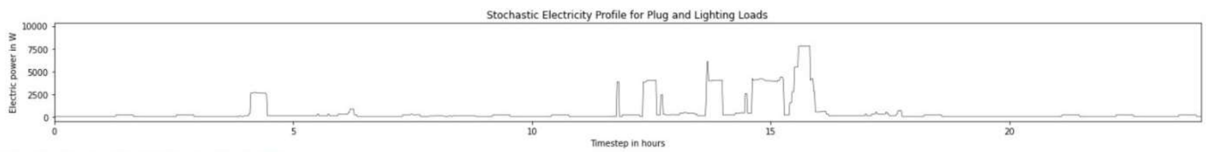
7LY3M0 – online workbook – answer sheet

4.1 Occupant Behaviour

1a. How does the electrical energy demand for [S1, S2, S3, S4 ...] compare?

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Electrical energy demand for one day in kWh:
13.018016290603
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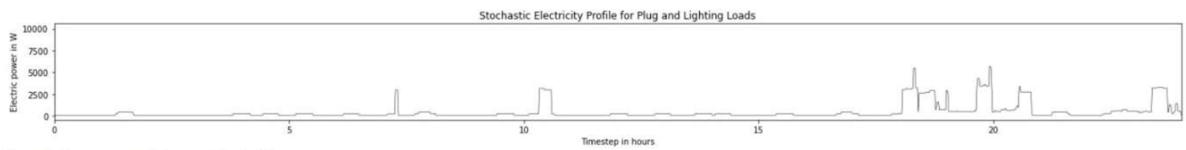


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Electrical energy demand for one day in kWh:
10.545890287886811
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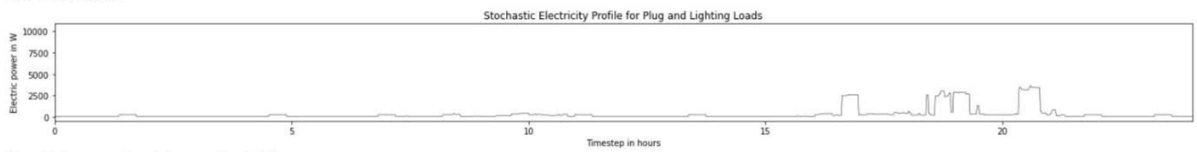


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Electrical energy demand for one day in kWh:
7.988950559802135
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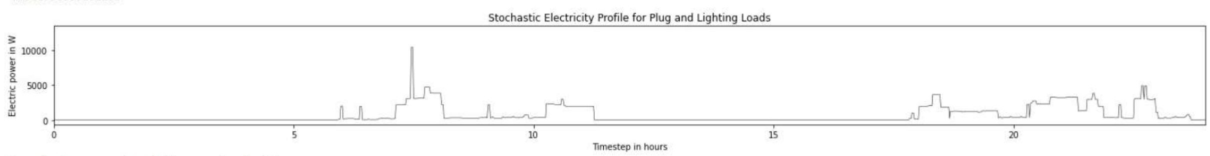


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Electrical energy demand for one day in kWh:
17.1227251721457
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The energy demand for the days vary quite strongly, as it should as this is what happens in (single person) households as well. The results look like pretty sensible, not a lot of electricity use at night when people are usually sleeping, by day the occupant will often be away from home but not always. Occasional peaks are logical as well. Overall the height of the peaks make sense, water cookers will often be 2.5kW, hoovers are in that range as well as are some other household appliances. Averaging ~500W as shown here is normal for single person households.

1b. For this particular case, what are the implications of using a static schedule versus a stochastic schedule?
If you use only one static schedule for all of those apartments you'll end up with a massive cumulative peak during the hours when the schedule decides energy is used. This is clearly unrealistic, all the occupants of a building aren't going to turn on their appliances at the exact same time every day (the grid wouldn't even be able to deal with that). Designing a building for this situation means that you end up designing for completely unfeasible peak loads, which is a waste of resources.

2a. Now that you have explored both modelling techniques, do you agree with this statement? Support your arguments using existing literature. Use max. 500 words for your answer.
Stochastic occupancy models do clearly provide more accurate temporal information, but that doesn't mean that they're always required to make accurate or useful predictions. It depends on the application. If you're using the schedules in a simulation to determine energy use over a year, looking at averages over the bigger picture, and not interested in peak loads, you can get away with using static schedules. When peak loads are of interest the stochastic schedule becomes necessary. Imagine designing a residential building using energy simulations. If you're using static schedules you might say that the occupants of an apartment will be at work/school every day from 8AM till 5PM. This means that by day during summer, when the radiant temperature is very high, you predict nobody turns on their AC because they're not home. Then the building is built, people start living in there and it turns out that energy use is way up from what you expected, since real humans don't have static schedules like that. People with children will probably be at home quite a lot during the summer, lots of people work part-time and working from home is also becoming increasingly more common. Lots of people to use AC during the day in the summer. If this had been modeled properly, by using stochastic scheduling, this could have been noticed and proper reflective windows/blinds could have been implemented to lower the mean radiant temperature indoors drastically.

3a. In the event of increased electrification of heating of the residential building stock (e.g. using heat pumps), how would you expect that the shape of the coincidence curve changes, and what does that mean for the sizing of network connections? What would be a possible solution? Answer this question in max. 500 words.
Peaks in household electricity use will usually be caused by household appliances, think of water kettles, hoovers and other short term electricity users. The issue shouldn't be due to true electricity peaks happening all at the same time, this is something that already happens with large television events (Schaps, 2014). The population of a country won't all turn on their heating or plug in their cars in the same 3 minute timeframe. With increased electricity demand the baseline will be bigger, but I don't see any reason to believe that the peaks will be higher. The coincidence curve is mainly looking at true peaks, which won't be more common. What will be more common is lots of occupants of the same building turning on their heating around the same time when they come home from work. If due to coincidence enough apartments turn on other appliances around that time peak power draw will still reach excessive levels, despite the coincidence curve showing that there isn't a problem. If households are expected to start using twice as much electricity the grid and network connections need to be able to handle twice as much power over longer periods of time. Luckily there is nothing that suggests peaks will become twice as large as well, which means that we only need to account for the current peaks over the doubled baseline.

Schaps, K. (2014, may 30th). England brews up sufficient power for World Cup tea-time surge. U.S. https://www.reuters.com/article/uk-soccer-world-england-electricity-idUKKBN0E92G220140529