Karlsruhe Institute of Technology

Energy System Modelling
Summer Semester 2020, Sample Exam Questions

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Oral exam

The following question are *not* identical to the oral exam, but give an indication of the difficulty level of the questions.

We are not testing for perfect math or memory recall. If you get a sign wrong or forget how to integrate cosine, you will not be penalised. We are testing for your understand of energy system modelling.

General Questions

- Describe variations of wind and solar in space and time (lectures 2-3)
- Describe what you would expect from the Fourier transform of wind and solar time series (lecture 2)
- What are the options for balancing variable renewables?
- What happens to feed-in when integrated over larger areas? (lecture 3)
- How does the duration curve of wind change when integrated over larger areas? (lecture 3)
- What is the correlation length of the wind? (lectures 3 & 16)
- When balancing only with networks, how does network distance depend on wavelength of variations? (lecture 3)

Networks and Storage

- What is the incidence matrix? Write down the incidence matrix of a given network. (lecture 3)
- What is the Laplacian? (lecture 3)
- How are power, voltage angles and the Laplacian related for a linear power flow calculation? (lectures 3-4)
- How is the PTDF derived? (lecture 4)
- Write down the relation between storage charging/discharging and its energy/state of charge for a discrete and continuous system. (lecture 4)
- When balancing with only storage, how does storage volume depend on frequency of variations for a sinusoidal generation pattern? (lecture 5, sheet 2)
- How is Demand Side Management different from Storage? (lecture 5)

Optimisation

- Write down the typical form of an optimisation problem. (lecture 6)
- What are the KKT conditions? (lecture 6)
- Describe each KKT condition. (lecture 6)
- How does the maximisation of economic welfare relate to optimisation and KKT?
- Write down KKT for a given two-node problem. Solve it for given demand and generators. (lecture 8)
- Screening curves, demand duration curve: derive generation fleet for given parameters and demand duration curve. (lecture 9, sheet 4)
- Explain the merit order effect (lecture 10)
- What is the 'no profit rule' (lecture 10)
- Are extreme prices in markets a problem? How can we incentivise capacity? (lecture 10)

Other topics

- Describe the opportunities of coupling to other energy sectors (lecture 9)
- What techniques can we use to reduce the complexity of energy system modelling calculations? (spatial clustering in lecture 13, PCA in lecture 14)
- What are some of the problems with optimization approaches to energy system modelling? (lecture 16)
- What is the near optimal space of an energy system optimization? How do we characterise it? (lecture 16)