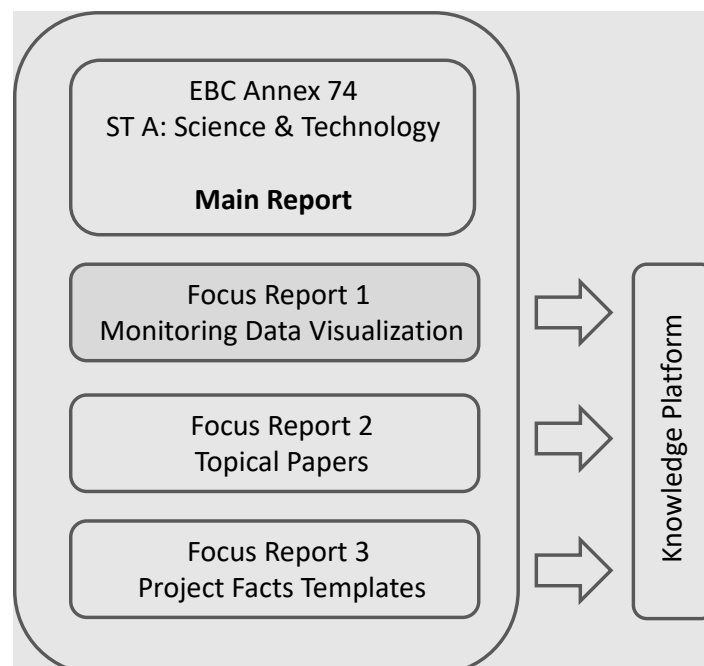


International Energy Agency

Competition and Living Lab Platform (Annex 74) Science & Technology (Subtask A) Focus Report 1: Monitoring Data Visualization

Energy in Buildings and Communities
Technology Collaboration Programme

November 2021



International Energy Agency

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November 2021

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Digital Object Identifier: <https://doi.org/10.25926/8ab3-kd54>

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Published by University Wuppertal, Faculty Architecture and Civil Engineering, Department Building Physics and Technical Services, Pauluskirchstr. 7, D - 42285 Wuppertal, Germany, 2021.

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Preface

The International Energy Agency

The International Energy Agency (IEA) was established in 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an international energy programme. A basic aim of the IEA is to foster international co-operation among the 30 IEA participating countries and to increase energy security through energy research, development and demonstration in the fields of technologies for energy efficiency and renewable energy sources.

The IEA Energy in Buildings and Communities Programme

The IEA co-ordinates international energy research and development (R&D) activities through a comprehensive portfolio of Technology Collaboration Programmes. The mission of the IEA Energy in Buildings and Communities (IEA EBC) Technology Collaboration Programme is to develop and facilitate the integration of technologies and processes for energy efficiency and conservation into healthy, low emission, and sustainable buildings and communities, through innovation and research. (Until March 2013, the IEA EBC Programme was known as the IEA Energy Conservation in Buildings and Community Systems Programme, ECBCS.)

The R&D strategies of the IEA EBC Programme are derived from research drivers, national programmes within IEA countries, and the IEA Future Buildings Forum Think Tank Workshops. These R&D strategies aim to exploit technological opportunities to save energy in the buildings sector, and to remove technical obstacles to market penetration of new energy efficient technologies. The R&D strategies apply to residential, commercial, office buildings and community systems, and will impact the building industry in five areas of focus for R&D activities:

- Integrated planning and building design
- Building energy systems
- Building envelope
- Community scale methods
- Real building energy use

The Executive Committee

Overall control of the IEA EBC Programme is maintained by an Executive Committee, which not only monitors existing projects, but also identifies new strategic areas in which collaborative efforts may be beneficial. As the Programme is based on a contract with the IEA, the projects are legally established as Annexes to the IEA EBC Implementing Agreement. At the present time, the following projects have been initiated by the IEA EBC Executive Committee, with completed projects identified by (*) and joint projects with the IEA Solar Heating and Cooling Technology Collaboration Programme by (☼):

Annex 1:	Load Energy Determination of Buildings (*)
Annex 2:	Ekistics and Advanced Community Energy Systems (*)
Annex 3:	Energy Conservation in Residential Buildings (*)
Annex 4:	Glasgow Commercial Building Monitoring (*)
Annex 5:	Air Infiltration and Ventilation Centre
Annex 6:	Energy Systems and Design of Communities (*)
Annex 7:	Local Government Energy Planning (*)
Annex 8:	Inhabitants Behaviour with Regard to Ventilation (*)

- Annex 9: Minimum Ventilation Rates (*)
- Annex 10: Building HVAC System Simulation (*)
- Annex 11: Energy Auditing (*)
- Annex 12: Windows and Fenestration (*)
- Annex 13: Energy Management in Hospitals (*)
- Annex 14: Condensation and Energy (*)
- Annex 15: Energy Efficiency in Schools (*)
- Annex 16: BEMS 1- User Interfaces and System Integration (*)
- Annex 17: BEMS 2- Evaluation and Emulation Techniques (*)
- Annex 18: Demand Controlled Ventilation Systems (*)
- Annex 19: Low Slope Roof Systems (*)
- Annex 20: Air Flow Patterns within Buildings (*)
- Annex 21: Thermal Modelling (*)
- Annex 22: Energy Efficient Communities (*)
- Annex 23: Multi Zone Air Flow Modelling (COMIS) (*)
- Annex 24: Heat, Air and Moisture Transfer in Envelopes (*)
- Annex 25: Real time HVAC Simulation (*)
- Annex 26: Energy Efficient Ventilation of Large Enclosures (*)
- Annex 27: Evaluation and Demonstration of Domestic Ventilation Systems (*)
- Annex 28: Low Energy Cooling Systems (*)
- Annex 29: Daylight in Buildings (*)
- Annex 30: Bringing Simulation to Application (*)
- Annex 31: Energy-Related Environmental Impact of Buildings (*)
- Annex 32: Integral Building Envelope Performance Assessment (*)
- Annex 33: Advanced Local Energy Planning (*)
- Annex 34: Computer-Aided Evaluation of HVAC System Performance (*)
- Annex 35: Design of Energy Efficient Hybrid Ventilation (HYBVENT) (*)
- Annex 36: Retrofitting of Educational Buildings (*)
- Annex 37: Low Exergy Systems for Heating and Cooling of Buildings (LowEx) (*)
- Annex 38: Solar Sustainable Housing (*)
- Annex 39: High Performance Insulation Systems (*)
- Annex 40: Building Commissioning to Improve Energy Performance (*)
- Annex 41: Whole Building Heat, Air and Moisture Response (MOIST-ENG) (*)
- Annex 42: The Simulation of Building-Integrated Fuel Cell and Other Cogeneration Systems (FC+COGEN-SIM) (*)
- Annex 43: Testing and Validation of Building Energy Simulation Tools (*)
- Annex 44: Integrating Environmentally Responsive Elements in Buildings (*)
- Annex 45: Energy Efficient Electric Lighting for Buildings (*)
- Annex 46: Holistic Assessment Tool-kit on Energy Efficient Retrofit Measures for Government Buildings (EnERGo) (*)
- Annex 47: Cost-Effective Commissioning for Existing and Low Energy Buildings (*)
- Annex 48: Heat Pumping and Reversible Air Conditioning (*)
- Annex 49: Low Exergy Systems for High Performance Buildings and Communities (*)
- Annex 50: Prefabricated Systems for Low Energy Renovation of Residential Buildings (*)
- Annex 51: Energy Efficient Communities (*)
- Annex 52: Towards Net Zero Energy Solar Buildings (*)
- Annex 53: Total Energy Use in Buildings: Analysis and Evaluation Methods (*)
- Annex 54: Integration of Micro-Generation and Related Energy Technologies in Buildings (*)
- Annex 55: Reliability of Energy Efficient Building Retrofitting - Probability Assessment of Performance and Cost (RAP-RETRO) (*)
- Annex 56: Cost Effective Energy and CO2 Emissions Optimization in Building Renovation (*)
- Annex 57: Evaluation of Embodied Energy and CO2 Equivalent Emissions for Building Construction (*)

- Annex 58: Reliable Building Energy Performance Characterisation Based on Full Scale Dynamic Measurements (*)
- Annex 59: High Temperature Cooling and Low Temperature Heating in Buildings (*)
- Annex 60: New Generation Computational Tools for Building and Community Energy Systems (*)
- Annex 61: Business and Technical Concepts for Deep Energy Retrofit of Public Buildings (*)
- Annex 62: Ventilative Cooling (*)
- Annex 63: Implementation of Energy Strategies in Communities (*)
- Annex 64: LowEx Communities - Optimised Performance of Energy Supply Systems with Exergy Principles (*)
- Annex 65: Long-Term Performance of Super-Insulating Materials in Building Components and Systems
- Annex 66: Definition and Simulation of Occupant Behavior in Buildings (*)
- Annex 67: Energy Flexible Buildings (*)
- Annex 68: Indoor Air Quality Design and Control in Low Energy Residential Buildings (*)
- Annex 69: Strategy and Practice of Adaptive Thermal Comfort in Low Energy Buildings
- Annex 70: Energy Epidemiology: Analysis of Real Building Energy Use at Scale
- Annex 71: Building Energy Performance Assessment Based on In-situ Measurements
- Annex 72: Assessing Life Cycle Related Environmental Impacts Caused by Buildings
- Annex 73: Towards Net Zero Energy Resilient Public Communities
- Annex 74: Competition and Living Lab Platform
- Annex 75: Cost-effective Building Renovation at District Level Combining Energy Efficiency and Renewables
- Annex 76: Deep Renovation of Historic Buildings towards Lowest Possible Energy Demand and CO2 Emissions
- Annex 77: Integrated Solutions for Daylight and Electric Lighting
- Annex 78: Supplementing Ventilation with Gas-phase Air Cleaning, Implementation and Energy Implications
- Annex 79: Occupant Behaviour-Centric Building Design and Operation
- Annex 80: Resilient Cooling of Buildings
- Annex 81: Data-Driven Smart Buildings
- Annex 82: Energy Flexible Buildings towards Resilient Low Carbon Energy Systems
- Annex 83: Positive Energy Districts
- Annex 84: Demand Management of Buildings in Thermal Networks
- Annex 85: Indirect Evaporative Cooling
- Annex 86: Energy Efficient Indoor Air Quality Management in Residential Buildings

Working Group - Energy Efficiency in Educational Buildings (*)

Working Group - Indicators of Energy Efficiency in Cold Climate Buildings (*)

Working Group - Annex 36 Extension: The Energy Concept Adviser (*)

Working Group - HVAC Energy Calculation Methodologies for Non-residential Buildings (*)

Working Group - Cities and Communities (*)

Working Group - Building Energy Codes

Summary

The Annex 74 „Competition and Living Lab Platform“ ran between January 2018 und June 2021 within the Energy in Buildings and Communities Technology Collaboration Programme (EBC) of the International Energy Agency¹. Annex 74 was intended as a platform mapping and linking the building competition and living lab experiences worldwide and working towards further improving existing as well as developing new formats. Annex 74 should stimulate the technological knowledge, the scientific level and the architectural quality within future competitions and living labs based on the development of a systematic knowledge platform as well as on the link to expertise from previous and current IEA activities². A total of eleven experts from nine countries participated in this small Annex with varying degrees of intensity.

Four documents were produced as a result of subtask A "Science and Technology". This report is the main deliverable. This document is supplemented by three so-called focus reports:

- The focus report "Monitoring Data Visualization" contains for a better overview the graphical processing of the measurement data collected within four past Solar Decathlon competitions.
- The report under the title "Topical Papers" contains a set of thematic in-depth papers that link typical topics of the Solar Decathlon with research and practice issues, pointing out connections to IEA research networks.
- The documentation "Project Facts Template" presents a newly developed data collection structure for the quantitative data of buildings in a competition.

The focus report "Monitoring Data Visualization" gives a detailed overview of the obtained monitoring data from Solar Decathlon Europe 2010, 2012, 2014 and Solar Decathlon Middle East 2018 by presenting a large number of illustrations. Each competition is structured in a separate chapter and begins with a brief summary of available data in form of a table. Figures related to comfort measurements, operation temperatures of household devices and electrical consumption as well as generation are included in each dataset. In general it can be seen, that resolution and amount of measurement data increases within the history of the Solar Decathlon.

More recent versions, like 2014 and 2018, include climate data as well as detailed information about electrical consumption and storage of electrical energy in batteries. Furthermore the SDME18 dataset is completed with detailed figures of electrical parameters such as voltage, current and frequency on all three phases. The less extensive chapters on the Solar Decathlons in Madrid, however, contain results of acoustic measurements. Comfort measurements, like temperature, relative humidity and air quality, were done in at least two different rooms in each competition.

All data are for download on the building competition knowledge platform after login². The aberrations used in legends relate to the SDE teams. More information to the team houses are part of the knowledge platform.

¹ <https://annex74.iea-ebc.org/>

² www.building-competition.org

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1. SDE 2010 - Madrid

Table 1: Overview of available monitoring data from the Solar Decathlon Europe 2010 in Madrid

1. acoustic performance I	9. freezer
2. acoustic performance II	10. washing machine
3. interior air temperature – main room	11. dishwasher
4. interior air temperature – bedroom	12. oven
5. relative interior humidity – main room	13. generation
6. interior air quality – main room	14. total consumption
7. interior lighting level	15. consumption – home electronics
8. fridge	

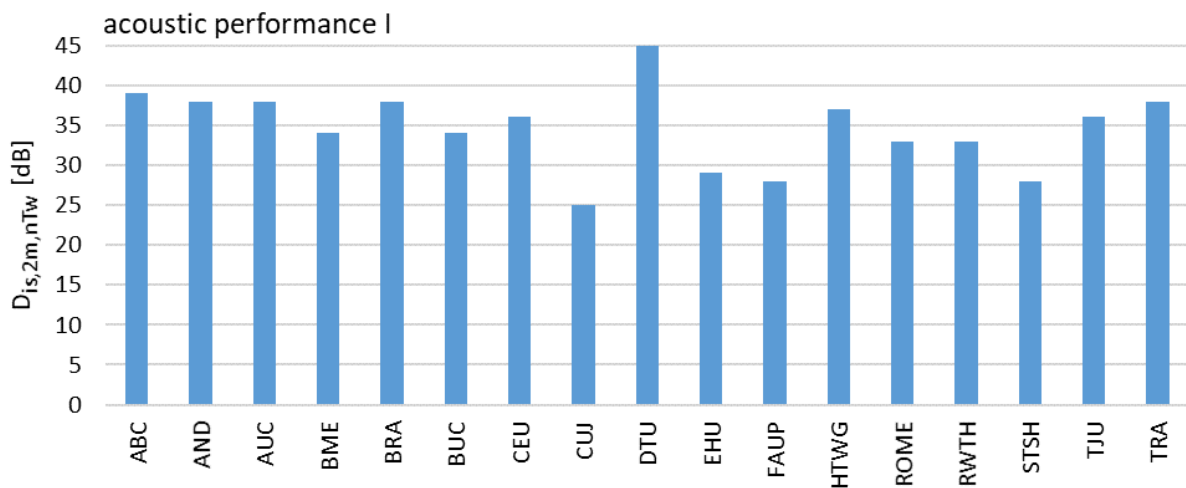


Figure 1: SDE10 acoustic performance I, competition period in June 2010

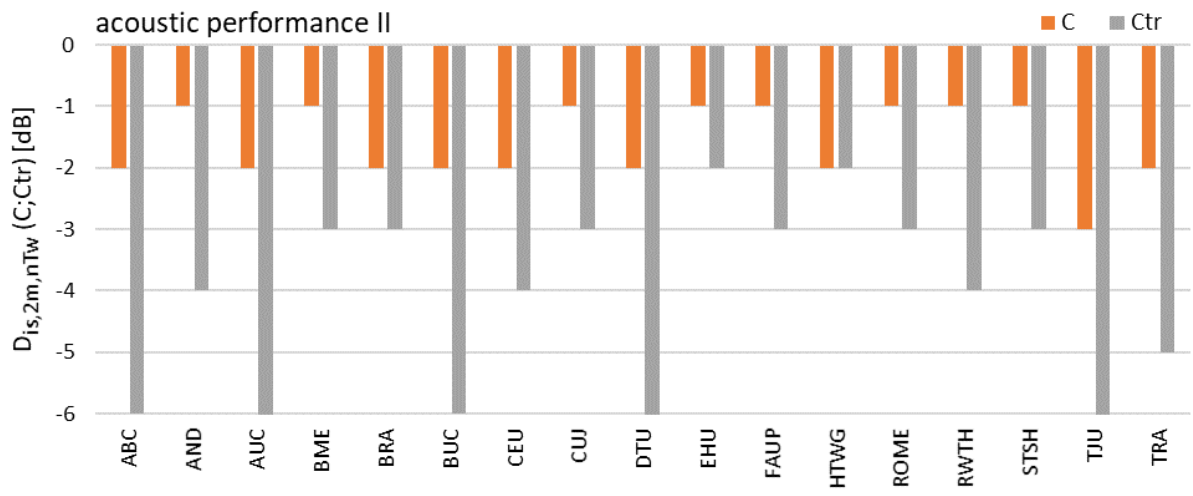


Figure 2: SDE10 acoustic performance I, competition period in June 2010

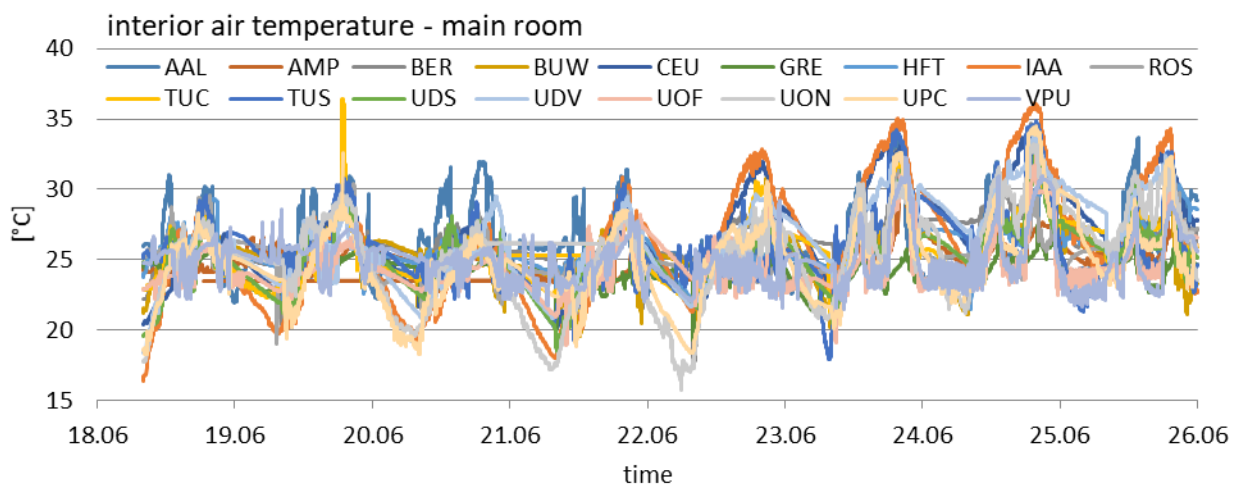


Figure 3: SDE10 main room air temperature, competition period in June 2010

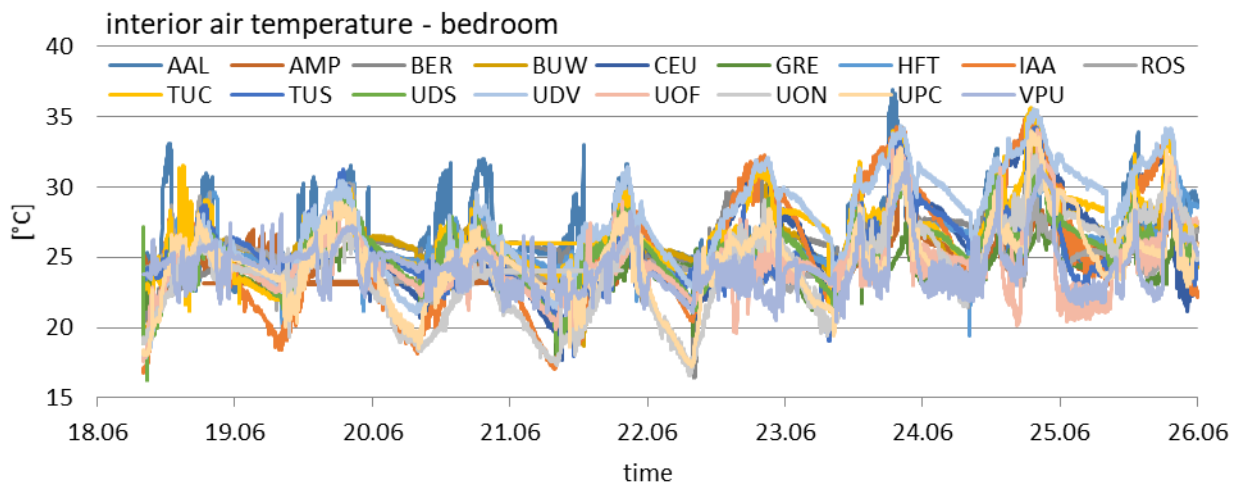


Figure 4: SDE10 bedroom air temperature, competition period in June 2010

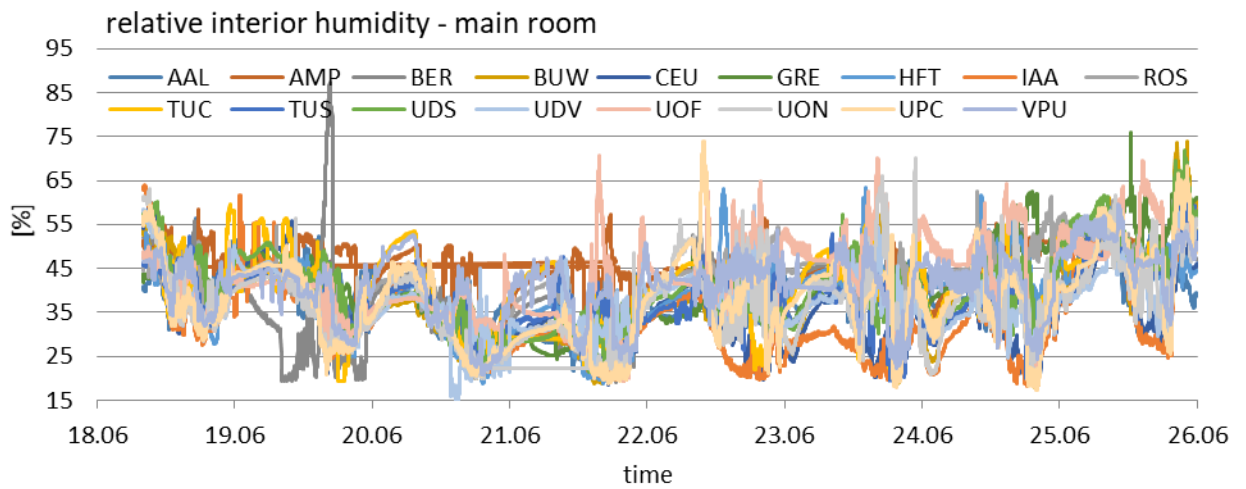


Figure 5: SDE10 relative interior humidity, competition period in June 2010

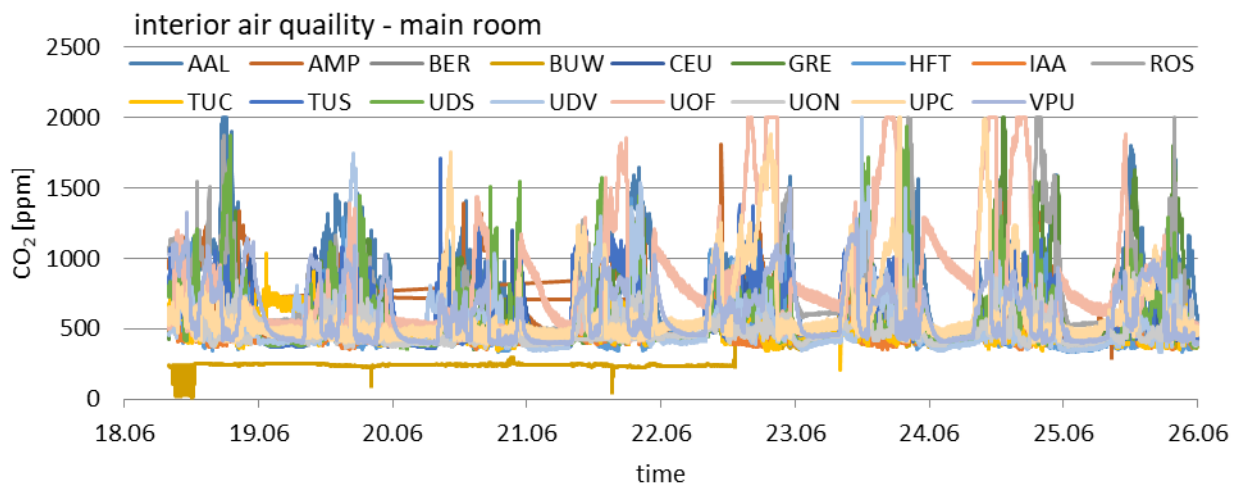


Figure 6: SDE10 interior CO₂ concentration, competition period in June 2010

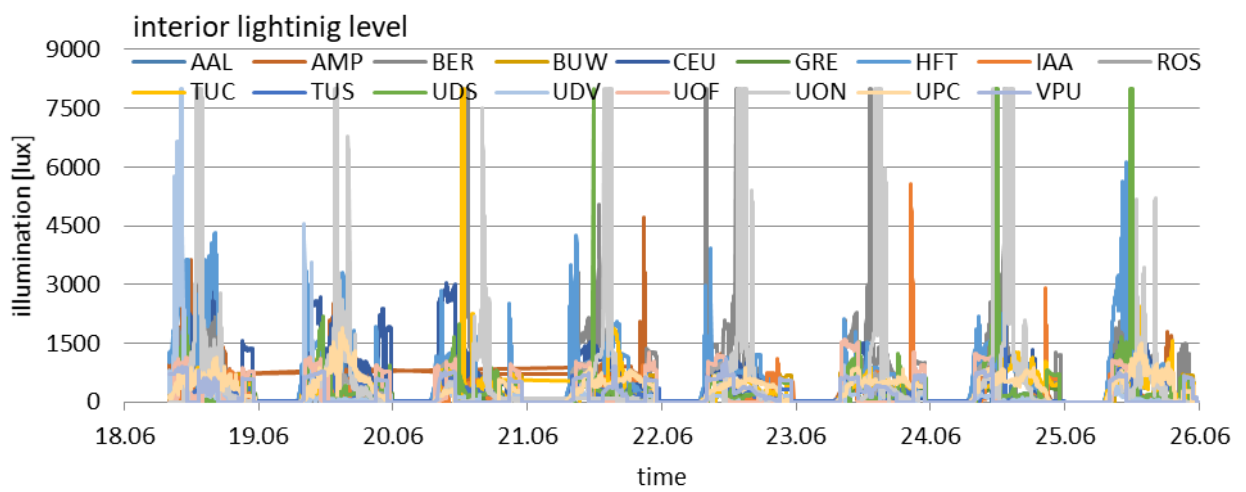


Figure 7: SDE10 lighting level, competition period in June 2010

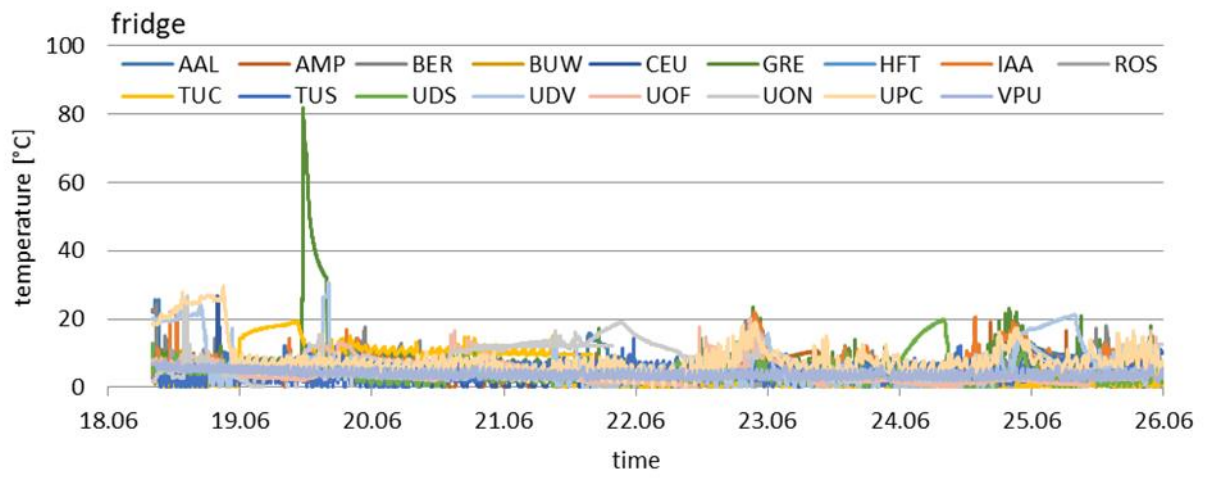


Figure 8: SDE10 temperature in the fridge, competition period in June 2010

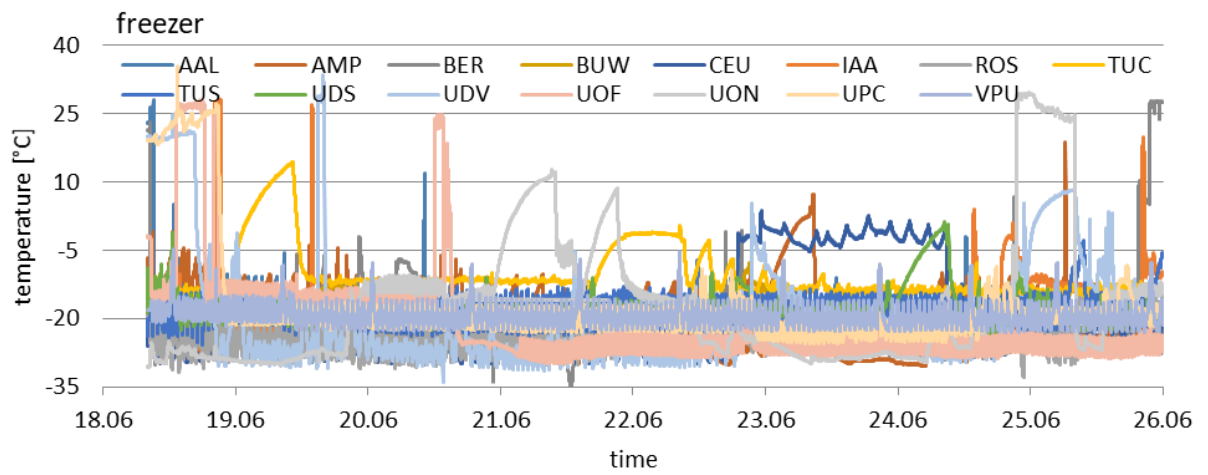


Figure 9: SDE10 temperature in the freezer, competition period in June 2010

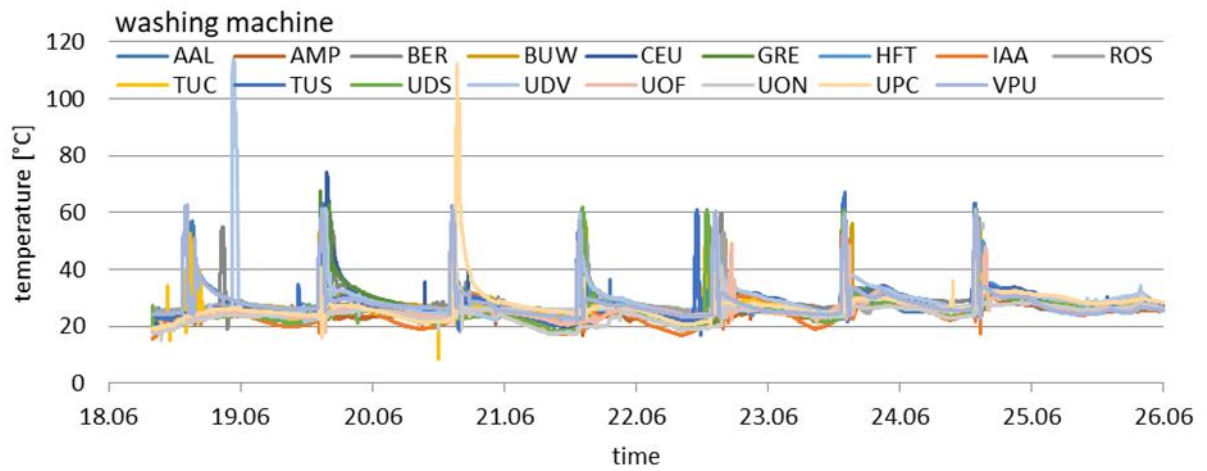


Figure 10: SDE10 temperature in the washing mashine, competition period in June 2010

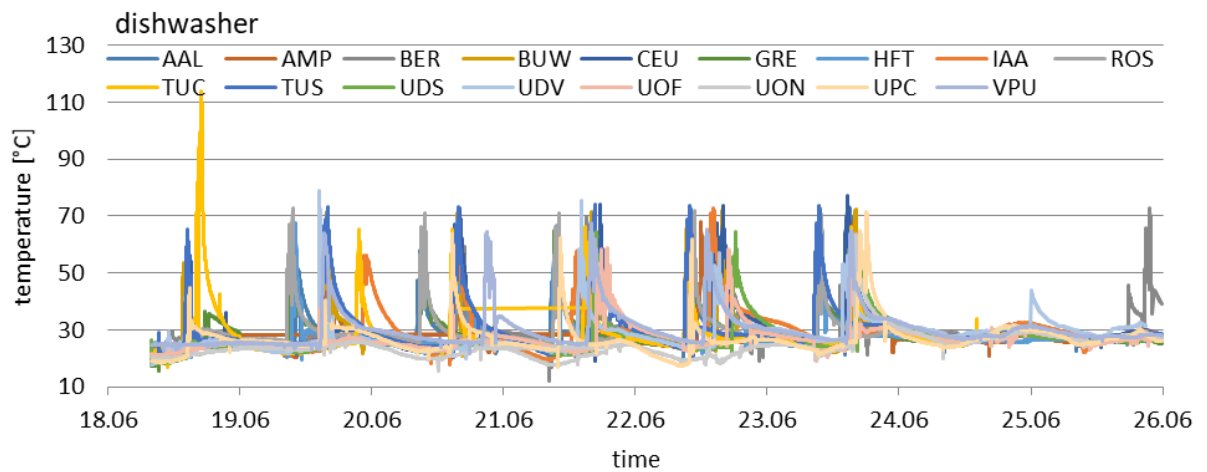


Figure 11: temperature in the dishwasher, competition period in June 2010

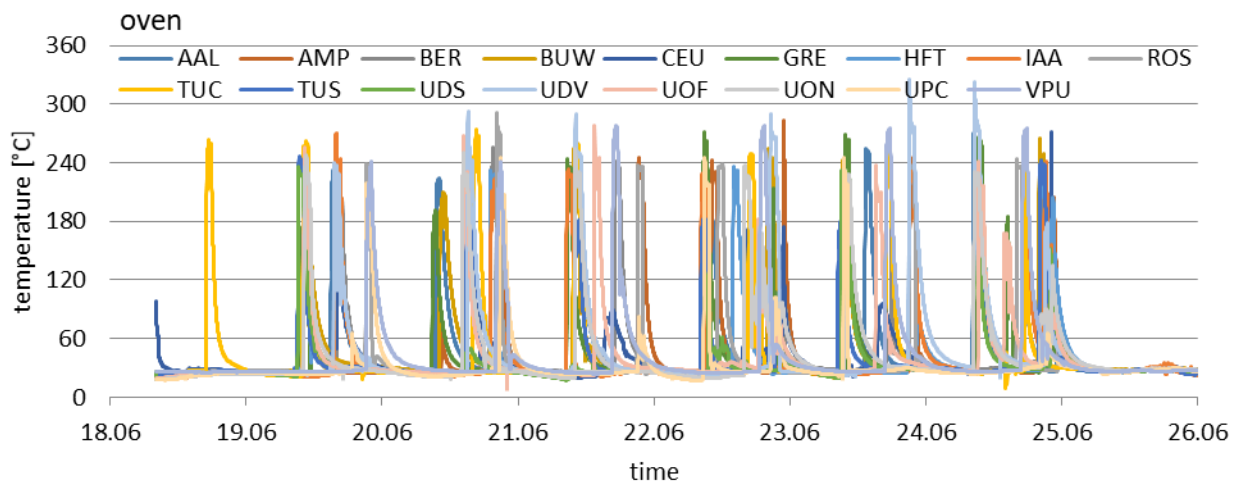


Figure 12: SDE10 temperature in the oven, competition period in June 2010

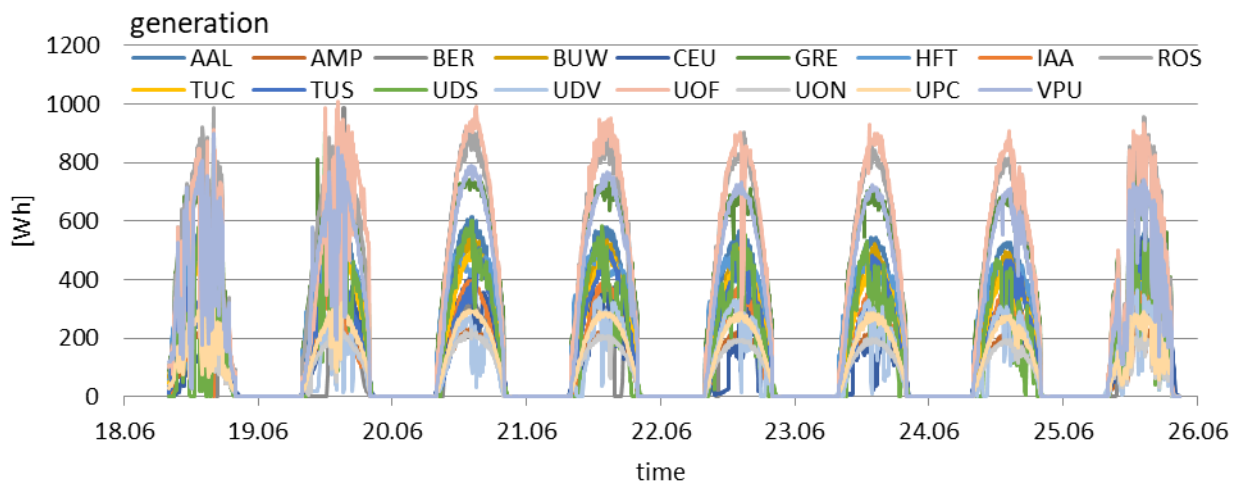


Figure 13: SDE10 energy generation, competition period in June 2010

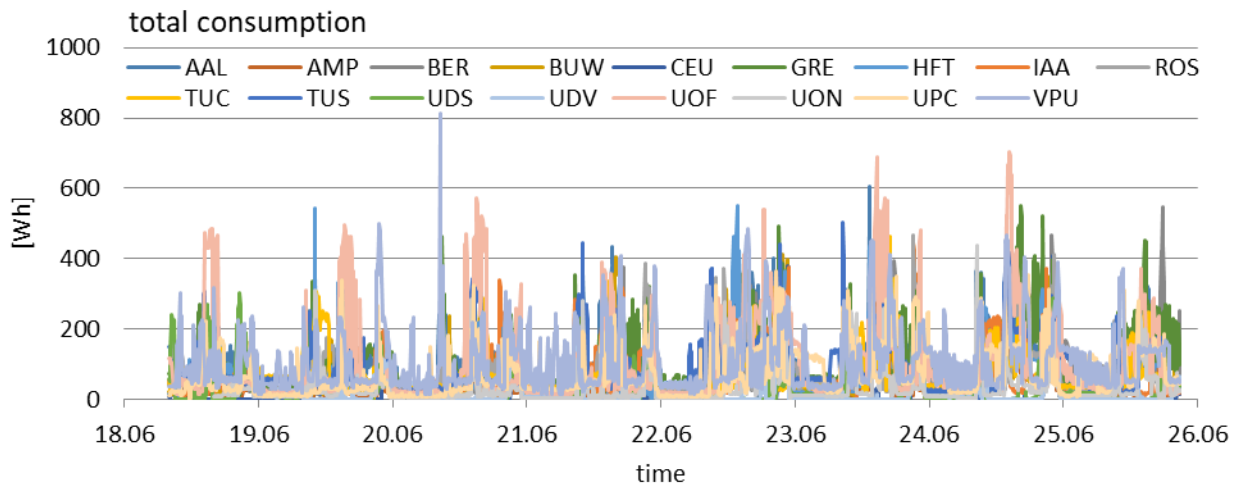


Figure 14: SDE10 total energy consumption, competition period in June 2010

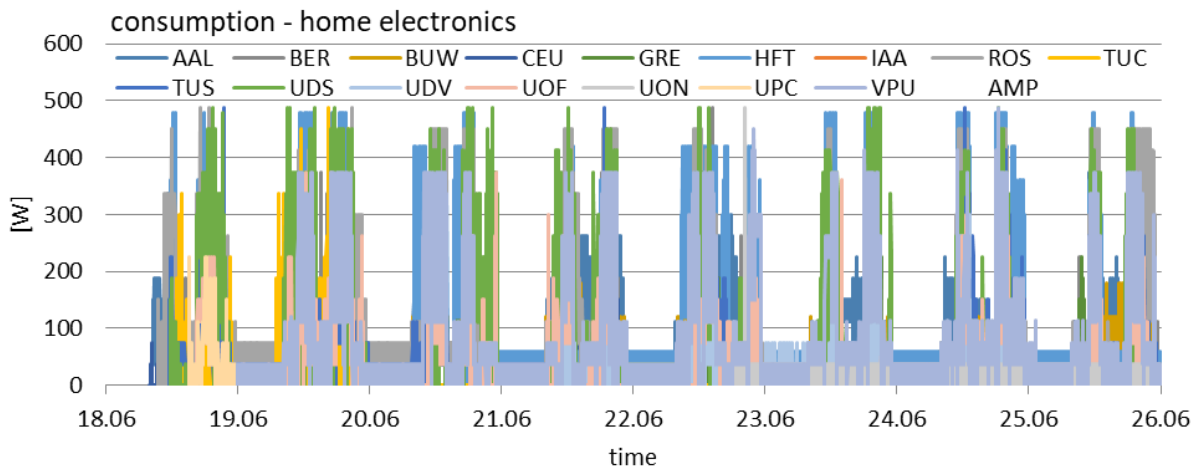


Figure 15: SDE10 consumption of home electronics, competition period June 2010

2. SDE 2012 - Madrid

Table 2: Overview of available monitoring data from the Solar Decathlon Europe 2012 in Madrid

- | | |
|---|------------------------------------|
| 1. acoustic performance I | 9. freezer |
| 2. acoustic performance II | 10. oven |
| 3. interior air temperature – main room | 11. washing machine |
| 4. interior air temperature – room 2 | 12. dishwasher |
| 5. relative interior humidity – main room | 13. generation |
| 6. interior air quality – main room | 14. total consumption |
| 7. interior lighting level | 15. consumption – home electronics |
| 8. fridge | 16. battery |

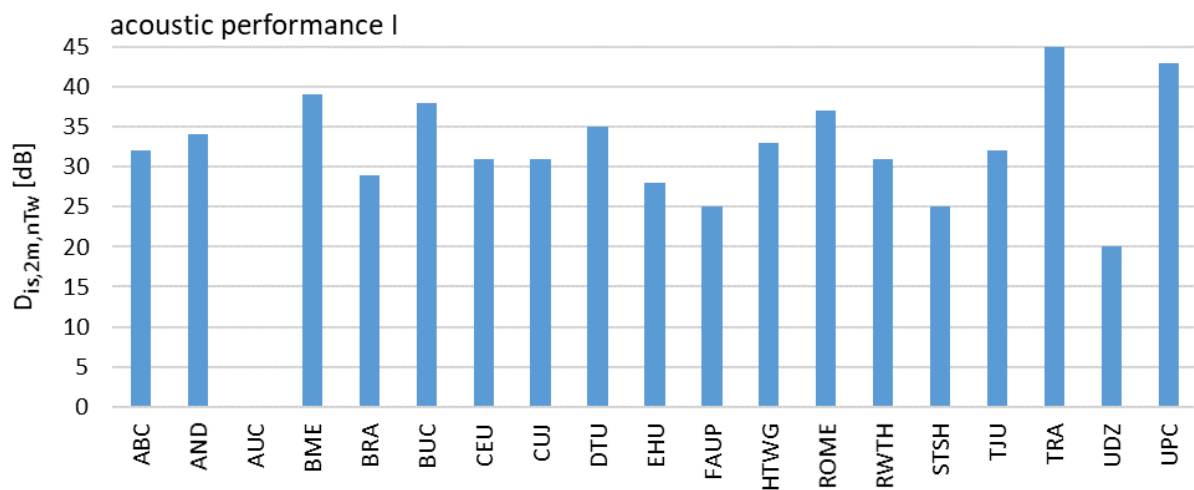


Figure 16: SDE12 results of acoustic performance tests I, competition period in September 2012

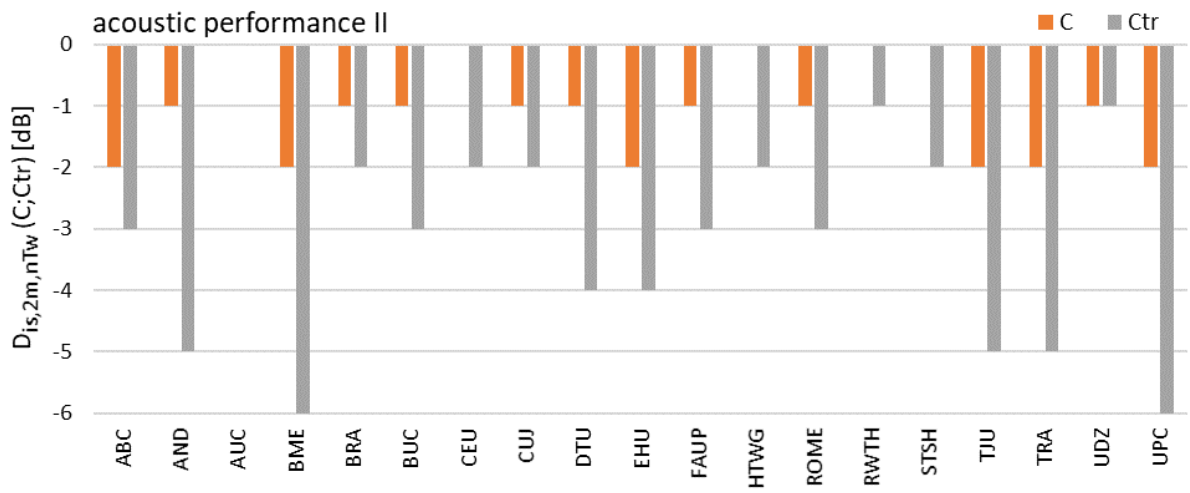


Figure 17: results of acoustic performance tests II, competition period in September 2012

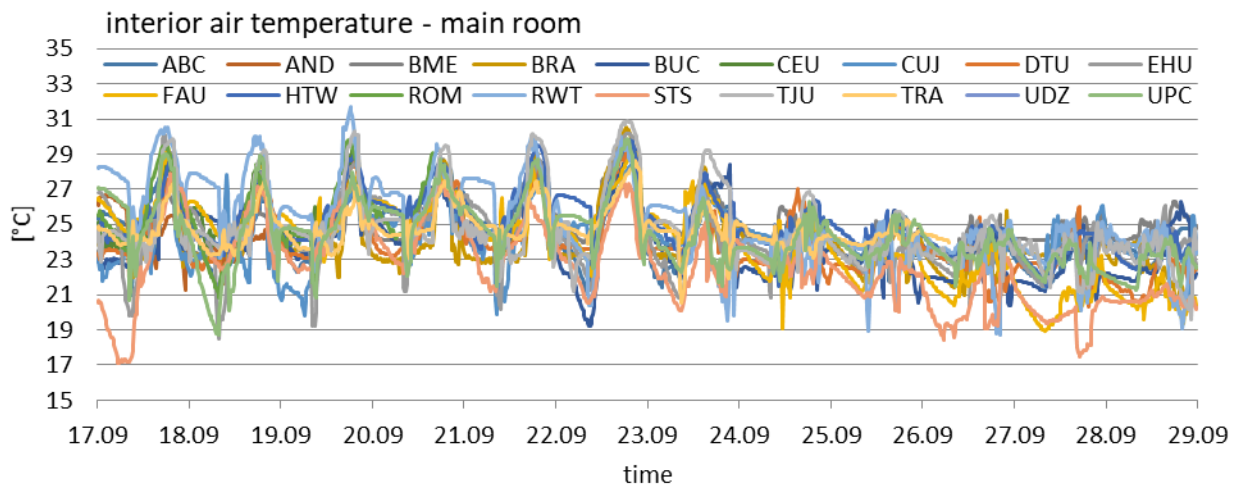


Figure 18: SDE12 interior air temperature – main room, competition period in September 2012

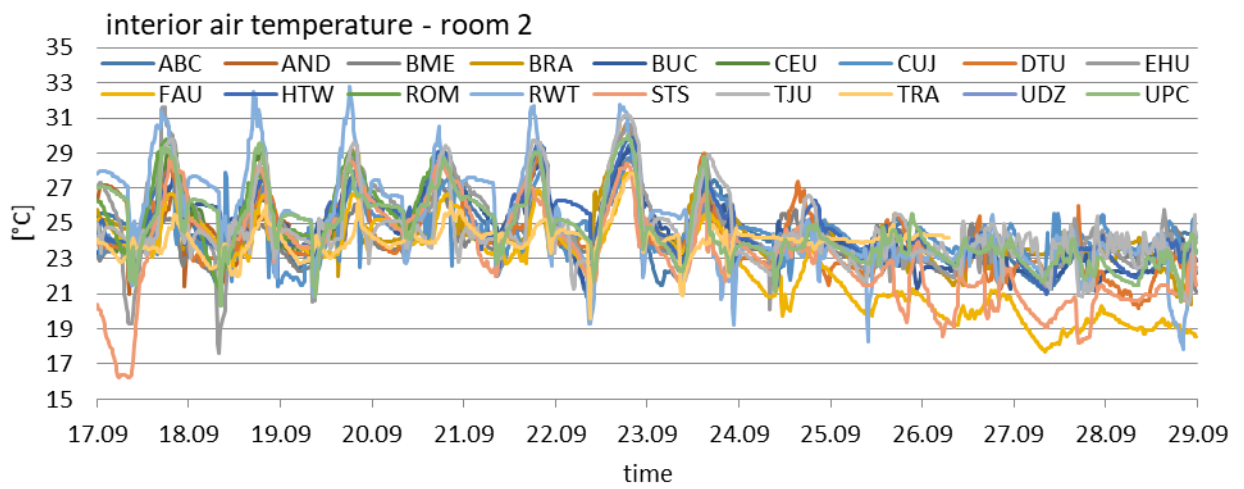


Figure 19: SDE12 interior air temperature – second room, competition period in September 2012

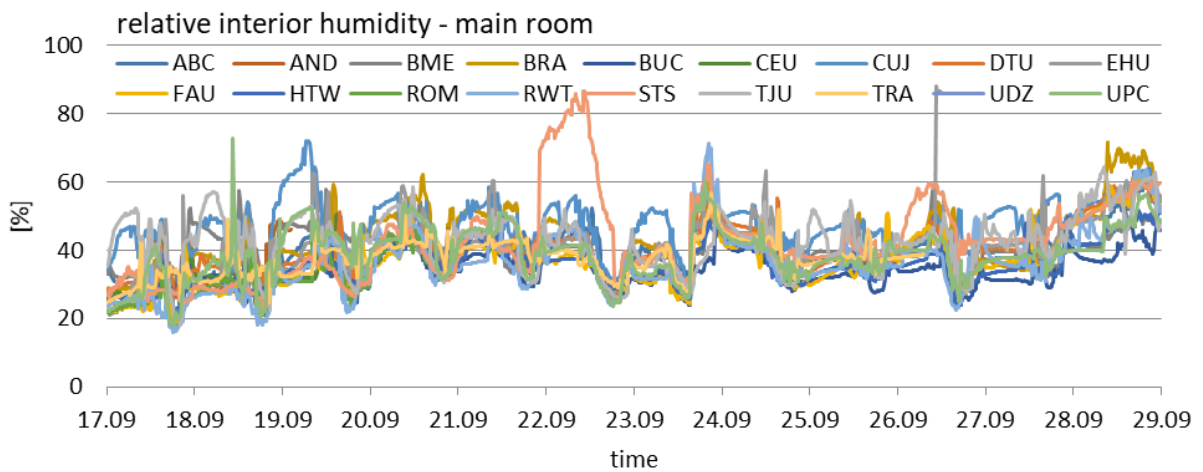


Figure 20: SDE12 relative interior humidity, competition period in September 2012

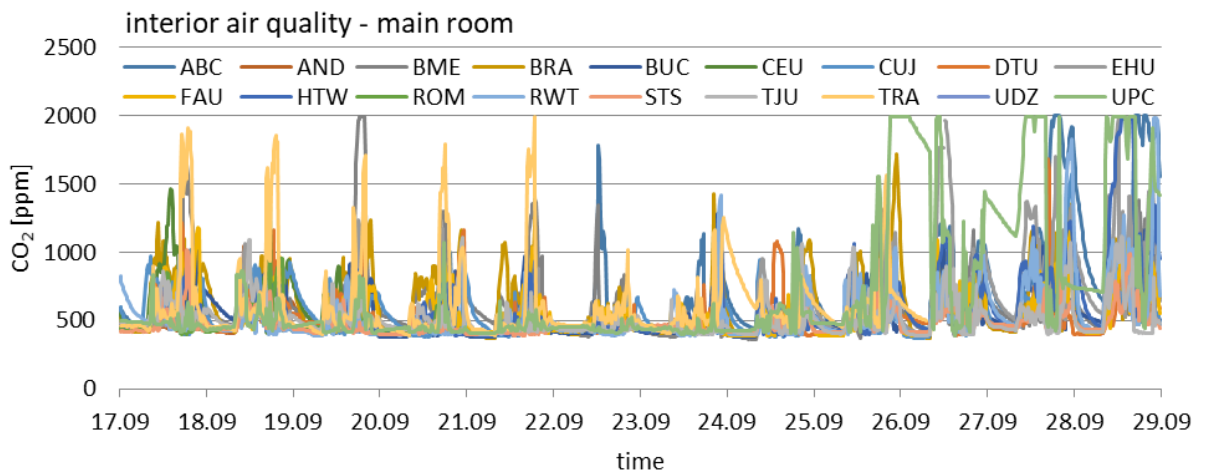


Figure 21: SDE12 interior CO₂ concentration, competition period in September 2012

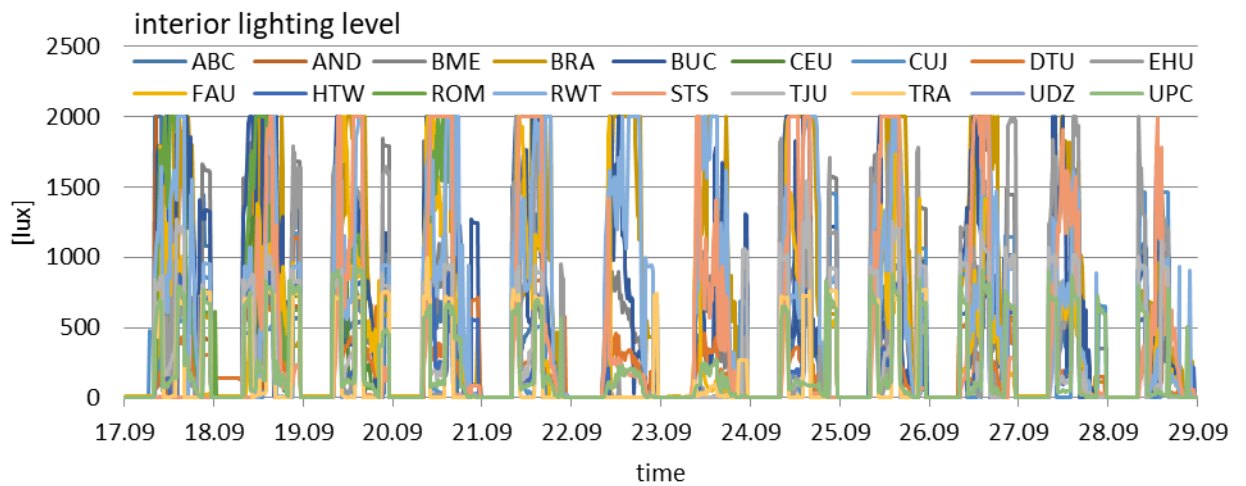


Figure 22: SDE12 lighting level, competition period in September 2012

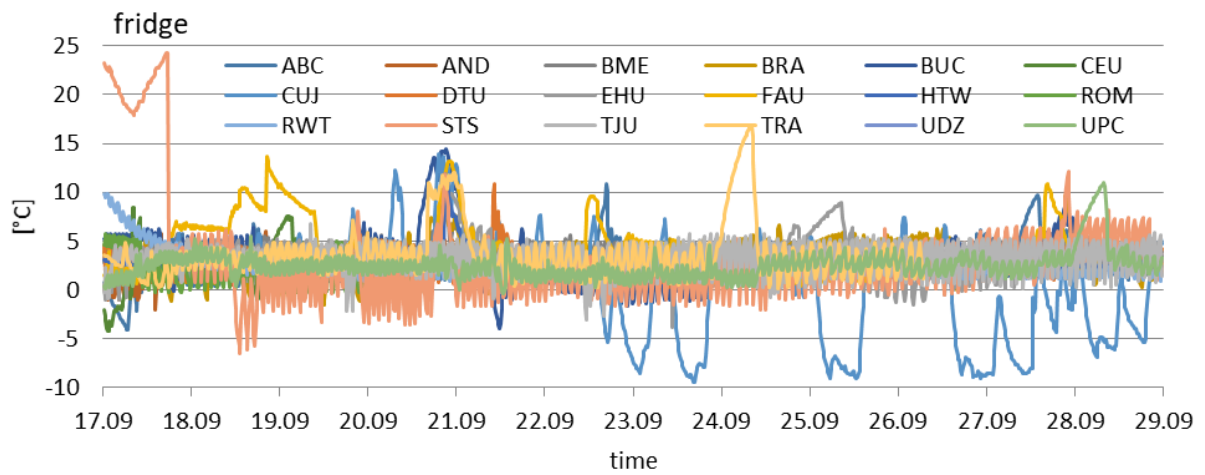


Figure 23: SDE12 temperature in the fridge, competition period in September 2012

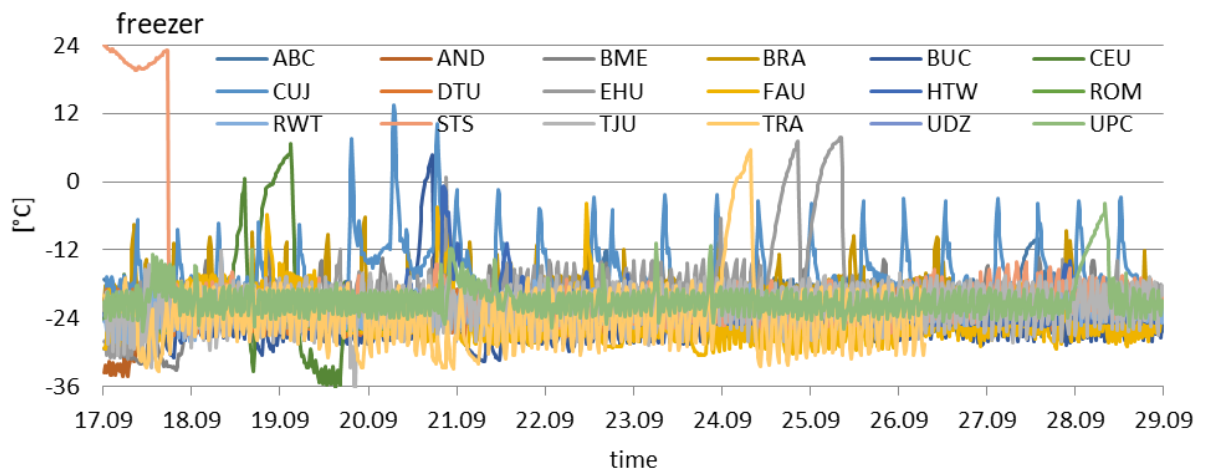


Figure 24: SDE12 temperature in the freezer, competition period in September 2012

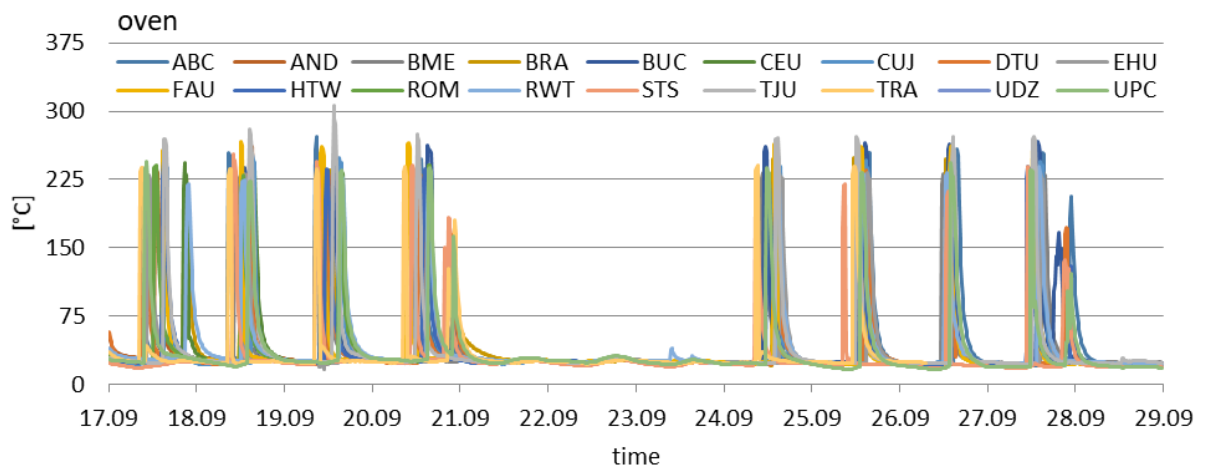


Figure 25: SDE12 temperature in the oven, competition period in September 2012

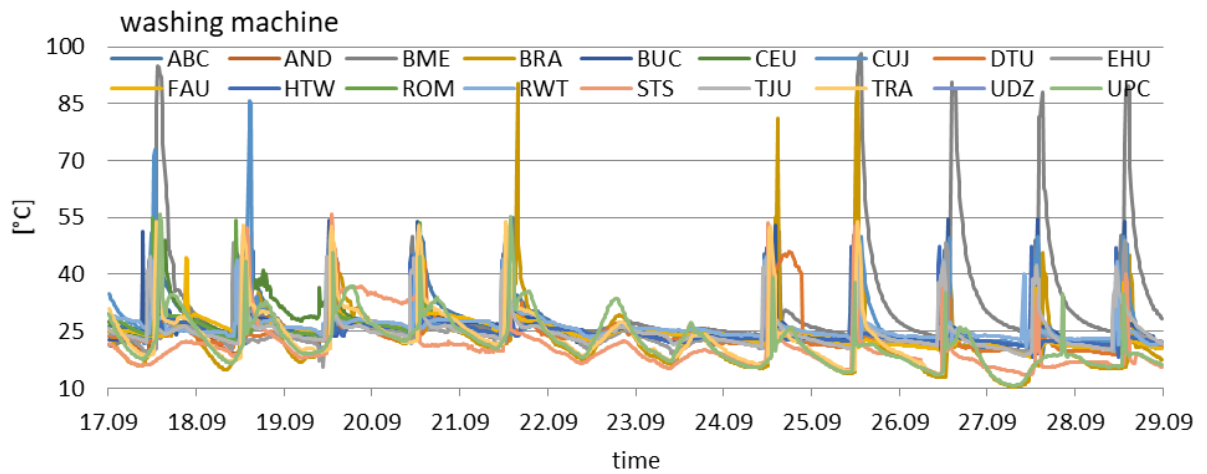


Figure 26: SDE12 temperature in the washing machine, competition period in September 2012

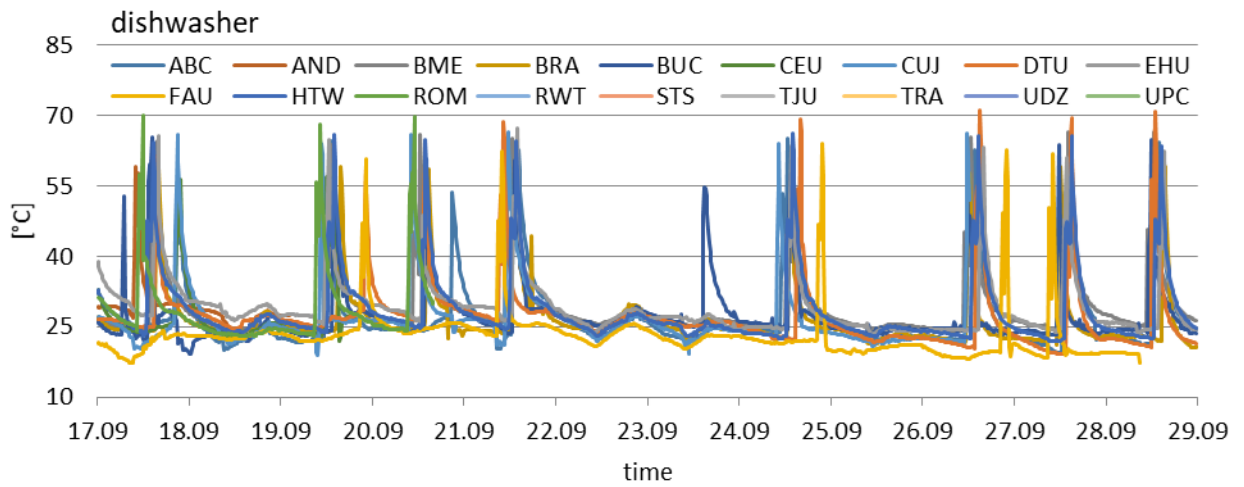


Figure 27: SDE12 temperature in the dishwasher, competition period in September 2012

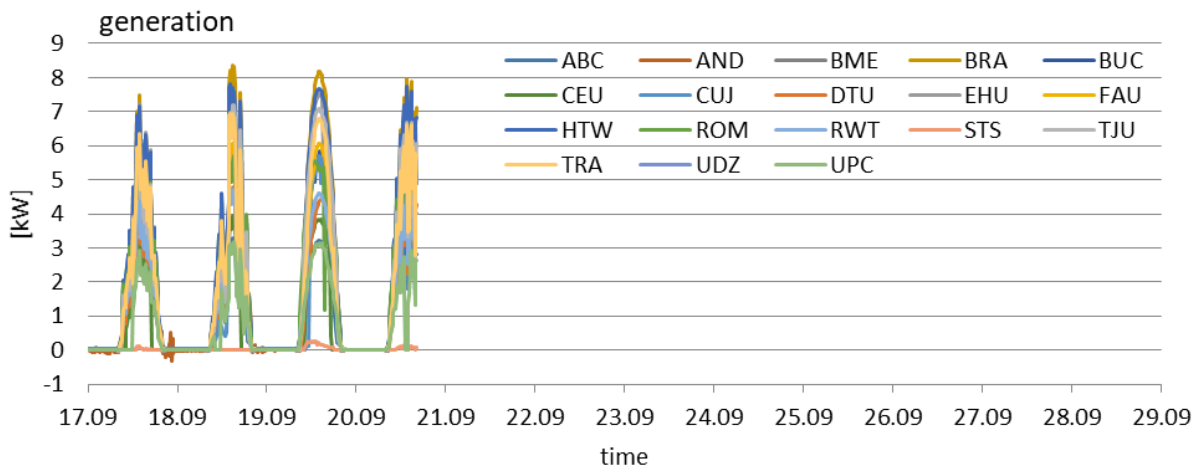


Figure 28: SDE12 energy generation, competition period in September 2012

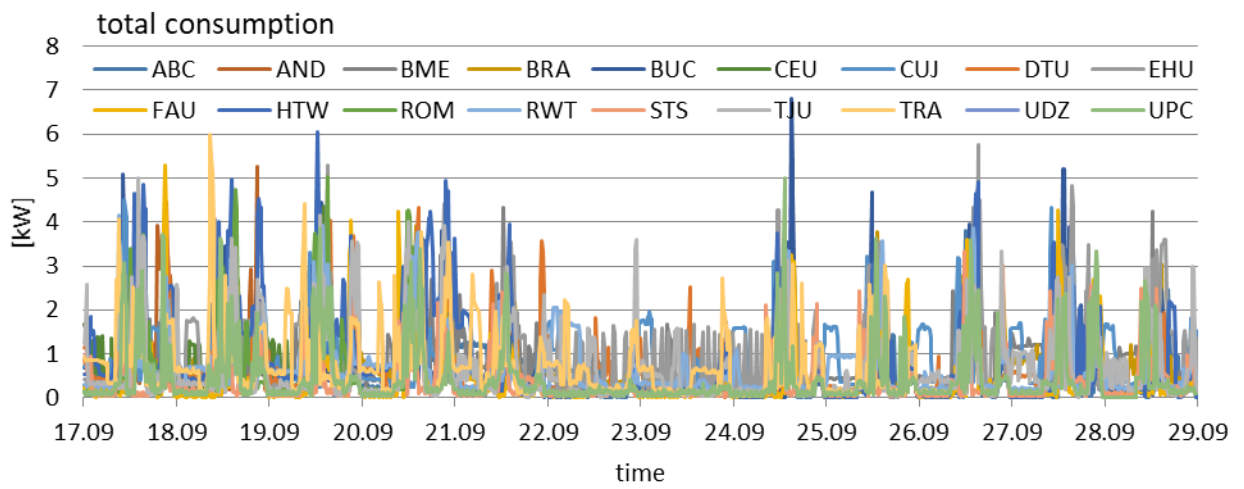


Figure 29: SDE12 total energy consumption, competition period in September 2012

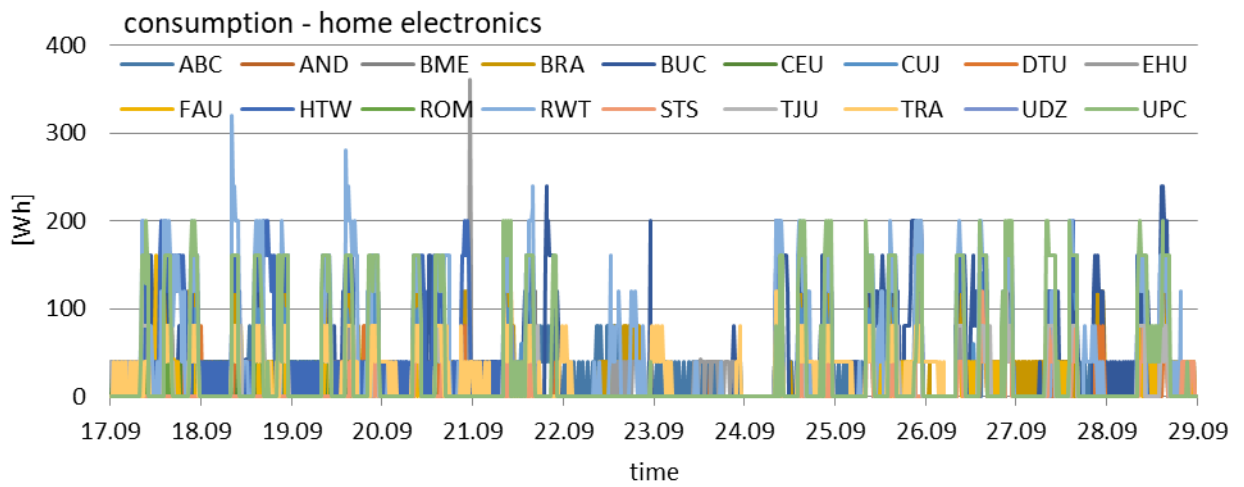


Figure 30: SDE12 energy consumption of home electronic devices, competition period in September 2012

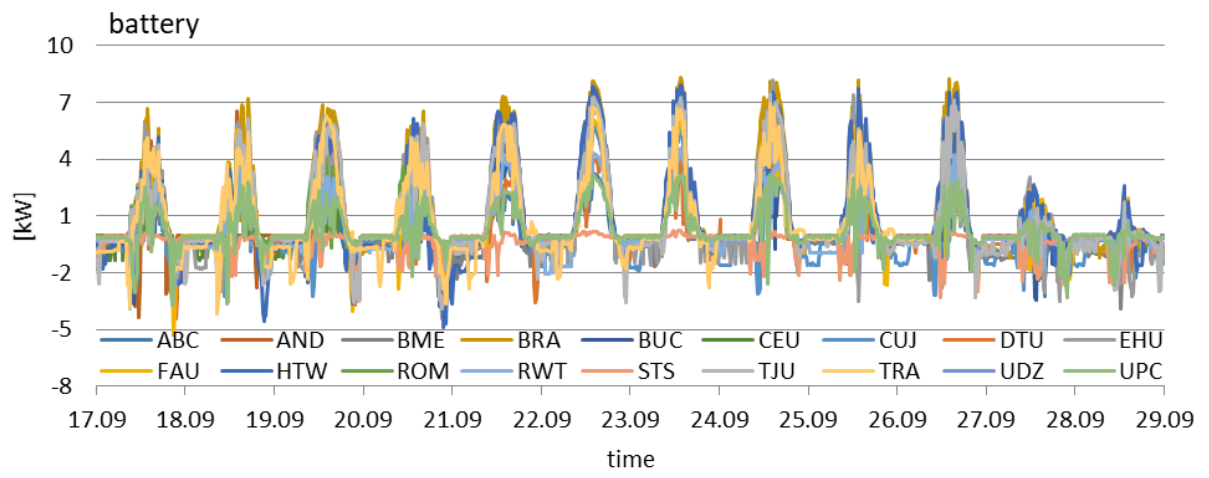


Figure 31: SDE12 load profiles of batteries, competition period in September 2012

3. SDE 2014 - Versailles

Table 3: Overview of available monitoring data from the Solar Decathlon Europe 2014 in Versailles

1. exterior air temperature	11. freezer
2. relative exterior humidity	12. washing machine
3. insolation	13. dishwasher
4. target interior temperature range	14. oven
5. interior air temperature – main room	15. total consumption
6. interior air temperature – room 2	16. consumption – appliances
7. interior air temperature – room 3	17. consumption – home electronics
8. relative interior humidity – main room	18. generation
9. interior air quality – main room	19. battery
10. fridge	20. grid

3.1 Climate Data

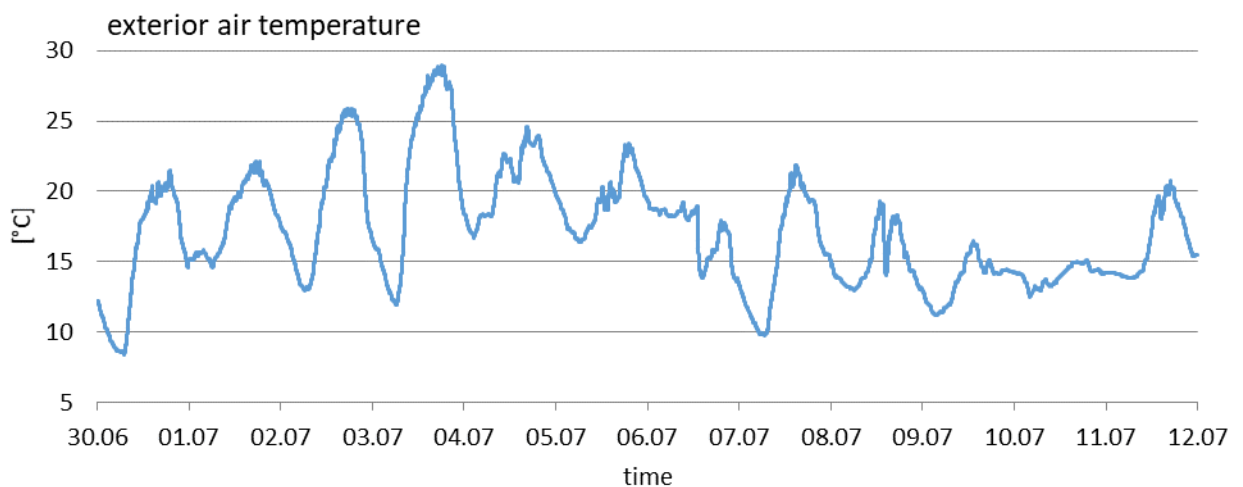


Figure 32: SDE14 exterior air temperature, competition period in July 2014

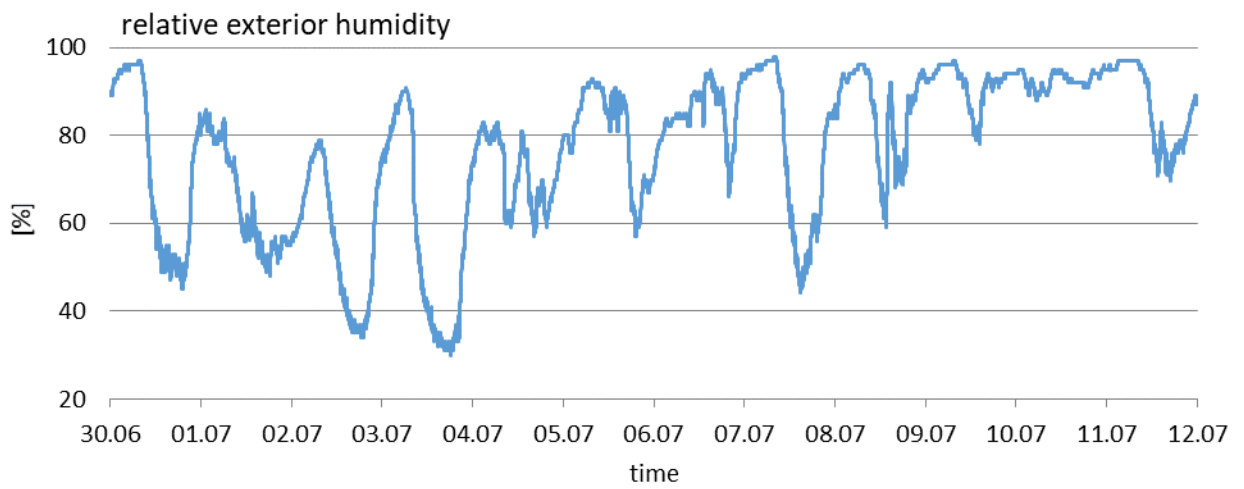


Figure 33: SDE14 relative exterior humidity, competition period in July 2014

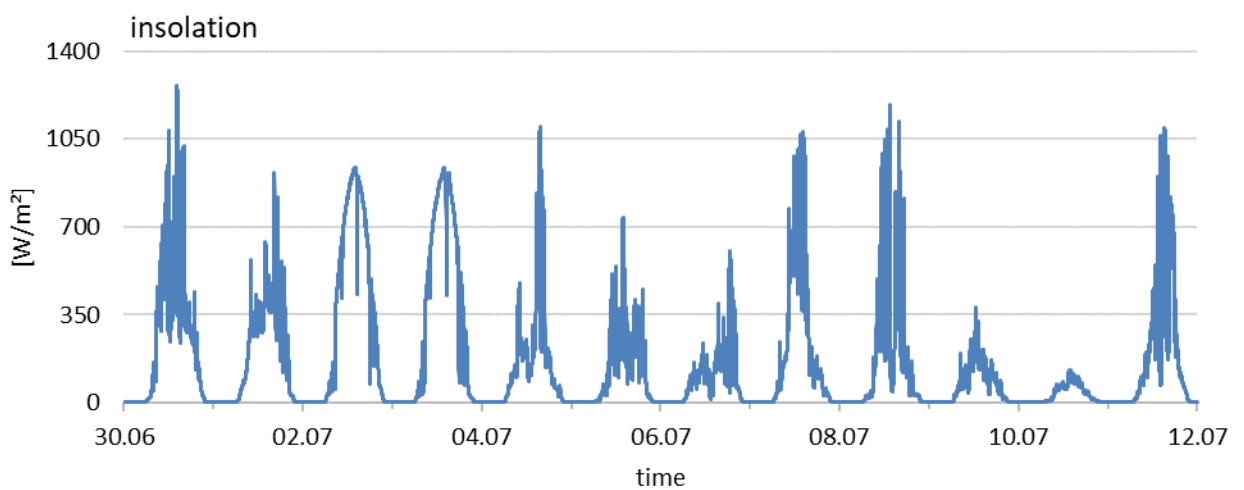


Figure 34: SDE14 insolation, competition period in July 2014

3.2 House related Data

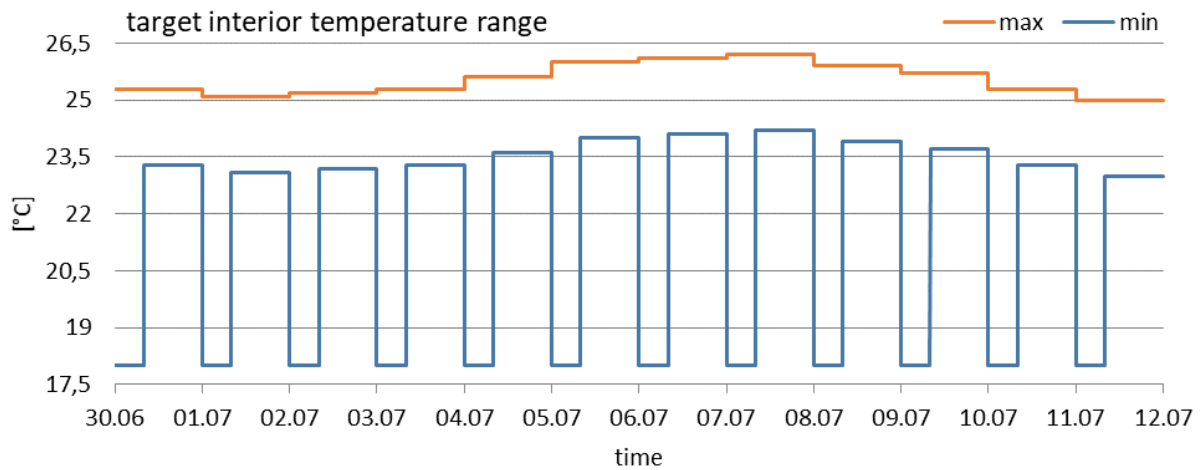


Figure 35: SDE14 target interior temperature range for scoring, competition period in July 2014

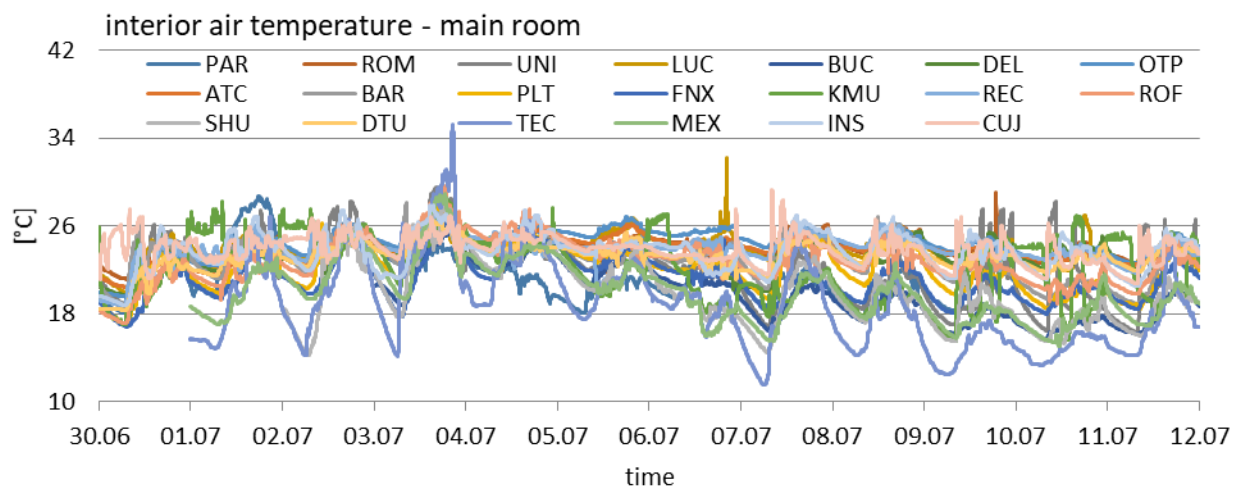


Figure 36: SDE14 interior air temperature – main room, competition period in July 2014

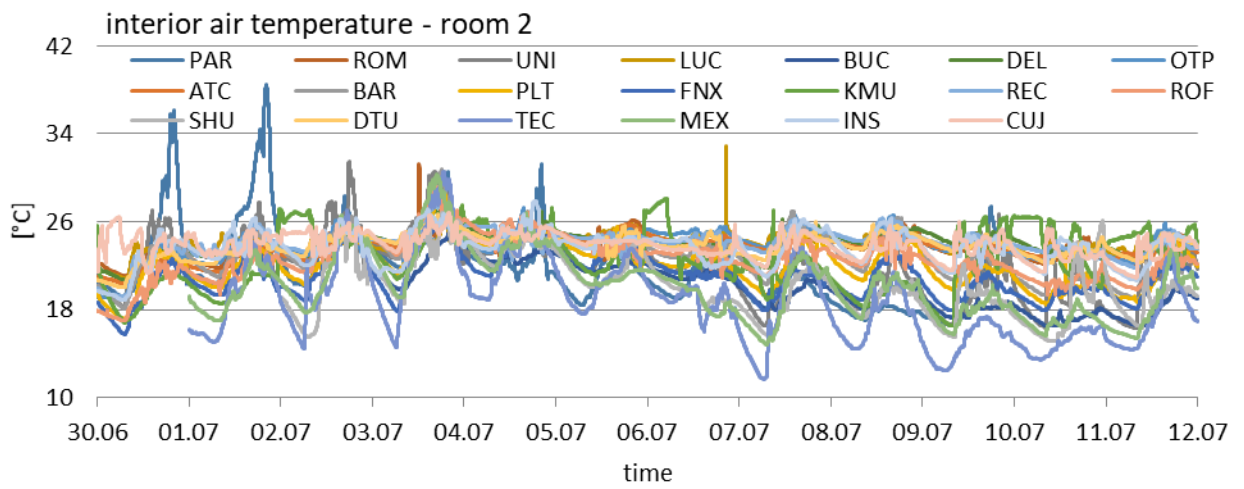


Figure 37: SDE14 interior air temperature – room 2, competition period in July 2014

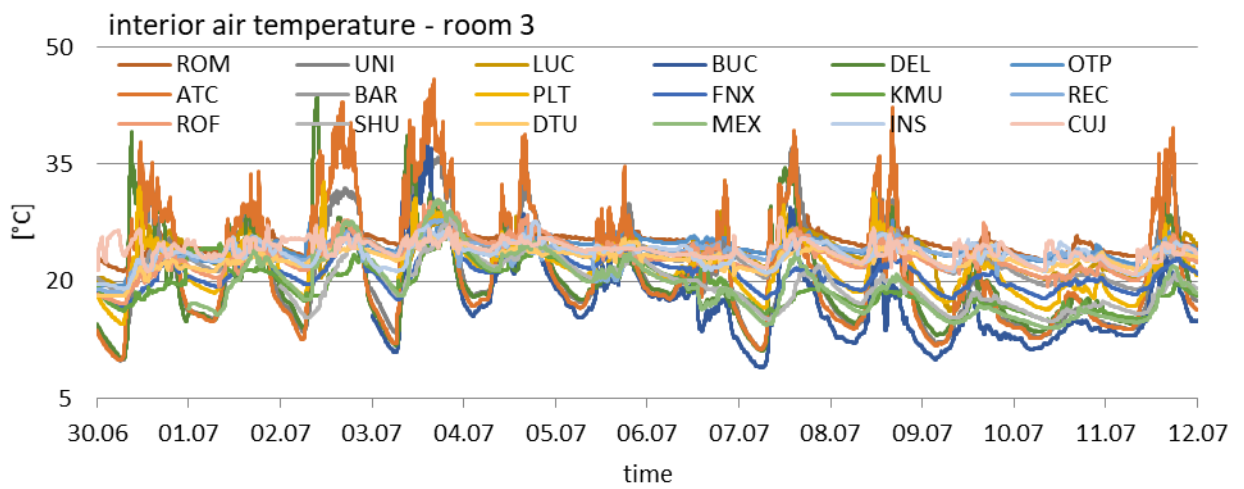


Figure 38: SDE14 interior air temperature – room 3, competition period in July 2014

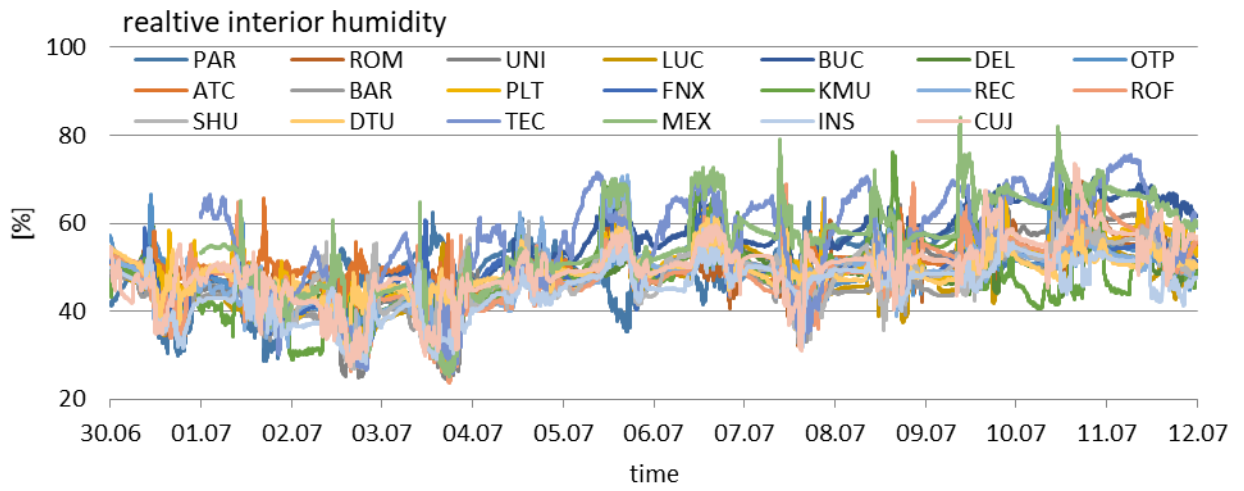


Figure 39: SDE14 relative interior humidity, competition period in July 2014

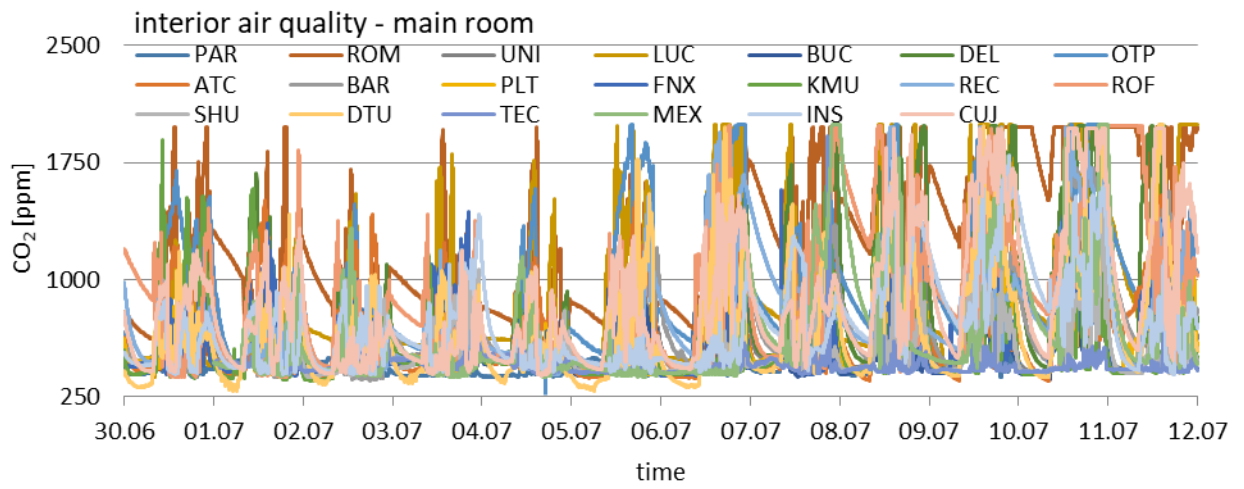


Figure 40: SDE14 interior CO₂ concentration, competition period in July 2014

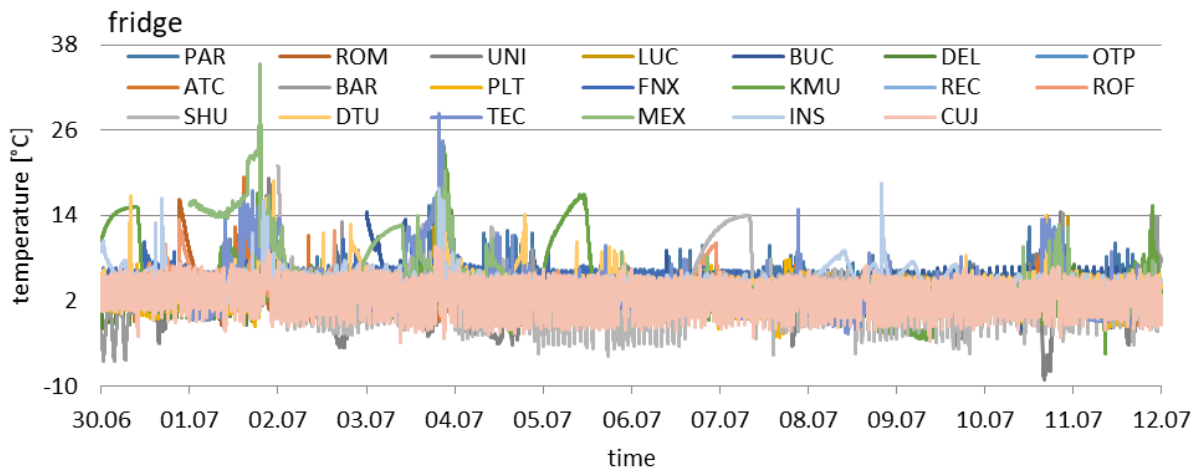


Figure 41: SDE14 temperature in the fridge, competition period in July 2014

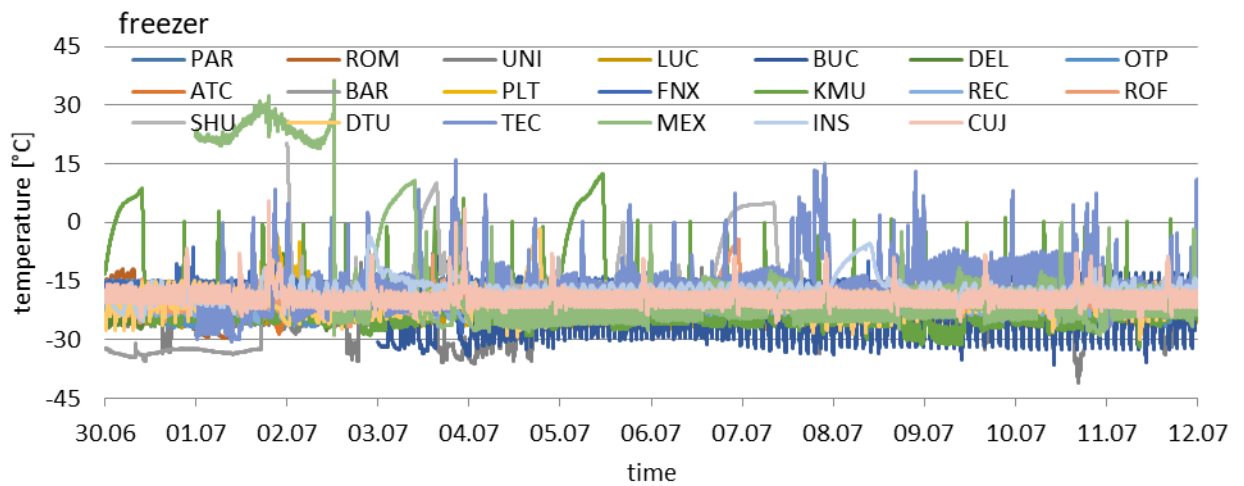


Figure 42: SDE14 temperature in the freezer, competition period in July 2014

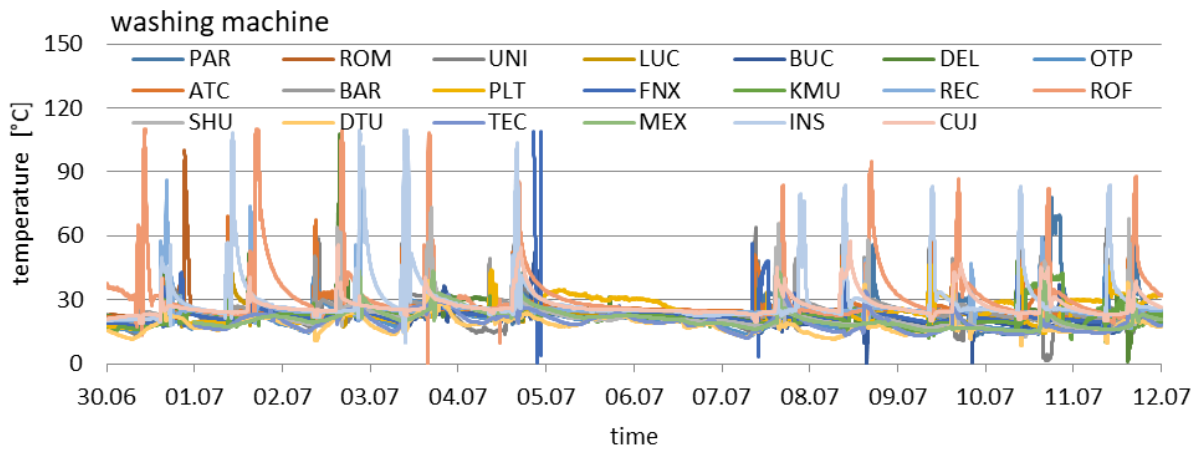


Figure 43: SDE14 temperature in the washing machine, competition period in July 2014

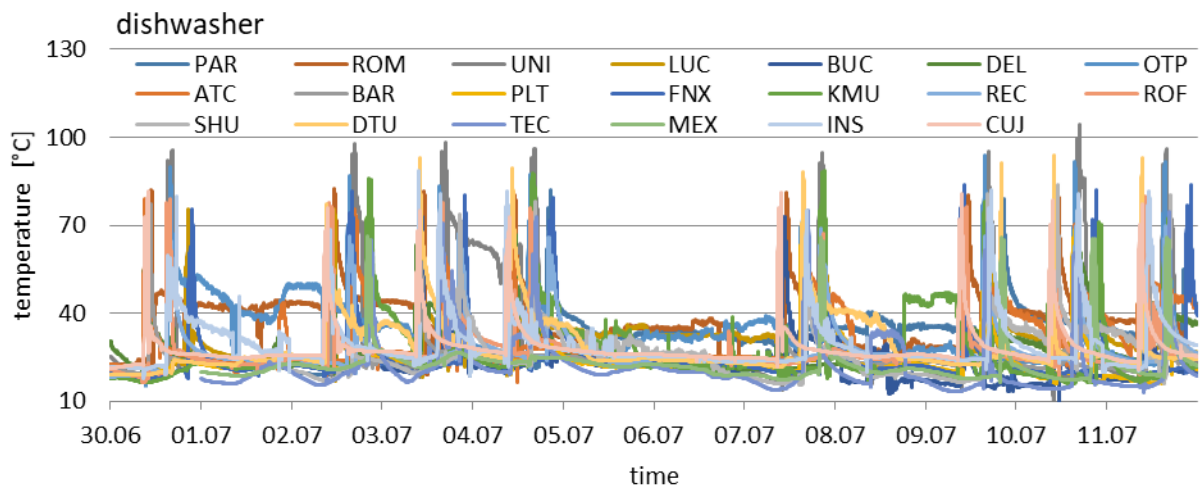


Figure 44: SDE14 temperature in the dishwasher, competition period in July 2014

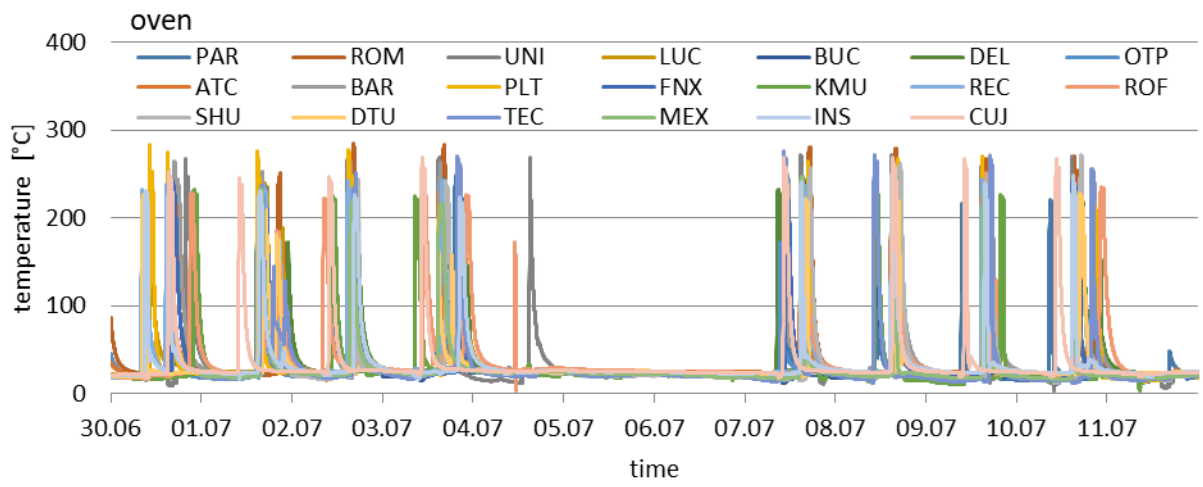


Figure 45: SDE14 temperature in the oven, competition period in July 2014

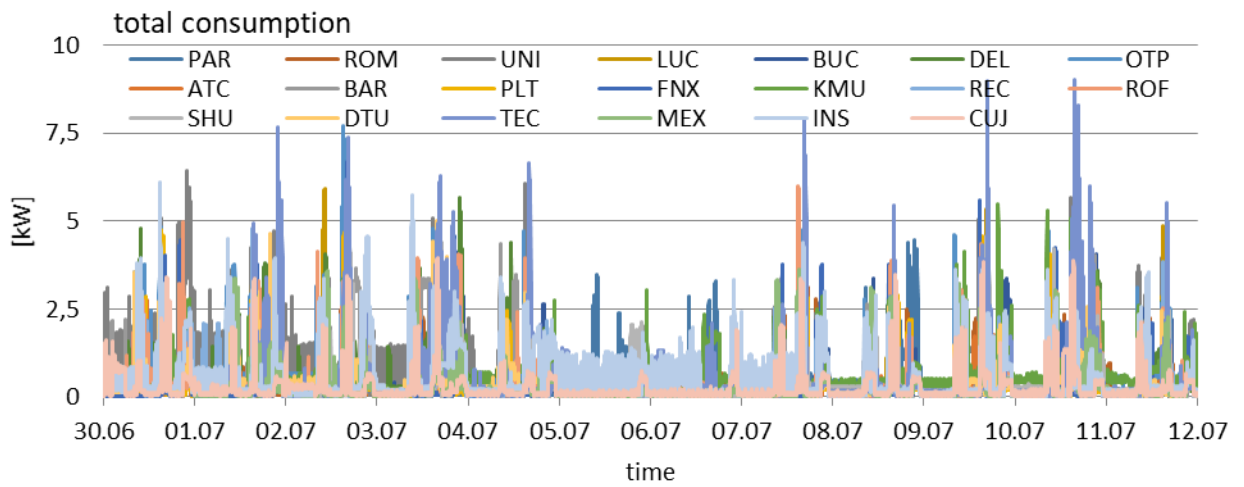


Figure 46: SDE14 total load profile of consumption, competition period in July 2014

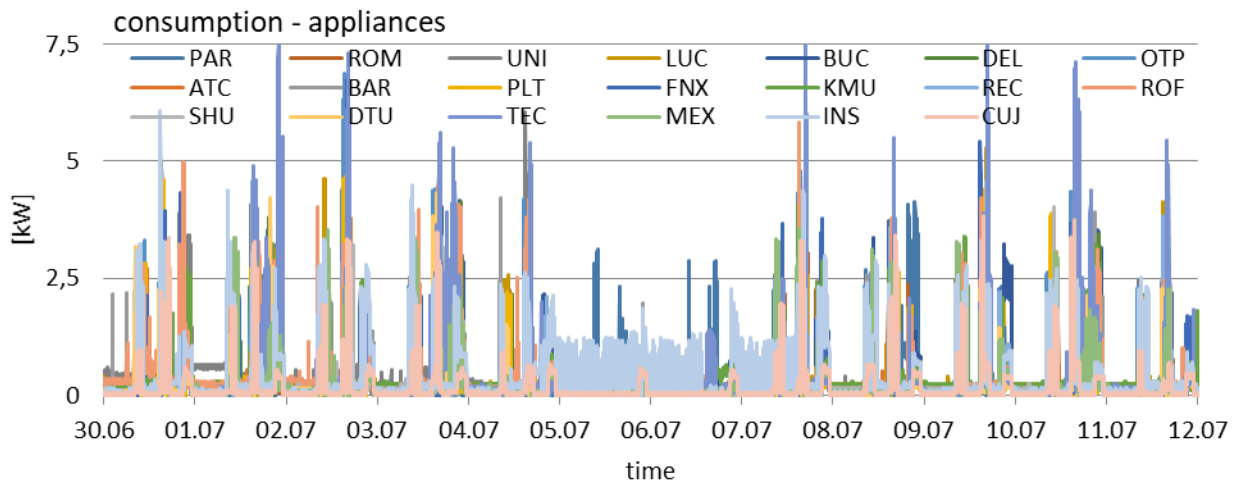


Figure 47: SDE14 load profile of appliances, competition period in July 2014

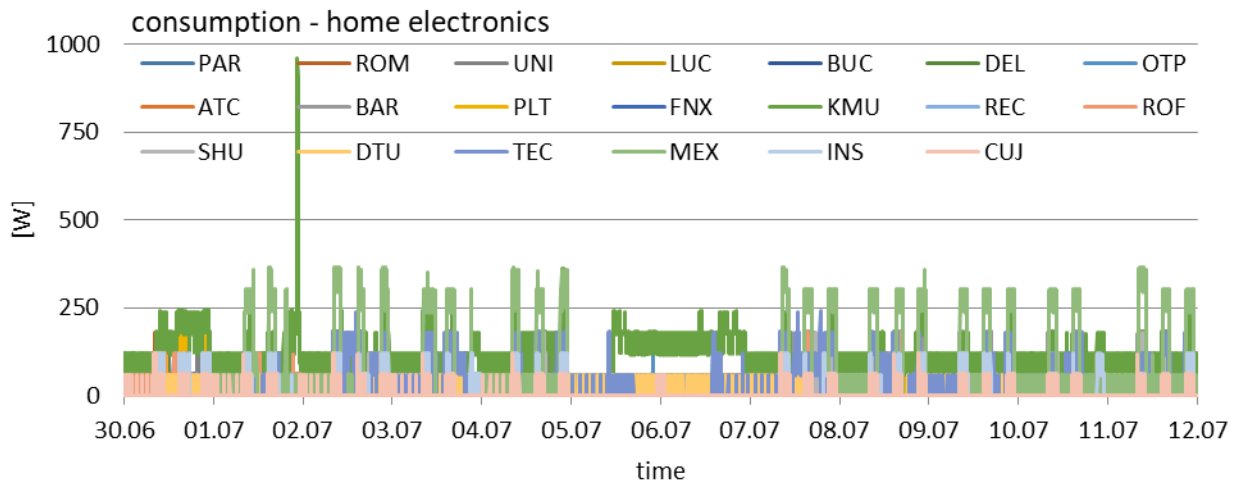


Figure 48: SDE14 load profile of home electronic devices, competition period in July 2014

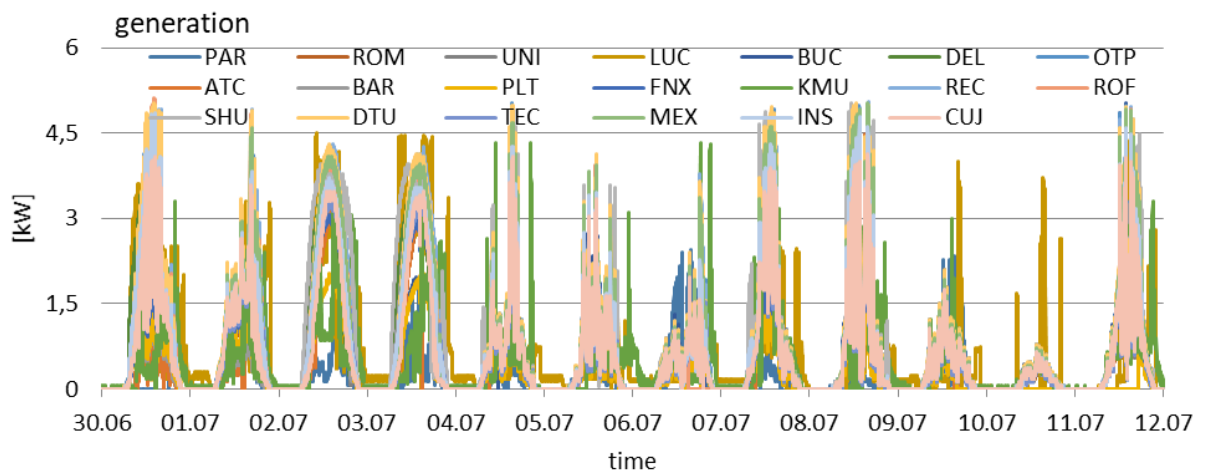


Figure 49: SDE14 energy generation, competition period in July 2014

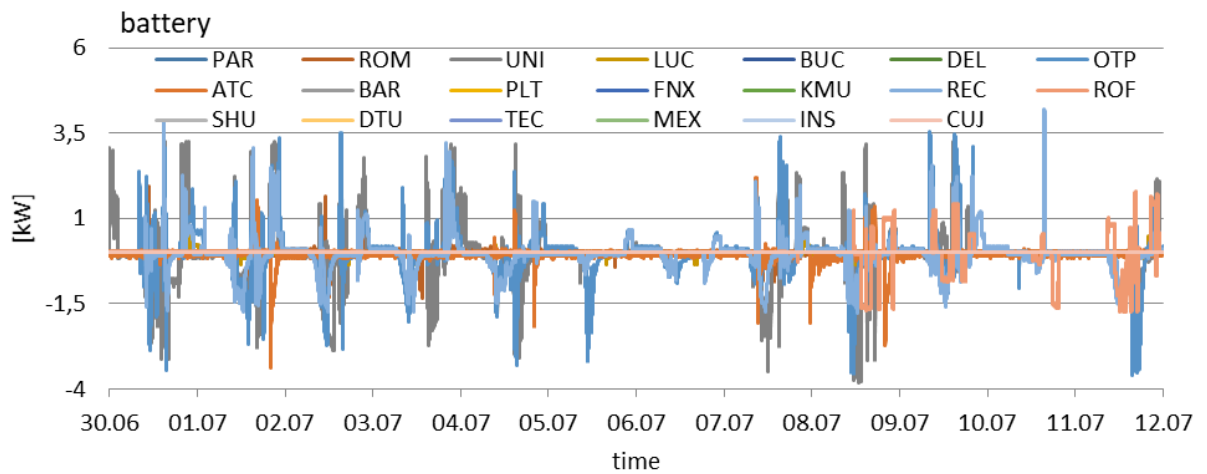


Figure 50: SDE14 load profile of batteries, competition period in July 2014

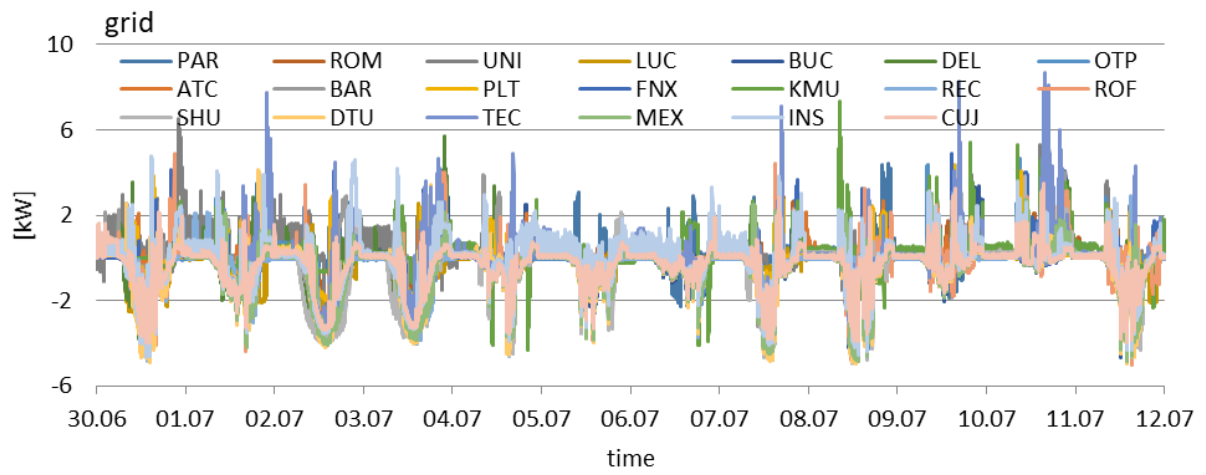


Figure 51: SDE14 load profile of the electricity grid, competition period in July 2014

4. SDME 2018 - Dubai

Table 4: Overview of available monitoring data from the Solar Decathlon Europe 2018 in Dubai

- | | |
|---|----------------------------------|
| 1. exterior air temperature | 28. meter 0 – frequency |
| 2. relative exterior humidity | 29. meter 0 – power in phase 1 |
| 3. global horizontal irradiation | 30. meter 0 – power in phase 2 |
| 4. target interior temperature range | 31. meter 0 – aggregated power |
| 5. interior air temperature – living room | 32. meter 0 – voltage in phase 1 |
| 6. interior air temperature – bathroom | 33. meter 0 – voltage in phase 2 |
| 7. interior air temperature – kitchen | 34. meter 0 – voltage in phase 3 |
| 8. relative interior humidity – living room | 35. meter 1 – current in phase 1 |
| 9. relative interior humidity – bathroom | 36. meter 1 – current in phase 2 |
| 10. relative interior humidity – kitchen | 37. meter 1 – aggregated current |
| 11. interior air quality – living room | 38. meter 1 – frequency |
| 12. interior lighting level – living room | 39. meter 1 – power in phase 1 |
| 13. interior lighting level – kitchen | 40. meter 1 – power in phase 2 |
| 14. fridge | 41. meter 1 – aggregated power |
| 15. freezer | 42. meter 1 – voltage in phase 1 |
| 16. washing machine | 43. meter 1 – voltage in phase 2 |
| 17. dishwasher | 44. meter 1 – voltage in phase 3 |
| 18. oven | 45. meter 2 – current in phase 1 |
| 19. consumption – cooling, ventilation and lighting | 46. meter 2 – current in phase 2 |
| 20. consumption – plug load, appliances and home automation | 47. meter 2 – aggregated current |
| 21. energy sent to grid | 48. meter 2 – frequency |
| 22. energy drawn from grid and price function | 49. meter 2 – power in phase 1 |
| 23. total consumption | 50. meter 2 – power in phase 2 |
| 24. generation | 51. meter 2 – aggregated power |
| 25. meter 0 – current in phase 1 | 52. meter 2 – voltage in phase 1 |
| 26. meter 0 – current in phase 2 | 53. meter 2 – voltage in phase 2 |
| 27. meter 0 – aggregated current | 54. meter 2 – voltage in phase 3 |

4.1 Climate Data

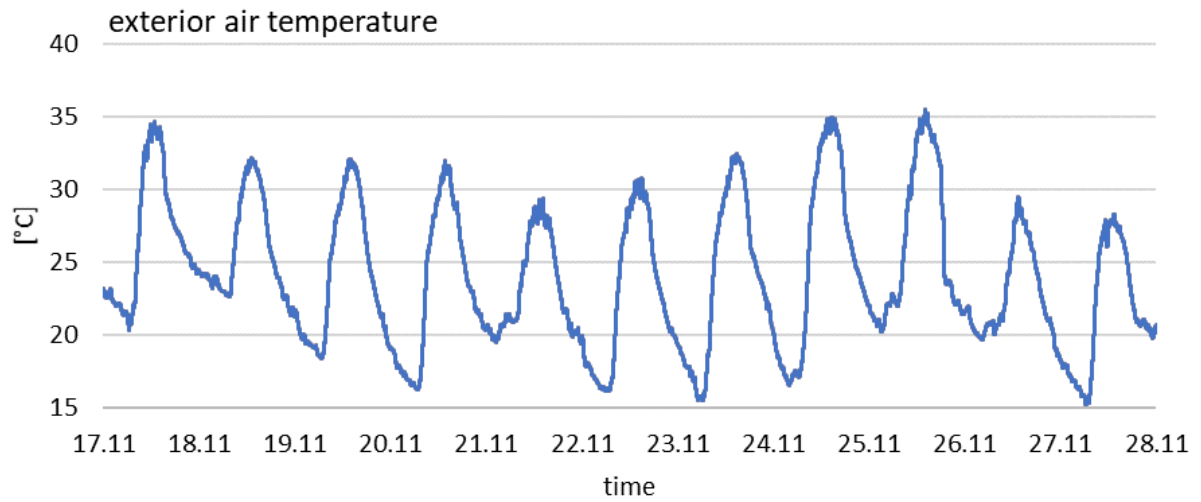


Figure 52: SDME18 exterior air temperature, competition period in November 2018

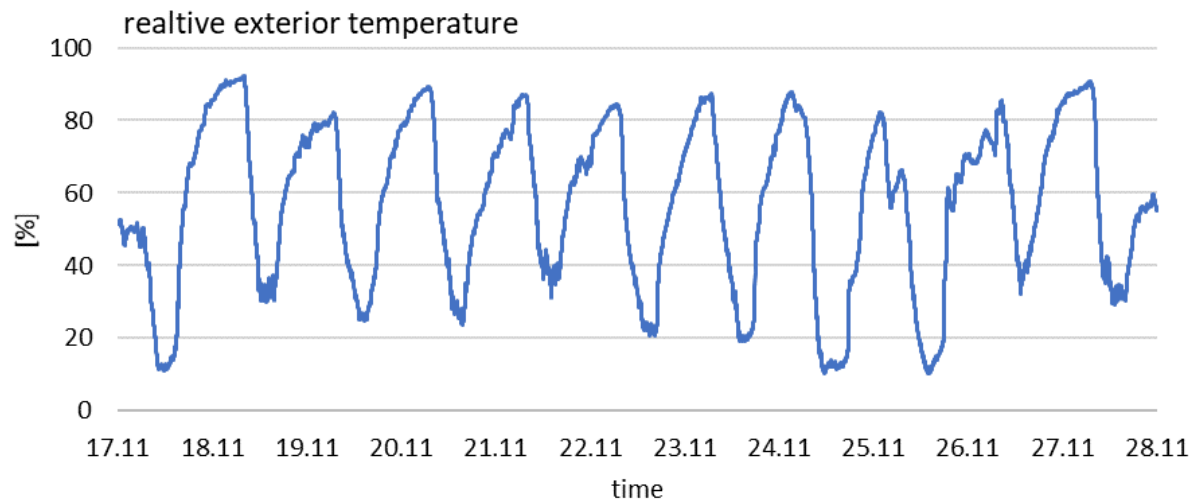


Figure 53: SDME18 relative exterior humidity, competition period in November 2018

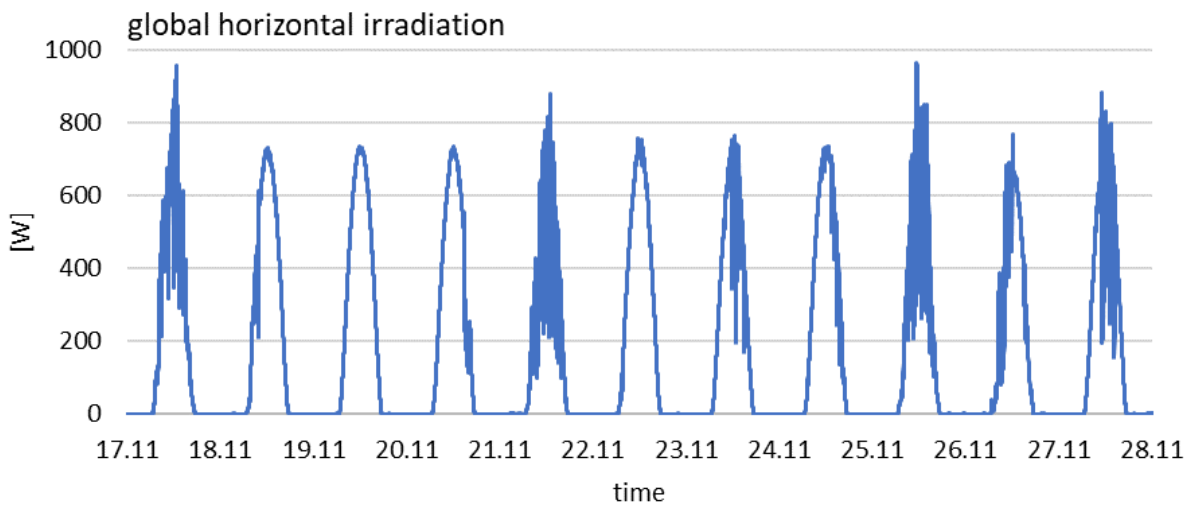


Figure 54: SDME18 global horizontal irradiation, competition period in November 2018

4.2 House related Data

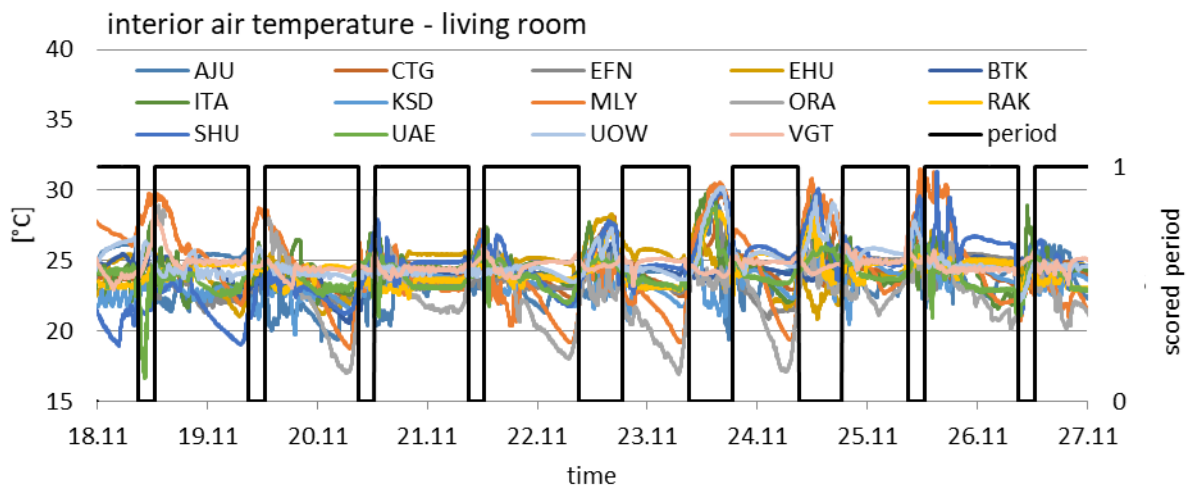


Figure 55: SDME18 interior air temperature – living room, competition period in November 2018

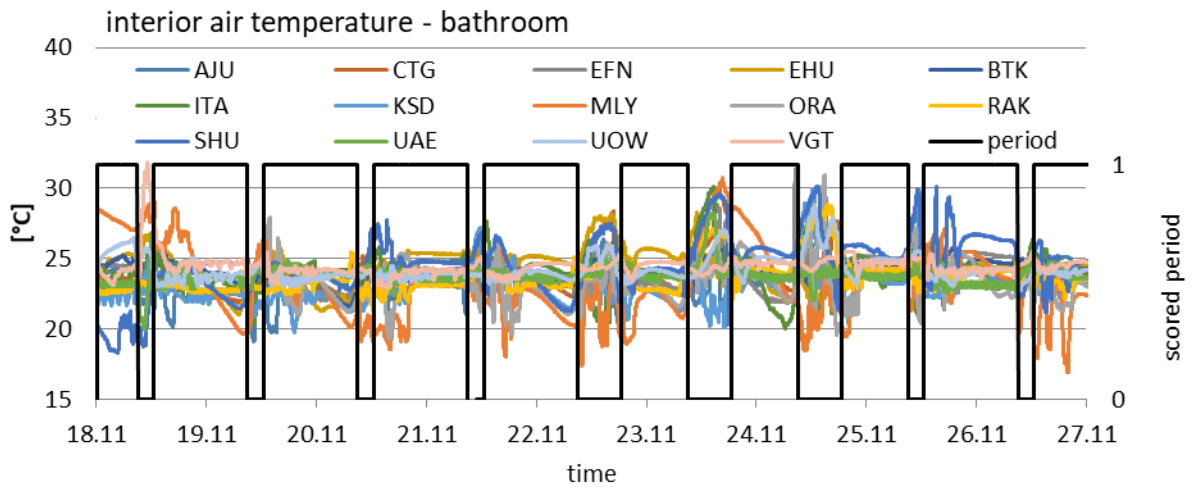


Figure 56: SDME18 interior air temperature – bathroom, competition period in November 2018

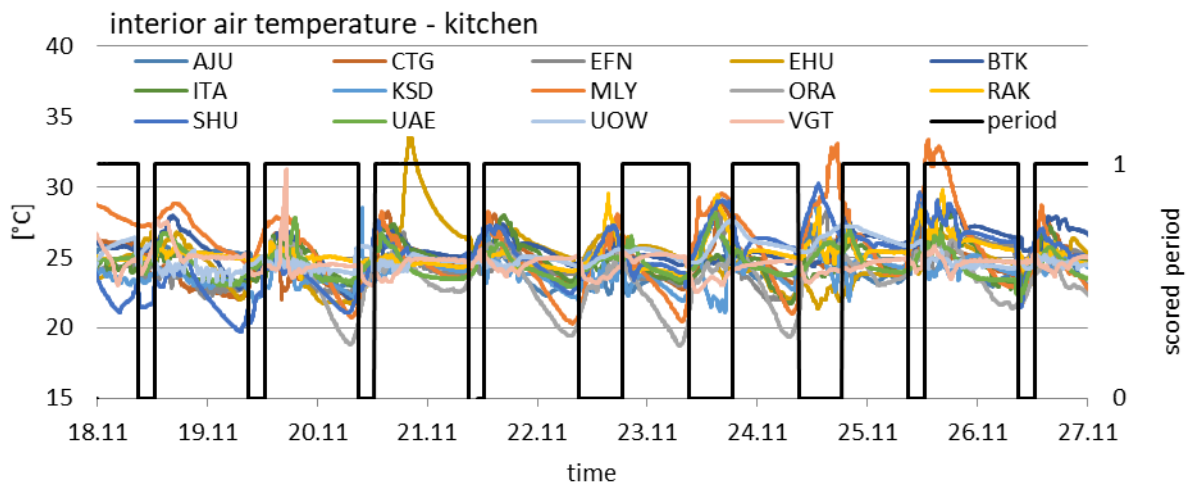


Figure 57: SDME18 interior air temperature – kitchen, competition period in November 2018

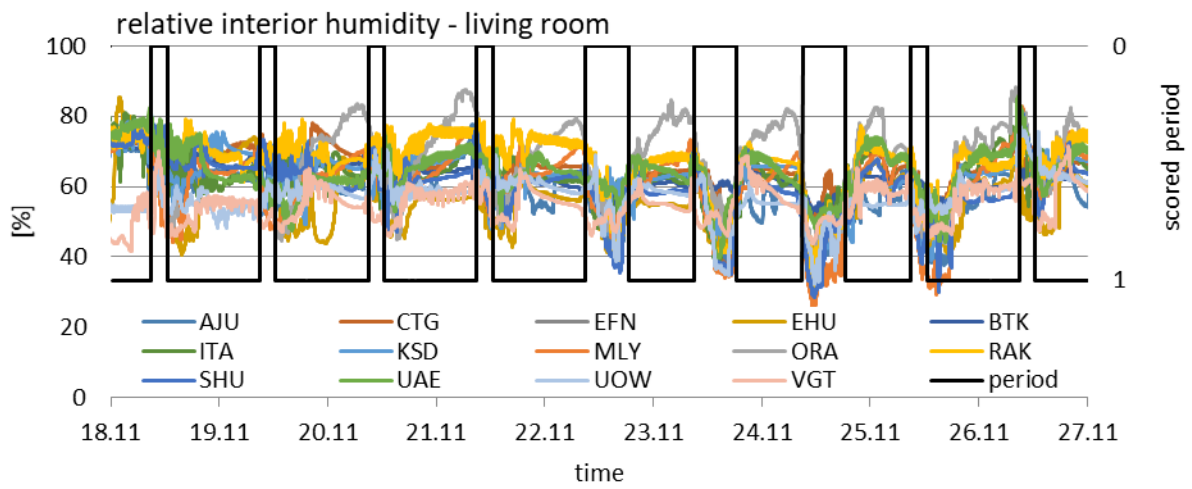


Figure 58: SDME18 relative interior humidity – living room, competition period in November 2018

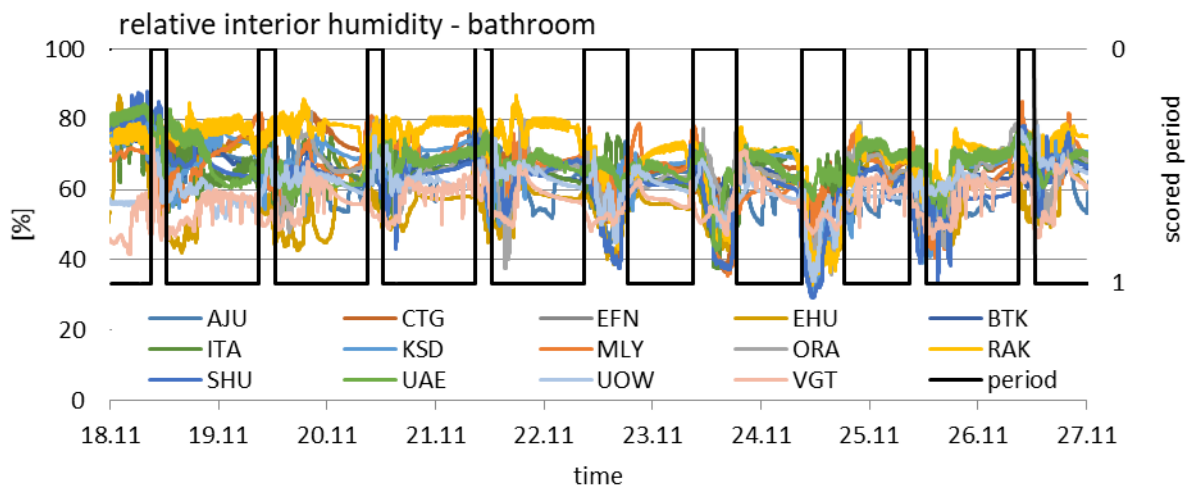


Figure 59: SDME18 relative interior humidity – bathroom, competition period in November 2018

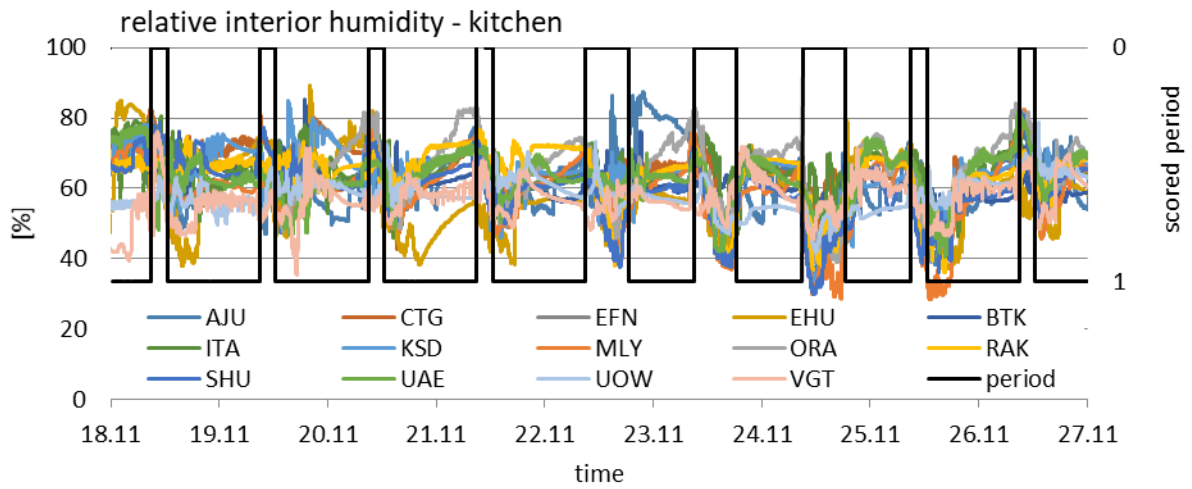


Figure 60: SDME18 relative interior humidity – kitchen, competition period in November 2018

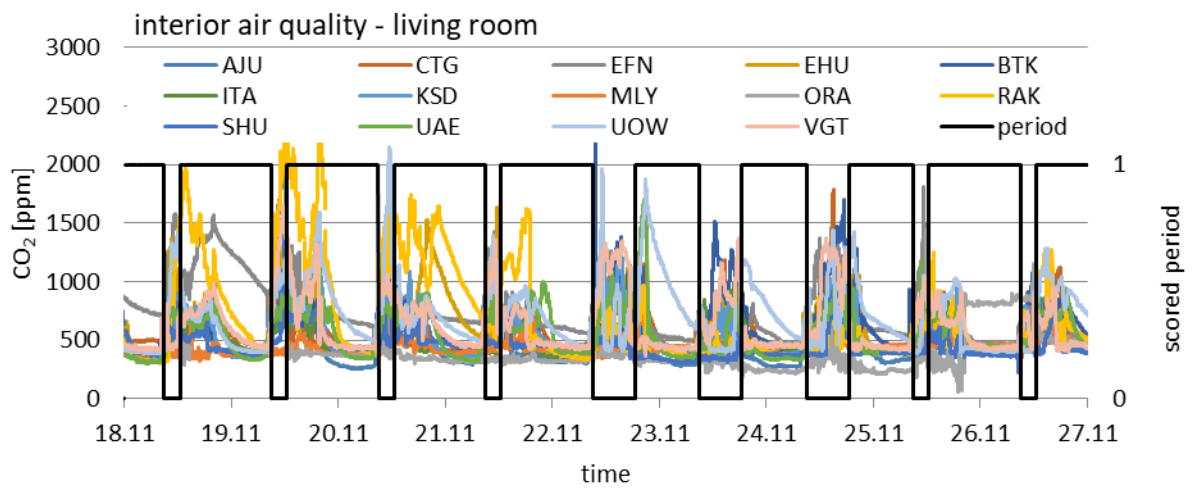


Figure 61: SDME18 interior CO₂ concentration, competition period in November 2018

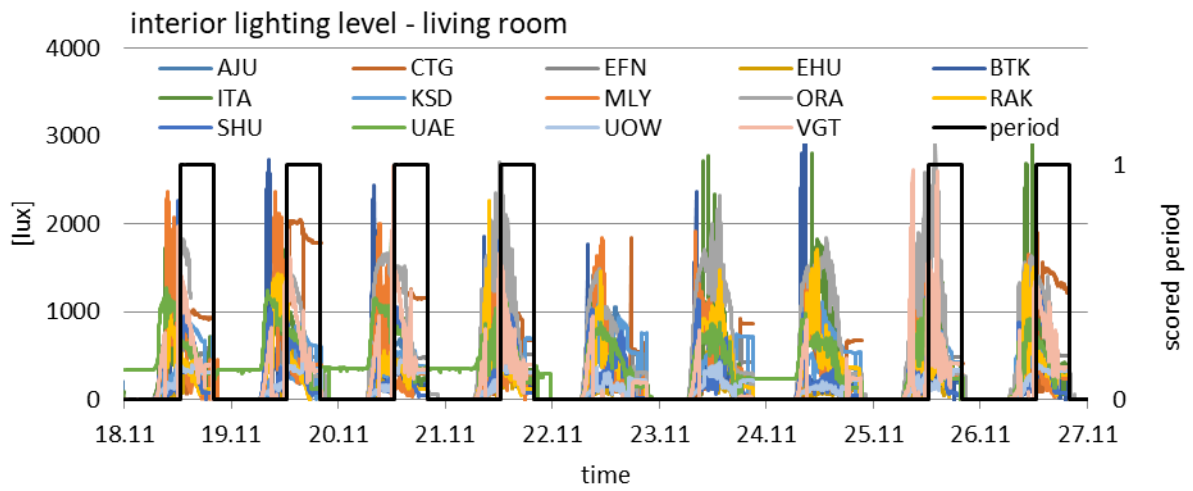


Figure 62: SDME18 lighting level – living room, competition period in November 2018

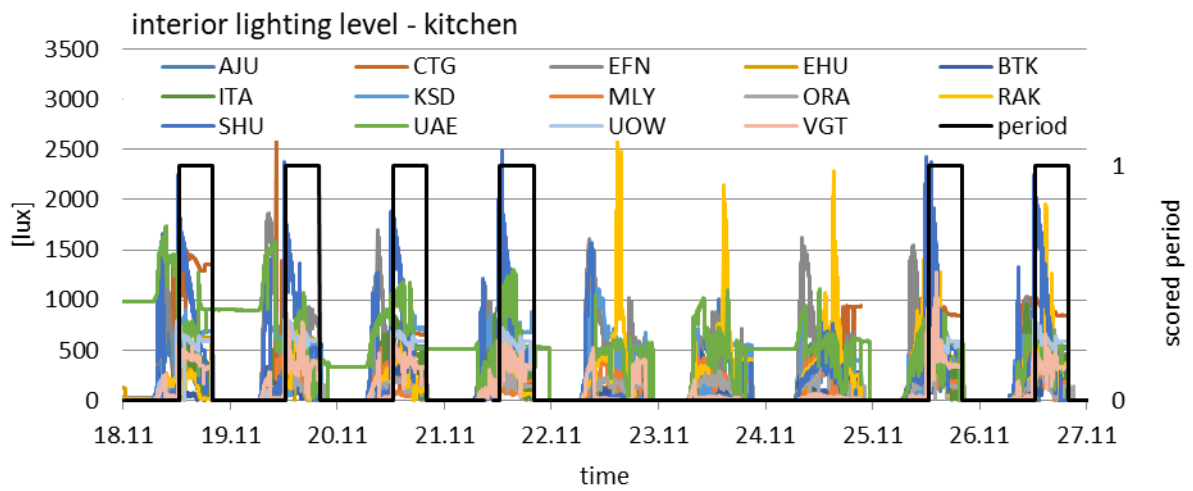


Figure 63: SDME18 lighting level – kitchen, competition period in November 2018

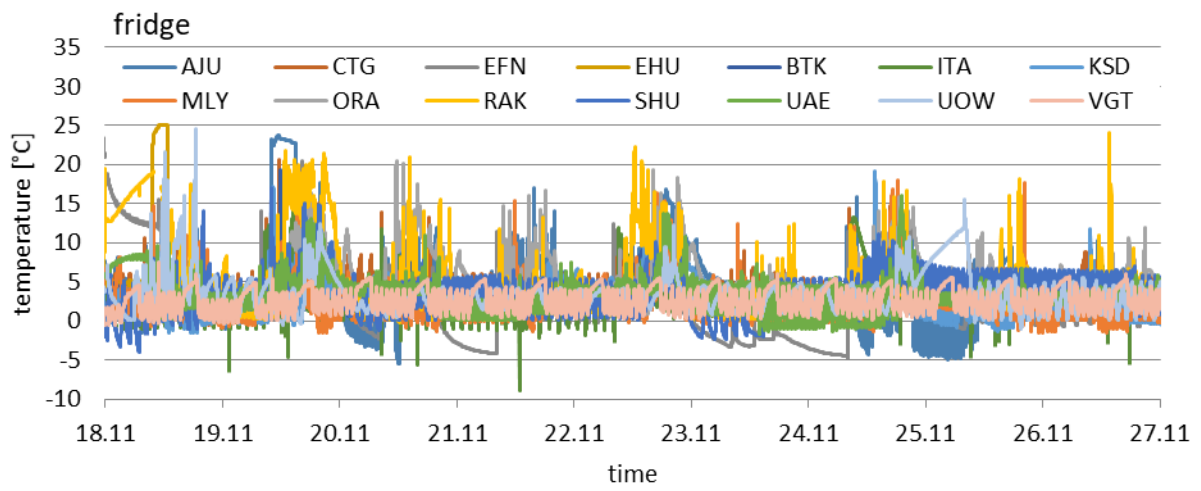


Figure 64: SDME18 temperature in the fridge, competition period in November 2018

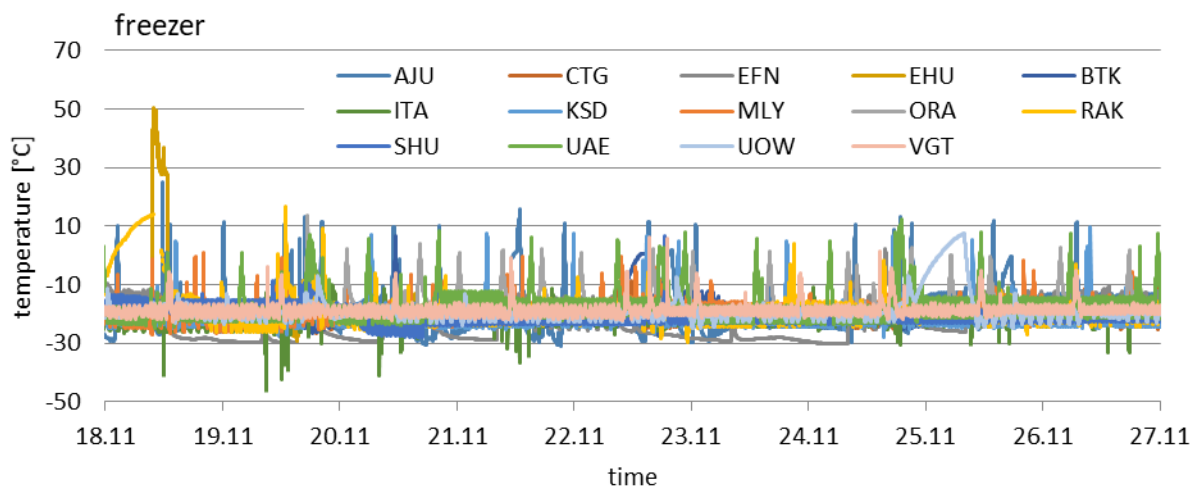


Figure 65: SDME18 temperature in the freezer, competition period in November 2018

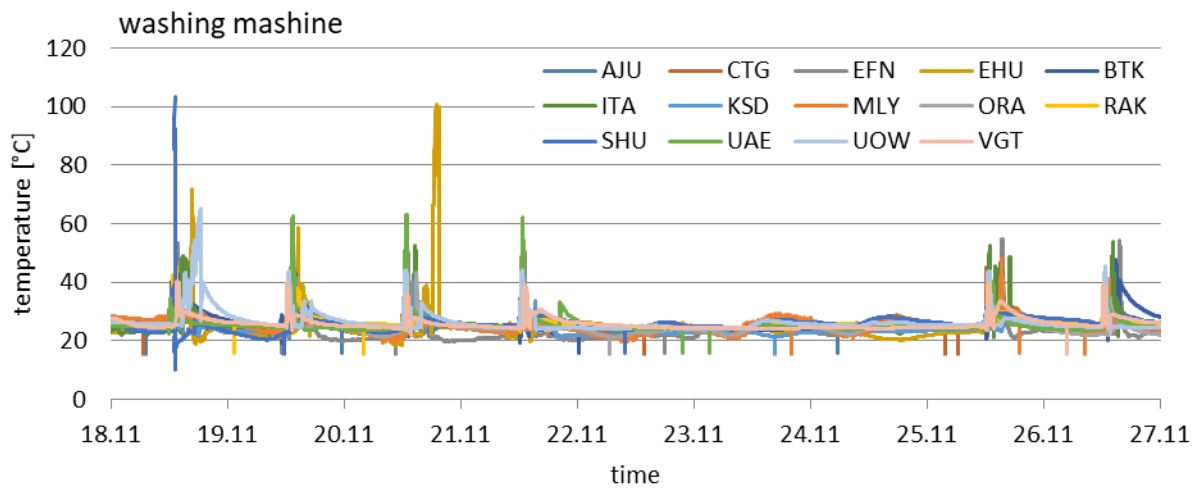


Figure 66: SDME18 temperature in the washing machine, competition period in November 2018

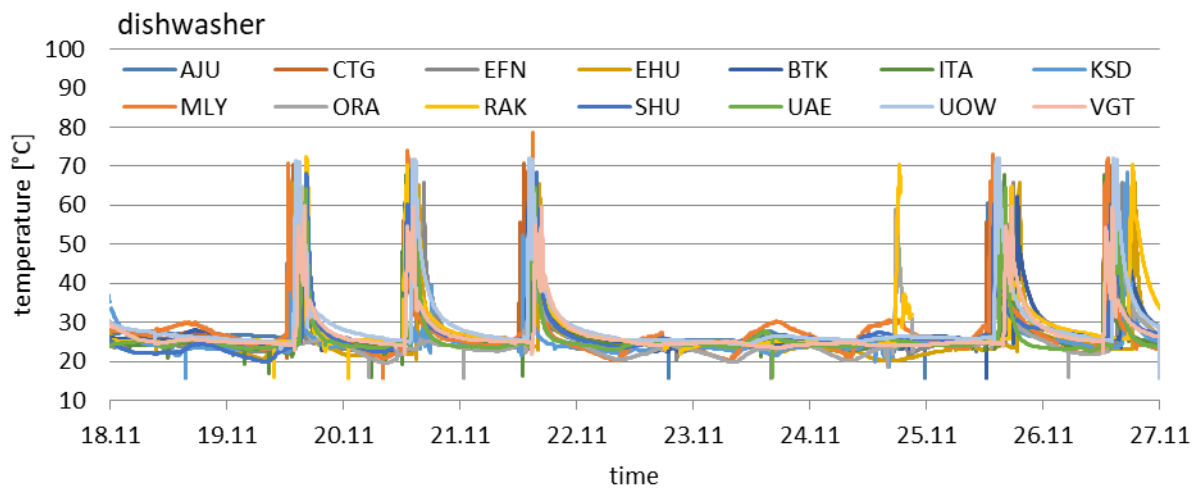


Figure 67: SDME18 temperature in the dish washer, competition period in November 2018

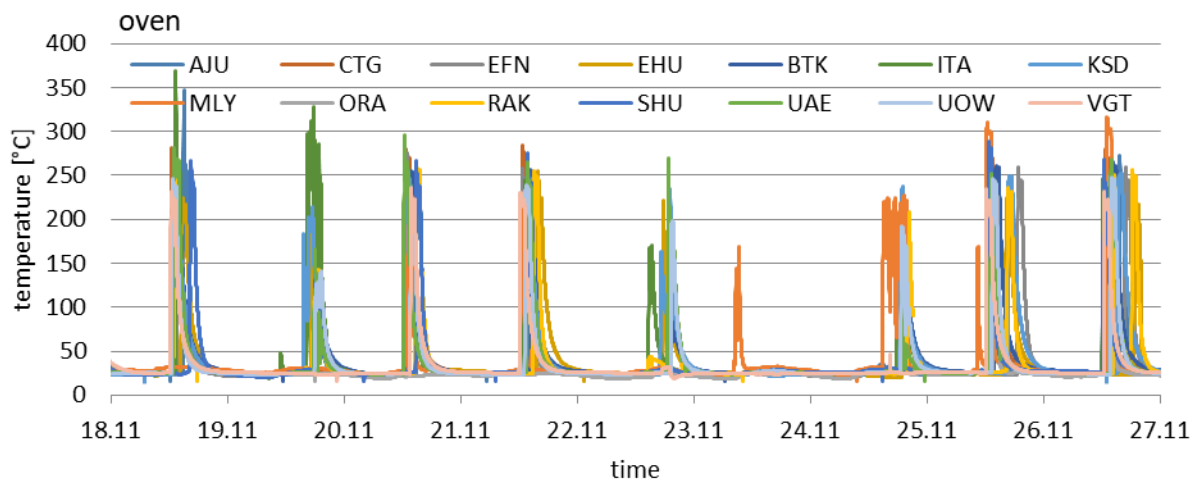


Figure 68: SDME18 temperature in the oven, competition period in November 2018

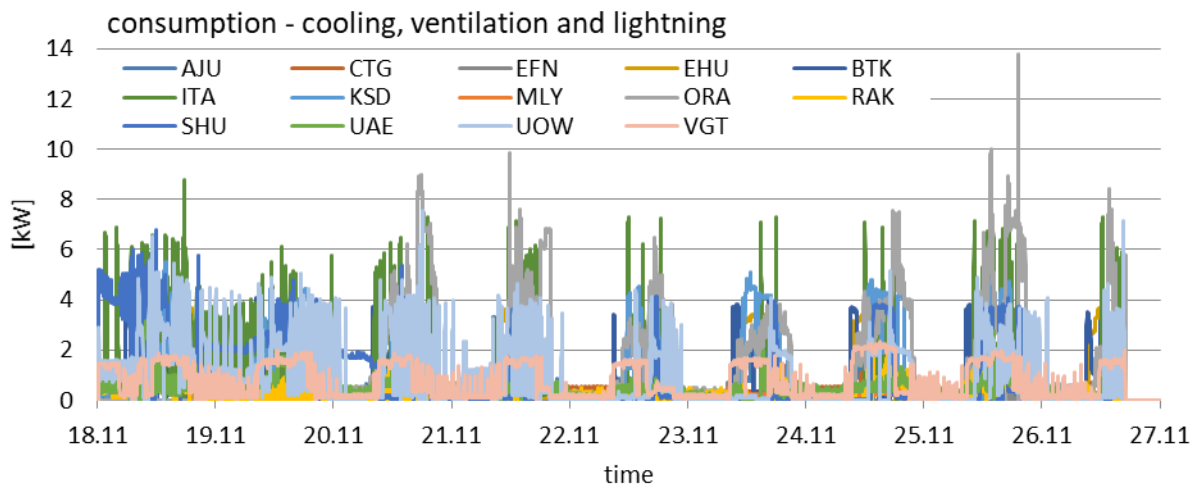


Figure 69: SDME18 energy consumption related to cooling, ventilation and lighting (called EV in rules document), competition period in November 2018

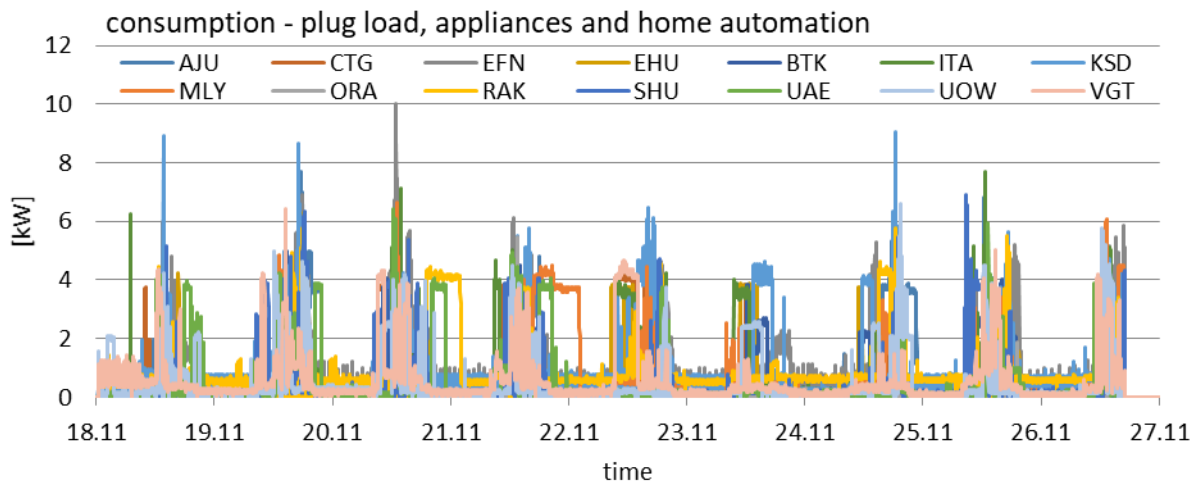


Figure 70: SDME18 energy consumption related to plug load, appliances and home automation (called EF in rules document), competition period in November 2018

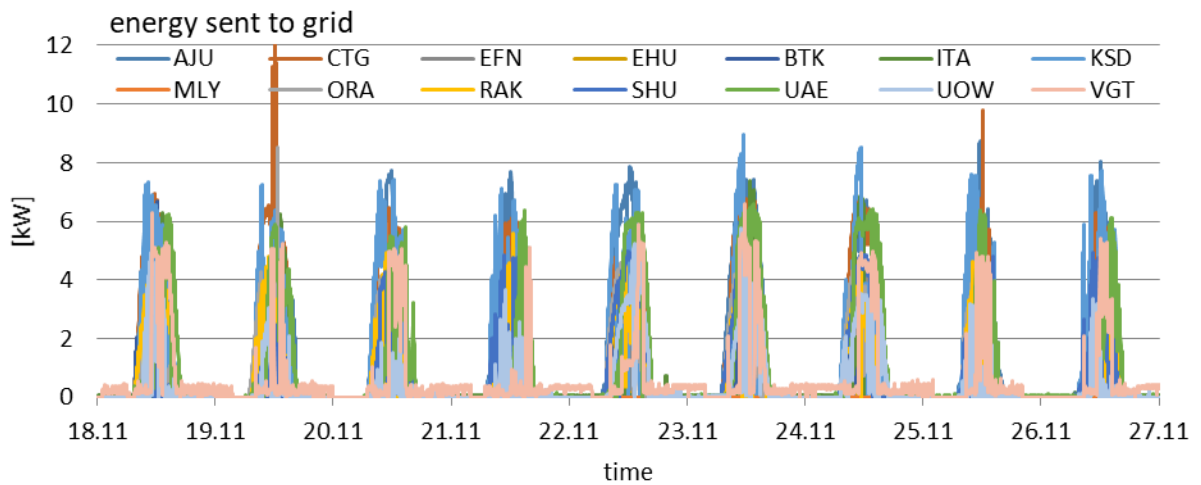


Figure 71: SDME18 energy sent to grid, competition period in November 2018

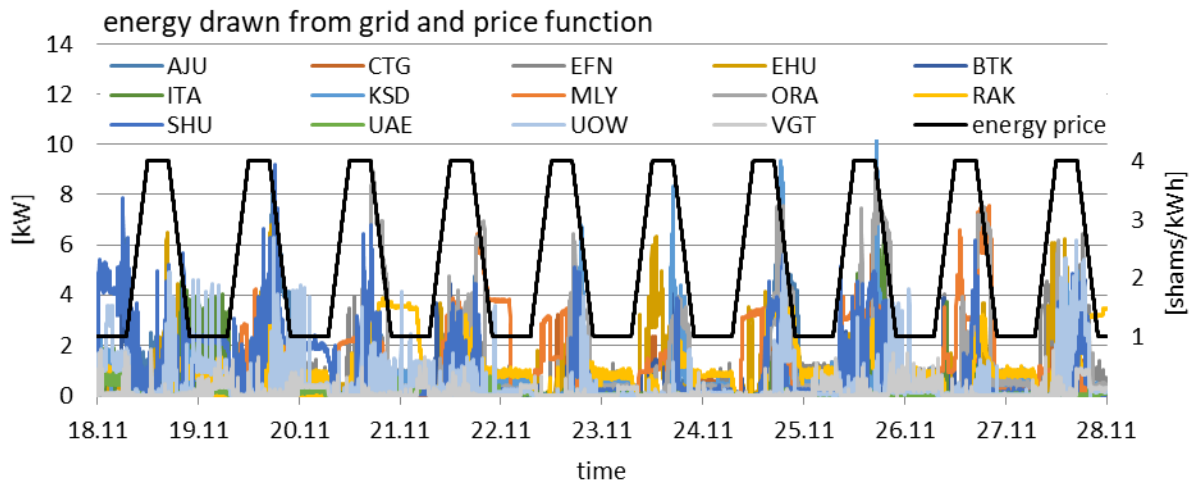


Figure 72: SDME18 energy drawn from grid in dependency of an energy price, competition period in November 2018

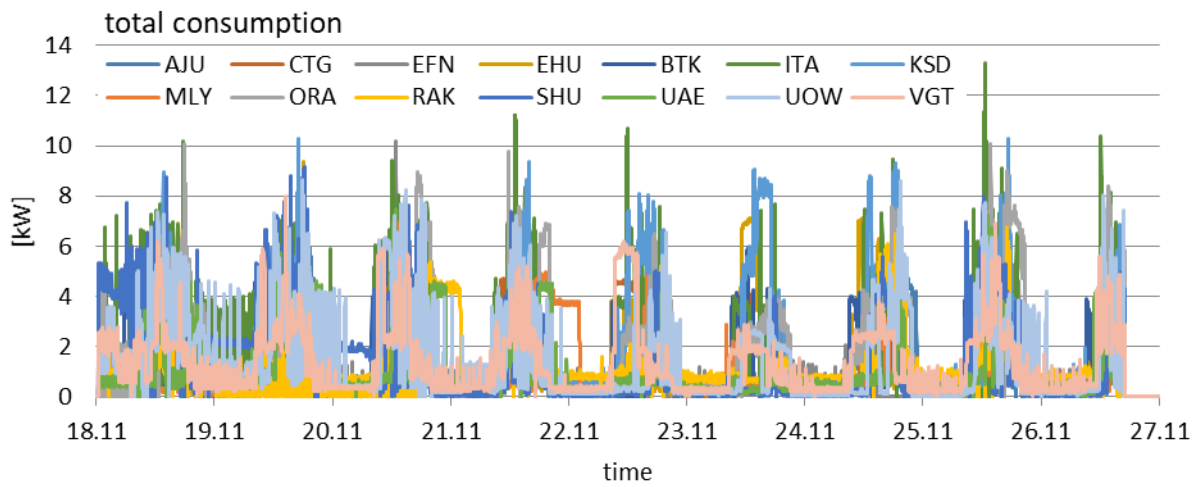


Figure 73: SDME18 total energy consumption, competition period in November 2018

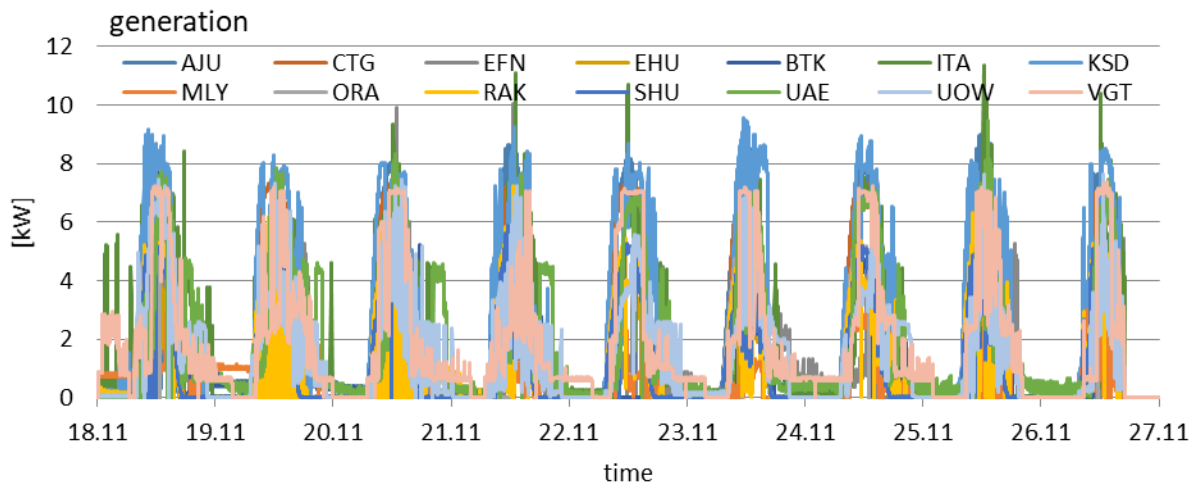


Figure 74: SDME18 total energy generation, competition period in November 2018

4.3 Detailed electrical parameters

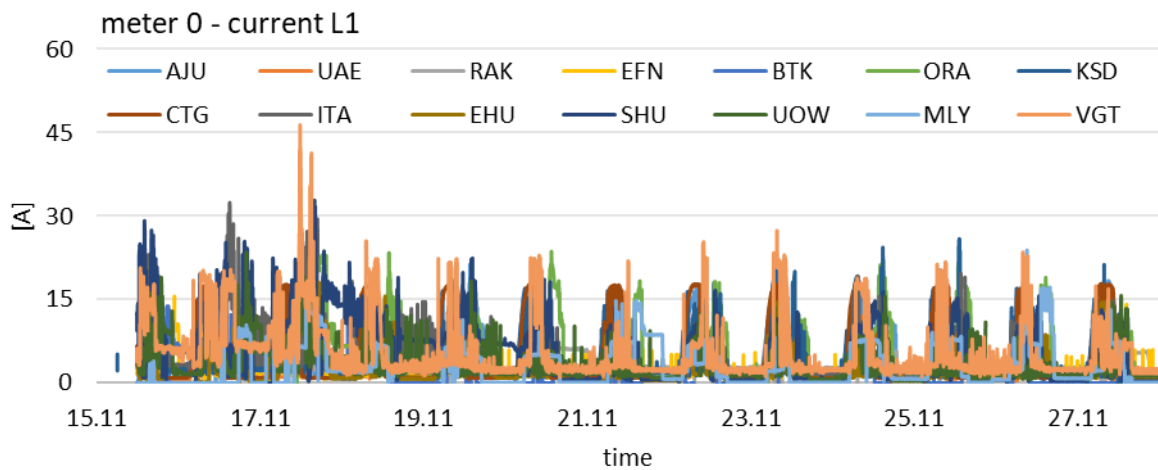


Figure 75: SDME18 current in phase 1 measured by meter 0, competition period in November 2018

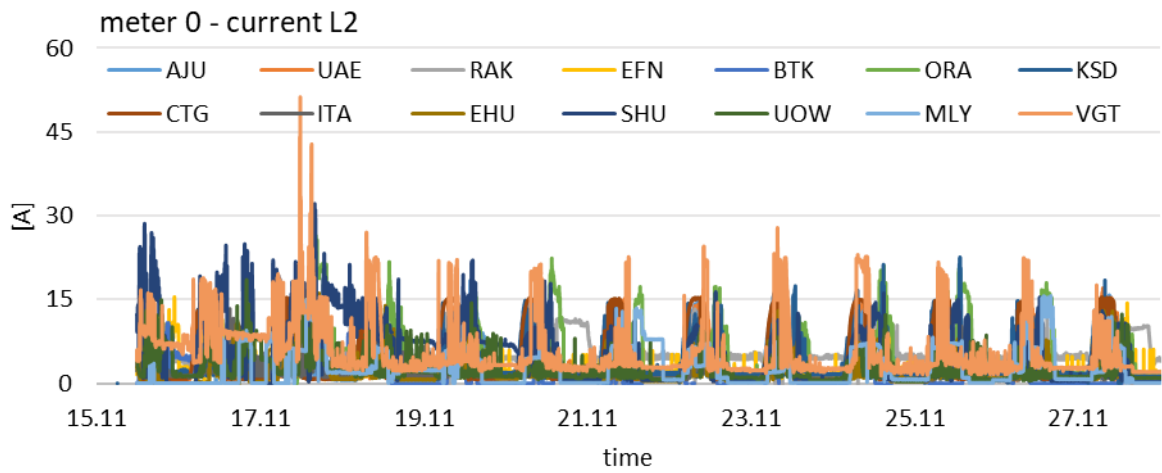


Figure 76: SDME18 current in phase 2 measured by meter 0, competition period in November 2018

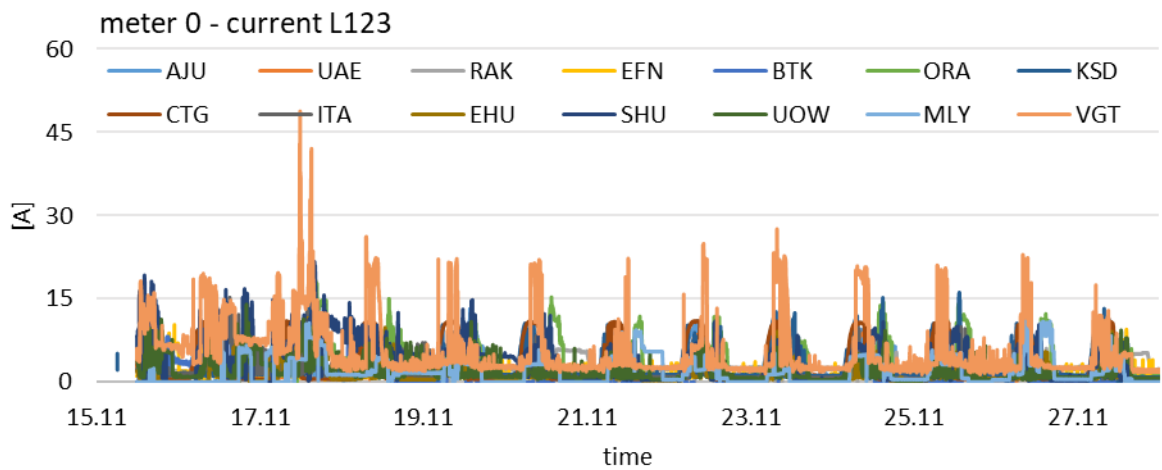


Figure 77: SDME18 aggregated current in all phases measured by meter 0, competition period in November 2018

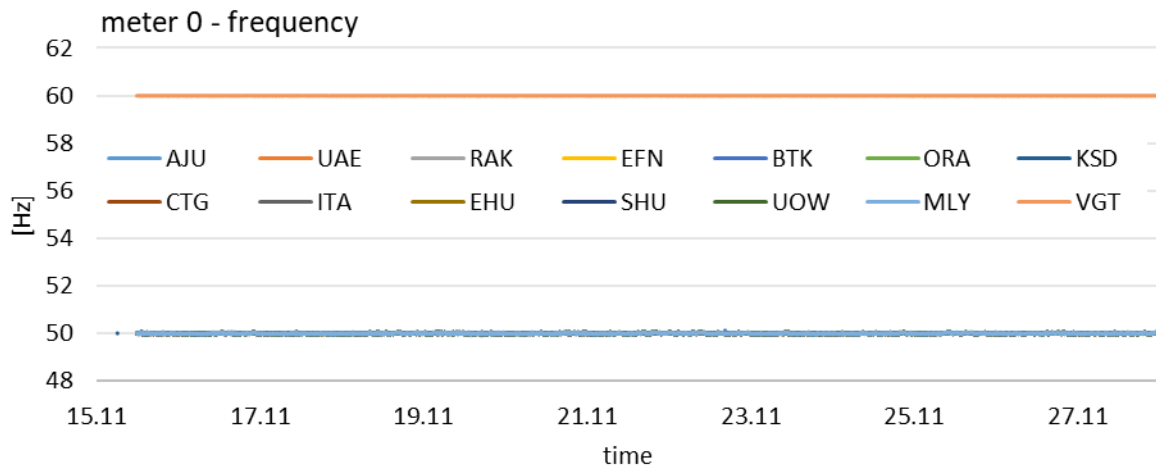


Figure 78: SDME18 frequency measured by meter 0, competition period in November 2018

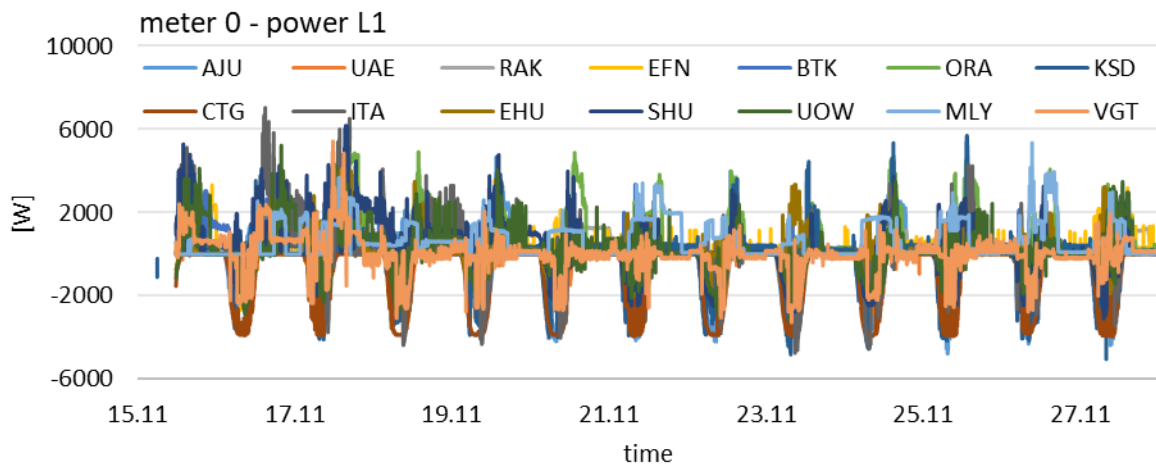


Figure 79: SDME18 power in phase 1 measured by meter 0, competition period in November 2018

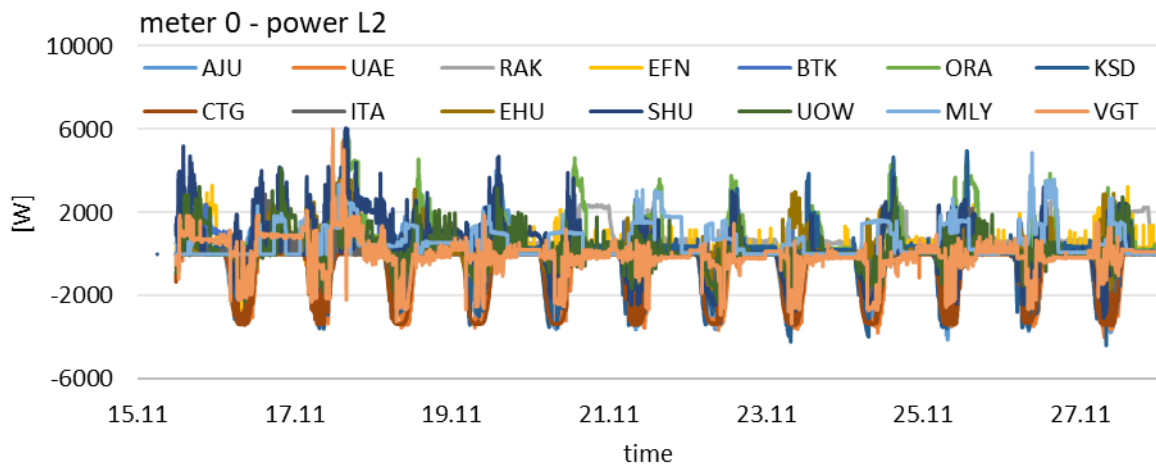


Figure 80: SDME18 power in phase 2 measured by meter 0, competition period in November 2018

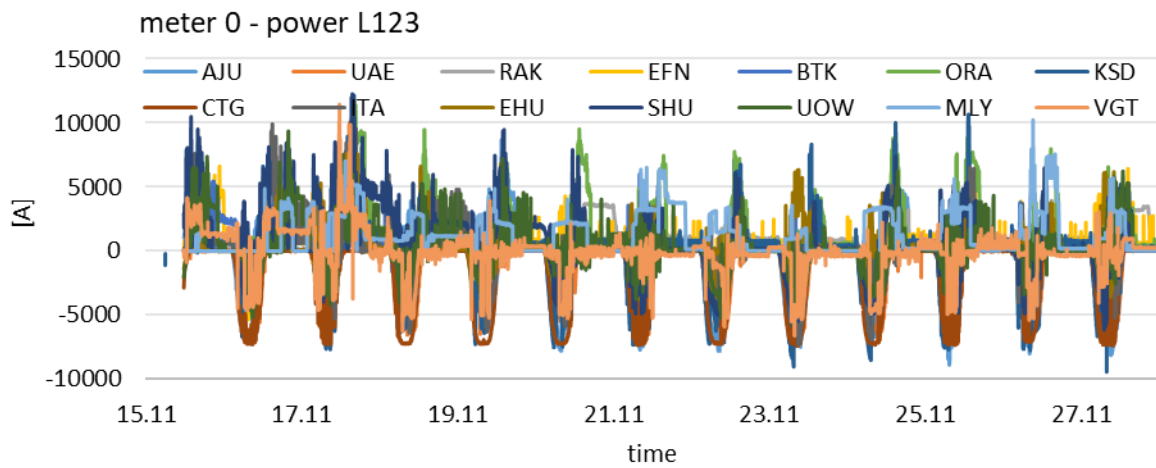


Figure 81: SDME18 aggregated power on all phases measured by meter 0, competition period in November 2018

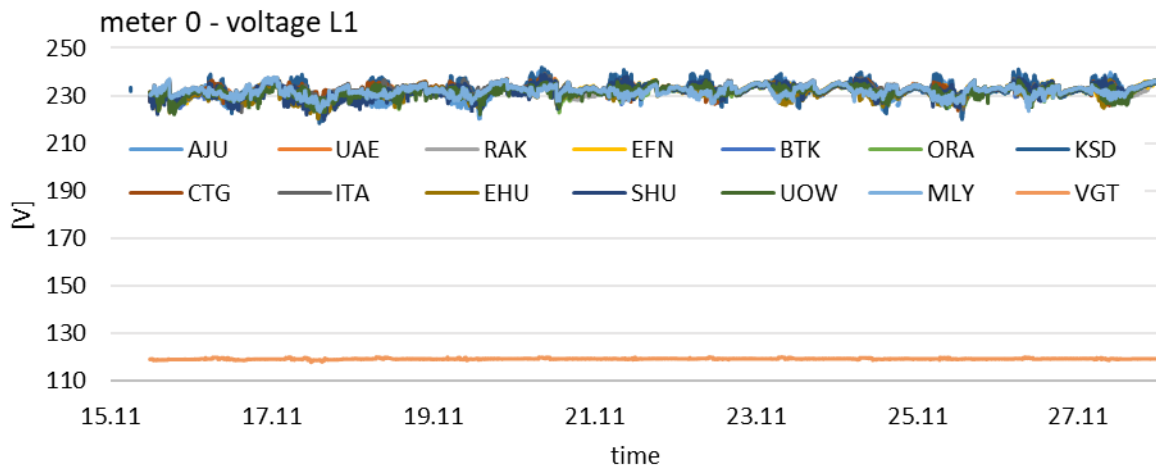


Figure 82: SDME18 voltage level on phase 1 measured by meter 0, competition period in November 2018

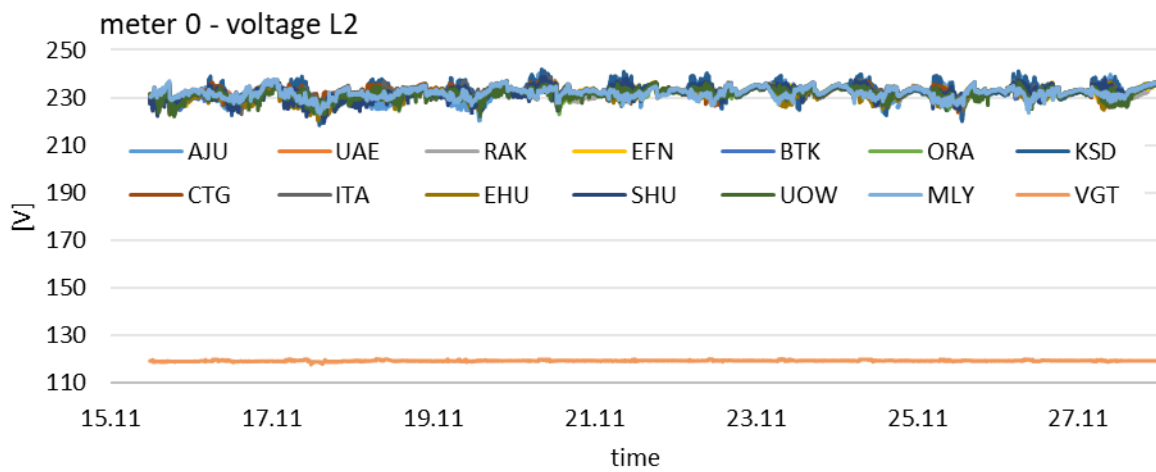


Figure 83: SDME18 voltage level on phase 2 measured by meter 0, competition period in November 2018

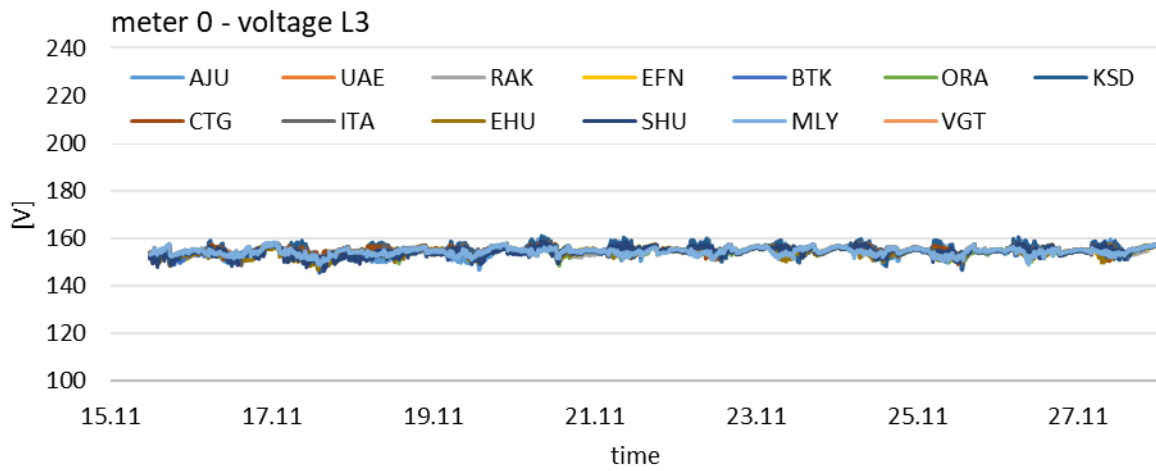


Figure 84: SDME18 voltage level on phase 3 measured by meter 0, competition period in November 2018

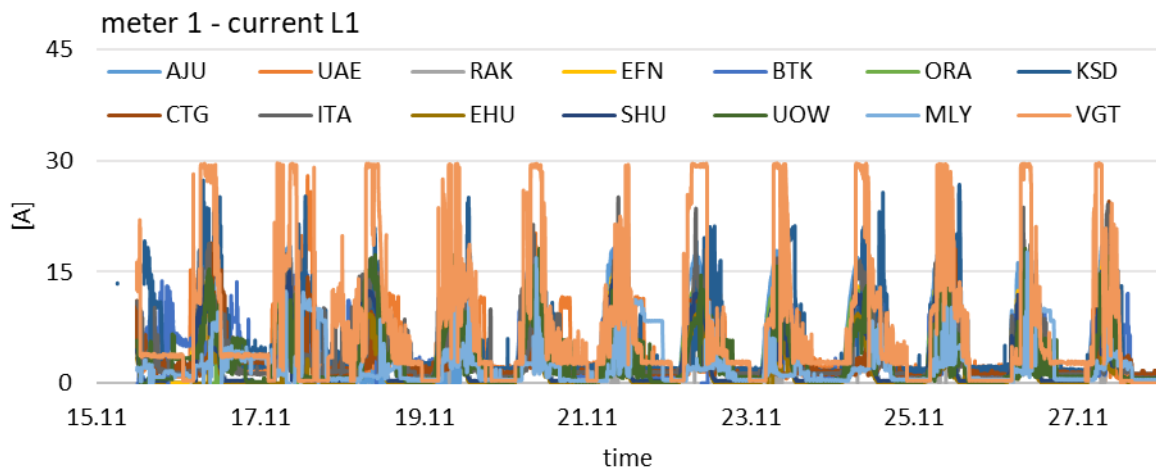


Figure 85: SDME18 current in phase 1 measured by meter 1, competition period in November 2018

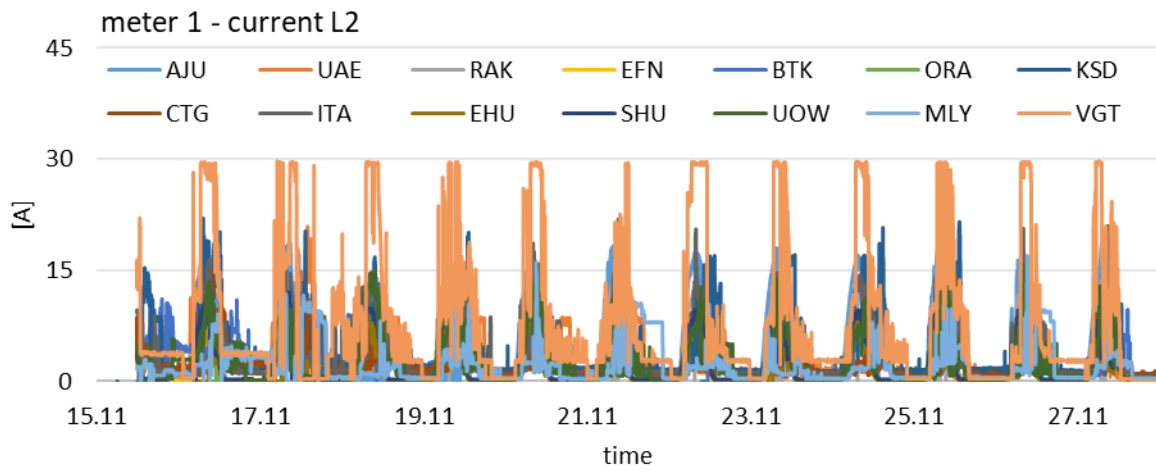


Figure 86: SDME18 current in phase 2 measured by meter 1, competition period in November 2018

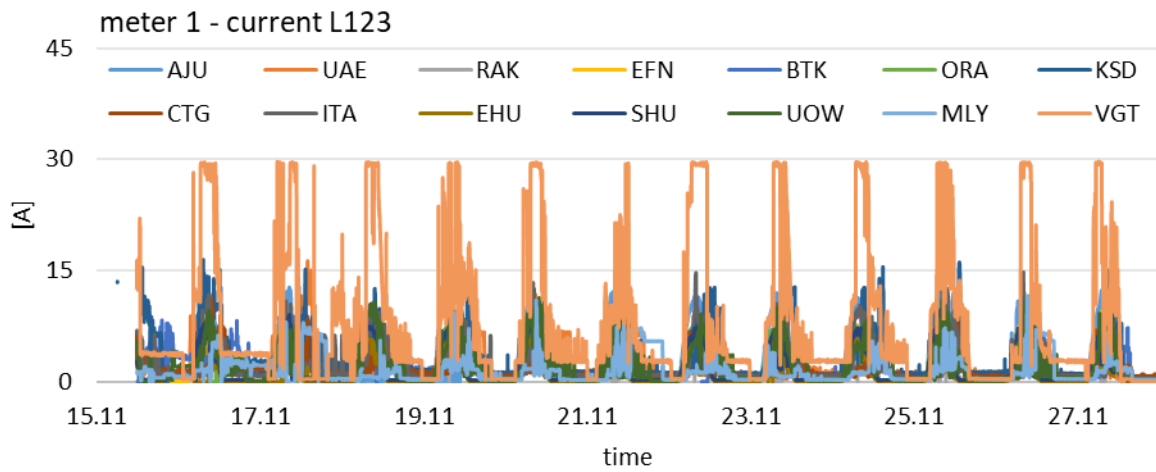


Figure 87: SDME18 aggregated current in all phases measured by meter 1, competition period in November 2018

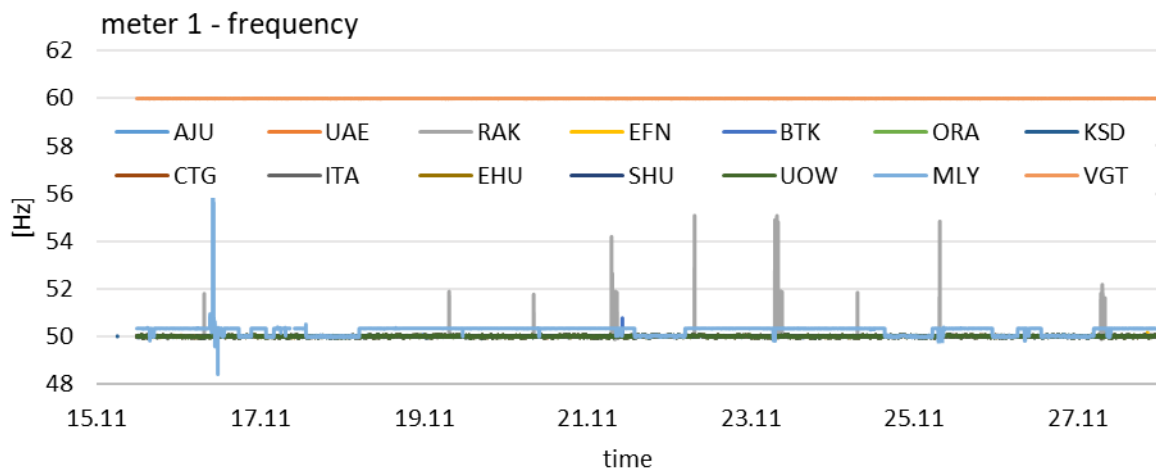


Figure 88: SDME18 frequency measured by meter 1, competition period in November 2018

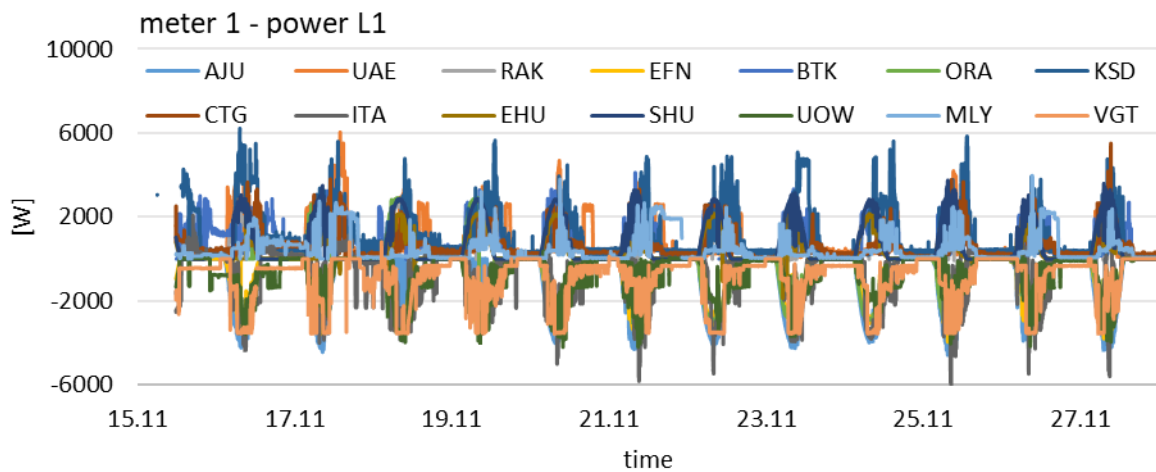


Figure 89: SDME18 power in phase 1 measured by meter 1, competition period in November 2018

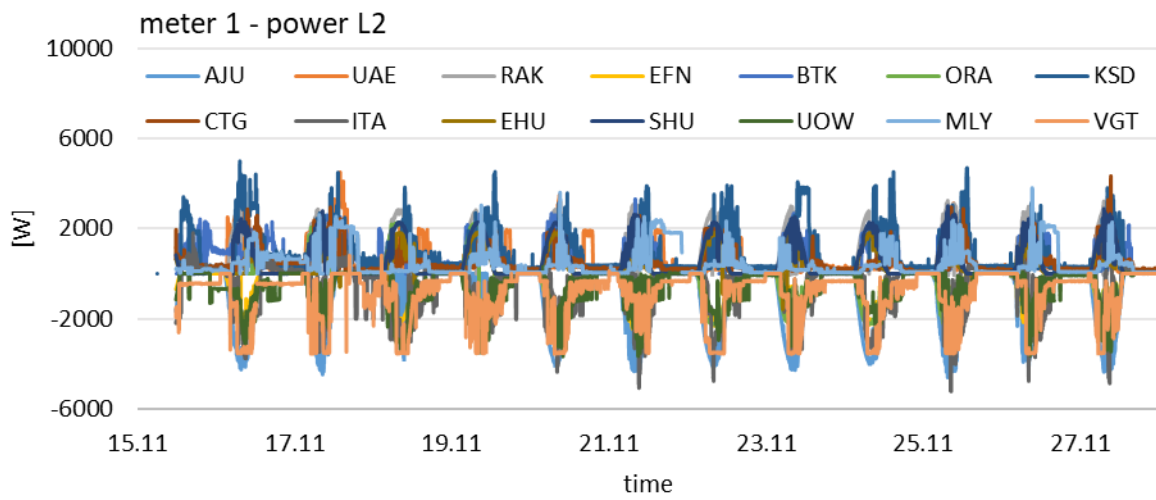


Figure 90: SDME18 power in phase 2 measured by meter 1, competition period in November 2018

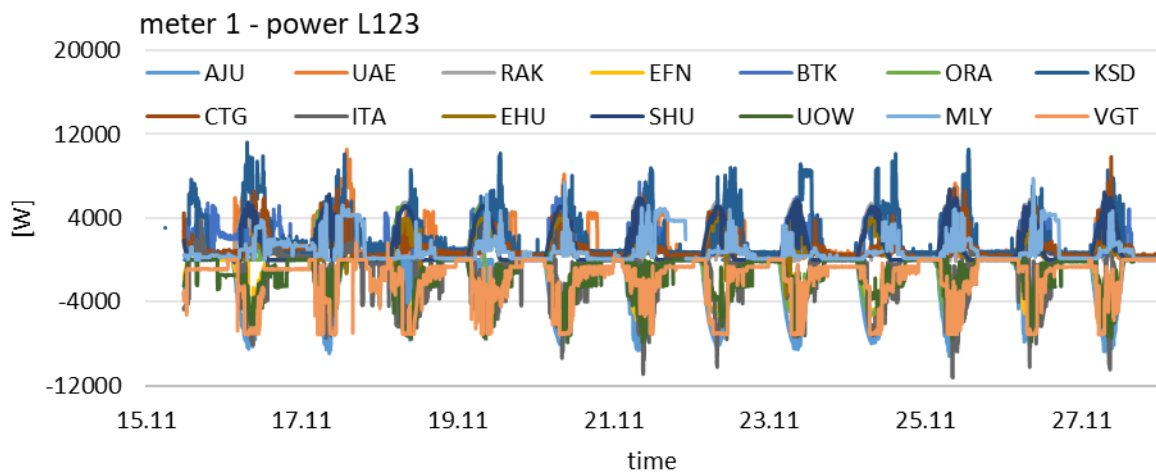


Figure 91: SDME18 aggregated power on all phases measured by meter 1, competition period in November 2018

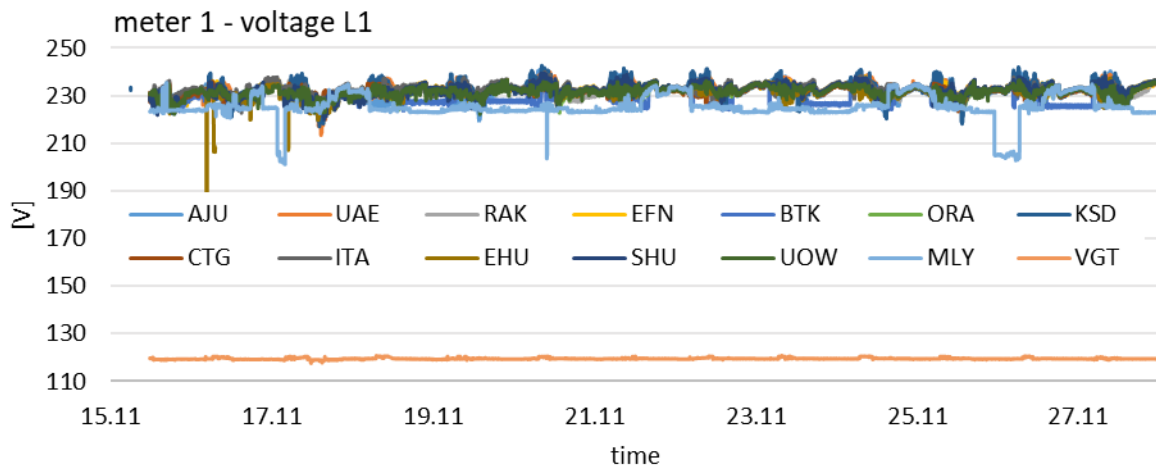


Figure 92: SDME18 voltage level on phase 1 measured by meter 1, competition period in November 2018

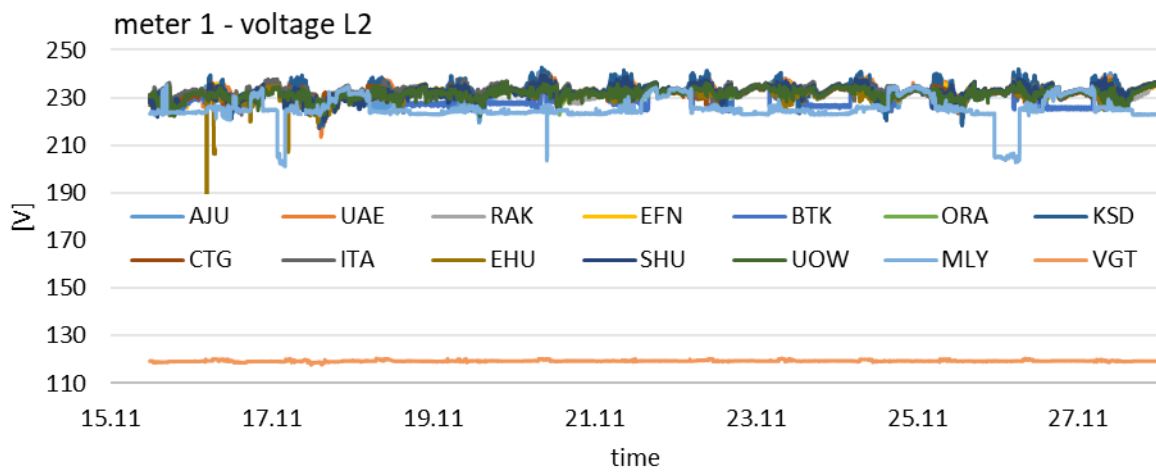


Figure 93: SDME18 voltage level on phase 2 measured by meter 1, competition period in November 2018

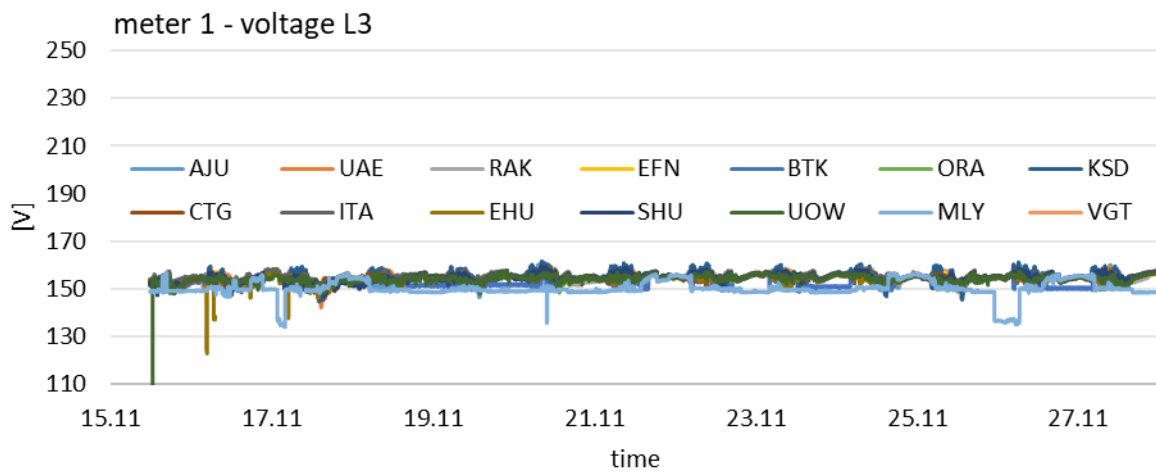


Figure 94: SDME18 voltage level on phase 3 measured by meter 1, competition period in November 2018

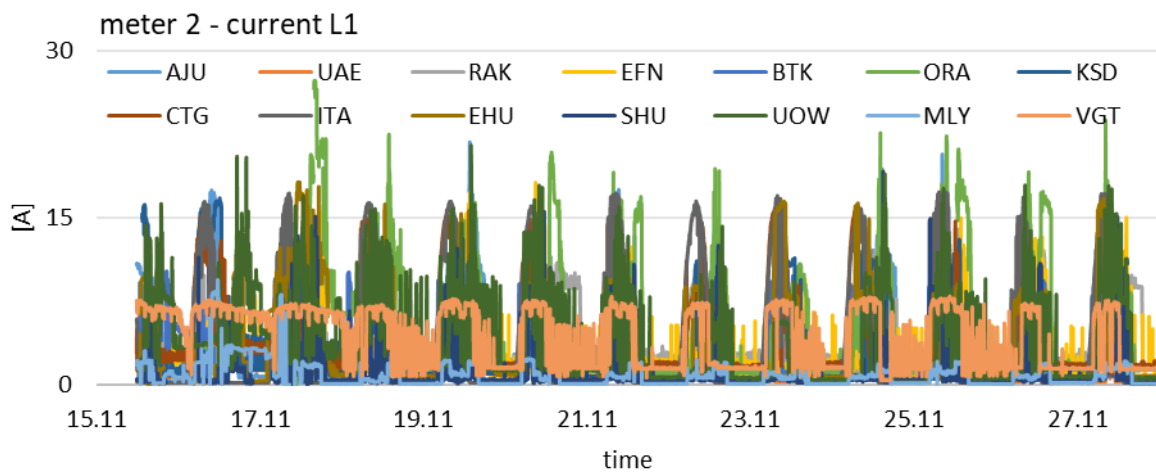


Figure 95: SDME18 current in phase 1 measured by meter 2, competition period in November 2018

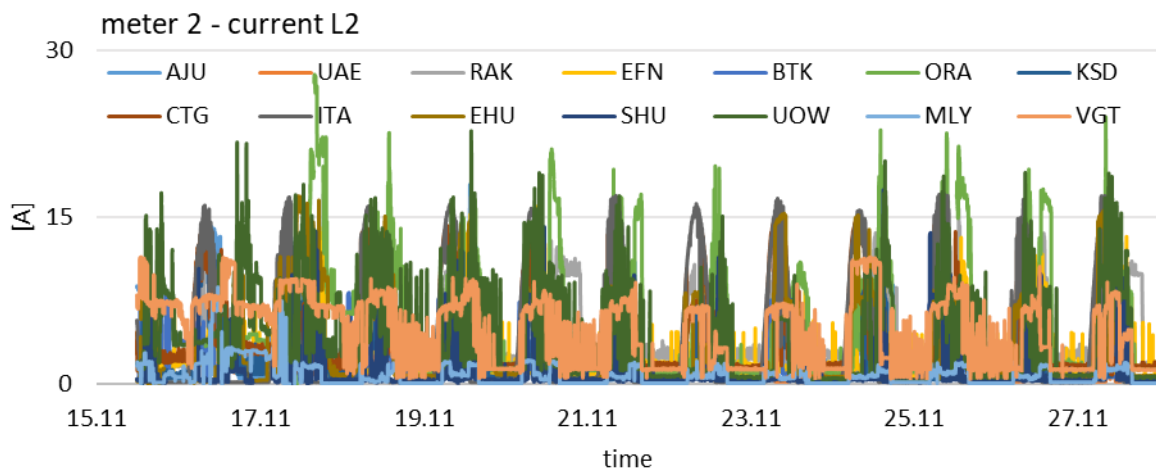


Figure 96: SDME18 current in phase 2 measured by meter 2, competition period in November 2018

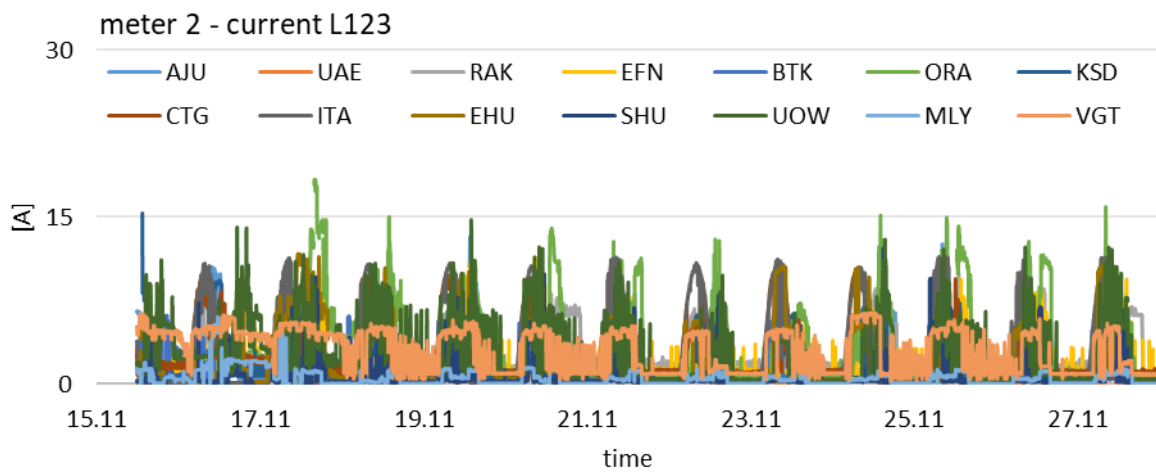


Figure 97: SDME18 aggregated current in all phases measured by meter 2, competition period in November 2018

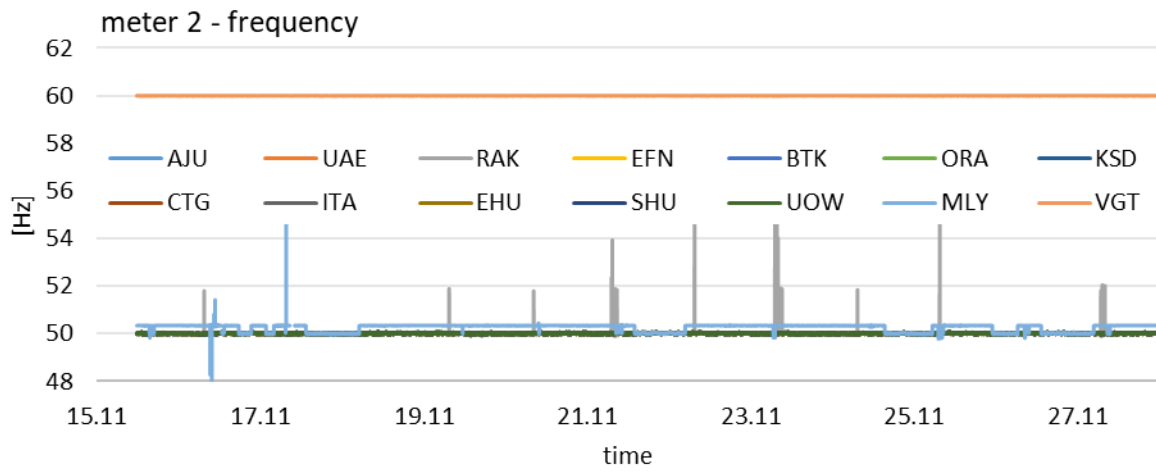


Figure 98: SDME18 frequency measured by meter 2, competition period in November 2018

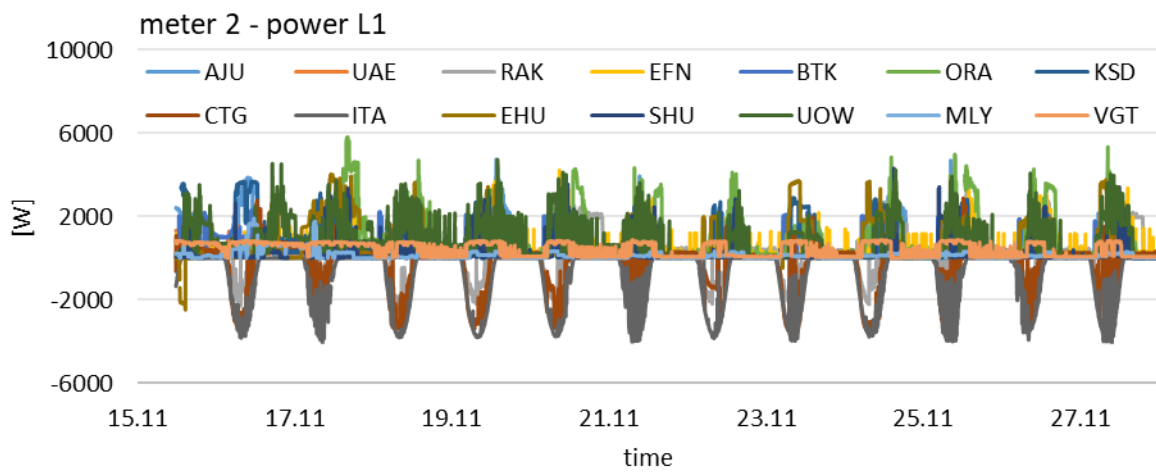


Figure 99: SDME18 power in phase 1 measured by meter 2, competition period in November 2018

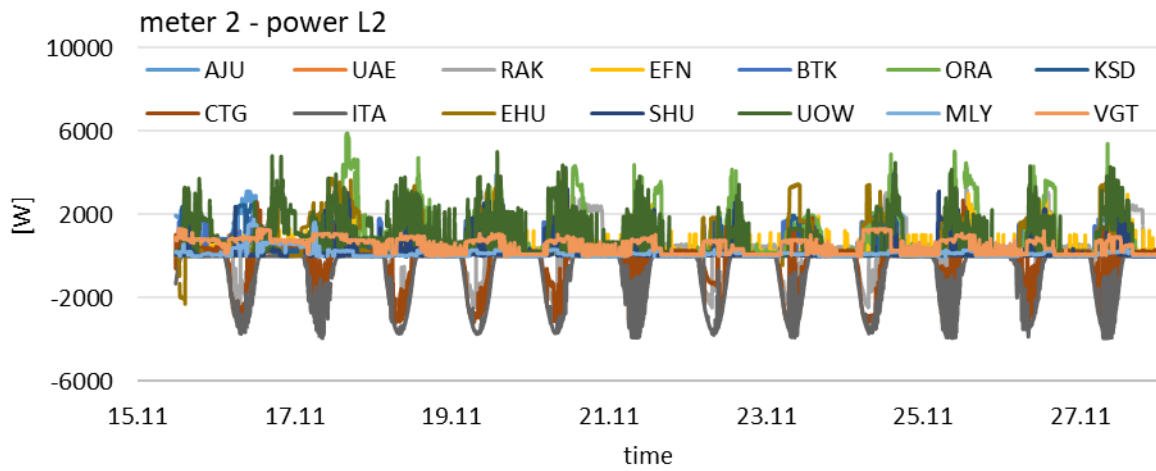


Figure 100: SDME18 power in phase 2 measured by meter 2, competition period in November 2018

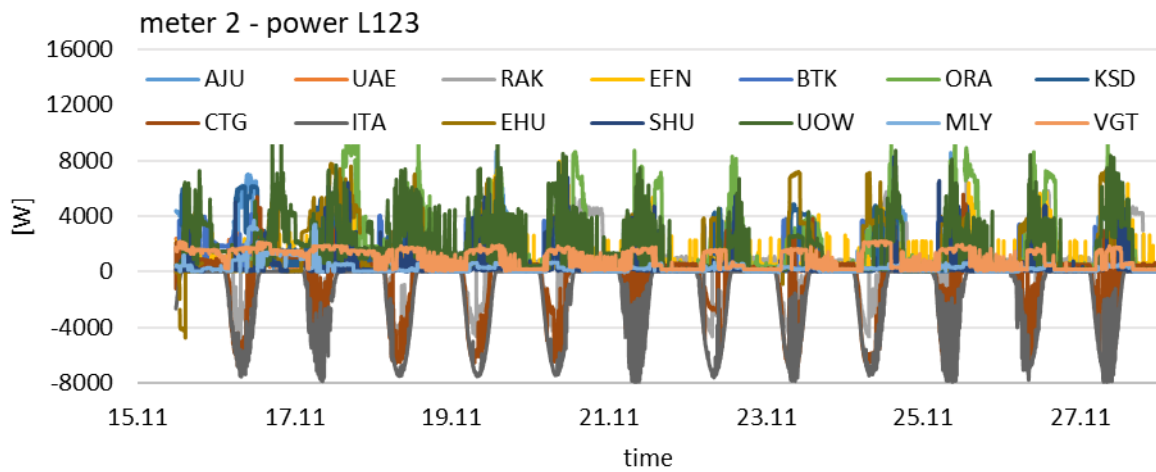


Figure 101: SDME18 aggregated power on all phases measured by meter 2, competition period in November 2018

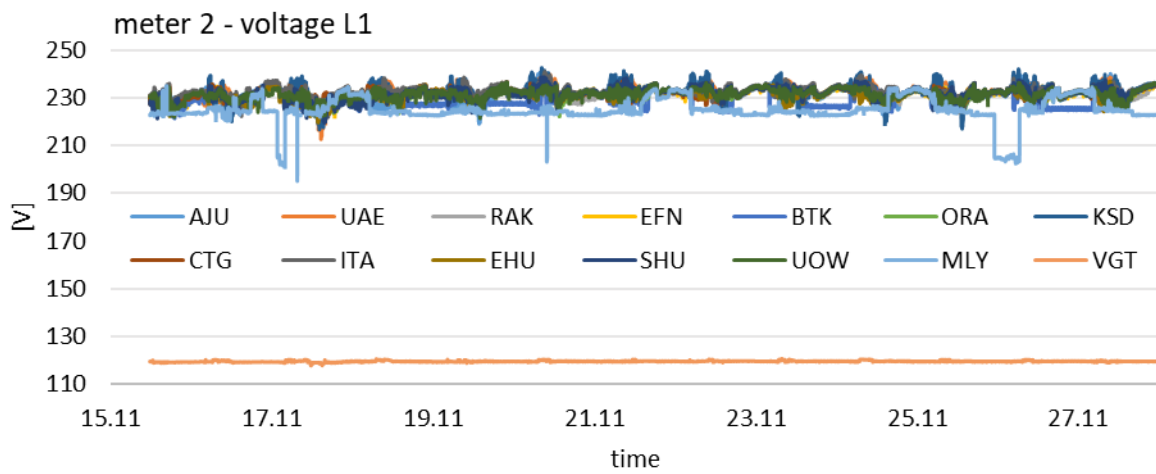


Figure 102: SDME18 voltage level on phase 1 measured by meter 2, competition period in November 2018

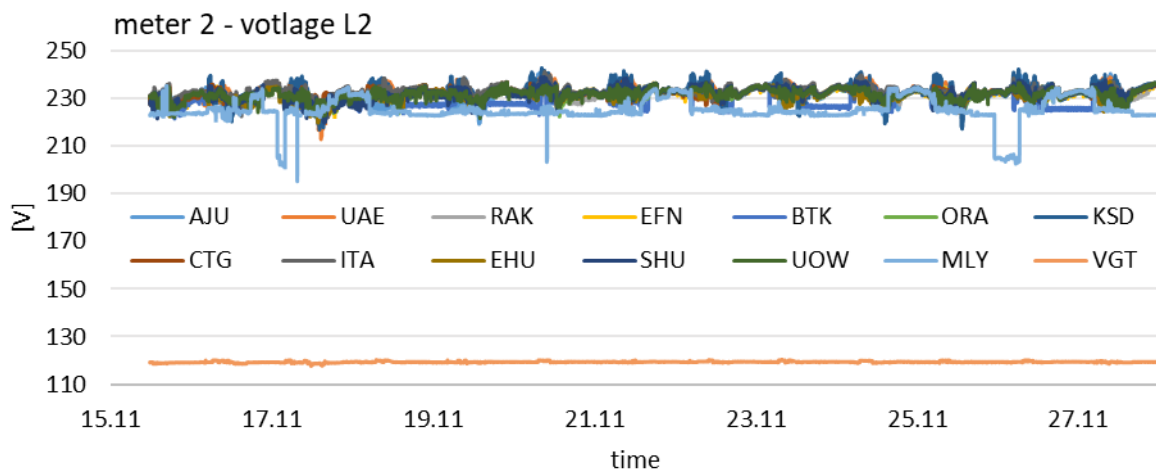


Figure 103: SDME18 voltage level on phase 2 measured by meter 2, competition period in November 2018

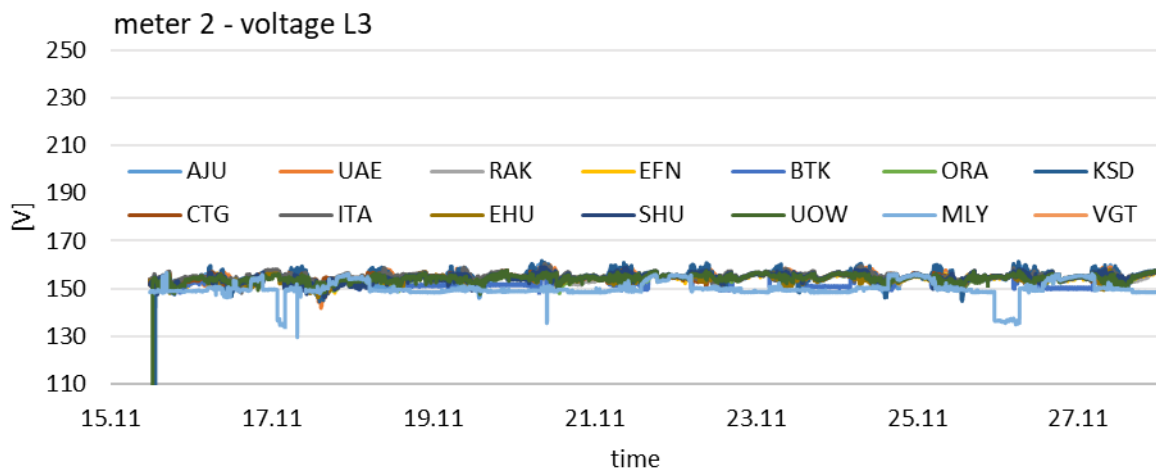


Figure 104: SDME18 voltage level on phase 3 measured by meter 3, competition period in November 2018

5. References

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