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Sustainable Hydropower Development

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Outlines

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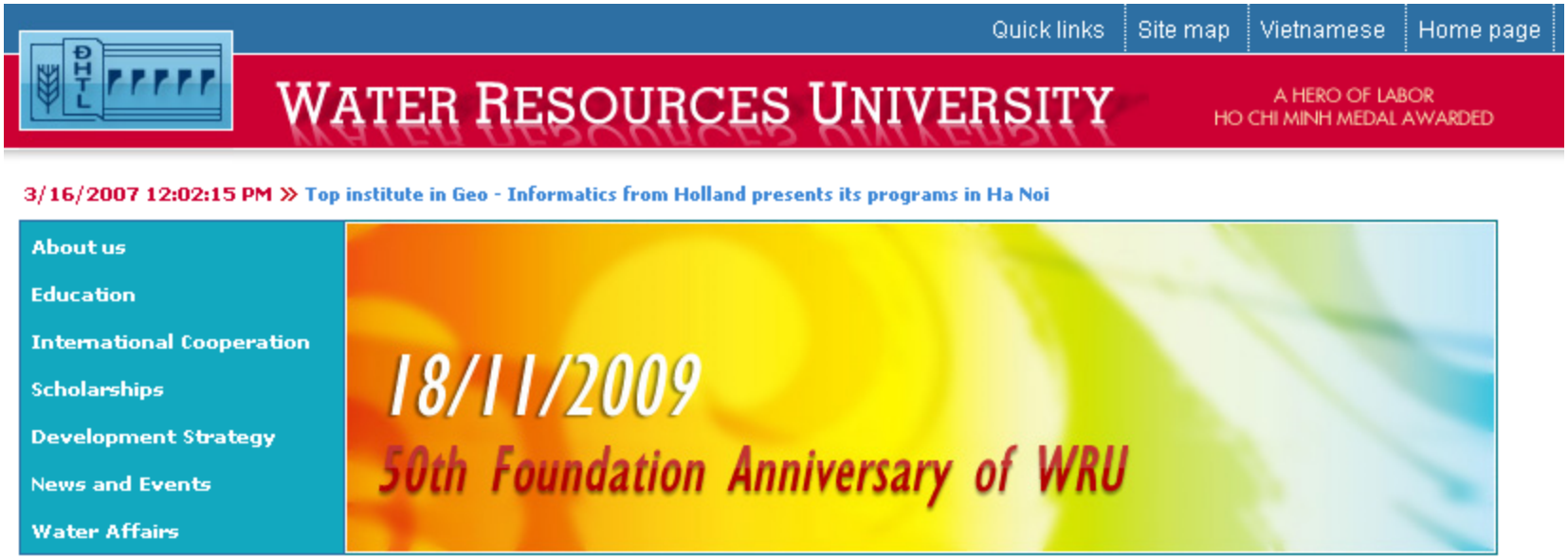
- From water wheel to hydropower
- Sustainability challenges
- Hydropower: Strengths & Weaknesses
- Hydropower in the world
  - Potential & development
  - As a renewable energy since Bonn Declaration
- Hydropower in Vietnam



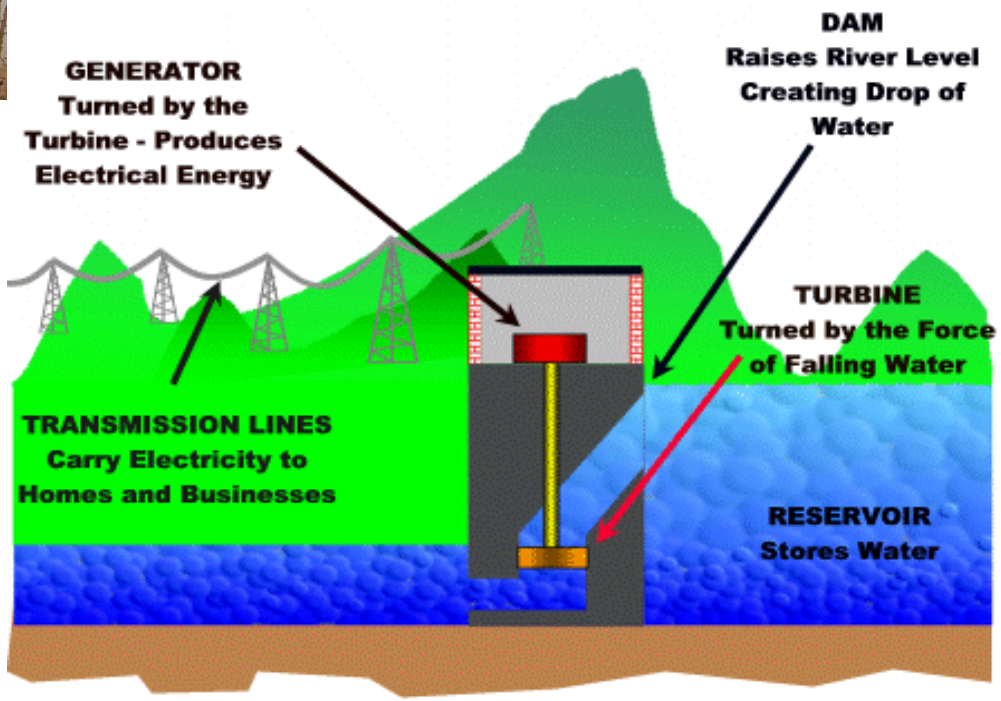
- 9 faculties
  - Environment
  - Civil engineering
  - Economics & management of natural resources
  - Energy engineering
  - Water resources engineering
  - Coastal & ocean engineering
  - Hydrology & water resources
  - Computer science & engineering
  - Mechanical engineering
- Bachelor (4 years), Master (2-3 years), PhD program
- 12,000 bachelor students (direct study program)
- Website: www.wru.edu.vn

Where I come from?

From water wheel to hydropower

4 types of hydropower

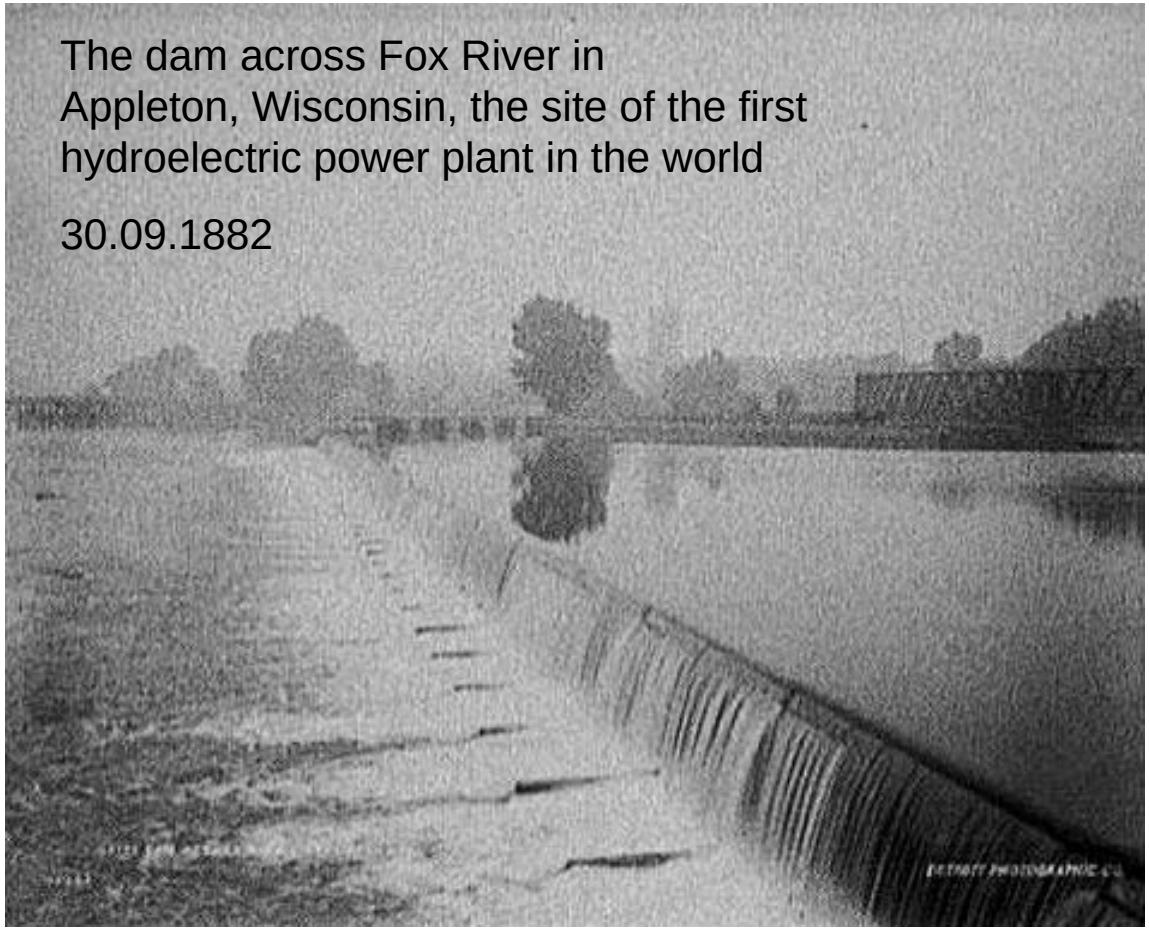
- Impoundment Hydropower
- Run-of-River Projects
- Microhydropower
- Diversion Hydropower



The first hydropower plant in the world

The first hydropower plant Appleton Wisconsin on Fox River (USA)

In operation since 30. Sep. 1882



Sustainability challenges

- Nearly 1/3 of the world's population has no access to electricity. Without concerted action at least 3.5 billion people, nearly 50% of the global community will face water scarcity by 2025.
- The world's energy systems, substantially based on fossil fuels → greenhouse gas emissions → climate change and global warming.
- **Socio-economic development + poverty reduction while simultaneously halting environmental degradation = The greatest challenges at the start of the 21st century**
- This challenge is most conspicuous in the policy for water and energy, as both are essential elements for human life.

Sustainability challenges (cont')

- From Stockholm in 1972 to Rio de Janeiro in 1992 & Johannesburg in 2002, world leaders have increasingly concluded that these elements must be considered in an integrated way.
- **The hydropower sector often at the centre of the debate on sustainability**.
- The World Commission on Dams (1998-2000) concluded that water infrastructure projects, including **hydropower schemes, had 'too often' been developed at an environmentally or socially unacceptable cost**. However, the Commission did not recommend that hydropower should be discouraged in the future, or that only the smallest of schemes should be developed. Instead, a more inclusive process was recommended in the planning, development and management of water and energy schemes

Role of hydropower

- Hydropower contributes one-fifth of the world's power generation, and provides the majority of supply in 55 countries.
- For several countries, hydropower is the only domestic energy resource.
- Its present role in electricity generation is substantially greater than any other renewable technology, and the remaining potential, especially in the less developed countries, is vast.
- Hydropower can be developed on a wide range of scales to meet diverse needs and market conditions.
  - Small-scale, decentralized development has been responsible for bringing light and power to remote and rural communities throughout the world.
  - Larger hydropower schemes feed the regional grid systems, substantially reducing the combustion of coal, which is the predominant power supply source.

Economic aspects

Advantages

- Low O&M costs
- Long life (50 to 100 years and more)
- Meets load flexibly
- Reliable service
- Instigate & foster regional development
- Highest energy efficiency rate
- Create employment opportunities
- Optimizes power supply of other generating options (thermal & intermittent renewables)

Disadvantages

- High upfront investment
- Precipitation dependent
- Decrease storage capacity due to sedimentation
- Long-term planning, agreements
- Multidisciplinary involvement
- Often requires foreign contractors and funding

Environmental aspects

Advantages

- No atmospheric pollutants
- Neither consumes nor pollutes the water
- No waste
- Avoids depleting non-renewable fuel resources
- Can create new freshwater ecosystems with increased productivity
- Enhances knowledge and improves management of valued species due to study results

Disadvantages

- Inundation of terrestrial habitat
- Modification of hydrological regimes
- Modification of aquatic habitats
- Water quality needs to be monitored/managed
- Greenhouse gas emissions can arise under certain conditions in tropical reservoirs
- Species activities and populations need to be monitored/managed
- Barriers for fish migration, fish entrainment
- Sediment composition and transport may need to be monitored/managed

Social aspects

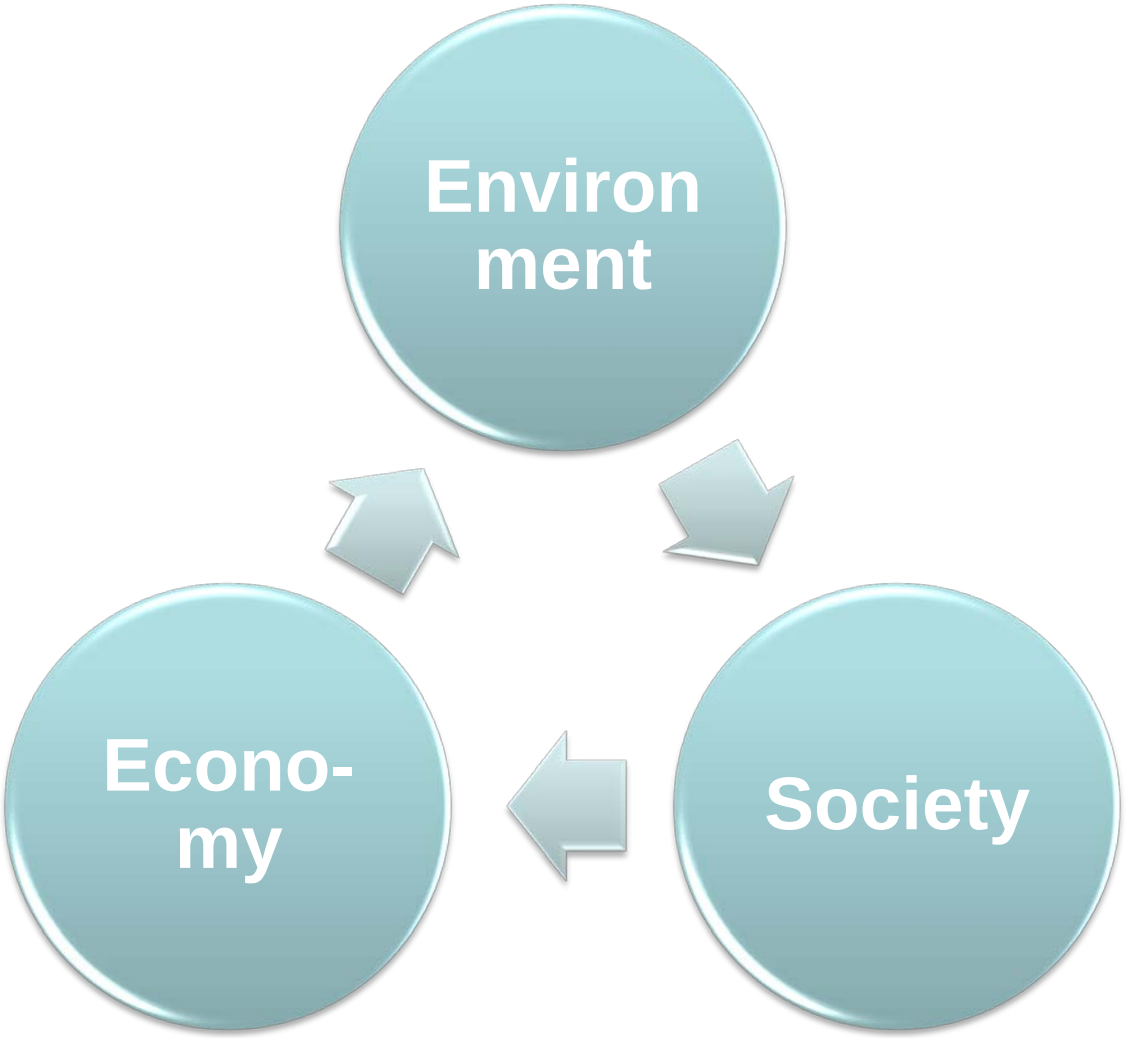
Advantages

- Leaves water available for other uses
- Often provides flood protection
- May enhance navigation conditions
- Often enhances recreational facilities
- Enhances accessibility of the territory and its resources (access roads and ramps, bridges)
- Provides opportunities for construction and operation with a high percentage of local manpower
- Improves living conditions
- Sustains livelihoods (freshwater, food supply)

Disadvantages

- May involve resettlement
- May restrict navigation
- Local land use patterns will be modified
- Waterborne disease vectors may occur
- Requires management of competing water uses
- Effects on impacted peoples' livelihoods need to be addressed, with particular attention to vulnerable social groups
- Effects on cultural heritage may need to be addressed

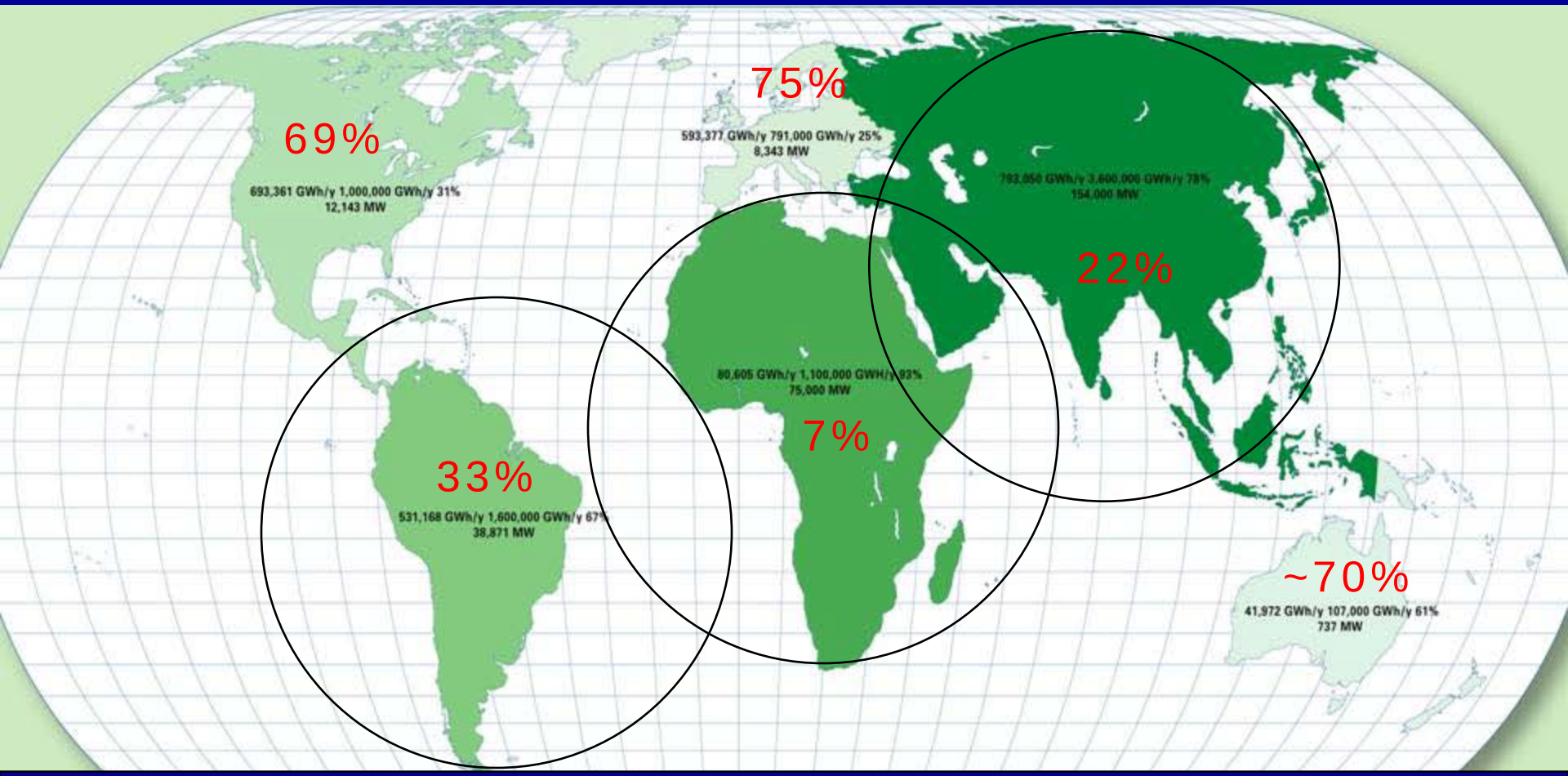
Harmonizing in hydropower development



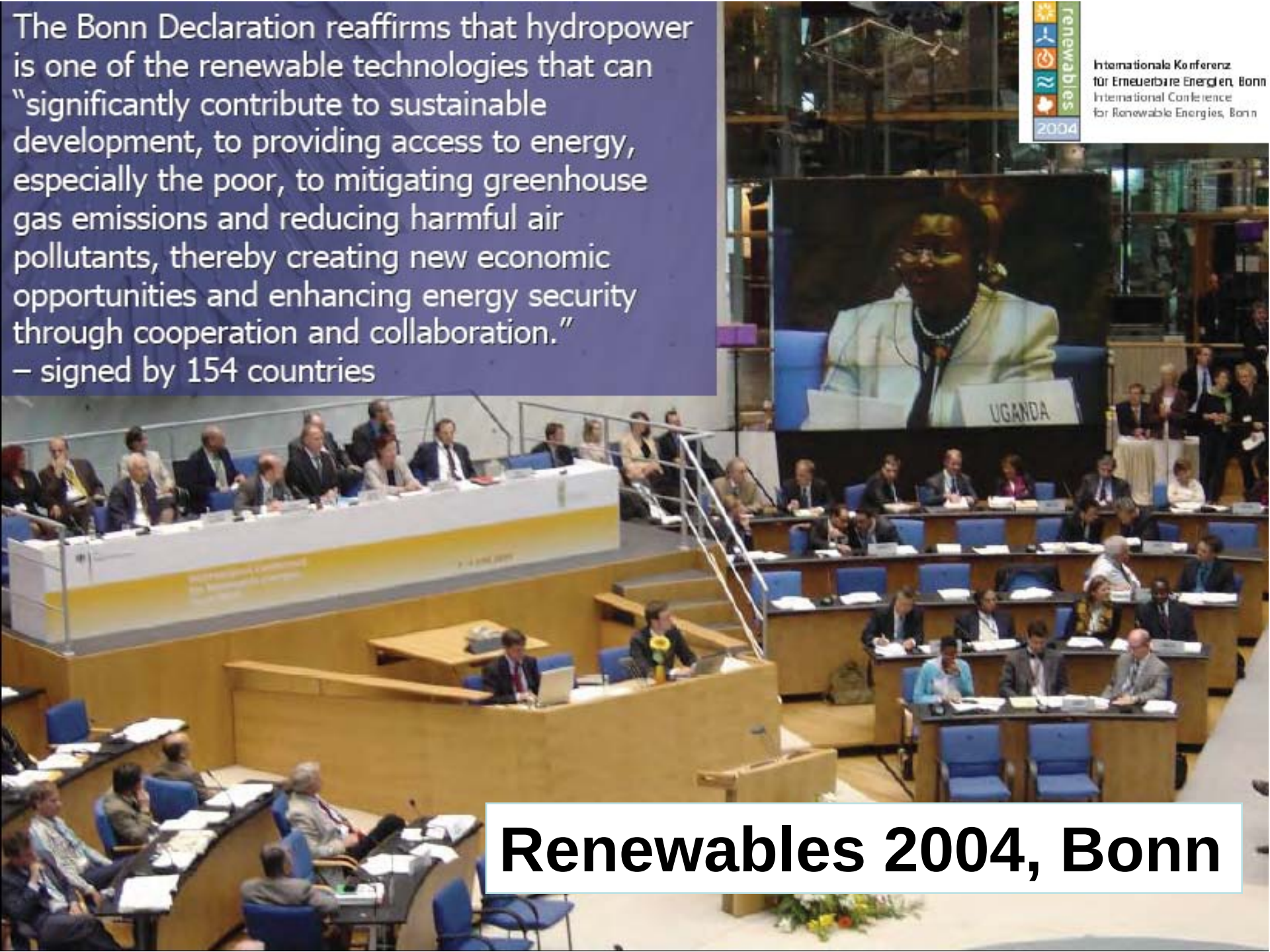
World's realistic potential developed: ~ 1/3

Current hydro production: 2889 TWh/y

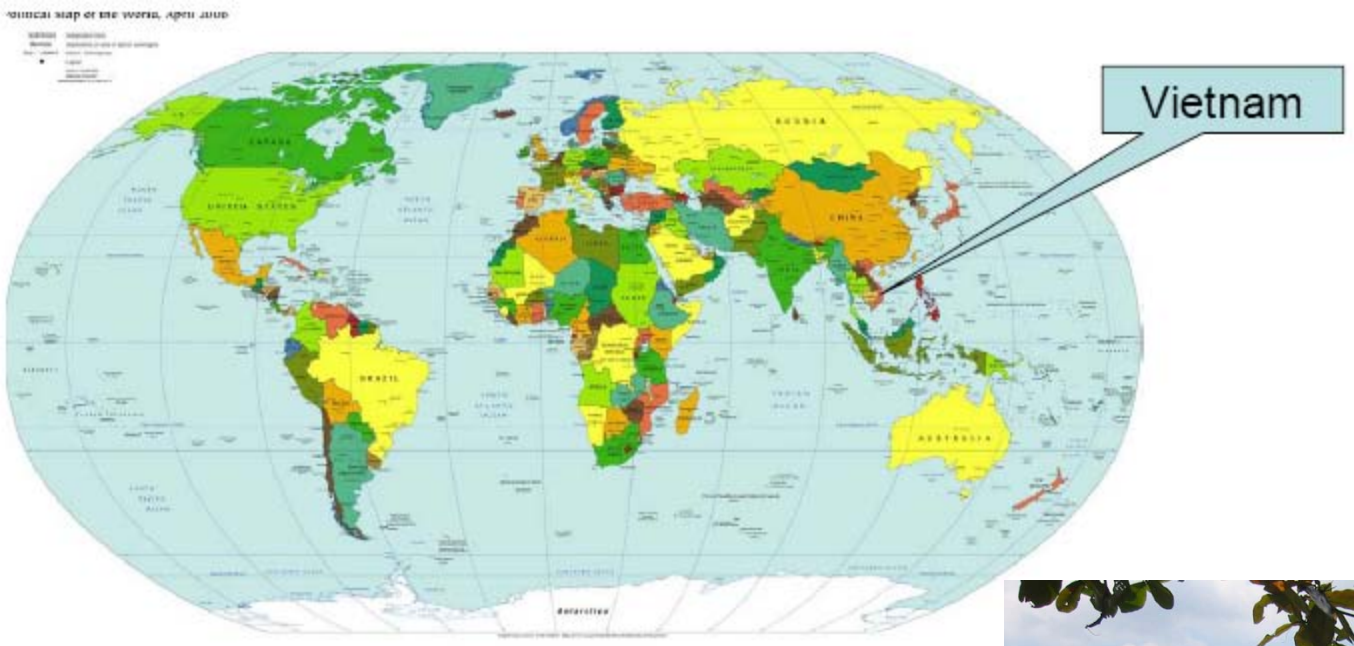
Realistic potential production: ~ 8600 TWh/y



"For non-OECD countries, hydroelectric plants produced 1546 TWh or 21.1% of total gross production reported in 2004. This represents a 9.8% increase over the previous year. Hydro production reported by non-OECD countries has increased at an annual average rate of 4.7% since 1973." – IEA Electricity Information, 2006


The Bonn Declaration reaffirms that hydropower is one of the renewable technologies that can "significantly contribute to sustainable development, to providing access to energy, especially the poor, to mitigating greenhouse gas emissions and reducing harmful air pollutants, thereby creating new economic opportunities and enhancing energy security through cooperation and collaboration."
– signed by 154 countries
renewables 2004
Internationale Konferenz für Erneuerbare Energien, Bonn
International Conference for Renewable Energies, Bonn
UGANDA
Renewables 2004, Bonn

Hydropower development in Vietnam

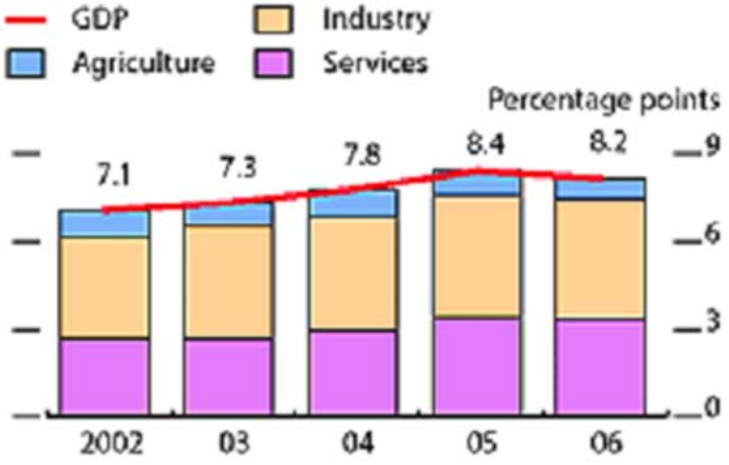


Hoa Binh hydropower 1,920 MW

(The Three Gorges Dam in China 22,500 MW)

Some figures: GDP, Electricity demand & investment

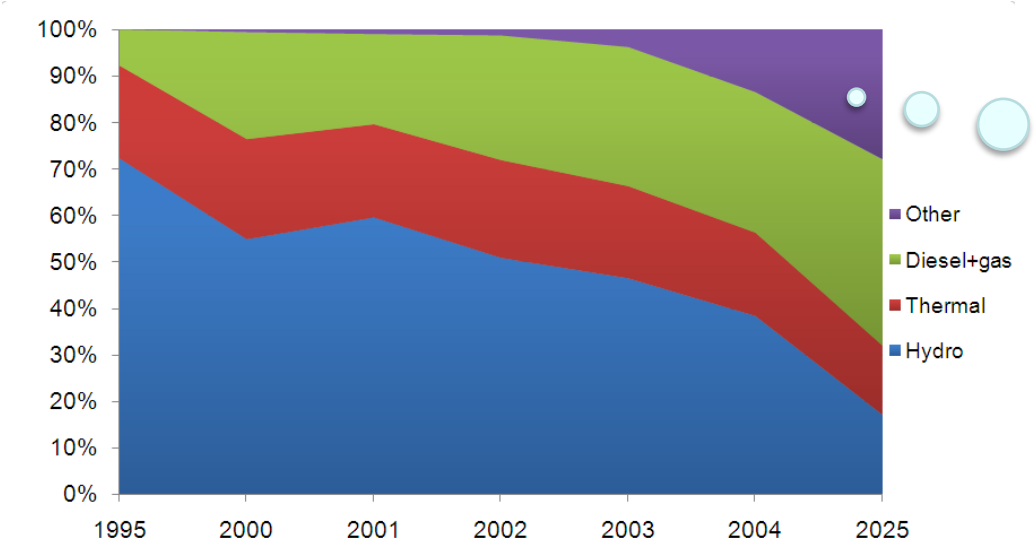
- Average GDP: 7-8%/year
- Growth rate of electricity demand: 15%/year
- Investment capital increased quickly, 12%/year in period of 1996 – 2004



Sources: Asian Development Outlook database; General Statistics Office of Viet Nam, available: http://www.gso.go.vn, downloaded 16 February 2007.

Electricity production/plan & contribution of hydropower

Year	2005	2010	2015	2020	2025
Total N (MW)	11,286	25,857-27,000	60,000-70,000	112,000	181,000
Hydropower (MW)	4,198	10,211	19,874	24,148	30,548
Hydropower (%)	**36.5**	**38-40**	**28-33**	**22**	**17**



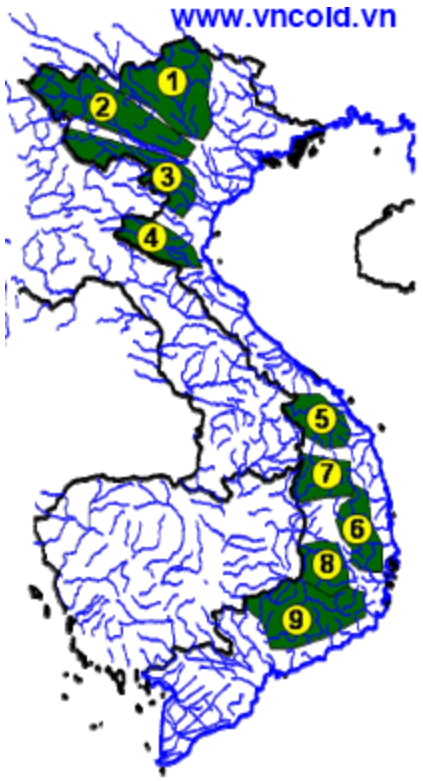
Other ?
Renewables OR
Nuclear

Hydropower development in future

- Hydropower plays an important part in electricity generation.
- Present levels of installed hydropower capacity represent 22.8% of the technical potential. How much of the remaining 77.2% should be developed depends on three things:
  i. Future growth of **demand for electricity**;
  ii. How much of this potential can be **developed in a socially, environmentally and economically desirable and sustainable manner**; and
  iii. What **alternative sources of power generation** are available. The plans set out in PDP VI anticipate that the majority of viable capacity will be developed over the next 10-15 years.

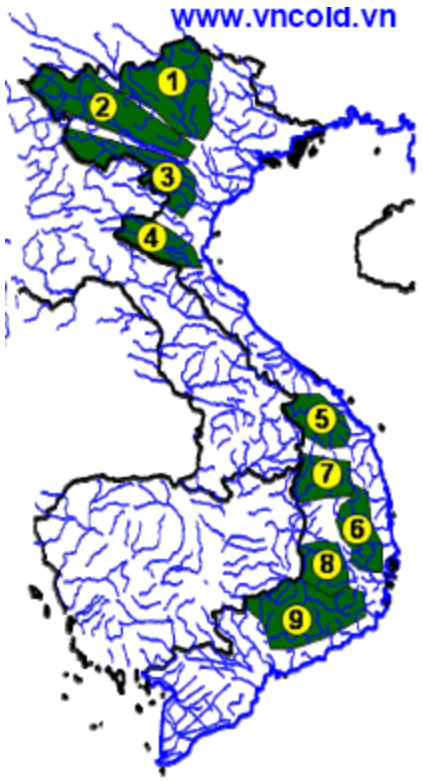
Geography and meteo-hydrology

- Total area 331.000 km^2 (4/5 of this is mountainous areas and highlands)
- Located in the tropical monsoon area, hot and humid, with large amount of rainfall.
- Average annual rainfall: 2,000 mm (highest 4,000-5,000 mm and lowest 1,000 mm)
- Generally, rainy season lasts from 3 - 5 months but unevenly distributed in term of spacial aspect.
- River network: 2,400 rivers longer than 10 km. Almost all rivers flow into the East Sea.
- Gross Run-off Volume is 870 bill. m^3/year, presented as annual average discharge as of 37,500 m^3/s.



Hydropower potential

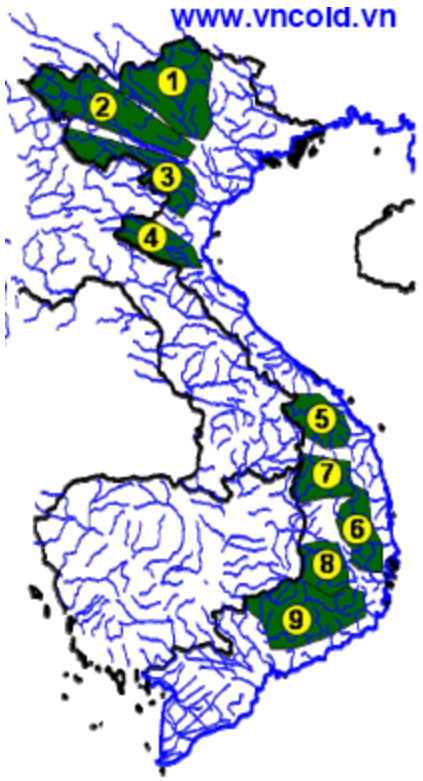
- **Theoretical potential**: ~ 300 bill. kWh (only accounting for rivers with length of over 10 km).
- **Technical potential**: ~ 123 bill. kWh, referred to as installed capacity of 31,000 MW.
- **Technical-economic potential** is identified as some of 75-80 bill. kWh, equivalent to capacity as 18,000-20,000 MW.
- By 2006, Total capacity of existing hydropower plants is 4460 MW which is considered as 18 bill. kWh of average annual energy production. It has been, therefore, over 20% of technical-economic potential exploited.



Hydropower potential (cont')

- ***Power energy potential of medium & small scaled hydropower projects lower 30 MW***

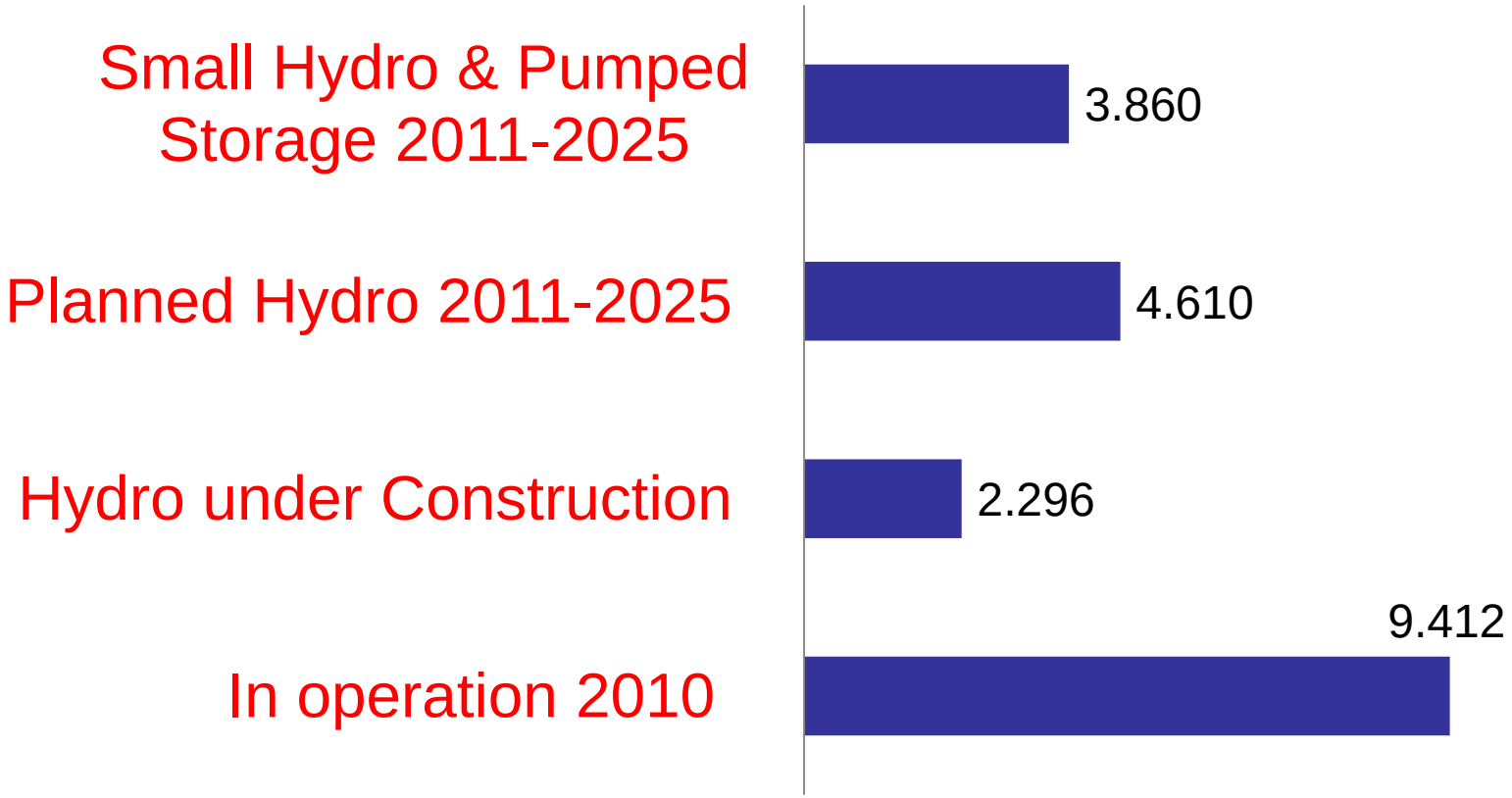
  Total Technical-economic potential of hydropower projects ≤ 30MW, some of 300 projects, is in the range of 2,500-3,000 MW, referred to as 10 bill. kWh of average annual energy production.



- ***Power energy potential of pumped storage power projects: 10 projects***

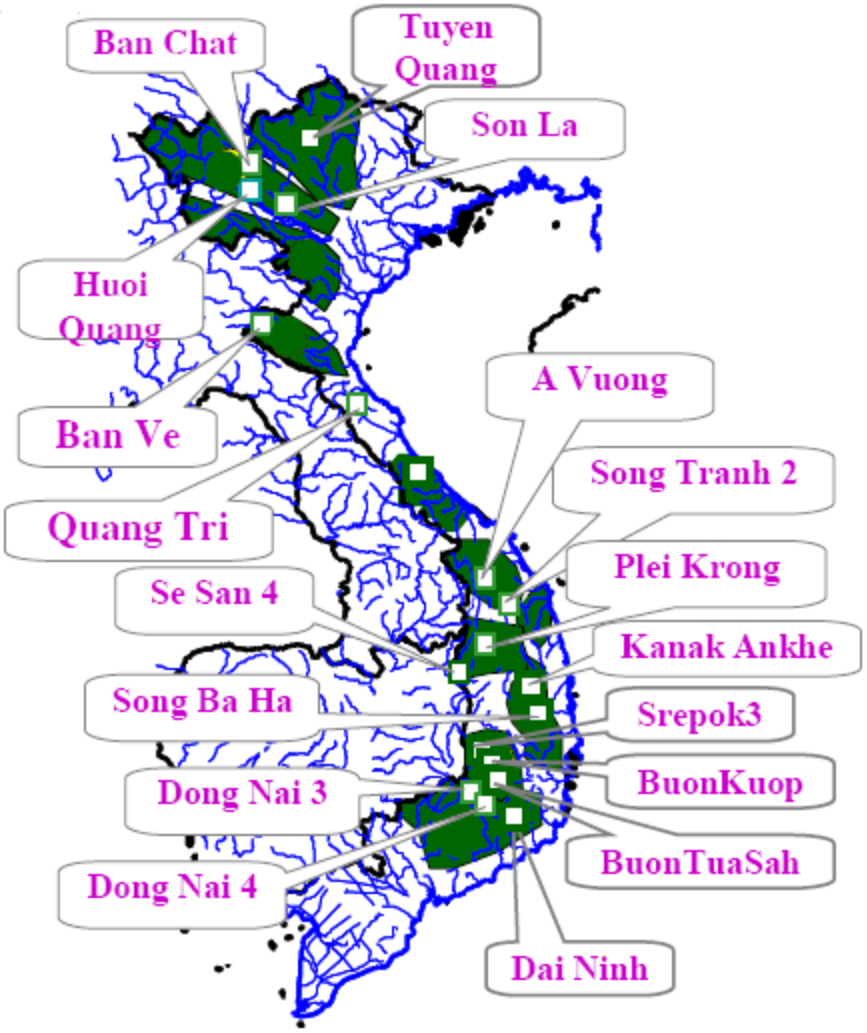
  Total capacity of 10,000 MW, has been identified viable (i.e in Sonla province 7 projects, Hoa Bình 1, Ninh Thuan 1 & Binh Thuan 1). Pre-feasibility report of 2 projects, in Sonla and Ninh Thuan, has been prepared.

Hydropower potential (cont')



Hydropower plants under construction in 2010 - 2015

- At the present, **19 projects** invested by EVN are under construction.
- In which Sonla hydropower plant, 2,400 MW, is the biggest one in the South East Asian. The first and second units are planned to commission by late 2010 and project completion in late 2012.



Hydropower plants under construction in 2010 – 2015 (cont')

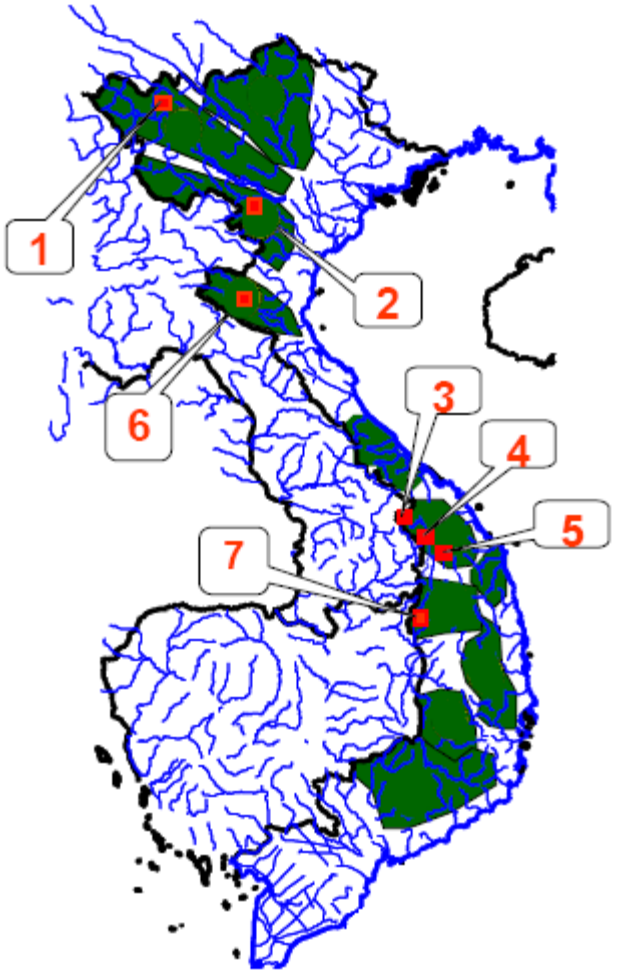
	Power Plant	Province	Installed Capacity (MW)	Dam type	Dam Height (m)
1	Tuyen Quang	Tuyen Quang	342	RDF	93
2	Son La	Son La	2400	RCC	138
3	Huoi Quang	Son La	520	CGD	130
4	Ban Chat	Lai Chau	220	RCC	104
5	Ban Ve	Nghe An	320	RDF	136
6	Quang Tri	Quang Tri	64	RDF	75
7	Song Tranh 2	Quang Nam	190	RCC	95
8	A Vuong	Quang Nam	210	RCC	82
9	Song Ba Ha	Phu Yen	220	ED	60
10	Se San 4	Gia Lai	330	RCC	74

	Power Plant	Province	Capacity (MW)	Dam type	Dam Height (m)
11	An Khe-Kanak	Gia Lai	173	RDF	64
12	Pkeikrong	Kon Tum	110	RCC	71
13	Dong Nai 3	Lam Dong	240	RCC	100
14	Dong Nai 4	Lam Dong	270	RCC	128
15	Dai Ninh	Lam Dong	300	RDC	50
16	Bac Binh	Binh Thuan	33	ED	25
17	Buon TuaSarh	Daklak	86	RDC	85
18	Buon Kuop	Daklak	280	ED	30
19	Srepok3	Daklak	220	RDC	60

Hydropower plant under construction in 2010 – 2015 (pre investment)

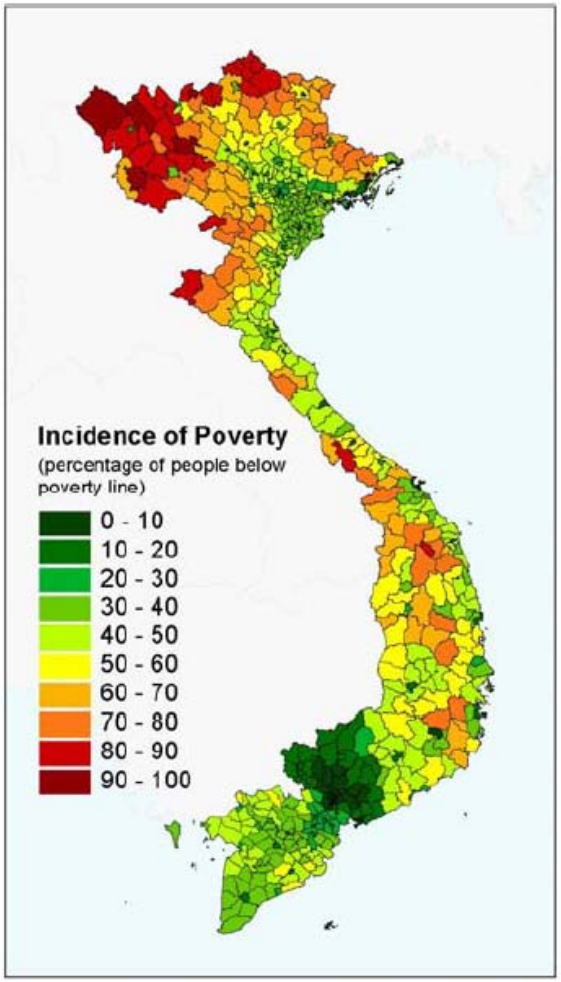
- 7 other projects are in pre investment

No.	Project	Province	Installed Capacity (MW)
1	Lai Chau	Lai Chau	1200
2	Trung Son	Thanh Hoa	250
3	Song Bung 2	Quang Nam	100
4	Song Bung 4	Quang Nam	145
5	Song Bung 5	Quang Nam	60
6	Khe Bo	Nghe An	90
7	Se San 4a	Gia lai	60



Hydropower development in persistent poverty pockets

- Remarkable progress in poverty reduction in recent years, but persistent poverty pockets remain in the central and northern mountainous areas: precisely where most hydropower development will take place.



Resettlement options & land scarcity

- Relocation policy:
  - Within the same province
  - In other province or area far from origin place
- 3 resettlement options

  A.A new concentrated site (71%)

  B.A mixed site with the existing village (26%)

  C.A site not far from the old site (2%)
- Land scarcity, allocation

Village before and after relocation

Instead of traditional village

Now “new ghetto”

Existing problems

- Resettlement, relocation
- Land scarcity, allocation
- Restoration of lives & livelihood
- Change in income & expenditure
- Improved housing
- Improvement of infrastructure
- Health and sanitation, waste (solid, human)
- Breakdown of community structure
- Loss of village, familiar, social coherence;
- Respect for important religious rites during resettlement
- Relationships between ethnic groups in new resettlement sites

Loss of landscape, heritage,...

Caves in Son La province

References

- http://www.sustainablehydropower.org
- http://www.vncold.vn/web/default.aspx
- Luong Van Dai, *Outlines of power sector in Vietnam – Hydropower potential and development*, Presentation at the HYDRO 2007 in Grenada (Spain)
- And many others