REF
RENEWABLE ENERGY FOUNDATION

Renewable Energy Foundation
Renewable Energy Data
Technology Analyses:
Apr. 2002 – Jan. 2007
Hydro Power

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2. National Load Factor
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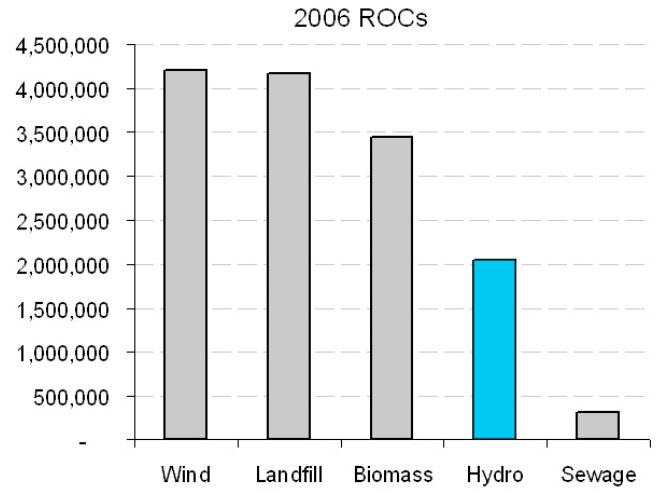
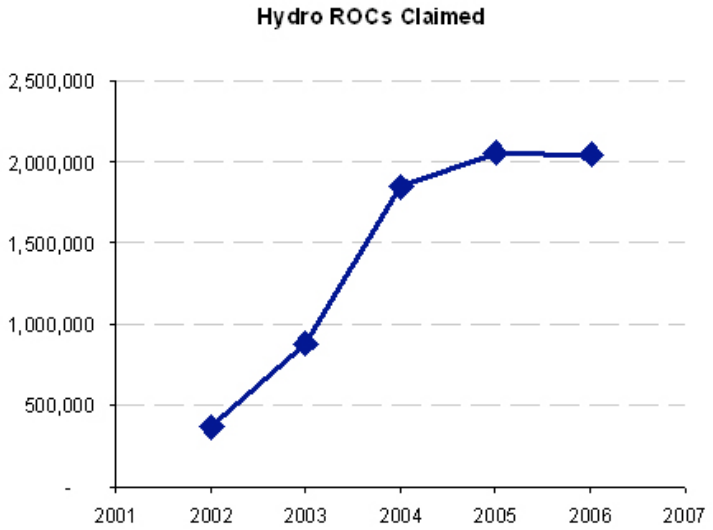
Hydro Contribution Since 2002

- Hydro was the fourth largest claimant of ROCs in 2006
  - Graph shows a 132% increase in ROCs since the first full year of the RO in 2003.
  - The number of plants claiming ROCs in 2003 was 124 and 198 in 2006 (59% increase)
- The Energy White Paper 2007 declared that from 1st April 2009, hydro is to remain on a banding of 1 ROC/ MWh
- The *Energy White Paper* 2007 declared the government's intent that from 1st April 2009, hydro operators will continue to receive 1 ROC/ MWh.





Description of the technology

- Hydro power is created by allowing a flow of water from a higher level to a lower level through a turbine where the potential energy of the water is transferred to kinetic energy. The turbine rotates a generator to produce electricity
- The general rule of calculating power from hydroelectric plant:[1]

  Power = head × flow × gravity acceleration × efficiency

  flow = the volume of water that can be captured and redirected to turn the turbine generator

  head = distance the water will fall on its way to the generator

- There are four types of turbines:-

  1. High head - above 100 m
  2. Medium Head - 20m to 100m
  3. Low Head - 5m to 20m
  4. Ultra Low Head - below 5m

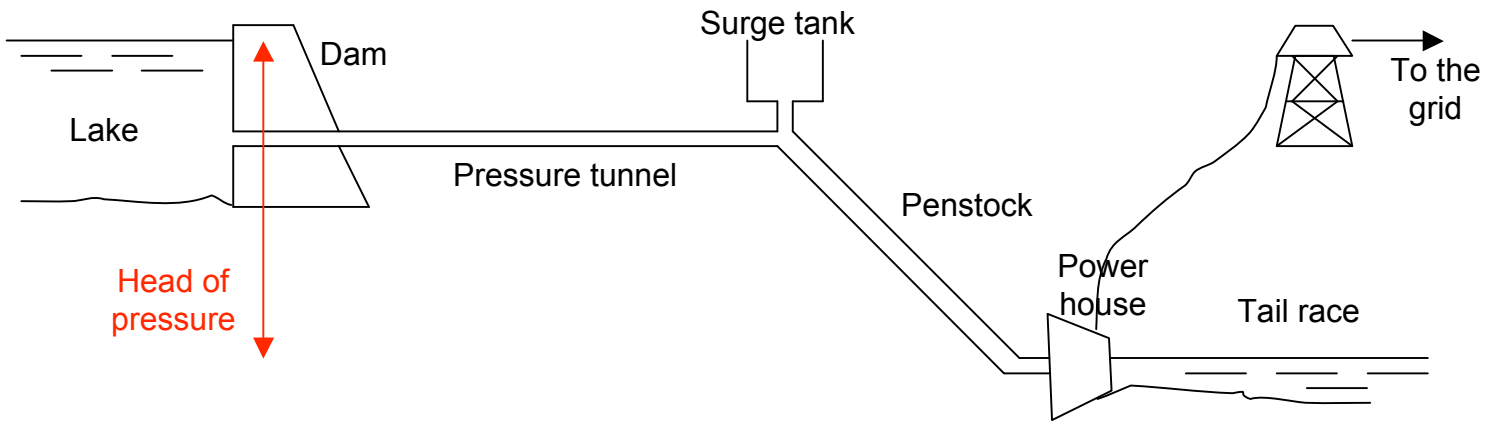
- The Renewable Obligation (RO) Order only accepts hydro generating stations which have a declared net capacity of 20 MW or less.

- The hydro generation plants in the UK that are entitled for ROCs (Renewable Obligation Certificates) are divided into two main categories by OFGEM (Office of Gas and Electricity Markets):-

1. Micro hydro (41 sites)
2. Hydro < 20MW DNC (169 sites)

1. Jog M.C., Hydro-Electric and Pumped Storage Plants,1988, John Wiley and sons
2. http://www.british-hydro.org/

Hydro Plant Example

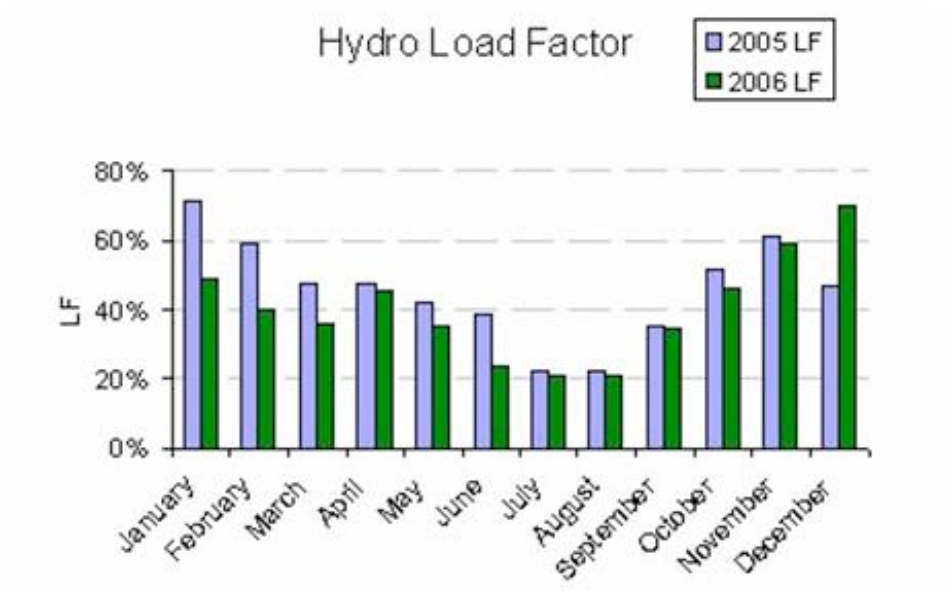


- The dam or weir (if there is one) provides an increase in the upstream water level and therefore pressure and storage capacity. The flow of water is managed by the operator to control both electrical power and flow in the downstream rivers. Small hydro plant typically have little storage and no ability to control water flow and power.
- The pressure tunnel and/or penstocks are used to carry the water from the reservoir to the power station. The surge tank acts as a pressure relief valve to prevent damage.
- The power house accommodates the turbines, generator, control equipment and transformers.
- Tail race: the water after passing through the turbine and is discharged into the river itself.

Jog M.C., Hydro-Electric and Pumped Storage Plants,1988, John Wiley and sons

National Load Factor

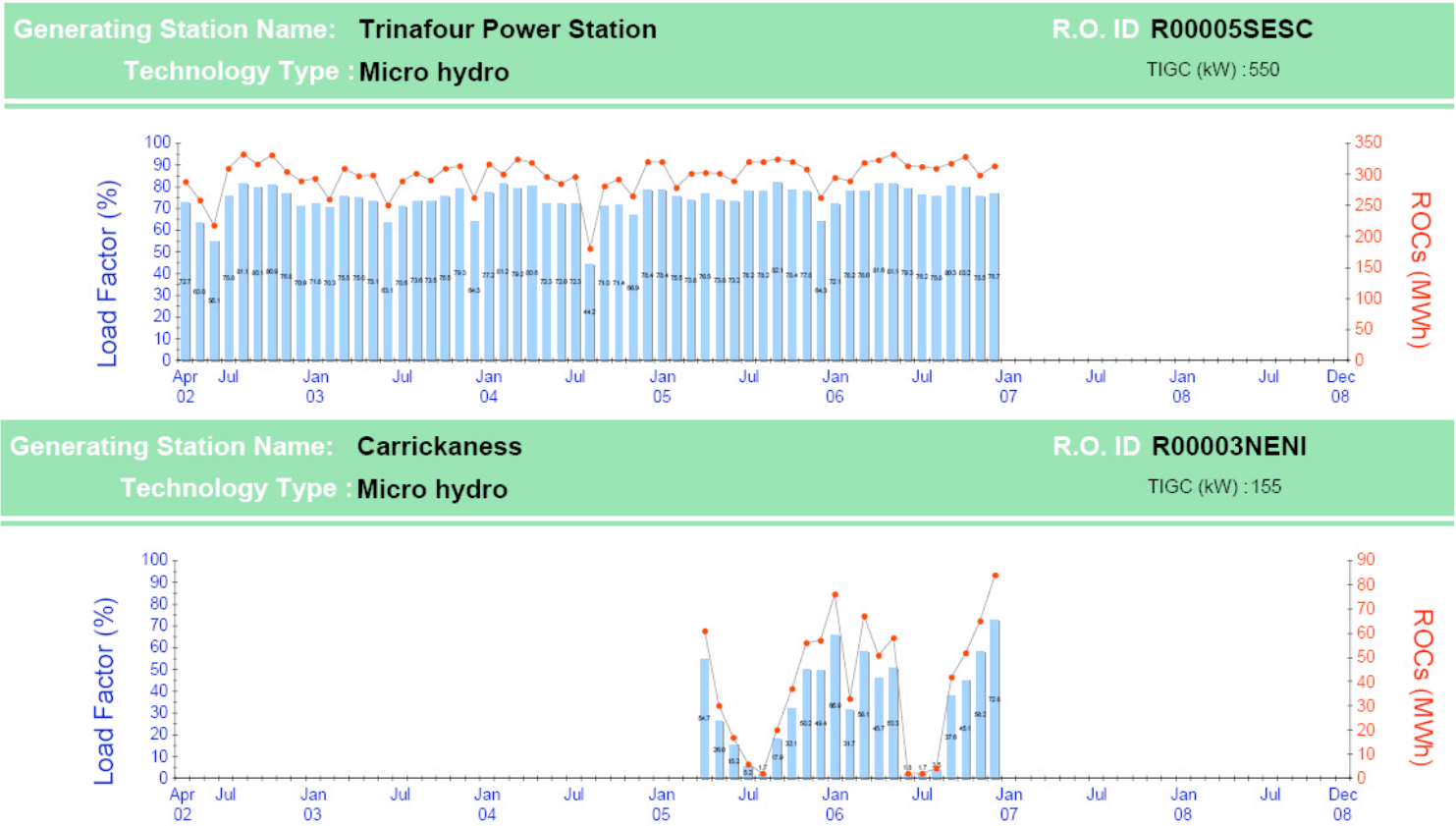
- The graph of load factor[1] shows that hydro power is strongly affected by the weather and season. For example, performance in January 2005 was superior to that in January 2006 probably as the result of higher rainfalls.
  - 265,000 ROCs v 196,000 ROCs (a 26% reduction)
- The Annual National Load Factors were
  - 2005 : 45.2%
  - 2006 : 39.9%



1. Load Factor is the amount of energy delivered in a time period divided by the potential generation if the plant runs at full capacity for all of that time.

Effect of storage capacity

- Damming a river provides considerable water storage which allows for water flow management and controllable hydro power throughout the year. However, it interferes with the natural water flows and is discouraged under contemporary environmental regulations.
- The variation in seasonal power output can be seen in the plots of Load Factor for Trinafour in Scotland which has a dam and Carrickaness in Northern Ireland which does not



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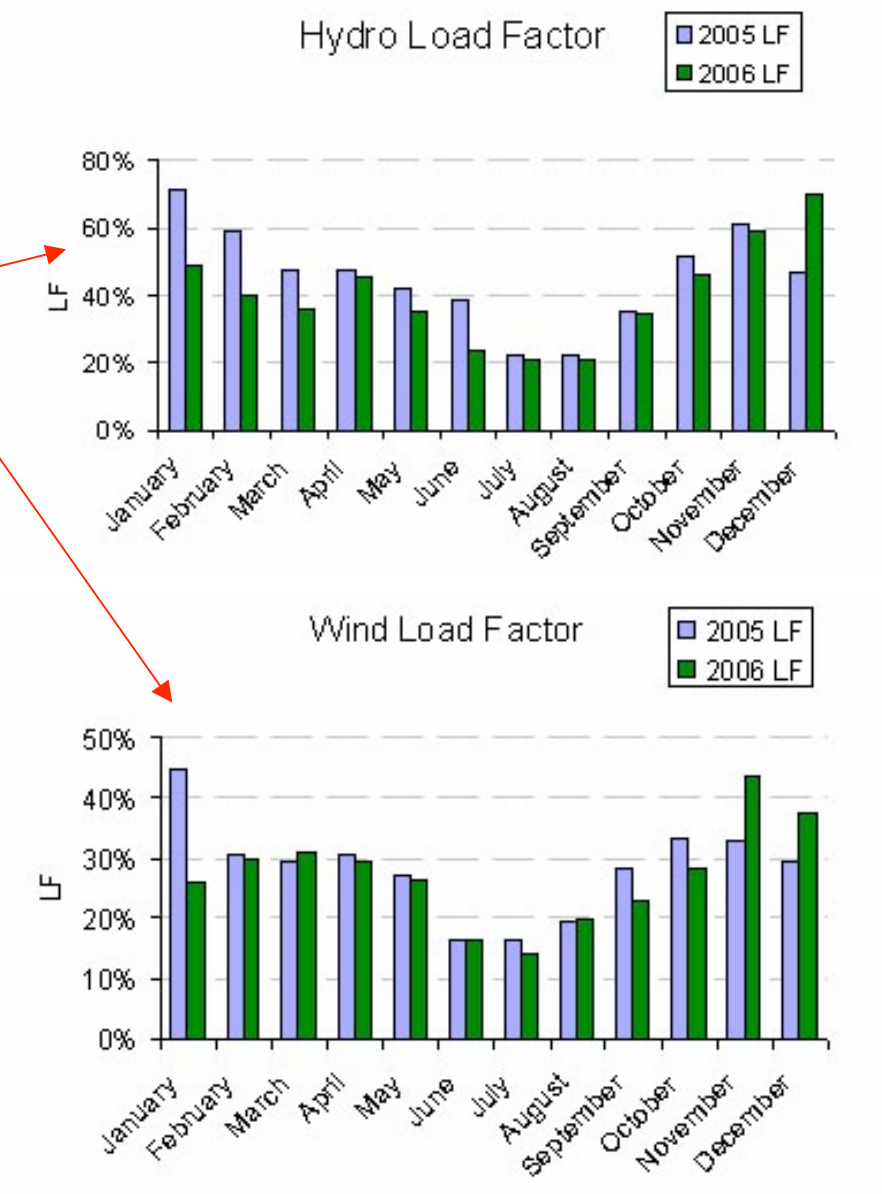
Hydro correlation to wind output

- It is important to note that Hydro and Wind Load Factors vary together with the seasons and months, since they share a common fuel source, meteorological phenomena, and in particular low pressure systems which bring both rain and wind to the country.
- This close correlation limits the degree to which hydro is able to smooth wind power output variations. This is particularly true for hydro plants without a dam.



Conclusions

- There has been a 132% increase in claimed ROCs since the first full year of the RO in 2003 to 2006. This was partly due to a 59% increase in the number of plants claiming ROCs.
- Hydro power output is strongly linked to the weather and strong variations occur. For example Jan 2006 provided 26% fewer ROCs than January 2005.
  - This weather based variation can be smoothed by the use of dams and proper water flow management. However, this interferes with the natural ebb and flow of rivers and effects wildlife and other river users. Contemporary environmental restrictions limit the future building of dams, which limits the economic return for significant new hydro plant and means the hydro plant which is built will have limited ability to provide base load through out the seasons.
- Comparison of hydro load factor with that of wind shows a strong correlation (strong low pressure systems bring both wind and rain), limiting the degree to which hydro (without dams) can act to balance wind generation.
- The Energy White Paper 2007 has declared that hydro is to remain on a banding of 1 ROC/ MWh.