

EGT3  
ENGINEERING TRIPOS PART IIB

---

Thursday 27 April 2017 2 to 3.30

---

**Module 4M18**

**PRESENT AND FUTURE ENERGY SYSTEMS**

*Answer not more than **three** questions.*

*All questions carry the same number of marks.*

*The **approximate** percentage of marks allocated to each part of a question is indicated in the right margin.*

*Write your candidate number **not** your name on the cover sheet.*

**STATIONERY REQUIREMENTS**

Single-sided script paper

**SPECIAL REQUIREMENTS TO BE SUPPLIED FOR THIS EXAM**

CUED approved calculator allowed

Engineering Data Book

**10 minutes reading time is allowed for this paper.**

**You may not start to read the questions printed on the subsequent pages of this question paper until instructed to do so.**

1 (a) List three reasons for the use of a power grid as a means of supplying electricity to users. Briefly discuss how well this applies to the UK transmission grid shown in Fig. 1. [25%]

(b) By making reference to power flow along an overhead transmission line, explain how the measurement of the voltage and phase at each end of the transmission line can be considered as smart grid infrastructure. [30%]

(c) (i) Describe two mechanisms that are used in conventional power systems to balance supply and demand. [20%]

(ii) It has been suggested that smart appliances could be used to facilitate the process of balancing supply and demand. Discuss how such a scheme could be implemented in a decentralized way and describe advantages and disadvantages associated with its operation. [25%]

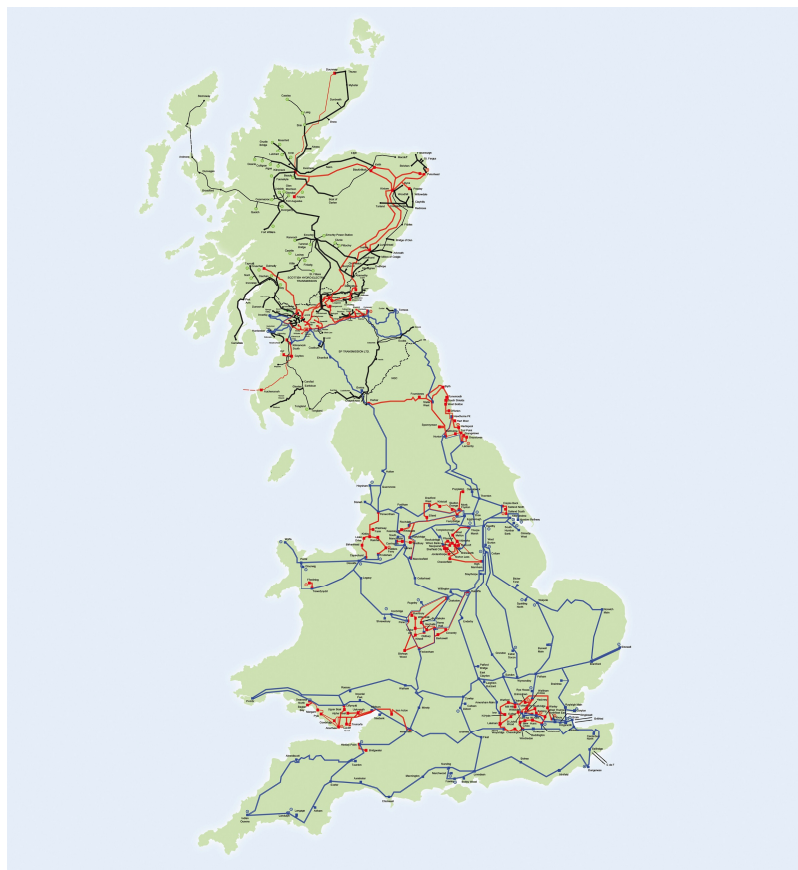


Fig. 1

2. (a) It is claimed that the careful recycling of steel could be a significant contributor to making steel production less carbon intensive. Discuss the energy intensity of steel and concrete production and whether recycling steel and concrete, as used in buildings, should be a priority in mitigating climate change. [35%]

(b) Explain the terms *rebound effect* and *temperature takeback function* in the context of energy retrofits of buildings. Why is it important to consider both in energy saving calculations? [25%]

(c) The UK parliament has acknowledged that the EC 2020 renewable energy targets for heating (12%) and transport (10%) are not likely to be met. By making reference to a *systems approach*, and government incentives, describe the difficulties and the best routes to meeting these targets, starting in 2017. [40%]

3. (a) With reference to the data below, discuss how changes in technology and concerns over global warming may influence the relative use of natural gas versus coal in the future. [50%]

Fuel	Chemical Composition	Lower heating value (MJ/kg)
Coal	CH <sub>0.5</sub>	20
Natural gas	CH <sub>4</sub>	42

(b) Combined Heat and Power (CHP) schemes are becoming increasingly common for industrial production including agricultural production.

(i) List the advantages of such schemes and comment on the challenges and opportunities presented by these schemes to the electricity grid. [30%]

(ii) Compare the use of CHP with Combined Cycle Gas Turbine (CCGT) electricity generation in the UK, noting the stated aim of reducing the consumption of gas for electricity production. [20%]

4. (a) The UK has seen a dramatic increase in energy from renewables. The installed capacity of solar energy in the UK places it 4th in the world at 9.8 GW. Tidal power schemes could provide another 6 GW, with the first 320 MW scheme having obtained government backing in January 2017. Wind and Hydro could provide 20 GW of power generated in Scotland. With respect to the summer load curve shown in Fig. 2, comment on the planning and operating challenges for the National Grid, with such a high penetration of renewable energy, and the advantages of deploying HVDC transmission schemes. [50%]

(b) In September 2016, the Adani company completed the world's largest solar farm in Kamuthi, India, with an installed capacity of 648 MW, using 2.5 million solar modules over 10 square kilometres. Adani is also developing a coal mine in Queensland Australia and its 350 km rail link to the port. Making reference to the Shell scenarios for 2100 and the growth of megacities, explain the logic of the Adani company. [50%]

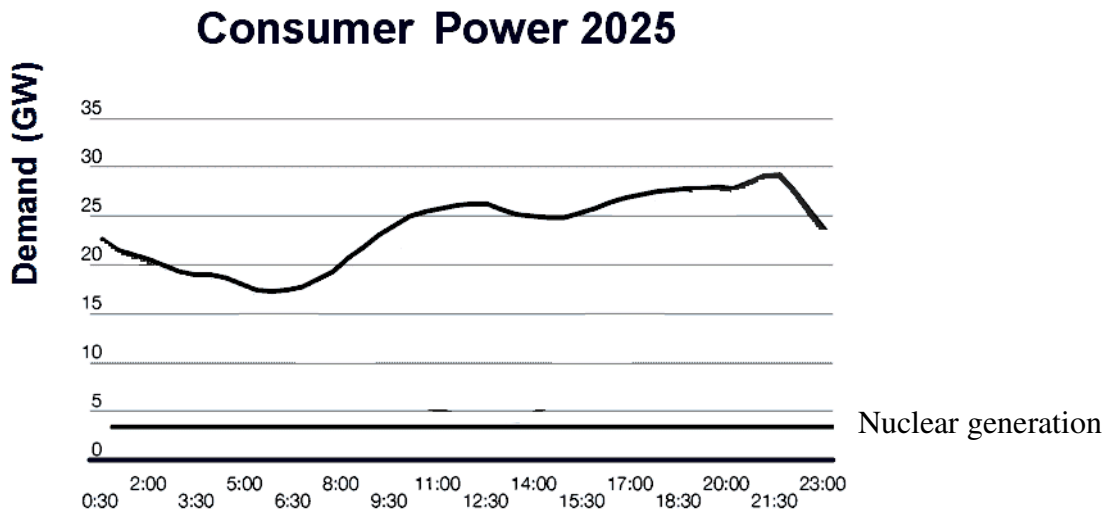


Fig. 2

**END OF PAPER**