

Climate Change and Energy Vulnerability Country dashboard – Quick View

Zambia - Draft

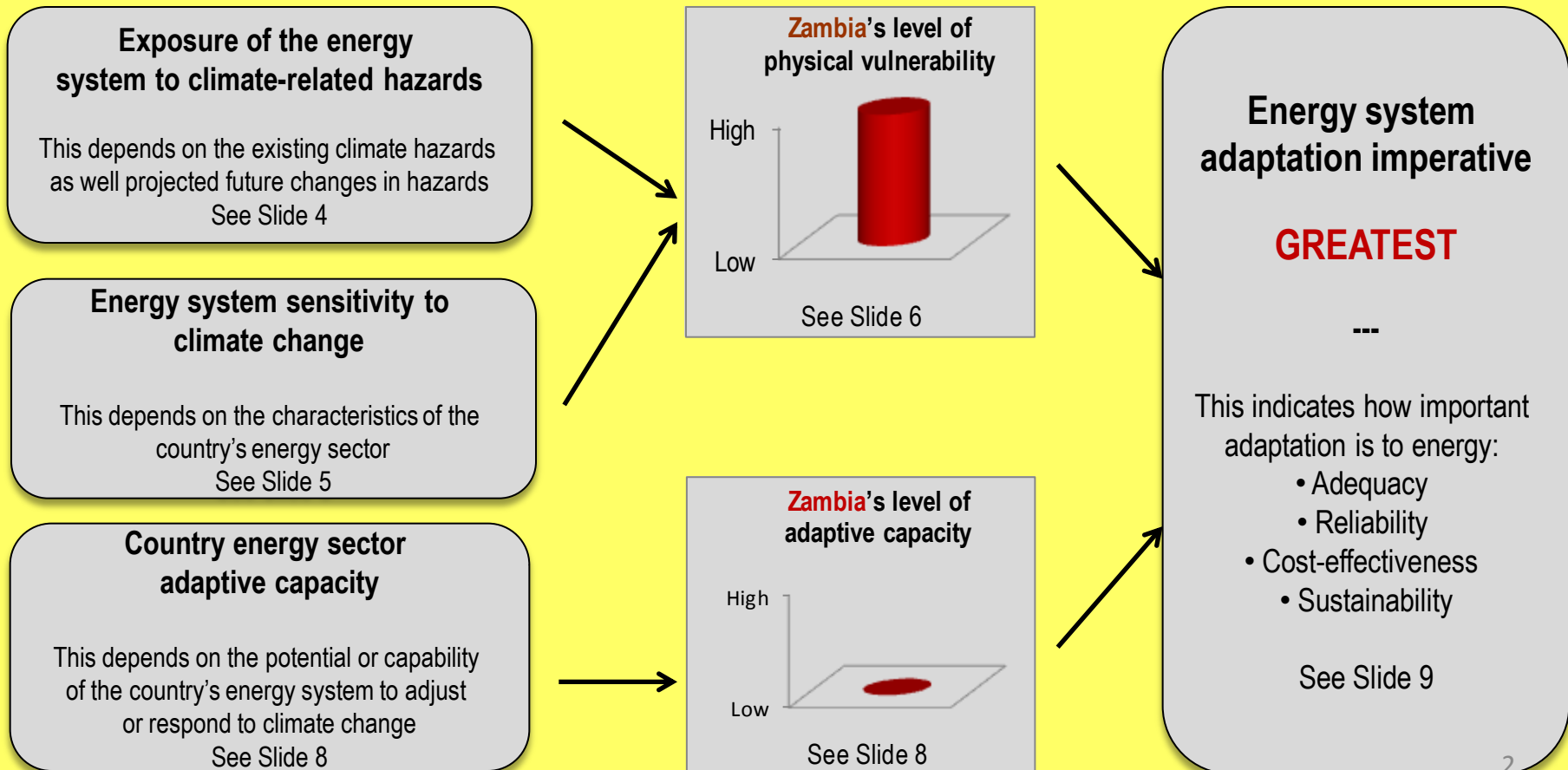
21 September 2012



Quick View Diagnostic

Zambia

The answers to the Quick View process generated scores for the country's energy sector on three interconnected dimensions: 1) Overall physical vulnerability of the energy sector; 2) Country and sectoral adaptive capacity; and 3) Imperative to adapt the energy sector. The results are summarized in the figure below and described in further detail in later slides.



Energy Sector Overview

An overview of the country's energy sector is important to understand the context within which climate-related risks will be experienced and how country vulnerability will be assessed.

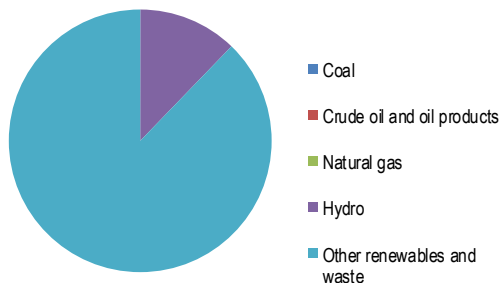
Key indicators in 2009 (IEA, 2012)

Total energy production (TEP)	7.2 Mtoe
Total primary energy supply (TPES)	7.9 Mtoe
Energy exports as a percentage of TEP	0.1%
Total final consumption (TFC)	6 Mtoe
Energy supply losses as a percentage of TPES	2.6%

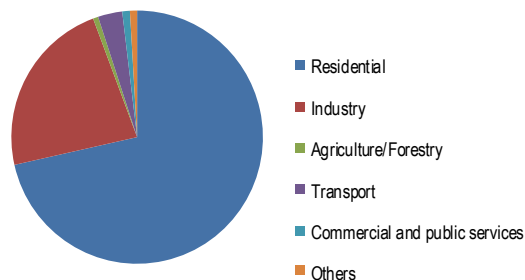
Key recent trends

- With the exception of petroleum, Zambia is self-sufficient in all its energy sources.
- Volume of imports of crude oil for petroleum products from South Africa has declined during recent years due to poor economic performance.
- Zambia used to be a large regional electricity exporter but exports have been curtailed in recent years due to rehabilitation work on existing power stations (Stenek, et al. 2011).
- There is increased demand due to economic development in residential and industrial sectors. The mining industry is the major consumer of electricity, accounting for about 60% (IFC, 2011).

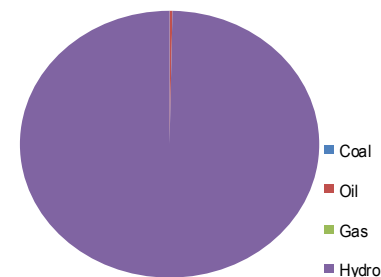
Energy production (ktoe) in 2009
(Source: IEA, 2012)



Final energy consumption (ktoe) by sector in 2009
(Source: IEA, 2012)



Electricity output (GWh) in 2009
(Source: IEA, 2012)



Exposure to Climate-related Hazards Part 1

Zambia

Observed climate-related hazards (country-level). Source: EM-DAT.

Hazard	Present-day average number of disasters per year	Estimated economic impact in 1990-2012 (in thousand USD)
Storms	-	-
<i>Yes if the country is affected by tropical cyclone footprints (World Bank Knowledge Portal)</i>		
Flood	0.6*	20,700
<i>Yes if floods exceed or are equal to 10% of the annual number of natural disasters (World Bank Knowledge Portal)</i>		
Mass movement	Very small number reported	-
<i>Yes if landslides exceed or are equal to 10% of the annual number of natural disasters (World Bank Knowledge Portal)</i>		
Drought	0.1**	-
<i>Yes if droughts exceed or are equal to 10% of the annual number of natural disasters (World Bank Knowledge Portal)</i>		
Wildfire	-	-
<i>Yes if wildfires exceed or are equal to 10% of the annual number of natural disasters (World Bank Knowledge Portal)</i>		

Country energy sector present-day exposure
NO
YES
NO
YES
NO

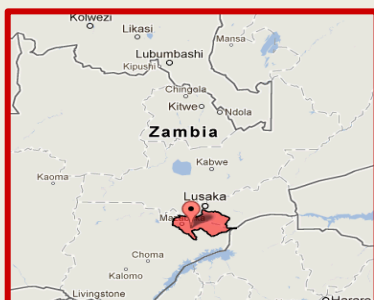
*The World Bank Knowledge Portal represent 5% but EM-DAT data provide an average of 0.6 floods per year. This implies that the frequency is higher for floods than droughts in the country.

** There is limited data on the economic impacts of droughts in Zambia (based on EM-DAT data).

Exposure to Climate-related Hazards Part 2

Zambia

Projections for changes in key climate-related indicators by the 2050s: Annual average change (%) for one or more river basin units and for greenhouse gas emission scenario A2 (high). Map(s) showing the river basin(s) concerned can be found below. Source: World Bank Climate Change Knowledge Portal. To see projections for each climate model and per river basin click [here](#).



Indicators (Envelope of GCM ensemble) (A2)	Basin No5841 near Chipsta, Zambezi (top map)	Basin No5856 near Lusaka, Zambezi (middle map)	Basin No5858 near Lusaka, Zambezi (bottom map)
Annual precipitation change	-6.6%/ +18.2%	-19.1%/ +24.3%	-16%/+15.1%
<i>'Increase' or 'Decrease' if at least 70% out of the available GCMs project an increase or decrease in annual average rainfall exceeding 5% respectively; 'No change' refers to cases where at least 70% of models project a small change (between -5% and +5%); and 'Uncertain' refers to cases where fewer than 70% models agree (World Bank Knowledge Portal).</i>			
Mean annual runoff change	-21.7%/ +38.1%	-22.3%/ +24.4%	-19.1%/+13.4%
<i>'Increase' or 'Decrease' if at least 70% out of the available GCMs project an increase or decrease in annual average runoff exceeding 5% respectively; 'No change' refers to cases where at least 70% of models project a small change (between -5% and +5%); and 'Uncertain' refers to cases where fewer than 70% models agree (World Bank Knowledge Portal).</i>			
Drought (low river flows)	-14.2%/ +45.9	-28%/ +28.7	-15.8%/+10.8%
<i>'Increase' or 'Decrease' if at least 70% out of the available GCMs project an increase or decrease in droughts exceeding 5% respectively; 'No change' refers to cases where at least 70% of models project a small change (between -5% and +5%); and 'Uncertain' refers to cases where fewer than 70% models agree (World Bank Knowledge Portal).</i>			
Flood (high river flows)	-28.3%/ +25.1%	-19%/+20.5%	-22.9%/ +16.2%
<i>'Increase' or 'Decrease' if at least 70% out of the available GCMs project an increase or decrease in floods exceeding 5% respectively; 'No change' refers to cases where at least 70% of models project a small change (between -5% and +5%); and 'Uncertain' refers to cases where fewer than 70% models agree (World Bank Knowledge Portal).</i>			

Country energy sector exposure by the 2050s
Uncertain
Uncertain
Uncertain
Uncertain

Energy System Sensitivity to Climate Change

Zambia

The following table shows areas of climate change sensitivity (in red and orange) in the country's energy system. Orange, white and green represent aspects where there is uncertainty, no obvious sensitivity or opportunity respectively.

Indicators of energy system sensitivity to climate-related changes	Responses and scores
Energy system-level concerns	
Energy sector water intensity	Yes
Energy supply efficiency	High
Country energy intensity	No
Fossil fuel resource extraction and processing	
Presence of coastal, offshore or inland extraction/processing plants prone to flooding and storms	No
Presence of processing plants in water-stressed areas	No
Energy supply	
Contribution of hydropower to power supply	Yes
Contribution of small reservoirs or run-of-the-river plants to total hydropower output	No
Contribution of thermoelectric facilities to power supply	No
Contribution of thermal power plants with open-circuit cooling to total thermoelectric output	Low
Contribution of woodfuel to household cooking	Yes
Power transmission & distribution and fuel transport	
Energy imports via climatically-sensitive routes over long distances	Yes
Proportion of transmission lines crossing areas vulnerable to extreme weather or unstable land	No
Energy demand	
Reserve margin adequate to respond to unusually high demand	Yes

Physical Vulnerability of Energy System to Climate Change

Zambia

It is the combination of responses on the 'Exposure of the energy system to climate-related hazards' (Slide 4) and 'Energy system sensitivity to climate change' questions (Slide 5) that gives physical vulnerability scores for each element of the energy service chain. The bar charts below represent the percentage of combinations where a vulnerability was identified. For further information on the indicators used to assess physical vulnerability, refer to the Rapid Assessment process document by clicking [here](#).

Energy service chain	Physical vulnerability scores
Energy system-level concerns <i>Percent out of 21 possible areas of climate change vulnerability*</i>	<p>A horizontal bar chart with a scale from 0 to 100. The bar extends to the 25 mark, representing 25% vulnerability.</p>
Fossil fuel resource extraction and processing <i>Percent out of 11 possible areas of climate change vulnerability*</i>	<p>A horizontal bar chart with a scale from 0 to 100. The bar extends to the 18 mark, representing 18% vulnerability.</p>
Energy supply <i>Percent out of 39 possible areas of climate change vulnerability*</i>	<p>A horizontal bar chart with a scale from 0 to 100. The bar extends to the 28 mark, representing 28% vulnerability.</p>
Power transmission & distribution and fuel transport <i>Percent out of 18 possible areas of climate change vulnerability*</i>	<p>A horizontal bar chart with a scale from 0 to 100. The bar extends to the 15 mark, representing 15% vulnerability.</p>
Energy demand <i>Percent out of 9 possible areas of climate change vulnerability*</i>	<p>A horizontal bar chart with a scale from 0 to 100. The bar is at 0, representing 0% vulnerability.</p>

* The number of possible areas of climate change vulnerability varies according to the degrees of complexity and sensitivity to climatic parameters of each element of the energy service chain. For example, energy supply is overall more sensitive to climate, and the interactions between climatic parameters and different modes of energy generation are more complex than in the case of fossil fuel resource extraction and processing.

Physical Vulnerability Example

Zambia

Recently, Zambia has been negatively affected by droughts and floods. For instance, the country has had to endure droughts in the rainy seasons of 2000/01, 2001/02 and 2004/05 while floods have occurred in 2005/06 and 2006/07 (Republic of Zambia, 2007).

Due to the dependency of the water and energy sector on hydro-electricity power (e.g. Kariba dam and Kafue gorge), the droughts led to reduction in hydropower generation with significant economic reduction in the power potential (CEEEZ, 2007).

Similarly, the country has been negatively affected by floods, which occurred during the rainy seasons of 2006/2007, 2007/2008, and 2008/2009.

For example, the 2008/2009 rainy season included flooding in the Northern, North Western, and Western Provinces, primarily impacting infrastructure (e.g. roads, water/sanitation services) and food security (DMMU, 2009).

In 2005, a mudslide event caused \$1.66 million (USD) in losses to the Kafue Gorge Upper plant, including: lost power revenue of \$1.0 million USD and labor, civil works costs, and electrical and mechanical materials (IFC, 2011).

Energy Sector Adaptive Capacity

Zambia

The following table shows the contribution of a number of factors to the country's energy sector adaptive capacity. Green, orange and red indicate positive, uncertain or negative contributions respectively. For further information on the indicators used to assess energy sector adaptive capacity, refer to the Rapid Assessment process document by clicking [here](#).

Adaptive capacity factors	Indicators	Responses and scores
Economic	Level of investment in the country <i>High if Gross Fixed Capital Formation (GFCF) is higher or equal to 30% of GDP</i>	Low
Technical	Aging power generation assets and infrastructure <i>Yes if average age of the country's power generation assets is more or equal to 20 years</i>	Unknown
	Overall quality of country energy assets and infrastructure <i>High if average annual number of power cut events is lower than 100</i>	Low
	Strong reliance on one form of power generation <i>Yes if 50% or more of the country's power supply comes from one single form of generation</i>	Yes
	Member of a regional grid system <i>Yes if country's power system is part of a transboundary and regional power grid system</i>	Yes
	Presence of an interconnected network system <i>Yes if customers are connected to several points of power supply rather than to a single point or a loop</i>	Unknown
Institutional and informational	Good level of knowledge of location of country's energy assets <i>Yes if there is geographic information (e.g. maps) available in government or World Bank publications</i>	Yes
	Availability of good quality data on observed climate, climate-related hazards <i>Yes if observed climate datasets are available in digital, short-time intervals, high spatial resolution formats, and for long baseline periods</i>	No
	Good level of knowledge on adaptation of energy sector, and evidence of good intra-government linkages on adaptation issues <i>Yes if level of knowledge and inter-government linkages are good based on expert knowledge</i>	No
Environmental & social	Priority water rights over other sectors <i>Yes if government or World Bank publications indicate that energy has priority over other sectors for water</i>	No
	Strong country disaster risk management and reduction <i>Yes if country has strong mechanisms in place to deal with increased extreme weather events based on expert knowledge</i>	No ⁹

Energy System Adaptation Imperative

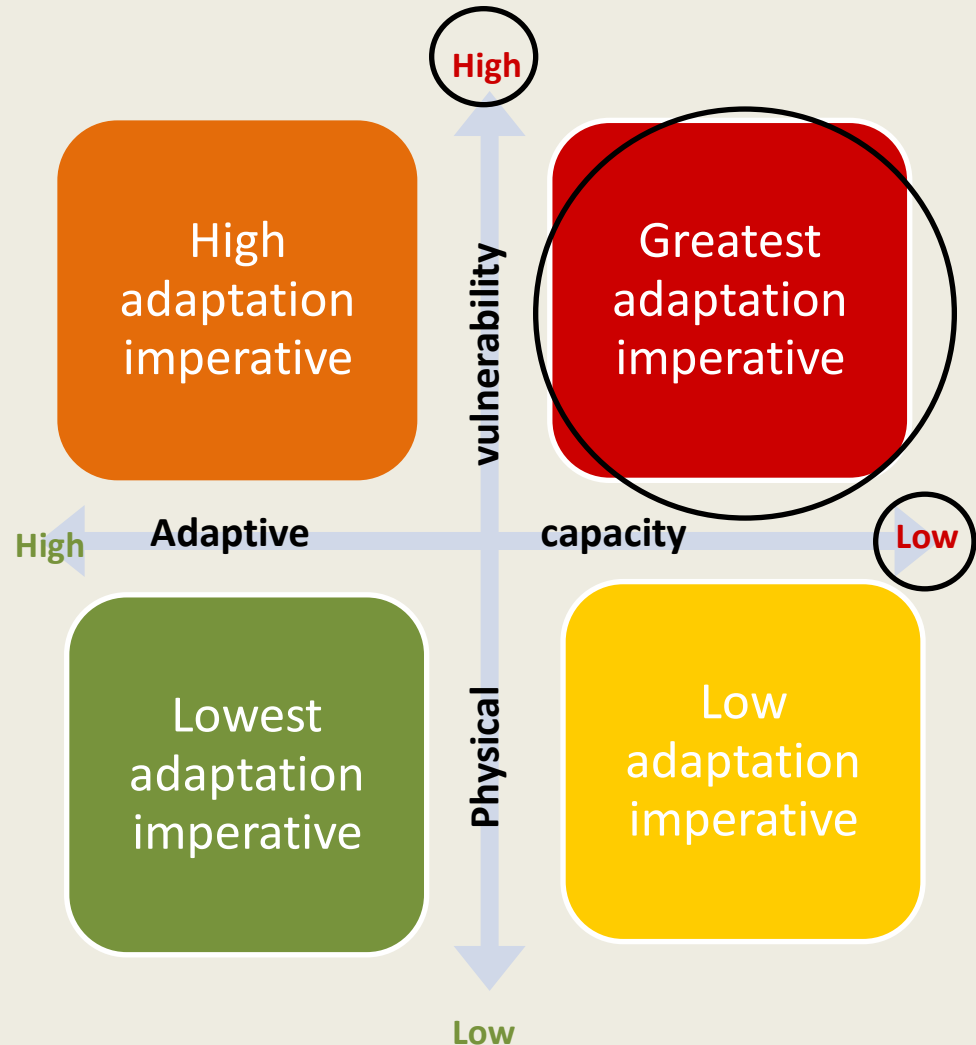
Zambia

As shown in the diagram on the right, **Zambia's** energy system has **the greatest** adaptation imperative due to the combination of:

- **High** physical vulnerability to climate change (see Slide 6).
- **Low** adaptive capacity (see Slide 8).

This result means that the country has a strong need for assistance to build adaptive capacity, define and implement adaptation measures to reduce vulnerability to climate change impacts, and exploit opportunities within the country's energy system.

Some actions are already underway in different areas of the energy service chain in Vietnam which help to build climate resilience. Due to climate change, the imperative for these actions is increased. This is further described in the following slides.



High-level Adaptations Options 1/2

Zambia

The following 2 tables show a typology of actions which provide the building blocks for an energy sector adaptation action plan. This involves:

- 1. Building the adaptive capacity of the energy sector:** Data collection, analysis and monitoring, and research on climate-related impacts in the energy sector; changing or developing regulations, tariffs, standards, codes etc.; awareness-raising and organizational development; and working in partnership.
- 2. Delivering adaptation on the ground:** Accept impacts and bear (some) loss; spread/share impacts; avoid negative impacts; and exploit opportunities.

Examples of actions to build adaptive capacity

Responsible body	Type of action	•Actions to strengthen standard and existing energy policy and measures	•New actions
Ministries of energy and finance	Data collection and monitoring, awareness rising and organizational development, working in partnership		<ul style="list-style-type: none"> •Enhance cooperation under the Southern African Power Pool (SAPP) to increase electricity exports to surrounding countries (and hence revenue) and to improve regional climate resilience and energy security •Deliver awareness-raising to all relevant organizations involved in the management, operation, regulation and funding of energy (including the NEA, IPPs and other relevant stakeholders)
	Changing or developing regulations, tariffs, standards, codes etc.	•ZESCO's electricity metering programme helps manage consumer demand	<ul style="list-style-type: none"> • Incorporate robustness to climate change and variability in design codes, procurement rules, and site selection and environmental impact assessment obligations • The Energy Regulation Board to encourage (e.g. via changes in tariffs) private investment in hydropower generation with a view to decreasing the ongoing power deficit
Utilities	Research and analysis		•ZESCO to enhance research and monitoring of the relationships between climate-related factors and the performance of hydropower assets, in collaboration with hydromet
	Data collection and monitoring		<ul style="list-style-type: none"> • ZESCO to design an asset management plan for hydropower plants taking account of climate change • ZESCO to monitor the impacts of climate change on energy asset performance
	Changing or developing regulations, tariffs, standards, codes etc		<ul style="list-style-type: none"> • ZESCO to review design standards of existing assets against climate change projections (e.g. spillway capacity of hydropower plants, waste water storage of thermoelectric plants, groundwater heave/buoyancy of pipelines, etc.) • ZESCO to review risks and safety standards of existing plants against climate change projections (e.g. fire, pollution control, etc.)
Hydromet office	Research and analysis		•Develop higher resolution climate change projections

Examples of actions to deliver adaptation

Responsible body	Type of action	Actions to strengthen standard and existing energy policy and measures	New actions
Ministries of energy and finance	Avoid negative impacts and spread / share /transfer impacts	<ul style="list-style-type: none"> The Rural Electrification Authority's Solar Energy, Mini-Hydro Power, and Grid Extension Programmes help to address energy security in rural areas and diversify generation assets 	<ul style="list-style-type: none"> Increase hydropower installed capacity, ensuring that new facilities are designed to cope with changing climate Develop and implement an energy diversification plan that increases the resilience of the current and future energy mix to the impacts of extreme events and peak demands Continue to promote renewable energy sources (wind, solar energy) to reduce the dependency on imported fossil fuels
Utilities	Avoid negative impacts	<ul style="list-style-type: none"> ZESCO's \$240 million 'Power Rehabilitation Project' aims to alleviate power shortages TAZAMA Pipeline Limited is replacing weak sections of the pipeline conveying crude oil to the INDENI refinery 	<ul style="list-style-type: none"> ZESCO to explore the use of pure or combined pumped storage electricity generation to cope with high demand peaks and periods of excess generation capacity (IFC, 2011) ZESCO to invest in additional hydropower plants to address the ongoing generation deficit and cope with increased hydrological variability due to a changing climate
	Spread / share /transfer impacts	<ul style="list-style-type: none"> Expansion of the national grid to the eastern province improves energy security, as does interconnection of Zambia's Chama district with Malawi's grid 	<ul style="list-style-type: none"> ZESCO to investigate weather insurance for its application to energy sector risk management
	Exploit opportunities	<ul style="list-style-type: none"> There are planned new hydro (Kafue Gorge Lower, Kariba North Bank, Itezhi-tezhi) and coal-fired (Maamba) electricity generation facilities (ERB, 2010) 	<ul style="list-style-type: none"> ZESCO to ensure investments in new energy assets (e.g. under the Rural Electrification Authority's programmes listed above) are climate resilient
Other stakeholders	Avoid negative impacts and exploit opportunities	<ul style="list-style-type: none"> Ramp up efforts to improve water efficiency 	<ul style="list-style-type: none"> Exploit opportunities for new engineering technologies that build resilience to climate change

Adaptive capacity: Potential or capability of a system to adjust or respond to climate change (IPCC, 2001).

Energy supply losses: Losses incurred between total primary energy supply and final use (TPES-TFC) as a percentage of total primary energy supply (IEA, 2011).

Exposure: Nature and degree of climate stress upon a system; it may include long-term changes in climate conditions, as well as changes in climate variability (IPCC, 2001).

Gross Domestic Product (GDP): Value of all final goods and services produced in a country in one year (World Bank, 2011a).

Metocean: Commonly used in the energy sector to refer to the ensemble of meteorological and oceanographic variables that characterize the physical environment of an asset or a project.

Physical vulnerability: Combination of sensitivity and exposure to climate change of a system; it corresponds to the biophysical effect of climate change on a system (Raleigh et al., 2008).

Reserve margin: Ratio of the difference between installed capacity and annual peak demand to the annual peak demand (World Bank, 2011a).

Sensitivity: Degree to which a system will be affected by or responsive to a change in a climate-related variable. (IPCC, 2001).

Total Energy Production (TEP): Sum of energy production (coal, crude oil and oil products, gas, nuclear, hydro, geothermal, solar, combustible renewables and waste, and others) (IEA, 2011).

Total Final Consumption (TFC): Sum of energy consumption by different end users (industry, transport, residential, commercial and public services, agriculture and forestry, and others) (IEA, 2011).

Total Primary Energy Supply (TPES): Total energy produced and imported minus energy exports and changes in energy stocks (IEA, 2011).

Vulnerability: Degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change (IPCC, 2001).

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