



Hydropower Generation

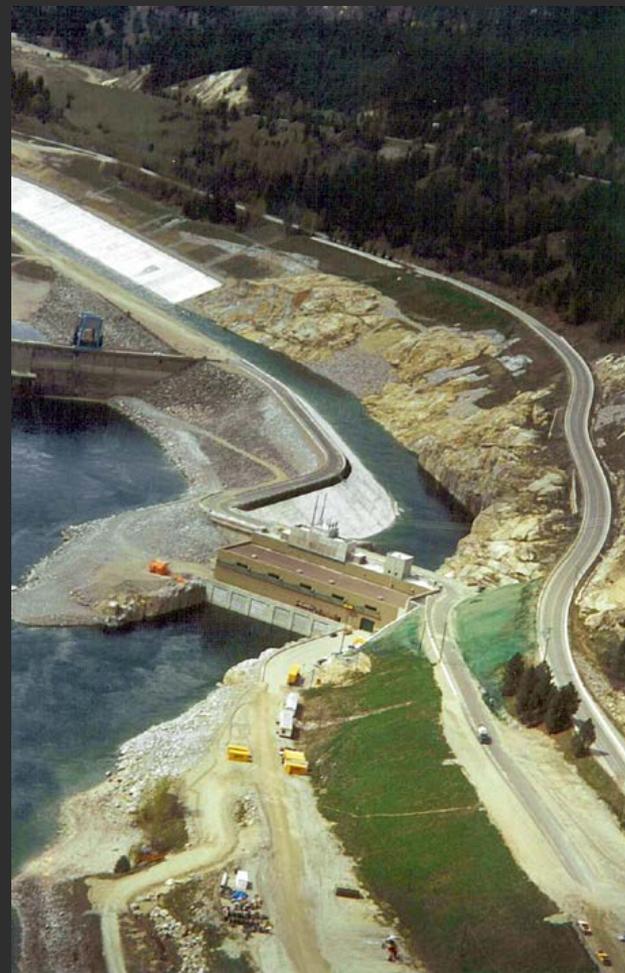
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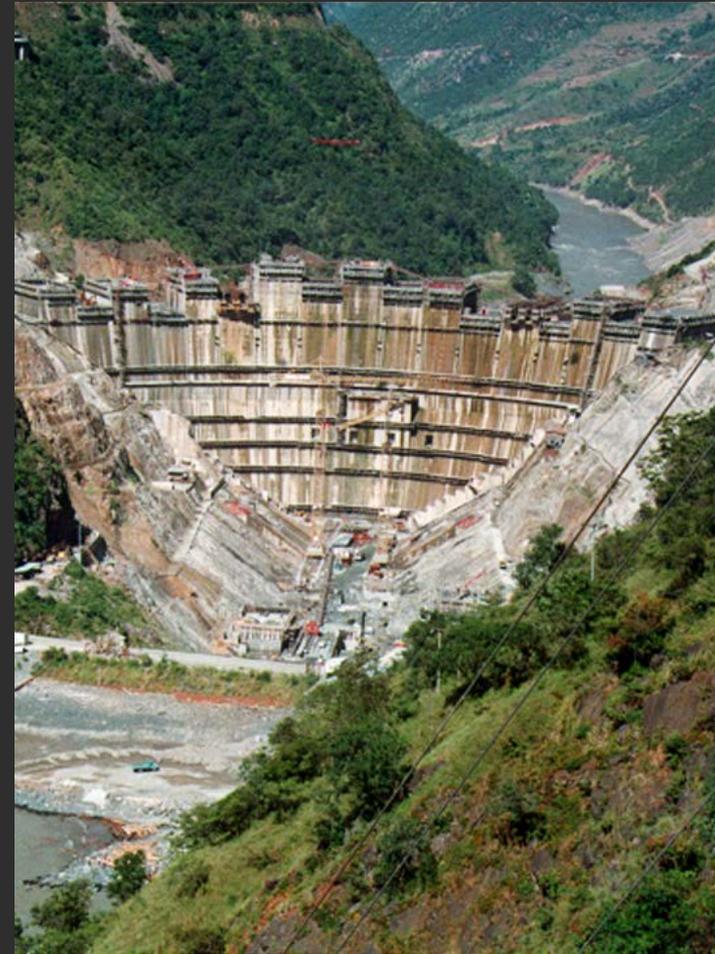
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- Introduction and Background
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- New Capacity



Introduction and Background

- Hydro development continues at steady pace worldwide
- 35 GW new hydro capacity under construction in 102 countries
- Hydro projects planned in 110 countries, totals 326 GW
- The World Bank renewed focus on hydro development and dams for multi-purpose projects
- 70% of economically feasible potential remains to be developed in developing countries.



Ertan Hydroelectric Project, China

Introduction and Background

- Hydropower currently supplies 21% of World's electricity
- By 2020, global electricity demand could reach 23,000 TWh - up to 28% could be supplied by hydropower
- Growth in electricity demand most rapid in regions where greatest potential for hydropower development lies



Tian Huang Ping Project, China

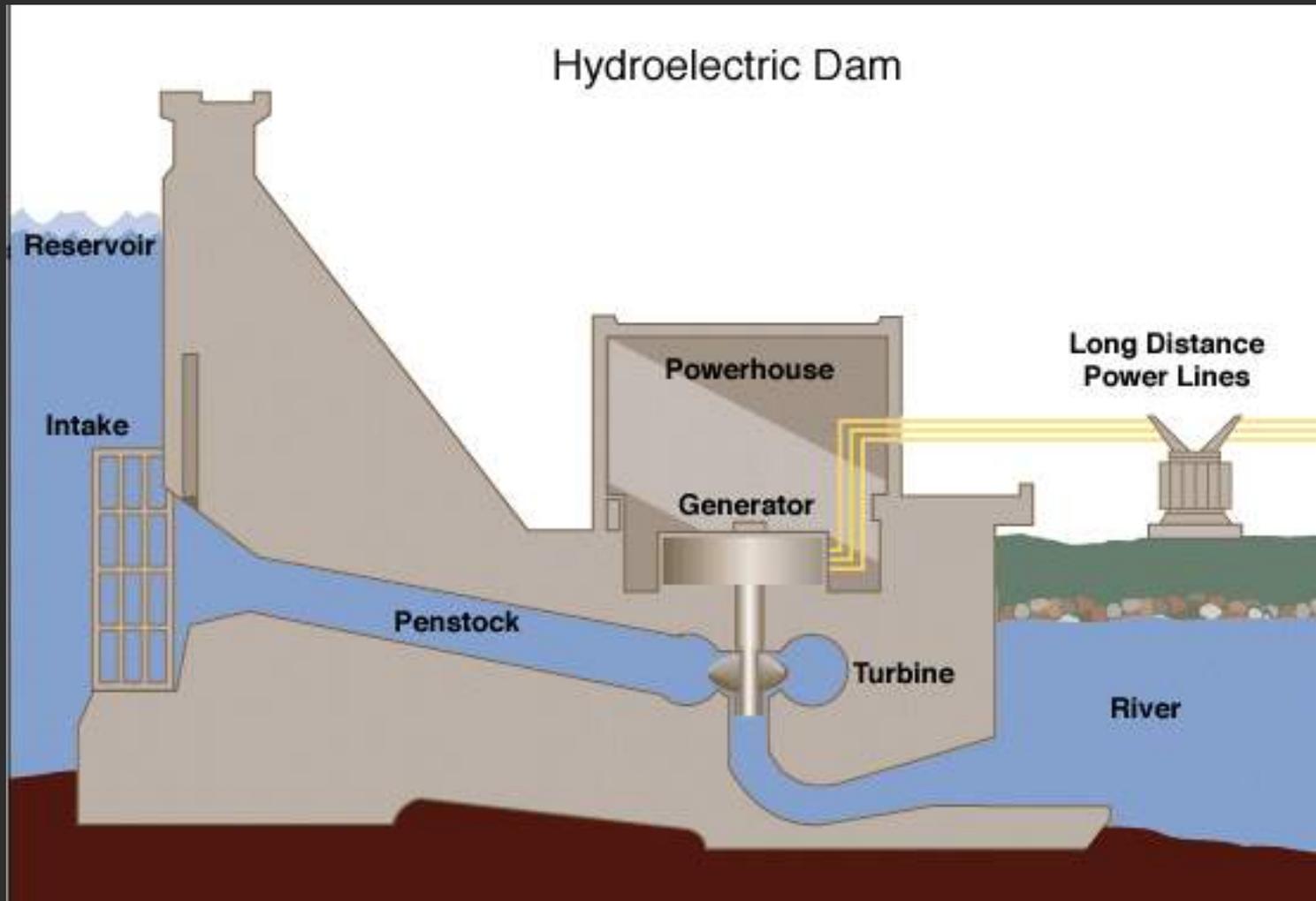
Benefits of Hydropower

- Proven technology (more than a century of experience) with modern power plants providing the most efficient energy conversion process (>90% efficiency)
- Peak load energy from hydropower allows best use of base load power from other renewable electricity sources (i.e., wind and solar power)
- Fast response time enables it to meet sudden fluctuations in demand
- Lowest operating costs and longest plant life
- The “fuel” is renewable
- Low emissions – Hydropower saved Greenhouse Gas emissions equivalent to all the cars on the planet (in terms of avoided fossil fuel generation-1997)

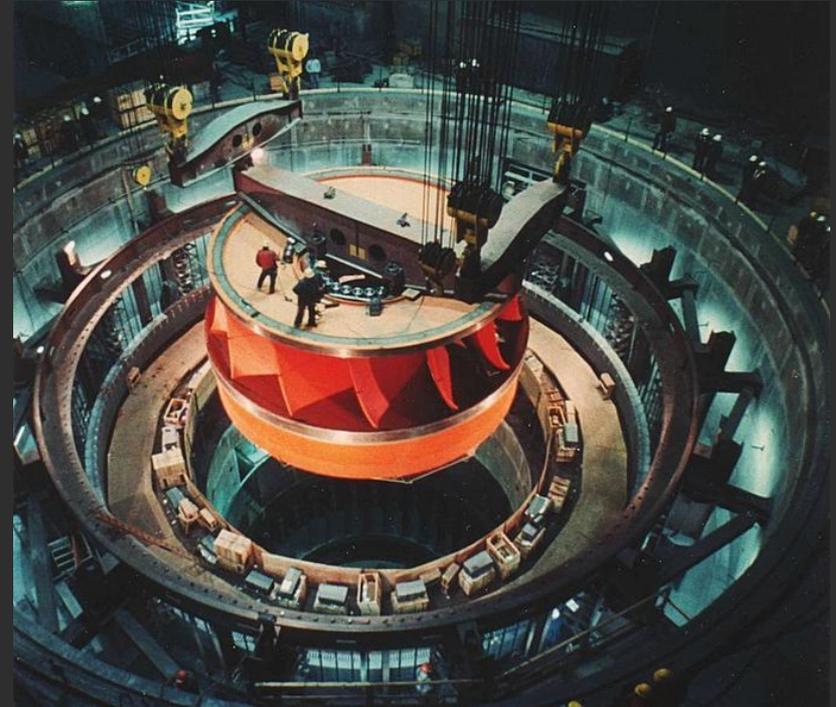
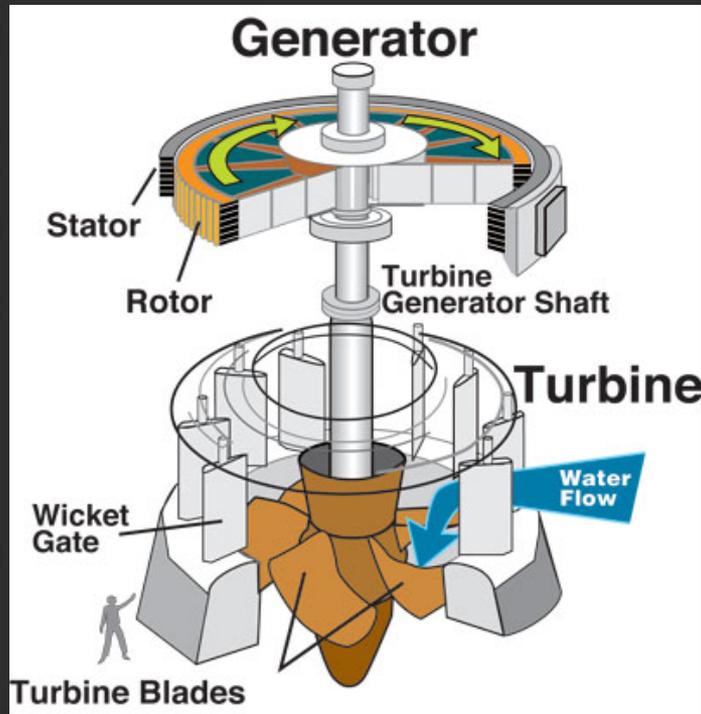
Hydropower Technology

- **Run-of-river** – River flow is diverted through a powerhouse back to the river generating power.
- **Storage** – Dam creates a storage reservoir and the water is released from the reservoir in accordance with the demand for generating power.
- **Pump storage** – Water flows from the upper reservoir through a powerhouse to the lower reservoir generating power. The powerhouse operation is reversed, pumping water from the lower reservoir to the upper reservoir where it is available for the next cycle to generate power.

Conventional Hydro

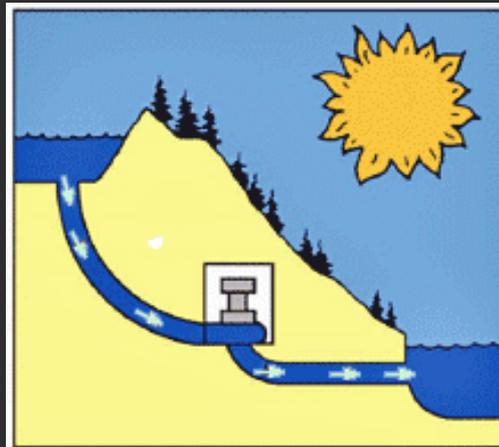
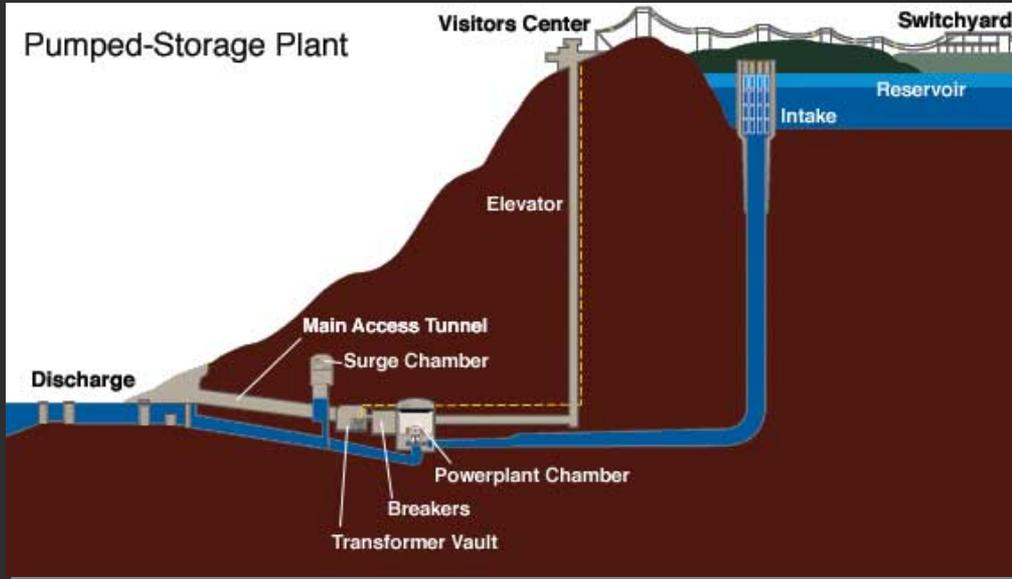


Typical Hydro Turbines

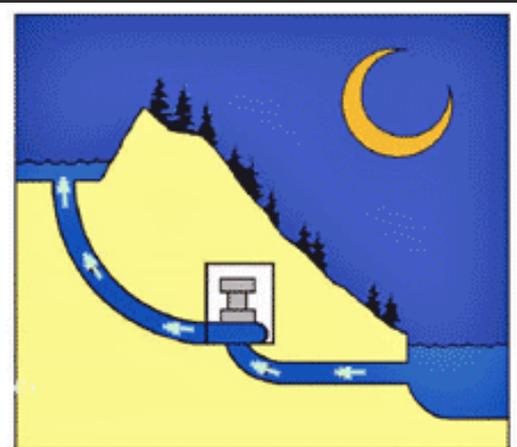


Knight Piésold

Pumped Storage



Daytime: Water flows downhill through turbines, producing electricity



Nighttime: Water pumped uphill to reservoir for tomorrow's use

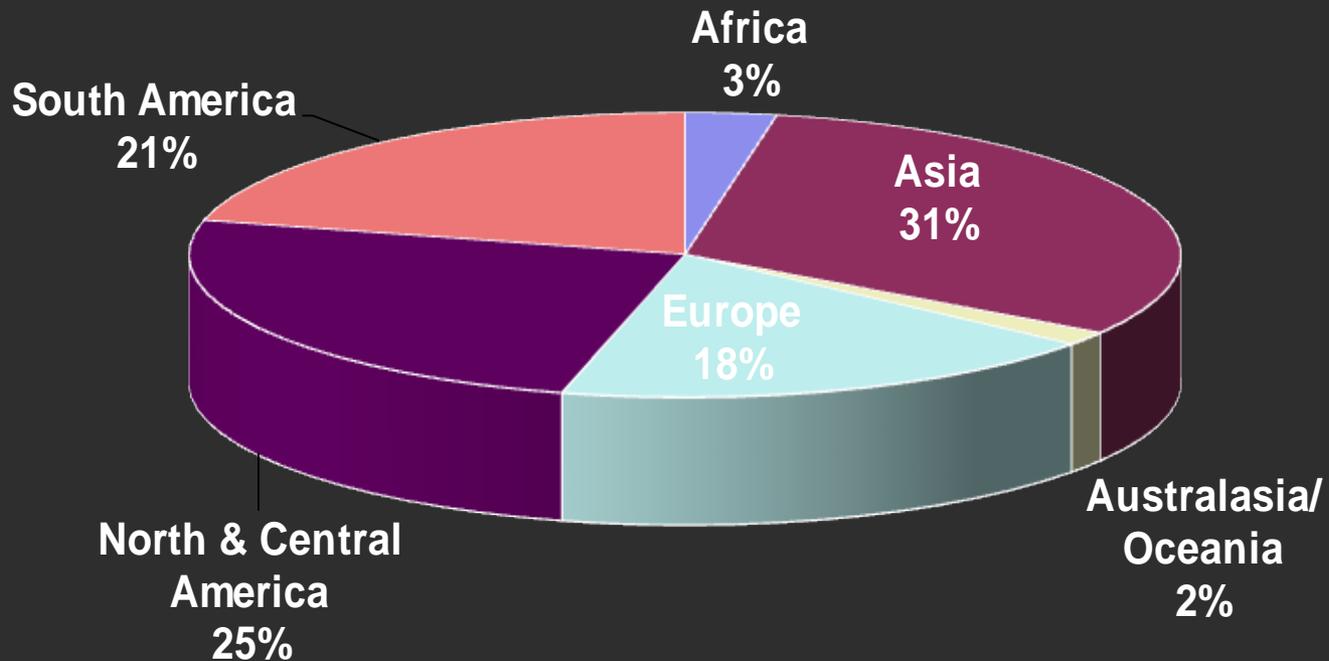
Hydropower Potential (GWh/yr)

	Gross Theoretical	Technically Feasible	Economically Feasible
Europe	3,200,000	1,140,000	770,000
Asia	19,000,000	6,800,000	4,000,000
Africa	4,000,000	1,750,000	1,100,000
North & Central America	7,200,000	1,660,000	1,000,000
South America	6,200,000	2,815,000	1,600,000
Australasia/Oceania	600,000	200,000	90,000
Total	40,200,000	14,365,000	8,560,000



Ghazi Barotha, Pakistan

Annual Hydro Production (2006-2007)



Economic Value

	Production (GWh/year)	Economic Value (\$Billions)
Europe	507,320	\$25.4
Asia	874,000	\$43.7
Africa	83,100	\$4.2
North/Central America	695,200	\$34.8
South America	590,660	\$29.5
Australia/Oceania	43,629	\$2.2
WORLD TOTAL	2,793,909	\$139.8



Chasma, Pakistan

Current World Capacity

REGIONS	CURRENT CAPACITY (MW)
Africa	21,200
Asia	257,500
Australasia	13,400
Europe	170,000
North/Central America	163,200
South America	120,750

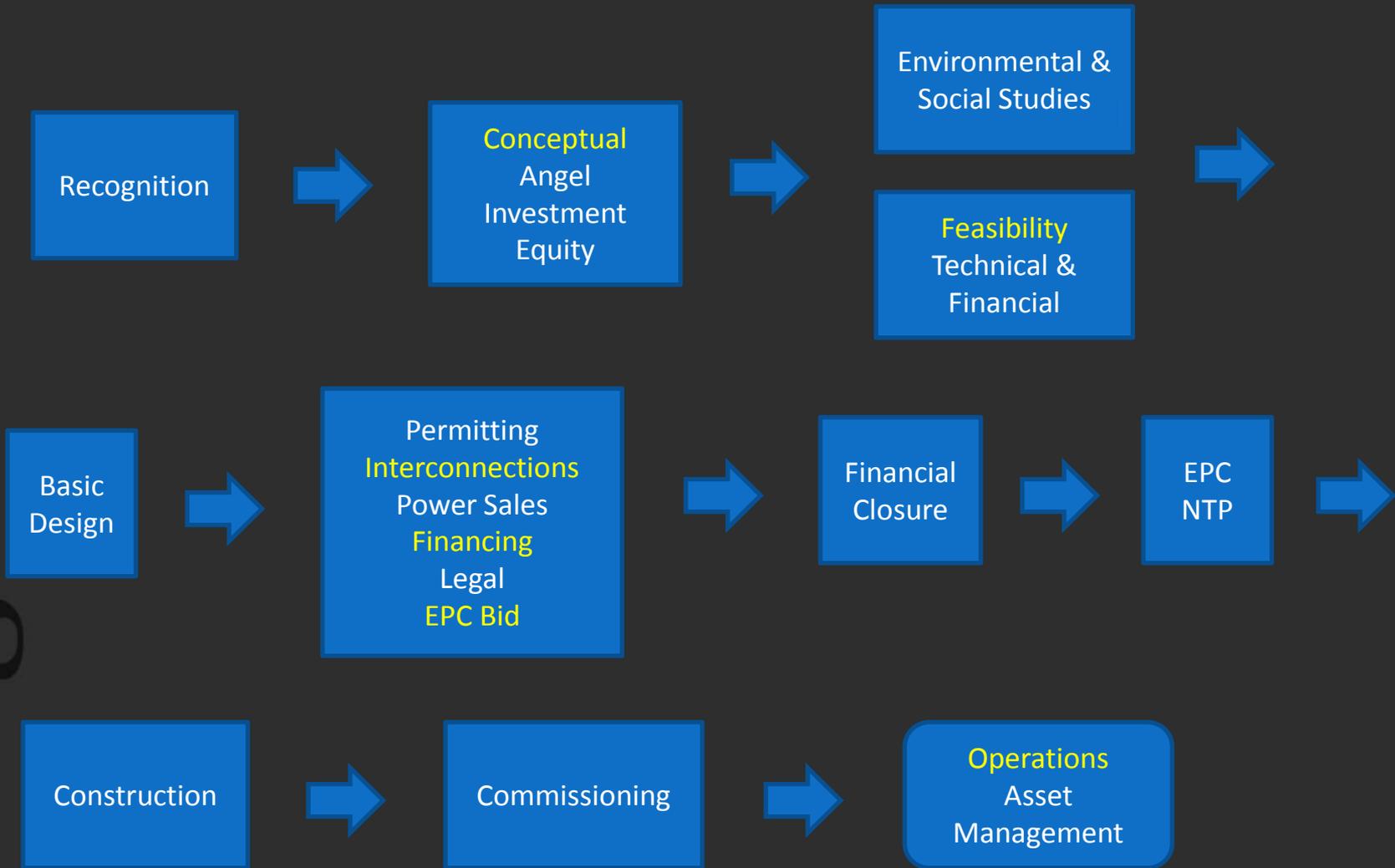
Planned World Capacity

REGIONS	MINIMUM CAPACITY (MW)	MAXIMUM CAPACITY (MW)
Africa	<24,000	82,000
Asia	<209,000	266,800
Australasia	<100	--
Europe	<12,370	12,900
North/Central America	<19,150	--
South America	<61,800	64,950

Capacity Under Construction

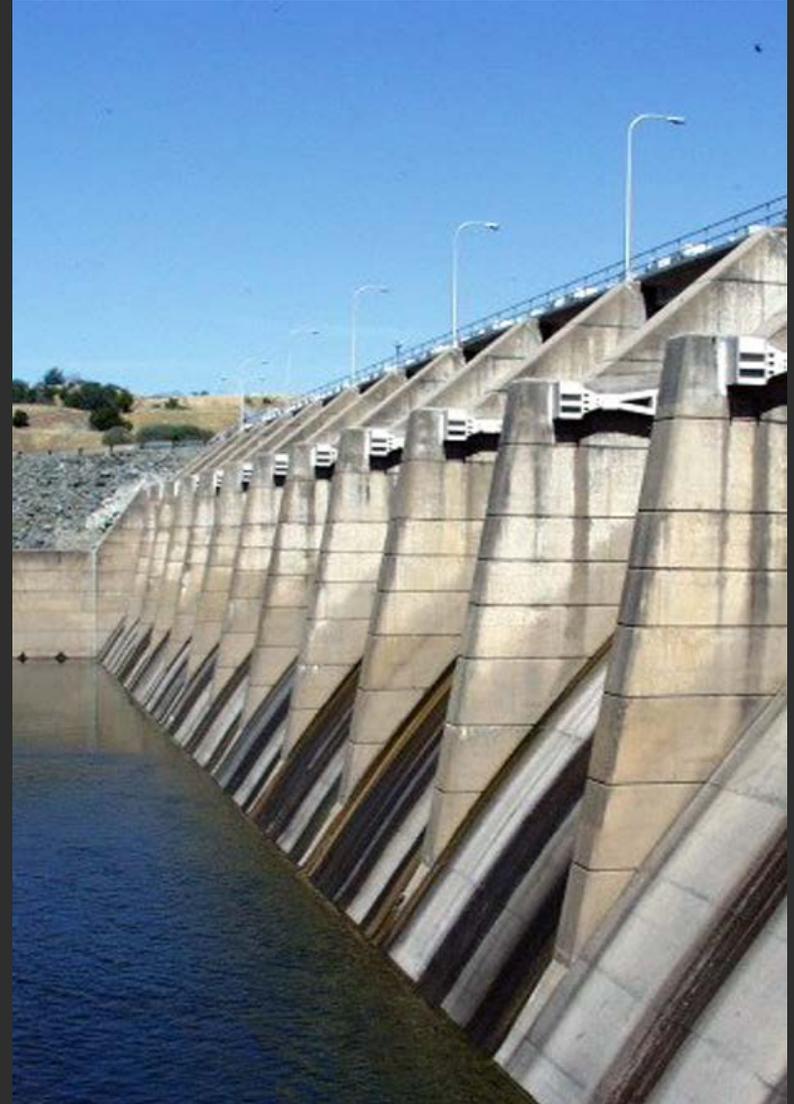
REGIONS	CAPACITY (MW)	NO. OF COUNTRIES
Africa	4,000	21
Asia	9,300	31
Australasia	20	--
Europe	2,700	28
North/Central America	<4,000	10
South America	15,400	12

Project Development Cycle



Issues Facing the Industry

- Privatization
- Environmental and social impact
 - Sedimentation
 - Fish protection
 - Water quality
 - Resettlement of local people
- Retirement of dams and hydroelectric facilities



Statistics – Largest Hydro Facilities

Rank and Name	Country	CAPACITY (MW)
1. Three Gorges	China	22,500
2. Itaipu	Brazil/Paraguay	14,750
3. Xiluodu	China	12,600
4. Belo Monte	Brazil	11,233
5. Guri	Venezuela	10,055
6. Ticirio	Brazil	8,370
7. Sayanao-Shushensk	Russia	6,500
8. Grand Coulee	US	6,494
9. Longtan	China	6,426
10. Krasnoyarsk	Russia	6,000



Guri Hydro Project,
Venezuela

Statistics – Hydro Producers

Country	Percentage Hydro	GWh/yr	Capacity (MW)
Norway	98.3	140,500	27,698
Brazil	85.6	363,800	69,087
Venezuela	69.2	85,960	14,622
Canada	61.1	369,500	69,205
Sweden	44.3	65,200	16,143
China	22.3	652,050	196,790
Russia	17.6	167,000	45,000
India	15.8	115,600	30,600
Japan	7.2	69,200	27,229
US	5.8	250,600	79,511
Rest of the World		974,000	268,373
World Total		2,794,000	741,121

Statistics – 50% Hydro Scenario

Regions	% of Electricity Supplied by Hydropower	No. of Countries
Africa	53	23
Asia	50	8
Australasia	50	4
Europe	50	6
North/Central America	50	4
South America	50	11

Sources

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Al Wehdah, Jordan