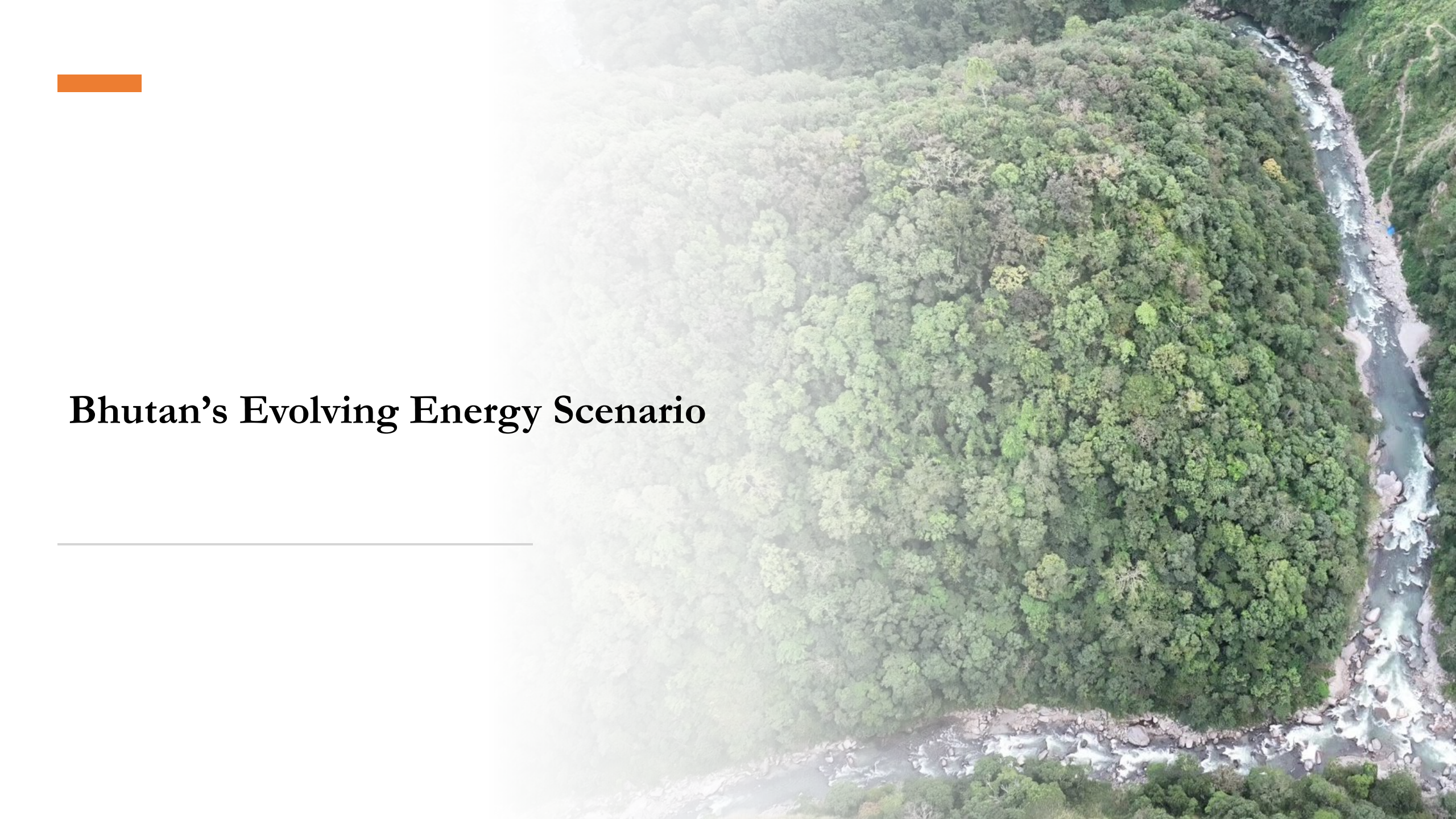




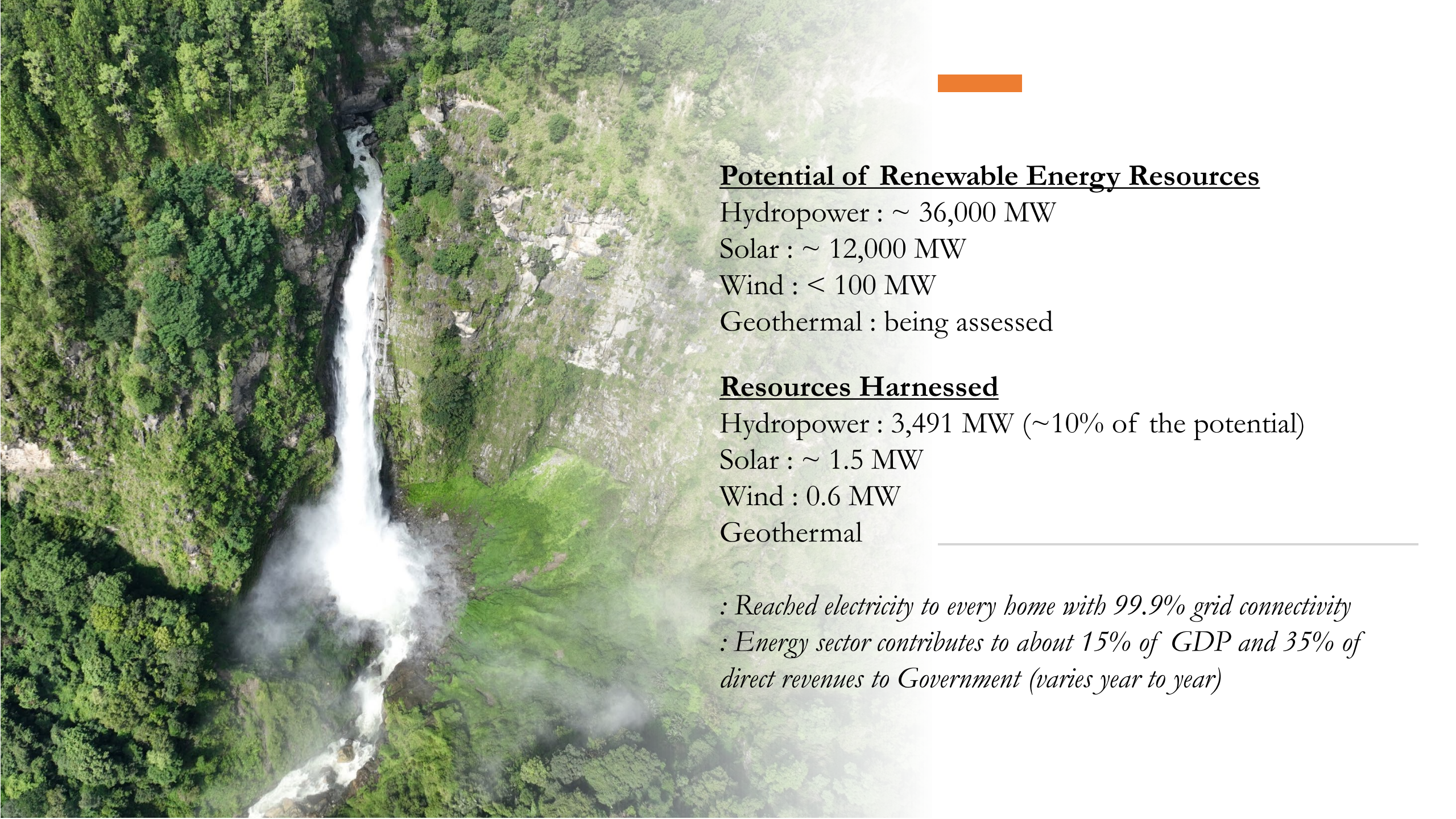
Challenges in Implementing Renewable Energy Technologies – Bhutan's Hydropower Lessons

22 May 2025
Chhewang Rinzin DGPC





Bhutan's Evolving Energy Scenario



Potential of Renewable Energy Resources

Hydropower : ~ 36,000 MW

Solar : ~ 12,000 MW

Wind : < 100 MW

Geothermal : being assessed

Resources Harnessed

Hydropower : 3,491 MW (~10% of the potential)

Solar : ~ 1.5 MW

Wind : 0.6 MW

Geothermal

: Reached electricity to every home with 99.9% grid connectivity

: Energy sector contributes to about 15% of GDP and 35% of direct revenues to Government (varies year to year)

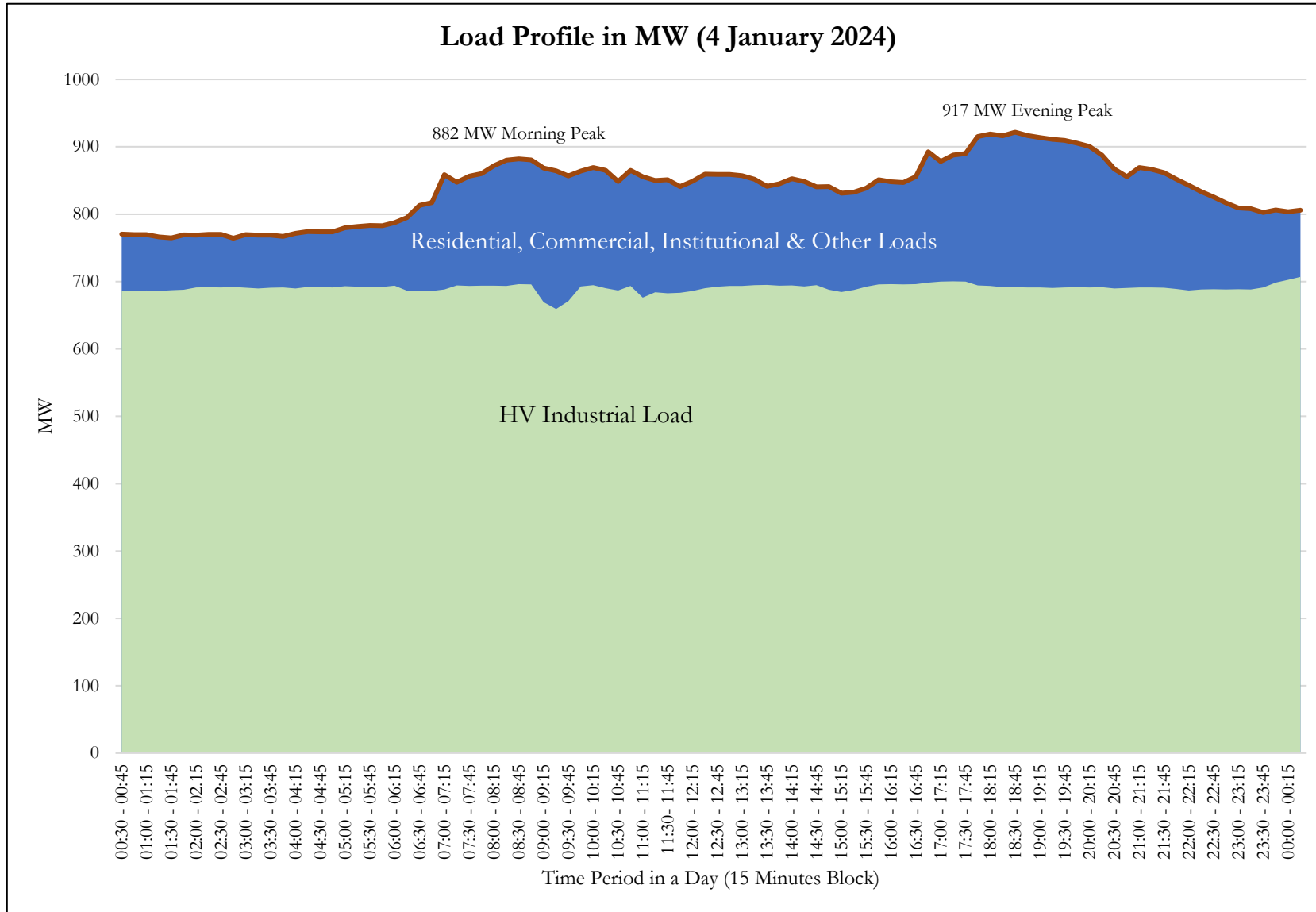
Installed Generation Capacity

SN	Power Plants/Projects	Installed Capacity (MW)	Year
1	Embedded Generation	9	1967 onwards
2	Chhukha	336	1986-1988
3	Kurichhu	60	2001-2002
4	Basochhu Upper Stage	24	2001
5	Basochhu Lower Stage	40	2004
6	Tala	1,020	2006-2007
7	Dagachhu	126	2015
8	Mangdechhu	720	2019
9	Nikachhu	118	2024
10	Punatsangchhu II*	1,020	2024-2025
11	Suchhu	18	2025
		3,491	

Run-of-River hydropower plants:
Winter generation is limited to
20-25% of installed capacity
(~650 MW)



A Typical Domestic Load Profile



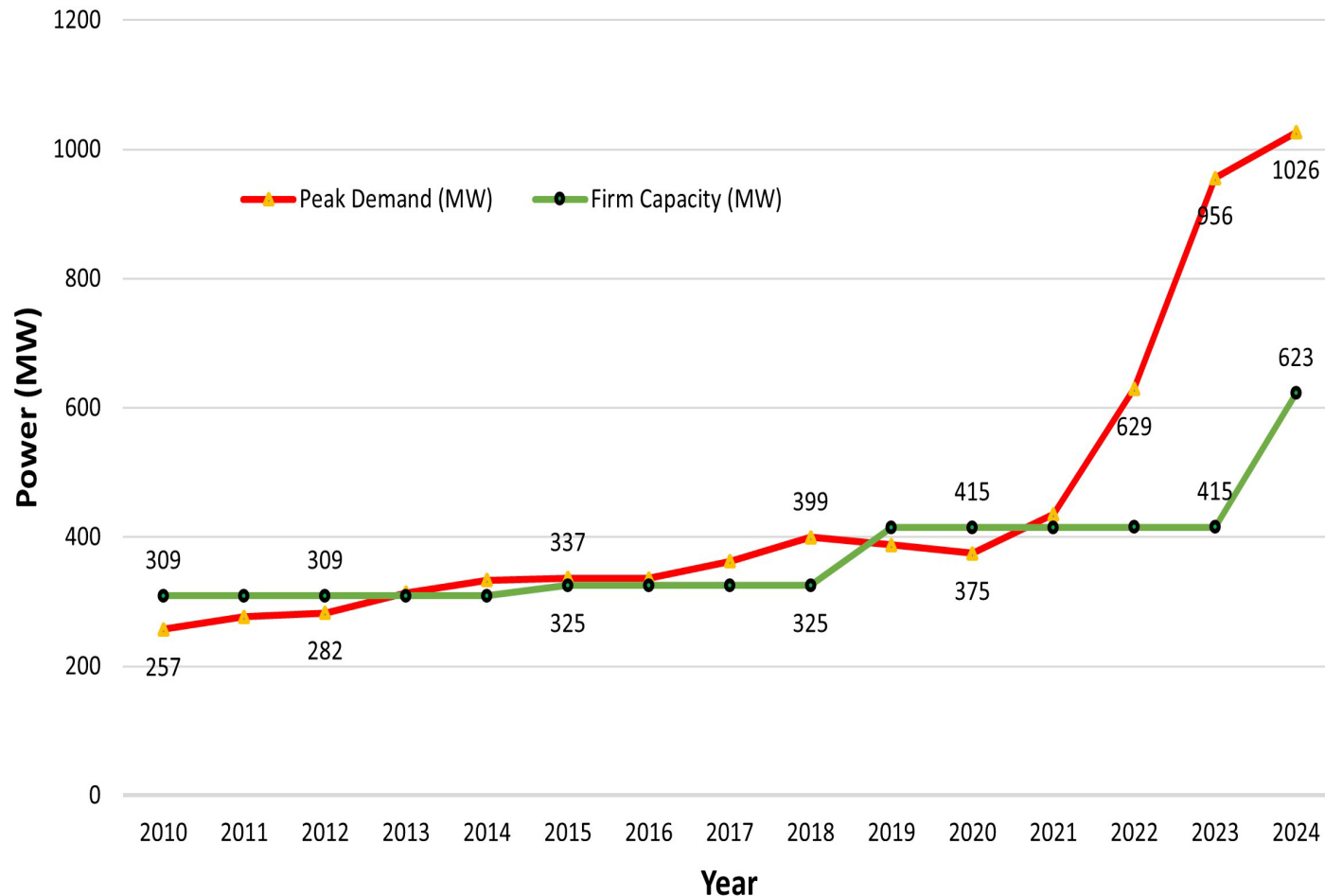
HV load represents the base load (~80-85%) and residential/others contribute to morning & evening peaks



Emergence of an Energy Deficit and Import Situation

Generation & Domestic Demand Trends over last 15 Years

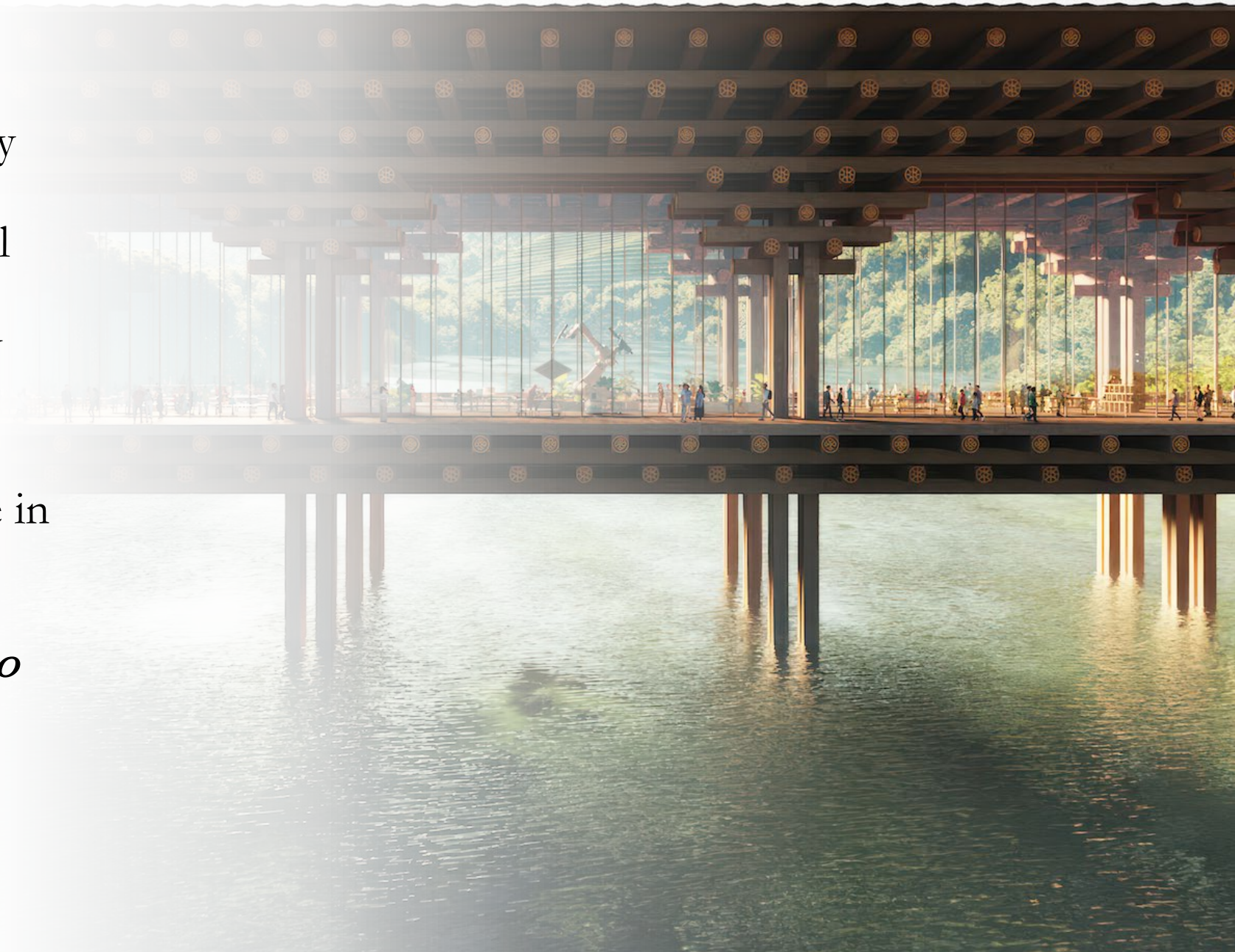
Peak demand outpaced firm power availability resulting in winter energy imports from India starting 2022



Winter season imports made in 2022 (240 MU), 2023 (680 MU) & 2024 (1,500 MU)

A Change in the Vision for Energy Future

- Further *expand the renewable energy sector* by tapping available sources including *solar*, wind, thermal and hydropower to enhance the current installed capacity of hydropower
- Maintain electricity prices among the most competitive in the region so that *hydro resources are not just a source of revenue, but also an enabler of other investments*
- Allow private sector investment



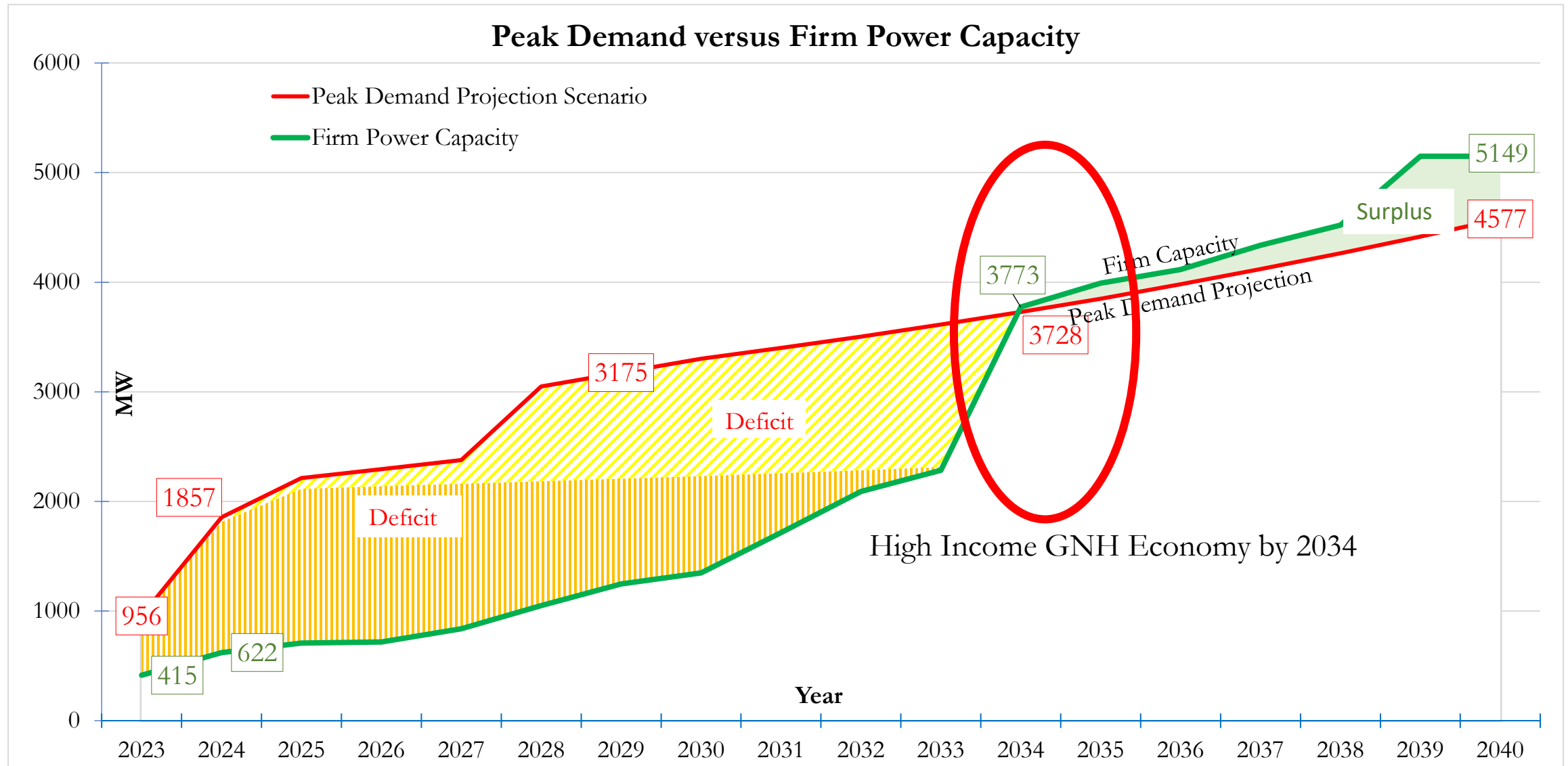
An aerial photograph showing a large concrete dam structure across a river. The river is a murky green color. The surrounding landscape is covered in dense, lush green forest. A road runs along the base of the dam, and there are some small buildings and structures near the dam's base. The sky is not visible.

Strategic Goal

“Develop additional generation capacity of 15,000 MW of hydropower and 5,000 MW of solar by 2040 to ensure Bhutan’s present and future energy security”

Vision and Strategies for Energy Security

Supply-Demand Projections [2024-2040]





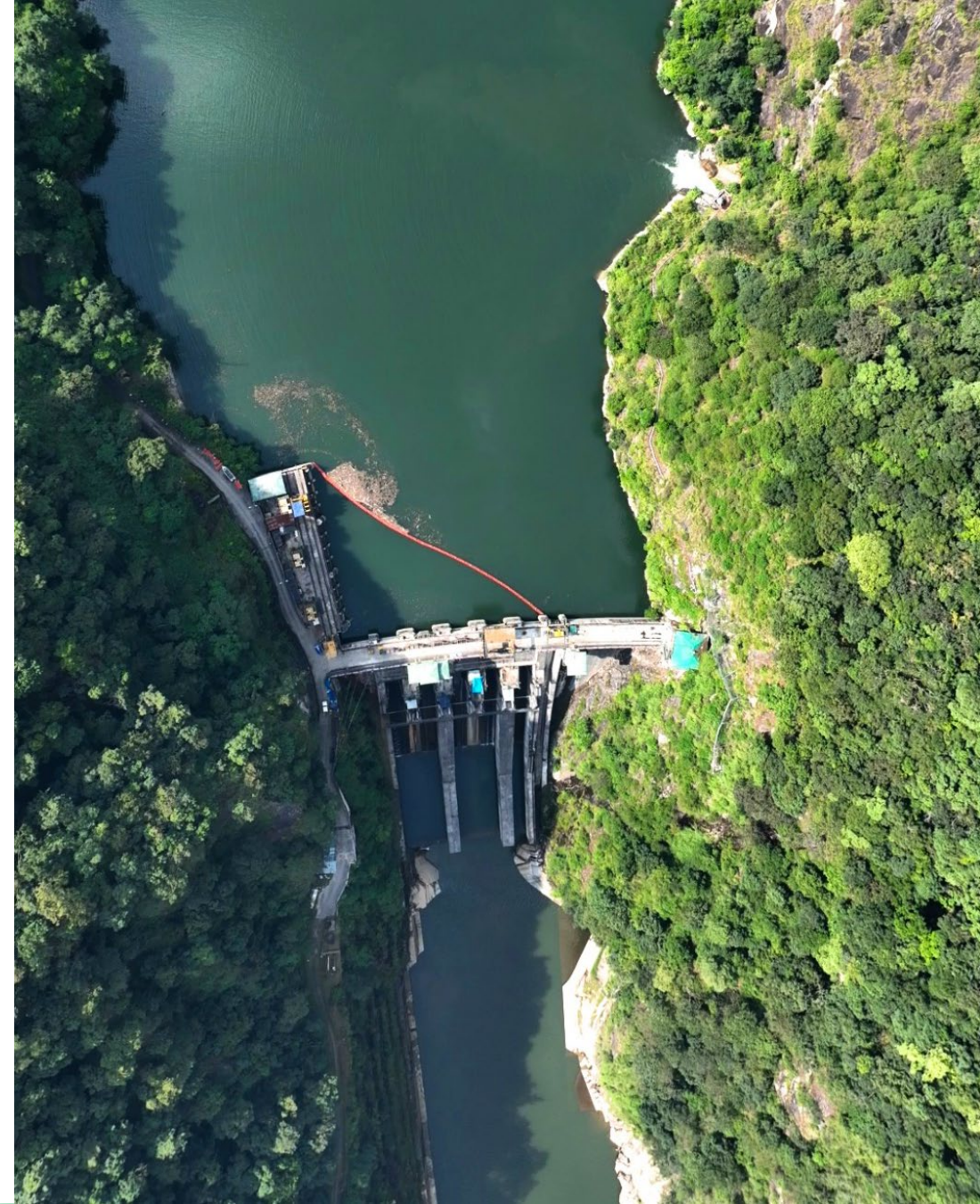
Challenges



Access to Financing

Meeting the target of 15,000 MW in Hydropower and 5,000 MW in Solar by 2040 will require huge financing:

- **Financing for additional 20,000 MW generation capacity:**
US\$ 26 billion (annually US\$ 1.70 billion)
- **Financing for associated transmission systems:**
US\$ 725 million



Access to Financing

Equity

- Operating Cash Flows
- Bilateral
- Partnerships
- Bonds
- IPOs
-

Debt

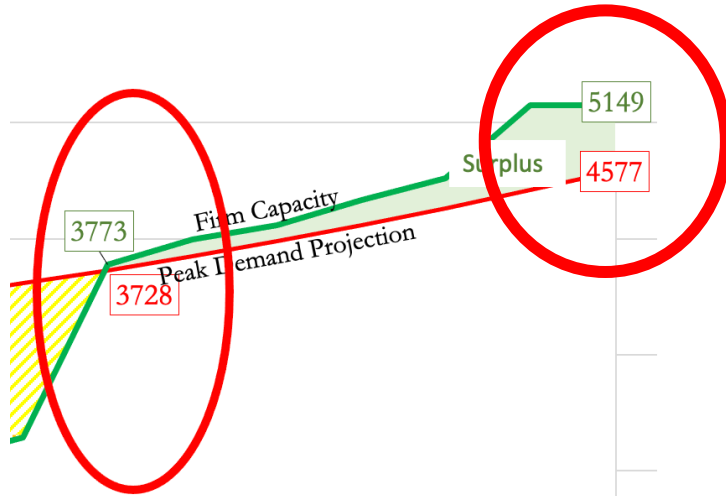
- Multilateral
- Bilateral
- Commercial
- Bonds
- EXIM
- ...

Challenges

- Sovereign Guarantees
- Credit Rating
- Size of Economy
- Financial Closure
- *Access to Climate Funds*
- *Green Bonds*



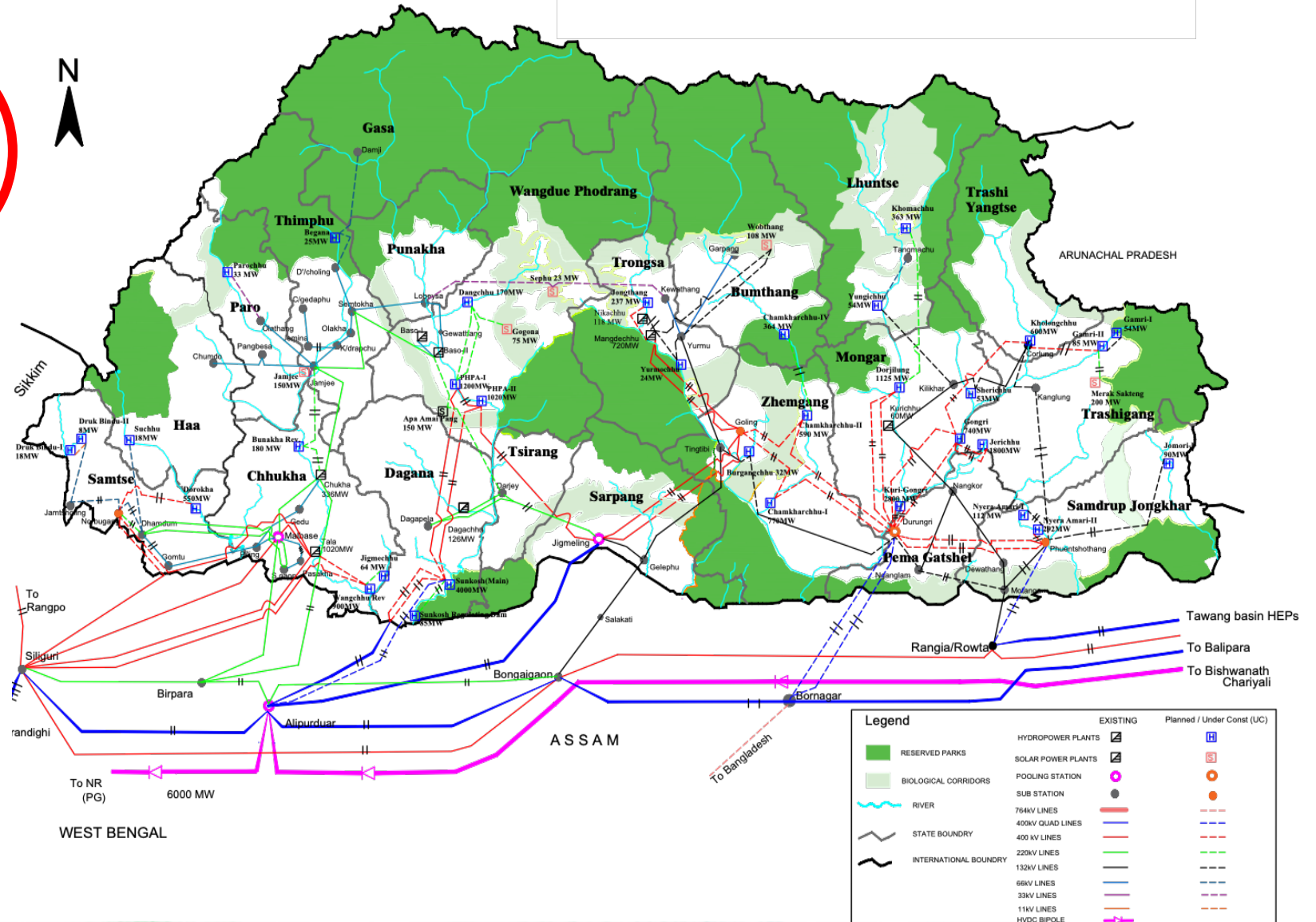
Access to Energy Markets



Income GNH Economy by 2034

033 2034 2035 2036 2037 2038 2039 2040

Plans to take generation capacity to 25,000 MW by 2040 to meet peak demand of 4,500 MW



Environmental and Social Impacts and Mitigation Measures

- 72% land area under forests
- Over 50% declared as parks and biological corridors
- Biodiversity and ecological hotspots
- Integrated water management systems
-

Needs better understanding and co-ordination so that the benefits accrue firstly to the people



Other Challenges

- Procurement sourcing
- Project management and monitoring
- Riparian rights
- Availability of human resources with the required expertise and experience
- Capacity of manufacturers and contractors





HYDROLOGY RIVER SUSTAINABILITY ENERGY RENEWABLES AQUATIC LIFE
HYDROPOWER
DAM POWER WATER HYDROELECTRICITY WILDLIFE
EFFICIENCY PENSTOCK TURBINE ENVIRONMENT
SOCIO ECONOMIC DEVELOPMENT

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