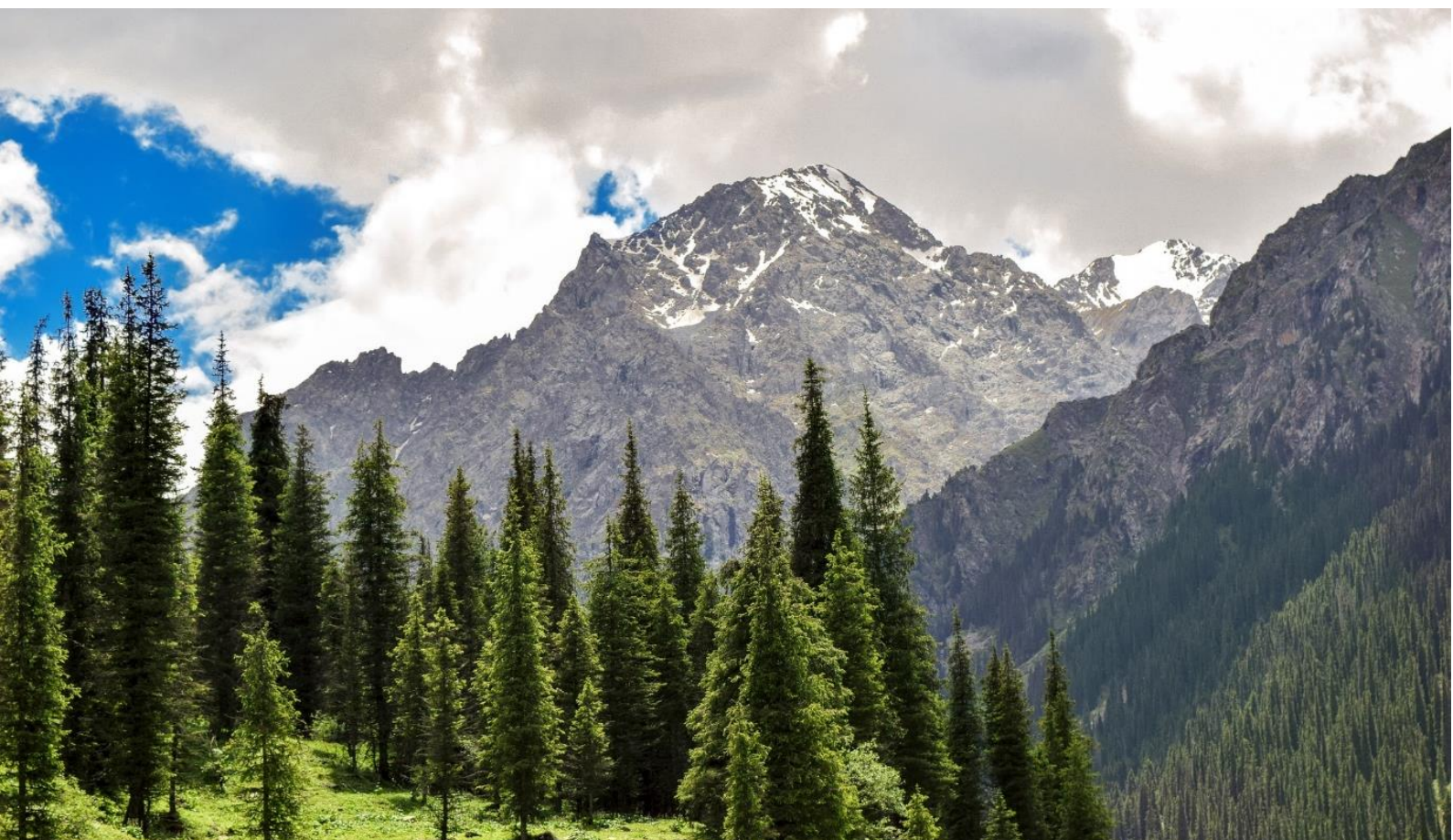




A Climate Resilient Energy Sector in the Kyrgyz Republic

Action Plan and Policy Recommendations Framework



**Olga Chepelianskaia
Madhurima Sarkar-Swaigood**

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Table of Contents

TABLE OF CONTENTS	3
I. THE ENERGY SECTOR'S CLIMATE VULNERABILITIES AND CHALLENGES	5
A. Energy Sector Overview	5
B. Climate Change Impacts on the Energy Sector	5
C. Climate Change Vulnerabilities of the Energy Infrastructure	6
II. EXISTING INSTITUTIONAL AND POLICY FRAMEWORK	7
A. Existing Institutional Framework	7
B. Existing Policy Frameworks	8
C. Ongoing Energy Projects	9
III. ENERGY CLIMATE RESILIENCE ACTION PLAN AND SUPPORTING POLICY RECOMMENDATIONS	12
Assess Climate Exposure of Present and Future Energy Sector's infrastructural Assets	12
Assess climate vulnerability of present and future energy sector's infrastructural assets	14
Prepare a Sectoral Climate Resilience Action Plan	17
Analyze barriers to implementing the action plan and prepare policy recommendations	20
Identify sources of finance for the priority assets' climate resilience strengthening	25
CONCLUSION	25
REFERENCES	26

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I. The energy sector's climate vulnerabilities and challenges

The Kyrgyz Republic is the third most vulnerable country to climate change impacts in Eastern Europe and Central Asia (UNDP, 2013). Climate change and extreme weather events annually cost the country's economy 1% to 1.5% of GDP (ADB, 2018). According to UNDP estimates, if disaster damage increases at the rate of the annual population growth (1.1% per year), a conservative assumption is that climate-related disasters could total USD 156 million by 2032 (UNDP, 2013).

This section summarizes climate change and related natural hazards' vulnerabilities of the energy sector in the Kyrgyz Republic. More detailed information can be found in the ESCAP report The Kyrgyz Republic - Climate Change and Disaster Risk Profile, March 2021.

A. Energy Sector Overview

Over 90% of the country's electricity generation comes from hydropower, which affects the sector's reliability and makes it highly vulnerable to climate change (ADB, 2019). Low electricity tariffs, which do not incentivize the sector to invest in energy efficient technologies or introduce renewable energy technologies at scale, further fragilize the sector. Over 45% of the electricity generating equipment is beyond its lifecycle (Climate Investment Programme, 2018). **Transmission and distribution** networks require a major upgrade: the transmission

network alone bears losses exceeding 25% of the generated electricity (UNECE, 2018).

Electricity exports had been a source of revenue for the country (ESMAP, 2018), however, the country gradually went from a status of a net exporter to a net importer between 2014 and 2016 (ESMAP, 2018), during which the gap in demand, due to extreme cold, was met through imports (WTO, 2021). In 2015, the country met only 45% of its domestic power demand and, since 2017, electricity exports have exceeded imports (WTO, 2021).

B. Climate Change Impacts on the Energy Sector

The energy sector shows signs of vulnerability to both the future temperature and precipitation anticipated patterns.

The RCP 4.5 scenario (50th percentile) **anticipates an increase of the annual average temperature by 2°C** for an intermediate future period of 2040-2059 in comparison with a reference period of 1986-2005. The anticipated temperature rise will increase evaporation losses and accelerate glacial melting, reducing reliability and availability of water for hydropower. **Rapid glacial melt can contribute to increasing hydropower generation in the short term (next 5 to 10 years), but significantly decrease it afterwards** (USAID, 2018). The likely future water stress may

also affect the thermoelectric cooling of the country's two thermal power plants.

The World Bank's Climate Smart Agriculture profile (2018) anticipates that the annual total precipitation over the Kyrgyz Republic is likely to increase across the country till the mid-century under the RCP 4.5 pathway and is likely to mostly impact the Chuy, Osh and Jalal-Abad regions. **Increased precipitation** may further exacerbate climate related disasters such as pluvial floods, glacial lake outburst floods, landslides and mudslides. Floods and mudslides can cause soil erosion and damage power generating facilities: dams, coal storage facilities, thermal power plants, transmission, and distribution lines.

C. Climate Change Vulnerabilities of the Energy Infrastructure

Climate change may affect the energy infrastructure in two ways: by gradual or incremental climate change patterns (such as a gradually increasing average surface mean temperature) and by changing extreme weather events patterns (such as intensified and more frequent heat waves). Climate change may intensify natural disaster risks (droughts, floods) or have a less direct relationship to them (earthquakes).

Climate change vulnerability depends not only on climate change patterns themselves, but as much on the **specifics of the energy sector assets**. Understanding how exactly and to what extent infrastructural assets are likely to be affected by climate change hence requires a thorough engineering analysis of each specific asset. However, a number of **well identified cause-to-effect patterns** can be taken into consideration when looking into climate proofing the energy sector. **Table 1** below summarises these cause-to-effect patterns relevant to the energy sector in Kyrgyz Republic.

Table 1: Climate change impact on the energy sector

Climate change pattern	Potential impact on the energy sector in Kazakhstan
Increased average and extreme temperatures	<ul style="list-style-type: none">▪ Increased evaporation and frosting decreases hydropower generation capacity▪ Reduced efficiency of thermal power plants▪ Ice can damage dam walls and block turbine inlets▪ Higher transmission losses and extension of cables in warmer temperature
Intensified precipitation patterns	<ul style="list-style-type: none">▪ Reduced coal quality and thermal power generation capacity▪ Heavy rain can trigger flashover faults across high voltage insulators▪ Heavy rain can cause short circuit in high voltage circuit breaker
Climate related natural disasters	
Droughts	<ul style="list-style-type: none">▪ Water scarcity can affect hydro power generation capacity and impact thermal power cooling systems
Floods	<ul style="list-style-type: none">▪ Damage to physical infrastructure (dam walls, turbines)▪ Fluctuations in inflow causing losses in the output
Landslides and mudslides	<ul style="list-style-type: none">▪ Damage to physical infrastructure (cables, dams, turbines, coal power plants)

Source: ESCAP, 2021

II. Existing Institutional and Policy Framework

A. Existing Institutional Framework

Energy Sector

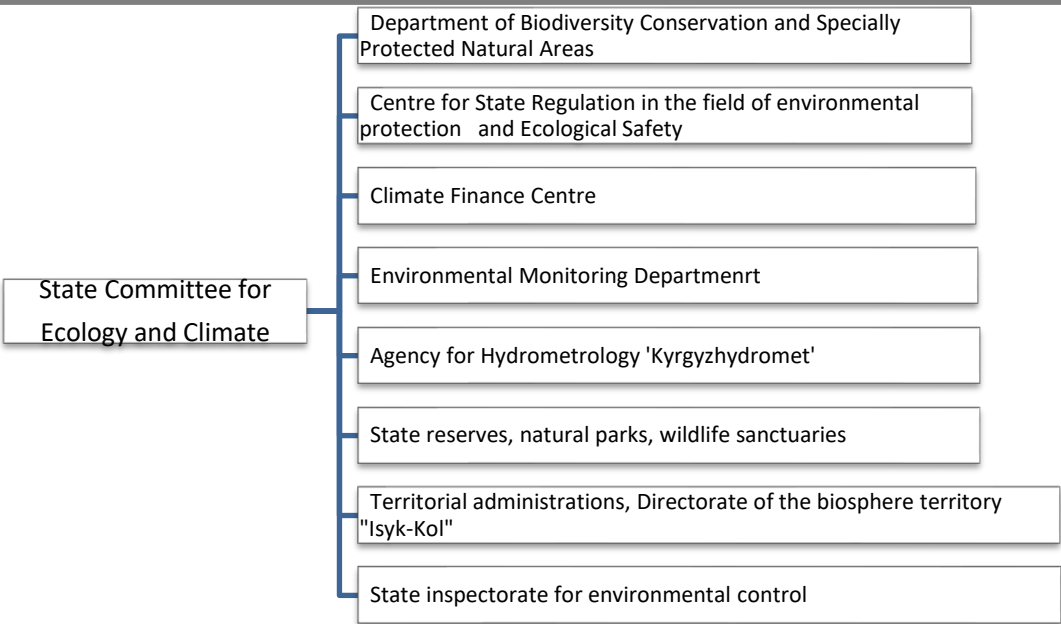
The Ministry of Energy and Industry (MES) is responsible for the development and implementation national policies in the energy sector. MES is the legal successor of the State Committee on the Industry, Power, and Subsoil Use (Office of Ministers of the Kyrgyz Republic, 2021). At present, there is **no dedicated department for climate change adaptation** under the Ministry of Energy and Industry.

Climate Change and Disaster Risk Management

Setting up the **State Committee on Ecology and Climate (SCEC)** as an independent body in 2021 was an important step for the country. The SCEC brought under one institutional roof all national climate activities such as fulfilling the country's obligations under the UNFCCC, elaborating climate policies, collecting and analysing climate related data (Kyrgyzhydromet),

or bringing climate finance into the country's sectoral activities. This set up has the advantage of an improved coordination between all the above activities, which used to belong to different ministries. In particular, **Kyrgyzhydromet**, earlier understaffed and hence not in a capacity to prepare detailed and localised climate change future scenarios, may now be in a better position to fulfil this critical task. At the same time, sectoral ministries such as the Ministry of Emergency Situations, which formerly hosted Kyrgyzhydromet, or the Ministry of Economy, which formerly hosted the Climate Finance Centre, could now be less engaged into climate activities. The success of the SCEC's mission at the national level will to a large extent depend on its capacity to elaborate sectoral climate policies and regulations, and to effectively engage sectoral ministries, including the Ministry of Energy and Industry, into their implementation. At present, such sectoral policies and regulations remain to be put in place.

FIGURE 1: Structure of the State Committee for Ecology and Climate



Source Office of Ministers of the Kyrgyz Republic, 2021

The **Ministry of Emergency Situations of the Kyrgyz Republic (MES)** is the state executive body responsible for disaster risk prevention, mitigation, and rescue operations. The MES has the responsibility to develop and implement national regulations on civil protection, fire safety, and human safety in relation to water bodies, floods, landslides, and mudflows. It also monitors and forecasts natural hazards over a short-term future, ranging from 1 to 5 years ahead (Ministry of Justice of the Kyrgyz Republic, 2021). Climate change related disaster risk preparedness however requires a medium to a long-term future anticipation supported by detailed sectoral regulations, which remains to be put in place in the Kyrgyz Republic.

B. Existing Policy Frameworks

Energy Policies

A number of national policies include energy related provisions:

- **The Law on Renewable Energy, 2008** aims to develop and use renewable energy sources, improve the energy structure, diversify energy resources, and ensure the energy security of the country.
- **The National Sustainable Development Strategy for the Kyrgyz Republic, 2013-2017** conferred high priority to hydropower, however did not identify climate change resilience provisions for this sector.
- **The Development Programme of the Kyrgyz Republic for the period, 2018-2022** includes development strategies covering different economic sectors. The energy sector's focus is on energy self-sufficiency and management efficiency while ensuring financial stability and transparency to meet the growing demand. No climate change resilience provisions have been identified.
- **The National Development Strategy of the Kyrgyz Republic, 2018-2040** identifies the country as a major producer of electricity in the region and aims to a sustainable energy sector development, energy security, and energy efficiency.

The country hence envisions the energy sector as a key sector for its successful economic development and views hydropower as a continuous major power source. To achieve this vision in the long run and ensure the country's economic stability, it is critical to increase climate

change and related disaster risk resilience of the sector. Policy, regulatory and institutional steps remain to be taken in this direction.

Climate Change and Disaster Risk Reduction Policies

Several strategic documents include climate change adaptation provisions at the national level:

- The vision of the **National Development Strategy of the Kyrgyz Republic 2018-2040** is to become a self-sufficient developed state. To achieve this vision in a sustainable manner, the country developed the **Green Economy Development Programme for 2019-2023**. This detailed document assesses key climate vulnerabilities in all economic sectors of the country, lists interventions to be undertaken and names institutions in charge. The Programme aims to achieve economic growth by reducing an intensive and irrational use of natural resources, which includes water – a major source of hydropower in the country. Green energy is listed as one of the 7 priority directions for the country.
- The Decree No. 549 of the Government of the Kyrgyz Republic dated from 2 October 2013 - **Priority Directions for Adaptation to Climate Change in the Kyrgyz Republic until 2017** - plans adaptation measures in the sectors of water resources, energy, agriculture, public health, climate emergencies, forest resources and biodiversity. This document requires an update. A Readiness support proposal for the development of a National Adaptation Plan (NAP) was approved by the Green

Climate Fund (GCF) on 18 May 2020 and is currently under preparation.

- The Climate Investment Programme (CIP), Operational Framework for Managing and Accessing Climate Finance in the Kyrgyz Republic, was finalized in May 2018 as a part of the Climate Investment Funds' Pilot Programme for Climate Resilience (CIF PPCR). It aims to facilitate adaptation measures in key climate sectors of the economy and support the Kyrgyz Republic in attracting resources through international climate finance mechanisms to implement climate change resilience investment activities

for identified 11 components, among which the energy sector: **Component 3 on Making energy supply infrastructure climate resilient.**

These valuable efforts need to be built upon by developing sectoral climate resilience policies, regulations and measures. At present, although the above-mentioned documents contain sectoral provisions, they do not elaborate in detail on specific activities which will allow the energy sector to increase its climate resilience and do not hold a binding character. Once this step is put in place, the identified measures will need to be supported by related budget allocations to be implementable.

C. Ongoing Energy Projects

The energy sector is one of the key economic engines of the country and requires consequent investments to fulfil its role in the country's economy. In particular, **investments into energy supply are critical to keep up with the growing demand.** Over 45% of the power generation capacity is estimated to be beyond its lifecycle, power transmission and distribution lines require a sizeable replacement and over 70% of steam and hot water networks are older than 25 years (Climate Investment Programme, 2018). At the same time, the electricity and

central heating sectors are highly indebted, and repayment faces difficulties due to **low electricity and heating tariffs.**

As a result, the country largely benefits from international development support and concessional loans for its energy sector projects. **Error! Reference source not found.** illustrates a number of projects in the energy sector:

Table 2: Key Projects in the Energy Sector

Project	Development partner/s	Funding amount	Implementation period	Expected Result
Rehabilitation of the Toktogul Hydropower Plant (HPP), Phase 3	Asian Development Bank Eurasian Development Bank	USD 110 million (Grant 50 M and loan 60 M) USD 40 million (loan)	2016-2023	Replacement of hydraulic units No. 1 and 3 with an increase in the capacity of each unit by 60 MW, auxiliary equipment and rehabilitation of gates and hydraulic structures.
Improving power supply to the Arkinsky massif, Leilek district, Batken region	Islamic Development Bank	USD 16.25 million (loan)	2014-2019	Construction of a 110 kV overhead line with a length of 51 km from the Aigultash-Samat 110 kV overhead line to the Arka substation, the Razzakova 110/35/10 kV substation, and reconstruction of the Arka 110/35/10 kV substation.
Construction of the Kambarata HPP-1		USD 2,9 million	2018-2025	Construction of a hydroelectric power station with an installed capacity of 1,860 MW
Energy sector development	Asian Development Bank	USD 44.8 million (grant - 28.09 M and loan -16.71 M)	2013-2018	Implementation of an automated control and data accounting system (ASKUE), communication and dispatch control and data collection system (SDCSD), modernization of substations, a study on the creation of a center to settle wholesale transactions for the supply of electricity, development of corporate and financial management capacity.
Rehabilitation of JSC "Oshelectro"	European Bank for Reconstruction and Development	EUR 5 million (grant 1 M and loan 4 M)	2017-2020	Modernization of SS-35 kV "Osh-3", replacement and installation of TP-KTP 10-6 / 0.4 kV, reconstruction and new construction of electrical networks of 10-0.4 kV overhead lines, including self-supporting insulated cables and installation of ASKUE meters and implementation ASKUE systems.

Key projects can be sub-divided into 3 categories:

- Construction of **new HPP of smaller scale** to meet the growing demand;
- **Renovation and reconstruction** of existing HPP to increase their capacity and replace the aged equipment;
- Improving power supply through **upgradation of infrastructure**, such as laying overhead cable, and providing access to an improved data and communication system.

Often times, these projects only mildly integrate climate change and related future disaster risk provisions, which leads to negative consequences. For example, the Toktogul HPP, which underwent rehabilitation since 2013, received the lowest water level in April 2021 (Pannier, Kyrgyzstan's Hydropower Problems Causing Concern In Neighboring Nation, 2021). Indeed, while international development partners usually require a climate change and disaster risk analysis to be performed and integrated into a project detailed design, national engineering standards do not contain such provisions, which results in projects being finalised with limited climate resilience inputs.

Action on integrating climate change provisions into national sectoral regulations and standards is all the more important considering that the country's water resources are critical not only to its power sector, but equally to the agricultural sector of the Central Asian region. For example, the Naryn river is used by the Kyrgyz Republic for hydropower generation upstream whereas Uzbekistan and Kazakhstan depend on its lower stream for their agricultural activities. The water level in the Toktogul reservoir dropped to 8.83 bcm in March 2021 while the critical level below which operations of the Toktogul HPP would be

affected has been estimated at 8.5 bcm (Pannier, Kyrgyzstan's Hydropower Problems Causing Concern In Neighboring Nations, 2021). A noticeable shrinking of this water source in the medium and long run could hence compromise the economic stability not only of the country, but also of the region.

Limitations to Making the Energy Sector Climate Resilient

Despite the energy sector being an economic priority for the country, several challenges remain to be addressed:

- The Kyrgyz Republic has one of the lowest electricity prices: USD 0.01 per kWh (ESMAP, 2018). In 2016, the tariff recovered only 63% of its costs (PEEREA, 2018). Low energy tariffs result in high governmental subsidies of the sector, which makes it dependent on concessional loans and limits the speed of its economic growth.
- The country is heavily dependent on one single power generation source – hydropower – which makes the sector particularly vulnerable to any incident affecting hydropower. A climate-resilient power system requires a diversification of power supply which, in turn, requires investments.

Mainstreaming climate change adaptation into all new power infrastructure related investments is an opportunity to not only make the country's energy sector climate resilient, but also to ensure that the power projects' lifecycle costs are lower through reduced repair and damaged costs and to avoid a major future energy crisis. The section below recommends action plan and policy measures' framework to achieve this objective.

III. Energy Climate Resilience

Action Plan and Supporting Policy Recommendations

Based on the context, challenges and initiatives identified above as well as based on learnings from relevant benchmark international practices, the present section identifies a set of steps most suitable to mainstreaming climate adaptation into the energy sector. It highlights short, medium and long-term steps the Kyrgyz Republic can undertake to integrate climate adaptation into energy development projects. These steps include conducting a sectoral climate change risk and vulnerability assessment, developing a climate resilient sectoral action plan, mapping legal and regulatory provisions required to facilitate its implementation, and linking pilot projects to climate finance.

Assess Climate Exposure of Present and Future Energy Sector's Infrastructural Assets

Conclusions of the ESCAP report Kyrgyzstan - Climate Change and Disaster Risk Profile (March 2021) can be taken as a basis for an initial climate risk and vulnerability screening of the energy sector's infrastructural assets. This assessment needs to be deepened for most important existing and planned infrastructural assets to identify each most critical asset's specific level or exposure. To achieve a tangible outcome in a reasonable timeframe, it is recommended to **start with 3 most important assets** for the country's socio-economic development. The section below details a number of sub-steps to undertake to identify these 3 assets and assess their climate exposure.

- I. **Map locations of present and planned future energy sector's infrastructure development assets in GIS.** A focus can be placed on the country's most critical and valuable energy sector's infrastructure assets, both in terms of investment cost and in terms of their importance for the country's socio-economic development.

These are likely to be selected from existing or planned thermal power plants, hydropower plants, renewable

energy generation sources, transmission and distribution lines. Hydropower plants and related water supply are of particular importance to the country and, hence, at least one or two assets should be identified under this sub-category.

- II. **Identify and feature areas most prone to climate change related natural hazards in GIS.** Ideally, a spatial analysis of localized historical and future climate trends should be conducted. However, if such an analysis is not yet institutionalized as a regular national activity, to optimize the time and the cost of this activity it is recommended to conduct a fast-track mapping first and to conduct a localized analysis of only selected areas at a later stage. To do so, it is recommended to utilize maps of natural hazards based on historical data and indicate areas in which natural hazards are most likely to be further enhanced by identified future climate change patterns.

- III. **Overlay these maps to**

identify location of most exposed key present and future infrastructural assets. Based on the outcome, prioritise 3 most valuable and most exposed assets located in highly exposed areas. These will be taken for an in-depth climate risk and vulnerability analysis.

IV. Downscale climate change projections and conduct an in-depth climate risk and vulnerability assessment for the 3 priority local areas corresponding to the 3

priority assets identified above. While a country level climate change assessment may be helpful at the initial mapping stage, it is not sufficient to accurately assess climate risk in a local area. Indeed, local past and future climate patterns may significantly differ from the average national pattern. This step will hence allow to better assess climate risk and vulnerability and help take informed decisions going forward.

Case Study 1: HPP adaptation to Impacts of climate change in Argentina

Summary of project outcomes

Nearly **1/3 Argentina's power supply comes from hydropower**. The water level in rivers supplying water to the country's HPP heavily relies on rainfalls, which got affected by climate change effects and resulted in a significant drop in hydropower generation in two regions. Analysis of alternative scenarios and options helped the country timely identify solutions.
Detailed project content

Argentina conducted a climate vulnerability assessment of the HPP sector over the period 2014–2040 and identified that HPP receiving water supply from Comahue and Cuyo basins were particularly vulnerable due to a change in historical rainfall patterns over these two basins.

Three scenarios were examined:

- Scenario H1 projected that hydropower generation would gradually decline and reach its lowest historical ratio between installed capacity and actually generated power by 2040. An estimate of how much power will need to be generated through alternative sources to cover the shortfall was conducted.
- Scenarios H2 and H3 assessed how the HPP could better perform during years of drought and examined in detail alternative power supply options, such as increasing fossil based thermal generation or increasing power imports.

The International Atomic Energy Agency (IAEA) **energy planning tool MESSAGE** (Model for Energy Supply Strategy Alternatives and their General Environmental Impacts) was used to assess different water supply scenarios and identify an optimal power generation mix for the event of a decreased water flow in the two climate vulnerable rivers.

Table 3: Capacity (MW) of existing and projected HPP

Plant status	Plant type	North-west	North-east	GBA+ BSAS+ LIT	Central Region	Cuyo	Comahue	Patagonia
Existing	Large & medium	131.1	3100	1890	835	987.4	4647	518.8
	Small	86.1			82.6	83.4	33.7	
Projected	Project type 1		1240	500		1681	1681	1842
	Project type 2	190	1440			750	2162	309
	Project type 3	110				185	4142	34

Note: BSAS — Province of Buenos Aires; GBA — City of Buenos Aires; LIT — Litoral.

Source: *Adapting the energy sector to climate change*, IAEA, 2019; pp.82-89

Lessons learned

- Developing and analysing alternative performance scenarios in the two vulnerable regions allowed to develop alternative options before the negative effect of climate change would be felt by the consumer and the country.
- A timely diversified power supply system can prevent negative effects of climate change on power supply. This diversification usually requires adjustments in the existing transmission and distribution systems.

Assess climate vulnerability of present and future energy sector's infrastructural assets

- I. **Assess the priority exposed assets' level of climate disaster related coping capacity.** Climate vulnerability of an asset depends not only on its exposure related to its location, but equally on its coping capacity.

For existing assets, more robust coping capacity in the power sector may include, for example, weather sealing critical equipment, raised dykes, critical piping insulation, flood resistant doors, raised elevation of backup diesel generators, or an increased drainage capacity to prevent effects of heavy rainfall and floods. Increasing temperatures related vulnerability in the Kyrgyz Republic is more complex to address since it mostly requires a holistic sectoral approach where the energy mix is optimized to decrease the sector's dependency on water availability; where future hydropower plants' sizes and locations are decided based on hydrological modelling, which incorporates future localised climate change projections; and where supply and demand side energy efficiency are viewed as an important source of power supply.

- II. **Assess the opportunity and the relevance of**

alternative locations for the future strategic assets among assets identified under step 1.4. If planning an alternative location for a vulnerable asset is feasible while maintaining its anticipated output, this option may be more cost effective than climate proofing an asset in an exposed area.

- III. **Assess the cost of climate proofing the identified vulnerable assets** and compare it with the estimated post damage repair cost, taking into consideration the estimated intensity and frequency of anticipated natural disasters assessed in Step 1.
- IV. **Conclude with an optimal cost-benefit solution** which strengthens climate resilience of the 3 priority assets.

Case Study 2: Qairokkum HPP rehabilitation project in Tajikistan

Summary of project outcomes

The project examined in detail climate risks through preparing alternative future climate change scenarios and hydrological modelling scenarios. This assessment helped identify an optimal climate resilience strengthening solution, which unfortunately was not taken forward due to increasing the capital project cost.

Detailed project content

Tajikistan receives as much as 98% of its power from hydropower generation. Similarly to the Kyrgyz Republic, seasonal glacier melting is an importance source of water supply in the country. As a result of climate change related increasing temperatures, glaciers have been melting faster than as per the historical trend, which threatens the hydropower sector's stability in the medium to long run.

The **Qairokkum hydropower plant** was selected as a pilot project to demonstrate how to rehabilitate an existing hydropower plant and make it climate resilient. The following activities took place:

- To identify **risks associated with climate change**, 4 localised future temperature and precipitation scenarios were developed and examined: hot-dry scenario, central scenario, warm-wet scenario and no climate change scenario.
- These future climate scenarios served as an input to future water inflow **hydrological modelling** of the Qairokkum reservoir. Three different hydrological models were generated: a snowmelt runoff model, a regression model and a water balance

model.

- Based on the outcomes, a min-max analysis technique was used to identify **an optimal climate resilience strengthening solution** which includes the best economic performance across climate scenarios.
- **Learning from an international best practice** was incorporated through a study tour of hydropower facilities in an OECD country for Barki Tojik staff, TajikHydromet and other relevant institutions.

Unfortunately, identified climate resilience strengthening measures were not implemented due to generating a higher capital cost. The project loan approved includes a replacement of 2 turbines in phase 1 and of 4 turbines in phase 2.

Lesson Learned

- Data required to model future water inflows and power generation capacity under different climate change scenarios was not easily obtainable. **Meteorological and hydrological data** in Tajikistan was scarce and not always digitally recorded, which is often the case in other countries of the region. To address this challenge, it is necessary to initiate detailed data collection at the earliest on the one hand and to identify most accurate ways of simulating future scenarios with limited collected data on the other hand.
- **Rehabilitation of existing structures** can help meet the growing demand for power.
- Capital cost considerations should be replaced by **lifecycle cost considerations** to allow climate resilience interventions to take place.

Figure 2: Qairokkum hydropower rehabilitation plant, Tajikistan



Source: NS Energy

Prepare a Sectoral Climate Resilience Action Plan

- I. **Prepare a detailed action plan to make the identified priority energy assets climate resilient**
- II. Utilize the above recommendations as a benchmark to indicate direction of action for other vulnerable sectoral assets and, if time and resources allow, prepare a **holistic Sectoral Climate Resilience Action Plan**. Alternatively, pilot implementation of the action plan prepared under step 3.1 could be tested and the sectoral action plan could be prepared based on lessons learned from it.

While it is difficult to make detailed climate adaptation recommendations for the sector without conducting country consultations and without making detailed assessments of selected assets, **diversifying power sources** seems an important step to minimise risks and achieve a more stable power supply in the face of the changing climate and more frequent and intense extreme weather events. The following measures can support this diversification:

- **Enhancing the usage of renewable energy sources:** An updated renewable energy law was approved in 2019. Nearly 95% of renewable energy projects focus on small HPP of 1,5 to 2 MW. While land allocation remains a major barrier, this focus has a high potential to reduce the country's dependency on a few big HPP. Wind energy also has high potential, however low energy tariffs remain a barrier to its deployment. Farmers already successfully utilise biogas. Finally, experimental solar energy can be looked at as a solution: for example, the

Asian Development Bank considered a floating solar station over the Toktogul reservoir, which could bring the advantages of reducing water evaporation while producing additional electricity.

- **Decentralising power generation** can strengthen the power grid through integrating small and large HPP as well as other renewable energy sources into a flexible system. The grid should allow for an easy isolation to prevent power outages during a repair or an emergency, as well as have the ability to bring power from a different generation source when the usual source has been hit by a disaster.
- **Improving efficiency of the transmission and distribution lines** can bring up to additional 25% of the currently produced power to the consumer, which can be seen as a power source in itself.
- **Improving energy efficiency in consumption:** The public sector and households consume nearly 70% of the electricity. Making consumption more energy efficient can also be seen as a full-fledged power source as it can reduce the pressure on power generation and even lead to increased power exports.
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Case Study 3: Use of Bioengineering Techniques to Strengthen the HPP Sector's Resilience to Landslides in Nepal

Summary of project outcomes

Hydropower is a major source of electricity in Nepal. Every year, Nepal faces numerous landslides due to prolonged rainfalls and snowmelts coupled with negative effects of deforestation and mining. A study was hence conducted to understand implications of climate change and related hydrology changes, and to identify climate resilience bioengineering solutions for HPP sites, considered to be cost effective.

Detailed project content

The study started with identified landslide related vulnerabilities of the HPP sector in Nepal. Spotting and evaluating risk zones through surveys and geological studies led to the conclusion that planting vegetation is a cost-effective way of increasing slope stability and hence avoiding landslides near and on HPP sites.

The study led to a number of practical conclusions:

- Geological features, soil and climatic conditions should determine the selection of suitable vegetation types. For example, altitude, slope direction and features, or type of soil influence a plant's growth speed and efficiently in stabilizing the slope. The root-soil relationship determines successful implementation of bioengineering techniques. Hence, only certain types of

plants possess characteristics suitable for bioengineering in each specific location.

- An economically feasible bioengineering technique includes the cost of materials and human resources, cost of transportation of materials and cost of project implementation itself.
- Longevity and effectiveness of a bioengineering intervention can be prolonged by effectively protecting and maintaining the vegetation over its lifecycle.

The study concluded with stressing that taking measures preventing landslides at the planning stage of an HPP is the most effective way of tackling landslide vulnerability. At present, however, a lack of guidelines and regulations for making the HPP sector landslide resilient and a lack of funds to implement preventive measures constitute major barriers.

Lessons Learned

- Climate change projections for the Kyrgyz Republic point at an increase of precipitation and an accelerated glacier melt in the near to intermediate future. Related more frequent and intense landslides and mudflows may affect the country's HPP sector. Bioengineering can be a cost-effective solution to make existing and new HPP landslide and mudflow resilient.

Figure 3: Bioengineering to prevent landslides in Nepal



Source: IUCN

Case Study 4: Adapting power lines in response to increasing temperatures in the United Kingdom

Summary of project outcomes

A timely problem identification and stakeholder engagement led to a cost-effective solution to sagging power lines as a result of an increasing temperature.

Detailed project content

The United Kingdom has been experiencing an increasing frequency of heatwaves. The UK climate projections of 2009 identified that summer temperatures would increase by up to 4°C in parts of the country under a medium emissions scenario by 2080. This increase in temperature could cause thermal expansion of power lines and create a sagging effect. Sagging lines could, in turn, pose a threat to public and infrastructure safety. In addition, it could reduce the allowable current under the existing current design standards and lead to a reduced efficiency, hence generating economic losses.

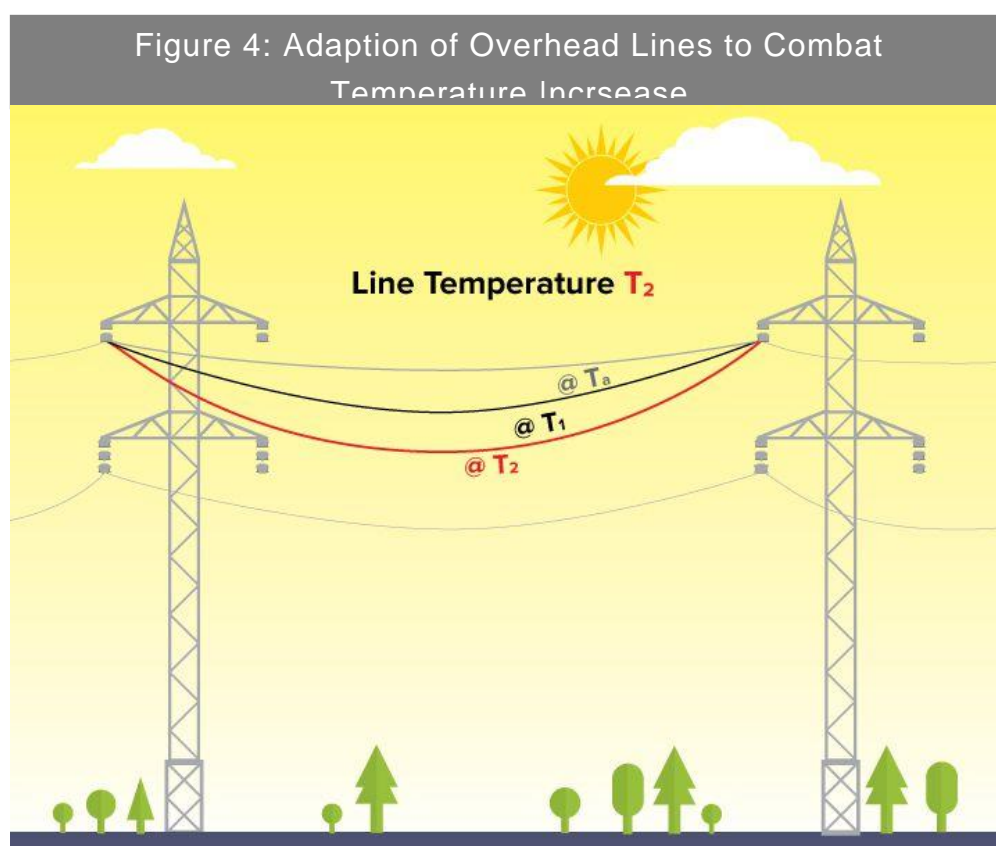
To address the potential challenge, the Western Power Distribution (WPD), a utility delivering electricity to 8 million customers throughout a 55,500 km² service area in the country, utilised outcomes of a UK Met Office's on climate change impacts on power generation, transmission, distribution, and demand. Based on this study, WPD identified that 'the

most cost-effective measure is to increase the minimum design temperature of new overhead line routes, the achievement of which would typically increase the design height of wood poles by 0.5 metres. This increased height could accommodate the projected increases in sagging without exceeding legal limits on the height of overhead lines. Through a cooperation with the Energy Network Association (ENA), WPD will be implementing the findings as an update to national standards.

Stakeholder engagement is at the core of this initiative. A designated Climate Change Adaptation Task Group facilitated discussions amongst stakeholders from the government, regulating agencies and members of network operators.

Lessons learned

- The existence of a sectoral in-depth climate change assessment significantly helps sectoral stakeholders timely act in the direction of climate resilience.
- Climate adaptation does not always result in a high additional capital cost. Often times, a smart and stakeholder engaging approach to identifying a solution lead to cost effective outcomes.



Source: Etap.com

Analyze barriers to implementing the action plan and prepare policy recommendations

- I. **Identify legal, regulatory and governance provisions** preventing activities identified in the action plan from getting implemented. Identify revision points to these provisions as well as new provisions required to support the implementation of the action plan.

As of today, a detailed climate change resilience action plan for the energy sector is not in place in the Kyrgyz Republic. At present, it is seen as a distinct topic to be managed by a dedicated body. For example, national standards regulating the detailed design of an HPP do not require taking into consideration future climate change but demand to only include past and present climate trends. As a result, detailed designs get approved without incorporating climate change into the lifecycle of a project.

- II. **Prepare a set of policy recommendations** which aim to support the implementation of the Sectoral Climate Resilience Action Plan.

Based on barriers identified under activity 4.1, identify relevant best practices and elaborate a set of policy, regulatory and governance measures which support mainstreaming of climate resilience into the energy sector. Measures which integrate climate resilience with an effective greenhouse gas emissions reduction, or climate change mitigation, should be identified in priority. For example, improving energy efficiency in Bishkek and Osh will reduce pressure on existing thermal power plants and make power delivery more stable while reducing the energy sector's carbon footprint.

As for climate adaptation recommendations, climate adaptation policy measures need to be elaborated through detailed stakeholder consultations. Policy suggestions below could be taken as a start for a discussion:

Governance and institutional set up

- **Build transparency and accountability of energy agencies:** Lack of

transparency in electricity tariff formation led to a total lack of support for a tariff increase, which the consumer does not relate to an improvement of the energy supply. Introducing transparency could in the medium run build confidence of the consumer and gradually generate their financial support so that the sector can proceed with much needed repair, maintenance and climate resilience investments.

Electricity tariffs

- **Set up a task force to develop a medium-term tariff policy.** The electricity sector was able to recover only 63% of its cost in 2016 (PEEREA, 2018). The sector has a significant debt and sizeable investment needs. The electricity tariff is a critical tool to bring health to the sector and to provide funds required for its climate adaptation. A task force could take into consideration both the sectoral situation and the socio-economic dynamic of the country and elaborate a progressive and differentiated tariff evolution. Consumers should be actively involved into the process.

Supply side management and diversifying the power mix

- **Update power supply related codes and standards mainstreaming climate change and related disaster risk parameters into them.** At present, despite the fact that most infrastructure projects in the country have a degree of climate change vulnerability, stakeholders' sensitivity to capital cost remains much higher than sensitivity to climate adaptation. National infrastructure related codes and standards do not support the latter since they require a project's detailed design to only consider past climate parameters, not future projected parameters. Incorporating future climate change parameters is however essential: both temperature and precipitation do not evolve in a linear manner in comparison with past climate change trends. Using past climate change trends alone leads to underestimating climate risk.

The country is at present benefitting from the Climate Technology Centre and

Network's support in introducing higher energy efficiency requirements into its building codes and standards. While the above work is only at its inception stage, the **process laid out for it could be applied to including climate**

adaptation to other sectoral codes and standards.

Mainstreaming Climate Adaptation into the National Building Code, Canada

Canada's National Building Code was updated in 2015. This update was taken as an opportunity to integrate anticipated **future climate parameters** and waive off a number of exceptions to **earthquake proof** building designs. To achieve this outcome, Environment Canada and the Canadian Commission on Building and Fire Codes cooperated on improving over 6,000 specific climatic design values used in the National Building Code and accordingly revised the Canadian Standards Association (CSA) standards (Jessica Boyle et al., 2013).

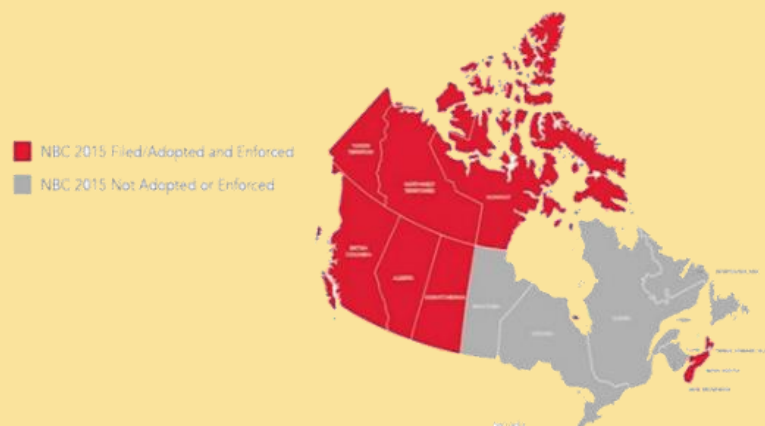
Realising that **buy-in and capacity of implementing entities** are key to reflect the revised code on the ground, the country developed a Public Guideline: Principles of Climate Adaptation and

Mitigation for Engineers in 2018. This national guideline informs engineers on why climate change adaptation and mitigation are relevant in their professional practice. The guideline consists of 11 principles that ensure sustainability and resilience of engineered systems, in particular for infrastructure and buildings (Engineers Canada, 2018).

Regional initiatives have also taken place in the country. In 2013, the Standards Council of Canada (SCC) of the Northern provinces developed the Northern Infrastructure Standardization Initiative (NISI). With federal funding support, this USD 3.5 million initiative integrated adaptation considerations into provincial codes and standards. (Jessica Boyle et al., 2013).

Figure 5: National Building Code of Canada

National Building Code of Canada (NBC) 2015 Adoption by Province/ Territory (as of June 2019)



Source: NRC Canada

Case Study 5: Écowatt Initiative

Summary of project outcomes

An increased public awareness helped prevent power cuts and increase power network resilience.

Detailed project content

In the French region of Provence-Alpes-Côte d'Azur, heating accounts for a significant portion of the demand for electricity during winters. Towards the end of 2000s, there were periods of extreme cold. Limited generation and transmission capacity could not meet the demand. This resulted in power cuts in 50% of the region.

The initial plan of new transmission lines failed due to the extreme cold and climate change.

It took the following actions to overcome the situation:

1. The Réseau de Transport d'Électricité de France (RTE) in collaboration with the government started the Ecowatt initiative. It controls electricity consumption by educating

the customers and alerting them to potentially major power cuts.

2. A website was set up. It uses color codes to indicate the current status of the electricity system:

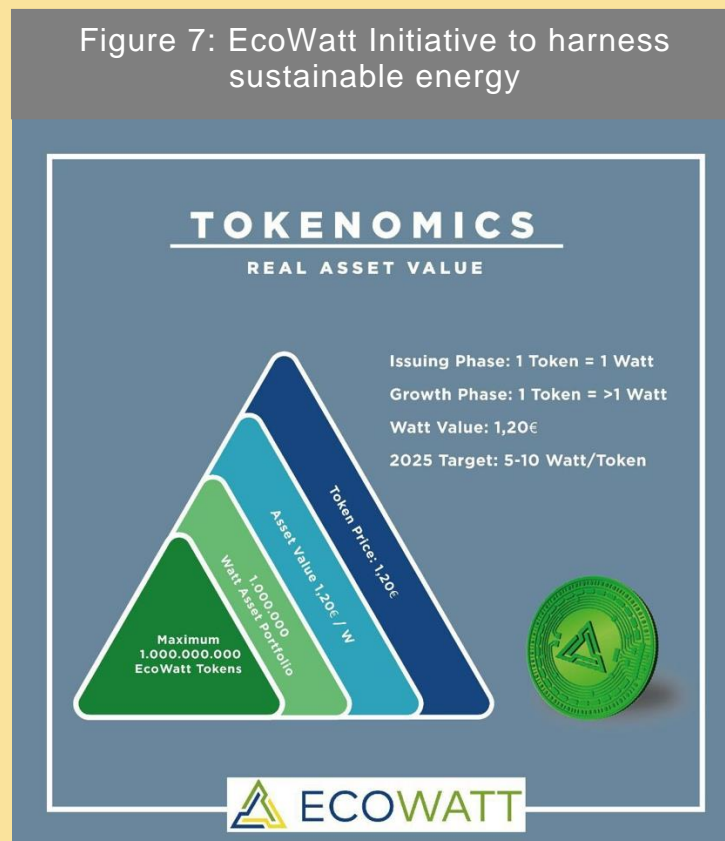
- Green: no risk of power cut
- Orange: moderate risk of power cut
- Red: high risk of power cut

3. When an orange or red situation arises, all subscribers are alerted via email, SMS, Facebook or Twitter.

Lessons learned

- Public awareness for efficient use of energy is a proven effective method to overcome power shortages.

Figure 7: EcoWatt Initiative to harness sustainable energy



Source: Medium

Case Study 6: Regulating power distribution companies' quality of services in Ecuador

Summary of the policy

The government of Ecuador introduced a regulation of the electricity services quality standards.

Detailed policy content

Article 8 of the Reglamento Sustitutivo del Reglamento de Suministro del Servicio de Electricidad (1999) defines the frequency and duration of power supply interruptions as 'quality of technical service'. Distribution companies have to comply with regulatory limits related to power cuts or shortages and to conduct regular surveys on customer satisfaction with the quality of their services. In case of non-compliance, the distribution company is fined by the regulatory agency.

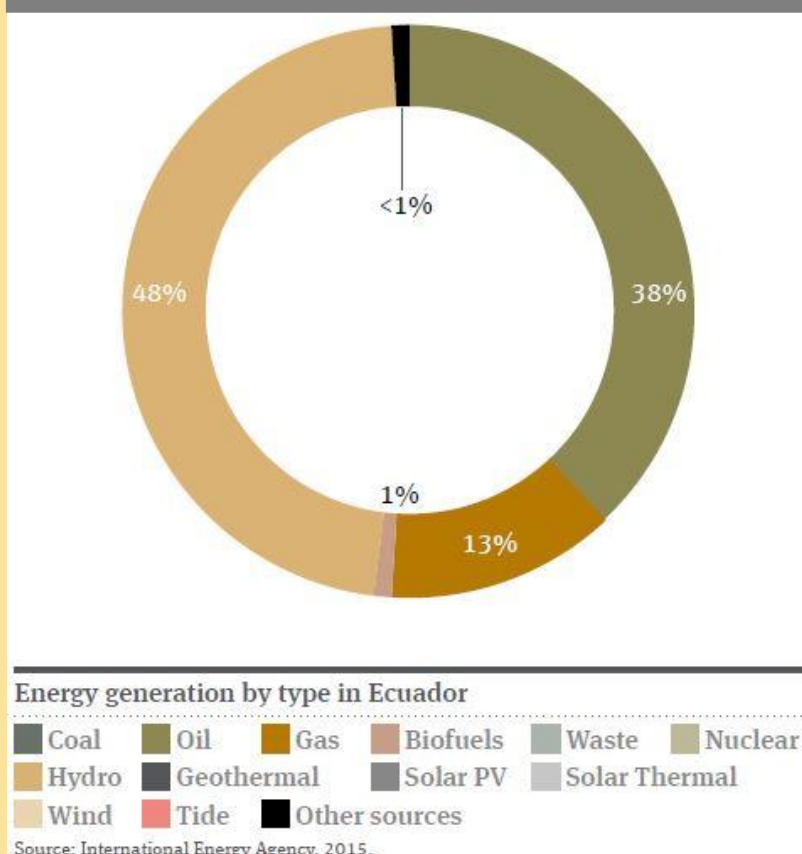
As a result of this initiative, the duration of power supply interruption decreased by 67.6 % (1,360

minutes) from 2011 to 2015, while the frequency of interruptions dropped by 59% in the same period, from 26 to 11 times per year. The average time of each interruption was 20% shorter in 2015 as compared to 2011. On average, in 2015 each consumer experienced 1 hour of interruption.

Lessons learned

- Regulating the quality-of-service delivery incites distribution companies and their suppliers to take climate resilience measures in order to avoid power shortages to the consumer.
- A regulatory mechanism and regular surveys improve reliability and transparency of the system, as well as create a better connect between the consumer and the supplier.

Figure 8: Energy generation sources in Ecuador



Source: International Energy Agency

Identify sources of finance for the priority assets' climate resilience strengthening

Once the Steps 1 to 4 are completed, the last mile connectivity to implementing the identified set of actions is to link them to finance. Indeed, often times, funds required to implement sectoral climate resilience activities are not budgeted and secured. On the other hand, climate change adaptation is increasingly supported by international financial institutions such as the Adaptation Fund, the Global Environment Facility (GEF) or the Green Climate Fund (GCF). These institutions are mandated to support projects which set climate change adaptation benchmarks at the national level and generate tangible climate adaptation benefits for the beneficiary country. In addition, policies of most multilateral and bilateral development banks as well as a large number of post COVID-19 recovery opportunities are connected to a green recovery.

During COP26, Japan pledged an additional 2 billion per year for the next five years, and Italy pledged an extra \$1.4 billion per year to help developing countries adapt to climate change

impacts. Projects increasing sectoral infrastructural climate resilience can hence tap into the internationally available climate finance and set a benchmark for their respective sectors. Steps 1 to 4 are therefore highly likely to unlock access to climate finance for the country. Step 5 focuses on identifying most suitable sources of climate finance and unlocking this funding opportunity for the country.

Climate finance can be regarded as one of the sources channeling the required investments into the country while making the sector climate resilient. Step 5.1 consists in identifying the most suitable climate financial entities to submit the three projects aiming to enhancing climate resilience of the 3 priority energy assets identified under activity 1.3. These entities would belong to the following categories:

- Financial institutions dedicated to climate finance;
- Multilateral and bilateral development banks;
- National governmental mechanisms when available;
- National private sector mechanisms when available.

Conclusion

The present report identified a number of generic structural and non-structural climate resilience measures relevant for the energy sector in Kyrgyzstan. It outlined a 5-step approach, which will assist the country in understanding sectoral climate vulnerabilities in detail, identifying priority assets at high risk, increasing climate resilience of these assets and identifying key barriers to a successful climate change adaptation of the energy sector. Undertaking these steps will allow Kyrgyzstan to identify key local challenges to address through implementing pilot projects, to prepare a national energy climate resilience framework and to unlock existing climate finance and green recovery funding opportunities.

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