Climate Change and Energy Vulnerability Country dashboard – Quick View

Nepal - Draft

21 September 2012

Quick View Diagnostic

Nepal

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.

Exposure of the energy system to climate-related hazards

This depends on the existing climate hazards as well projected future changes in hazards
See Slide 4

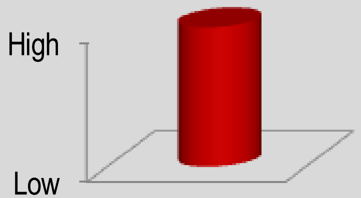
Energy system sensitivity to climate change

This depends on the characteristics of the country's energy sector
See Slide 5

Country energy sector adaptive capacity

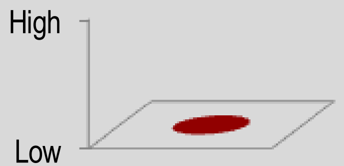
This depends on the potential or capability of the country's energy system to adjust or respond to climate change
See Slide 8

Nepal's level of physical vulnerability



See Slide 6

Nepal's level of adaptive capacity



See Slide 8

Energy system adaptation imperative

GREATEST

This indicates how important adaptation is to energy:

- Adequacy
- Reliability
- Cost-effectiveness
- Sustainability

See Slide 9

Energy Sector Overview

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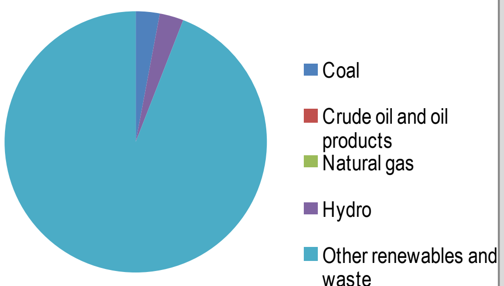
An overview of the country's energy sector is important to understand the context within which climate-related risks will be experienced and how country vulnerability will be assessed.

Key indicators in 2009 (IEA, 2012)	
Total energy production (TEP)	10 Mtoe
Total primary energy supply (TPES)	8.8 Mtoe
Energy exports as a percentage of TEP	0.1%
Total final consumption (TFC)	9.9 Mtoe
Energy supply losses	26.8%

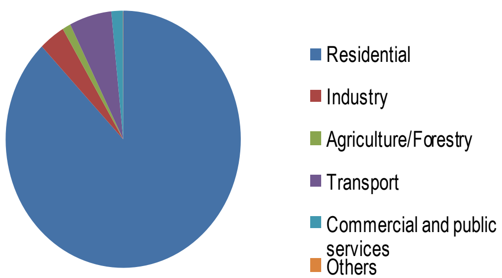
Key recent trends

- High annual electricity demand growth of 9- 10% (ADB, 2010)
- Largely unexploited hydro electricity potential but increasing investment in the sector to meet domestic demand and export to India (WECS, 2010)

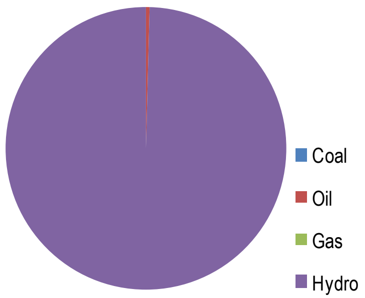
Energy production (ktoe) in 2009 (Source: IEA, 2012)



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

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Observed climate-related hazards (country-level). Source: EM-DAT. For more information see the Nepal Country Adaptation Profile here.

Hazard	Present-day average number of disasters per year	Estimated economic impact in 1990-2012 (in thousand USD)	Country energy sector present-day exposure
Flood	1.1	298,300	Yes
Yes if floods exceed or are equal to 10% of the annual number of natural disasters (World Bank Knowledge Portal)			
Storms	Very small number reported	-	No
Yes if the country is affected by tropical cyclone footprints (World Bank Knowledge Portal)			
Mass movement	0.5	-	Yes
Yes if landslides exceed or are equal to 10% of the annual number of natural disasters (World Bank Knowledge Portal)			
Drought	Very small number reported	-	No
Yes if droughts exceed or are equal to 10% of the annual number of natural disasters (World Bank Knowledge Portal)			
Wildfire	Very small number reported	6,200	No
Yes if wildfires exceed or are equal to 10% of the annual number of natural disasters (World Bank Knowledge Portal)			

Exposure to Climate-related Hazards Part 2

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Projections for changes in key climate-related indicators by the 2050s: Annual average change (%) for one or more river basin units 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 No54 near Dharan, Ganges (top map)	Basin No 76 near Kathmandu, Ganges (middle map)	Basin No96 near Birendranagar, Ganges (bottom map)	Country energy sector exposure by the 2050s
Annual precipitation change	-8.5%/+23.8%	- 11.9% /+22.9%	-20.7%/+26.4%	**Uncertain**
'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).				
Mean annual runoff change	-17.1/+64.9%	- 19.2% /+69.7%	-21.6%/+26.7%	**Uncertain**
'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).				
Drought (low river flows) change	-22.1/+100	- 26.6% /+64%	-23.6%/+36.5%	**Uncertain**
'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).				
Flood (high river flows) change	-15.1/+41.7	- 14.1% /+42.8%	-15.1%/+23.6%	**Uncertain**
'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).				

Energy System Sensitivity to Climate Change

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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 sector water intensity	No
Energy supply efficiency	Low
Country energy intensity	Yes
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	Considerable
Contribution of small reservoirs or run-of-the-river plants to total hydropower output	Considerable
Contribution of thermoelectric facilities to power supply	Small
Contribution of thermal power plants with open-circuit cooling to total thermoelectric output	-
Contribution of woodfuel to household cooking	Considerable
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	Unknown
Energy demand	
Reserve margin adequate to respond to unusually high demand	No

Physical Vulnerability of Energy System to Climate Change

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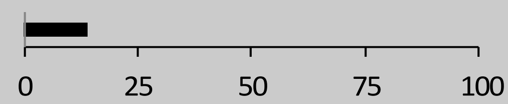
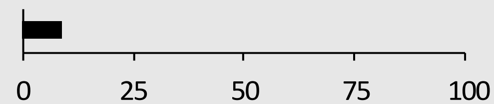
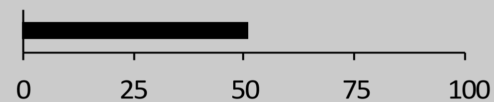
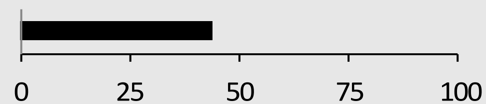
It is the combination of responses on the 'Exposure of the energy system to climate-related hazards' (Slide 4) and 'Energy system sensitivity to climate change' questions (Slide 5) that gives physical vulnerability scores for each element of the energy service chain. The bar charts below represent the 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 *Percent out of 21 possible areas of climate change vulnerability**	
Fossil fuel resource extraction and processing *Percent out of 11 possible areas of climate change vulnerability**	
Energy supply *Percent out of 39 possible areas of climate change vulnerability**	
Power transmission & distribution and fuel transport *Percent out of 18 possible areas of climate change vulnerability**	
Energy demand *Percent out of 9 possible areas of climate change vulnerability**	

* 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

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In recent years, Nepal has experienced power shortages due to the high-dependence of the country's hydropower production on run-of-the-river plants. All but 92 MW of Nepal's hydropower is from run-of-river schemes with small daily pond storage (WECS, 2005).

For instance, in 2007- 2008 annual peak power supply demand was 640/542 MW and 720/308 MW in the wet and dry seasons respectively, resulting into load shedding of above 30 hours a week (WECS, 2010). Load shedding mainly due to electricity supply deficit is expected to continue until at least 2013/14 (NEA, 2011).

During the 2008- 2009 drought Kathmandu experienced power cuts lasting up to 16 hours per day (WFP, 2009).

A 1981 Glacial Lake Outburst Flooding (GLOF) was estimated to have a peak discharge of 16,000 m3/ sec at the source. The vent led to closing the China- Nepal highway for one year, destroyed the Friendship Bridge and modified the river for 30 km downstream (Shardul et al., 2003).

In 2001, over 3,252 glaciers, 2,323 glacial lakes and 20 potential GLOF sites were referenced (ICIMOD and UNEP, 2002). Current trends show an increase in lake volume and all the evidence suggest GLOF risk is expected to increase in magnitude and frequency due to that increasing temperatures on account of climate change (Shardul et al., 2003).

Energy Sector Adaptive Capacity

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

Energy System Adaptation Imperative

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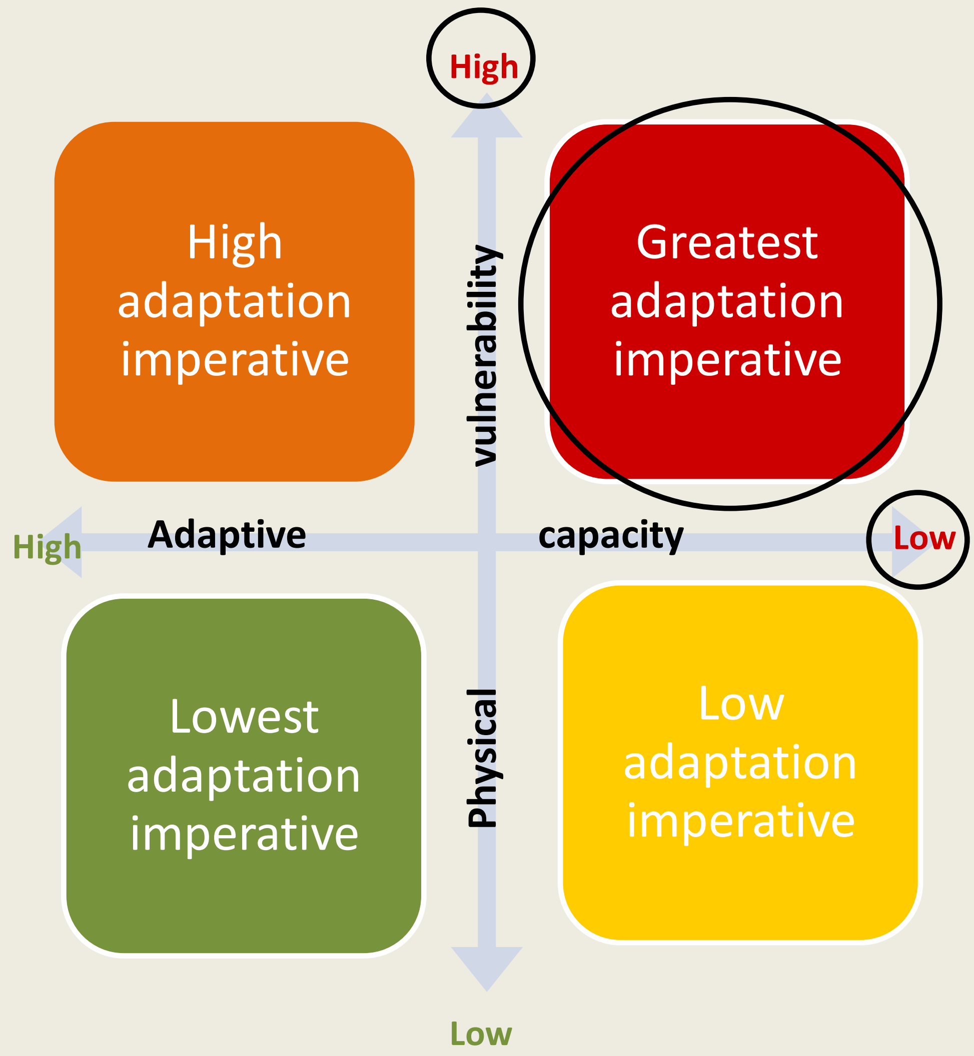
As shown in the diagram on the right, Nepal's energy system has the greatest adaptation imperative due to the combination of:

- 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

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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	• In the Tsho Rolpa Glacier Lake, an early warning system, consisting of sensors located downstream of the end moraine and connected to 19 downstream stations equipped with audible alarms, was put in place in 1998 but is currently non operational.	• Enhance GFOL early warning systems • Deliver awareness-raising to all relevant organisations involved in the management, operation, regulation and funding of energy (including the NEA, IPPs and all relevant other stakeholders) • Strengthen/develop partnership agreements between the NEA and major IPPs, the hydromet office and major energy users to facilitate increased access to energy-related statistical data and analyze them in the context of climate change
	Changing or developing regulations, tariffs, standards, codes etc.		• Introduce cost-based mechanisms for setting both wholesale and retail tariffs and other incentives to promote energy resilience to climate change •Incentivize international and domestic private sector investment in hydropower production, e.g. removal of mandatory requirement s that all power generated by private companies is sold to Nepal under their system of PPAs, • Reduce the monopoly of the NEA to promote greater market competitiveness, e.g. enacting the Hydropower Development Policy and the Electricity Act (1992) and Electricity Regulations (1993) (ADB, 2009)
Utilities	Research and analysis	• In 2000, a risk assessment requested by the NEA and completed at Tsho Rolpa (IFC, 2011). Based on preliminary assessment, a further lowering of 1.5m is required.	• Conduct detailed flood risk assessments of all energy generation, transmission and supply infrastructure and associated facilities • Map out GLOF risks to hydropower plants and explore potential adaptation options , e.g. relocation, drainage of the lake)
	Data collection and monitoring		• Develop an asset management plan for each of the hydropower plants, their performance and operation and climate change vulnerability
Hydromet office	Research and analysis		• Further monitoring and research on baseline conditions, e.g. hydrology • Develop higher resolution climate change projections on rainfall and monsoon

High-level Adaptations Options 2/2

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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 exploit opportunities	• The National Planning Commission's long term plan aims by 2027 to : - Generate 4,000 MW of power through hydro-electicity to meet domestic demand; - Cover 20% of the population through isolated small and micro-hydropower systems and 5% of the population through alternative energy sources (ADB, 2009).	• Increase storage capacity to address over dependency on run-of-the-river plants highly vulnerable to seasonal variability and long-tern changes in river runoff • Increase hydropower installed capacity, ensuring that new facilities are designed to cope with changing climate • Develop and implement an energy diversification plan that increases increase 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	• Existing engineering mechanisms to generate electricity more efficiently, e.g. coping with streamflow fluctuation as a result of current seasonal and climate variability (Shardul et. al. 2003) • Plants with 3 in-take channels and turbines. During dry season one or more in-take channels are shut off and therefore, avoid losses due to excess capacity (Shardul et. al. 2003)	• The NEA to identify key hydropower plants most at risk from key climate hazards, e.g. GFOLs, floods and landslides and plan proactively for actions be needed to make them climate change-resilient. • The NEA to develop available options and explore the economic benefits of designing hydropower plants resilient to future lowered capacity due to climate change
	Spread / share impacts		• Diversify the locations of new hydropower assets to avoid concentrating assets in locations at high risk of climate impacts. (For instance, locations most affected by flood risk or GLOFs near glacial lakes)
	Exploit opportunities	• Hydro identified as a priority export commodity . Approximate forecasts of 100 MW by 2012, 450 MW by 2017, and 700 MW by 2027 (Hosterman et al., 2009) • 3 Indo-Nepal Cross border Transmission Interconnections are under construction (USAID, 2012) • The National Planning Commission's long term plan aims by 2027 to expand electricity services to cover 75% of the population through the national grid (ADB, 2009)	• The NEA/ PCNC to devise new transmission systems connecting to India ensuring they are protected against severe weather • The NEA and Butwal Power Company to design and implement a climate resilient rural electrification programme increasing access to affordable and sustainable electricity

Definitions

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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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Nepal

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