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Findings published in scientific publications



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Kyriaki Foteinaki
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Preface

EnergyLab Nordhavn – New Urban Energy Infrastructures is an exciting project which will continue until the year of 2019. The project will use Copenhagen's Nordhavn as a full-scale smart city energy lab, which main purpose is to do research and to develop and demonstrate future energy solutions of renewable energy.

The goal is to identify the most cost-effective smart energy system, which can contribute to the major climate challenges the world are facing.

Budget: The project has a total budget of DKK 143 m (€ 19 m), of this DKK84 m (€ 11 m) funded in two rounds by the Danish Energy Technology Development and Demonstration Programme (EUDP).

Forord

EnergyLab Nordhavn er et spændende projekt der løber til og med 2019. Projektet vil foregå i Københavns Nordhavn, og vil fungere som et fuldskala storbylaboratorium, der skal undersøge, udvikle og demonstrerer løsninger for fremtidens energisystem.

Målet er at finde fremtidens mest omkostningseffektive energisystem, der desuden kan bidrage til en løsning på de store klimaudfordringer verden står overfor nu og i fremtiden.

Budget: Projektets totale budget er DKK 143 mio. (EUR 19 mio.), hvoraf DKK 84 mio. (EUR 11 mio.) er blevet finansieret af Energiteknologisk Udviklings- og Demonstrationsprogram, EUDP.

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For further information on this specific deliverable, please contact:

Kyriaki Foteinaki
kyfo@balslev.dk

For other information regarding EnergyLab Nordhavn, please contact:

EnergyLab Nordhavn Secretariat

Center for Electric Power and Energy, DTU Electrical Engineering
Elektrovej
Building 325
DK-2800 Kgs. Lyngby
Denmark

E-mail eln@dtu.dk
Tlf. +45 45 25 35 54

www.energylabnordhavn.dk

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Executive Summary

The objective of the task is to collect all the findings published in scientific publications in relation to Work Package 3.

Resumé

Formålet med opgaven er at indsamle alle de resultater, der er offentliggjort i videnskabelige publikationer i relation til Arbejdspakke 3.

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1. PhD thesis

1. Foteinaki, K. (2019), 'Models for flexible building operation in the Nordhavn district energy system', Department of Civil Engineering, Technical University of Denmark.

2. Journal articles

2.1 Published

1. Hu, Maomao; Xiao, Fu; Jørgensen, John Bagterp; Li, Rongling. Price-responsive model predictive control of floor heating systems for demand response using building thermal mass. In: Applied Thermal Engineering, Vol. 153, 2019, p. 316-329.
2. Zong, Yi ; Su, Wenjing ; Wang, Jiawei ; Rodek, Jakub Krzysztof ; Jiang, Chuhao ; Christensen, Morten Herget ; You, Shi ; Zhou, You ; Mu, Shujun. Model Predictive Control for Smart Buildings to Provide the Demand Side Flexibility in the Multi-Carrier Energy Context: Current Status, Pros and Cons, Feasibility and Barriers. In: Energy Procedia, vol: 158, pages: 3026-3031. Presented at: 10th International Conference on Applied Energy 2019. DOI: <https://doi.org/10.1016/j.egypro.2019.01.981>
3. Foteinaki, K., Li, R., Heller, A. and Rode, C. (2018) 'Heating system energy flexibility of low-energy residential buildings', Energy and Buildings. 180, 2018, 95–108, doi: 10.1016/j.enbuild.2018.09.030.
4. Cai, Hanmin; Ziras, Charalampos; You, Shi; Li, Rongling; Honoré, Kristian; Bindner, Henrik W. Demand side management in urban district heating networks. In: Applied Energy, Vol. 230, 2018, p. 506-518.
5. Wang, Andong; Li, Rongling; You, Shi. Development of a data driven approach to explore the energy flexibility potential of building clusters. In: Applied Energy, Vol. 232, 2018, p. 89-100.
6. Li, Rongling; You, Shi. Exploring Potential of Energy Flexibility in Buildings for Energy System Services. In: C S E E Journal of Power and Energy Systems, Vol. 4, No. 4, 2018, p. 434-443.
7. Barthelmes, V.M.; Li, R.; Andersen, Rune Korsholm; Bahnfleth, W.; Corgnati, S.P.; Rode, Carsten. Profiling Occupant Behaviour in Danish Dwellings using Time Use Survey Data. In: Energy and Buildings, Vol. 177, 2018, p. 329-340.
8. Finck, Christian; Rongling Li; Kramer, Rick; Zeiler, Wim. "Quantifying demand flexibility of power-to-heat and thermal energy storage in the control of building heating systems". In: Applied Energy, Vol. 209, 2018, p.409-425
9. Rongling Li; Dane, Gamze; Finck, Christian; Zeiler, Wim. "Are building users prepared for energy flexible buildings—A large-scale survey in the Netherlands". In: Applied Energy, Vol. 203, 2017, p.623-634

10. Zong, Yi ; Awadelrahman, M. A. Ahmed ; Wang, Jiawei ; You, Shi ; Træholt, Chresten ; Xiao, Xianyong, "Enhancing Wind Power Integration through Optimal Use of Flexibility in Multi-Carrier Energy Systems from the Danish Perspective", in journal: World Journal of Engineering and Technology (ISSN: 2331-4249), vol: 5, issue: 4, pages: 78-88, 2017, http://file.scirp.org/Html/79551_79551.htm
11. Wang, Jiawei; Zong, Yi; You, Shi and Træholt, Chresten, "A review of Danish integrated multi-energy system flexibility options for high wind power penetration", in journal: Clean Energy (ISSN: 2515-4230) (DOI: <http://dx.doi.org/10.1093/ce/zkx002>), vol: 1, issue: 1, pages: 23-35, 2017
12. Awadelrahman, M. A. Ahmed ; Zong, Yi ; Li, Hongwei ; Agert, Carsten. / Economic Model Predictive Control for Hot Water Based Heating Systems in Smart Buildings. In: Energy and Power Engineering. 2017 ; Vol. 9. pp. 112-119.
13. Zong, Yi ; Böning, Georg Martin ; Santos, Rui Mirra ; You, Shi ; Hu, Junjie ; Han, Xue. / Challenges of implementing economic model predictive control strategy for buildings interacting with smart energy systems. In: Applied Thermal Engineering. 2016 ; Vol. 114. pp. 1476–1486.
14. Katarzyna M. Luc, Alfred Heller, Carsten Rode, "Energy Demand Flexibility in Buildings and District Heating Systems - a Literature Review", Advances in Building Energy Research (accepted)
15. Foteinaki, K., Li, R., Rode, C., & Andersen, R. K. (2019). Modelling household electricity load profiles based on Danish time-use survey data. Energy and Buildings, 109355. <https://doi.org/10.1016/j.enbuild.2019.109355>

2.2 Submitted

1. Foteinaki, K., Li, R., Péan, T., Rode, C. and Salom, J. (2019) 'Evaluation of energy flexibility of low-energy residential buildings connected to district heating'. Submitted to a peer-reviewed journal- under revision.

3. Conference papers

1. M. H. Christensen, D. C. Nozal, I. Kavadas and P. Pinson, "Data-driven learning from dynamic pricing data - Classification and forecasting," 2019 IEEE Milan PowerTech, Milan, Italy, 2019, pp. 1-6.
2. G. L. Ray, M. H. Christensen and P. Pinson, "Detection and Characterization of Domestic Heat Pumps," 2019 IEEE Milan PowerTech, Milan, Italy, 2019, pp. 1-6.
3. Foteinaki, K., Li, R., Heller, A., Christensen, M. H. and Rode, C. (2019) 'Dynamic thermal response of low-energy residential buildings based on in-wall

- measurements'. Published in the proceedings of 13th REHVA World Congress CLIMA 2019. Bucharest, Romania.
4. L. Sarran, M. H. Christensen, C. A. Hviid, A. M. Radoszynski, C. Rode, P. Pinson, Data-driven study on individual occupant comfort using heating setpoints and window openings in new low-energy apartments-preliminary insights, Published in the proceedings of 13th REHVA World Congress CLIMA 2019. Bucharest, Romania.
 5. Rongling Li, Kyriaki Foteinaki, Christian Finck, Morten Christensen, Shi You. On the energy flexibility in buildings: from components to building cluster. Accepted to SBE19 conference, Tokyo, Japan.
 6. Lucas Beltram, Morten Christensen, Rongling Li. Demonstration of heating demand peak shaving in smart homes. Submitted to CISBAT 2019 conference, Lausanne, Switzerland.
 7. Rongling Li, Morten Christensen. Heating demand peak shaving in smart homes. To be presented at EnergyLab Nordhavn Session in Smart Energy Systems International Conference, Copenhagen, Denmark.
 8. Hanmin Cai, Rongling Li, Shi You, Jan Eric Thorsen, Kristian Honoré. Flexibility in integrated energy system: experimental insights from EnergyLab Nordhavn project. To be presented at EnergyLab Nordhavn Session in Smart Energy Systems International Conference, Copenhagen, Denmark.
 9. Jiang, Chuhao ; Zong, Yi ; Su, Wenjing ; Qi, Zhiyuan. Exploring the Demand Side Flexibility of a New Residential Building. Published in the proceedings of the 2nd International Symposium on Computer Science and Intelligent Control 2018. DOI: <https://doi.org/10.1145/3284557.3287305>
 10. Rongling Li, Yunran Chen and Carsten Rode. "Heat Flexibility as a Function of the Outdoor Climate: A Study of Danish Dwellings". *COBEE2018 Conference*, February 2018.
 11. Verena M. Barthelmes, Rongling Li, Rune K. Andersen, William Bahnfleth, Stefano P. Corgnati and Carsten Rode. "Profiling Occupant Behaviour in Danish Dwellings using Time Use Survey Data - Part I: Data Description and Activity Profiling". *COBEE2018 Conference*, February 2018
 12. Verena M. Barthelmes, Rongling Li, Rune K. Andersen, William Bahnfleth, Stefano P. Corgnati and Carsten Rode. "Profiling Occupant Behaviour in Danish Dwellings using Time Use Survey Data - Part II: Time-related Factors and Occupancy". *COBEE2018 Conference*, February 2018
 13. Yi Zong, Jiawei Wang, Jakub Krzysztof Rodek, Chuhao Jiang and Morten Herget Christensen, et.al., "Model Predictive Control for Smart Buildings to Provide the Demand Side Flexibility in the Multi-Carrier Energy Context: Current Status, Pros and Cons, Feasibility and Barriers", submitted to 10th International Conference on Applied Energy (ICAE2018), 22-25 August 2018, Hong Kong, China.

14. Rongling Li, Feng Wei, Yang Zhao and Wim Zeiler. "Implementing Occupant Behaviour in the Simulation of Building Energy Performance and Energy Flexibility: Development of Co-Simulation Framework and Case Study". Paper for Building Simulation 2017 Conference, August 2017, San Francisco USA
15. Rongling Li, Andong Wang, Carsten Rode and Shi You. "Energy Flexibility of Building Cluster – Part I: Occupancy Modelling". IBPC2018 Conference, September 2018, USA.
16. Finck, Christian; Rongling Li; Zeiler, Wim. "Performance maps for the control of thermal energy storage". Paper for Building Simulation 2017 Conference, August 2017, San Francisco USA
17. Gianniou, P., Foteinaki, K., Heller, A., & Rode, C. (2017). "Intelligent Scheduling of a Grid-connected Heat Pump in a Danish Detached House". In Proceedings of Building Simulation 2017, San Francisco, United States.
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20. Wang, Jiawei; You, Shi ; Zong, Yi; Træholt, Chresten "Energylab Nordhavn: An integrated community energy system towards green heating and e-mobility" part of: Proceedings of 2017 IEEE Transportation Electrification Conference and Expo, (ISBN: 978-1-5386-2894-2), pages: 1-6, 2017, IEEE, Presented at: 2017 IEEE Transportation Electrification Conference and Expo, Asia-Pacific, 2017, Harbin, China
21. Yu, Xingji; You, Shi; Jiang, Yüewen; Zong, Yi and Cai, Hanmin, "An evolving experience learned for modelling thermal dynamics of buildings from live experiments: the Flexhouse story" in journal: Energy Procedia (ISSN: 1876-6102), vol: 141, pages: 233-239, 2017. Presented at: 4th International Conference on Power and Energy Systems Engineering (CPESE 2017), 2017, Berlin.
22. Li, Rongling; Wang, Jiawei; Zong, Yi; Foteinaki, Kyriaki; Rode, Carsten, "Enhancing demand side flexibility in Nordhavn buildings for integrated multi-energy systems", part of: Book of Abstracts, Sustain 2017, 2017, Technical University of Denmark (DTU), Presented at: Sustain 2017, 2017, Kgs. Lyngby
23. Ahmed, Awadelrahman M. A.; Zong, Yi; et al., "Potential Energy Flexibility for a Hot-Water Based Heating System in Smart Buildings via Economic Model Predictive Control ", part of: Proceedings of 2017 International Symposium on Computer Science and Intelligent Controls (ISBN: 978-1-5386-2941-3), pages: 1-5, 2018, IEEE, Presented at: 2017 International Symposium on Computer Science and Intelligent Controls, 2017, Budapest.

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25. Santos, Rui Mirra ; Zong, Yi ; Sousa, Joao M. C. ; Mendonça, Luís ; Thavlov, Anders. / Nonlinear Economic Model Predictive Control Strategy for Active Smart Buildings. Proceedings of IEEE ISGT 2016. IEEE, 2016.
26. Santos, Rui Mirra ; Zong, Yi ; Sousa, Joao M. C. ; Mendonca, Luis ; You, Shi ; Mihet-Popa, Lucian. / Fuzzy predictive filtering in nonlinear economic model predictive control for demand response. Proceedings of 2016 IEEE Electrical Power and Energy Conference. IEEE, 2016. pp. 1-6

4. Student projects

1. Juan Sala Coca, Data analysis of smart homes - clustering and pattern identification, MSc-thesis, 2019, DTU Byg
2. Samuele Fortina, How is district heating used in Nordhavn? MSc-thesis, 2019, DTU Byg
3. Lucas Beltram, Investigation of building energy flexibility in Nordhavn, Special course, 2019, DTU Byg
4. Yunran Chen, Categorization of dwelling heat flexibility regarding outdoor climate for integration in district energy systems, MSc-thesis, 2018, DTU Byg and TU Eindhoven.
5. Ann-Britt Vejlgård and Julie Lindgaard Hald. Simulation of building energy consumption on an urban scale. BSc-thesis, 2018, DTU BYG.
6. Christine Emilie Pettersen Sandersen. Thermal Flexibility in Different Buildings in a District Heating Network, MSc-thesis, 2017, DTU BYG.
7. Jakub Krzysztof Rodek, Model Predictive Control - based domestic load scheduling in multi-energy context, MSc-thesis, 2017, DTU CEE.
8. Chuhao Jiang, Learning-based modeling and load forecast in a multi-energy context for smart building management, MSc-thesis, 2017, DTU CEE.
9. Athanasia Keli, Energy flexibility potential of large scale buildings. Special course, 2017, DTU BYG.
10. Athanasia Keli. Analysis of the thermal energy use in apartments of a low-energy building in Nordhavn for achieving flexibility. Special course, 2017, DTU BYG.
11. Yann Randrianarison. Investigation of building designs with active technologies and impact on building energy performance and indoor climate: a short literature review and investigation. Special course, 2017, DTU BYG.

12. Audrey Ryan. Real-life studies of user acceptance of smart home energy technologies. External research stay - Report 2017, DTU BYG.
13. Lucile Sarran, Impact of building design parameters on energy flexibility in Nordhavn district, MSc-thesis, 2016, DTU BYG.
14. Emanuele Zilio - Analysis of building services systems for flexible operation of buildings in smart city district Nordhavn, MSc-thesis, 2016, DTU BYG.
15. Magdalini Psarra, Investigation of Optimization Tool Coupled to Building Energy Simulation: EnergyPlus and GenOpt Application, Special course, 2016, DTU BYG.