Hydroelectricity:

Indirect solar power

Reliable technology

Competitive price

1/6 of world's annual electrical output

(= 90% of all renewables)

Hydroelectricity:

Power (carried by water) in kW

= 10 X Q (flow rate, m^3/s) X H (effective head)

Turbo-generator transforms potential E into electric E

* (NB) electric power

Hydroelectricity:

Type of turbine = f (head, req. power)

Hydroelectricity: world resource

Only 0.06% of water arrives on the ground as precipitation
(others simply as evaporation)

Total (or available) resource:
40 000TWh per year
(= 15 times of world present hydroelectric output)

Technical potential resource:
15 000TWh per year

Hydroelectricity: world resource

Technical potential resource:
15 000TWh per year

Question: practical, acceptable, and affordable to develop?
→ Practical potential / Economic potential

Hydroelectricity

Contribution to all E

Norway: ~100%
Brazil: 80%
Canada, Sweden: 50%

Hydroelectricity:

Stored Energy

Potential Energy: MgH (see the main text of p.156)

Req. power: Enough volume (i.e. flow rate) of water
Enough head

Hydroelectricity: Noria (~ 5000 years ago)

Hydroelectricity: Norse or Greek mill, 1st, 2nd century BC

Hydroelectricity: 20 000 working mills in England by the end of 17th century

Al-Jazari (1136-1206)

Al-Jazari’s musical robot band

Hydroelectricity: 푸르네롱 브누아 (1802-1867), in 1832

Efficiency: 80% of water energy into mechanical output

Outward flow

Hydroelectricity: Francis turbine – inward flow

Hydroelectricity:

Classification of hydroelectric installations

-By the effective head of water
-By the capacity – the rated power output
-By the type of turbine used
-By the location and type of dam, reservoir

•Classification by the head (no clear boundaries)
Low-head: less than 10 meters
High-head: more than 100 meters

Hydroelectricity: propeller (axial-flow turbine)
– for low head, for very large volume of water

Hydroelectricity

Turgo: for medium head

Hydroelectricity

Cross-flow turbine (Mitchell-Banki, Ossberger turbine):
for small scale plants with outputs below 100kW