Last lecture

Hydro power stations,

Wind turbine farms,

Solar cells

And Final exam

Hydro Power

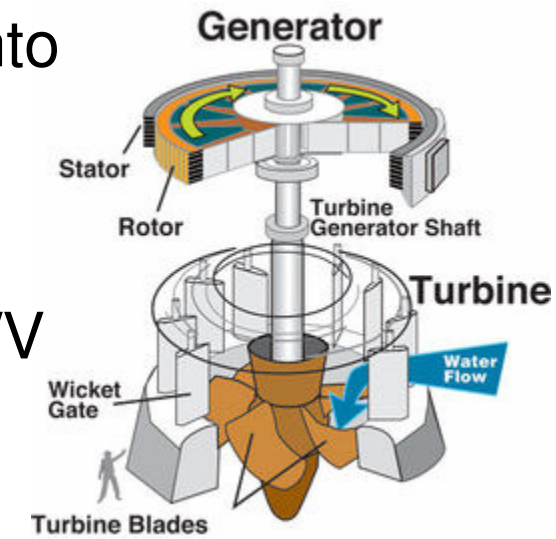
Gravitational potential energy is transformed into electrical energy. Power = Energy/Time

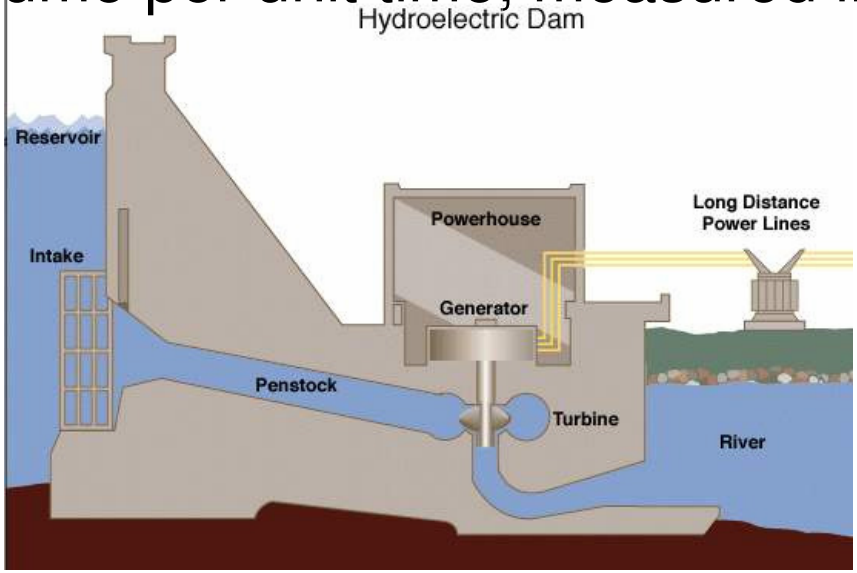
$$P = \Delta m\, g\, h/\Delta t$$

So the power depends on the amount of the water per unit time. Using the density $\rho = m/V$ (1000 kg/m^3 for water), we obtain

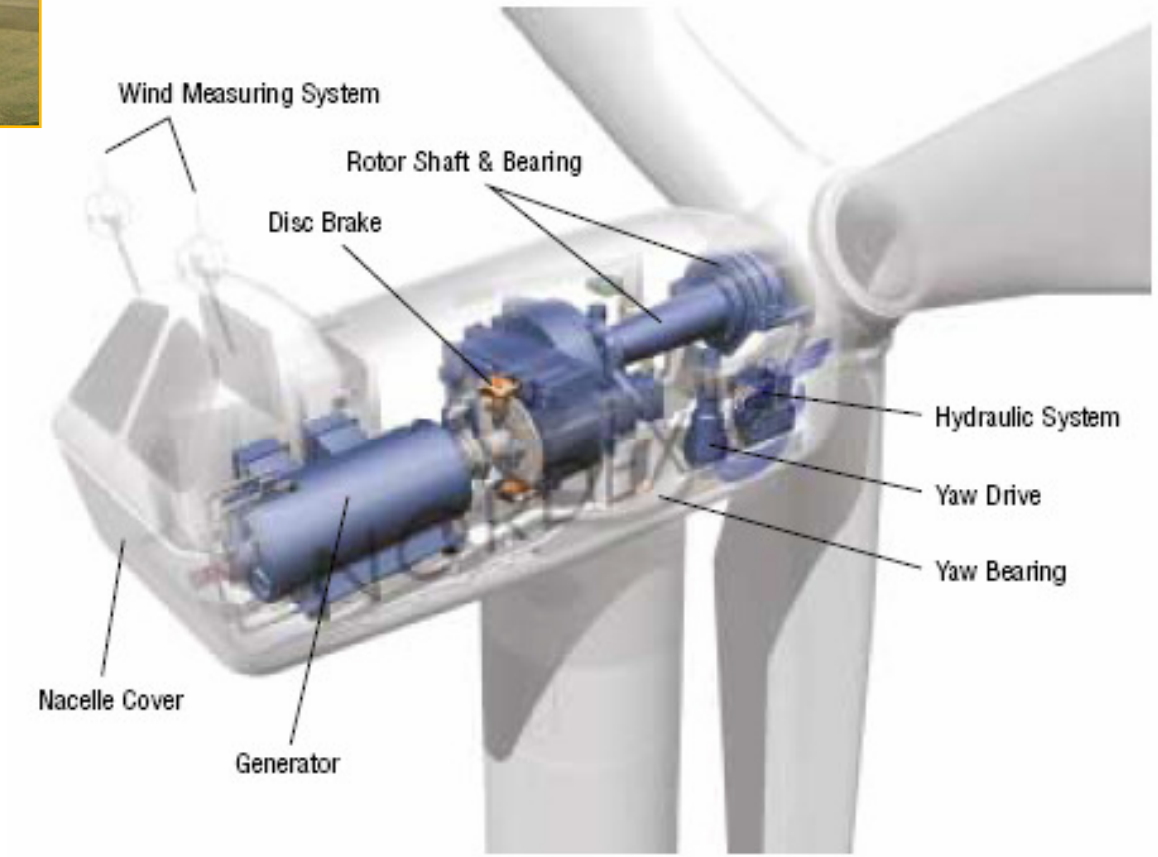
$$P = \rho\, g\, h\, (\Delta V/\Delta t)$$

The term in brackets is the flow rate, which is a volume per unit time, measured in m^3/s.





Wind Turbines



Wind Power

- Wind energy is in form of kinetic energy:
  $K = \frac{1}{2} m v^2$
- Similarly to flowing water in a hydro power station, it makes sense to express the mass in terms of a flow rate and consider power:
- $P = K/t = \frac{1}{2} \Delta m/\Delta t \, v^2$
- Using the density ($\rho = 1.28$ kg/m^3 for air):

  $P = \frac{1}{2} \rho \, (\Delta V/\Delta t) \, v^2$
- Important for the windmill is the amount of wind that moves through the area A defined by the rotor blades: $\Delta V/\Delta t = A \, \Delta x/\Delta t = A \, v$.
- $P = \frac{1}{2} \rho \, A \, v^3$

Wind Power: Le Nordais Wind Turbine

This is data from a online text. We can proof that it's wrong!

Average wind speed in the region	28 km/h
Wind speed to produce 200 kW	15 km/h
Wind speed to produce 750 kW	51 km/h
Maximum wind speed (turbine stops)	85 km/h
Height of tower	55 m
Length of blades	14 m
Length of nacelle	8.5 m
Weight of one blade	3 t
Weight of nacelle	19.5 t
Weight of electric generator	5 t
Weight of entire installation	75 t
Gear box ratio	80:1
Lower speed of blades	15 r/min
Higher speed of blades	22.5 r/min

$P = \frac{1}{2} \rho A v^3$ (available power)

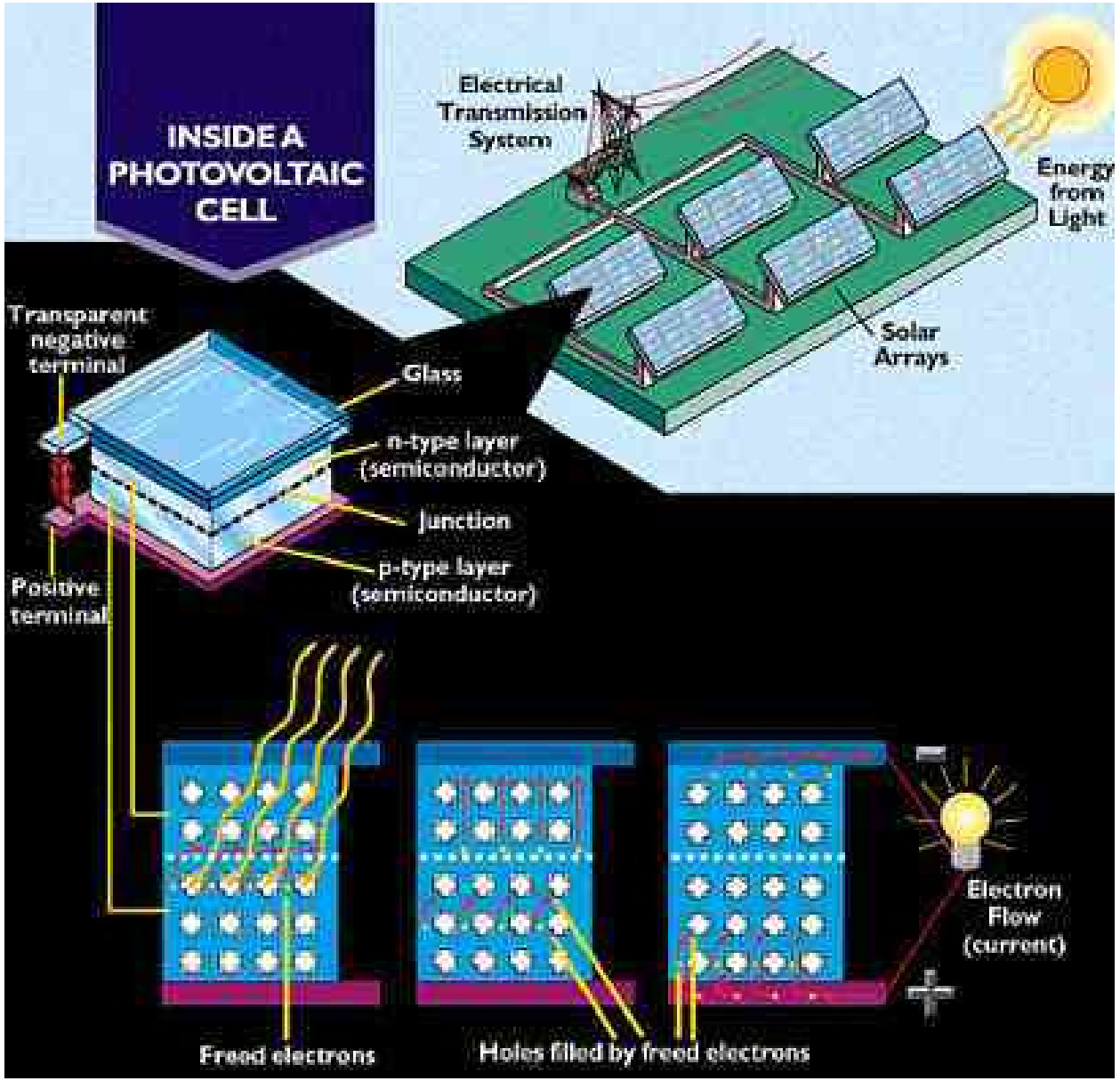
$= 28.5$ kW (at 15 km/h)

$= 1.12$ MW (at 51 km/h)

Solar Power

- Solar panel usually converts radiation energy into electricity using the photovoltaic effect in solar cells.

- In solar cells, the work is done by the incoming solar radiation: radiation triggers electronic transitions which lead to a current.



http://inventors.about.com/library/inventors/blsolar3.htm

Solar cell power

Electrical energy generated per day=

Solar panel area X average solar radiation

X daytime hours X efficiency.

Currently solar cell efficiency is less than 25%.

Final exam

- 10 PRS-like questions (multiple choices; both conceptual and quantitative)
- 2 tutorial-problem-like questions (context rich)

3 Master physics like questions

Open book but no laptops/cell phones etc.

Resource center still open next week during regular hours.

Thank you for attending my lectures

and good luck to your final.