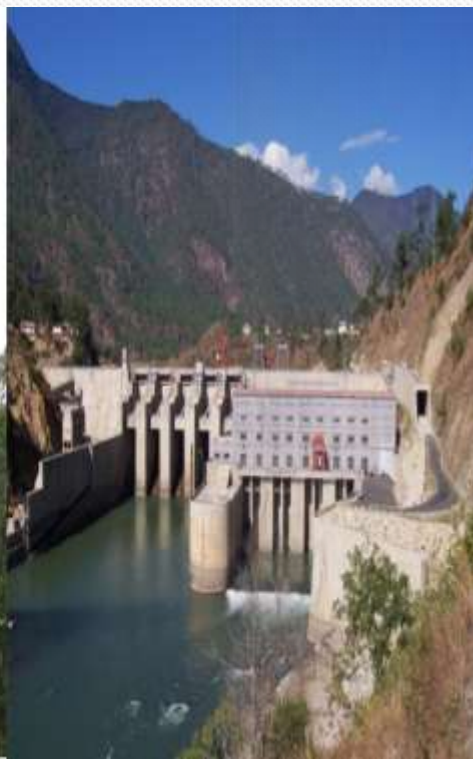


Hydropower Development: Bhutan's Experience

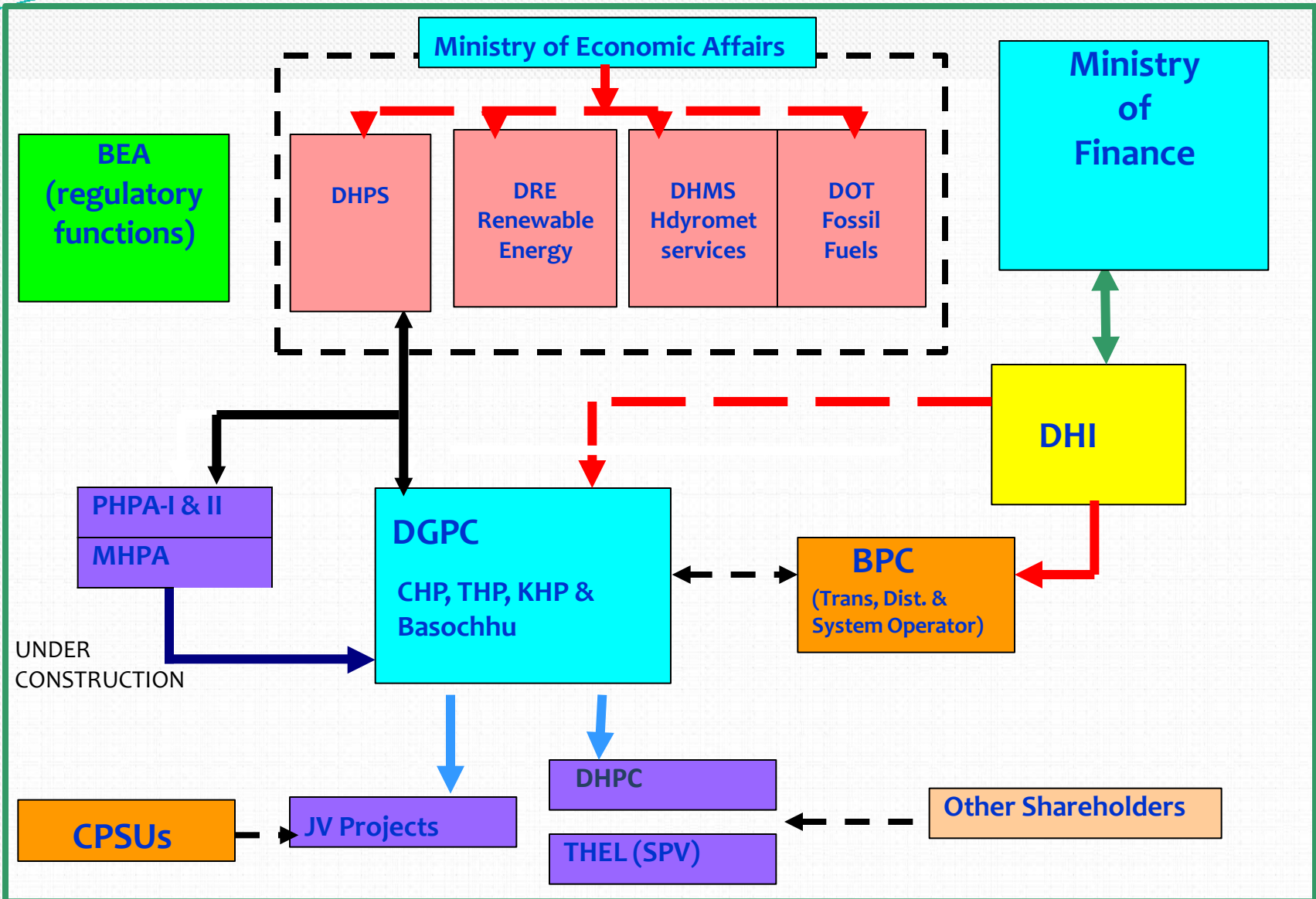
Dissemination Workshop on the Study for Development of Potential
Regional Hydro Power Plant in South Asia
Kathmandu, Nepal
9-10 May 2016



Presentation Outline

- 1. Energy Sector Structure**
- 2. Sector Reforms**
- 3. Hydropower Potential**
- 4. Development Status**
- 5. Opportunities & Challenges**
- 6. Looking ahead**

Energy Sector Structure



Power Sector Reforms

- 1. Electricity Act passed by the 79th Session of the NA on 26th July 2001**
- 2. Unbundling of Power Sector in 2002**
- 3. BPC – Responsible for Transmission & Distribution**
- 4. DGPC (Established in Jan 2008) – O&M of all existing hydropower plants owned by RGoB and construction of HEPs**
- 5. BEA- Responsible for Regulation, became fully autonomous in January 2010**
- 6. DHPS – Nodal Agency for Hydropower Sector**
- 7. DRE & DHMS – Nodal Agency for Renewable Energy & Hydro-met Services**

Hydropower – the key sector

- ✓ Key to achieving economic self-reliance. Prior to harnessing of hydropower, Bhutanese economy almost entirely dependent on foreign aid.
- ✓ Earnings from this sector ploughed back into the social & industrial sectors.

- ✓ Affordability
 1. Domestic tariff kept low to stimulate economic growth.
 2. Rural electrification given high priority.
 3. ~75% of generation exported.

Environmentally benign

1. All major rivers in Bhutan flow through deep valleys.
2. No settlements effected.
3. Run of the river projects.
4. Very rich forests, over 72% coverage; catchment well conserved.

Hydropower Potential

The steep and rugged Himalayan mountains and fast running rivers promise huge hydropower potential

- ❑ 30,000 MW potential
- ❑ 23,760 MW (76 sites of >10 MW) techno-economically viable for development



Existing Hydropower Plants

1. Developed Hydropower Potential

Hydropower Plant	Capacity (MW)
Tala HEP	1020
Chukha HEP	336
Basochhu HEP	64
Kurichhu HEP	60
Dagachhu HEP	126
Micro/Mini (24 Nos)	~9

Total installed
Capacity: ~1615 MW

6/8/2016



Under Construction:

Plant	Installed Capacity (MW)	Commissioning Date	Generation (MU)	Mode of Implementation
Punatsangchhu-I	1200	2018	5700	Bilateral
Punatsangchhu-II	1020	2017	4000	Bilateral
Mangdechhu	720	2017	2900	Bilateral
Kholongchhu	600	2020	2599	JV
Nikachhu	118	2019	492	PPP
Total	3,658		15,691	

Projects planned for implementation:

- ❖ Bunakha (180 MW), Wangchhu (570 MW), Chamkhachhu-I (770 MW) under JV
- ❖ Sankosh (2560 MW), Amochhu (540 MW) and KuriGongri(2640 MW) under IG
- ❖ 9 Projects under PFR/DPR – IPP/PPP mode

10,000 MW Hydropower Development by 2020

	Inter-Governmental Projects						Joint- Venture Projects				
Project Name:	Puna-I	Puna-II	Mangdechhu	Sankosh	Amochhu	Kuri-Gongri	Chamkhar chhu-I	Bunakha	Wang chhu	Kholong chhu	TOTAL
Installed Capacity (MW)	1,200	1,020	720	2,560	540	2,640	770	180	570	600	10,800
90% dependable year generation (MU)	5670.78	4357.36	2923.70	6267.00	1835.00	13855.00	3252.92	1669.27	2526.38	2592.83	45,000.00

- ✓ Modalities of Implementation were agreed - 6 projects under IG mode & 4 projects under JV mode.
 - 3 IG projects under construction (Puna-I, Puna-II & Mangdechhu)
 - Implementation of 1 JV project has initiated (Kholongchhu)
 - 1 DPR yet to be carried out

JV Mode:

- ✓ As per SHDP (concession terms, reversion of plant, royalty energy & JVC to be registered under Companies Act 2000 of Bhutan)
- ✓ Agreed to implement 4 JV projects with 70% debt and 30% equity with each JV partner holding equal equity shareholdings.
- ✓ The 70% debt will be raised by the JV Company where the GoI PSUs will take the lead role.

Impact of Hydropower

1. **Electricity sales (domestic and export) contributes to over 45% of the total internal revenues to the government, and ~20% GDP**
2. **>75% of electricity was exported to India in 2014**
3. **Access to Electricity**
 - Urban 100%**
 - Rural 99%**
 - Industrial consumption 100%**

Opportunities

1. **Renewable, Clean form of Energy**
2. **Reduction in GHG emission**
3. **Export /Market demand in India and South Asia (peaking energy)**
4. **~ 30,000 MW Potential**
5. **Benign environment (political, social & physical/techno-economic)**
6. **Business development opportunities (Energy Companies, Construction Industries, Equipment, Support services, etc.)**

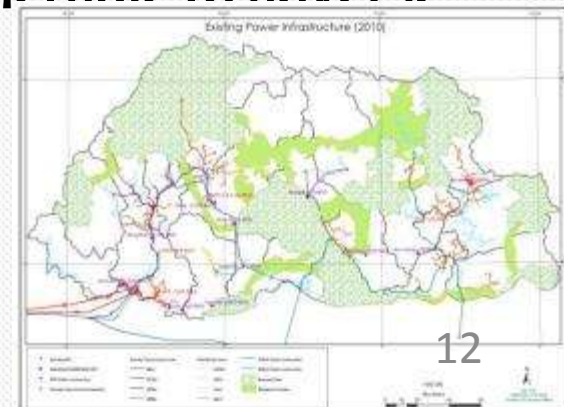
Challenges

1. Socio-Economic:

- ✓ Resources constraints (capital intensive, skills & technology !)
- ✓ Risks (long gestation, weather, geology, seismology)
- ✓ Market (pricing, competition)
- ✓ Transport cost (land locked !)

2. Environment

- ✓ Constitutional Environment Mandate (60 %) forest cover versus growing population/development needed
- ✓ Fragile mountain eco-system and extremely vulnerable to adverse impact to climate change;
- ✓ Lacks capacity to respond to adverse impacts of climate change;



Challenges Contd...

- ✓ Increasing threats from 25 glacier lakes (potentially dangerous with possibility of GLOF)
- ✓ Loss of biodiversity;
- ✓ Loss of agricultural land;

3. Political and HR Capacity

- ✓ New political system;
- ✓ Limited people trained with required expertise
- ✓ Planning for sustainable hydropower development

Energy Security - Domestic Power Demand and Supply

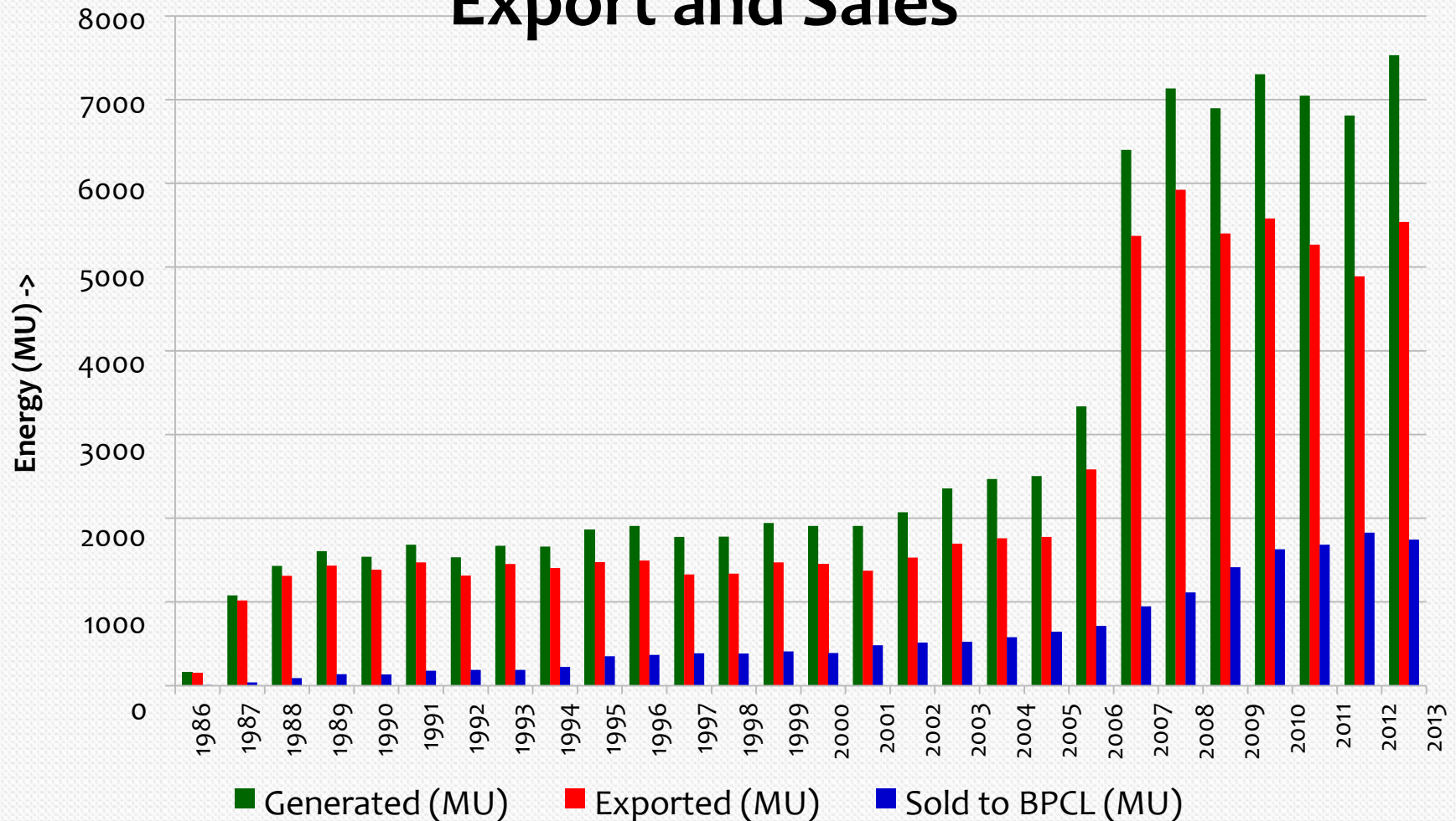
1. Power supply shortage expected during the winter months of 2016-17 mainly due to:

- Accelerated Hydropower Development of 10,000MW**
- Accelerated RE**
- Growth of Industries**

2. Current Power Supply - from 5 Generating Stations of DGPC and small/mini/micro hydro projects of BPC – ~1615 MW

3. Peak Demand – ~336 MW in 2015

Year -wise total Energy Generation, Export and Sales



Looking Ahead

- 1. Update Power System Master Plan (2003-2022), preparation of Integrated Water Resource Management Plan (IWRMP) and (Social Impact Assessment) SIAs**
- 2. 9 projects under PFS/DPR stage**
- 3. Continue harnessing Hydro to achieve economic self reliance**

TASHI DELEK !

6/8/2016

17