



Simulation-Based Optimisation Coupling OpenModelica and GenOpt

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Introduction

Open-source software – Control, Security, Stability and Community

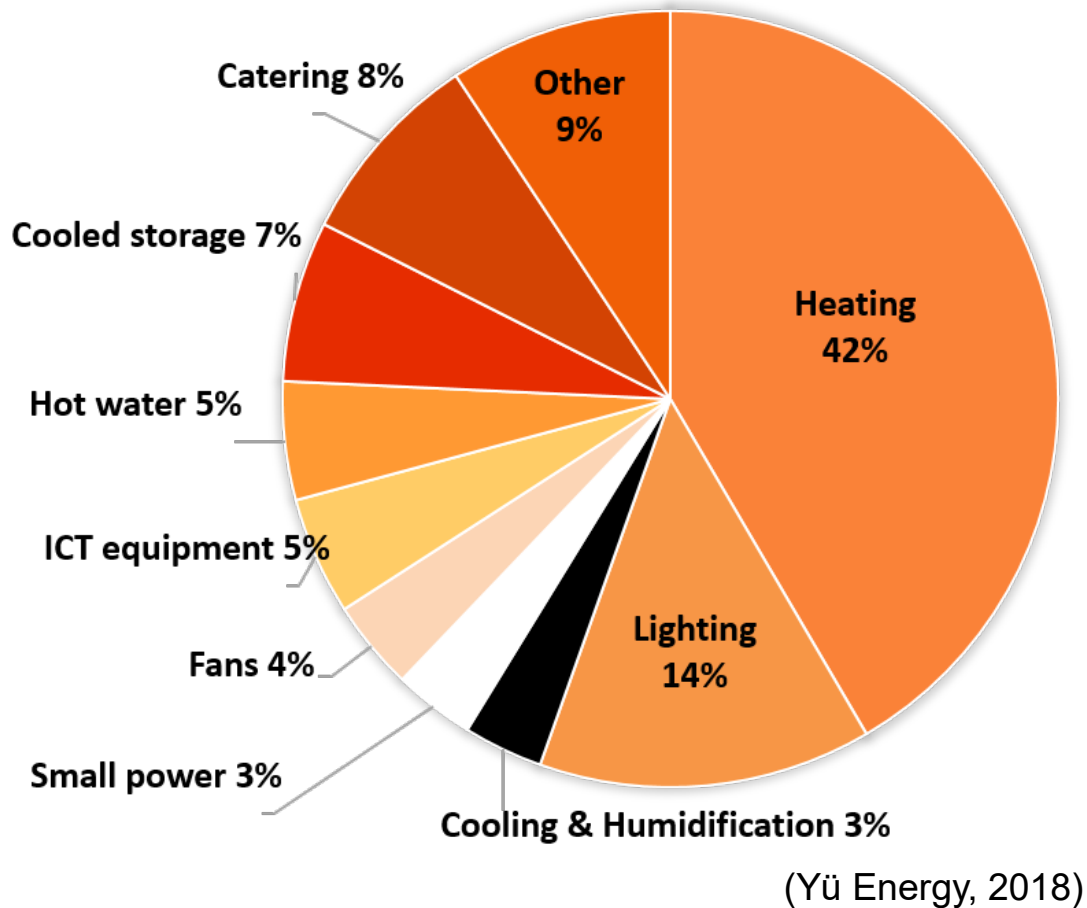
Aim

- Investigate the coupling of OpenModelica and GenOpt

Objectives

- Script alteration
- Simulation-based optimisation
- Analysis and evaluation

Buildings



40 % Total Energy Use



36 % Total Greenhouse Gas Emissions



30 % Total CO2 Emissions

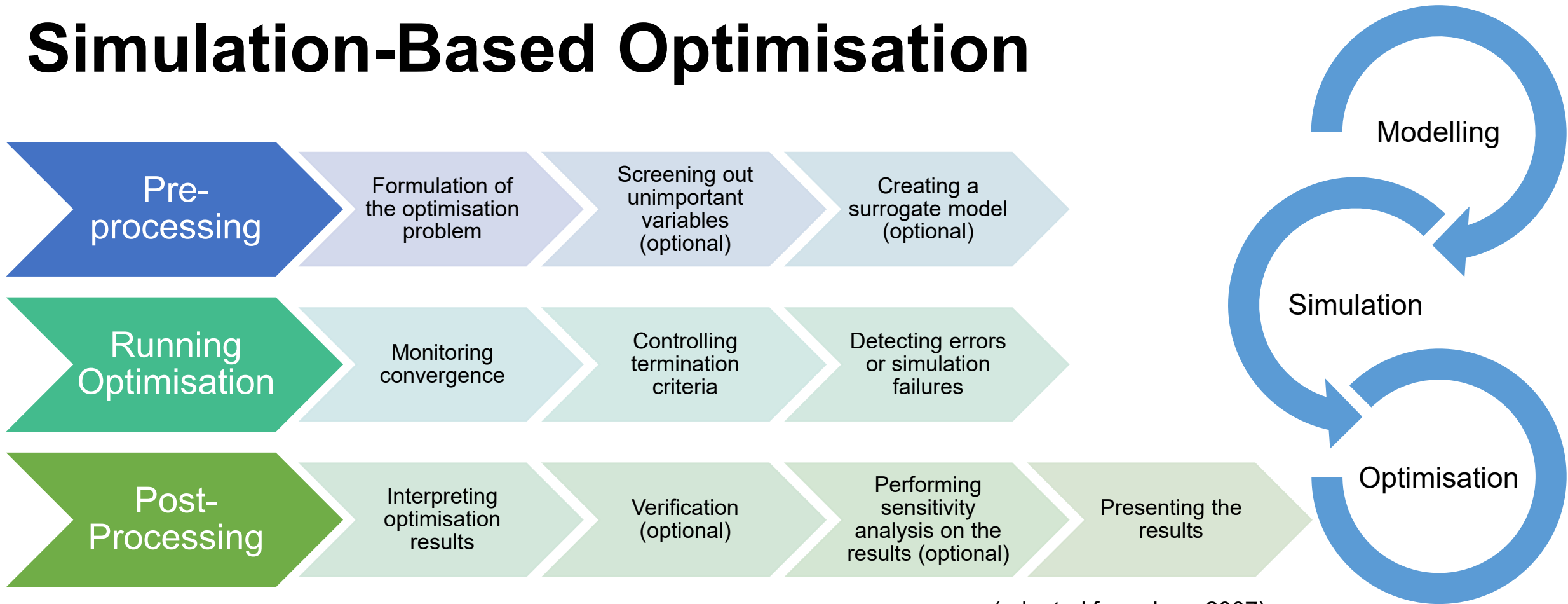
(UN, 2019)

Building Performance Gap

150 - 250 %

(IPEEC, 2019)

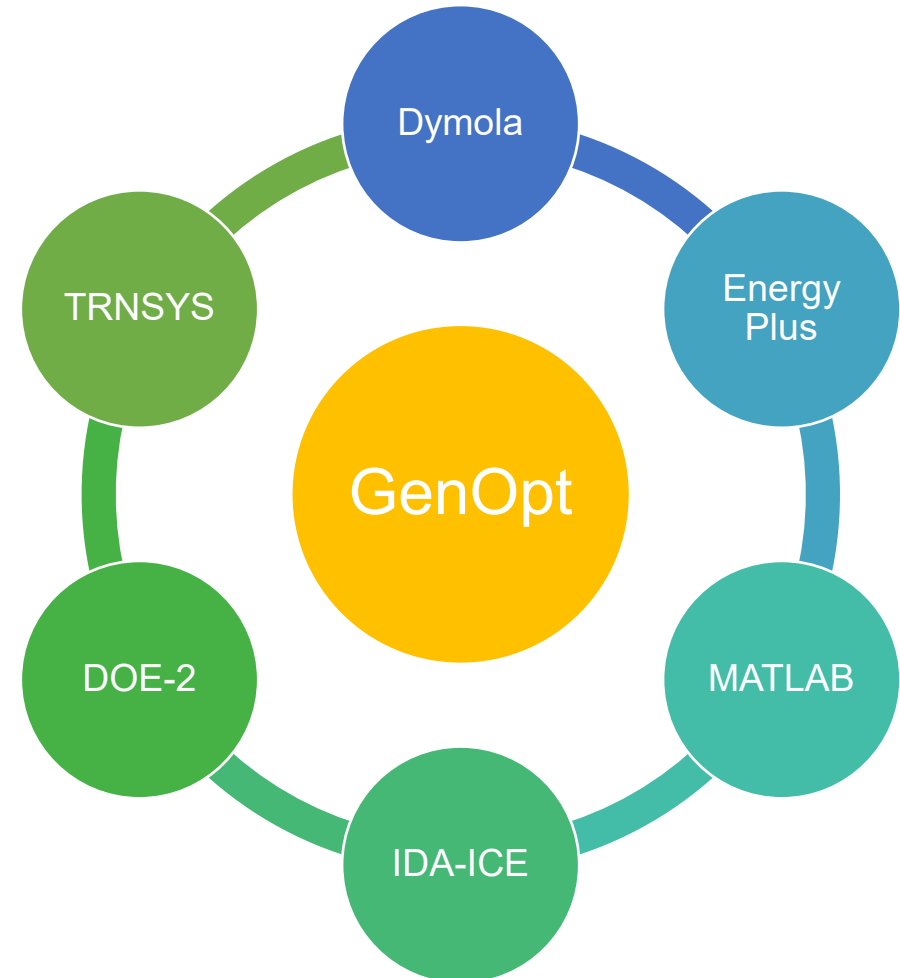
Simulation-Based Optimisation



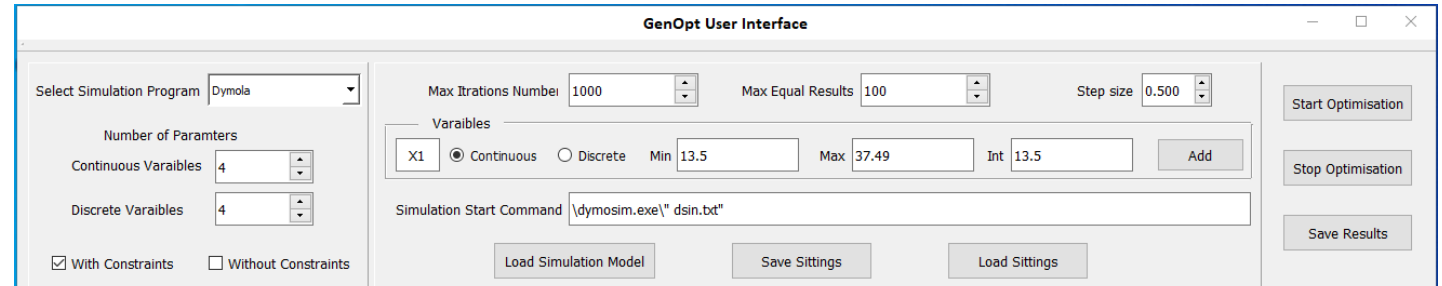
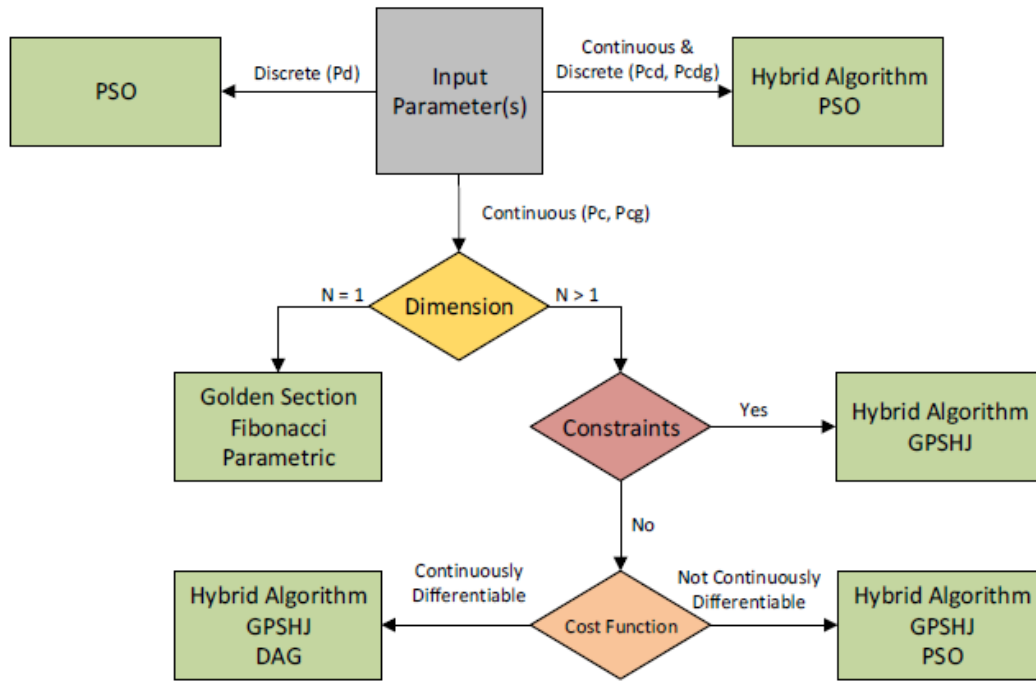
(adapted from: Lee, 2007)

GenOpt

- Optimisation program
 - Lawrence Berkeley National Laboratory
 - Minimisation of a cost function
 - Multi-dimensional and one-dimensional
 - Library of optimisation algorithms
- External simulation program
 - Text input and output files



Algorithm Selection



Key		Algorithms											
		Hybrid Algorithm	GPSHJ	DAG	PSO	Golden Section	Fibonacci						
0	Not relevant												
1	Optional												
2	Relevant												
3	Required												
4	Essential												
Rating	Weight	User Requirement											
2.6	0.13	5	0.65	4	0.52	3	0.39	4	0.52	5	4.00	4	0
3.4	0.17	2	0.34	4	0.68	3	0.51	3	0.51	5	0.85	5	0
0.6	0.03	5	0.15	5	0.15	4	0.12	4	0.12	4	0.12	3	0
2.0	0.10	3	0.30	5	0.50	4	0.40	4	0.40	5	0.50	5	0
1.4	0.07	2	0.14	5	0.35	3	0.21	3	0.21	4	0.28	3	0
3.4	0.17	5	0.85	4	0.68	3	0.51	4	0.68	4	0.68	3	0
3.4	0.17	3	0.51	3	0.51	4	0.68	4	0.68	5	0.85	5	0
2.6	0.13	3	0.39	5	0.65	4	0.52	4	0.52	5	0.65	5	0
0.6	0.03	5	0.15	3	0.09	4	0.12	4	0.12	4	0.12	3	0
20	1	<<< Total Score >>>						3.48	4.13	3.46	3.76	8.05	4

(Dudhee, Abugchem and Vukovic, 2020)

Optimisation Algorithms

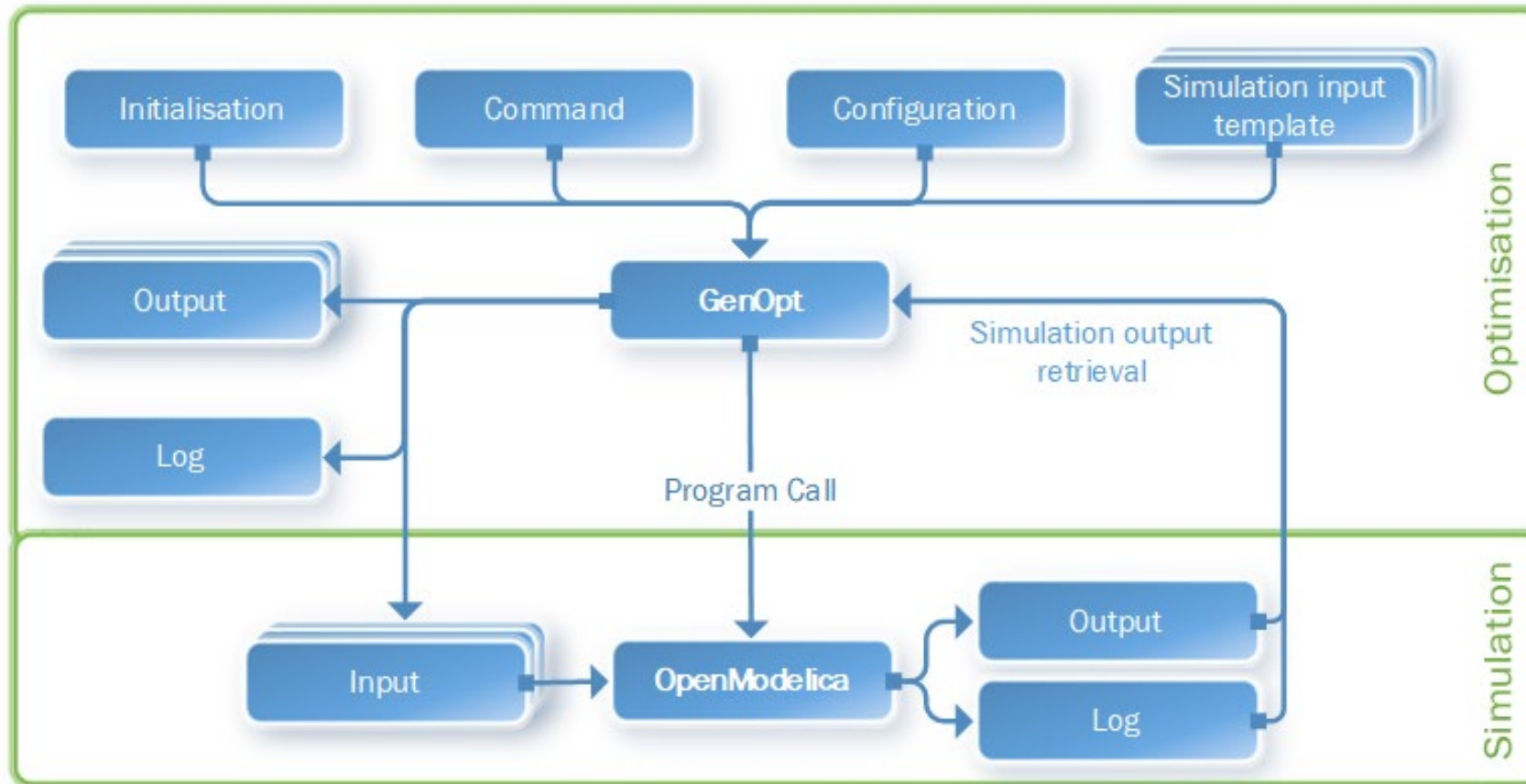
GenOpt

- Golden Section Interval
- Fibonacci
- PSO
 - Particle Swarm Optimisation
- Hybrid
 - PSO (global) and Hooke-Jeeves (local)
- GPSHJ
 - Generalized Pattern Search with Hooke-Jeeves
- DAG
 - Discrete Armijo Gradient

OMOptim

- NSGA-II
 - Nondominated Sorting Genetic Algorithm II
- PSO
 - Particle Swarm Optimisation
- SA1
 - Simulated Annealing
- SPEA2
 - Strength Pareto Evolutionary Algorithm 2
- SPEA2Adapt
 - Auto-adaptive

Methodology - Overview



Simulator

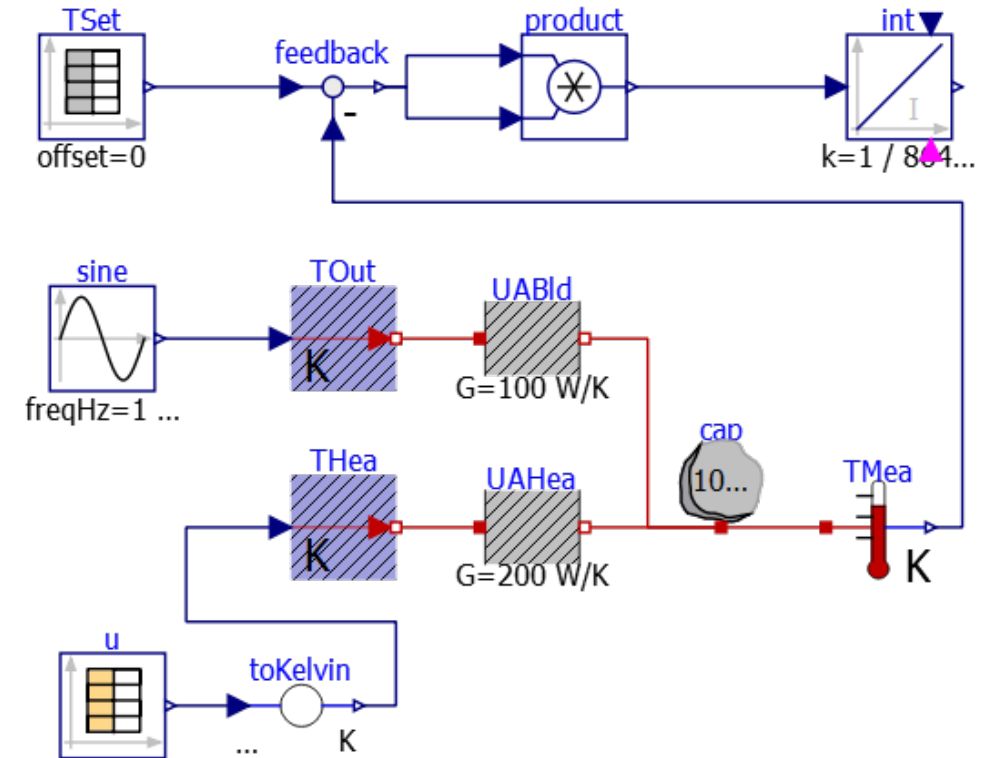
- OpenModelica

Optimiser

- GenOpt

Energy System Modelling

- Simple room heating system
- $U \rightarrow$ Heat source
 - $Ini = 25$
- Tset
 - 0, 288.15 (15 °C)
 - 25200 (7hr), 293.15 (20 °C)
 - 68400 (19hr), 288.15 (15 °C)
 - 86400 (24hr), 288.15 (15 °C)



(adapted from: GenOpt example)

OpenModelica and GenOpt Coupling

OpenModelica

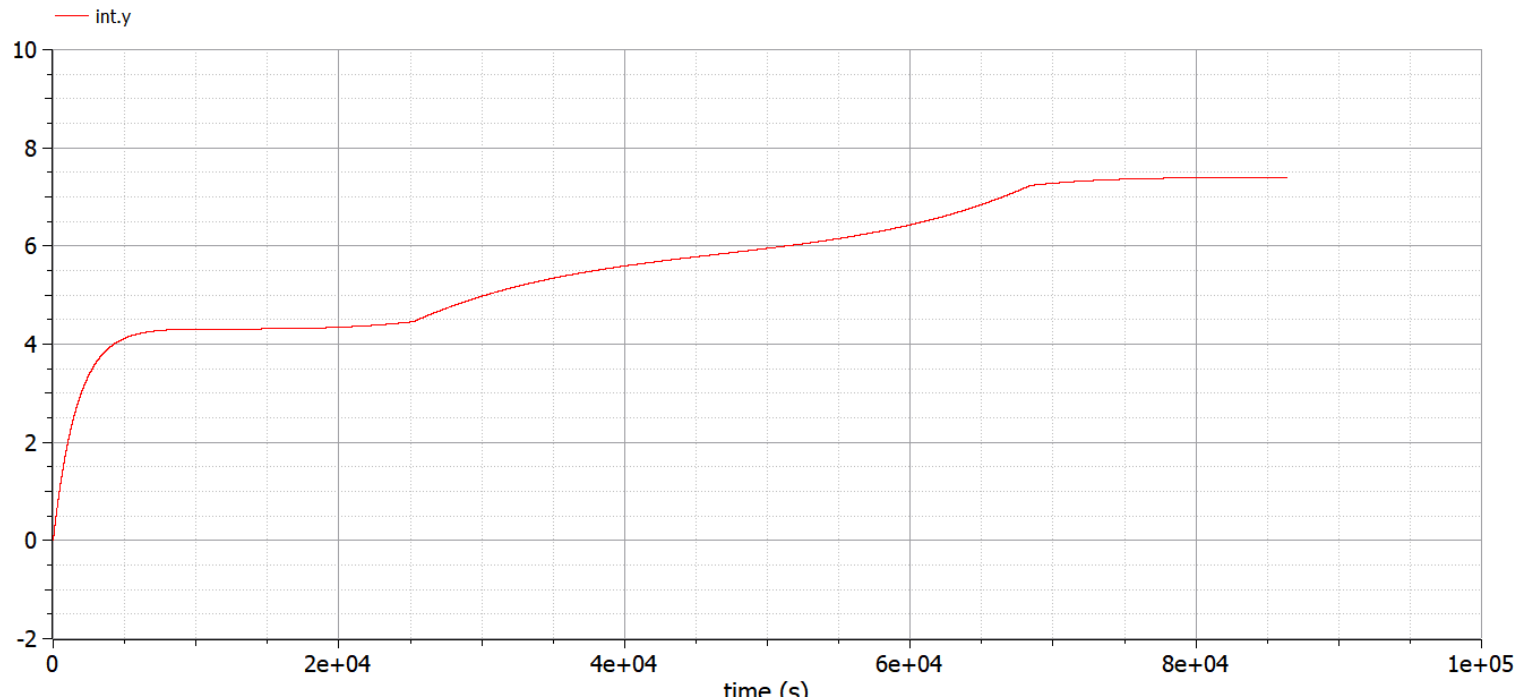
- Results file
 - Objective function
 - results.txt
- Simulation script
 - Load and simulate model
 - script.mos
- Log file
 - Same folder as model.mo

GenOpt

- Initialisation file (.ini)
 - Load/copy all required files
 - script.mos
- Configuration file (.cfg)
 - Command opens OMC and script.mos

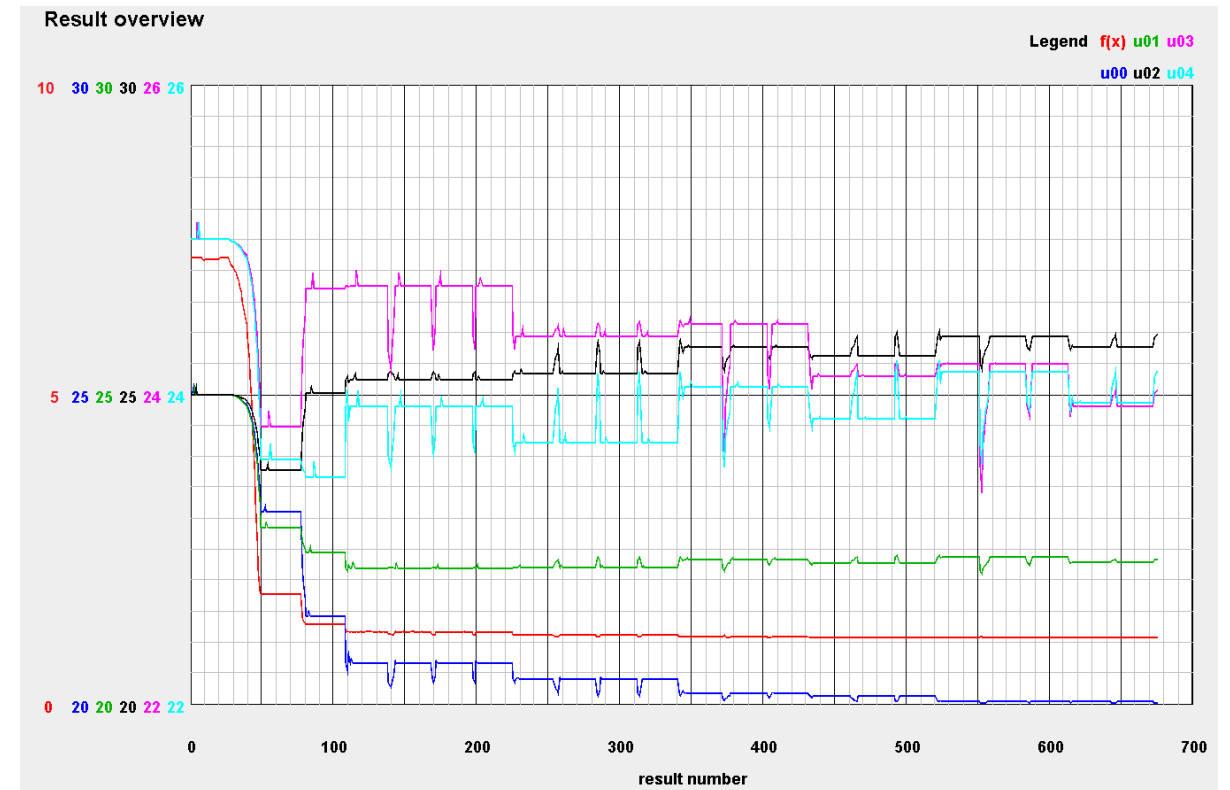
Simulation Results – OpenModelica

- StopTime = 86400
- Interval: 1s
- Method: dassl
- $f(x) = 7.39415$



Optimisation Results - GenOpt

- OpenModelica > GenOpt
- Discrete Armijo Gradient
- $U \rightarrow$ Heat source
 - Min = 20
 - Max = 30
 - Step = 1
- Objective function minimised



Issues and Recommendations

- Coupling OpenModelica with GenOpt
 - Result file location
 - Changeable
 - Log file
 - Simulation #: cannot rename file model.log



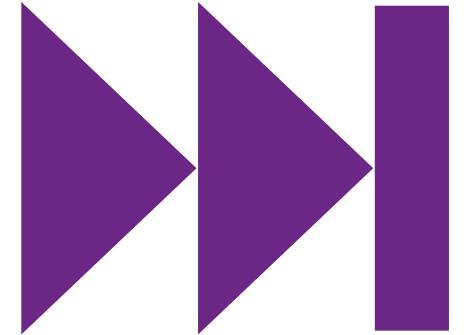
Conclusion

- GenOpt coupled with OpenModelica
- Decreases the cost function of a problem
- Energy systems simulation-based optimisation
- Save energy and decrease CO2



Future Plans

- Comparative analysis of OMOptim and GenOpt
- Integration of real-time information
 - Sensory data
 - Accurate parameters
 - Enrich models
- Digital Twin-based simulation



References

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Thank you
Any Questions?

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