PhD Examination – Required amendments

University of Reading

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School/Department	School of the Built Environment
Title of Thesis	Control and Schedule Adjustments of Battery Based Energy Storage in Low-Voltage Distribution Networks
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Name of Internal Examiner	Dr Phil Coker

Abstract

a) Para 1. Remove 'e.g.' and replace with full text as appropriate. Note - this is an uncomfortable usage of 'e.g.' that recurs throughout the thesis. You may wish to attend to this elsewhere.

b) Para 2 - 3.8kW reduction. State from what level. It is not clear in isolation whether this is a significant improvement or not. This problem occurs at various points in later chapters and should be amended where possible (incl. p26 near end, p29 para 2. p36 para1).

c) Word count. Abstracts are required to be no more than 300 words.

Introduction

d) 1.1.1 first para, p5. Not all loads are distribution connected - amend. Also correct 'gird' while you are there.

e) Objectives, p13

- clarify Objective 1 to specify that energy in each HH remains unchanged and real power is constant.
- Objective 2. Clarify to indicate some rescheduling of energy between HHs.
- Review Objective 4 and clarify as necessary. From discussion, you apply AIMD in a new way, both (i) allocating location specific set points and (ii) adopting a varying step size. This is not quite the same as modifying AIMD. Perhaps the objective is to find ways of applying AMID tailored to distribution networks.

f) Field trials – there is an opportunity to add an update to mention how this work fed into the TVV field trials. This is a suggestion only, not a requirement.

Literature Review

g) Storage benefit list, p22-25

- Amend list to avoid duplication, grouping overlapping benefits together (Congestion relief / upgrade deferral; ToU / Renewable Integration / Arbitrage.)
- Tighten power quality treatment

h) DNO / supplier distinction, p27, para 2. Need to distinguish clearly between DNOs and suppliers. Suggest you separate projects into two distinct paragraphs.

i) Clarify implication that Injecting reactive power can change frequency (p35)

j) Note reliability statistic applies to transmission system, not whole system and check no. of 9s (p38)

Chapter 3

k) DN losses, p59, para 3.
- Currently states LV losses are negligibly small before talking about losses of 5% - 12%. Amend 'negligibly' or otherwise clarify.
- Somebody must pay for undelivered energy. Amend '… nobody pays for…'

l) Performance metrics / objective functions (chapter 3). More discussion is needed on the value of each - what does the DNO care most about? This could point to a multi-objective optimisation as future work. Suggest small addition in this chapter and further treatment in Conclusions chapter.

m) Figure amendments (fig 3.13 - 3.18, p78 - 84)
- Remove caption reference to 'nominal substation voltage' or add to graphs
- Clarify six line, three colour approach; perhaps dashed lines for second set
- Fig 3.17, text contradicts figure. Check and amend.
- Fig 3.18, caption contradicts graph. Check and amend.

n) Box plots (fig 3.20, p86) - annotate / describe box plots at first use

o) Equations 3.21 (p68) and 4.2. Define units of time.

p) Neutral current, p59. Cost parameter 'neutral load' is used and text also refers to 'power flow in the neutral conductor' / 'neutral power'. This is an unconventional definition and concept and should be highlighted as such or rephrased as 'neutral current'.

q) p58, para 1. Replace 'Experts would agree…'

Chapter 4

r) Fig 4.2, p103. Relabel 'demand' as 'substation load' or similar.

s) Fig 4.3, p104. Item labelled as MPC is predictor. Amend.

t) PID definition, p106. Logic used here is not a conventional PID approach. Check this and flag unconventional approach to reader.

u) Weighting factors, p108, 'α and β weights guaranteed a convergent and stable solution' is over-claimed. Reword. No formal proof is provided, which could be covered in future work.

v) Peak reduction benefit. Review why DNO cares about this and implications for results.

w) 4.5.2, p115. Bring case designation into description

x) Fig 4.9, p119. Check description of graph and case labelling. Amend as necessary.

Chapter 5

y) Include definition of 'α'

z) Base load (5.2.2, p129)
- Perfect foresight assumption. This is a major assumption here. Justification and implications need considering.
- Replace 'base load' with 'baseline' (or similar), including in subsequent text

aa) Algorithm 1, p136. Complete caption

bb) 'Irish dataset' (p139) Introduce at appropriate point and reference

cc) Table 5.1, p149. Caption should specify that this refers to two previous figures

dd) p151, 1st para. Replace ‘north-east’ with ‘top right’. Clarify explanation of figure 5.8.

ee) 5.4.2, p151. Description of fig 5.9 over-plays smoothing. Amend with accurate description.

Chapter 6

ff) Amend title, p159.

gg) Clarify EV trip schedules, p165. There is a lack of clarity here about whether leaving always means leaving home (which would be clearer) or could be leaving somewhere else ahead of returning home. Evening distribution appears to sometimes be taken as returning home, sometimes as leaving. Equations (6.2) and (6.3) need checking and amending if necessary. If this has any implications for later work, then discuss possible actions with Internal Examiner.

hh) Fig 6.2, p167. Near zero shape is unconventional for Weibull distribution. Is this a special case of shape factor, impact of log scale or other? Check and clarify / amend if necessary.

ii) p167. Errors in per trip energy use. Units do not currently make sense. Check and amend as necessary.

jj) p178, para 1. Remove / replace 'optimised'.

kk) Figs 6.13 and 6.14 need greater explanation (p179)

ll) Asset utilisation, p181. High asset utilisation is potentially a good thing, which could be penalised by current choice of metric. Appropriateness of metric needs discussing. Consider proposing alternative(s) under future work.

mm) Fig 6.13(a), p189 – 191. Commentary needs checking. Asserts that 'only half of the deployed storage devices were active in Case C… (p189) and 'more than half… never partook' (p191). Fig appears to show that rather more than half are active at least some of the time.

Discussion / Conclusions

nn) Some greater reflective content is needed, specifically to cover:
- Why the approaches adopted were chosen, with reference to other possible approaches.
- Relevant factors that influence the usefulness of the findings
- What would need to be considered before findings could be taken forward and implemented.
This could be done by adding a new sub-section, or by re-working 7.3.

oo) 7.3 Future work
- Numerous future work references are currently included as throw away statements. Extract these and combine into a single 'future work' sub-section with tighter argument, following 7.3.6.
- AI (7.3.5) and Cyber Security (7.3.6) aspects are highly speculative and do not derive from the work presented. You may wish to remove some of this content while refocussing this overall section (7.3) on the work that you actually carried out.

pp) Include specific DNO recommendations. This could be as part of a reworked 7.4.