Note:

1. The content in green is newly updated from the last version (v1.0).

2. This template is the guidance for content to be included in the report (which means it is strictly defined), and it is the recommended structure to follow (which means you can tweak). It is fine to have your own format as long as it fits in the page limits (strict page limits; font size not smaller than 10).

**Report Title**

Group Number:

Name of members (in the format: ‘subsystem 1: xx xx; subsystem 2:xx xx; subsystem 3: xx xx’)

*Note: This is a formal report and should be well-written and organized. Part of the grade will be for professionalism and presentation. (This paragraph should be deleted in your report.)*

# Abstract

An abstract of approximately 200 words describing your problem and the results obtained. Do not write generalities and be specific about your work.

# Introduction

This section should introduce a qualitative statement of the system design optimisation project. Describe the system design problem, the anticipated trade-offs that motivate the optimisation study, and the previous work that has been done by others. Define the goal of your study.

Image of the property and areas of focus.

# System-level problem and Subsystem breakdown

Present a system-level optimisation formulation, with a single top-level objective, all relevant variables, and constraints. Remember, there should be at least 8 variables and 8 constraints at this level. Present it in negative null form with the below structure. You may want to rename your variables or functions so that it is easier to follow; e.g., if one variable is speed/velocity, you may want to call it or instead of .

where

subject to

...

...

(Note: feel free to move the formulation part to ‘Section 6.System-level optimisation’, if you think it works better with your structure)

State clearly in the text what each variable represents, what each function means, and where the equations came from. Justify why you have chosen your objective and your constraints (with references where relevant).

Identify the individual subsystems, rationalize selection of these subsystems, and explain qualitatively how they are linked. A diagram may help to show the interdependencies (e.g., linking variables, outputs from one subsystem that are inputs to another or to the system-level problem, etc.).

# Subsystem 1 – Window Integrated Photovoltaics

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Panel | Transparency (%) | Area (m) | Power (W/m2) | Transmissivity – h value (unit?) | Cost of panel (£) |
| 1 | 0 | 1.54 | 104 | 0 | 600 |
| 2 | 10 | 1.54 | 88 | 0.24 | 600 |
| 3 | 30 | 1.54 | 62 | 0.31 | 600 |
| 4 | 50 | 1.54 | 42 | 0.38 | 600 |
| Original Glass Window | 100 | na | 0 | 0.55 | 0 |

Subsystem one focuses on the use of Building Integrated Photovoltaics (BIPVs) which can be implemented in the pre-existing window frames of the domestic property. The model of BIPV used was PS-M-NX Series panels from Polysolar (1) . This model of BIPV was selected for its range of available transparency types and relatively high power values compared to other models. Having spoken to a representative from Polysolar it was gathered that the panels came in a fixed size and price regardless of power rating. The panels could be cut down to size to fit window space required. It is also assumed that each window will be completely filled with one type of panel for consistency and aesthetic purposes. Another assumption made is that to a single series type of panel should be used so that a single inverter can be implemented for all BIPVs **(Source).**

Table 1 PS-M-NX Properties

|  |  |  |
| --- | --- | --- |
| Window | Area (m2) | Region |
| 1 | 1.4 | Roof area southeast |
| 2 | 1.4 | Roof area southeast |
| 3 | 0.5 | Façade southeast |
| 4 | 0.5 | Façade southeast |
| 5 | 1.8 | Façade southeast |

Table 2 Window Properties

**IS IT POSSIBLE TO TEST DIFFERENT TRANSPARENCY TYPES – tested and Panel 1 is better show in diagram**

Present your subsystem-level problem. Introduce the problem with some text to explain the objective, motivation, and modelling approaches used.

Subjective design decision – minimise use of intrusive panels so subsystem 1 is required

Image of subsystem

# Optimisation formulation

In negative null form, present the subsystem optimisation formulation. This should stand alone and it should possible to optimise without knowledge of the other subsystems. If there are interdependencies, use parameters to represent assumptions needed to decouple the subsystems. (Remember to be consistent with variable names in the system-level formulation.)

where

subject to

Description of c(x), p(x), l(x) and e(x)

Describe all functions and variables. Justify this structure using references and explain any assumptions.

# Modelling approach

Describe all models needed. This should make it entirely clear how the objective and each constraint are calculated. Justify each model/function with a reference or an explanation of why the model is meaningful. Explain any assumptions that you have made.

# Explore the problem space

Analyse the monotonicity or expected/known constraint activity to the extent possible. Simplify your formulations wherever possible.

**Show results from class test showing all the solutions. DOE, full factorial with every combination of values. Describe the lack of gradient…**

If the functions are simulations (black boxes), conduct a DOE covering the design space and see if you can determine monotonicity or develop a useful metamodel.

# Optimise

**Fmincon show that doesn’t work, as expected**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Solver** | **Time to solve (s)** | **Variables** | **Years for ROI** | **Upfront cost (£)** | **Energy Generated (kWh/year)** | **Hours of work lighting** |
| Genetic Algorithm | 5.2096 | 0 0.104 0 0 0 | 21.192 | 1300 | 158.92 | 6 |
| Particle Swarm | 0.67967 | 0 0.104 0 0 0 | 21.192 | 1300 | 158.92 | 6 |

Note must be made that the solvers are both stochastic, so it is unlikely to produce exactly repeatable results.

Test two different optimisation algorithms using MATLAB. Explain how you set this up and solved it and show the results (both optimum and optimisers). Conduct post optimal analysis (e.g. sensitivity analysis and/or parametric study)

# Optional: Optimise with an advanced formulation (rename this heading)

Re-formulate the problem in at least one of the following ways: (1) Multi-objective optimisation, (2) Robust design optimisation, or (3) Reliability-based design optimisation. Present the formulation, solve it, and discuss the results. If you chose a multi-objective problem, this must include a Pareto frontier. (Note: this can be counted as the second optimisation method if you only have one for Subsection 3.4).

# Discussion

Briefly summarise this subsystem’s optimisation. Discuss which method seemed to work best, and/or discuss the pros and cons of each. Discuss some of the challenges, design implications, and how the analysis could be improved in the future for application in the real world.

# Subsystem 2 (rename this heading, and copy the subsection titles from Section 3)

# Subsystem 3 (rename this heading, and copy the subsection titles from Section 3) – this is only for the group of three members.

# System-level optimisation

Describe the strategy for solving the system-level optimisation problem. Present a new, more precise formulation if needed, with justifications for any models, parameters, and assumptions.

Explore the problem space, and then solve the system-level problem. Justify the solution method.

Present the results, discuss what they mean, and describe some of the challenges and future work needed for application in the real world.

# Conclusion

Briefly and quantitatively summarise what was achieved in the study. Was the goal is met, how, and by how much was the system optimised?

Briefly summarize the greatest challenges in system design and optimisation, and summarise key lessons learnt.

# References

List citations here in numbered style; [1] … [n]. Refer to all of them in the text using numbers, e.g. [1].

# Appendix A. Nomenclature

Define all symbols that you use, particularly for the mathematical model development. Make sure you use a consistent nomenclature and set of symbols in subsystems. (It may also be convenient to divide the symbols list to subsystems.)

Note:

1. Upper limit: 8 pages for groups of 2 members (11 pages for the group of 3), excluding References and Appendix of Nomenclature.

2. Except for ‘Appendix A. Nomenclature’, no other Appendices are accepted.

References

(1) Polysolar. *PS-M-NX Series panels - Product Specifications for a-Si/μc-Si thin-film glass/glass laminate BIPV glazing units.* Available from: <http://www.polysolar.co.uk/documents/PS-M-NX%20Technical%20Specification%20sheet.pdf> [Accessed 05/12/2018].