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Building Climate Resilience into Hydro Power Sector in Nepal: Challenges and Prospects

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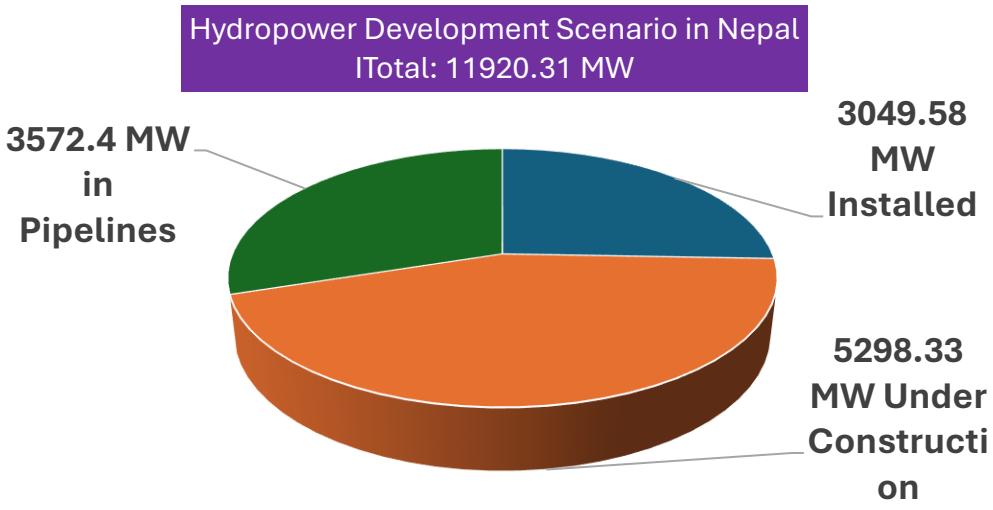
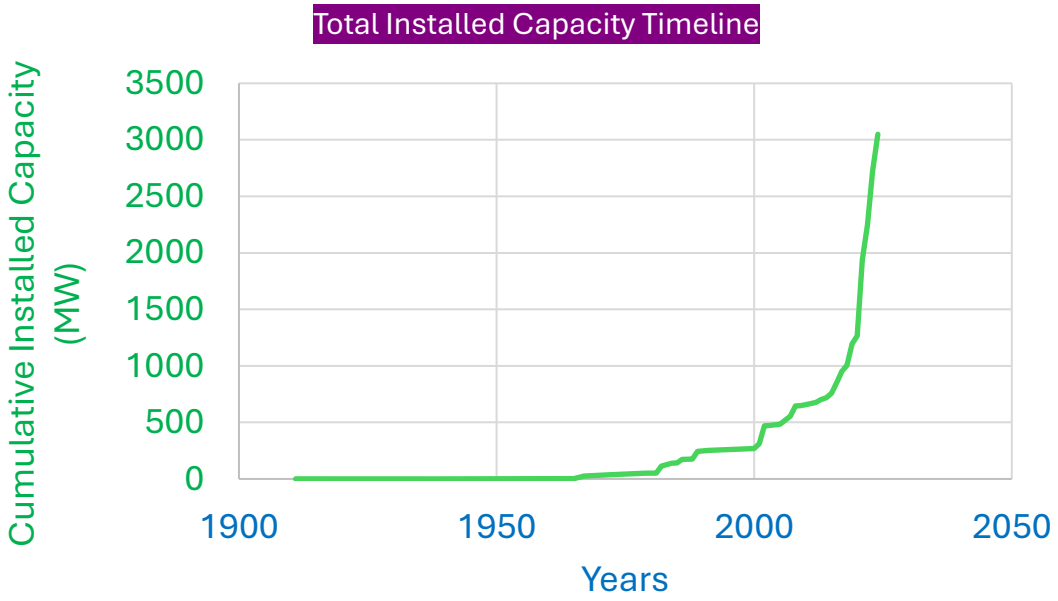
1. Nepal: Brief Profile

Mountains: Peaks above 6000m: 200 and Peaks above 8000m:13
Major River Basins: **Koshi, Narayani and Karnali**
Geographical Regions: Plains, Hills and Mountains
Temperature ranges: (5°C to 47°C in Plains, 0°C to 28°C in Hills and below 0°C to 16°C in Mountains)
Total Population: 29.164 million (2021 Census)
Population Growth Rate: 0.92%
Population Density: 198 per square kilometer
Economic Growth Rate: 2.7% (2023)
GDP : 40.91 Billion Dollars (2023)
Estimated Hydropower Potential: 72,544 MW (WECS, 2019)
Electricity Used for Household Purpose: 92.32%
Industrial Electricity Use: 1.31%
Other Electricity Uses: 6.37%
Electricity generated in 2023: 10536 GWh
Electricity generated in 2022: 9521 GWh

2. Hydroelectricity Scenario: Targets and Risks





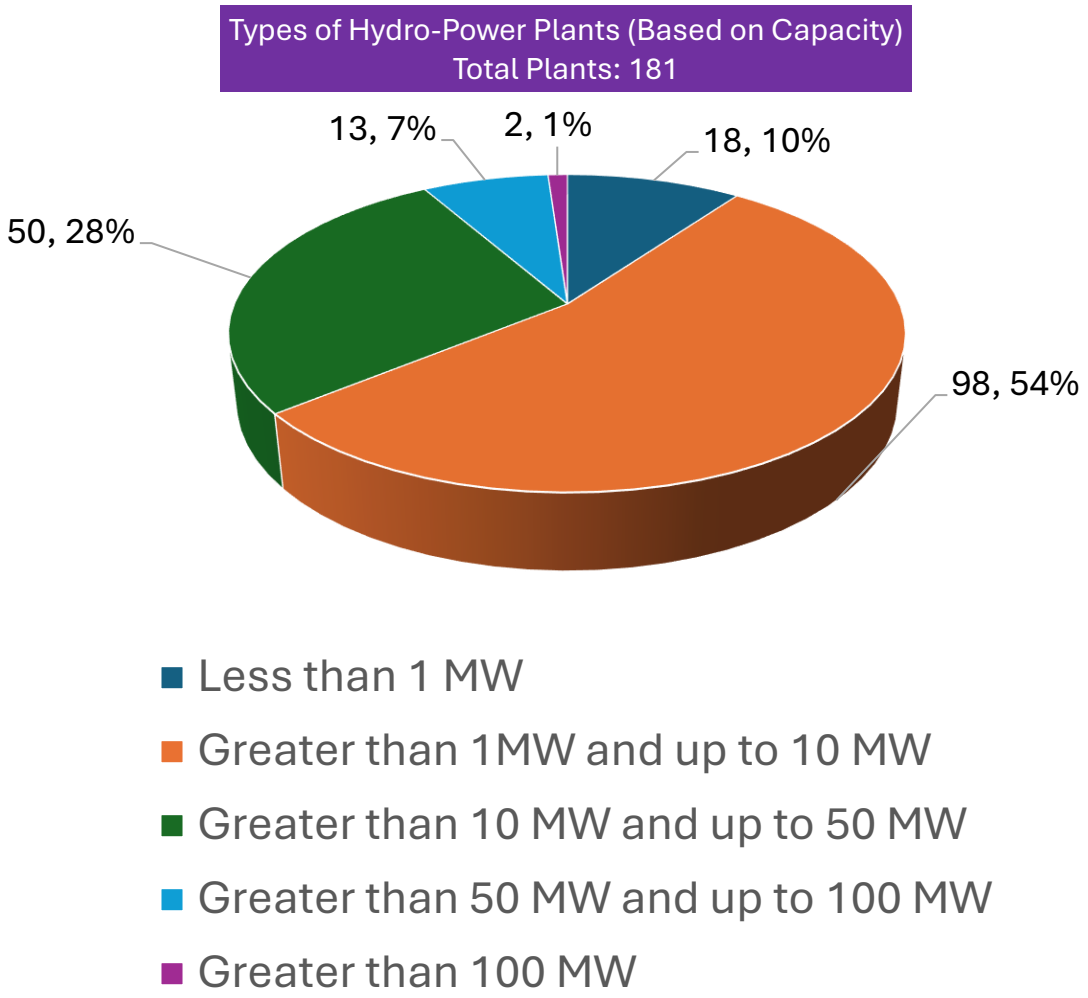
NDC Targets of Nepal (for 2030):

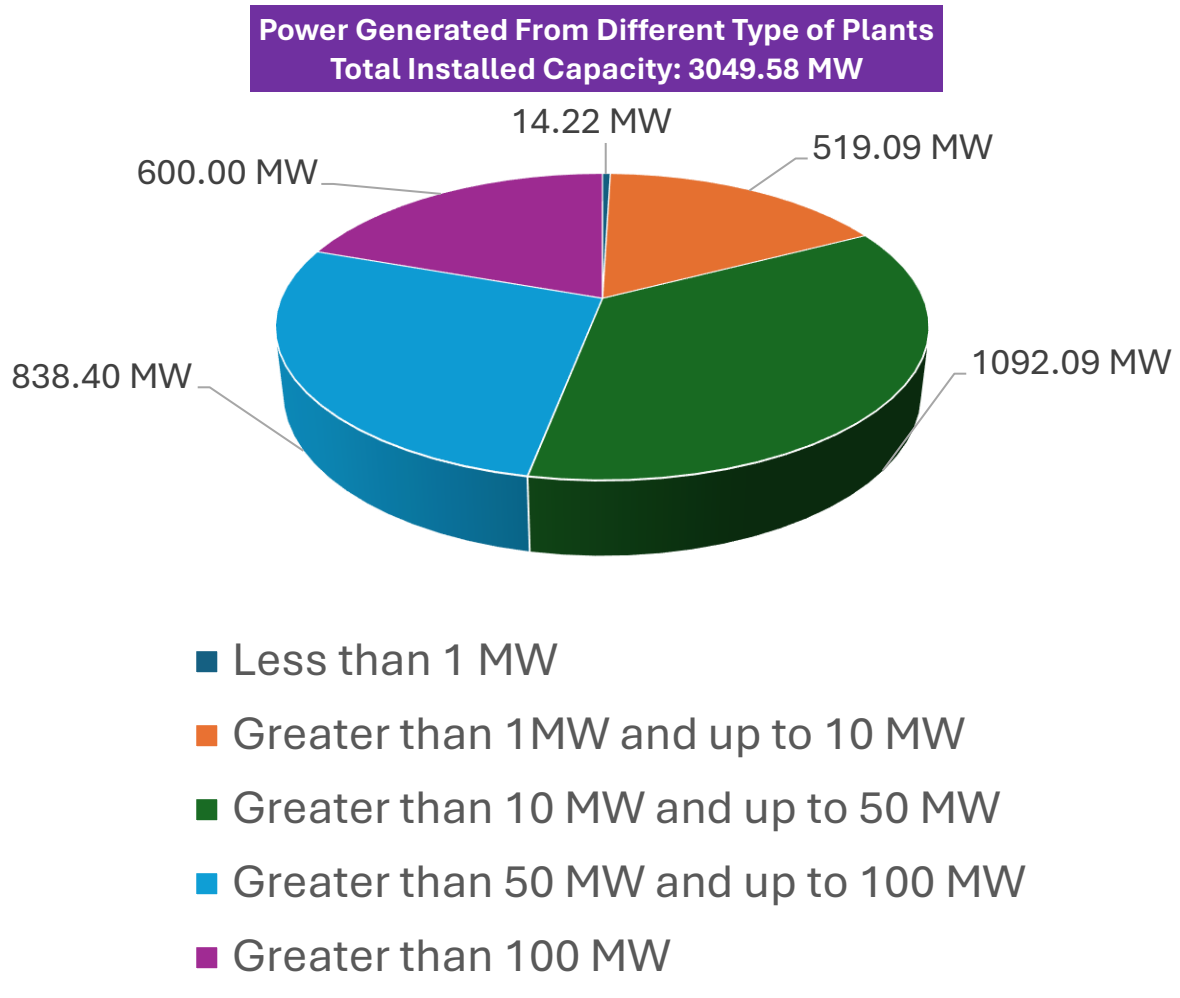
- Increase clean energy generation to 15,000 MW
- Meet 15% of total energy demand through clean energy sources
- Increase the share of EVs in sales of passenger vehicles to 90%
- Build 200 km of electric rail network
- Increase the proportion of households using electric stoves as means of primary cooking to 25%

Climate Change Risks in Hydro-Power Sector:

- Increased Flooding
- Increased Erosion
- Frequent Landslides
- Frequent Landslide Dam Outburst Flods (LDOFS)
- Higher Glacial Lake Outburst Flood (GLOF) risk
- Increased Draught
- Increased Heat Stress

2.1 Hydroelectricity Scenario: Types of Power Plants





3.0 Challenges Posed by Climate-Events on Hydropower Plants

Sunkoshi 10.05 MW Power Plant : 2014 - Jure Landslide caused by heavy rainfall dammed the Sunkoshi River and caused severe flooding downstream on breaching of the dam.

Bhotekoshi 45 MW Power Plant : 2016 – GLOF in Tibet caused flooding in Bhotekoshi river that severely damaged the hydropower plant

3.0 Challenges Posed by Climate-Events on Hydropower Plants (Contd..)

Sediment Deposition in the reservoir (left) and forebay (right) of the Kaligandaki 'A' reservoir (144 MW Plant)

Damage of Runner and Facing Plates of at Kaligandaki 'A' hydropower

3.0 Challenges Posed by Climate-Events on Hydropower Plants (Contd..)

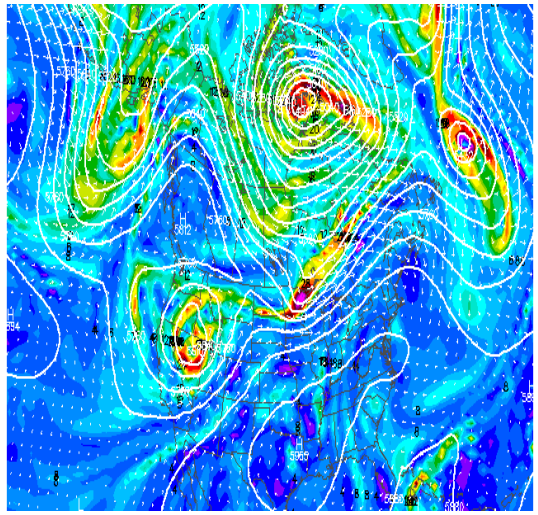
Upper Tamakoshi Hydropower Plant (456 MW) : Heavy rainfall on 27-28 September, 2024 caused flash floods and landslides leading to damage in the headworks and halted the power generation. Twenty-one other hydel plants and nine transmission lines were damaged resulting in disruption of 1000 MW of power generation due to events following the incessant rains.

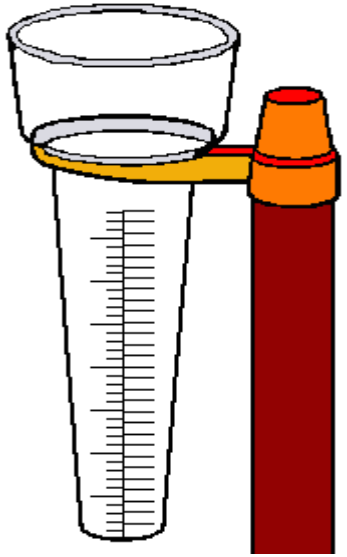
Wreck of transmission line structure (Kabeli Corridor: 200 MW)

Submerged power house (Bagmati Small Hydropower-22 MW)

4.0 Prospects of Interventions for Climate Resilience

Resilience against Extreme Weather Events, Seismic Events, GLOF Events and Increased Occurrence of landslides





- Utilizing More Detailed Data for Design:
  - ✓ Assessing the Climate Change Impacts using all GCM outputs representing full distribution of projected impacts.
  - ✓ Using Reliable Precipitation Data based on extensive network of precipitation stations spanning the whole catchment area for the detailed design of the project.
- Increasing the flood passing capacity of the main and emergency spillway by modifying the design

4.0 Prospects of Interventions for Climate Resilience (Contd..)

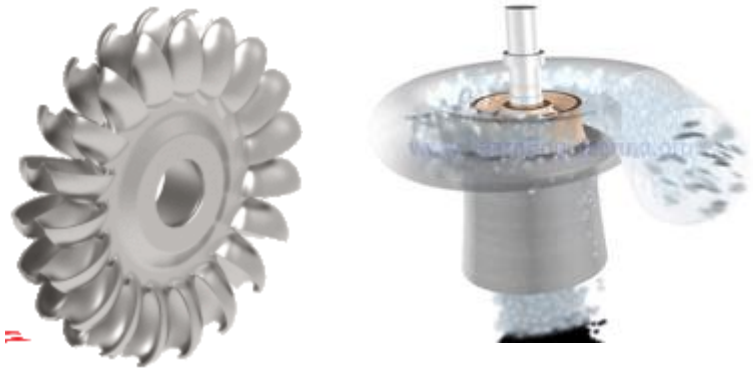
Resilience against Soil Erosion, Turbine Erosion, Slope Failure and Landslide:

- Identifying potential landslides
- Monitoring sediment and slope stability on real time basis
- Increasing the size of the bottom outlet of the reservoir to avoid sedimentation.
- Trapping sediments upstream by constructing check dams in the upstream regions of the reservoir and using enhanced trapping devices e.g. centrifugal, hydro-cyclones, vortex basins
- (Re)coating of turbines
- Sloping intakes

4.0 Prospects of Interventions for Climate Resilience (Contd..)

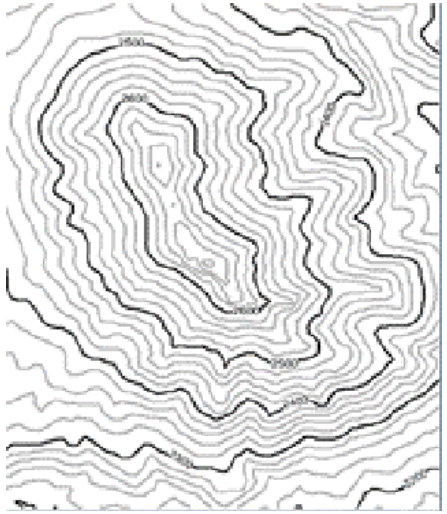
Resilience against Low Flow (Draught or Winter):

- Using better climate information and plant management, plant cooperation and reservoir management
- Upgrading turbine during retrofit
- Choosing right turbine for the flow conditions
- Making provision for additional turbine or upgrade



Resilience against Slope Failure, Landslide Activity and Flooding:

- Shifting the key power-plant components to locations with stable topography
- Protecting key infrastructure, e.g. intake structure, power house with set-back or raised structure (and potentially some key structures underground)
- Using Smart tailrace gates



4.0 Prospects of Interventions for Climate Resilience (Contd..)

Resilience against Erosion, Slope Failure, and Landslides:

- Deploying Bio-engineering solutions for key project components: grass lines, grass seeding, shrub and tree planting, bush layering, palisades, wattling, stone pitching, check dams, and bamboo crib walls

Risk Management and Adaptation:

- Operating Early warning system for dissemination and communication of GLOF, landslide, and flood risk information and early warnings to the operators and managers of power plants could help in

THANK YOU