, and the need for raising awareness and outreach and information campaigns on the benefits of EE solutions*), developing scalable business models, structuring and originating initial transactions, and building the capacity of market actors. GCF funds can be successfully utilised for these purposes to drive a paradigm shift in the market and promote sustainable, low-emission and climate-resilient development.

Co-financing levels are determined on a case-by-case basis and, in EE projects and programmes, may be characterised by:

(1) Scaling up industrial energy efficiency: Higher levels of co-financing can be expected when scaling more mature industrial technologies, while for some pilot projects demonstrating new manufacturing technologies, limited co-financing may be appropriate.

(2) Enhancing "space" energy efficiency: GCF funds can be utilised in high risk and high transformational potential positions within a "space" EE finance programme, *such as first-loss reserves or subordinated co-financing*, which could help encourage the uptake of such financial instruments in other climate funds by reducing existing risk barriers.

(3) Catalysing rapid market switch to highest efficiency appliances/equipment: Higher levels of co-financing can be expected in markets with substantial EE appliances/equipment programme experience.

4.4 Complementarity and Coherence

GCF seeks to strengthen complementarity and enhance coherence with other climate finance institutions by combining resources, upscaling/sequencing interventions, mobilising different financial instruments, building on complementarities identified in a previously funded project to complement each other, provided that such an endeavour is strongly anchored on national priorities. GCF has a significant knowledge base and has established institutional arrangements to enhance complementarity and coherence with other climate finance institutions.

4.5 Incremental costs versus full costs

When developing funding proposals, AEs should propose the cost of the project and level of concessionality GCF should use to finance its share of the costs. In any EE funding proposal, AEs should state clearly whether they are requesting GCF support for incremental costs[12] or full costs[13] and justify that request (GCF, 2021b). At a minimum, all funding proposals must include a qualitative methodology connected to a strong theory of change (ToC). Based on this assessment, GCF and AEs agree on which part of an EE project/programme is eligible to be funded by GCF and which may be better suited for co-financing. This reasoning is used to guide concessionality and determine the appropriate financial instruments and terms for the portion financed by GCF to ensure efficiency and effectiveness (GCF, 2018a).

For EE projects and programmes, particularly for more mature technologies and services, the level of concessionality from GCF will often be based on incremental cost principles. Given the technical nature of many of these projects/programmes, a quantitative analysis of incremental cost is usually possible by analysing an alternative project/programme that does not result in a high climate impact (commonly called the baseline). *In most cases, the baseline is one where a less-efficient process, equipment or product is used to provide electricity, heating, or cooling services until the end of the equipment's lifetime.* These calculations are best incorporated into a holistic economic and financial analysis and could thus easily include lifecycle costs. For some activities, *such as capacity building and raising awareness*, granting full costs may be appropriate for projects addressing critical barriers in the enabling and institutional and market development environment, *as well as in some pilot projects for new breakthrough technologies*.

[12] Incremental costs are the difference in costs incurred with respect to a baseline project to produce a new output or an equivalent output in a way that results in mitigation and/or adaptation impact. (GCF, 2021b)

[13] Full costs associated with outputs that result in mitigation and/or adaptation impact. (GCF, 2021b)

5 Case studies

The following case studies illustrate how transformational projects and programmes in different country contexts can systematically address critical barriers to energy-efficient climate solutions.

5.1 Seven countries: Scaling up industrial energy efficiency in the Corporate Sector

Theme	Mitigation		
Country	Armenia, Jordan, Kazakhstan, Morocco, Serbia, Tunisia, Uzbekistan	Project size	USD 1 billion
Emission reduction	17.2 million tonnes of carbon dioxide equivalent (Mt CO2eq) mitigated	GCF financing	Loans: USD 252 million Grants: USD 5.5 million
EES category	B	Co-financing	Loans: USD 757.5 million Grants: USD 1.4 million
Accredited entity	EBRD	Co-finance ratio	75.9%
Approval	August 2020	Completion	September 2024
Information	www.greenclimate.fund/project/fp140		

Impact potential. Emissions from industry account for about 30% of total (GHG) emissions. They arise from various economic sectors, mainly extracting and processing primary materials for manufacturing and construction, including for chemicals and fertilisers, pulp and paper, non-ferrous metals, food processing, and textiles.

Country ambitions. This programme is GCF's first at-scale investment to promote the rapid uptake of low-carbon technologies in the industrial sector across Armenia, Jordan, Kazakhstan, Morocco, Serbia, Tunisia, and Uzbekistan.

Barriers addressed. Critical barriers to the uptake of climate technologies across industrial, agribusiness, and mining sectors contribute to higher costs for early adopters due to a lack of access to suitable financial products with affordable pricing. In addition, companies face a range of capacity barriers related to identifying, prioritising, developing, implementing, and monitoring low-carbon projects and the respective climate governance procedures. This programme seeks to forge a low-carbon pathway by promoting the uptake of high climate impact technologies and stimulating behavioural change at the corporate governance and management level.

Pathway to paradigm shift. The programme has been designed to facilitate a transformational shift within energy-intensive industries in countries from various world regions, including Armenia, Jordan, Kazakhstan, Morocco, Serbia, Tunisia, and Uzbekistan. To enable a paradigm shift and transformational change required within these energy-intensive sectors, the programme is based on the innovation of linking climate considerations at a project level with the uptake of long-term climate corporate governance performance that is supported by the adoption of sectoral low-carbon trajectories in each country. By setting short-term climate change mitigation 2030 targets through low-carbon investment planning and incorporating climate governance principles into decision-making, corporate entities can contribute to sectoral and country-specific low-carbon pathways while also following a gender-responsive approach. Moreover, the transformation process is stimulated by emerging carbon pricing schemes in carbon taxes or markets, which have a systemic effect across economic sectors.

Expected impact. The programme is expected to reduce emissions related to GCF result area "buildings, cities, industries and appliances" by 15.5 Mt CO_2eq (reduced over a 20-year asset lifetime); and GCF result area "energy access and power generation" by 1.7 Mt CO_2eq (reduced over a 20-year asset lifetime). The programme will result in lower energy intensity with over 111,400 TJ in energy savings over the investment lifetimes.

5.2 Nine countries: Enhancing "space" energy efficiency pathway case study: Cooling Facility

Theme	Mitigation		
Country	Bangladesh, El Salvador, Kenya, Malawi, North Macedonia, Panama, Sao Tome and Principe, Somalia, Sri Lanka	Project size	USD 879.8 million
Emission reduction	16.24 million tonnes of carbon dioxide equivalent (Mt CO2eq) mitigated	GCF financing	Loans: USD 125 million Grants: USD 32 million
EES category	Intermediation 2	Co-financing	Loans: USD 563.4 million Guarantees: USD 50 million Grants: USD 109.4 million
Accredited entity	World Bank	Co-finance ratio	83%
Approval	October2021	Completion	N/A
Information	www.greenclimate.fund/project/fp177		

Impact potential. The Cooling Facility provides key solutions to cooling from multiple angles, including regulation and policy, technical assistance, and most importantly, financing to address barriers inhibiting the broader adoption of clean cooling solutions that are energy efficient and rely on low-GWP refrigerants.

Country ambition. Given the still early-stage focus on cooling globally, to address both development and climate change purposes, the Cooling Facility seeks to cater to different country contexts, efforts, and priorities in response to the Covid-19 pandemic. This includes cooling-related products and services required for buildings, cold chains (e.g. vaccine supply chains), and health facilities.

Barriers addressed. The facility supports activities that address and help remove regulatory/policy-related, institutional, market and behavioural barriers to the development of sustainable cooling investments by (a) providing technical assistance and building capacity among state and non-state actors (such as commercial banks, private investors, and technical companies, and end-user beneficiaries); (b) supporting the design of sustainable implementation mechanisms and business models; (c) increasing end-user awareness of the benefits of low-carbon cooling solutions; (d) facilitating access to affordable sources of financing; and providing credit lines to financial intermediaries.

Pathway to paradigm shift. The Cooling Facility will be one of the world's first cooling-focused facilities with the aim of providing cooling solutions in Bangladesh, El Salvador, Kenya, Malawi, North Macedonia, Panama, Sao Tome and Principe, Somalia, and Sri Lanka. The injection of USD 157 million from GCF, channelled in the form of grants and loans, will be tailored to the needs of projects in the nine countries through various financing modalities, such as public financing to sovereign or sub-sovereign entities and credit lines to commercial banks, loans or subsidies to households, municipalities, and small, medium and large enterprises. Supported projects will propose activities, technology, and applications that aim to achieve market transformation, create new markets and business activities at local, national, or international levels, and can potentially be replicated in other sectors or geographic areas.

Expected impact. Over 25 years, the programme is estimated to contribute to addressing climate change by mitigating16.24 million tonnes of carbon dioxide equivalent (Mt CO2eq). An estimated 4.22 million people will benefit as direct beneficiaries from the investments and 16.86 million people as indirect beneficiaries (i.e. risk reduction from heatwaves and other extreme events).

5.3 Mongolia: Energy Efficient Consumption Loan Programme

Theme	Mitigation		
Country	Mongolia	Project size	USD 21.5 million
Emission reduction	0.47 million tonnes of carbon dioxide equivalent (Mt CO2eq) mitigated	GCF financing	Loans: USD 9 million Grants: USD 1 million
EES category	Intermediation 3	Co-financing	Loans: USD 11.5 million Grants: USD 9 million
Accredited entity	Xac Bank	Co-finance ratio	54%
Approval	October 2018	Completion	May 2029
Information	https://www.greenclimate.fund/project/sap004		

Impact potential. Previous interventions have not achieved impact at the scale needed to meet the target population's financing needs, due to lack of beneficial financial terms, lack of scale, slow product development processes, or changing market and regulatory contexts. Building on lessons learned and XacBank's prior experience, the programme finances heating and housing solutions with reduced emissions and improved environmental and health co-benefits.

Country ambition. One-half of Mongolia's population lives in Ulaanbaatar, where more than 60% of residents live in the surrounding peri-urban areas, many of whom migrated to Ulaanbaatar in response to climate change-driven livelihood disruptions. Faced with extremely low winter temperatures and challenging socio-economic conditions, these residents burn low-grade coal and rubbish in inefficient cook stoves for heating and cooking, with dire consequences for public health and the environment.

Barriers addressed. There is a need to mainstream affordable financing for energy efficient solutions that improve health and wellbeing, without placing an undue financial burden on peri-urban households. The GCF grant contributes to disposal management of old heating appliances, EE analytics and housing evaluation costs, raising awareness, and capacity building efforts. GCF´s loan concessionality alleviates existing household financing barriers, enabling a degree of scale more aligned with the financing needs of the affected population.

Pathway to paradigm shift. This EE consumption loan programme is the first heating appliance and housing lending programme to be implemented at scale in Mongolia. It demonstrates how to scale up finance for heating and housing solutions with reduced emissions and improved environmental and health co-benefits. The paradigm shift initiated has a potential to significantly reduce the long-term health risk of living in Ulaanbaatar, ultimately lowering health care costs and driving improved socio-economic outcomes for its direct beneficiaries.

Expected impact. This programme provides loans for energy efficient heating appliances and housing products, with heating appliances certified to achieve at least a 20% reduction in energy usage. Over 10 years, the programme is estimated to mitigate climate change by 0.47 million tonnes of carbon dioxide equivalent (Mt CO_2eq). The programme will impact an estimated 15,278 direct beneficiaries.

6 GCF Investment Criteria for Impactful Proposals

Proposed projects need to address six GCF investment criteria to receive funding. This section provides specific guidance to project developers on how to develop high-quality EE funding proposals that meet these investment criteria. Project developers should refer to instructions from the GCF handbook (GCF, 2021c) and recent board decisions in addition to this Guide.

6.1 Impact potential

GCF aims to support technologies, business models, and partnerships that have a high mitigation potential in energy-intensive and hard to decarbonise economic sectors and markets. While energy, material and resource efficiency projects and programmes primarily impact mitigation, projects are encouraged to specify adaptation impact, for example *strengthening the resiliency of electric, district heating, and cooling utility systems (e.g. through demand response and efficiency programmes to counteract peak demand and address risks associated with extreme weather) and integrating adaptation into urban planning, real-estate developments, and building design (e.g. green roofs, green buildings, and green city districts)*. This impact can be delivered through the three paradigm shifting pathways where conventional energy consumption, transformation and usage patterns need to be disrupted.

(1) **Scaling-up energy efficiency in industry:** proposals targeting energy-efficient industrial manufacturing processes for low-carbon or zero-carbon steel, (petro-)chemicals, and cement, particularly in countries where the share of fossil fuels is high or where markets are not developed.

(2) **Enhancing "space" energy efficiency:** proposals targeting sector coupling between energy infrastructure systems and networks, allowing for energy-efficient electricity, heating, and cooling services in real-estate "spaces" across building types and city districts, particularly in countries with ambitious plans for EE in the built environment or national targets for "space" efficiency, where electricity, district heating, district cooling, and other network infrastructure expansion or renovation can increase the share of energy efficiency at a large-scale system or network level, enable fuel switches and fossil fuel replacements, and unlock private sector infrastructure investment.

(3) **Catalysing rapid market switch to highest efficiency appliances/equipment:** proposals enabling best-in-class energy-efficient appliances/equipment supply chains to be replicated in the future beyond a sectoral or national scale and continue to accrue long-term co-benefits beyond its investment period. In countries where access to basic clean cooking and low-carbon electricity services is low, this could include proposals targeting strengthening local markets and productive use that build on locally specific portfolios of super-efficient appliances, products, and services (e.g. air conditioners, refrigerators, fans, motors, pumps, radios, TVs, and cookstoves) for households and MSMEs.

There is a wide range of technical options for achieving people-centric adaptation and mitigation impact, and all proposals are considered on a case-by-case basis in line with country priorities and needs. Proposals should take into careful consideration the GCF environmental and social policies (GCF, 2021d) to safeguard against possible negative environmental and social impacts [14] of *some large-scale energy-efficient industrial infrastructure developments, real estate developments and retrofits of building complexes*, and to be mindful of how they deliver long-term, lasting solutions to beneficiaries. This includes case-by-case measures within frameworks and plan, *for example to avoid that a reduction in future energy, resource and material efficiency gains and associated price,*

[14] As per the GCF Revised environmental and social policy adopted in 2021, "Environmental and social impacts refer to any change, potential or actual, to (i) the physical, natural, or cultural environment, and (ii) impacts on surrounding community and workers, resulting from the activities to be supported."

time and space savings from the implementation of proposed energy, resource and material efficiency improvements would ultimately result in increased energy, resource and material use due to behavorial or other systemic responses (so-called rebound effects[15]).

6.2 Paradigm shift potential

High impact GCF EE projects and programmes should result in a paradigm shift, which means delivering national, context-specific "tipping points" for systemic transformational change beyond a single EE project. GCF sub-criteria for assessing paradigm shift include innovation, scalability, knowledge and learning, sustainability, market transformation, and replicability (GCF, 2015). EE funding proposals are evaluated for their ability to crowd in private sector investments, establish strategic partnerships along a value chain, and create a lasting positive impact on national, regional, or city-level development(s) across one or several energy end-use sectors.

Depending on the nature of the energy, material and resource efficiency project or programme, paradigm shift may include innovation along the following paradigm shifting pathways:

Scaling-up energy efficiency in industry: proposals targeting energy-efficient industrial manufacturing processes for low-carbon or zero-carbon steel, chemicals, and cement.

Enhancing "space" energy efficiency: proposals scaling up business models that allow sector coupling across infrastructure systems and networks, providing energy-efficient electricity, heating, and cooling services for owners and users of real-estate "spaces" (across building classes and city districts).

Catalysing rapid market switch to highest efficiency appliances/equipment: proposals implementing ambitious ToCs for EE appliances/equipment supply chains to be replicated beyond a sectoral or national scale and continue to accrue long-term co-benefits beyond a GCF-supported investment period.

Transformative energy, material and resource efficiency projects are likely to address systemic barriers to widespread investment in adopting energy-efficient technologies, products, and services, including regulatory reforms for EE standards, labels, certificates, norms and associated measurement, testing, and verification methodologies.

Project developers are encouraged to benchmark EE policy options included in their proposal against best practices compiled in open-access EE policy databases. *For example, the CLASP database tracks "real-world" EE policy options across more than 160 countries.*

Section 3 of this Guide outlines in detail how EE projects and programmes can deliver transformational planning and programming, catalyse climate innovation, mobilise finance at scale, and expand and replicate knowledge across three high potential paradigm shifting pathways.

6.3 Sustainable development potential

Energy, material and resource efficiency projects and programmes deliver significant impact and co-benefits to sustainable development. GCF specifies co-benefits in the four areas of economic, social, environmental, and gender empowerment. Even though EE baseline data and scientifically verifiable impact and co-benefits have been difficult to establish upfront in some GCF EE projects and programmes, project developers are encouraged to present data-rich EE measurement, monitoring, and verification systems and resulting EE databases that link project planning to sustainable economic development potential, climate impact, and co-benefits.

EE projects and programmes typically have wide-ranging impact and co-benefits on sustainability, including:

[15] Thiesen, J., Christensen, T.S., Kristensen, T.G. et al. Rebound effects of price differences. Int J Life Cycle Assess 13, 104 (2008). https://doi.org/10.1065/lca2006.12.297

Economic co-benefits include energy-related cost savings and increased energy security for an economy through optimised energy management, reduction or replacement of (imported) fossil fuels, national energy demand reduction, and green industrial development by establishing energy-efficient, low-carbon manufacturing sectors; innovation and job creation in high-tech industries by delivering energy, material and resource efficiency solutions to the market allowing for poverty alleviation and income enhancement.

Social co-benefits include stable and secure energy provisions via efficient electricity, heating and cooling systems serving health facilities, education facilities and public administration, energy-related cost savings for all end-users (including households, MSMEs).

Environmental co-benefits include reduced local, regional, and global GHG and particulate emissions and resulting positive impact on local air, water, and soils quality through reduced energy demand and replacements of fossil fuels with zero-carbon fuels.

Gender empowerment co-benefits include inclusion and empowerment of women to participate and thrive in technology-focused energy-efficiency projects and programmes.

Effort is nonetheless required to ensure that these co-benefits reach and benefit the most vulnerable and marginalized groups in society. Therefore energy-efficiency project proposals should provide clear, people-centric strategies for co-benefits to be designed and delivered. More attention must be given to ensure that projects enhance inclusion and empower women who can be disenfranchised through male-dominated technology-led projects. EE project and programme designs should take this into account through appropriate and context-specific measures. At the least, an energy-efficiency project should specify end-user categories and support targeted knowledge exchange, learning and capacity building measures to enhance climate resilience in all parts of the society and economy.

Project developers should form strategic alliances and public-private partnerships to support country-specific infrastructure research, demonstration, and development pathways and specify co-benefits on a case-by-case basis*, e.g. for industrial energy-efficiency project proposals that target low- and zero-carbon manufacturing processes for cement, steel, and (petro-)chemicals*.

6.4 Needs of the recipient

For impactful energy, material and resource efficiency projects and programmes, attention must be given to identifying and addressing the needs of recipients. This involves working with recipients to understand their priorities and the barriers that they experience to shifting to low-emission development pathways. Depending on the nature of the energy-efficiency project and its underlying paradigm shifting pathway(s), relevant recipients could include:

Scaling-up energy efficiency in industry: owners of public/private manufacturing companies, including steel, chemical, and cement plants, owners of public/private industrial parks, owners of special economic zones.

Enhancing "space" energy efficiency: owners and users of industrial, commercial, and public buildings, including manufacturing companies, MSMEs, and national, regional or city-level public administration authorities in charge of health facilities, education facilities, and other public administration buildings, (owners of) energy service companies (e.g *super-ESCOs*) and technology providers that provide EE services and investment on behalf of public or private clients

Catalysing rapid market switch to highest efficiency appliances/equipment: end-users of energy-efficient technologies, products, and services including households, manufacturing companies and MSMEs, and national, regional, or city-level public administration authorities, (owners of) energy service companies (*e.g. super-ESCOs*) and technology providers that provide EE services and investment on behalf of public or private clients.

For an effective energy, material and resource efficiency project and programmes, developers should carefully put aside their assumptions about the needs of recipients to discover and understand how issues look from the point of view of those recipients and understand the underlying business models, value chains, and barriers that they experience.

Project developers should form strategic partnerships to jointly support large-scale investment in innovation in line with country-specific industrial strategies for EE projects and programmes that target low- and zero-carbon manufacturing processes, which are less commercially ready for scale-up.

Needs of the recipient can also emerge at country scale, *such as insufficient, unpredictable, or unclear energy, material and resource efficiency funding opportunities for cross-cutting climate actions*. Proposals should therefore outline how the proposed intervention will address the identified needs and barriers in a specific local context. In many cases, recipient needs can be identified through careful stakeholder interviews, participative planning approaches, early-stage industry sector benchmarking, and market segment mapping.

6.5 Country ownership

GCF adopts a country-driven approach and works with local and national development partners to implement climate investments in developing countries. Not only should high impact EE projects and programmes respond to the needs of recipients, but there should be strong alignment with national plans, policies, and institutional frameworks. This includes alignment with the country's Nationally Determined Contributions (NDCs), associated sectoral plans and strategies, *including National Energy Efficiency Action Plans (NEEAPs), National Cooling Action Plans (NCAPs), Montreal Protocol Kigali Implementation plans, any other EE-specific national action plans, Technology Need Assessments (TNAs) as well as country programmes developed by the National Designated Authorities (NDAs) and Focal Points*. In addition, country ownership includes engagement with all relevant public and private sector stakeholders at the time of proposal development and during implementation. Project developers are encouraged to increase the impact of partnerships with Direct Access Entities (DAEs) and ensure that they can fully engage in the project design, implementation, and monitoring of the portfolio. This is especially relevant for GCF priority investments in LDCs, SIDS and African states.

Depending on the nature of an energy, material and resource efficiency project and programme, relevant stakeholders across the three EE pathways could include:

Scaling-up energy efficiency in industry: national public administration authorities including regulators, public/private manufacturing companies, international financial institutions, public/private utilities, scientific institutions, and research laboratories.

Enhancing "space" energy efficiency: national, regional or city-level public administration authorities, public/private real estate developers, public/private utilities, international and local financial institutions, energy service companies, technology service providers, end-users of energy-efficient technologies, products, and services.

Catalysing rapid market switch to highest efficiency appliances/equipment: energy service companies, technology service providers, original equipment manufacturers, international and local financial institutions, international and national standard organisations, scientific institutions and testing laboratories, end-users of energy-efficient technologies, products, and services.

EE projects and programmes that are locally accepted and supported have a strong foundation to ensure that they deliver significant and lasting positive impact. Engagement with all stakeholders along the value chain ensures that they agree to and are aligned with project outcomes and approaches. This is particularly important for *low-carbon industrial manufacturing developments and large-scale green city district and building developments or retrofits*, where vulnerable groups may be adversely affected by large-scale infrastructure developments. Risks arising from

land-grabbing and related human rights violations need to be addressed early on, in line with GCF safeguard standards.

6.6 Efficiency and effectiveness

GCF aims to offer a comparative advantage in its use of donor funds and is able to experiment with a diverse range of instruments and new investment vehicles, including expanded access modalities and partnerships to maximise engagement with the private sector. These factors are assessed on a case-by-case basis, in line with the financial and non-financial barriers addressed through a mix of financial instruments and technical assistance.

Project developers are encouraged to compare the efficiency and effectiveness of their projects against comparable EE projects and programmes in the GCF portfolio and the portfolio of other public or private climate investment funds globally. Efficient and effective projects should describe how the proposal applies and builds on the best-in-class EE standards, norms, and practices in the targeted sector(s) of the economy. EE project developers should partner with local, regional, and/or international financial institutions to "crowd in" the private sector and strengthen the capacity and awareness of those institutions for future investments.

6.7 Coalitions and networks multiply energy efficiency portfolio impact

Public and private sector stakeholders are encouraged to work together in an effective and mutually beneficial manner to implement coherent energy, material and resource efficiency projects and programmes at scale. Without greater international cooperation, global CO_2 emissions in critical sectors, *such as industry and buildings*, will likely not fall to net-zero by 2050. Enhanced international cooperation in the EE sector should include improved energy, material and resource efficiency data sharing agreements, *in particular for technology innovations*. The lack of accurate, granular, and open-source techno-economic and financial EE datasets still hinders an improved understanding of the often complex and frequently changing relationship between the production, transformation, and consumption processes of energy, materials and resources in an industry and country context. Integrating digital concepts and processes to design, collect, analyse, and monitor various energy, material and resource efficiency topics is recommended to be discussed as part of innovative EE funding proposals.

7 Conclusion

Three distinct transformational EE pathways will enable advancing ambitious NDC goals, and Paris Agreement aligned sustainable development impact during this decade while enabling a green recovery from the ongoing pandemic and increasing resilience towards future economic, societal, and environmental challenges. These are centred around (a) scaling up industrial energy efficiency, (b) enhancing "space" energy efficiency and (c) catalysing rapid market switch to the highest efficiency appliance/equipment.

Faster action on energy, resource, and material efficiency is both essential and achievable. Put simply, EE is the first fuel – the fuel one does not have to use – and in terms of supply, it is abundantly available and cheap to extract. As highlighted in this Guide, there are many choices for stakeholders along value chains to be made and many good examples showing what works in specific local contexts. Key factors are alignment between long-term strategic industrial development, infrastructure and energy systems planning, national financial planning and green budgeting, which integrate climate and development goals through ambitious, consistent, and measurable energy, material and resource efficiency targets across technologies, industries and economic sectors.

While significant gaps in the coverage of EE investments across sub-sectors and sources of climate finance remain globally, future projects proposed to GCF for funding are encouraged to contribute to improved monitoring of sources of finance and financial instruments for each pathway, particularly with regard to adaptation and

resilience. Overall, selecting the most appropriate financial mechanisms and structures for GCF and co-financiers 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*). Guiding factors will be technology and business models and the proposed financing mechanism itself (*such as attractiveness to financiers, transaction costs, private sector leverage, cost-effectiveness, and the sustainable development potential*).

Generally, for mature EE technologies, products, and services 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, beneficiaries more vulnerable, more public sources are likely, and GCF funding will likely be more concessional. Substantial investment in advancing innovations for energy-efficient industrial manufacturing processes is still required. Public financing will not suffice for the projected investment needs for the 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 pooling and blending finance from different sources work for developing countries are of paramount importance.

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Annexes

Annex 1: Global and regional energy efficiency networks, partnerships, alliances and coalitions with links to the GCF´s paradigm shifting pathways

Global and regional networks, partnerships, alliances and coalitions are listed in alphabetical order for each paradigm shifting pathway to provide additional resources for designing transformational energy efficiency projects or programmes. All websites below were most recently accessed in August 2022.

Scaling-up industrial energy efficiency pathway

- Alliance to End Plastic Waste - *focus on innovative and impactful solutions to end plastic waste globally*. Website: https://endplasticwaste.org
- Alliance to Save Energy: Energy Efficiency Global Alliance - *focus on faster and deeper implementation of energy efficiency solutions to meet global energy and climate goals*. Website: https://eeglobalalliance.org/about
- Coalition for Energy Savings - *focus on energy efficiency and savings as the first consideration of energy policies and the driving force towards a secure, sustainable and competitive European Union*. Website: www.energycoalition.eu
- De-risking energy-efficiency investments platform - *focus on improved energy efficiency data exchanges for financial risk analysis across Europe*. Website: https://deep.eefig.eu/
- Energy Efficiency Financial Institutions Group - *focus on accelerating private finance to energy efficiency in Europe*. Website: https://ec.europa.eu/eefig/index_en
- Ellen MacArthur Foundation: Plastics Pact Network - *focus on transformational circular economy solutions for plastics*. Website: https://ellenmacarthurfoundation.org/the-plastics-pact-network
- Global Logistics Emission Council - *focus on emission reduction and enhance efficiency across global logistics supply chains globally*. Website: https://www.smartfreightcentre.org/en/glec-partnership/
- International Standards Organisation energy management standards development community - *focus on energy management approaches in various industries and economic sectors globally*. Website: https://www.iso.org/iso-50001-energy-management.html
- Lawrence Berkeley National Laboratory: Center of Expertise for Energy Efficiency in Data Centers - *focus on energy efficiency concepts and cost savings for data centres in North America and beyond.* Website: https://datacenters.lbl.gov/
- International Energy Agency: Advanced Materials for Transportation Technical Cooperation Program - *focus on material and fuel efficiency improvement for current and future transportation technologies globally*. Website: https://tcp-ia-amt.org/index/
- International Energy Agency: Clean and Efficient Combustion Technical Cooperation Program - *focus on efficient, low-carbon combustion processes to lower pollutant emissions in transportation, power generation, industry and buildings globally*. Website: https://www.ieacombustion.com/
- International Energy Agency: Energy Efficiency Hub - *focus on fostering exchange and collaboration on key energy efficiency topics*. Website: https://www.iea.org/areas-of-work/international-collaborations/energy-efficiency-hub
- International Energy Agency: Energy Technology Systems Analysis Technology Cooperation Program - *focus on energy systems modelling tools and platforms to build national, regional and global energy systems models for energy technology assessments and scenario analysis*. Website: https://iea-etsap.org/
- International Energy Agency: Hydrogen Technical Cooperation Program - *focus on hydrogen value chain implementation in the areas of production, storage, distribution, power, heating, mobility and industry worldwide*. Website: https://www.ieahydrogen.org/
- International Energy Agency: Industrial Energy-Related Technologies and Systems Technical Cooperation Program - *focus on energy and cost savings in a broad range of industry sectors globally*. Website: https://iea-industry.org/
- Mission Innovation: Clean Hydrogen - *focus on research and development in hydrogen technologies and industrial processes and delivering at least 100 hydrogen valleys covering production, storage and end-use worldwide*. Website: http://mission-innovation.net/missions/hydrogen/

- Mission Innovation: Materials for Energy Innovation Community - *focus on advanced materials for clean energy technologies globally*. Website: http://mission-innovation.net/platform/materials-for-energy-m4e/
- Mission Innovation: Net-Zero Industries - *focus on emissions reductions in heavy industries, such as steel, cement, and chemicals, worldwide*. Website: http://mission-innovation.net/missions/net-zero-industries-mission/
- Mission Innovation: Zero-Emission Shipping - *focus on zero-emission fuels, ships, fuel infrastructure and related efficiency improvements worldwide*. Website: http://mission-innovation.net/missions/shipping/
- Regulatory Assistance Project - *focus on accelerating the transition to a clean, reliable, and efficient energy future for the world's four largest power markets: China, Europe, India, and the United States*. Website: https://www.raponline.org/
- Sustainable Energy for All: Copenhagen Centre on Energy Efficiency - *focus on the uptake of energy efficiency policies and actions at a global scale*. Website: https://c2e2.unepdtu.org/
- United Nations Framework Convention on Climate Change: Climate Technology Centre and Network - *focus on technical assistance and capacity building for energy efficiency in developing countries and emerging economies globally*. Website: https://www.ctc-n.org/
- World Bank Energy Sector Management Assistance Program: Regulatory Indicators for Sustainable Energy – Energy Efficiency – *focus on national policy and regulatory frameworks for sustainable energy including energy efficiency*. Website: https://rise.esmap.org/
- World Economic Forum: Global Plastic Action Partnership - *focus on the eradication of plastic pollution*. Website: https://globalplasticaction.org/
- World Economic Forum: Shaping the Future of Energy, Materials and Infrastructure Platform - *focus on an effective and efficient transition of the energy, materials and infrastructure for a sustainable, resilient, and inclusive society worldwide*. Website: https://www.weforum.org/platforms/shaping-the-future-of-energy
- World Resources Institute: Platform for Accelerating the Circular Economy - *focus on circular economy materials, design concepts, technologies and business models globally*. Website: https://pacecircular.org/

Enhancing "space" energy efficiency pathway

- Alliance to Save Energy: Energy Efficiency Global Alliance - *focus on faster and deeper implementation of energy efficiency solutions to meet global energy and climate goals*. Website: https://eeglobalalliance.org/about
- American Council for an Energy-Efficient Economy - *focus on analysis and tools to reduce energy waste and combat climate change through investments, programs, and behaviours that use energy more effectively in North America*. Website: https://www.aceee.org/
- Asean Centre for Energy - *focus on energy efficiency and conservation within the ASEAN region*. Website: https://aseanenergy.org/topics/energy-efficiency-and-conservation/
- Buildings Performance Institute Europe - *focus on climate-neutral built environment in Europe, aligned with the ambition of the Paris Agreement*. Website: https://www.bpie.eu/
- Climate Group: Energy Productivity 100 alliance - *focus on energy productivity, energy efficiency and energy demand reduction for improved business competitiveness globally*. Website: https://www.theclimategroup.org/ep100
- Climate Works Foundation: Clean Cooling Collaborative - *focus on increasing access to climate-friendly cooling globally*. Website: https://www.cleancoolingcollaborative.org/
- Coalition for Energy Savings - *focus on energy efficiency and savings as the first consideration of energy policies and the driving force towards a secure, sustainable and competitive European Union*. Website: www.energycoalition.eu
- Cool Coalition - *focus on energy-efficient air conditioning and cooling worldwide*. Website: https://coolcoalition.org/
- Copenhagen Centre on Energy Efficiency: Global Energy Service Company Network - *focus on energy performance contracting approaches worldwide in response to the global climate change challenge and the goals set out by the Paris Agreement*. Website: https://globalesconetwork.unepdtu.org/
- Covenant of Mayors for Climate and Energy - *focus on concepts for energy saving insurances and energy-efficiency as a service across municipalities in Europe* and beyond. Website: https://www.covenantofmayors.eu/
- Efficiency Valuation Organization - *focus on products and services to facilitate investments in energy efficiency projects worldwide*. Website: https://evo-world.org/en/
- Energy Efficiency Financial Institutions Group - *focus on accelerating private finance to energy efficiency in Europe*. Website: https://ec.europa.eu/eefig/index_en
- European Council for an Energy Efficient Economy - *focus on evidence-based research, knowledge and analysis of energy efficiency policies in Europe* and beyond. Website: https://www.eceee.org/

- Global Alliance for Buildings and Construction - *focus on action towards a zero-emission, efficient and resilient buildings and construction sector worldwide*. Website: https://globalabc.org/about/about-globalabc
- International Energy Agency: District Heating and Cooling including Combined Heat and Power Technical Cooperation Program - *focus on research and policy for district heating and cooling systems with low environmental impact worldwide*. Website: https://www.iea-dhc.org/home
- International Energy Agency: Energy in Buildings and Communities Technical Cooperation Program - *focus on research and development efforts towards near-zero energy and carbon emissions in the built environment globally*. Website: https://www.iea-ebc.org/
- International Standards Organisation energy management standards development community - *focus on energy management approaches in various industries and economic sectors worldwide*. Website: https://www.iso.org/iso-50001-energy-management.html
- Mission Innovation: Innovation Community on Affordable Heating and Cooling of Buildings - *focus on low carbon, efficient and affordable heating and cooling technologies and services for buildings worldwide*. Website: http://mission-innovation.net/platform/innovation-community-ic7
- Regulatory Assistance Project - *focus on accelerating the transition to a clean, reliable, and efficient energy future for the world's four largest power markets: China, Europe, India, and the United States*. Website: https://www.raponline.org/
- Sustainable Energy for All: Copenhagen Centre on Energy Efficiency - *focus on the uptake of energy efficiency policies and actions at a global scale*. Website: https://c2e2.unepdtu.org/
- United Nations Framework Convention on Climate Change: Climate Technology Centre and Network - *focus on technical assistance and capacity building for energy efficiency in developing countries and emerging economies globally*. Website: https://www.ctc-n.org/
- World Bank Energy Sector Management Assistance Program: Regulatory Indicators for Sustainable Energy – Energy Efficiency – *focus on national policy and regulatory frameworks for sustainable energy including energy efficiency. Website*: https://rise.esmap.org/

Catalysing rapid market switch to highest efficiency appliances/equipment pathway

- Alliance to Save Energy: Energy Efficiency Global Alliance - *focus on faster and deeper implementation of energy efficiency solutions to meet global energy and climate goals*. Website: https://eeglobalalliance.org/about
- American Council for an Energy-Efficient Economy - *focus on analysis and tools to reduce energy waste and combat climate change through investments, programs, and behaviors that use energy more effectively within and beyond the North America region*. Website: https://www.aceee.org/
- Asean Centre for Energy - *focus on energy efficiency and conservation within the Asia-Pacific region*. Website: https://aseanenergy.org/topics/energy-efficiency-and-conservation/
- Center for Law and Social Policy (CLASP) - *focus on appliance and equipment energy performance and quality, to mitigate and adapt to climate change and expand access to clean energy*. Website: https://www.clasp.ngo/
- Clean Energy Ministerial: Super-efficient Equipment and Appliance Deployment Initiative - *focus on super-efficient appliances, lighting, and technical equipment worldwide*. Website: https://superefficient.org/
- Climate Group: Energy Productivity 100 - *focus on energy productivity, energy efficiency and energy demand reduction for improved business competitiveness*. Website: https://www.theclimategroup.org/ep100
- Climate Works Foundation: Clean Cooling Collaborative - *focus on increasing access to climate-friendly cooling worldwide*. Website: https://www.cleancoolingcollaborative.org/
- Coalition for Energy Savings - *focus on energy efficiency and savings as the first consideration of energy policies and the driving force towards a secure, sustainable and competitive European Union*, with lessons learned for emerging markets. Website: www.energycoalition.eu
- Cool Coalition - *focus on energy-efficient air conditioning and cooling*. Website: https://coolcoalition.org/
- Copenhagen Centre on Energy Efficiency: Global Energy Service Company Network - *focus on energy performance contracting approaches worldwide in response to the global climate change challenge and the goals set out by the Paris Agreement*. Website: https://globalesconetwork.unepdtu.org/
- Covenant of Mayors for Climate and Energy - *focus on concepts for energy saving insurances and energy-efficiency as a service across municipalities in Europe and beyond*. Website: https://www.covenantofmayors.eu/
- European Council for an Energy Efficient Economy - *focus on evidence-based research, knowledge and analysis of energy efficiency policies in Europe* and beyond. Website: https://www.eceee.org/

- Efficiency Valuation Organization - *focus on products and services to facilitate investments in energy efficiency projects worldwide*. Website: https://evo-world.org/en/
- International Energy Agency: Energy Efficient End-Use Equipment Technology Collaboration Programme - *focus on energy efficiency for all energy using equipment and systems worldwide*. Website: https://www.iea-4e.org/
- International Energy Agency: Energy Efficiency Hub - *focus on fostering exchange and collaboration on key energy efficiency topics*. Website: https://www.iea.org/areas-of-work/international-collaborations/energy-efficiency-hub
- International Energy Agency: Energy Technology Systems Analysis Technology Cooperation Program - *focus on energy systems modelling tools and platforms to build national, regional and global energy systems models for energy technology assessments and scenario analysis*. Website: https://iea-etsap.org/
- International Network for Energy Sufficiency Research and Policy - *focus on promoting energy sufficiency research and approaches worldwide*. Website: https://www.researchgate.net/project/ENOUGH-International-network-for-sufficiency-research-policy
- Regulatory Assistance Project - *focus on accelerating the transition to a clean, reliable, and efficient energy future for the world's four largest power markets: China, Europe, India, and the United States*. Website: https://www.raponline.org
- Sustainable Energy for All: Copenhagen Centre on Energy Efficiency - *focus on the uptake of energy efficiency policies and actions at a global scale*. Website: https://c2e2.unepdtu.org/
- United for Efficiency Initiative - *focus on energy-efficient appliances and equipment in developing countries and emerging economies*. Website: https://united4efficiency.org/
- United Nations Framework Convention on Climate Change: Climate Technology Centre and Network - *focus on technical assistance and capacity building for energy efficiency in developing countries and emerging economies globally*. Website: https://www.ctc-n.org/
- World Bank Energy Sector Management Assistance Program: Regulatory Indicators for Sustainable Energy – Energy Efficiency – *focus on national policy and regulatory frameworks for sustainable energy including energy efficiency. Website*: https://rise.esmap.org/

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