# Hydro Energy

## Slide Index



## Slide 2: Hydro Energy

- Hydropower refers to the generation of electrical power through the extraction of energy from the moving water streams.
- A large fraction of radiation reaching the Earth's surface is absorbed by the oceans, warming them and adding water vapour to the air.
- The water vapour condenses as rain to feed rivers into which dams and hydroelectric turbines can be located to extract the energy of the flowing water.
- Moving water can be extremely powerful.
- The kinetic energy of flowing water can be used to drive hydro-electric turbines to produce electricity.

## Slide 3: Hydroelectric Power: Hydro Energy Converted to Electricity

- Gravity makes water flow from a high to a low place.
- The moving water contains kinetic energy.
- Hydroelectric power stations are able to transform the kinetic energy in moving water to electrical energy.
- In a hydroelectric power station part of a river's flow is sent through pipes.
- The water turns the turbines.
- And the turbines turn the electricity generators.
- The water is returned to the river further downstream.
- In the conventional system, water is stored behind a dam wall.

- The power station is normally situated close to the dam wall.
- The water is released on demand, powering huge turbines that generate electricity.

## Slide 4: Hydroelectric Power in SA

- Eskom operates hydroelectric power stations at both the Gariep Dam and the Vanderkloof Dam.
- In South Africa, its most important role is the storage of 'electricity' in case of unexpected demand, or in case of sudden operational disturbances at one of the power stations supplying the regular demand.
- These hydroelectric plants are also referred to as peaking power stations.
- In mountainous countries hydroelectricity is an important source of energy.

## Slide 5: Hydroelectric Power: Pumped Storage Plant

- A Pumped Storage Plant is currently the only practical way of storing 'electricity' on a large scale.
- This type system has a power plant located between two dams, the upper reservoir and the lower reservoir.
- It then uses reversible/ two way pump turbine which at low electric demand, the water is pumped from the lower reservoir to the upper reservoir.
- On peak hours where the is a high electricity demand, the turbine is switched to generation mode and produce electricity to feed the grid.
- The idea is simply to use surplus electricity – e.g. at night or weekends during low demand (off-peak) periods – to pump water to a mountain-top reservoir.
- In South Africa we have two such systems in operation: Palmiet (400 MW) and Drakensberg (1 000 MW), whilst Ingula (1 332 MW) is still under construction.

## Slide 6: *Hydroelectric Power*: Pump Storage dams

- Igula Pump Storage dam is situated in Kwazulu Natal in the Drakenberg area. It has a power generation capacity of 1332 MW from four units. These dams also play a significant role in stabilizing the grid. Not only when needed on peak periods but also to maintain load on off peak periods.

## Slide 7: *Hydropower:* Run-of-river systems

- There are also many other small hydroelectric stations in South Africa, some privately owned, some Eskom stations and by municipalities. They range from 15kW to 3MW power generators. Some municipalities use hydropower turbines in their water treatment plants. This technology has a potential for rural off grid electrification.

## Slide8: Large Dams: Cahora Bassa

- Cahora Bassa is a hydroelectric power station located in Mozambique that supplies power to South Africa.
- South Africa imports about 9000 GWh per year from Cahora Bassa hydroelectric generation station.
- The power line can transmit 1 920 megawatts.

## Slide 8: Large Dams: The Issues

Potential environmental, social and economic benefits and concerns.

*Benefits:*

There are potential economic benefits, such as:

- Sustains livelihoods (fresh water, food supplies)
- Flood control
- Hydroelectric power.

*Concerns:*

- Significant evaporative water losses
- The relocation of people who have been or will be displaced by the rising waters.
- Siltation that could limit the dam's useful volume.
- Loss of numerous valuable biospheres, archaeological and cultural sites.
- Loss of habitat.

## Slide 10: Large Dams: Three Gorges

- The biggest water storage project in the world is the Three Gorges in China.
- The Three Gorges Dam is a hydroelectric river dam that spans the Yangtze River.
- The total electricity-generating capacity of the dam will reach 22500 megawatts, at which point it will be the largest hydroelectric power station in the world.
- As with many dams, there is a debate over costs and benefits.
- The rising water level on 7 November 2006 can be seen clearly from an aerial photo.
- Compare this to the water level on 17 April 1987.
- The dam was first proposed in 1919 by Sun Yat Sen and was eventually approved in 1992.
- The biggest opposition was due to the displacement of more than a million people, who lost their homes and workplaces.
- China also lost one of its valued landscapes.

## Slide 11 &12: Small-scale Hydro

- Small-scale hydro energy varies in size but is generally seen as smaller than 10 megawatt.
- Smaller hydro power plants have received a growing attention in the past few decades due to the growing environmental issues that major hydro developments has.
- Small scale can be separated into 3 categories – Mini-hydro, micro-hydro and pico-hydro
    - Mini-hydro: 100 kW to 1 MW; either stand-alone schemes or more often for feeding into the grid.
    - Micro-hydro: 5 kW to 100 kW; usually used to provide power for small communities or rural industries in remote areas, inaccessible to grid.
    - Pico-hydro: < 5 kW, used for generating power in rural residential, industrial and remote applications.
- Small-scale hydro power plants operate on same principle of large-scale power plants where flowing water is converted used to rotate turbine where it is converted to mechanical energy, which then turns the generator to generate electricity or electrical energy.
- Small-scale pumped storage hydro schemes also exist.
- Small-scale hydro plants normally consist of basic components such as a intake weir or settling basin, channel, forebay tank or reservoir, penstock and powerhouse containing the turbine and generator. (See figure (Gatte & Kadhim) above.)
- Small hydro plant can be developed and constructed at existing dams, rivers and lakes.
- In many cases, its potential for generating electricity is highly dependent on the seasonal variation of flow in rivers or dams where it is constructed.

## Slide 13: Small-Scale Hydro Power Plants in South Africa

- The first bidding round of the Renewable Energy Independent Power Producer Procurement Programme started in 2011.
- Up to date four bidding rounds have been completed.
- The following website contains a map which provides the details of each REIPPPP project in South Africa www.eskom.co.za/Whatweredoing/Pages/RE_IPP_Procurement_Programme.aspx

The following details can be viewed on the website:

- **Name** of the project
- Type of **technology** being build
- The **capacity** of the power plant and the
- Current **status** of the project

| Bidding rounds | Capacity allocated (MW) | Number of Projects |
|---|---|---|

| | | |
|---|---|---|
| Window 1 | - | - |
| Window 2 | 46.8 | 2 |
| Window 3 | - | - |
| Window 4 | 5 | 1 |
| Total | 51.8 MW | 3 |