

Deliverable no.: D.2.3
SAT test report. Validation of automated meter readings and data collection system, according to specification from T2.1.

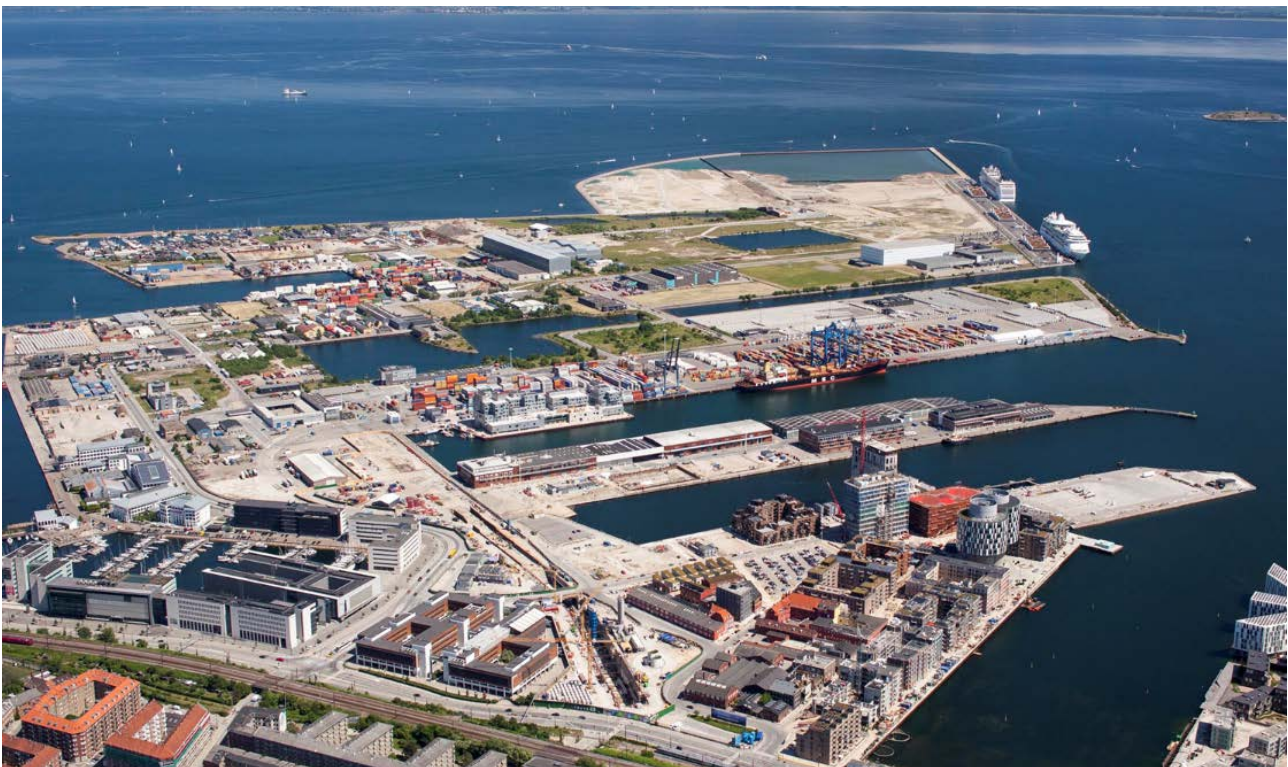


Photo: By & Havn / Ole Malling

Balslev
Author, Boris Lund Havmøller
Date, June, 12, 2019

Public deliverable

Confidential deliverable

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.

Project Information

Deliverable no.: D2.3

Deliverable title: SAT test report. Automated meter readings are validated, according to specification from T2.1 and reach the data collection system as specified in T2.1.

WP title: Data and measurements

Task Leader: Ole Michael Pedersen

WP Leader: Benny S. Hansen

Comment Period: 17, 07, 2019 to 12, 08, 2019 (udfyldes)

For further information on this specific deliverable, please contact:

Ole Michael Pedersen, olemp@radiuselnet.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

Table of Contents

1. TEST OF DATA FROM RADIUS SERVER TO DTU DMS FOR DATA FROM NORDHAVN	7
2. DATA IN THE RADIUS DOMAIN	8
3. DATA IN THE ENERGYLAB NORDHAVN DOMAIN	8
4. DATA HANDLING OF PERSONAL DATA	8
5. TEST	9
6. CONCLUSION	16

List of Abbreviations

DTU: Danmarks Tekniske Universitet (Technical University of Denmark)

MDM: Measurement Data Management

DMS: Data Management System

SAT: System Acceptance Test

FTP: File Transfer Protocol

CSV: Comma Separated Values

Executive Summary

Radius is a partner in the EnergyLab Nordhavn project (ELN) and provides measurements/data from the relevant areas and customers in the electricity distribution grid in Nordhavn. Measurements/data are collected from the energy meters from customers via Radius' remote metering system, and transferred to Radius' data management system called MDM. The measurements/data are made available for the Data Management System (DMS) at DTU via a secure file transfer protocol (sFTP-).

This document describes the System Acceptance Test (SAT) of the automated measurements/data delivery from Radius' MDM, to DTU's DMS in ELN. The SAT report documents validation and approval of the automated meter readings, according to the requirements of ELN specified in T2.1.

Version Control

Version	Date	Author	Description of Changes
v1	2019-06-12	Boris Lund Havmøller	First release
V2	2019-07-17	Benny Stougaard Hansen	Implement reviewer comments to the final doc.

Quality Assurance

Author	Reviewer	Approver
Boris Lund Havmøller	Chresten Træholt	WPL group

Status of deliverable		
Action	By	Date/Initials
Sent for review	Palle Holdt	18.06.2019
Reviewed	Chresten Træholt	1.07.2019
Verified	Benny Stougaard Hansen	17-07-2019/BSTH
Approved	WPL group	12-08-2019

1. Introduction

This report includes a validation of the data from the power metering system used by Radius. To validate the data ELN has installed separate power meters on a selection of apartments. The data delivered from the power meters installed by ELN have a significantly higher time resolution (minute resolution/KNX) compared to data from Radius' (hourly resolution/Kamstrup). This document also describes the data flow from Radius' power meters to DTU's DMS and compares it to requirements from T2.1.

2. Test of data from Radius server to DTU's DMS for data from Nordhavn

This document describes the data flow from the electric power meters in Nordhavn obtained from the remote metering system into Radius' data management system, MDM (Figure 1). The data from MDM is sent simultaneously to Datahub (EnergiNet) and Radius' cloud database. The data from the metering in the MDM are subject to changes and validations. Therefore the data in the Datahub and the Radius cloud database is updated continuously for up till 14 days. After 14 days the data will be extracted to a Radius' server. Every morning the extracted data on Radius server is saved as a csv-file and transferred to an sFTP server at DTU. From this server DTU accesses data (by username and password) to their DMS (Data management system).

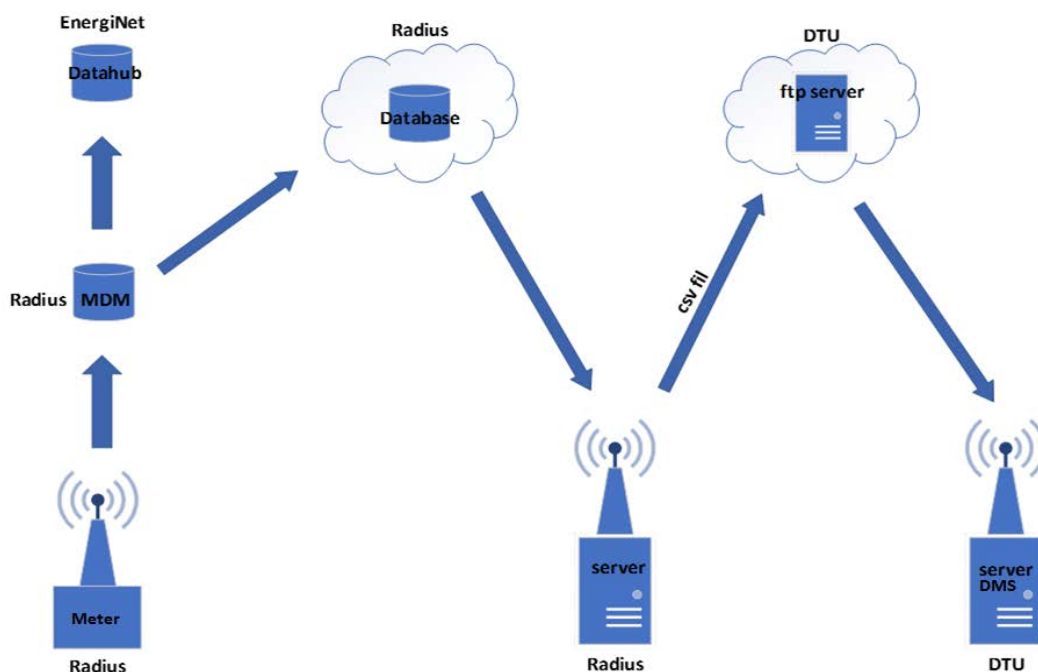


Figure 1: Data flow from remote meters to the DTU server

The data flow does however not fulfill all requirements of EnergyLab Nordhavn as the data is not available after approximately 3 days, but instead 14 days.

Datasets are defined according to the specifications defined in the documents “Energydata.dk – data model” and “Data-structure for data in EnergyLab Nordhavn” to be found on www.energylabnordhavn.dk.

3. Data in the Radius domain (*Kamstrup meters*)

Data from Radius is available in Radius Data management system called MDM. Meterdata for energy consumption is automatically sent to the MDM and is updated 4 times every day with hour-data. From the MDM the data is sent to Energinet’s DataHub. DataHub handles energy data for customers, consumption, prices and is in charge of uniform communication between professional participants in the electricity market. The data in the MDM is subject to changes and validations. Therefore the data in the DataHub can be updated several times. The data used for this report is from 11th to 21st January 2019. The Radius energy meters are read every hour, data is pulled from the meters and the following data is available:

Data element	Explanation
Date and time	Date and time for reading (UTC time)
Point Of Delivery (POD)	The id number for installation
Energy	kWh

Table 1 Radius energy meter reading data

4. Data in the EnergyLab Nordhavn domain (*KNX*)

The data used for this report is from 11th to 21st January 2019. The energy meters are read every minute and the following data is available:

Data element	Explanation
Date and time	Time for reading (UTC time)
Reg. nr.	The reg. nr. of the apartment
Energy	kWh

Table 2 EnergyLab Nordhavn KNX energy meter reading data, Reg nr. and POD are not published in this report as they are confidential.

5. Handling of personal data

The data from the power meters are considered **personal** and is therefore subject to special legislation (GDPR) to protect the privacy of the person that the data relates to. All personal data collected directly by ELN has been collected after obtaining the explicit

consent of the data from the power meters, even though this is not a requirement for data collected under research exemption. This is, however, an ethical choice and a way to ensure trust in the community. For further details on data handling within the project, see ELN delivery 2.1c.

6. TEST

The test consists of the following: In 21 apartments at Sundkajen at Nordhavn additional KNX energy meters are installed by EnergyLab Nordhavn. From these apartments 21 energy meters DTU extracts data from the individual household's power consumption. In the same apartments Radius has installed the new standard of Radius power meters from Kamstrup. The hourly values from Radius' MDM are compared to the hourly values of DTU's DMS.

It is chosen that the test case will cover a period of two weekends and 5 weekdays from 11th to 21st of January 2019.

Apartments in EnergyLab Nordhavn that export data to DTU and Radius

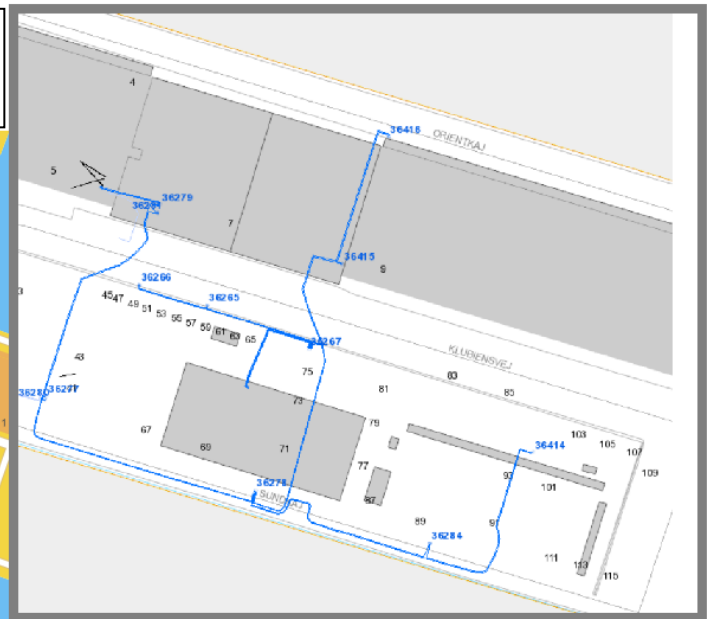


Figure 2 The apartments at Sundkaj.

For the selected 11 days, 5 of the chosen apartments did not have available KNX power meter data stored at DTU datahub. This leaves 16 apartments that can be used for test cases. 5 test cases are chosen to validate and compare the data from the two set of power meters.

The test cases are used to compare the data collected from the KNX power meters of EnergyLab Nordhavn with the Kamstrup power meters of Radius.

It is possible to find the 5 test cases specific addresses in a confidential appendix. Limited access to this document can be provided through contact to Radius or DTU.

DTU has the 1st of May 2019 provided data from the DMS in comma-separated values (CSV) files from the 16 meters on the specific dates.

It must be noted, that “time stamp” in the data export from DMS (energydata.dk) is in Universal Time Coordinated (UTC), equal to Greenwich Mean Time (GMT) and Zulu time (Z).

The “time stamp” in the data export from MDM (Radius) is local Danish time, Central European Time (CET) / Central European Summer Time (CEST), i.e. with daylight offset. This means that during the summer period, the time in MDM is 2 hours ahead and in the winter period 1 hour ahead of DMS/energydata.dk time stamp.

For the test cases (1 hour offset), the time stamps are synchronized to ease the validation.

During the analysis of the datasets from the 16 apartments, it became clear that for several of the apartments from the same stairwell and the same floor, the DMS’s data from the power meters seemed to be switched around. Whether or not this switching of data originates from a mistake in the installation at the apartments is unclear. The KNX data for the test cases have been switched back to allow validation of the meter readings.

It is observed that the data from the DMS in general follows the same trend as data from MDM but with a small deviation margin within around 10% or less, – except very few data fall outs (outliers).

TEST CASE 1:

Test case 1, 13th January 2019:

Time stamp	Energy [kWh]	Energy [kWh]
	Radius	EnergyLab Nordhavn (DMS)
2019-01-13 00:00:00.000	0,53	0,54
2019-01-13 01:00:00.000	0,17	0,16
2019-01-13 02:00:00.000	0,11	0,11
2019-01-13 03:00:00.000	0,12	0,12
2019-01-13 04:00:00.000	0,17	0,17
2019-01-13 05:00:00.000	0,11	0,11
2019-01-13 06:00:00.000	0,17	0,17
2019-01-13 07:00:00.000	0,19	0,19
2019-01-13 08:00:00.000	0,56	0,56
2019-01-13 09:00:00.000	1,91	1,92
2019-01-13 10:00:00.000	0,52	0,51
2019-01-13 11:00:00.000	0,26	0,26
2019-01-13 12:00:00.000	0,24	0,24
2019-01-13 13:00:00.000	1,27	1,27
2019-01-13 14:00:00.000	0,7	0,7
2019-01-13 15:00:00.000	0,68	0,68
2019-01-13 16:00:00.000	0,34	0,34
2019-01-13 17:00:00.000	0,33	0,34
2019-01-13 18:00:00.000	1,12	1,14
2019-01-13 19:00:00.000	2,1	2,09
2019-01-13 20:00:00.000	1,08	1,05

2019-01-13 21:00:00.000	0,23	0,23
2019-01-13 22:00:00.000	0,26	0,27
2019-01-13 23:00:00.000	0,2	0,2
2019-01-14 00:00:00.000	0,18	0,17

Table 3: Test case 1, 13th January 2019. Significant deviations of data from DMS to MDM are highlighted.

The data had to be switched back as the KNX power meters on this floor had been mixed. It is observed that the data from the DMS in general follows the same trend as data from MDM but with a small deviation margin, see Table 3.

TEST CASE 2:

Test case 2, 12th January 2019:

Time stamp	Energy [kWh]	Energy [kWh]
	Radius	EnergyLab Nordhavn (DMS)
2019-01-12 00:00:00.000	0,15	0,15
2019-01-12 01:00:00.000	0,19	0,19
2019-01-12 02:00:00.000	0,13	0,14
2019-01-12 03:00:00.000	0,17	0,18
2019-01-12 04:00:00.000	0,18	0,16
2019-01-12 05:00:00.000	0,16	0,16
2019-01-12 06:00:00.000	0,14	0,14
2019-01-12 07:00:00.000	0,08	0,09
2019-01-12 08:00:00.000	0,86	0,85
2019-01-12 09:00:00.000	0,36	0,37
2019-01-12 10:00:00.000	0,3	0,29
2019-01-12 11:00:00.000	1,25	1,26
2019-01-12 12:00:00.000	0,64	0,62
2019-01-12 13:00:00.000	0,27	0,27
2019-01-12 14:00:00.000	1,29	1,29
2019-01-12 15:00:00.000	1,85	1,83
2019-01-12 16:00:00.000	0,52	0,52
2019-01-12 17:00:00.000	0,28	0,29
2019-01-12 18:00:00.000	1,12	1,15
2019-01-12 19:00:00.000	0,52	0,48
2019-01-12 20:00:00.000	0,65	0,67
2019-01-12 21:00:00.000	0,63	0,63
2019-01-12 22:00:00.000	0,48	0,45
2019-01-12 23:00:00.000	0,17	0,17
2019-01-13 00:00:00.000	0,19	0,19

Table 4: Test case 2, 12th January 2019. Significant deviations of data from DMS to MDM are highlighted.

The data had to be switched back as the KNX power meters on this floor had been mixed. It is observed that the data from the DMS in general follows the same trend as data from MDM but with a small deviation margin, see Table 4.

TEST CASE 3:

Test case 3, 20th January 2019:

Time stamp	Energy [kWh]	Energy [kWh]
	Radius	EnergyLab Nordhavn (DMS)
2019-01-20 00:00:00.000	0,19	0,19
2019-01-20 01:00:00.000	0,23	0,23
2019-01-20 02:00:00.000	0,19	0,18
2019-01-20 03:00:00.000	0,24	0,24
2019-01-20 04:00:00.000	0,2	0,2
2019-01-20 05:00:00.000	0,25	0,25
2019-01-20 06:00:00.000	0,19	0,2
2019-01-20 07:00:00.000	0,24	0,23
2019-01-20 08:00:00.000	0,17	0,17
2019-01-20 09:00:00.000	0,23	0,23
2019-01-20 10:00:00.000	0,17	0,17
2019-01-20 11:00:00.000	0,23	0,23
2019-01-20 12:00:00.000	0,17	0,17
2019-01-20 13:00:00.000	0,22	0,22
2019-01-20 14:00:00.000	0,21	0,21
2019-01-20 15:00:00.000	0,28	0,28
2019-01-20 16:00:00.000	0,19	0,19
2019-01-20 17:00:00.000	0,24	0,24
2019-01-20 18:00:00.000	0,14	0,14
2019-01-20 19:00:00.000	0,07	0,7
2019-01-20 20:00:00.000	0,59	0,58
2019-01-20 21:00:00.000	0,44	0,45
2019-01-20 22:00:00.000	0,4	0,4
2019-01-20 23:00:00.000	0,95	0,94
2019-01-21 00:00:00.000	0,36	0,37

Table 5: Test case 3, 20th January 2019. Significant deviations of data from DMS to MDM are highlighted.

It is observed that the data from the DMS in general follows the same trend as data from MDM but with a small deviation margin, see Table 5.

TEST CASE 4:

Test case 4, 15th January 2019:

Time stamp	Energy [kWh]	Energy [kWh]
	Radius	EnergyLab Nordhavn (DMS)
2019-01-15 00:00:00.000	0,11	0,1
2019-01-15 01:00:00.000	0,07	0,07
2019-01-15 02:00:00.000	0,06	0,06
2019-01-15 03:00:00.000	0,1	0,1
2019-01-15 04:00:00.000	0,08	0,08
2019-01-15 05:00:00.000	0,08	0,08
2019-01-15 06:00:00.000	0,11	0,11
2019-01-15 07:00:00.000	0,07	0,08
2019-01-15 08:00:00.000	0,18	0,18
2019-01-15 09:00:00.000	0,07	0,06
2019-01-15 10:00:00.000	0,16	0,16
2019-01-15 11:00:00.000	0,97	0,97
2019-01-15 12:00:00.000	0,82	0,82
2019-01-15 13:00:00.000	0,08	0,07
2019-01-15 14:00:00.000	0,15	0,15
2019-01-15 15:00:00.000	0,13	0,14
2019-01-15 16:00:00.000	0,11	0,1
2019-01-15 17:00:00.000	0,17	0,17
2019-01-15 18:00:00.000	0,09	0,09
2019-01-15 19:00:00.000	0,19	0,19
2019-01-15 20:00:00.000	0,32	0,33
2019-01-15 21:00:00.000	0,16	0,15
2019-01-15 22:00:00.000	0,11	0,12
2019-01-15 23:00:00.000	0,15	0,15
2019-01-16 00:00:00.000	0,16	0,15

Table 6: Test case 4, 15th January 2019. Significant deviations of data from DMS to MDM are highlighted.

The data had to be switched back as the KNX power meters on this floor had been mixed. It is observed that the data from the DMS in general follows the same trend as data from MDM but with a small deviation margin, see Table 6.

TEST CASE 5:

Test case 5, 18th January 2019:

Time stamp	Energy [kWh]	Energy [kWh]
	Radius	EnergyLab Nordhavn (DMS)
2019-01-18 00:00:00.000	0,34	0,34
2019-01-18 01:00:00.000	0,26	0,27
2019-01-18 02:00:00.000	0,15	0,14
2019-01-18 03:00:00.000	0,13	0,13
2019-01-18 04:00:00.000	0,16	0,16
2019-01-18 05:00:00.000	0,16	0,16
2019-01-18 06:00:00.000	0,13	0,13
2019-01-18 07:00:00.000	0,16	0,16
2019-01-18 08:00:00.000	0,13	0,13
2019-01-18 09:00:00.000	0,16	0,16
2019-01-18 10:00:00.000	0,18	0,18
2019-01-18 11:00:00.000	0,19	0,19
2019-01-18 12:00:00.000	0,17	0,17
2019-01-18 13:00:00.000	0,98	0,98
2019-01-18 14:00:00.000	0,32	0,32
2019-01-18 15:00:00.000	0,2	0,2
2019-01-18 16:00:00.000	0,19	0,19
2019-01-18 17:00:00.000	0,22	0,22
2019-01-18 18:00:00.000	0,24	0,24
2019-01-18 19:00:00.000	0,27	0,27
2019-01-18 20:00:00.000	0,25	0,25
2019-01-18 21:00:00.000	1,02	1,02
2019-01-18 22:00:00.000	0,25	0,24
2019-01-18 23:00:00.000	0,22	0,23
2019-01-19 00:00:00.000	0,29	0,29

Table 7: Test case 5, 18th January 2019. Significant deviations of data from DMS to MDM are highlighted.

It is observed that the data from the DMS in general follows the same trend as data from MDM but with a small deviation margin, see Table 7.

7. Conclusion

For the SAT approximately 33 % of the KNX energy meters in ELN have been selected and tested with a wide range of measurement points.

The data from Radius' MDM are proven to follow the same trend as data from DTU's DMS. Most values from the MDM are with very little deviation from the DMS. The values of the data from Radius' power meters are validated.

The structure in the data transfer from Radius's MDM to DTU's DMS fulfills the requirements of EnergyLab Nordhavn. The latency of the data flow from Radius to the DMS could be improved.

Radius data should be the reference data in the sense that these has been approved for billing by EnergiNet