PHYS-C6370 Fundamentals of New Energy Sources (5 cr)
Tfy-56-4311 Uudet energiatekniikat (5 op L) /New energy sources (5 p, G)
(please indicate which course you choose; Tfy is the old course, PHYS is the new one)

Exam 27.1.2015 ; You may write your answers in English, Finnish, German, Swedish
Indicate which course you choose! You are allowed to use a calculator in the exam (Peter Lund 0405150144)

1. Describe the principles, performance (energy output), and technology concepts of wind power. (6p)

2. Explain the main process chain steps of bio-ethanol production. (6p)

3. Short answers only (each 1p):
   a) IPAT
   b) Hotelling's rule
   c) How much need CO_2 emissions be reduced by 2050 in industrialized countries to stabilize the climate change (max. temperature increase 2-2.5 C)?
   d) In which situations could the output of a solar cell exceed its nominal power level (W_p)?
   e) How much electricity produces 1 kW_p of photovoltaics per year in Southern Finland?
   f) Bioenergy potential (%) of world energy production

4. Short analysis (each 2 p)
   a) How does the output of a typical 5 MW wind power plant change if wind speed drop from 8 to 7 m/s?
   b) How does the power of a 1 MW photovoltaic system change when the solar radiation intensity increase from 500 to 1000 W/m^2?
   c) Up to how much biogas could you get from biomass (crop, plants) from 1 ha of land area?

5. The figure on left describes the realized and predicted wind power penetration in Germany (a). The figure on right describes the price and volume of photovoltaics (PV) and wind power (b).

   a) Analyze the German wind power penetration curve from a technology diffusion point of view. What qualitative and quantitative information does the curve contain? (3p)
   b) Analyze the global PV and wind power development from a technology learning point of view (learning parameters and curve, future prices, etc) ? (3p)